Mubashir Hussain Masoodi
Muneeb U Rehman *Editors*

Edible Plants in Health and Diseases

Volume 1 : Cultural, Practical and Economic Value

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Dedicated affectionately to our teachers who played a pivotal role in shaping our careers

Preface

Plants are an exceptional example of natural products, having remarkable medicinal properties due to diverse phyto-constituents, which have a definite action on diverse bioactivities. Regular consumption of edible plants has been negatively correlated with the risk of development of diseases and improvement of health. The aim of the book was to document the role of edible plants in human health and to identify some wild medicinal plants frequently used for the edible purpose. We have compiled information about edible plant material with potential anti-inflammatory, antioxidant, antimicrobial, and antiviral activities and other properties of biological interest. We also attempted to analyze the distribution of edible plants from different geographical regions. Accumulation of resource of phytochemical compounds from different edible plant species is also done. The potential of edible plants was further explored for their possible economic opportunities which could help local communities achieve socioeconomic sustainability.

The book implements a conceptual approach towards edible medicinal plants, focusing on using these plants in people's daily diet and the overall health benefits. The book also addresses and explores the cultural, practical, and socioeconomic impact of edible plants in different geographical regions.

Srinagar, Jammu and Kashmir, India — Mubashir Hussain Masoodi
Riyadh, Saudi Arabia — Muneeb U Rehman

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About the Editors

Mubashir Hussain Masoodi is presently working as Professor & Head Department of Pharmaceutical Sciences at the University of Kashmir, J&K, India. He holds a PhD in pharmaceutical chemistry from the School of Pharmaceutical Education & Research (SPER), Jamia Hamdard, New Delhi, India, and postdoctoral fellowship from National Center for Natural Products (NCNPR), University of Mississippi, USA. Prof. Masoodi has more than 20 years of teaching and 10 years of research experience in the field of Natural Product Research. He is the recipient of several national and international fellowships and awards such as Indo-US UGC Raman Postdoctoral Fellowship, Young Scientist Award-2010 by J&K State Council for Science & Technology, and best publication award by Indian Drug Manufacturer's Association (IDMA), Mumbai. He has published more than 80 research papers in peer-reviewed, international journals and has ten book chapters to his credit. He is on the editorial and review boards of many reputed high-impact, international scientific journals. Currently, Prof. Masoodi is engaged in quantification and semi-synthetic modification of pharmacologically active compounds, as well as their screening to check their biological activities for drug discovery.

Muneeb U Rehman is a faculty member at the College of Pharmacy, King Saud University, Riyadh, Saudi Arabia. He holds a doctorate in toxicology (specialization in cancer biology and natural product research) from Jamia Hamdard, New Delhi, India. Dr. Rehman has more than 10 years of research and teaching experience in the field of toxicology, biochemistry, cancer biology, natural product research, and pharmacogenomics. He is the recipient of several national and international fellowships and awards. He has published more than 100 research papers in peer-reviewed, international journals and has five edited books and thirty seven book chapters to his name. Dr. Rehman is on the editorial boards and is a reviewer of several high-impact, international scientific journals. Currently, Dr. Rehman is engaged in studying the molecular mechanisms of cancer prevention by natural products and the role of pharmacogenomics and toxicogenomics in evaluating the effectiveness and safety of drugs.

1 The Folkloric Uses and Economic Importance of Some Selected Edible Medicinal Plants Native to Oman: A Brief Overview

U. M. Dhanalekshmi, Tanveer Alam, and Shah Alam Khan

Abstract

The Sultanate of Oman, also known as land of frankincense, is one of the fastest growing economies in the Gulf countries. This country of the Arabian Peninsula is worldwide known for its heritage and culture. Nature has bestowed Sultanate of Oman with abundant natural resources. About 1200 vascular plants species are found across Oman. Some of these species are of significant cultural, medicinal and economic value. Once upon a time, Omani frankincense was used as a trading currency and was considered as precious as gold. Various parts of several wild species are edible and consumed by the locals as a source of nourishment as well as fodder for the domestic animals. Hundreds of plants are still popularly used as folkloric medicines.

This chapter aims to provide an insight on the folkloric uses and economic benefits of some selected edible plants native to the Sultanate of Oman. Information on nutritional value, folkloric uses, biological activities, phytochemistry, and economic importance of the selected Omani edible plants have been presented in brief.

Keywords

Edible plants · Folklore · Oman · Traditional uses · Phytochemistry

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Abbreviations

Cal	Calories
CNS	Central nervous system
ER	Estrogen receptor
FAO	Food and Agriculture Organization
HDAC	Histone deacetylase
HSV	Herpes simplex virus
IUCN	The International Union for Conservation of Nature
MAF	Ministry of Agriculture and Fisheries
MCF-7	Michigan Cancer Foundation-7
PGE_1	Prostaglandin E_1
UAE	United Arab Emirates
UNESCO	United Nations Educational, Scientific and Cultural Organization
WHO	World Health Organization

1.1 Introduction

Nature has bestowed Sultanate of Oman with more than 1200 vascular plants species. The published data revealed that 51% of the total flora is found in Northern Oman, 18% in Central Oman, and 58% of total flora in Southern Oman (Patzelt et al. 2014). Majority of these plants belong to angiosperms and several out of these species are of significant medicinal and economic value (Miller and Morris 1988).

Since ancient times, the different parts of many edible and native plants have been used by the local people in their daily life for various purposes such as folkloric medicine, source of nourishment, fodder for domestic animals, timber, fuel, for making furniture and other wooden items. These plants have also been a source of livelihood for a number of local people (Ghazanfar 1998). A lot of medicinal plants have been used in traditional medicine practice for centuries in the various forms such as infusion, decoction, paste or as powder to combat acute and chronic ailments equally, however, the hidden potential of rich flora of Oman is yet to be unlocked fully. In this context, the wild and edible plants in general are of significant economic importance and can certainly help in boosting the economy of the country. The scientific, systematic, efficient, and sustainable exploration of natural resources may lead to identification or discovery of bioactive molecules. Also, the medicinal plant products could be developed as nutraceuticals, cosmetics, functional foods, herbal supplements, and as phyto-pharmaceuticals for phytotherapy.

Ethnobotany and folkloric uses of medicinal plants of Northern, Central, and Southern Oman have been extensively covered and are considered as gold standard for reference (Ghazanfar 1994, 1996, 1998; Ghazanfar and Al-Sabahi 1993; Miller and Morris 1988). The present chapter highlights the folkloric uses and economic importance of some selected medicinal plants of Oman (Fig. 1.1). We have tried our

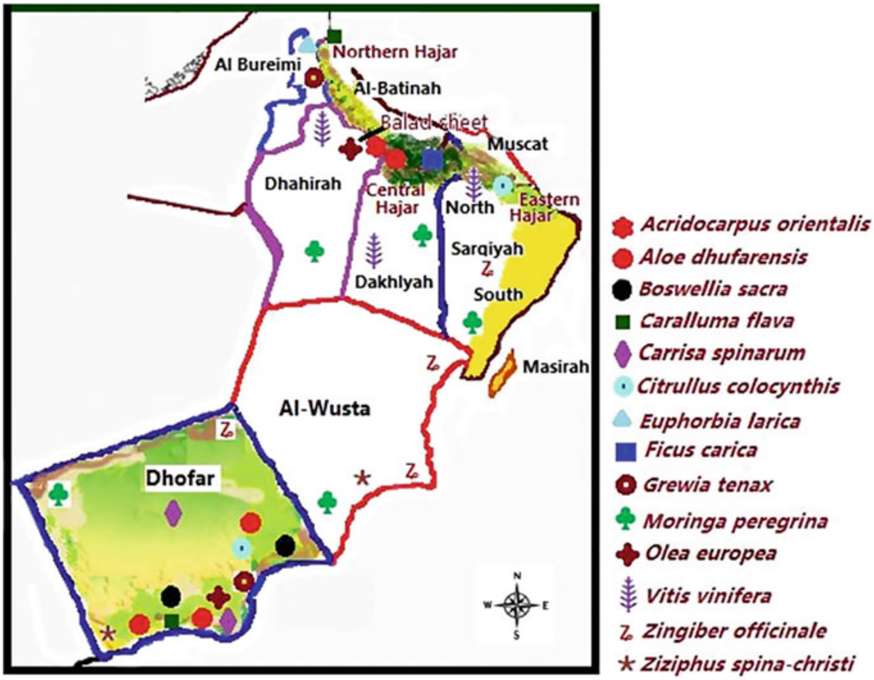

Fig. 1.1 Selected medicinal plants found copiously in various locations of Sultanate of Oman

best to present the information on nutritional status, folkloric uses, biological activities, phytochemistry, and economic importance of the selected Omani medicinal plants.

1.2 Economic Importance of Omani Medicinal plants

Plants have been used by the mankind since ancient time as a source of nutritional food, traditional medicine, spices, essential oils, resins, gums, fibers, and hard woods, etc. Plants play a vital role in boosting the economy of a country through agriculture and trade. The past few decades have witnessed an exponential growth in the global trade of medicinal and aromatic plants. The plant based natural products have been widely utilized by pharmaceutical, food, and cosmetic industries. The herbal drugs and herbal based cosmetics, personal care products, dyes etc., are gaining popularity among the new generation.

Sultanate of Oman is a home to about 1200 native plant species out of which approximately 448 are medicinal plants. Several of these edible plants and plant derived products have been used for the commercial trade to fuel the emerging economy. Plant fruits are consumed by the locals as a part of their diet. Dates, frankincense, pomegranate, grapes, figs, olives, etc. are some of the valuable cash crops of Oman. The Omani frankincense oil is in high demand in the international market and amounts to ~30–40 tones. Oman generated revenue of approximately $23 million in 2018 from the export of dried or fresh products such as dates, figs, pineapples, avocados, guavas, mangoes, and mangosteens. Oman was ranked 67th largest exporter of the grapes in 2018 for exporting grapes worth of $1.09 million. A number of small and medium enterprises of Oman have started manufacturing herbal based cosmetics products and the demand for these products is increasing among the public.

Most of the plants reviewed in this chapter have economic value and the details of their trade, export commodities are explained for contemplation. Although, a brief account of only 14 edible plants is covered in this chapter yet it represents the diversity in the Sultanate of Oman which is prodigious. Diversification into higher value crops can be a promising option for small and average size farms particularly to improve the economy of the country. Given below is an account of 14 economically important edible plants native to Oman.

1.2.1 *Acridocarpus orientalis* A. Juss.

Acridocarpus orientalis (*A. orientalis*) is a photoautotrophic shrub. It is commonly known as *Qafas* in Arabic language. It belongs to the family Malpighiaceae of flowering plants and has a synonym *Anomalopteris orientalis* (Ghazanfar and Al-Sabahi 1993). This plant is native to Arabia and commonly found in the Central and Northern parts of Oman, especially in the area surrounding Jabal Al-Shams (Fig. 1.2) (Ksiksi and Hamza 2012). It grows in the wadis and in rocky pockets at an altitude of 300–1500 m (Pickering and Patzelt 2008). It grows in Dhofar region and from there extends to Yemen and in the mountains in the Northern part of the country (Ghazanfar 1991).

A. orientalis is widely consumed to treat headache by the residents of the Jabal Al-Akhdar (the green mountain) area and also in the plains of other Western Gulf countries. A paste prepared from the powdered seeds of this plant was also applied

Fig. 1.2 *Acridocarpus orientalis* plant growing in Izki, Ad Dakhiliyah Governorate. (Original pictures taken by Mr. Mohammed Abdullah Salim Al-Broumi)

topically to ameliorate headache. A yellow dye extracted from the seeds of this plant is used for commercial purpose in Oman (Hussain et al. 2014a). The mixture of crushed leaves in oil has been used to relieve swellings, muscle pains, and to treat arthritis (Pickering and Patzelt 2008). Leaves chopped in oil are used as anti-convulsant (Cronquist 1981). It is a popular folkloric medicine owing to its diverse biological properties such as hepatoprotective, analgesic, anti-plasmodial, anti-oxidant, anti-trypanosomal, and anti-leishmanial activities (Ksiksi et al. 2017; Ksiksi and Hamza 2012). In traditional medicine, the extracted oil of stems and leaves is administrated as antipyretic, anti-inflammatory, to reduce muscular pain, to treat constipation and in some cases to relieve labor pain (Ghazanfar and Al-Sabahi 1993). The plant has been shown to exhibit anti-histone deacetylase (HDAC) properties making it a potential candidate for the treatment of cancer (Lotfy et al. 2020; Ksiksi and Hamza 2012). The other traditional uses include management of paralysis, tendon and joint pains, urinary complaints as well as treatment of the udder inflammation in cattle (Al Hinai et al. 2020).

1.2.2 *Aloe dhufarensis*

Aloe dhufarensis Lavranos (*A. dhufarensis*) (family: Asphodeloideae or Asphodelaceae) is a conspicuous perennial species endemic to the deserts of Dhofar and Southern Oman. Its common name includes *Subr* in arabic, *Tuf* in Jibbali but it is locally known as *Alsabbar Alzafariu* and *Isqal*. They have tight rosette of broad, grayish, and unarmed succulent leaves. It is highly drought and wind tolerant. *A. dhufarensis* looks beautiful in the rocky slopes and is commonly found in Wadi Adonib, the region where it was first discovered, in Wadi Ayun, Wadi Darbat bed, Jebel Samhan and Jabal Al-Qamar parts of Oman (Ghazanfar 1995, 1998; Carter et al. 2011; Divakar et al. 2016; Miller and Morris 1988). It is still rare in cultivation but an easy plant for dry warm temperate and tropical climates (Patzelt 2014).

Traditionally in Dhofar, an orange-yellow pigment from the dried juice of the leaves is used as a cosmetic dye to color face, necks, bosom, arms, and legs in orange yellow. It is a popular belief that it helps to protect the wearer against cold and other diseases (Miller and Morris 1988). Leaf juice is used to treat a range of ailments including headaches, aching limbs and joints, burn wounds, diabetes, and constipation (Ghazanfar 1995, 1994). It is also used as a skin smoothening agent, for measles and chickenpox rashes treatment, as vermifuge, for the management of unproductive cough, epistaxis, allergy, hay fever, stroke, jaundice, to treat melancholy, dyspnea, to stop excessive perspiration and as an emmenagogue and purgative (Miller and Morris 1988; Ghazanfar 1994, 1998). The latex is painted over sores and wounds of circumcision, to speed up healing and to prevent infection (Marwah et al. 2007).

The juice of the leaves is well-known source of a phytochemical constituent emodin, which acts mainly in the large intestine (Miller and Morris 1988). Other isolated chemical constituents include aloesin, homonataloside B, aloeresin A, homonataloin A and B, anthrones, phenolic pyrones, tannins, anthraquinones,

Fig. 1.3 Dried *A. dhufarensis* juice for sale in the souq of Muttrah, Oman

chromone glycosides, coumaryl glycosides, anthracene glycosides, and other polyphenols (Alvaro 1999). Other species of aloes are reported to contain vitamins A, C, and E, niacin, vitamin B2, B12, choline and folic acid (Singh and Khatkar 2011). However, it is used medicinally by the locals, scientific research reports of this specific species is sporadic and hence phytochemical and pharmacological analyses will at some future date expected to justify local people's faith in its medicinal property. For trade, the juice is collected with a scoop or piece of bark and left to dry (Fig. 1.3). In Dhofar, leather pouch is the most commonly used container to store the product for sale. The successive layers of the juice are collected into the leather pouch and dry out before adding another layer. One leather pouch (approximately 50–80 g) sells for about 5 Omani rials in the markets of Dhofar. Dried juice is being considered more potent than the fresh juice (Miller and Morris 1988).

1.2.3 *Boswellia sacra* Flueck

Boswellia sacra (Flueck) is a tree in the Burseraceae family. It is commonly known as frankincense or olibanum-tree. Frankincense is the precious oleo-gum resin harvested from a number of different trees that belong to the genus *Boswellia*. Frankincense in Arabic is known as *al-libān* or *al-bakhūr* (Moussaieff and Mechoulam 2009; Iram et al. 2017). *Boswellia sacra* (*B. sacra*) is a small deciduous tree that reaches up to 2–8 m high with one or several trunks covered with papery bark. It possesses an oval tear shaped and generally a pale yellow color, sometimes with green, red or blue tinges (Fig. 1.4) (Greene 1993; www.eol.org).

B. sacra often grows on rocky slopes and ravines, up to an altitude of 1200 m, mostly in calcareous soil. *B. sacra* is commonly found in arid woodland of Oman and precariously eroding slopes in the mountains of Dhofar. This species grow in the north of Salalah and in the ancient time was traded from the Sumhuram coastal city (Khora Rori). In 1998, the International Union for Conservation of Nature (IUCN)

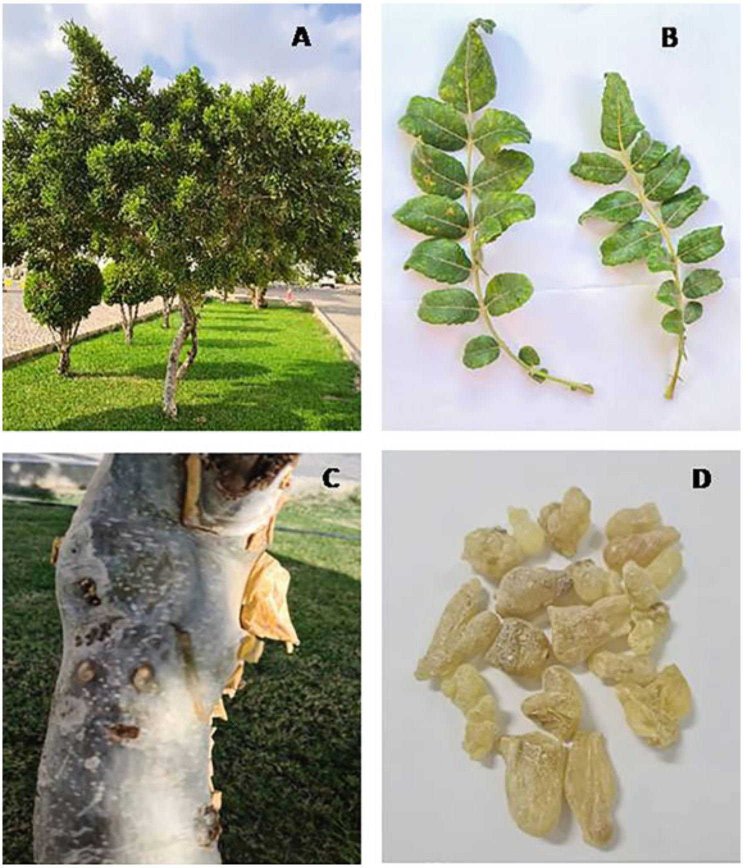

Fig. 1.4 (**a**–**d**) *B. sacra* tree in the campus of University of Nizwa, Oman showing; (**a**): full view of tree, (**b**) leaves, (**c**) trunk, and (**d**) oleo-gum resin. (Original pictures taken by Dr. T. Alam)

found that frankincense species, *B. sacra*, is "near threatened" and UNESCO inscribed Oman as a Land of Frankincense World Heritage Site (Mosti and Tardelli 2006).

Resins containing mixtures of bioactive pentacyclic triterpenes (60–85%), gums primarily mixture of polysaccharides (20–30%) and volatile oil comprising of mono, di and sesquiterpenes (5–9%) are the main reported constituents of frankincense. The biological and therapeutic activities of frankincense are attributed to the presence of boswellic acid and its derivatives in the resin portion which belong to the chemical class of pentacyclic triterpenes. Pentose and hexose sugar along with some oxidizing and digestive enzymes have been identified in gum portion (Al Harrasi and Al-Saidi 2008; Iram et al. 2017).

Frankincense has been used as an incense since ancient times and is an important part of Omani life. It has become an important component in the preparation of cosmetics and perfumes. Unani (Greek) and Chinese traditional system of medicines use olibanum for its anti-inflammatory, sedative, anti-hyperlipidemic, and anti-bacterial properties (Banno 2006; Akihisa et al. 2006). *B. sacra* has also been reported to stimulate the immune system and exhibit anti-microbial, anti-fungal, and anti-inflammatory activities (Moussaieff 2008; Banno 2006; Schillaci 2008; Camarda et al. 2007; Mikhaeil 2003). Frankincense because of its unique oriental fragrance has been widely used as an important ingredient in the manufacture of cosmetic products including perfumes, soaps, creams, lotions, and detergents.

In Oman, frankincense is traditionally used for gastrointestinal ailments, as antipyretic, analgesic to relieve pain associated with muscular and joint pain, and routinely to treat flu, cough, and upper respiratory infections including asthma. It is a custom in Dhofar to offer bowls of burning incense to the visitors as a mark of respect. Usually, men waft the smoke of the incense about their beards, chest, and heads while women perfume their head shawls and in less formal circumstances stand over the brazier and trap the smoke under their gowns rendering themselves odiferous.

It is a common practice to store high quality of frankincense in special containers for important occasions. For example, high quality frankincense is burned when children have to recite long passages from the Holy Qur'an or when people swear an oath. It is also burned at the shrines, tomb, at wedding and religious occasions. It is believed to keeps away all evil influences.

According to Oman's traditions, green frankincense (*B. sacra*) is the best chewing gum and spice for sweets (chew, drink its water or extract). Frankincense resin strengthens teeth and gums, improves digestion, removes accumulated mucus, and makes a fresh and pleasant smell in mouth. Small pieces can be applied on hurting tooth and protects healthy teeth from caries (https://www.sacressence.com).

1.2.4 *Caralluma flava* (N.E.Br.)

Caralluma flava (N.E.Br.) is a xerophytic plant well-known to the hill folk of Oman. It is commonly known as *Qahr-al-luhum* in Arabic language. It belongs to the family Apocynaceae (Asclepiadaceae) and has various synonyms, *viz., Desmidorchis flava*, *Desmidorchis flavus*, and *Crenulluma flava* (Mosti and Raffaelli 2004).

It is a regional endemic plant, most often grows on the Omani-Yemeni border (Mahra-Dhofar) where it extends into the Hajar mountains (UAE). It is found abundantly in the Al Fazayeh region of Dhofar and grows rarely in Central and Northern Oman (Raees et al. 2015). *Caralluma flava* (*C. flava*) can be found in rocky limestone areas, dry riverbeds, and coastal hills along rocky watercourses. Stems are green in color, succulent in nature with an irregular, rough surface and quadrangular with wavy edges (Fig. 1.5) (Bruyns and Jonkers 1993; Patzelt 2015; Grulich 2015; Albers and Meve 2002).

The plant has been used for generations in traditional Omani society due to its medicinal properties. It is used in the management of diabetes and to treat peptic ulcer. It is consumed fresh to treat high fever, leprosy, and rheumatism. Ear inflammation was also treated by instilling drops of its juice (Bruyns and Jonkers

Fig. 1.5 *Caralluma flava* growing in the Jabal Al-Akhdar, Oman. (Original pictures taken by Mr. Rashid Al Harrasi & Muhammad Adil Raees)

1993; Al-Naqeb 2017). The sap obtained from the stems is used for the fast healing of cuts and wounds. The succulent stems have soothing effect and therefore used as a cooling agent on sunburns, skin itching, and also rubbed on burns for the soothing effect. Fresh stems are eaten raw with an addition of lemon and salt for constipation. Tea prepared from the powder of dried plant is consumed for hepatic disorders, flatulence, hypertension, and diabetes. It is also used by the local people as a general tonic to suppress hunger, quench thirst, and for gastrointestinal disorders (Divakar et al. 2016; Ghazanfar 1994; Adnan et al. 2014; Mandaville and Bovey 1978). After rains, the entire plant (stems and young fruits) becomes edible (Grulich 2015; Miller and Morris 1988).

Most characteristic phytoconstituents of this plant are pregnane glycosides, flavone glycosides, megastigmane glycosides, triterpenes, and saponins (Adnan et al. 2014). Pregnane glycoside (Nizwaside) was identified and used against breast cancer cell lines like MDA, MB231 (Hussain et al. 2015). *C. flava* has been shown to exhibit in vitro and in vivo pharmacological activities such as anti-microbial, anti-diabetic, anti-oxidant, and anti-cancer activity, etc. These therapeutic activities of *C. flava* could be attributed to the presence of active compounds such as flavones, flavonoid glycosides, and pregnane glycosides (Adnan et al. 2014).

1.2.5 *Carissa spinarum*

Carissa spinarum L (*C. spinarum*) (family: Apocynaceae) is known as *Emir* in Arabic. It is a spiny shrub with profuse branches, possesses white flowers and small edible berries. Berries are flesh, green, 8–10 mm in diameter (Ghazanfar 2018). It is found in escarpment mountains of Salalah-Ghadow road and the summit plateau in Dhofar (Jabal Al-Samhan) (Ghazanfar 2018; Mosti et al. 2012). The roots, leaves, and fruits are commonly used. They contain various chemical components including tannins, flavonoids, triterpenoids, phenolic compounds, steroids, sterols, glycosides, carbohydrates alkaloids, lignans, and anthraquinones. The fruits are eaten along with the seeds by the local people and are sweet in taste (Gemechu et al. 2020).

It is used traditionally to treat chest complaints, rheumatism, headache, syphilis, herpes simplex virus, hernia, ulcer, and worm infestation. It is also used for the treatment and management of measles, typhoid fever, jaundice, wounds, chickenpox, myalgia, respiratory disorders, and sexual asthenias in males. The traditional birth attendants use the decoction from dried leaves to increase labor and bring about quick child delivery especially during difficult labor (Wambugu et al. 2011; Burkill et al. 1985). Fruits are rich in moisture content (64%). Other nutritional contents in the fresh fruit include vitamin C, proteins, phosphorus, potassium, calcium, magnesium, and iron (Gemechu et al. 2020; Parmar and Kaushal 1982). Scientifically reported pharmacological activities are anti-cancer, anthelminitic, anti-malarial, anti-arthritic, anti-convulsant, hepatoprotective, anti-diabetic, anti-rheumatic, anti-microbial, and anti-oxidant and wound healing effect. The plant extract at a dose level of 2000 mg/kg neither showed any mortality nor caused behavioral changes amongst the graded dose groups of experimental animals (Hegde et al. 2010). The small fresh fruits are commonly eaten and are also sold at certain places in Oman. The bushes of this wild plant are thorny and are used by the villagers as a fence. These bushes are very hard, drought-resistant, tolerant to extreme weathers and can grow even on very poor and rocky soils. Therefore, they can be effectively used for afforestation purpose in soil conservation. Leaves are promising tanning material. The tree wood is used for making combs, ladles, and other useful household items (Parmar and Kaushal 1982).

1.2.6 *Citrullus colocynthis*

Citrullus colocynthis (*L.*) *Schrad* (family: Cucurbitaceae) is a perennial herb native to central plains of Oman. It is commonly known as *Handal* in Arabic and *Surl*, *Hedeg* in Dhofari Arabic. It is popularly known as bitter apple, bitter cucumber, desert guard, yellow apple, and wild guard in other parts of the world. It is a plant with woody, tuberous rootstock with a long trailing or climbing vine like stems (Huxley 1992) and can tolerate temperature up to 40°C. The large, spherical hard fruit is about 5–10 cm in diameter with a bitter pulp and possess medicinal and nutraceutical values (Fig. 1.6) (Facciola 1998). It is widely distributed in the desert areas and especially comes up quickly after rain in the drier parts of Dhofar (Miller and Morris 1988; Ghazanfar 2004; Hussain et al. 2014b; Selvaraj et al. 2010). It is a native vegetation of the hyper-arid area in central plains (desert) of Oman which has no natural water seepage, springs, or permanent or seasonal water bodies, and which receives only patchy rainfall (Ghazanfar 2004). It is also reported in the Eastern Hajar Mountains (right) specifically located in the Al-Sharqiya governorate, Oman (Al Hinai et al. 2020). Leaves, fruits, seeds, flour, and roots are commonly used (Al Hinai et al. 2020; Selvaraj et al. 2010). Seeds are used for propagation with a good success rate (Patzelt et al. 2008).

Fig. 1.6 *Citrullus colocynthis* in the Wadi Al Khoudh, Oman. (Original picture taken by Mr. Hamood Al-Rahabi)

It contains phytochemicals like cucurbitacins, flavonoids, glycosides, unsaturated fatty acids, carbohydrates, essential oils, terpenoids, carotenes, and alkaloids (Divakar et al. 2016; Hussain et al. 2014b). Seeds are rich in fatty acids like myristic, palmitic, stearic, oleic, linoleic, and linolenic acid. Protein content of the seeds includes lysine, leucine, and methionine (Shaheen and Hamed 2003). It also contains iso-vitexin, iso-orientin, luteolin, naringein, quercetin, *p*-terphenyl, cucurbitacin E 2-O-β-D-glucoside, and α-amyrin (Selvaraj et al. 2010; Gurudeeban 2007; Hussain et al. 2014b). It is one of the documented medicinal plants used in the traditional medicine in the Eastern Hajar mountains of Oman (Al Hinai et al. 2020).

Traditionally, a decoction made from the fruit berries is used for the treatment of insects and dog bites (Divakar et al. 2016; Miller and Morris 1988). It is also used as traditional medicine for nerve disorders (hysteria, epilepsy, sedative), snake and scorpion bites, dermatological and topical diseases, cardio vascular and circulatory diseases, gastrointestinal disorders, and others (wounds, cuts, narcotic, tonic, anticancer, and goiter) (Hussain et al. 2014b; Al Hinai et al. 2020). The fresh fruits have astringent and laxative properties and are used for the treatment of cancer, asthma, tuberculosis, dyspepsia, constipation, throat diseases, and elephantiasis (Selvaraj et al. 2010). Leaves are used for the treatment of asthma and painful menstruation. Roots are used for the treatment of rheumatism, amenorrhea, and inflammation of the breast. Leaves, fruits, and roots are indigenously used in the treatment of hemorrhoids in the Eastern Hajar mountains and Al-Sharqiya region, Oman (Al Hinai et al. 2020). Infusion of crushed leaves or roots with goat's milk, or seeds taken with food, as a laxative, poultice made from crushed leaves and garlic, applied on bites and stings (Ghazanfar 1998). It contains minerals like S, Ca, K, Mg, Sb, Sn, Si, Ag, Sr, Mb, Se, P, Fe, Zn, Cd, Cu, Ar, Co, Cr, Pb, Hg, Ni, and amino acids like alanine, valine, glycine, isoleucine, etc. (Selvaraj et al. 2010; Simmons et al. 1982; Hussain et al. 2014b). The flour prepared from the seeds is rich in micronutrients (vitamins and minerals), calcium, and niacin and could therefore be used in food for consumption as bread. Kernels of the seed contain oil 50%, protein 30%, carbohydrate 10%, and fiber content 3% and is a good source of edible oil (Selvaraj et al. 2010). Cucurbitacin B/E glucosides have been reported to inhibit the growth of ER+ MCF-7 and ER-MDA-MB-231 human breast cancer cell lines and exhibit significant anti-oxidant property (Selvaraj et al. 2010; Meybodi 2020). It has been revealed that fruit, seed extracts have an insulinotropic effect (Nmila et al. 2000; Meybodi 2020). Leaves extract possess anti-inflammatory effect by virtue of its ability to block the effect and inhibit the release of serotonin and prostaglandin E_1 (PGE_1) on vascular membrane (Selvaraj et al. 2010). It also possesses local anesthetic, hypolipidemic, anti-convulsant, anti-fertility, anti-allergic, anti-microbial activities, etc. (Daradka et al. 2007; Meybodi 2020; Hussain et al. 2014b).

C. colocynthis, a medicinal or toxic plant, is a major debate among the public. Several studies supported the traditional uses of this plant and also reported that some parts of the plant if consumed in large amounts may lead to adverse effects and it is a fatal agent for rabbits when administered in large amount in the form of pulp extract (Shafaei et al. 2012). Acute toxicity case report of a 48 year old man who ingested decoction of this plant fruit for self-treating his constipation was documented (Rezvani et al. 2011).

1.2.7 *Euphorbia larica* Boiss.

Euphorbia larica Boiss is a perennial species of Euphorbiaceae family. It has the synonym *Tirucalia larica*. It is commonly known as Spurge tree in English and *Isbaq* in Arabic. *E. larica* is a photoautotroph and deciduous, dense, erect perennial evergreen shrub with yellow/green branched stem and it has no leaves. It can grow up to 1.5 m height (Fig. 1.7). Lower stems are smooth, woody, and brown in color, while the upper stems are light green. Milky sap exudate is obtained when stems are broken into small pieces. Fruits are spherical brown capsules (1 cm) with seeds. Flowering season of this plant is from November to April (Feulner et al. 2003).

E. larica is a dominant and common component of the native desert flora of Northern Oman. It grows in gravel plains, mountain slopes at elevation of up to 1300 m. *E. larica* is commonly found in the Hajar mountains and Ru'us Al-Jibal on bare limestone rock (Frey and Kürschner 1986).

E. larica contains flavonoids (kaempferol-3-rutinoside, rutin, 6-methoxyapigenin), coumarins, glucosides, triterpenoids, and steroids (β-amyrin acetate, lupeol, lupeol acetate, ginnone, ambrein, and lupeone), and hydroxy-acids such as 2-methyl-2,2-dimethyl-1,1-(2-hydroxy)-1-propanoic acid and 2-methyl-1,3-hydroxy-2,4,4-trimethylene propanoic acid (Ulubelen et al. 1983, 1986; Asghari and Ebrahimzadeh 2002).

Dried branches and leaves are used for building of roofs; the sticky latex is used to capture small birds and to catch fish by throwing branches into water. The fish are poisoned by the plant's sap. The latex of *E. larica* is known to possess anti-parasitic activity and is used to treat camels (Pickering and Patzelt 2008). In the traditional

Fig. 1.7 *Euphorbia larica* growing in Hajar *mountains*. (Original picture taken by Dr. Tapan K Mohanta)

medicine, *Euphorbia* species were used to treat skin problems (bites, boils, burns, warts), wounds, migraines, and intestinal parasites (Divakar et al. 2016; Özbilgin and Citoțlu 2012). Resins, latex, and tree saps are frequently used in Oman as folkloric medicine to dress wounds arising from burns, bites, and boils (Ulubelen et al. 1983).

1.2.8 *Ficus carica*

Ficus carica L. (*F. carica*) is a perennial deciduous tree belonging to the Moraceae family with a local Arabic name *Tin* and Fig in English. In Oman, fig trees produce one or two crops per year depending on the cultivar. It grows up to a height of 7–10 m with a smooth gray bark with large and fragrant leaves. It has a milky sap. Its edible fruits consist of a hollow fleshy, succulent receptacle structure called syconium. Commonly available fig is the mature syconium on the outside and numerous one-seeded fruits on the inside. Edible nutritious fruit measures 3–5 cm long with green skin and it turns purple or brown after ripening. Fruits can be eaten fresh or dried, preserved, canned, and candied or used as a jam (Weli et al. 2015; Slatnar et al. 2011; Subash et al. 2016). It is found in the mountain oases of Balad Seet in Northern Oman, Maqta and Jabal Al-Akhdar. The oasis Balad Seet is located in a small valley of the Al-Hajar mountain range and surrounded by limestone cliffs up to 1200 m (Gebauer et al. 2007a). Its presence is also recorded in Wadi Hinna, Oman. Barks, leaves, tender shoots, fruits, seeds, latex are commonly used plant parts (Weli et al. 2015). It contains phytochemicals like phytosterols (stigmasterol, sitosterol), tyrosine, pentoses, bergaptene polyphenols, and proantocyanidins (Weli et al. 2015). Red wine and tea contains less phenolic components than figs (Subash et al. 2016). It also contains aliphatic alcohols, coumarins, anthocyanine pigments, flavones, flavanols, volatile compounds and phenols (Slatnar et al. 2011; Mawa et al. 2013).

Traditionally, it has been used for the management and treatment of jaundice, inflammation, ulcers, warts, constipation, respiratory disorders, and cardiovascular diseases (Subash et al. 2016). Greek athletes were said to have diet of fig to improve their strength and swiftness and the alcoholic drink prepared from the fermented figs was traditionally very popular in Oman (Miller and Morris 1988). It has a nutritional status rich in vitamins, minerals especially calcium and potassium, water, fats, fibers, proteins, nitrogen free compounds and carotene (Subash et al. 2016; Mawa et al. 2013). It is a well-nourished food and used in many food industrial processes (Weli et al. 2015). Leaves extract has been demonstrated experimentally to possess anti-diabetic and hypoglycemic effect (Weli et al. 2015). Effective inhibition of the colon cancer cell lines proves its cytotoxic and anti-oxidant effect (Herre et al. 2008). Owing to high potassium content in the fruits, it shows effective anti-hypertensive response and controls the balance of blood pressure, fiber content in the fruit helps in reducing the body weight (Wallis 2008). Ethanolic extract of the fruit is reported to exhibit anti-pyretic effect at varying doses. It also possesses weak anti-helminitic and anti-microbial effects (Weli et al. 2015). Figs possess anti-spasmodic, anti-platelet, anti HSV, hemostatic, hepatoprotective and anti-tubercular activities. It has also been reported that fig fruit has the ability to improve memory, anxiety, and learning skills of Alzheimer's disease, i.e., neuroprotection (Subash et al. 2016). Crude extract of the fruits showed high acute toxicity with hemorrhagic enteritis (Mawa et al. 2013).

1.2.9 *Grewia tenax* (Forssk.) Fiori

Grewia tenax (Forssk.) Fiori (family: Tiliaceae) is a valuable wild fruit producing thornless shrub native to Southern and Northern Oman. However, the first record of its occurrence in Al-Hajar mountains of Northern Oman has been reported in 2007 (Gebauer et al. 2007a, b). It grows up to 3 m in height which flowers in March-April and produce fruits in August-September. The literature revealed *G. tenax* species to grow in lowlands and mountains with a maximum altitude of 1250 m above sea level in neighboring Gulf countries (Collenette 1985; Jongbloed et al. 2003; Al-Hubaishi and Muller-Hohenstein 1984) but in contrast, the species was found growing up to an altitude of 1850 m in the Wadi Muaydin, Northern Oman.

The *G. tenax* fruits growing wildly in Northern Oman are paired (2–4), orange-red colored, delicious and are eaten by the local people. The mature orange colored as well as green immature fruits are also reported to be a popular food in Southern

Oman (Miller and Morris 1988). The fruits have a similar flavor to the kernel of maize. The leaves and young twigs of the shrubs are also heavily grazed by the livestock (Miller and Morris 1988; Von Maydell 1990). The wood is strong and therefore was considered as firewood, for making charcoal and to make artifacts by the local people. The fruits, roots, and leaves have been used to treat an array of common diseases (digestive disorders, skin diseases, cough, fever, wound healing) in indigenous system of medicine in Africa, Southeast Asia, and elsewhere. Liver problems and upper respiratory diseases were cured with roots while fruit juice and fruit decoction were used as supplement in iron deficiency. Leaves and twigs were often used in the treatment of trachoma, tonsillitis, and as a poultice to treat swelling (El Ghazali et al. 1994, 1997).

The phytochemical analysis of the plant showed the presence of flavonoid glycosides (luteolin diglucoside) flavonoids (rutin, apigenin, chrysoreol), phenolic acids (ferulic acid, *p*-coumaric acid), flavonols (myricetin, quercetin glucoside), and leucoanthocyanidins (pelargonidin) (Hashmi and Qaiser 1990; Sharma and Patni 2012).

Analysis of the nutritional composition of fruits of *G. tenax* grown in Sudan showed to contain 13% moisture, 20.5% crude fiber, 5.2% ash, 66% carbohydrates, 7.7% protein, and 1.7% lipids. A total of 14 amino acids were detected in the fruits which fulfill the requirements of the FAO/WHO standard protein. The iron content of fruits is 20.8–22.3 mg/100 g which makes it quite popular as an iron supplement for anemic children (Elhassan and Yagi 2010).

G. tenax is a wild plant of enormous economic importance. It has been used as a source of iron rich food for humans and fodder for livestock. Its fruits can be made into a refreshing drink to quench thirst in summer.

There is a need to exploit and validate the traditional medicinal uses of this wild species. Efforts are also warranted to domesticate and conserve the *Grewia* species for sustainable management of biodiversity.

1.2.10 *Moringa peregrina* (Forssk.) Fiori

Moringa peregrina (Forssk.) Fiori (family: Moringaceae) is commonly known as horseradish tree, miracle tree or Omani drumstick tree in English and as *shu'a* in Arabic. *M. peregrina* is a multipurpose tree (7–12 m high) that grows wildly in the Oman including the most arid locations such as on the hillside or in a well-drained spot in a dried bed of river (wadi). The stem odor is quite distinctive and oily. Its wood is regarded as a good source for charcoal production (Miller and Morris 1988; Ghazanfar and Al-Sabahi 1993). It is one of those Omani wild plants that was earlier harvested for food either for humans or for livestock.

It is a five petaled flowering tree with excellent fragrance which blooms in April in large sprays. The cylindrical fruits having longitudinal grooves hang from its branches and are approximately up 30 cm long (Fig. 1.8). The bark has gum canals which produces gummy exudates. The leaves and pods have been reported to contain vitamins A, B1, B2, B3, C, several amino acids and various other

Fig. 1.8 *Moringa peregrina* growing on a hillside in Wadi Bani Khalid. (Original photo taken by Mr. Zaher Saleem Al Darwashi)

micronutrients (Al-Owaisi et al. 2014). Omani villagers used its stems, which are termite resistant, for making furniture and in the home construction. Shu'a tree is given significant importance due to its nutritional, medicinal, and industrial applications.

The various parts of the tree are edible and consumed as vegetable primarily because of their high minerals, vitamins, protein, low fat, and low carbohydrate content. The roots and the young pods of *Moringa* are cooked and eaten as a food. In almost all the gulf countries, the leaves are traditionally used to flavor the meat during preparation prior to barbeque on charcoal (Senthilkumar et al. 2018).

The leaves, stem, bark, and seeds of the tree are also used as ethno-medicine in Oman for variety of diseases. The bark juice is having antiseptic activity while the crushed seeds have been reported to be effective in curing the digestive ailments including constipation and stomach cramps (Divakar et al. 2016). Its seeds are widely used by the herbalists to control diabetes in rural areas of Sultanate of Oman (Reddy et al. 2015). The seed oil is having a pleasant taste and is used externally for the bone setting. The seed oil is very popular among locals and is widely sold in the weekly and traditional markets across Oman. The pod oil is used to treat infantile paralysis. Rutin, quercetin, apigenin, lupeol acetate, β-amyrin, and β-sitosterol are some of the major chemical constituents of the plant (Somali et al. 1984). Juice of the leaf contains zeatin, a plant hormone which has been reported to increase the yield of any crop by 25–30%. The protein present in its seed powder can coagulate the dispersed particles in water and therefore can be effectively used to purify water (Nouhi et al. 2019).

M. peregrina parts have been shown to exhibit useful biological activities such as anti-oxidant, anti-microbial, anti-diabetic, anti-spasmodic, anti-hypertensive, anti-hepatotoxic, lipid lowering activity, anti-inflammatory, anti-cancer, and can be helpful in the treatment of memory disorders, etc. (Senthilkumar et al. 2018). The biological activities of the plant have been attributed to the high content of phenolic compounds. The seed oil mainly contains unsaturated fatty acids with oleic acid as the major constituent. Presence of campesterol, stigmasterol and β-sitosterol and the tocopherols in the oil have also been reported. Isothiocyanates constitutes the major volatile components of the seed and leaves (Afsharypuora et al. 2010).

This wild plant of Oman holds promise as future crop and therefore deserves protection and further exploration for commercial opportunities for the local people.

1.2.11 *Olea europaea* L

Olea europaea L. (family: Oleaceae) known as olive in English and *Zaitoon or Ootm* in Arabic is a perennial tree. This evergreen olive species is predominantly grown in Western Hajar mountains in Northern Oman above an altitude of 2000 m and in Dhofar's coastal hill slopes (Miller and Morris 1988). Olive tree is of significant economic importance because of the edible fruit and its oil. The fruits of wild olive growing in Northern Oman are edible (Fig. 1.9). It has whitish flowers which bloom in May to June while fruits mature by August.

The olive oil possesses numerous health benefits and is a rich source of nutrients. It is an essential part of the Mediterranean diet. A number of studies have shown it to protect from certain type of cancers, cardiovascular and neurodegenerative diseases (Abdelrahman et al. 2019). Phytochemical studies have revealed the presence of tyrosol derivatives, biophenols, flavones glycosides, flavonoids (rutin, quercetin, luteolin), triterpenes/triterpenic acid (oleanolic acid, β amyrin, ursolic acid, betulinic acid), *seco*-iridoids (oleuropein), elenolic acid, sterols (β sitosterol, cycloartenol, gramisterol), aromatic acids (caffeic acid, ferulic acid, cinnamic acid, phloretic acid), and sugars, etc. (Hashmi et al. 2015). Oleic acid is the major constituent of olive oil but palmitic, linoleic, stearic, and myristic acids are also present in the minor amount. Olive oil is used as cooking oil in many countries.

The paste prepared from the mixture of leaves and barks was used in cases of snake bite, skin rash, irritation, and itching. Aqueous extract of bark prepared by

Fig. 1.9 Olive fruits before harvesting in Jabl Al-Akhdar. (Original photo taken by Mr. Zaher Saleem Al Darwashi)

maceration is taken orally as a laxative to relieve constipation. In Northern Oman, traditional healers used to apply olive fruit juice around infected eyes and to treat paralysis. Blisters and ulcers were treated with the ash of burnt leaves while paste prepared by mixing the fruit powder, salt, and dates is applied to the fractured limb (Ghoneim 1990; Ghazanfar and Al-Sabahi 1993). The olive oil is also used as demulcent, laxative, hair tonic and to sooth the skin. Its twigs are popularly used as alternative to toothbrush like miswak (*Salvadora persica*). The leaves are used as fodder for domestic animals. In Dhofar region, the hard wood of olive was used in construction, as fuel and for making furniture and other wooden objects. The wood of this tree was in heavy demand as fire wood and the wood ash was used as fertilizer. The wood was also used for the production of charcoal (Miller and Morris 1988).

Oman exports olive oil to many countries in the world but Somalia and UAE were the top most importers of Omani olive oil in 2018. It was ranked 49th largest exporter of olive oil worldwide in 2018. Oman generated revenue of approximately $71.7k from the export of Olive oil in the same year (https://oec.world). The data released by Oman’s Ministry of Agriculture and Fisheries (MAF) for the harvesting of olives from Jabal Al-Akhdar during Aug to Dec 2019 showed a production of approximately 8028 L of olive oil from 60 tones of olives. Due to its economic importance, government has encouraged and supported the farmers to cultivate the olive trees in the low lying areas in the wilayats of Izki, Ibri, Bahla, and Nizwa as a new source of income. The increase in the production of olive oil in future will certainly boost the economy of the country (Al-Zoubi 2020).

1.2.12 *Vitis vinifera* L

Vitis vinifera, the common grape vine, is a species of *Vitis* (family: Vitaceae). It is commonly called *Ainab* in Arabic. The grape fruits hang in bunches. *V. vinifera* is a woody climber reaching up to 15–18 m high and fruits grow in clusters of 15–300. Fruits botanically called berries and are oval or globose in shape while color can be crimson, black, dark blue, yellow, green, orange, and pink (Fig. 1.10). Fresh grapes are widely consumed as table grapes. They are also used for the production of jam, grape juice, jelly, grape seed extract, raisins, vinegar, and grape seed oil (Cronquist 1981; Ghazanfar 1994).

The origin of grape family is traced to the Oman and has been named after the city of Muscat which is located on the coast of the Gulf of Oman (Robinson et al. 2012).

Grapes are actually produced all over Oman but the major farms are found in areas like Jabal Al-Akhdar, Yanqul, and Ibra. The temperature at Jabal Al-Akhdar, Nizwa of Al Dakhliya Governorate is suitable for grapes farming. However, some farms in Muscat especially in Barka are also growing grapes for commercial

Fig. 1.10 Fruits of *Vitis vinifera* growing in a farm house at Jabal Al-Akhdar. (Original picture taken by Mr. Ghanim Salim Aalthani)

purpose. In Wakan place, two or three different varieties of grapes are grown but the small yellow-green berries are more popular among people. This variety has crisp flesh texture and is very sweet.

Raw grapes contain high amount of water (~82%), carbohydrates (12–18%), protein (0.5–0.6%), and fat (0.3–0.4%). A 100 g of raw grapes provides 69 kcal of energy and is also a source of small amount of vitamin K (14%). Polyphenolic compounds particularly proanthocyanidins are important constituents of grapes. The phenolic substances are primarily concentrated in the seeds and skins of the berry. The red and purple color of the grapes is due to the phenolic compounds (https://www.extension.iastate.edu).

The major biological activities of grape and its constituents are anti-oxidant, anti-cancer, immuno-modulatory, anti-diabetes, anti-atherogenic, neuroprotective, anti-obesity, anti-aging, and anti-infective. Resveratrol is a major bioactive compound found in grapes that exhibit wide array of biological activities (Valli Kanagarla et al. 2013; Yadav et al. 2009). Leaves possess venotonic, cardioprotective, astringent, and diuretic properties. The fruits are source of energy and vitamins. They also display useful activities including anti-cancer, hepatoprotective, hair growth promoting effect, and prevention of ischemic processes.

Dried and fresh grapes are used in bronchitis, cough, and earache. A drink prepared by boiling fruit in water followed by straining is used to treat coughs. Grape juice blended with bee honey was used as eardrops for the treatment of ear pain (Cronquist 1981). Grapes are considered to be one of the main elements on the tables of local people in Al Rawdha town (Oman Observer 2017).

Grapes provide a good variety for agricultural crops in the country. Oman exported $1.09 million in grapes in 2018, making it the 67th largest exporter of grapes in the world and imported $22.7 million in grapes, becoming the 50th largest importer of grapes in the world (https://oec.world).

1.2.13 *Zingiber officinale* Roscoe

Zingiber officinale (Roscoe) belongs to the family Zingiberaceae. It is commonly known as ginger in English and *Zangabeel* in Arabic. It is an herbaceous perennial aromatic plant that grows up to 1 m in height. Ginger is native to Oman and it is cultivated widely throughout the tropical areas. Fresh ginger is called *Zanjabeele ratab* and dried one is known as *Zanjabeele yabis* (Tauheed et al. 2017).

Ginger is a flowering plant which grows as annual pseudo-stems. Flowers are having pale yellow petals with purple edges, and arise from the rhizome directly. The rhizome or the underground stem of the ginger is the most frequently used part in medicine, cosmetics, food products and as a spice (Chen et al. 2000; Li 2008).

Ginger, a spice of multiple health benefits, has been found to be rich in minerals, vitamins, lipids, proteins, carbohydrates (starch), essential oil, and biologically active phytochemicals (Rahmani et al. 2014). Raw ginger contains 79% water, 18% carbohydrates, 2% protein, and 1% fat. The dietary fiber, ash, vitamins A, B, and C, minerals are also present. Energy value of 100 g of ginger is approximately

80 cal. Phytochemicals of ginger include alkaloids, saponins, flavonoids, steroids, tannins, glycosides, and terpenoids (Ugwoke and Nzekwe 2010; Dhanik et al. 2017).

The characteristic aroma and flavor of ginger is attributed to the presence of essential oils which is approximately 1–3% of the weight of fresh ginger. The main constituents of essential oil are zingerone, shogaols, and gingerols (An et al. 2016; Al Dhahli et al. 2020). Ginger had been used as a folkloric and a common house hold medicine since ancient time which has been documented in Arabic ethno-medicine book. Ginger is used in indigenous system of medicine for indigestion, hypertension, arthritis, intestinal and throat infections, vomiting, nausea, lung diseases, cold, cough, pain, swellings, etc. (Rehman et al. 2011; Mele 2019). In the Arab world, ginger tea and Arabic ginger qahwa (coffee) are among the most popular hot beverages (Al Dhahli et al. 2020). A decoction made from ginger roots is used mainly to treat infections of the respiratory tract and stomach disorders. The admixture of honey with crushed grated ginger juice is also used for the treatment of sore throat and common cold in Northern and Southern provinces of Oman (Divakar et al. 2016). Various ginger herbal preparations in Chinese, Ayurvedic, and Tibb-e-Unani system of medicine are used for the treatment of catarrh, rheumatism, nervous diseases, gingivitis, toothache, asthma, stroke, constipation, and diabetes (Tapsell et al. 2006). Volatile oil of ginger is widely used in aromatherapy, flavor, and perfumery industries (Ali et al. 2008). Rhizome is used in bronchitis, cough, and as eye drops in cataract. Rhizome cooked with salt and water can be used as an expectorant (Ghazanfar and Al-Sabahi 1993).

The value of exports of commodity group 0910 "Ginger, saffron, turmeric (curcuma), thyme, bay leaves, curry, and other spices" from Oman totaled $1.79 million and in 2018 (https://trendeconomy.com).

1.2.14 *Ziziphus spina-christi* (L) Desf.

Ziziphus spina-christi (L) Desf. (family: Rhamnaceae) is commonly known as *Sidr* in Arabic and Christ thorn in English. It is one of the main large trees of Northern Oman (10–12 m) which is cultivated for its edible fruits and wood. Although, this species of *Ziziphus* is able to tolerate extremely dry and harsh weather conditions, but its presence has also been noted in gravely dry wadis (Fig. 1.11) (Miller and Morris 1988; Al-Hakmani et al. 2014). The evergreen *Ziziphus* tree grows widely throughout Oman but more prominently in Southern Oman (Dhofar region) and in Northern Oman during monsoon season. In Northern Oman, Sidr leaves are used as a source of livestock forage and fodder under open grazing field (Ghazanfar 1994; Ghazanfar and Al-Sabahi 1993). The beautiful scented flowers of Sidr are used as a nectar source by Omani honey bees. Honey produced from this tree is regarded as of high grade and fetches a good price in the market.

The Sidr fruit is called *nabaq*. Since ancient time *nabaq* is considered as a source of nourishment because of its high vitamin C content. The fruit of a size of small cherry ripens during hot and dry weather and the pulp of the yellow ripe fruit with a single brown seed has a pleasant flavor and tastes like dried apple. Traditionally, the

Fig. 1.11 *Ziziphus spina-christi* tree and its unripe fruits growing in Wadi Bani Khalid. (Original photo taken by Mr. Zaher Saleem Al Darwashi)

fruit was dried and stored because the fruit upon storage in dry place for long time becomes reddish brown, sweeter, and softer (Miller and Morris 1988). Its fruits are widely collected and sold on local markets in Oman.

The kernels are also eaten raw or cooked in water, milk or buttermilk to treat the pneumonia. The fruits are eaten by grazing sheep and goats and the foliage by camels. The powdered sun-dried fruits are mixed with water to prepare cakes similar to gingerbread (Ali et al. 2006). Sidr leaves have been used traditionally for hair cleansing while powdered leaves for making a skin cream. The wood is used as fuel, in production of good quality of charcoal and for making furniture. The Omani craft industry uses its wood for making shovels, spoons and also small boats.

Numerous studies have shown the crude extracts of various parts of the *Ziziphus* plant to possess anti-microbial, anti-cancer, anti-diabetic, anti-nociceptive, anti-hypertensive, anti-diarrheal, and CNS effects, etc. The plant contains diverse classes of secondary plant metabolites such as cyclopeptide alkaloids (mauritine C, amphibine B), flavonoids (quercetin, rutin, hyperin, apigenin glycoside), triterpenic acids (betulinic acid, ursolic acid), phenolic acids (ferulic acid, cinnamic acid), tannins (epigallocatechin), volatile oils (geranyl acetone, terpeneol), fatty acids (oleic acid, myristic acid), and saponins (christinin A-D), etc. (El Maaiden et al. 2020).

The pulp of fresh *Z. spina-christi* fruits contains carbohydrates (85.69%) which make it a good source of food. The free sugars present include glucose (6.2%), rhamnose (2.6%), xylose (5.7%), and the fructose. It also contains 7.5% of mucilage making it a popular demulcent and emollient in the traditional medicine (Nazif 2002; Ads et al. 2017). Berry-Koch et al. reported that approximately 4.8 g protein, 0.9 g fat, 3.7 mg niacin, and 30 mg ascorbic are present in 100 g of the dried fruit pulp giving approximately 315 cal (Berry-Koch et al. 1990).

Ministry of Environment has urged the Omani citizens to grow indigenous trees like Sidr to protect the environment vis a vis to benefit the Omani economy as locally produced honey of high quality primarily comes from the hives kept near this tree. Many small and medium enterprises in Oman have started manufacturing Sidr based cosmetic products like Sidr soap, Sidr scrub, Sidr shampoo, etc. (https://timesofoman.com). A group of young people in Oman has established an Omani Sidr Association (OSA) to conserve this multipurpose tree that benefits local inhabitants immensely (Al Nasseri 2019).

1.3 Conclusion

This chapter is an eye bird view of some of the traditionally and economically important medicinal plants native to Oman as well as few plants which are endemic to Dhofar region, Oman. Unfortunately, traditional plant knowledge is diminishing due to the modernization and lack of passing information by the elderly inhabitants to the new generations. Our report provides a concise overview of 14 edible medicinal plants that were used in ethno-medicine practice since olden days for curing various ailments. Some of these wild growing edible plants are not explored scientifically and are in the list of endangered species. These plants are of significant economic importance as (1) many of these plants are used as feed for livestock; (2) the fruits of some edible plant species are good source of nutrition and are sold in the local market; (3) seed oils of several plants are used for cooking, are sold in local market and also exported (4) some plants are used as fuel; and (5) the timber is used to make furniture and other wooden items in addition to their widespread use in folkloric medicine. Few of these wild edible plants may extinct if proper measures are not taken to conserve them. It is noteworthy that monograph and the published literatures on these endemic plant species native to Oman will play an important role in conservation of these natural resources. The Sultanate of Oman has several programs, societies and museum to conserve the flora and fauna in order to maintain the traditional claim and economic importance of medicinal plants. There is a great hope for the development of novel drugs from medicinal plants native to Oman for dreadful diseases. Also, the volatile oils isolated from these medicinal plants can be used in cosmetic and perfumery industry. Oman takes a prodigious pride in its magnificent ecology, climate, precious environment, and diverse flora.

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2 Socio-Economic Importance of Some Promising Edible Medicinal Plants from Rajasthan, India

Mohamad Taleuzzaman, Adil Ahmad, and Sadaf Jamal Gilani

Abstract

Rajasthan is one of the largest states of India. The land of this area is scorching, generally not suitable for agriculture, but several wild plants and herbs are a source of edible medicinal plants. Northern west districts have forests, wild plants, or herbs that grow in this region. The desert areas have plants that are a source of medicine and provide food during the famine. Herbal medicine is a choice for treating several chronic diseases globally, preferably because of fewer side effects. Continuously the demand for herbal medicine in the market is increasing. The traditional knowledge of plants in this region adopted the modern cultivation methods to increase production. Overall, the marketing of medicine and raw materials contributes to the state's economy.

Keywords

Edible medicinal plants · Rajasthan · Herbal medicine · Famine · Economy

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2.1 Introduction

In the past century, world food production and calorie intake per capita have increased significantly, but the proportion of under-nourished people decline; the exact figure has risen to over 963 million (Wennberg 2014; UNICEF 2007). Marginal land of this area from where food production is high, but due to scarcity of water the production may perform poorly. That is the reason it requires exploring alternate sources of food (Nellemann et al. 2009). A population of the world's different regions maintains their life from the forest. The diversity in the wild plant provides another type of food. It contributes to household food security in rural areas that depend upon them to fulfil their additional food requirements (Tiwari et al. 2010). Some wild plants, sometimes, provide more nutritional value as compared to common vegetables and fruits (Nordeide et al. 1996). The wild of Ladakh region has a deciduous shrub known by the name 'the berries of sea buckthorn' which contains over 100 nutrients vital for body functions, including carotenoids, flavonoids, and phytosterols and vitamin C, E, K. Food industries like Mamta Agro Foods, a subsidiary of Mamta Drinks and industries Ltd., Baddi, Himachal Pradesh, prepares several industrial products. Many of the local population are involved in its harvesting and processing and provides seasonal employment.

In the world, India is identified as the richest floristic region, its primaeval estate of medicinal herbs. There are a total of 16 agro-climatic zones and 45,000 various plant species, of which 15,000 are medicinal and 1500 medicinal plants are identified in the Indian system of medicine. During the Second World War, India started to farm medicinal plants to fulfil the market demands and provide various species of medicinal plants; it was the best source of income (Choi et al. 2001). In several countries, the government and private industries produce a large quantity of medicinal plants through cultivation to fulfil the market demand and reduce the pressure on species collected from the natural wilderness (Schippmann et al. 2002).

In India, medicinal plant farming is the source of regular income that contributes to the country's economy. Agriculture institutions focus on the cultivation of medicinal plants for the country's progress (Shukla and Sinclair 2009). The World Wide Fund for Nature (WWF) declares that the leading producers of medicinal plants responsible for economic growth are less economically attractive. For a long-standing trade, it will be better if the community members work together and put a contractual order to supply the manufacturers. Hamilton el al. 2004 quotes that farming of medicinal plants or herbs by the farmer is the right option for the better use of land and to increase financial capital. In India, 2 lakh hectares of land are for the cultivation of medicinal plants. Crops like Plantago ovate (Isabgol), Trachyspermum copticum (Ajwain), Withania somnifera (Ashwagandha), Papaver somniferum (Opium poppy), Cassia angustifolia (Senna), etc. have been banned for medicinal purposes in India due to government policy.

Indigenous medicines have been prepared from plant materials, and the contribution is about 75% which are collected from wild habitats. The largest dealers of medicinal plants in the world are countries like India, Brazil, and China. The estimated business of medicinal plants from India is worth Rs. 550 crores and hopefully it may reach 1000 crores. Presently worldwide, the trade of medicinal plants is about US$14 trillion annually and estimated to reach US$5 billion by 2050, according to the WHO. Yearly, the business of medicinal plants in India is around $60 billion. The top three countries, India, China, and Thailand, are 436 crores, 22,000 crores, and 10,000 crores, respectively. This sector is likely to grow, but still, in some countries, it is in the beginning stage.

In India, Rajasthan is one of the largest states with 342 lakh sq km geographical area; in this state the diversity of medicinal plants is relatively high. In different kinds of formulations, the use of herbs is common, and its source is usually wild (Table 2.1 and Fig. 2.1).

Udaipur, a district in Rajasthan, has distinctive features it is covered by Aravali hills which have a rich presence offlora, including medicinal plants. Two crucial medicinal plants are Ajwain and Isabgol, which are cultivated mainly in Udaipur and Chittorgarh districts. The area of this state is 253,745 hectares, with an average productivity of 560 kg/hectares. Isabgol farming in Rajasthan is very high, the total area for this occupied 136,277 hectares, and its production is around 49,130 million tons. From Udaipur, it is around 2406 hectares and 919 million tons, respectively. A survey has been done to know the farmer's response about the cultivation of medicinal plants in this district. Results revealed relative economics of medicinal crop vis a vis traditional crops and socio-economic factors associated with adopting medicinal cultivation plants. Rajasthan is located in the northwestern part of India; it is among the most significant state. The longitudes and latitudes lie between 2303′–30012′ and 69030′–78017′ respectively. The districts situated in the southern part of Rajasthan are Banswara, Chittorgarh, Dungarpur, Partapgarh, Rajsamand, and Udaipur. The dominating population in this region is Bhil, Damor, Garasia, Kathodia, and Meena tribes.

Each tribe has its own socio-religious cultural life and prefers to live in small groups in a small village. It is generally situated between forests or adjacent to it, where there is sufficient supply of natural water in the form of river, spring, or water holes. The houses in these villages are either small huts of 'Kaccha house' made up of either mud bricks or completely plants and their parts.

Climate in Rajasthan in tribal areas is tropical where the temperature during summer varies between 39.0 and 45.6 °C and in winter 7.0 and 12 °C. Average rainfall recorded has been 65 cm, and the land of this area has a deciduous type of vegetation. The population in this area entirely relies on plants and plant products. The documents gathered by the works of this area are based on the traditional knowledge of ethnomedicinal plants, and this information is minimal about the socio-economic plants of this area. Before civilization, wild edible plants (WEP) were an essential source for humanity. Wild fruits are supplementing diet but play a very vital role for the people of this area (Table 2.2 and Fig. 2.2a, b).

The collection of plants by the local inhabitants does not need any skills or capital investment (Alcorn 1990; FAO 1995; Ros-Tonen 2000). During the famine, plants and their parts were used to source food (King 1870).

Table 2.1 A list of plants with their botanical as well as local names

Botanical name	Family	Local name	Locality	Utilization
Amaranthus gangeticus L.	Amaranthaceae	Kangani	Rajpura	Seeds are used as pseudo cereal. They are cooked like rice and are relished by the tribals
Cassia tora L.	Caesalpiniaceae	Paudina	Rajasmand	Leaves and flowers are cooked as vegetable. Leaves are stored after sun drying and are cooked with maize dalia and are considered a disease-free vegetable
Commelina benghalensis L.	Commelinaceae	Kallni, Mokta	Kumbhalgarh	Purgative effect, for the treatment of leprosy used ‘pakoris’ made by mixing leaves and tender shoots with gram flour
Diospyros melanoxylon Roxb.	Ebenaceae	Timbru	Rajpura	Fruits are edible. Dried fruits are stored for periodic uses. Fruits are available even during famine conditions to satiate hunger of the poor tribals. Unripe fruits are used as starter curds for instant curding of milk
Ensete superbum (Roxb.) Chees.	Musaceae	Junglikela	Jargah hill	Fruits are palatable. From shaft, leaf sheaths are removed and then it is made into pieces (Chaun): these are then chewed. Flower buds are cooked as vegetable
Madhuca indica J.F. Gmelin	Sapotaceae	Mahua	Mehenduriya	The flowers and fruits are eaten raw or cooked. The flowers are compressed into ‘laddoos’. The seeds locally called ‘Dolma’ are also eaten and edible oil called ‘Ghee’ is also extracted from them, which is used for cooking purposes. During famine the bark is boiled in water to make ‘rab’ and consumed locally. Special dishes are prepared from the flowers and fruits
Nymphaea nouchali Burm. F.	Nymphaeaceae	Kamal	Anjana	Petiole is cooked as vegetable
Phoenix sylvestris (L.) Roxb.	Arecaceae	Khajoor	Anjana	Fruits are eaten fresh or in dried form. After the rains, saplings sprout up. These young tender shoots are cooked as vegetable. Sap is obtained by giving a cut near the apex of the tree. The sap is said to ooze for 7 days or so. It is then boiled down to sugar. During scarcity periods, the farinaceous deposit from the apex of the tree is eaten by the tribals
Urginea indica (Roxb.) kunth.	Liliaceae	Junglikanda	Rajpura	Used as a vegetable after detoxification of bulbs pieces
Wrightia tinctorial Br.	Apocynaceae	Khani	Dariba	The latex is sucked by children directly from the trunk or after taking it on leaves. According to them, it resembles butter in taste. The sap (latex) is also used by tribal herdsman for instant curdling of milk. They add a few drops of latex in the milk, which curdles immediately and then they eat bread with it. Bhills call this curd ‘Khubinu’.

Fig. 2.1 List of medicinal plants with their botanical names

Presently, worldwide, according to the WHO, about 80% population lean towards traditional medicines for primary healthcare (Farnsworth 1990). Two thousand five hundred plants belonging to 1000 genera are used in India as conventional medicine. The use of plants for the treatment of various ailments at the national and international level has been discussed by many scientists mainly in magico-religious beliefs, rituals, and worship by different traditional tribes and rural communities (Sharma and Kumar 2011; Meena and Yadav 2010; Mesfin et al. 2013; Mahmoud and Gairola 2013). Now it is clear that plants are used by human beings for food, medicine, industry product, and spiritual purposes. Ethnobotany provides information about the use of plants by domestic populations, and economic botany concentrates on the cultivation of plants in the modern era.

2.2 The Therapeutic Value of Edible Medicinal Plants

Because of increasing health problems, several chronic diseases, and pathological complications, researchers focus on finding novel foods to overcome these problems. The edible medicinal plants are a source of nutrients and pharmaceuticals (Ramadan and Al-Ghamdi 2012). Adequate nutrients are compulsory for organic needs, and the ingredients of associated pharmaceuticals cure the disease. Health experts confirm the abundance of nutrients and pharmaceuticals in the edible medicinal plants that promote health, improve general well-being, cure the disease, and reduce the risk of illness (Krupa 2008). Medicinal food plants are recognized as therapeutic either in traditional medicine, ethnomedicine, or biomedicine. Medicinal foods not only have the purpose to satisfy hunger and provide micro- and macronutrients to the body but also supply bioactive compounds that decrease

Table 2.2 Wild edible plants used by tribal people of Pali district of Rajasthan

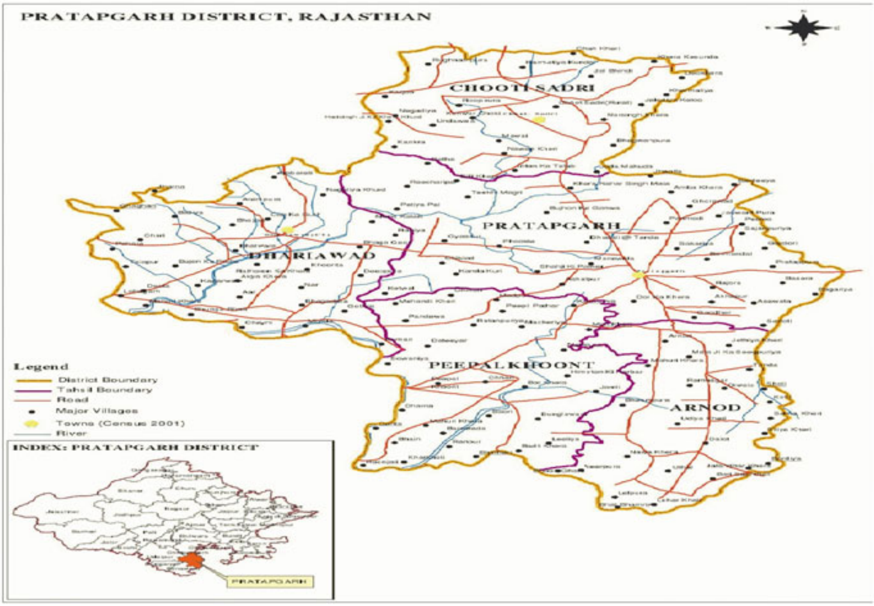
S. No.	Botanical name	Family	Useful part	Mode of consumption
1.	*Achyranthes aspera*	Amaranthaceae	Young plant	As vegetable
2.	*Adhatoda vasica*	Acanthaceae	Flowers	Eaten as vegetable
3.	*Amaranthus spinosus*	Amaranthaceae	Tender shoots and young leaves, mature stems	Cooked as vegetable
4.	*Argyreia nervosa*	Convolvulaceae	Leaves	Eaten as vegetable
5.	*Asparagus racemosus*	Liliaceae	Young shoots	Eaten cooked, raw
6.	*Bacopa monnieri*	Scrophulariaceae	Leaves and tender shoot	Eaten cooked as vegetable
7.	*Bauhinia variegata*	Caesalpiniaceae	Flower buds seed	Eaten cooked, eaten after roasting
8.	*Boerhavia diffusa*	Nyctaginaceae	Young leaves	Eaten cooked as vegetable
9.	*Bombax ceiba*	Bombaceae	Unripe fruits, flower	Eaten raw, cooked as vegetable
10.	*Cannabis sativa*	Cannabinaceae	Immature leaves with tender shoots	Used as vegetable, narcotic effect
11.	*Carissa carandas*	Apocynaceae	Fruits	Either eaten raw or pickled
12.	*Cassia fistula*	Caesalpiniaceae	Flowers, buds, pod	Used as vegetable
13.	*Centella asiatica*	Apiaceae	Leaves and young shoots	Eaten as vegetable
14.	*Chlorophytum tuberosum*	Liliaceae	Leaves, root	Cooked as vegetable, eaten as raw
15.	*Cissus quadrangularis*	Vitaceae	Young shoots	Eat as curries
16.	*Cordia dichotoma*	Cordiaceae	Fresh leaves, fruits	Eaten as vegetable
17.	*Curcuma amada*	Zingiberaceae	Rhizome	In salad and chutney
18.	*Diospyros melanoxylon*	Ebenaceae	Fruits	Ripe fruits are eaten as raw
19.	*Eclipta prostrata*	Asteraceae	Tender leaves	Used as vegetable
20.	*Launaea procumbens*	Asteraceae	Leaves	Cooked as vegetable
21.	*Leptadenia reticulata*	Asclepiadaceae	Flower	Cooked as vegetables
22.	*Madhuca Indica*	Sapotaceae	Flowers	Eaten as vegetables, flowers are dried and powdered by the tribals and then they make chapattis out of it
23.	*Moringa oleifera*	Moringaceae	Fruits, young and tender leaves and flowers	Used as vegetable. The fruit known as drum stick is highly suitable with pulses

24.	*Nyctanthes arbor-tristis*	Oleaceae	Flowers, leaves	Used as vegetable
25.	*Phyllanthus fraternus*	Euphorbiaceae	Tender leaves, shoots along with fruits	Eaten raw or cooked as vegetable
26.	*Portulaca oleracea*	Portulacaceae	Tender shoots and leaves	Used as vegetable alone or mixed with other vegetables
27.	*Saccharum spontaneum*	Poaceae	Young shoots and rhizome	Eaten as sugarcane, sweet in taste
28.	*Saraca indica*	Caesalpiniaceae	Fruit	Chewed as substitute for areca nut
29.	*Solanum nigrum*	Solanaceae	Young leaves, ripe fruit	Used as mixed vegetable with other vegetables, eaten raw
30.	*Solanum xanthocarpum*	Solanaceae	Fruit	Eaten as vegetable
31.	*Thespesia populnea*	Malvaceae	Young leaves and flower buds	Eaten fried
32.	*Tribulus terrestris*	Zygophyllaceae	Whole plant	Cooked as vegetable
33.	*Vitex negundo*	Verbenaceae	Tender leaves	Used as vegetable
34.	*Xanthium strumarium*	Solanaceae	Saplings, young shoots and leaves	Used as vegetable usually with potato and other vegetables
35.	*Ziziphus mauritiana*	Rhamnaceae	Fruit	Eaten fresh. The fruits are sliced or pounded and dried under the sun and preserved for future use. The powdered sour item is used to mix with other curries. Pickles are also prepared with this fruit

Fig. 2.2 Medicinal plants in Rajasthan

nutrition-related diseases and ensure physical and mental well-being (Rivera et al. 2005).

All over the world, medicinal foods are part of the cultural and customary diet in several populations. From research, it is clear that nutrition plays a vital role in the prevention of chronic disease and also provides prophylactic benefits. The concept of edible medicinal plants is to prevent chronic disease and provide preventative benefits. Still, research needs to know the exact mechanism of action of the isolated



Figs. 2.3 and 2.4 Show the location of the study area in Rajasthan and India

compounds of various traditionally used plant extracts. A precaution is necessary when the edible medicinal plants are used as dietary adjuncts on conventional pharmacological therapy. One should carefully investigate the possible interaction, either food-drug or herb-herb interaction (Ramalingum and Fawzi Mahomoodally 2014). Edible medicinal plants of Rajasthan are given in Table 2.3.

Table 2.3 Edible medicinal plants from Rajasthan, India

Biological source	Family	Part used	Part used in different form	Therapeutic effect	Agro techniques	Reference
Capparis decidua (Forsk.) Edgew	Capparaceae	Young shoot	Powdered	Toothache	Rooted stem cuttings	Kumar et al. (2013)
		Young leaves		Boils and swellings		
		Bark		Cough and asthma		
		Root bark		Intermittent fever, rheumatism and inflammation		
		Root	Ash	Bone setting		
		Fruit	Edible	Biliousness and cardiac trouble		
		Fruit	Dried	Cure cough and as vermifuge		
			Powdered			
		Stem	Fresh juice	Ring worm disease		
Cissus quadrangularis Linn.	Vitaceae	Stem	Juice	Scurvy	Stem cuttings	
		Shoots/ stem	Fresh paste	Bums and wounds healing		
		Whole plant	Powdered	Carminative, anthelmintics, aphrodisiac, and stomachic		
		Stem	Crushed	Poultice for bone setting		
Mollugo cerviana (L.) Seringe	Molluginaceae	Whole plant	Powdered	Antiseptic and stomachic	Grown easily from seed	
		Plant	Infusion	Fevers, promoting lochial discharges and blood purification		
		Oil	Boiling the roots	Gout and rheumatism		

		Seed	Boiled in water	Body cool during summer		
Punica granatum Linn.	Punicaceae	Root	Powder or decoction	Dewarming among children	Cutting/seeds	
		Flowers	Juice	Bleeding nose		
		Fresh fruit	Juice	Dyspepsia, cold, cough, diarrhoea, and dysentery		
		Fruits	Rind	Bleeding piles, colitis, uterine disorders, diarrhoea, dysentery, and cough		
		Flower	Powdered	Bronchitis		
		Seeds	Powdered	Stomachic		
		Stem bark	Powdered	Bronchitis and pyorrhoea		
Salvadora oleoides Decne.	Salvadoraceae	Fruit	Raw	Cooling effect	Propagated through seeds	
		Leaves	Powdered	Cough		
		Young branches and roots	Raw	Tooth brush		
		Seed	Paste and oil	Rheumatism		
Tamarindus indica Linn.	Caesalpiniaceae	Fruit	Pulp	Digestive, carminative and laxative	Propagated by seed or vegetatively	
		Fruit	Infusion of pulp	Loss of appetite		
		Fruit	Juice	Heat stroke and fever		
		Fresh leaves	Poultice	Swellings, bleeding piles and boils		
		Seed	Powdered	Chronic diarrhoea, dysentery, and jaundice		

(continued)

Table 2.3 (continued)

Biological source	Family	Part used	Part used in different form	Therapeutic effect	Agro techniques	Reference
		Flower	Poultice	Inflammations and conjunctivitis		
		Seed	Kernel	Mild purgative and stimulant		
		Stem	Bark	Sores and boils		
Ziziphus mauritiana Lamk.	Rhamnaceae	Fruits	Mucilaginous	Tonic, digestive, and blood purifier	Easily grown from seeds and planted	
		Fruits	Loshanda	Cold, cough, and chest problems		
		Seeds	Liquid	Sedative, anti-emetic, and relieve abdominal pain during pregnancy, antidote		
		Leaf	Paste	Old wounds and ulcers		
		Root bark	Liquid	Thirst and bronchial asthma		
		Branches	Gummy product	Dysentery		
Citrullus colocynthis	Cucurbits	Seed	Oil	Bowel complaints		Nadakarni (2009)
		Seed	Oil	Epilepsy		Tomar and Kumar (2019)
		Fruits	Small fruits are collected during rainy season, stuffed with salt and ajwain (powder)	Acute stomach ache		Krupa (2008)
		Seeds	Oil and powder	Cooking purpose		Badifu and Ogunsua (1991)
				Soup thickener and flavouring agent		

		Fruit	Extract of pulp	Anti-bacterial		Singh et al. (1996)
		Fruit	Juice of fruit mixed with sugar	Dropsy		
		Root	Poultice	Inflammation of the breasts		
		Root	Powder of roots mixed with ginger and jaggery	Inflammation of joints		
		Seed	Oil	Useful in hair growth and maintaining them black		
		Fruit and root	Fruit and root paste with water	Boils and pimples		
		Root	Equal parts of the root with long pepper is given as pill	Rheumatism		
		Root	Paste of root applied to the enlarged abdomen of children	Enlarged abdomen		
		Fruit	Juice of the fresh fruit is made. Cotton dipped in juice is placed over the mouth of uterus	Timely and easy delivery		
		Fruit	Decoction is drunk	Hepatitis		Dafni and Lev (2002)
		Root	Paste	Ascites, jaundice, urinary disease and rheumatism		Meena et al. (2014)
		Fruit and root	Fruit and root-antidote	Snake poison		
		Fruits	Fruits in low doses	Urticaria, constipation, and toxaemia		
		Seed	Seed oil apply on hair	Blackness grey hair		
		Seed	Pulp of seeds	Malaria		Ali et al. (2004)

(continued)

Table 2.3 (continued)

Biological source	Family	Part used	Part used in different form	Therapeutic effect	Agro techniques	Reference
		Fruit	Fruit pulp dried and powdered and taken orally	Cause abortion		Gupta and Solanki (2013)
		Fruit and seed	Jam prepared from pulp of fruits and seeds	Effective in curing biliousness in animals		Upadhyay et al. (2010)
		Root	Root base mixed with cow milk is applied on hypogastrium	Easy delivery		Yadav et al. (2006)
		Whole plant	Glycosidic extract (50 mg/kg)	Lowering glucose level		Jung et al. (2006)

2.3 Famine Food Plants Used in Different Districts of Rajasthan

Traditional knowledge of local inhabitants that rely on herbs, plants, or different fruits to meet their essential nutrients, especially during the drought period, is detail below.

2.3.1 Plant Species and Their Practices of Utilization and Perceptions of Inhabitant

2.3.1.1 Cenchrus biflorus (Bhurat)

Grass of the desert grown generally throughout the year is used as emergency food during the famine period around this locality. In the prickly husk, the seeds are enclosed. It is a nutrient-rich food; prepared seeds are ground and baked into thick sogra. They believe that seeds have a high content of fat and trace elements, but no scientific data is available to confirm the same.

2.3.1.2 Prosopis cineraria (Khejari)

This is the most common tree found in the desert. As a vegetable, it is using during the famine by the local name of sangeri, the young pods of the plant. The fruits of the plant have sweet pulps believed as an excellent source of carbohydrates and nutrients. During the famine period, the bark of khejari was ground and mixed with flour to prepare rotis.

2.3.1.3 Calligonum polygonoides (Phog)

This plant commonly grows on the bare dunes of the desert, generally in February and March. Buds of this plant are used by the inhabitants with buttermilk and salt. A high amount of protein is present in the flowers.

2.3.1.4 Tribulus terrestris (Kanti, Gokhru)

Small annual herb, during famine spiny fruit is used as a source of nutrients. Seeds are ground for baking into bread or mixed with bajara.

2.3.1.5 Acacia nilotical (Banwalio)

An evergreen tree. Seeds are known as ‘nilario’ and are eaten roasted or raw at the time of acute scarcity.

2.3.1.6 Capparis decidua (Ker)

This plant or shrub is generally found in the desert area throughout the year. Unripe fruits of this plant are used as vegetables and pickles which contain a high amount of protein.

2.3.1.7 Zizyphus nummularia (Bordi)

In dry open plains, this thorny bush is very common; even it grows in the areas of scanty rainfall. Fruits of this plant are ripened, dried, and stored in the session which are then used during the famine. Inhabitants of this locality use distilled spirituous liquor from fruits, flowers, bark, roots, etc. The powder form of fruits is eaten as such or mixed with jaggery.

2.3.1.8 Citrullus colocynthis (Tumba)

In the districts Jaisalmer and Barmer of the state, this plant is grown in the desert area. Before the use process is done, seeds are cleaned and washed several times with salt water to remove the bitterness; or for few weeks, seeds are buried with salt kept in a small pit. During the scarcity of food, it is used with chapattis either solely or mixed with bajara. A famous delicious regional food named Kankra is prepared by mixing seeds with flour.

2.3.1.9 Citrullus lanatus (Matira)

In the desert, watermelon grows especially in dry sand; the fruit’s pulp is eaten as fresh. Seeds of the fruit are dried and made into flour. Rotis are made by mixing flour with bajara. People also eat roasted seeds with salt during the famine.

2.3.1.10 Cucumis callosus (Kachari)

The fruits are a common source of vitamin C, ripe fruits are eaten, and unripe fruits are used as vegetables. Local people used it during the famine and on normal days.

2.3.1.11 Salvadora oleoides (Kharo Jal, pilu)

Inhabitants of the desert area during the scarcity of food use the fruit of this plant that grows in the arid region as an evergreen shrub or small tree. It is believed that the excessive use of this fruit produces tingling and small ulcer in the mouth.

2.3.1.12 Lasiurus hirsutus (Sevan)

It is a valuable grass that grows in the desert area; seeds of this plant are ground and mixed with bajra flour and baked into sogra. It is a good source of vitamin A as believed.

2.4 Cultivation in Rajasthan

Agriculture is the main occupation of tribals. Although farmers use advanced agricultural implements in various parts of Udaipur, the poor tribals of this particular region cannot manage these implements. They still depend on traditional methods and tools. To manufacture these traditional implements, tribal farmers depend on plants—plough, traditionally known as a hal or har. The yoke and beam of the plough are made up of Acacia nilotica. The wood for the share is taken from Acacia catechu. To fix the parts, use strongly wooden pieces of Tectonagar and are inserted along.

Leveller, traditionally known as maido, ken, and hamada, is a thick rectangular wooden block around 10 ft long. Generally using two poles, it is connected to a yoke to which the beasts of burden are tied. One or more persons stand on it while the oxen pull it.

The commonly used timber for making a leveller is Terminalia tomentosa. Acacia catechu and Zizyphus papyrus may be used also.

A leveller is also employed for covering seeds after broadcasting or levels the soil after ploughing. Seed drill, traditionally known as penni or parani, is a seed-sowing device made of hollow bamboo. Its one end is sliced into several parts; the ring-separated pieces are shaped into a circular rim of the cone or funnel so formed. Sewing leather on the inside is an optional reinforcement.

The ripe crop is harvested with iron sickles, traditionally known as dental or danteda with bamboo handles. Threshing is carried out under the hooves of oxen generally. The harvested grains are heaped around a wooden post to which two to three oxen are tied with a rope. A person with a stick ushers the oxen round and round the post (mend), treading the grains.

Though a pole from the durable wood of any species may be planted as mend, inquiries in several crops field revealed that the usual species selected are Acacia catechu, Diospyros melanoxylon, Tectona grandis, and Terminalia tomentosa.

The use and cultivation of plants and their products for nourishment, shelter, and protection by the early man suggest a very long history of ethnobotany.

Two branches ethnobiology and human ecology have very great significance for the security of human beings and the animal world. Without knowing the composition of plant products, they have been used for ages to preserve the community's art, tradition, and culture. The development of ecology relies on the contribution of ethnobiology.

2.4.1 Study Area: Pratapgarh Tehsil, Rajasthan—Geographical Location

Pratapgarh is located at 24.03° N 74.78° E with an average elevation of 580 m; this is said to be the second-highest place in Rajasthan after Mount Abu. The district is situated on the junction of the Aravali mountain ranges and the Malwa plateau, with a unique location of transjunction of geological characteristics of two different habitats. The geographical area of Pratapgarh is 411,736 hectares, out of which forest area is 120,976 hectares, shown in Figs. 2.3 and 2.4.

2.4.2 Climate, Soil, Topography, and River

In this area, the climate is characterized by a sub-tropical dry climate with distinct hot summers, cold winters, and rainy monsoons. In May–June, the temperature reaches above 43 °C, and in December–January, it reaches the lowest up to 6 °C.

Table 2.4 Table showing statistics of Pratapgarh district land area

S. No.	Particulars	Figure in hectare
1	Total area	411,736
2	Forest	121,003
3	Other than agriculture land	10,916
4	Charageha (permanent)	22,735
5	Actual sown area	178,228
6	Agriculture use	27,587
7	Padat	9147
8	Trees and gardens	194

June–September experience average rainfall of 856 mm with a maximum of 951 mm and a minimum of 517 mm.

The study area of Pratapgarh town and its neighbourhood come under the geographical entity of Aravaliscarpl. This area of land having an average elevation between 350″ and 580″ and Mahi and Jakham Rivers developed the primary drainage system. The adjoining districts of Pratapgarh are Dungarpur, Banswara, Chittorgarh, and Udaipur. In Pratapgarh and Chittorgarh districts, most of the area is either uneven and under cultivation or in the form of ravines and rough surfaces, therefore totally useless for any agricultural practice. The land-use statistics of the district are shown in Table 2.4.

2.4.2.1 Soil Types

The soil is highly fertile, black cotton soil made of magma of volcanoes. According to the hydrogeological survey, the soil is distributed in three categories.

1. Red soil: Such type of soil has high iron-rich sedimentary rock, low nutrients, and poor growing soils.
2. Black loam soil: Such type of soil has high nutrients, moisture, and humus and is rich in oxidized ions.
3. Clay loam soil: This soil type is suitable for plant growth, rich in clay particles with traces of metal oxides.

2.4.3 River System

The presence of multiple rivers is due to the Mahi Basin; the names of rivers include Mahi, Jakham, Som, Moran, and Anas with other seasonal rivers Era and Karma. Most of all rivers flow to Arab Sagar.

2.4.3.1 Mahi River

This river originates from the Dhar district of Madhya Pradesh; in Madhya Pradesh state, this river flows southwards for about 120 km then enters in Banswara district of Rajasthan. This river is also called a golden line of the Wagad and Khantal region. This river crosses the tropic of cancer two times; the total area of this river is

16,985 km^2. The tributaries of the Mahi River are Eru, Nori, Chap, Som, Jakham, Anas, and Moran.

2.4.3.2 Jakham River

The Jakham River originates southwest of the hills near Chotisadri in Pratapgarh district of Rajasthan. The Jakham River flows through the hilly region of Udaipur district in the South-western direction and joins with the Som River near Rangoli. The sub-basin is situated in Chittorgarh and Udaipur district. The total catchment area of this is 2318 km^2, and the tributaries are Karmani and Sukhi.

2.4.3.3 Som River

This originates from hills near the village of Kherwada Tehsil of Udaipur district in Rajasthan. This river flows South-East through the hilly region and joins with the Mahi river near the village Baneshwer. Mainly the catchment area lies in Udaipur and Dungarpur districts of Rajasthan. The total catchment area of this river is 6443 km^2; the tributaries are Tide, Gomti, and Jakham.

2.4.3.4 Moran River

This river from the southern hills of Dungarpur town and joins with the Mahi River near galiyakot village. The total area of this river is 6047 km^2; Karma and Sukhi are the tributaries.

2.4.3.5 Anas River

From the hills south of Kanguwa Village in Dungarpur, this river originates and merges with Mahi River. The total catchment area of the Anas River is 6047 km^2.

2.5 Support on Economy

Parts of the population in a rural area of Rajasthan rely on edible medicinal plants to earn. Edible medicine is obtained from plants and animals to maintain their health and/or of animals (Mathur 2018). The seasonal plants also contribute to the economy. Edible plants are referred to as plant species cultivated or domesticated but are found in various natural areas and used as food.

A study was carried out in the year 2000–2001 in the Chipiya Nada village of Jodhpur district to work out the economics of various products obtained from Prosopis cineraria trees. The study area was 4 hectares having trees of different ages with a density of 12–15 trees per hectares. The findings are given in Table 2.5.

Another study in the same village on an open-grown *P. cineraria* tree of 60 years of age having a large crown showed that the tree would fetch about Rs. 1032/tree to the farmers from its various components if the tree is not lopped every year. The details are given in Table 2.6.

The trend of market prices of dried fruit, called Sangri, in Jodhpur during 1996–2000 is given in Table 2.7.

Table 2.5 Various produces of *P. cineraria*, their yield, and economic value

Products	Average yield/tree (kg)	Total yield (kg)	Rates/kg (Rs.)	Total value (Rs.)
Fodder	10	500	3	1500.00
Fuel wood (twigs of lopped tree)	2.500	125	0.40	50.00
Dry pods	0.500	25	60	1500.00

Table 2.6 Economic analysis of various components of a *P. cineraria* tree

Products	Quantity	Rates	Value in Rs.
Fodder	60–75 kg	Rs. 3/kg	180.00
Fuel wood (twigs of lopped tree)	80 kg	Rs. 0.40/kg	32.00
Pods	5–6 kg	Rs. 60/kg	300.00
Total wood (wet)	8 quintal	Rs. 60–70/quintal	520.00

Table 2.7 Market prices of Sangri

Years	Buying prices (Rs./kg)		Selling prices (Rs./kg)	
	Dry	Wet	Dry	Wet
1996	40.00	5.00	48.00	6.00
1997	43.00	5.00	50.00	6.00
1998	58.00	7.00	70.00	8.00
1999	55.00	6.00	58.00	7.00
2000	55.00	8.00	60.00	9.00

2.6 Challenges

In the ecosystem, the distinctive challenge is deforestation, and it is because of industrialization and colonization. The key to forest diversity is the various plants that are present in the forest. Also, the forest is a haven for multiple animals and plant species. Over 13,000 documented terrified groves were notified in India. The developing countries' economy depends upon forest products. The human population increases continuously, and it is challenging to provide daily needs like food and medicine; human beings rely on the forest to fulfil daily requirements. Excess requirements lead to continuous erosion of forest and forest products, and it creates a challenge to meet the needs and conserve useful bio-resources (Samal et al. 2004).

In the market, the requirement increases continuously; different species are added to the list of medicinal plants. To fulfil the expansion we need to keep the purity of the standard and correct identification of the plant (Ballabh and Chaurasia 2009). The product market price of medicinal plants and derived materials gives limited information; it does not provide exact information about profits, supply, and demand. These are significant challenges identified based on screening of the existing knowledge in the medicinal plants' field.

2.7 Conclusions

Rajasthan, a state of India, is the hub of various plants used as a source for medicine, food, and industrial products. A survey needs to update the multiple species of plants for updating and cross-validation of data from time to time. From this exciting information regarding distribution, production, and market rates, economics worked on how it contributes to the state's economy and the country. The existing markets, a marketing network for various products, will help the farmers cultivate the product. Priority is always given to the long shelf-life of the products and the quality of the product material and its certification.

The studies indicate that the cultivation of edible medicinal plants adopted in these locations is socio-economical, with several farm patches, yearly income from agriculture activities, and a utilization system. Such adaptation farming provides financial resources, facilities, and necessary materials to develop medicinal plants and make them more valuable. Finally, after studying the medicinal plants in this region, looking more domestication of these plants and determining the profitable cultural features. Needs more work on the planting, maintenance, and harvesting of these plants. It is our hope that the farmers of these localities will improve the economy by marketing medicinal products, foods, and industrial products.

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3 Traditional and Economic Valuation of Edible Plants Used for the Treatment of Diabetes

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Abstract

Diabetes has emerged as one of the major health problems of the modern world. It is often described as a syndrome rather than a disease. It is considered to result in abnormalities in carbohydrate, fat and protein metabolism. It signifies a condition where body is unable to regulate carbohydrate metabolism due to partial or complete absence of insulin. Inadequate regulation of the blood sugar in turn starts a cascade of imbalances in the fat and protein metabolism. These impose serious consequences to the health of patients. The complications that ensue due to glycation of proteins and deposition of fat are diabetic nephropathy, retinopathy and cardiovascular disorders. Thus diabetes along with its related complications result in high incidences of morbidity and mortality among the sufferers. As per the recent estimates the incidence of diabetes are increasing at alarming rates worldwide. India in particular is termed as the diabetes capital of the world. The conventional antidiabetic drugs are oral hypoglycaemic drugs and insulin therapy. These interventions are effective in the management of diabetes,

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however, they do not treat it and some of them have serious side effects. Medicinal plants offer highly attractive alternative to synthetic antidiabetic agents. In this chapter the plants with antidiabetic potential are described with focuses on edible plants. The use of edible antidiabetic plants or products remains the mainstay of the chapter. Individual plants have been described with respect to the biological source, geographical origin and distribution, traditional uses along with their biologically active compounds and pharmacological reports.

Keywords

Edible plants · Traditional and economic valuation · Diabetes · Hypoglycaemic drugs

3.1 Introduction

Diabetes is a metabolic syndrome with high personal, social and economical impacts. It is defined as syndrome as it results in metabolic disorders like obesity, hypertension and dyslipidaemia, etc. These associated abnormalities result in high incidences of cardiovascular morbidity and mortality in diabetes (Ahamad et al. 2019). The number of individuals diagnosed with diabetes is increasing rapidly. India being the part of the International Diabetes Federation (IDF) for the Southeast Asia (SEA) region. As per its estimates, the number of people with diabetes in the world is 415 million while in the SEA region there are 78 million people affected by the disease; it is slated to rise to 140 million by 2040. Moreover, there have been 77 million cases of diabetes in 2019 in India that is expected to rise to 101.0 million and 134.2 million by 2030 and 2040, respectively (IDF 2019).

Disease has always been considered as a disruption by the people all over the world. It poses social, mental and economic challenge to people. Different communities have devised practices and traditions to overcome diseases and stay healthy. Man has always explored the use of plants, animals and minerals to develop agents to prevent or mitigate diseases and to maintain health. Medicinal plants and animals and their products have been used throughout the globe from the beginning of human civilization. Plants have served man for food, clothes, shelter and as remedies for ailments. Edible plants in the form of vegetables and spices are reported beneficial in several human ailments including diabetes. Since the ancient days, mankind has explored natural resources and used them as a remedy for the cure against the diseases. The traditional systems such as Ayurveda, Unani, Chinese traditional medicine and Homeopathy are examples of prominent traditional systems used for the treatment of diseases (Fabricant and Farnsworth 2001).

Plants have an unsurmountable advantage in the search for new drugs owing to their age-old human use. Based on this historical perspective, the compounds derived from medicinal plants can be expected to have least human toxicity. Besides, the diversity of chemical compounds resulting due to the evolutionary development of plants is often equal or superior to those by the combinatorial chemistries

(Newman et al. 2003). Alternative medicines like Ayurveda, Unani, Kampo and Traditional Chinese Medicine use natural products as effective interventions that have become a significant part of the therapeutic regimes against cancers, diabetes, malaria, arthritis, inflammation, liver diseases and neuro-degenerative diseases (Patwardhan et al. 2004). World Health Organization has found that a significant part of the world's population (about 65%) uses traditional medicines for their basic health care. These medicines are used in the primary healthcare system especially in the developing nations (Farnsworth et al. 1985). It is also estimated that about 80% of the world's population have used herbal medicines at least once in their life time, this includes people from developed countries.

The utilization of plants as drugs is a vital component of the complementary healthcare practices in India. Here most practitioners of the traditional systems formulate and dispense their recipes for different diseases. The interest in these medicines is growing rapidly among populations because of the increased evidences of their effectiveness (Dubey et al. 2004). The high cost of synthetic drugs also plays a part in making people to opt for traditional medicines. During the last few decades, the utilization of herbal drugs has expanded globally and day-by-day its popularity is increasing. As an extension of the increased use of medicinal plants for the prevention and treatment of diseases, edible plants are being widely used for therapeutic and preventive purposes. This has given rise to the concept of nutraceuticals and functional foods. Diabetes continues to be one of the major challenges to the wellbeing of a large part of world population. Researchers are looking for safe and effective drugs from natural sources especially for the management of diabetes. As per ethnobotanical reports there are about 800 plants that are beneficial against diabetes (Alarcon-Aguilara et al. 1998; Grover et al. 2002). Several edible plants have proven to be antidiabetic activity using presently available experimental methods. In this chapter, an effort has been made to compile data on the traditional and economic valuation of edible plants used for the treatment of diabetes.

3.2 Current Therapies for Diabetes Mellitus

Type 1 and 2 diabetes mellitus are incurable chronic conditions but have been managed since insulin became medically available in 1921. Type 1 DM is mainly treated by the administration of exogenous insulin and exercise. Type 2 DM is treated by oral hypoglycaemics and insulin supplementation. For improvement of insulin availability mainly exogenous insulin preparations, sulphonylureas and meglitinides are used. For the treatment of insulin resistance biguanides, thiazolidinediones, dipeptidyl peptidase IV inhibitors (DPP-IV) and sodium-dependent glucose transporter (SGLT) inhibitors are used. The conventional drug therapies for diabetes include the use of oral hypoglycaemic drugs and insulin injection. None of these regimens result in recovery from diabetes. Moreover, these drugs are associated with several adverse effects. Plants are the source of hypoglycaemic drugs that are widely used in several traditional systems for the management of diabetes and its related conditions. Many medicinal plants have been investigated for their role in diabetes management. These plants may delay the onset and progression of diabetes or rectify the underlying abnormalities through multiple mechanisms. Several plants and their extracts have been subjected to trials in experimental animals and humans and were found to be effective (Grover et al. 2002). Newman and Cragg (2016) reported that a total of 52 drug molecules were discovered between 1981 and 2014; out of which seven drugs were natural products or natural product derivatives; 23 were derived biological sources and four drugs were of synthetic origin. Eleven drugs were synthesized that mimic natural products and seven drugs were synthesized with natural products as the pharmacophore for the treatment of diabetes.

3.3 Traditional Edible Plants Used in Diabetes

Since ancient times plants are recognized to fulfil human necessities like food, clothes, shelter and remedies for ailments. Since the time immemorial, mankind has explored natural resources and used them as a remedy against diseases. The traditional system of medicines such as Ayurveda, Unani and Homeopathy are examples of the traditional practices adopted by different cultures for treating diseases. Plants have been used as medicinal agents for the treatment of various ailments in different ancient civilizations. The knowledge of medicinal values of these plants was inherited from generation to generation. It is imperative to use medicinal plants that have been properly documented and researched. This is also needed to ensure safe use of natural products as therapeutic and medicinal agents. Higher medicinal plants have several advantages in drug discovery compared to synthetic drugs because they have a long history of use by humans as food and spices that are generally regarded as safe (Lahlou 2007). In the traditional systems of medicine, several edible plants are reputed to have beneficial effects in diabetes, and their efficacy is also proven by experimental studies. The following section highlights the use of some common medicinal plants in diabetes. Table 3.1 compares the key features related to the composition and mechanisms of action of antidiabetic medicinal plants:

3.3.1 *Aegle marmelos* (Bael)

Aegle marmelos L. (Rutaceae) fruit pulp is traditionally considered useful in the management of diabetes. The alcoholic leaf concentrate of *A. marmelos* showed marked enhancement in the ability to neutralize the excess glucose in glucose-challenged rats (Sachdewa et al. 2001). Water extract of *A. marmelos* fruits is known to show a hypoglycemic impact in streptozotocin-induced diabetic rats at the dose of 125 and 250 mg/kg two times per day. After 4 weeks, the blood glucose level was brought back to the normal (Kamalakkannan and Prince 2003). The impact of methanolic concentrate of *A. marmelos* has been screened on glucose carrier (Glut-4), peroxisome proliferator activator receptor (PPAR-γ) and

Table 3.1 Traditional edible plants with antidiabetic activity

Plants	Edible part	Bioactive phytochemicals	Pharmacological action	References
Aegle marmelos	Fruits	Aqueous extract	Inhibits α-glucosidase enzyme	Kamalakkannan and Prince (2003)
Allium cepa	Bulb	Scillaren A and B	Hypoglycaemic effect	Islam et al. (2008)
Allium sativum	Bulb	S-allyl cysteine	Antidiabetic effect	Sheela and Augusti (1992)
Carica papaya	Fruits	Quercetin, Kaempferol flavonoids and β-sitosterol	Hypoglycaemic effect	Kaur et al. (2019)
Camellia sinensis	Leaves	Caffeine and Epigallocatechin gallate	Antidiabetic effect	Sabu et al. 2002)
Cinnamomum tamala	Leaves	Essential Oils	Antidiabetic effect	Kumar et al. (2012a, b)
Cinnamomum zeylanicum	Bark	Essential Oils	Inhibits α-glucosidase enzyme	Kaskoos (2019)
Coriandrum sativum	Fruits	Essential Oils	Antidiabetic effect	Naqvi et al. (2012)
Cucumis sativus	Fruits	Syringic and *p*-coumaric acids	Hypoglycaemic effect	Shah et al. (2013), Jamal et al. (2011)
Curcuma longa	Rhizome	Curcumin, Ferulic acid	Decreases insulin resistance	Na et al. (2011)
Eugenia jambolana	Fruits	β-sitosterol, quercetin, kaempferol	Antihyperglycemic effects	Jana et al. (2015)
Ficus racemosa	Fruits	α-Amyrin acetate	Hypoglycaemic effect	Ahmed and Urooj (2010)
Magniferaindica	Fruits	Mangiferin	Antidiabetic effect	Irondi et al. (2016)
Malus domestica	Fruits	α-amylase and quercetin	Antidiabetic effect	Patel et al. (2012, 2015)
Momordica charantia	Fruits	Peptides and Charantin	Increases insulin release and decreases insulin resistance, and inhibits α-amylase and α-glucosidase enzymes	Ahmed et al. (1998), Anun et al. (2006), Fuangchan et al. (2011), Perumal et al. (2015), Raish et al. (2016), Singh et al. (1989), Singh and Gupta (2007)

(continued)

Table 3.1 (continued)

Plants	Edible part	Bioactive phytochemicals	Pharmacological action	References
Moringa oleifera	Immature green pods	Flavonoids	Hypoglycaemic effect	Gilani (1992)
Murraya koenigii	Leaves	Essential oils	Antidiabetic effect	Arulselvan et al. (2006)
Nigella sativa	Seeds	Thymoquinone	Antihyperglycemiceffects	Sangi et al. (2015)
Ocimum sanctum	Aerial parts	Eugenol, caffeic acid, *p*-coumaric acid	Antidiabetic effect	Singh et al. (2016)
Olea europaea	Fruits and oil	Oleuropein	Decreases fasting blood glucose levels.	Khalili et al. (2017), Lepore et al. (2015)
			Increases insulin secretion and sensitivity.	
Punica granatum	Fruits	Gallic acid	Hypoglycaemic effect	Middha et al. (2013)
Psidium guajava	Fruits	Gallic acid and Carotenoids	Antidiabetic effect	Barbalho et al. (2012)
Rosa damascena	Flowers	Flavonoids	Inhibits α-glucosidase enzyme	Gholamhoseinian et al. (2009)
Trichosanthes dioica	Fruits and Seeds	Tetra and pentacyclic triterpenes, Cucurbitacin B, Charantin	Antihyperglycemic effects	Rai et al. (2008)
Trigonella foenum-graecum	Seeds	4-Hydroxy-isoleucine	Increases insulin release	Yoshikawa et al. (1997)
Zingiber officinale	Rhizome	Shogaol and gingerol	Hypoglycaemic effect	Akhani et al. (2004)

phosphatidylinositol kinase (PI-3 kinase) engaged with glucose transport. It was found active at 100 ng/mL dose and was compared with insulin and rosiglitazone. Umbelliferone galactoside from the stem bark of this plant demonstrated significant decrease in fasting glucose level and improved insulin level in STZ-induced diabetic rat. It also markedly truncated glycated haemoglobin, glucose-6-phosphatase and improved the hexokinase activities (Kumar et al. 2013).

3.3.2 *Allium cepa* (Onion)

Allium cepa (Liliaceae) is one of the widely cultivated plants used as vegetable and for flavouring around the world. The main onion producing states in India are Maharashtra, Madhya Pradesh, Karnataka, Tamil Nadu, etc. Sulphur compounds present in the onions are responsible for the flavour of the onion that is affected by the type of water supply used in cultivation (Jose and Krishnakumar 2017). Quercetin and its glycosides are the most abundant flavonoids in onion (Marrelli et al. 2019). Antidiabetic properties of aqueous onion extract and the compounds isolated from onion and their synthesized derivatives were screened. All the samples exhibited significant antihyperglycemic and antihyperlipidemic effects in diabetic rats (Islam et al. 2008).

3.3.3 *Allium sativum* (Garlic)

Allium sativum Linn (Liliaceae) is another widely consumed and cultivated plants. Its fresh and dried rhizomes are used. Garlic and its disulfur compounds have been used for their antimicrobial, hypolipidemic, antithrombic, hypoglycaemic and antitumor effects (Thomson and Ali 2003). Its alcoholic extract exhibited potent activity in diabetic rats (Eidi et al. 2006). Its rhizomes contain S-allyl cysteine sulphoxide that has antidiabetic effect in rats with alloxan induced diabetes (Sheela and Augusti 1992).

3.3.4 *Carica papaya* (Papaya)

Carica papaya Linn (Caricaceae) is a medicinally important plant from Central America and cultivated in tropical regions in Africa and Asia. *C. papaya* serves as tenderizing agent, digestant and medicine against a wide range of diseases. It contains quercetin, kaempferol and sterols. Some of these compounds exhibited hypoglycaemic effects. Payapa has antibacterial, antifungal, hypoglycaemic, anticancer, cytotoxic, anti-thrombocytopenic, antihypertensive effects. It also shows anti-HIV, antihyperlipidemic, anti-inflammatory, antifertility, antiparasitic, anthelmintic, anti-arthritic, antiulcer and nephroprotective activities (Kaur et al. 2019). Aqueous extract of papaya seeds showed antidiabetic and antihyperlipidemic activities in the STZ and nicotinamide-induced diabetic rats (Venkateshwarlu et al. 2013).

3.3.5 *Camellia sinensis* (Tea)

Camellia sinensis (syn. *Thea sinensis*) belongs to the family Theaceae that occurs as an evergreen bush indigenous to Assam (India), China and Japan. It grows to about 9 m height, however, in cultivated tea gardens it is pruned to 1.2–1.5 m height (Duke 2001). Today tea is one of the most consumed beverages besides coffee. The flavour of the tea is due to volatile oils and its stimulant activity is because of caffeine. Its astringent taste is due to tannins that is controlled by letting it ferment. Other tea-like beverages are produced using the leaves or blossoms of different medicinal plants (Yamamoto et al. 1997; Mahmood et al. 2010). Epigallocatechin gallate from tea leaves decreases lipid peroxidation and content of hydroxyl and superoxide radicals when tested in vitro. The effective level required to inhibit superoxide, hydroxyl and lipid peroxidation radicals to half was found to range from 10 to 136 mg/mL. Administration of green tea polyphenols to rodents at 500 mg/kg BW extended the glucose tolerance time to 60 min. Green tea polyphenols were additionally found to diminish sugar levels in diabetic rats. Its pre-treatment for 2 weeks blunted the surge in glucose levels on allox an administration (Sabu et al. 2002).

3.3.6 *Cinnamomum tamala* (Indian Bay Leaf)

Cinnamomum tamala (Lauraceae), commonly known as Indian Bay Leaf, Tejpat or Malabar Leaf, is native to India, Bhutan and China. The leaf volatile oil contains a high proportion of monoterpenes consisting of sabinene, β-ocimene and myrcene along with some sesquiterpenes, namely germacrene A and α-gurjunene (Mir et al. 2004). *C. tamala* is used for lipid lowering activity, antidiabetic activity, antioxidant activity, anti-diarrhoeal activity, gastroprotective activity, stimulant, astringent, diuretic, carminative, antifungal activity, reno-protective properties and immunomodulatory property (Pravin et al. 2013). Oral administration of volatile cinnamon oil and its main constituent have antihyperglycemic and antihyperlipidemic effects in rats with STZ-induced diabetes (Kumar et al. 2012b).

3.3.7 *Cinnamomum zeylanicum* (Cinnamon)

Cinnamomum zeylanicum Blume (Lauraceae) is fundamentally for its aroma and essence in different industries. It is also used for flavouring foods, cosmetics and medicines (Huang et al. 2007). The cinnamon species barks are the sources of flavours utilized worldwide in cookery, traditional and modern medicines (Sangal 2011; Vangalapati et al. 2012). The oil is emmenagogue, liver tonic, anti-inflammation, antisapasmodic and carminative (Kirtikar and Basu 1984). The main constituents of cinnamon oil are cinnamaldehyde. It is responsible for its aromatic smell and the biological activities (Yeh et al. 2013). The steam-distilled oil from *C. zeylanicum* has antioxidant (Chericoni et al. 2005) and antidiabetic effects (Lee et al. 2013; Kaskoos 2019).

3.3.8 *Coriandrum sativum* (Coriander)

Coriandrum sativum Linn (Apiaceae) has its origin from Eastern Mediterranean and it is used as a spice. One of the major producers of coriander is India along with China and Russia. Its fruits are used in curry powder. Leaves are known as Cilantro and are used for garnishing and in preparing chutney, sauces and curries. Fruits are carminative and spasmolytic in action. The dried coriander fruits contain about 0.1–0.3% of volatile oil. The major components in the oil of coriander fruits are linalool (corinaderol), neryl acetate, γ-terpinene and pinene. The pharmacological actions of *C. sativum* include antioxidant, antiseptic, antihyperglycemic, hepatoprotective and antihyperlipidemic effects (Asgarpanah and Kazemivash 2012). Aqueous extract of *C. sativum* reduces blood glucose level and thus exhibits antidiabetic effect (Naquvi et al. 2012).

3.3.9 *Cucumis sativus* (Cucumber)

Cucumis sativus belongs to the family Cucurbitaceae. Genus *Cucumis* having two types of subgenus which are present in African and Asian regions. Cucumber is indigenous to the Himalayan region of northern India (Pune, Maharashtra, Uttar Pradesh, Himachal Pradesh) and is domesticated in China, Europe and America (Mukherjee et al. 2013). *C. sativus* is a well-known food and with known therapeutic uses in Ayurveda. Extract of *C. sativus* showed hypoglycaemic effect in rabbits (Shah et al. 2013). HPLC analysis determined that five compounds present in the extract inhibited β-glucosidase activity. Two major compounds, namely syringic and *p*-coumaric acids are well known to reduce blood glucose levels (Jamal et al. 2011).

3.3.10 *Curcuma longa* (Turmeric, Haldi)

Curcuma longa L. (Zingiberaceae) is found in the tropical and subtropical areas. It is a perennial herb with about 1 m high stem (Eigner and Scholz 1999). In Asia it is mainly grown in China and India. In India it is locally known as Haldi. The bright yellow colour of rhizomes is due to the presence of fat-soluble polyphenol called curcuminoids. Major constituents of *C. longa* are curcuminoids such as curcumin, demethoxycurcumin and bisdemethoxycurcumin (Chauhan and Mehla 2015). It has anticoagulant, antioxidant, antimicrobial, immunological, anti-inflammatory, anti-cancer, antidiabetic effects (Mehrotra et al. 2013; Labban 2014). Turmeric is regarded as antidiabetic in the Indian sub-mainland (Zhang et al. 2013; Arun and Nalini 2002; Na et al. 2011).

3.3.11 *Eugenia jambolana* (Jamun)

Eugenia jambolana (Syn. *Syzygium cumini*) belongs to family Myrtaceae. Its fruits are popularly known as Jamun or Indian blackberry. It has been indicated in Ayurveda for use against diabetes. Several antidiabetic compounds have been isolated from *E. jambolana* such as sterols: sitosterol; flavonoids: quercetin, kaempferol, myricetin; and polyphenols: gallic acid and ellagic acid. *E. jambolana* has shown hypoglycaemic effects in animal models and human trials (Ravi et al. 2004; Sharma et al. 2006; Jana et al. 2015).

3.3.12 *Ficus racemosa* (Indian Fig Tree)

Ficus racemosa (Moraceae) is considered sacred and an important medicinal plant in India. Genus *Ficus* has more than 800 members that include trees, epiphytes and shrubs in tropical and subtropical regions. It is found in Bengal and Central India. Its bark, fruits, leaves, seeds and root latex are traditionally used against varied diseases. The bark is considered particularly useful in asthma, diarrhoea, epilepsy, gastritis, inflammatory disorders, diabetes, infections and sexual disorders. *F. racemosa* bark has shown a strong hypoglycaemic in in-vitro studies (Ahmed and Urooj 2010).

3.3.13 *Mangifera indica* (Mango)

Mangifera indica (Anacardiaceae) is commonly known as mango. According to Ayurveda, its different parts are associated with various medicinal properties. *M. indica* is the source of medicinally or pharmacological active polyphenols and carotenes. *M. indica* possesses various pharmacological activities such as antioxidant, radioprotective, immunomodulatory, antiallergic, lipolytic, antidiabetic, anti-bone resorption, antitumor, anti-inflammatory, antimicrobial and antiparasitic (Shah et al. 2010). *M. indica* kernel powder is useful in diabetes and related complications (Irondi et al. 2016).

3.3.14 *Malus domestica* (Apple)

Malus domestica (Syn. *M. communis*, *M. pumila*) belongs to the family Rosaceae. Flavonoids are the main phytochemical compounds present in apple that are particularly concentrated in its peels. These include procyanidins, catechins, chlorogenic acid, phloridzin and quercetin. The apple pomace also contains some catechins, procyanidin and phloridzin but in much lower concentrations than in the peels with the exception of chlorogenic acid that is in higher quantity in the pomace. Pharmacologically consumption of an apple can also be related to a lower risk for diabetes and related complications because apple contains a higher concentration of quercetin (Patel et al. 2012). *M. domestica* extracts showed the highest alpha-amylase inhibitory activity which attributes to its antidiabetic potential (Patel et al. 2015).

3.3.15 *Momordica charantia* (Bitter gourd)

Momordica charantia Linn. belongs to Cucurbitaceae with its fruits known as bitter gourd. It is used in several traditional functional foods and medicines in Asia. Its consumption is particularly beneficial in diabetes. Cucurbitane-type triterpenoids are present in the plant. Charantin is the main constituents of its fruits and is reported to effective antidiabetic effect (Ahamad et al. 2017). Charantin was found to produce a gradual and significant fall in glucose when administered to normal rabbits. However, the impact was inconsistent in alloxan induced diabetes in rabbits. On pancreatectomy, the hypoglycaemic effect was found to be moderate. Thus chirantin was postulated to improve insulin release and sensitivity (Lotlikar and Rao 1966). A peptide found in its seeds and fruits, namely Polypeptide-P, was also found to be hypoglycaemic when administered in gerbils (Khanna et al. 1981). The water extract of fruits stimulated release of insulin from mice pancreas (Welihinda et al. 1982). Alcoholic extract of *M. charantia* fruits increases glucose uptake in hepatic tissues and muscles and thus prevents post-prandial hyperglycemia (Chandrasekar et al. 1989).

3.3.16 *Moringa oleifera* (Drumsticks)

Moringa oleifera Lam. (Moringaceae) is an uncommonly nutritious vegetable plant with various potential uses. It is a useful tree with almost each of its parts are utilized for food and other beneficial property. Its young pods are commonly known as drumsticks and are most utilized part of the tree. It has a light green colour and a slight asparagus taste. The blossoms are eatable when cooked, having a taste like mushrooms. The roots are shredded and utilized as a condiment (Fahey 2005). The main chemical constituents responsible for its pharmacological activities are flavonoids namely apigenin, quercetin and kaempferol. The leaves of the plant when mixed to the diet lower the blood glucose level in diabetics even though the plasma level did not alter much, indicating the blood glucose response to the leaves was not because of insulin secretion (Gilani 1992).

3.3.17 *Murraya koenigii* (Curry Leaves or Curry-Patta)

Murraya koenigii (Rutaceae) varies from being a pubescent shrub to a small tree. It has faint aromatic smell and is locally known as Curry-patta in India. Its leaves are used as a spice in India. Its leaves, bark and the roots are tonic, stomachic, stimulant and carminative in action as per the traditional systems of medicine (Nayak et al. 2010). The main constituents of its leaf volatile oil are α-pinene, sabinene, β-pinene, β-caryophyllene and limonene. The extracts of its leaves exhibited antihyperglycemic activity in experimental rats. The observed antidiabetogenic effect was because of antioxidant action of *M. koenigii* (Arulselvan et al. 2006; Arulselvan and Subramanian 2007).

3.3.18 *Nigella sativa* (Black Cumin)

Nigella sativa (Ranunculaceae) is native to South of Europe and is common Mediterranean region. It is also found widely in India, Middle East, Asia and Africa (Al-Ghamdi 2001). Black cumin, as its seed is commonly referred to, is used as medicine and spice as such or as oil. It is beneficial in the treatments of respiratory, digetsive, kidney and liver function, circulatory and immune system ailments (Dwivedi 2004). The significant hypoglycaemic activity has been reported with the use of seeds of *Nigella* and is attributed to their volatile oil. Clinical investigations have supported the antidiabetic effect of the plant (Anwar-ul-Hassan et al. 2004; Al-Hader et al. 1993). Thymoquinone present in its seeds is reported to have beneficial effects in STZ-induced diabetes in rats (Sangi et al. 2015).

3.3.19 *Ocimum sanctum* (Basil or Tulsi)

Ocimum sanctum (Lamiaceae) is a widely distributed medicinal herb used in traditional systems of medicine. In Ayurveda and Siddha systems, the plant is recommended as antimicrobial, antiprotozoal, anti-inflammatory, antiallergic, antimalarial, anthelmintic, antidiarrheal, antihypertensive, cardioprotective, CNS depressant, memory enhancer, anti-hypercholesterolaemic, hepatoprotective, chemo-preventive, antidiabetic, antithyroid, antiulcer, antioxidant, anticancer, immune stimulant, antifertility, anti-arthritic, antiasthmatic and anticoagulant (Pandey and Madhuri 2010). Its leaves contain volatile oil, phenolics, lignans, flavonoids, terpenoids, fixed oil, mucilage, polysaccharides and β-sitosterol. Seed oil is rich in triglycerides with linolenic acid as the major content (Singh and Chaudhuri 2018). Eugenol, the main constituent of its oil, combats diabetes by bringing down blood glucose through α-glucosidase inhibition. It also prevents glycation thereby offering relief in diabetic complications (Singh et al. 2016).

3.3.20 *Olea europaea* (Olive)

The olive tree belonging to family Oleaceae is one of the main cultivated crops that grows predominantly in Mediterranean nations. Olives are considered an important part of the diet in Arabian nations. Oleuropein is a predominant phenolic compound present in its leaves and is responsible for its valuable antidiabetic activity (Ahamad et al. 2019). Decoctions of olive leaves have been traditionally used against diabetes (Mootoosamy and Mahomoodally 2014). Treatment with oleuropein demonstrated significant glucose lowering effect in diabeticrats (Khalili et al. 2017). Oleuropein administration also improved glucose utilization (Poudyal et al. 2010), improved insulin sensitivity (Lepore et al. 2015) and decreased insulin resistance (Kim et al. 2014). It is also reported to decrease fasting glucose concentration in diabetic rats (Nekooeian et al. 2014).

3.3.21 *Punicagranatum* (Pomegranate)

Punica granatum (Lythraceae) is cultivated in the Mediterranean, tropical and sub-tropical areas on a large scale. Fruits are very popular as pomegranate throughout the world. It is produced in central Asia, the USA, Russia, China and Japan for fruit production. In the traditional Unani system, flowers serve as astringent, haemostatic, antibacterial and antifungal. It is also used in wound healing, bronchitis, diarrhoea, digestive problems, dermal interacted wounds and diabetes. It has antiparasitic, blood tonic and antiulcer uses in Ayurveda. Chemical constituents of *P. granatum* are ellagic acid, punicalagin, flavonoids, anthocyanidins, anthocyanins, flavonols and flavones. *P. granatum* flower extract improves the insulin sensitivity and decreases blood glucose level in rats (Dipak et al. 2012). Punicalagin and punicalin are the major tannins which exhibit antihyperglycaemic effect. Valoneic acid dilactone which possesses antidiabetic property is present in the Punica peel (Middha et al. 2013).

3.3.22 *Psidium guajava* (Guava)

Psidium guajava (Syn. *P. fragrans*, *P. pomiferum*, *P. cujavus*) belonging to Myrtaceae family is a significant restorative plant found in tropical and subtropical areas that is broadly utilized as food and in folk medicine worldwide (Gutiérrez et al. 2008). Leaf, seed and bark of *P. guajava* contain different bioactive compounds in which are helpful in attaining well-being. Leaves mainly contain phenolic compounds such as isoflavonoids, rutin, gallic acid, catechin, epicatechin besides naringenin and kaempferol. The fruit pulp contains vitamin C and carotenoids. The seeds and barks have glycosides, carotenoids and polyphenols. Its parts have hepatoprotective, antioxidant, anti-diarrhoeal, anti-inflammatory, anticancer, antimicrobial, antispasmodic, antihyperglycemic and analgesic effects (Barbalho et al. 2012). The ethanolic extract of its stem bark exhibits antidiabetic properties (Mukhtar et al. 2006).

3.3.23 *Rosadamascena* (Rose)

Rosa genus belongs to family Rosaceae and consists of more than 200 species and 20,000 cultivars (Cuizhi and Robertson 2003). Flowers are used for decorative, perfumery and medical purposes. They are utilized as nursery plants, cut blossoms or indoor plants. Rose oil acquired by water distillation of petals contains citronellol, geraniol and nerol as a major chemical compound. The flower oil is widely used in many industries as perfume and flavouring as well as for making various types of food items (Khan and Ur-Rehman 2005; Hassanein 2010). Oral administration of the methanolic extract exhibited significant reduction in blood glucose after maltose loading and inhibited post-prandial hyperglycaemia comparable to that by acarbose in normal and diabetic rats. The effect is believed to be through the inhibition of carbohydrate metabolizing enzymes (Gholamhoseinian et al. 2008, 2009).

3.3.24 *Trichosanthes dioica* (Pointed Gourd or Parwal)

Trichosanthes dioica Roxb. (Cucurbitaceae) is one of the edible cucurbits distributed in tropical Asia and Australia. It is an annual herb; fruits commonly referred to as 'Pointed Gourd' and 'Parval' in India. Charak Samhita mentions that it protects human body organs like heart, liver, spleen, etc. The phytochemicals present in its fruits and leaves include tetra- and pentacyclic triterpenes, glycosides, alkaloids, flavonoids, carbohydrates, fixed oils, steroids, tannins, phenols, vitamins A and C. Cucurbitacin B and charantin are main the constituents of fruits. Seeds contain a large number of peptides. Seed extract contains 7-oxihydrokarounidol-3-benzoate. Two main phytosterols, namely 24α- and 24β-ethylcholest-7-enol are reported from its fruits (Kumar et al. 2012a). The seed extract of *T. dioica* has shown potential antihyperglycemic activity (Rai et al. 2008). Lupeol, a dietary triterpene is present in *T. dioica*. The plant has been extensively studied for anti-inflammatory, antidiabetic, anticancer, reno-protective, antimicrobial and hepatoprotective effects (Khandaker et al. 2018).

3.3.25 *Trigonella foenum-graecum* (Fenugreek)

Trigonella foenum-graecum Linn. belongs to family Papilionaceae and is an aromatic, annual herb, commonly known as Fenugreek. It is 30–60 cm tall and cultivated in different regions of the world. It is a reputed spice and is cultivated throughout the world (Kirtikar and Basu 1985). It is used as antipyretic, antidiabetic, antioxidant, anthelmintic and gastroprotective (Jayaweera 1981; Toppo et al. 2009). Fenugreek is antihyperglycemic and hypocholesterolemic in effect (Khosla et al. 1995). The compounds reported from the plant are 4-hydroxy isoleucine, saponins and polysaccharides. Trigonelline and choline are the major alkaloids in the plant (Yoshikawa et al. 1997).

3.3.26 *Zingiber officinale* (Ginger)

Zingiber officinale (Zingiberaceae) is generally utilized as a spice and is commonly known as ginger. For quite a long-time ginger is the key ingredient in several Ayurvedic, Unani and Chinese medicine formulations. Ginger has expectorant, anticancer, immunomodulatory, anti-inflammatory, hypoglycaemic, hypolipidemic and anti-emetic effects (Ali and Blunden 2008; Ajith and Aswathy 2008). Ginger contains several potential bioactive substances, mainly gingerols, shogaols, bisabolene, geranial, zingiberenes and neral (Al-Amin et al. 2006). The juice from ginger rhizomes exhibits anti-hyperglycaemic activity in both normal and STZ-induced diabetes in rats (Akhani et al. 2004).

3.4 Economic Valuation of Edible Plants Used in Diabetes

Edible plants have immense medicinal and pharmacological values. Successful strategies for selecting plant candidate for isolation, characterization and drug discovery involves selection of plants based on traditional or ethnomedicinal use. Edible plants in the form of food and spices are consumed on large scale throughout the world. The medicinal value of such plants makes them more valuable for mankind. Several edible plants traditionally have been used for the management of diabetes such as Bitter gourd, Fenugreek, Olive, Turmeric, Ginger, Garlic, Black cumin, Cinnamon, etc. These edible plants are cultivated on large scale for consumption as food and spices. Table 3.2 presents the list of common traditional plants and their parts used in India for the management of diabetes.

3.5 Conclusion

Medicinal plants are considered as good candidates in drug discovery due to their chemical diversity and long history of use as food, drugs and spices by humans. Plants are considered as a unique source of newer chemical structures and scaffolds for drug discovery programmes. Natural products have always played a key role in modern drug discovery. It is highlighted by the fact that about more than the half of the recently approved drugs are derived or devised from natural products. This is predominantly because of recent advances in the field of extraction, isolation, characterization and pharmacological screening methods of natural products. In recent decades an ever-increasing number of drugs were discovered from natural products. Folklore medicines are generally utilized in rural areas due to their easy accessibility and cost effectiveness. Thus it is very important to manage diabetes with plants and their products that are accessible and affordable. Edible antidiabetic plant drugs make the proposition doubly beneficial as envisioned by Hippocrates in his proclamation '*Let food be thy medicine and medicine be thy food*'.

Table 3.2 List of common traditional plants and their parts used in India for the management of diabetes

Plants	Common name	Edible part
Aegle marmelos	Bael	Fruits
Allium cepa	Onion	Bulb
Allium sativum	Garlic	Bulb
Carica papaya	Papaya	Fruits
Camellia sinensis	Tea	Leaves
Cinnamomum tamala	Indian Bay Leaf	Leaves
Cinnamomum zeylanicum	Cinnamon	Bark
Coriandrum sativum	Coriander	Fruits
Cucumis sativus	Cucumber	Fruits
Curcuma longa	Turmeric	Rhizome
Eugenia jambolana	Jamun	Fruits
Ficus racemosa	Gular	Fruits
Mangifera indica	Mango	Fruits
Malus domestica	Apple	Fruits
Momordica charantia	Bitter gourd	Fruits
Moringa oleifera	Drumsticks	Immature pods
Murraya koenigii	Curry leaves	Leaves
Nigella sativa	Black Cumin	Seeds
Ocimum sanctum	Basil or Tulsi	Aerial parts
Olea europaea	Olive	Drupes and oil
Punica granatum	Pomegranate	Fruits
Psidium guajava	Guava	Fruits
Rosa damascena	Rose	Petals
Trichosanthes dioica	Pointed Gourd	Fruits
Trigonella foenum-graecum	Fenugreek	Seeds
Zingiber officinale	Ginger	Rhizome

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4 Cultural and Socio-Economic Perspective of Some Promising Edible Plants from Northern Pakistan

Jallat Khan, Kaynat Saleem, Sumreen Asim, Ahmad Khan, Sarfraz Ahmed, Awais Qamar, Muhammad Imran Tousif, Farhan A. Khan, Nusrat Shafiq, and Muther Mansoor Qaisrani

Abstract

Edible plants are perhaps one of the most important and significant sources of human food, which have played a key role in improving the health and economy

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of rural populations. Food and health have a great relationship as people now demand healthy, natural, and tasty food. Moreover, these plants are consumed as a source of food because of their traditional knowledge and belief. and culture as nutrition due to their traditional knowledge, feelings, and manners about these natural sources.

The sustainable development and use of biodiversity are directly related to economic development. The term sustainable usage may be defined as "the utilization of the components of biodiversity by retaining it and does not result in the decrease of biological diversity in the future." Therefore, biodiversity continues to fulfill the requirements and objectives of the present and future population. The economic evaluation of biodiversity requires classifying their advantages, the materials, and the services offered to the community.

Edible plants play a vital role as a part of biological diversity. Edible plants also contribute to human nutrition. These edible moieties also play a significant role in rural areas as they are easily accessible and cost effective.

Overall, these edible plants as diet and medication are in danger of disappearing. In the era of modernization, there is a dire need to study and document these edible plants with an ethnobotanical point of view and find technology-based ways to explore their potential for the welfare of humanity.

This study is focused on exploring the cultural and socio-economic importance of edible plants, which are used by the population of northern Pakistan.

Keywords

Biological diversity · Edible plants · Cultural · Socio-economy · Sustainable use

4.1 Introduction

Since the beginning of human civilization, edible plants are being used for different purposes like food, fiber, medicine as well as in feeding domestic animals. In India, about 800 species of edible plants are being used as a source of food by tribal population (Deshmukh and Waghmode 2011; Khan et al. 2017). During the times of food crises, edible plants play a key role in providing extra nutrients and meeting the food requirements to rural population. In this way, edible plants play a significant role in providing the food requirements of people living in the rural areas (Shaheen et al. 2017b).

In developing countries, edible food plants are recognized to maintain a balance between agricultural productivity and population growth. People in villages use edible food plants as food because these plants provide nutritious leaves, useful seeds, bulbs, stalk, roots, delicious fruits, etc. especially at times of food crises. Due to their availability and great utilization, these plants have significant importance particularly in indigenous cultures. In the era of modernization, as the old traditions of many tribal societies are at the verge of degeneration, there is a dire need to study and document these edible plants from an ethnobotanical point of view and find technology-based ways to explore their potential for the welfare of humanity.

Today, edible plants have received more importance due to their role in human health as nutrition. Pakistan has such a unique biodiversity, which includes various climate zones with a large variety of plant species due to their nutritional and therapeutic values (Gurib-Fakim 2006).

The northern areas of Pakistan ranging from the Salt range, Kaghan-Naran valley, Tilla Jogian, Kala Chitta Hills, and Murree of Potohar region; moist temperate areas of Ayoubia and Galiat; Margalla Hills (foothills of Himalayas) at Islamabad; Siran valley, Babusar pass leading to Chalas and Gilgit in Hazara and Palus valley of Kohistan; Skardu, Naltar valley, Neelam valley and its surrounding areas in Kashmir; and Ferry Meadows, Yasin, and Gupus valley, Astor valley, Khungrab pass leading to Tibet and China, Ghanche, Hunza valley, Shigar and Khaplu valley leading to K-2 area (second highest peak in the world), Deosai region (one of the highest plateau of the world) in the Karakorum ranges of Gilgit-Baltistan are the hot spot areas of edible vegetables and fruits. In Swat Kalam valley, Chail valley and Madian valley; Kala kot, and Madan valleys of Dir, Bamburit valley of Chitral, Mahodhand, and Malam Jaba are well-known areas for edible fruits and vegetables.

4.2 Socio-Cultural Biodiversity of Edible Plants

In a specific region, the diversity of animals, plants, and other living organisms is called biodiversity (Aumeeruddy 1996; Pei 1994). Functional diversity, ecosystem diversity, genetic diversity, and species diversity are the four categories of biodiversity.

Biodiversity, genetic diversity, and functional diversity have been recognized as a genetic resource for countries (Hickel 2016). Since the 1980s, in the context of economic, social, and cultural perspectives, the idea of biodiversity has been developed. The purpose of biodiversity is to provide more advantages to human beings through the usage of modern biotechnology. The advantages of biodiversity and its components have been maximized through gene resources and have thus gained popularity (Wilson 1988).

The pressure increased on the environment caused by environmental issues becomes more popular in many years. In severely damaged areas to improve the ecosystem function, the reestablishment of biodiversity and its solutions must be preferred (Karabak 2017). In recent years, the most commonly used concept of "Biodiversity Conservation" is not only regarded as a famous terminology but also considered as a trend for awareness. We should be aware of our dependence on wildlife in a broad range due to environmental changes. The wildlife must be conserved due to this awareness by searching ways to investigate different measures to be taken and how these sources should be used for sustainability.

So, biodiversity needs to be reestablished on a priority basis and work for the improvement of the ecosystem in the affected areas. In accomplishing the task of reestablishment, environmental economy plays a vital role. Awareness about the economic usefulness of all limited resources like biodiversity has great importance (Smith et al. 2006).

In the 1970s, the sustainable development concept was emerged. This concept demonstrated a model in which naturally occurring resources are efficiently managed to meet the requirements of today's generation and also gives preference to environmental quality. Economic growth and ecological balance together without endangering the capability of next generations to fulfill their necessities are considered as sustainable development (Carvalho 2006).

After the 1970s, environmental disasters have become the world agenda. The idea to protect the environment as the main element of development has emerged.

In a sustainable development, all natural resources must be maintained. Due to the increase in population, inadequate and unbalanced nutrition, dieting and many other health issues like obesity and other common diseases lead people to feed on various foods, which enhanced the interest in edible plant species (Gürlük 2010).

4.3 Some Promising Families of Edible Plants

Edible plants of different families have their diverse existence. Table 4.1 shows some of the promising edible plants of different families.

Table 4.1 Some promising families of edible plants present in the world

Group	Family	Species
Lily Family	(Liliaceae)	Wild garlic, Wild onions, Wild leeks, Camas, Glacier lilies
Heath Family	Ericaceae	Cranberry, Blueberry, Huckleberry
Mint Family	Lamiaceae	Wild mint, Self-heal
Pine Family	Pinaceae	Pine, Hemlock, Douglas-fir, Spruce
Cattail Family	Typhaceae	Narrow-leaf and broad-leaved cattail
Sunflower Family	Asteraceae	Dandelion, Wild sunflower, Salsify, Chicory, Pineapple weed, Oxeye, daisy, Common burdock, Thistle species
Rose Family	Rosaceae	Blackberry, Raspberry, Salmonberry, Thimbleberry, Wild roses, Hawthorn, Serviceberry, Choke-cherry, Wild strawberry, Silverweed
Purslane Family	Portulacaceae	Miner's Lettuce, Spring Beauty
Beech Family	Fagaceae	Oaks, Chestnuts, Beeches
Mustard Family	Brassicaceae	Pennycress, Shepherd's purse, Watercress

4.4 Classification of Edible Plants

The classification of edible plants includes the parts of edible plants which are safe for human use. In this way, the classes of edible plants may be termed as edible plant stems, edible plant flowers, edible plant fruits, edible plant roots, edible plant leaves, edible plant seeds, etc. as shown in Fig. 4.1.

4.5 Why Edible Plants Are Important?

According to a report by the Food and Agricultural Organization (FAO), one billion population of the world normally use edible vegetables in their daily diet. Their use in daily diet is due to their ability of adding a variety of taste, texture, and color. They are also known as protective food as these are used against various diseases due to the presence of different phytochemicals.

Increase in population is a global concern and in developing countries like Pakistan there is a huge gap between the number of individuals and available food. Consequently, now research is mainly based on the usage of edible plants which may decrease the gap between available food and population (Aruscavage et al. 2006; Shaheen et al. 2017b).

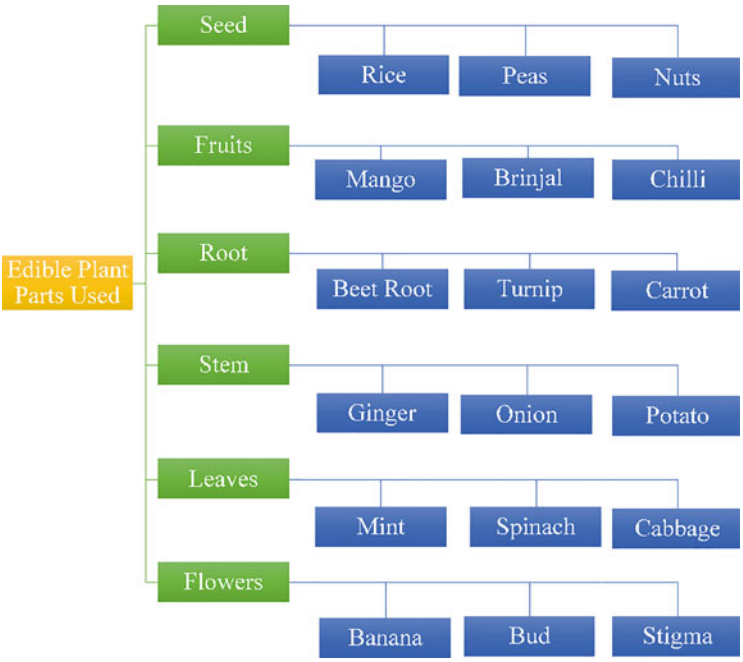


Fig. 4.1 Classification of edible plants on the basis of parts used

Cultivation of food plants can be used to reduce malnutrition. Mostly nutrients are deficient in diet of the poor people due to the deficiency of vitamins and minerals. A survey showed that in 2004 about 190 million children with age less than 5 years had deficiency of both vitamins and minerals, and in the same year about 0.6 million people died due to vitamin deficiency. To counter food insecurity, edible plants can be used.

They are not cultivated nor domesticated but found in wild habitat and can be used as a great source of food. So accordingly, different parts such as roots, leaves, or fruits of these plants can be used as food moieties. An example of these plants is weeds grown in urban areas to indigenous plants.

There has been a resumption of interest in wild food plants in recent years due to agitation on the nature of mass-produced crop plants worldwide, which are micronutrient deficient. The high degree of inhibition of food and infectious diseases, combined with the lack of access to rural health systems, offers a practical alternative to traditional plants and medical care for endangered households (Heywood 1999).

Recently, a great interest is observed for the evaluation of nutritional analysis of edible plants. The importance of these edible plants can be known by coupling their nutritional value and ethnobotanical importance. Native people know these plants, their importance, and their methods of collection. About one billion people around the world use food from wild plants on a daily basis, and over 300 million people rely on wild forest for their survival. About 250,000 plants are used by human beings for daily consumption.

Reports show that over 7000 species of wild edible plants are cultivated as food source. Vegetables cover a major part of human food, and they are available at an affordable price. The chemical content of wild edible plants is investigated by a number of scientists. Green vegetables are a great source of vitamin C. Various antioxidants, minerals, fibers, and vitamins are found in edible plants. These plants can be used against a variety of diseases, including cardiovascular diseases, chronic cancer, inflammation, and diabetes. Very little attention has been given to the properties of inorganic substances according to literature review that play a central role in the development of many active and essential chemical substances and are thus responsible for therapeutic and nutritional characteristics. Edible herbs and locally available plant parts are known for their distinctive medicinal value, color, and taste, are also rich sources of iron, calories, and proteins, and are used to treat degenerative diseases and nutritional deficiency as part of food (Banerjee and Jalota 1988).

Millions of people in developing countries depend on wild, medicinal, and edible plants to meet their nutritional needs and health care needs. As sources of energy and micronutrients, edible plants have an important role. Edible plants are used in small quantities as food, deal with hunger, have an effect on the intake of cereal staples, and play a vital role for indigent rural society in household food security. It provides food variety by giving an option to use different edible plants in a single meal. In traditional medicine, edible plants have a crucial function. In the war against diseases, trace elements present in edible plants play both curative and preventive roles. Due to the medicinal importance of the traditional Eastern medicinal method, which highly utilizes the trace elements of the medicinal plant, the flora present in the developing countries remains virtually unexplored (May et al. 1996).

Compared to their overall body weight and overall composition, there is a small portion of mineral elements found in the plant material, but no doubt they play an essential physiological role in the human body's metabolism. Edible plants are locally available, so they are inexpensive for the low-income segment of the economic community. These edible plants contain rich quantities of nutrients that play a vital role in food protection and nutrition and are also used as supplements.

The reduction in the genetic diversity of plant species, especially in vegetables, has become the cause of modern agricultural techniques and marketing systems globally. Good policies, robust information, and an institutional climate are needed for the prosperous commercialization of wild edible plants, which should boost investor trust in the sector. Edible plants provide national finance and the individuals involved in the trade and production of these plants with many economic advantages. Edible plants helps in boosting the economy of individuals involved in their production and trade that ultimatly contribute in the national economy. With growth, however, edible plants are threatened, and traditional information associated with these wild plants is at risk of being lost (Shaheen et al. 2017a, b).

There are several medicinal edible herbs in Pakistan that are dispersed due to the varied climate throughout the region. Eighty percent of Pakistan's population resides in villages and rural areas and these plants have been used in folklore medicine as well as by hakims. Pakistan is very rich in flora due to complex climatic conditions and soil conditions. There are 270,000 total vascular plants present on earth, of which 6000 species of higher plants occur in Pakistan, including 2000 species of medicinal plants (Shaheen et al. 2017b).

4.6 Socio-Economic Importance of Edibles Plants

Because of the immense economic potential and widespread cultural acceptability, the world has witnessed scientific and commercial interests in edible plants and plant-based products, but only less than 5% of species have been analyzed as potential medicinal products while rest of the plants remain to be analyzed. It is clear that edible plant use is not negligible in many parts of the world, but this is the truth that today human plant foods are based on a very small number of crops (Hood 2010).

Often the nutritional value of conventional edible plants is greater than many known fruits and vegetables. Edible plants throughout the world, and especially in developing countries, make a significant contribution to the local community life. Edible plants play a vital socio-economical role as these are used in cultural and religious ceremonies, poisons, medicines, fibers, and dyes. Through the sale of edible harvested material, people in villages generate income for their livelihood and household needs (Hinnawi 2010).

Wildlife species are significantly affected by the destruction of nature as a result of climate change, pollution, deterioration of ecosystems, and so on. To make these species sustainable or to protect these species, some steps need to be taken as the human factor is the most important risk for edible species. Moreover, these edible plants grow naturally so their consumption can not determind. This is the most important issue in the determination of their economic contributions (Abbasi et al. 2013; Okafor 1980).

4.6.1 Contribution Towards Local Economy

Edible plant species have a great contribution towards the income of the people of remote areas. These species directly contribute to those who sell and collect them. For the subsistence family businesses which are involved in farming, these plants become one of the key sources of income. Moreover, these edible species play a significant role in uplifting the economy of women of rural regions.

Women in these regions collect, market, and process many species. The model areas chosen for pilot studies were researched, and it has been found that the collectors, mainly women, selling the collected species from various places like fields, lakesides, gardens, sea region, forests, and even the rocky zones from outside or within the rural areas in local markets mainly contribute to their family income. After their collection, the required species must be used freshly in accordance with their home and market requirements. Moreover they clean, bond, sort, and strip them in accordance to their properties, and then they sell them in the local market (Samant and Dhar 1997).

In nature, people living in villages are considered as a principal key element in protecting these species. Precautionary measures must be taken to enhance their awareness about the advantages of biodiversity, cultivating the species which covers a very small area and protection of the species on-site, and to assure the sustainable use (Chakravarty et al. 2016).

4.6.2 Being Tradable

Edible plant species, mainly the unprocessed one, are being sold locally and to some extent in big cities. In national and foreign markets, these species are traded as refined or unrefined products. These species are also sold for different edible (tea and spices) and medicinal purposes in the district and local markets (Polat et al. 2012b). Mostly, species that are tradable are used for medicinal purposes at international markets. Some species are at risk of extinction because of the income obtained from these tradable species. The workers who collect this specie sell in huge quantities to be paid more. In rural areas, it has been noted that the density of these plant species decreases due to high demand. People collect these species in huge quantities when they visit remote areas. These species can be protected by concentrating on the cultivation of edible species and taking steps to protect these species. In local and district markets, some goods are sent through mediators. It means the market prices of the species vary according to their demand, recognition, and availability (Polat et al. 2012a).

4.6.3 Importance in Animal Feeding

The people who collect edible plants in remote areas of different regions are usually economically weak. Mostly they do this job for the survival of their families. To fulfill their domestic needs, they feed a few of their cattle or sheep/goats. They feed few of their cattle or sheep/goats with the remains of these edible plants to meet their domestic needs. Besides, the majority of these plant species are being utilized as animal feeding directly (Mirzaei-Aghsaghali 2012; Ogle et al. 2003).

4.6.4 Importance in Terms of Contribution to Tourism

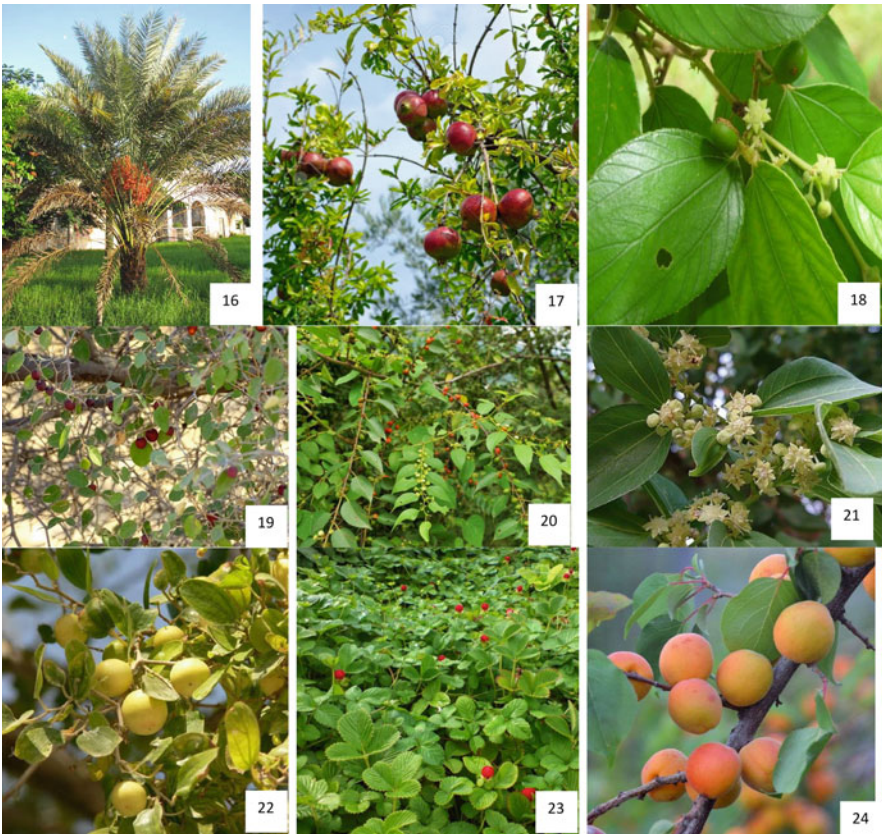
Tourism is one of the important segments for the elimination of regional economic imbalances, and this sector is continually growing. Today, the tourism sector has got a new trend due to people's passion for visiting different areas, and one of the reasons which attract these visitors is varied food culture of different regions. Geographical characteristics reveal that growing of edible plants and meals made by using these edibles has a great importance in food/culinary culture in a region or in a country (Cömert and Özkaya 2014; Sarıoğlan and İskenderoğlu 2016). Edible plant species attract tourists in terms of visuality, nutrition, and commerce. Being an integral part of the traditional structure and culture for centuries, these plants have great importance in local tourism. Their example includes Aegean herbs, Black Sea dishes, and Alacati Herbs Festival. Other examples include Mediterranean cuisine which provides an attractive alternative source for the tourists. Some markets attract tourists due to their historical background, variety of their products, and spatial size, and then it becomes a product which fascinates tourists (Ataberk 2010). The herb Aegean has become a tourism product because this herb possesses unique qualities. Every year, Alacati Herbs Festival participation continuously increases foreign and local tourists, which show a great interest in this festival. In this way the income of local people increased as well as it improves the residential area in various ways and it creates new jobs. Tourist hotels and restaurants also include edible herbs in their menus. The participation of people into tourism differs depending on their daily income, gender, health status, education, age, and nutrition. It is reported that long-stay tourists eat their meals at the restaurants or accommodation places where meals are made of edible herbs (Cömert 2014; Karaca et al. 2015).

4.6.5 Ethnomedicinal Importance of Edible Plants

Since ancient times, people used plant species against different ailments, and they are still in use (Abbasi et al. 2009) as they are an important constituent of conventional medicines and used as a raw material for different medicines (Abbasi et al. 2011; Hussain et al. 2008). Also, the knowledge on their use as conventional medicine is in danger because of the decrease in the population of old people of remote areas. On the other hand, the youth population has no or very little knowledge about these plant species. To keep the information safe, record about their use as a folk medicine should be preserved (Akan and Bakır 2015) (Fig. 4.2, Table 4.2).

Fig. 4.2 Photographs showing the phenotypic features of the abovementioned edible plants (fruits and vegetables) from 1 to 50 consecutively

Fig. 4.2 (continued)



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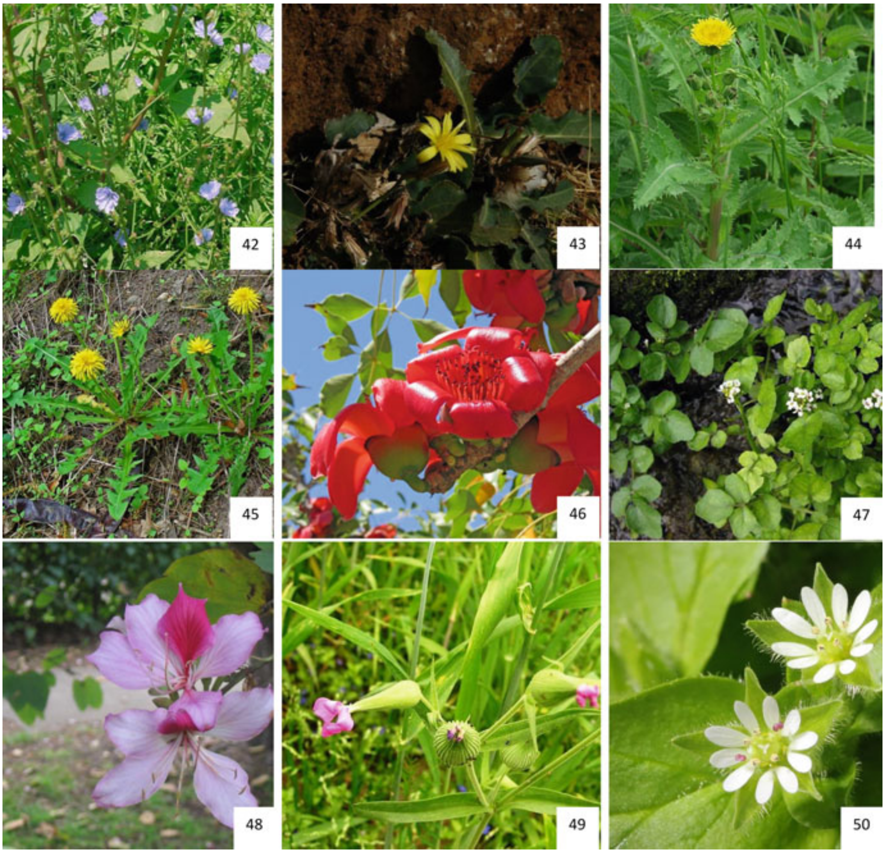

Fig. 4.2 (continued)

Table 4.2 Some promising edible plants (fruits, vegetables) of Northern Pakistan

Scientific name	Common name	Family	Occurrence in Pakistan	Ethnobotanical uses	Medicinal uses
Pistacia integerrima	Spogel seed, Kangar	Anacaediaceae	Murree, Hazara, Swat, Rawalpindi, Kashmir, Margalla Hills	Used as fodder, fuel, construction tool handles, and furniture	Asthma, cough, and to cure gleets (Ahmad et al. 2010)
Berberis lyceum	Royle Berberry, Sumbul	Berberdiaceae	Murree, Hazara, Balakot, Dir, Chitral, Swat, Kashmir, Margalla Hills, Islamabad	Used as fodder, fuel; thorny branches are used as hedge	Earache, skin infections, blood purifier, rheumatism, boon fracture, injury, and to heal wounds (Sabir et al. 2013)
Opuntia dillenii	Prickly pear, Nakh band	Cactaceae	Hazara, Balakot, Swat, Margalla Hills, Attock, Taxila, Peshawar	Fresh fruits are peeled off and eaten raw. Thorny stem is used as hedge	Diabetes, gastric ulcer, inflammation, and to reduce cholesterol level (Qasim et al. 2016)
Viburnum foetens	Himalayan Silver Fir, Guch	Caprifoliaceae	Hazara, Balakot, Swat, Murree, Kashmir	Eaten raw, used as fodder, fuel, in construction, brooms and baskets	Used to cure constipation (Bibi et al. 2010)
Diospyros lotus	Date plum, Kala malook	Ebenaceae	Hazara, Balakot, Swat, Murree, Chitral	Used as fodder, fuel, and tool handles	Used to cure constipation (Uddin et al. 2011)
Juglans regia	Walnut, Khor	Juglandaceae	Hazara, Swat, Murree, Chitral, Kashmir	Eaten raw, used as fodder, bark is used for cleaning teeth, fuel, in making furniture tool handles	Cough, constipation, weakness in legs, treat mouth gums and toothache (Verma et al. 2013)
Ficus carica	Fig, Trakani Phagwar	Moraceae	Hazara, Kashmir, Rawalpindi, Swat, Murree, Margalla Hills	Eaten raw. Unripe figs are cooked in water as vegetable. Leaves are used as fodder; wood and branches are used as fuel, in making tool handles, shelters	Powder of dried *Ficus carica* figs and dried seeds of *Amaranthus viridis* is taken orally with water or milk to cure eye vision problem. Milky latex is applied topically to cure skin infections (Çalişkan and Polat 2011)

Ficus glomerata	Cluster fig, Bar	Moraceae	Hazara, Kashmir, Swat, Murree, Margalla Hills	Dried and fresh ripened figs are eaten raw. Leaves are used as fodder; wood and branches are used as fuel, making tool handles, and shelters; also used as shade tree	Ripened fruit endocarp is eaten raw to cure cough, constipation, weakness in legs. Fresh leaves and bark are crushed and applied topically to treat mouth gums and toothache (Joseph and Raj 2010)
Ficus carica	Fig, Trakani Phagwar	Moraceae	Hazara, Kashmir, Rawalpindi, Swat, Murree, Margalla Hills	Dried and fresh ripened figs are eaten raw. Unripe figs are cooked in water as vegetable. Leaves are used as fodder; wood and branches are used as fuel, in making tool handles, shelters	Powder of dried *Ficus carica* figs and dried seeds of *Amaranthus viridis* is taken orally with water or milk to cure eye vision problem. Milky latex is applied topically to cure skin infections (Soni et al. 2014)
Ficus glomerata	Cluster fig, Bar	Moraceae	Hazara, Kashmir, Swat, Murree, Margalla Hills.	Dried and fresh ripened figs are eaten raw. Leaves are used as fodder; wood and branches are used as fuel, making tool handles, shelters; also used as shade tree	Powder of ripened dried figs is taken orally along with milk or water to cure intestinal worms, piles, and menstrual disorders, while fresh fruits are eaten raw against constipation (Sudhakar et al. 2012)
Ficus palmate	Fig, Phagwar	Moraceae	Hazara, Kashmir, Rawalpindi, Swat, Gilgit, Skardu, Murree, Margalla Hills	Dried and fresh ripened figs are eaten raw. Young leaves and unripe figs are cooked as vegetables. Leaves are used as fodder, wood is used as fuel, in tool handles, thatching, sheltering. Plant is cultivated as shade tree	Fresh leaves are boiled in the milk of goat and taken orally to cure bowel complaints whereas milky latex is applied topically on warts, small tumors, pimples, and to remove prickles. Fruits are eaten raw to cure constipation (Wadood et al. 2013)

(continued)

Table 4.2 (continued)

Scientific name	Common name	Family	Occurrence in Pakistan	Ethnobotanical uses	Medicinal uses
Morus alba	White mulberry, Chitta toot	Moraceae	Hazara, Kashmir, Rawalpindi, Swat, Murree, Margalla Hills	Dried and fresh ripened fruits are eaten raw. Leaves are used as fodder; wood is used as fuel, in tool handles, furniture, thatching, sheltering; branches are used in making baskets; also cultivated as shade tree	Fresh fruits and leaves are boiled in water and decoction is taken orally to cure throat ache (Wang et al. 2013)
Morus laevigata	Mulberry, Safed shahtoot	Moraceae	Hazara, Kashmir, Rawalpindi, Swat, Peshawar, Margalla Hills	Dried and fresh ripened fruits are eaten raw. Leaves are used as fodder; wood is used as fuel, in tool handles, furniture, thatching, sheltering; branches are used in making baskets; also cultivated as shade tree	Juice of fresh fruits is taken orally to cool the blood and body Inflammation (Memon et al. 2010)
Morus nigra	Black mulberry, Kalatoot	Moraceae	Hazara, Kashmir, Rawalpindi, Swat, Gilgit, Peshawar, Margalla Hills	Dried and fresh ripened fruits are eaten raw. Leaves are used as fodder; wood is used as fuel, in tool handles, furniture, thatching, sheltering; branches are used in making baskets; also cultivated as shade tree	Fresh fruits and leaves are boiled in water and decoction is taken orally to cure throat ache (Özgen et al. 2009)
Myrsine Africana	African boxwood, Khukan	Myrsinaceae	Hazara, Kashmir, Margalla Hills, Chitral, Bunir, Murree	Fresh ripened fruits are eaten raw. Leaves are used as fodder; wood is used as fuel, hedges, sheltering; young branches are used in making baskets, ropes, and brooms	Powder of dried fruits is taken orally with curd or buttermilk to kill intestinal worms. Decoction of young leaves is taken orally against scanty urination, kidney stones (Abbhi et al. 2011)

Olea ferruginea	Wild olive, Kahou	Oleaceae	Hazara, Kashmir, Margalla Hills, Dir, Chitral, Bunir, Murree, Salt range	Fresh ripened fruits are eaten raw. Leaves are used as fodder; wood is used as fuel, sheltering, construction, tool handles, furniture; young branches are used in making ropes and brooms	Young leaves are crushed and chewed to cure mouth gums, toothache (Amin et al. 2013)
Phoenix dactylifera	Date palm, Khagoor/ Doka	Palmae	Haripur, Margalla Hills	Fresh ripened fruits are eaten raw. Leaves are used in shelters, hedges; in making ropes, decorative articles, and brooms. Wood is used as firewood, construction	Dried fruits are boiled in milk and given to children during measles as tonic, while leaf paste is applied topically in cattle to cure mouth infection (Anjum et al. 2012)
Phoenix sylvestris	Wild date palm, Jungli Khagoor	Palmae	Haripur, Margalla Hills	Fresh and dried ripened fruits are eaten raw. Leaves are used in shelters, hedges; in making ropes decorative articles and brooms; wood is used as firewood, construction	Ripened fruits are eaten raw to cure constipation, abdominal pain and vomiting (Sharma et al. 2016)
Punica granatum	Pomegranate, Durni	Punicaceae	Hazara, Margalla Hills, Salt range, Murree, Chitral	Fresh and dried ripened seeds are eaten raw. Leaves are used as fodder; branches in shelters, hedges, fencing; wood is used as firewood, construction, tool handles	Powder of dried rind is taken orally to cure diabetes, diarrhea, piles, and dysentery, whereas dried seeds are ground and powder is taken orally to treat stomach disorder, internal body inflammation, jaundice, and gas trouble (Bhandary et al. 2012)
Ziziphus mauritiana	Indian Plum, Moti Ber	Rhamnaceae	Hazara, Kashmir, Margalla Hills, Salt range	Fresh and dried ripened fruits are eaten raw. Leaves are used as fodder; branches used in shelters, hedges, fencing; wood	Ripened fruits are ground and powder is taken with water against constipation, whereas leaf extract is applied topically

(continued)

Table 4.2 (continued)

Scientific name	Common name	Family	Occurrence in Pakistan	Ethnobotanical uses	Medicinal uses
				is used as firewood, construction, tool handles	on hairs as antidandruff (Adeyemo 2011)
Ziziphus nummularia	Wild jujube, Choti Ber	Rhamnaceae	Hazara, Peshawar, Malakand, Margalla Hills, Kashmir, Salt range	Fresh and dried ripened fruits are eaten raw. Leaves are used as fodder; branches used in shelters, hedges, fencing; wood is used as firewood	Ripened fruits are ground and powder is taken orally with water to cure constipation, whereas leaf extract is applied topically on hairs as antidandruff (Goyal et al. 2012)
Ziziphus oxyphylla	Jujube tree, Phitni	Rhamnaceae	Hazara, Peshawar, Margalla Hills, Kashmir, Swat, Buner, Salt range	Fresh and dried ripened fruits are eaten raw. Leaves are used as fodder; branches used in shelters, hedges, fencing; wood is used as firewood	Decoction of roots is taken orally to remove intestinal worms (Ahmad et al. 2017)
Ziziphus sativa	Jujube tree, Barri	Rhamnaceae	Hazara, Margalla Hills, Swat, Kashmir	Fresh and dried ripened fruits are eaten raw. Leaves are used as fodder; branches used in shelters, hedges, fencing; wood is used as firewood, making tool handles	Fresh leaves are boiled in water and used to wash hairs as antidandruff (Asgarpanah and Haghighat 2012a)
Ziziphus spina-christi	Christ thorn, Jhand Ber	Rhamnaceae	Hazara, Margalla Hills, Kashmir, Quetta	Fresh and dried ripened fruits are eaten raw. Leaves are used as fodder; branches used in shelters, hedges, fencing; wood is used as firewood	Fresh leaves are boiled in water and used to wash hairs as antidandruff (Asgarpanah and Haghighat 2012b)
Duchesnea indica	Indian strawberry, Budi meva	Rosaceae	Hazara, Margalla Hills, Kashmir, Dir, Chitral, Swat, Murree	Fresh ripened fruits are eaten raw. Aerial parts are grazed by cattle	Young leaves are boiled in water and decoction is taken orally to cure cough and throat ache (Firdous 2014)

Prunus armeniaca	Armenian plum, Harii	Rosaceae	Hazara, Margalla Hills, Kashmir, Dir, Chitral, Swat, Murree, Gilgit, Hunza	Fresh and dried ripened fruits are eaten raw. Leaves are used as fodder; wood is used in shelters and as fuel	Fresh ripened fruits are eaten raw to cure constipation (Erdogan-Orhan and Kartal 2011)
Prunus domestica	Round plum, Lucha	Rosaceae	Hazara, Margalla Hills, Kashmir, Dir, Chitral, Swat, Murree, Gilgit, Hunza	Fresh ripened fruits are eaten raw. Leaves are used as fodder; wood is used in shelters and as fuel	Fresh ripened fruits are eaten raw to cure constipation, stomach inflammation (Mahmood et al. 2009)
Pyrus pashia	Black pear tree, Kali Batangi	Rosaceae	Hazara, Margalla Hills, Kashmir, Dir, Chitral, Swat, Kaghan, Murree, Gilgit, Hunza	Fresh ripened fruits are eaten raw. Leaves are used as fodder; wood is used in shelters, making tool handles, furniture, as fuel; branches used as hedge; young leaves are used to stain hands	Fresh ripened fruits are eaten raw to cure constipation (Tsering et al. 2012)
Rosa brunonii	Himalayan musk rose, Tarni	Rosaceae	Hazara, Margalla Hills, Kashmir, Chitral, Swat, Murree, Quetta, Ziarat	Fresh ripened fruits are eaten raw. Leaves are used as fodder; branches are used for fencing, hedging, as firewood	Decoction of fresh flowers is taken orally to cure constipation (Verma et al. 2016)
Rosa moschata	Musk rose, Jangligulab	Rosaceae	Hazara, Margalla Hills, Kashmir, Chitral, Swat, Murree	Fresh ripened fruits are eaten raw. Leaves are used as fodder; branches are used for fencing, hedging, as firewood	Decoction of fresh flowers is taken orally to cure constipation (Shah et al. 2014)
Rubus ellipticus	Asian wild raspberry, Akha	Rosaceae	Hazara, Kalam, Margalla Hills, Kashmir, Chitral, Swat, Murree	Fresh ripened fruits are eaten raw. Leaves are used as fodder; stem and branches are used for fencing, hedging, as firewood	Juice of fresh fruits is taken orally to cure diabetes (Sharma and Kumar 2011)
Rubus ulmifolius	Elm leaf blackberry, Kali baripluchii	Rosaceae	Hazara, Kashmir, Swat, Murree, Gilyat	Fresh ripened fruits are eaten raw. Leaves are used as fodder; stem and branches are used for fencing, hedging, as firewood	Fresh fruits are eaten raw against inflammation and indigestion. Young leaves are boiled in water and decoction is

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Table 4.2 (continued)

Scientific name	Common name	Family	Occurrence in Pakistan	Ethnobotanical uses	Medicinal uses
					taken orally to treat cough and diarrhea (Morales et al. 2013)
Zanthoxylum armatum	Toothache tree, Timbur	Rutaceae	Hazara, Kashmir, Swat, Murree, Dir	Fresh dried ripened fruits are used as condiment in food. Leaves are used as fodder, young leaves are used in cooked food as carminative; stem and branches are used for fencing, hedging, as firewood. Young twigs are used as toothbrush	Powder of dried fruits is taken orally with water to cure cholera, stomach disorder, gas trouble, and indigestion, whereas young branches and twigs are used as toothbrush and effective against mouth gums and toothache (Singh and Singh 2011)
Grewia optiva	Monkey soap, Dhaman	Tiliaceae	Hazara, Kashmir, Swat, Murree, Peshawar	Fresh dried ripened fruits are eaten raw. Leaves are used as fodder; wood is used as fuel; bark of young branches is used in making ropes	Leaves are given to cattle to increase milk production. Decoction of fresh leaves is applied topically on painful joints (Anwar et al. 2015)
Celtis australis	European hackberry, Batkair	Ulmaceae	Hazara, Kashmir, Punjab, Gilgit, Chitral	Fresh ripened fruits are eaten raw. Leaves are used as fodder; wood is used as fuel, in making tool handles, shelter	Fresh leaves are boiled in water and decoction is taken orally to cure stomach disorder and cough (Shokrzadeh et al. 2019)
Vitis jacquemontii	Tree of Heaven, Gidardakh	Vitaceae	Hazara, Swat, Kashmir	Fresh ripened fruits are eaten raw. Leaves are used as fodder	Fresh fruits are eaten raw and found effective against constipation (Ahmad et al. 2013)
Vitis parvifolia	Summer grape, Kali baridakh	Vitaceae	Hazara, Swat, Kashmir	Fresh ripened fruits are eaten raw. Leaves are used as fodder	Fresh fruits are eaten raw and found effective against constipation, whereas extract of fresh leaves is taken orally in kidney pain (Khan et al. 2015)

Amaranthus spinosus	Spinay amaranth, Ghinar	Amaranthaceae	Murree, Haripur, Abbottabad, Balakot, Manshera, Kahouta, Margalla Hills, Islamabad, Muzaffarabad	Fresh leaves are cooked in water and used as vegetable (sag). Aerial parts are also used as fodder for cattle	Dried seeds of *Amaranthus spinosus* and dried fruits of *Ficus carica* are ground together with sugar. This powder is taken orally to cure eye vision problem (Sarker and Oba 2019)
Amaranthus viridis	Slender Amaranth, Ghinari	Amaranthaceae	Murree, Hazara, Kaghan, Swat, Rawalpindi, Islamabad, Kashmir	Fresh leaves are cooked in water and used as vegetable (sag). Aerial parts are also used as fodder for cattle	Dried seeds of *Amaranthus viridis* and dried fruits of *Ficus carica* are ground together with sugar. This powder is taken orally to cure eye vision problem (Ahmed et al. 2013)
Digera muricata	Wild rhubarb, Tundulla	Amaranthaceae	Murree, Haripur, Abbottabad, Balakot, Manshera, Kahouta, Margalla Hills, Islamabad, Rawalpindi, Muzaffarabad	Fresh leaves are cooked in water and used as culinary vegetable (sag). Aerial parts are also used as fodder for cattle	Fresh leaves are cooked in water and paste is taken orally to cure constipation (Mathad and Mety 2010)
Dryopteris ramosa	Oak Fern, Gunji	Aspidiaceae	Murree, Gillyat, Abbottabad, Naran, Shogran	Young leaves are cooked in water and used as culinary vegetable	Young leaves cooked as vegetables are taken orally to cure gastric ulcer, constipation (Baloch et al. 2021)
Bidens bipinnata	Spanish needles, Siryala	Asteraceae	Murree, Hazara, Gilgit, Kashmir	Young leaves are cooked in water and used as culinary vegetable	Fresh leaves are crushed and mixed in water. This extract is applied topically to cure leprosy and skin cuts (Yang 2014)
Cichorium intybus	Chicory, Kashni	Asteraceae	Kurram, Peshawar, Swat, Hazara, Astor, Gilgit, Baltistan, Murree	Young leaves are cooked in diluted milk (Lusii) and used as culinary vegetable	Fresh leaves are boiled in water, and this decoction is taken orally to cure fever, gas trouble, and body swelling (Nandagopal and Kumari 2007)

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Table 4.2 (continued)

Scientific name	Common name	Family	Occurrence in Pakistan	Ethnobotanical uses	Medicinal uses
Launaea procumbens	Bold-Leaf Launaeae, Makhna	Asteraceae	Waziristan, Kurram, Peshawar, Swat, Hazara, Astor, Gilgit	Young leaves are cooked in diluted milk (Lusii) and used as culinary vegetable	Fresh leaves are ground along with sugar and extract is taken orally to cure painful micturition (Reddy and Mishra 2012)
Sonchus asper	Sow thistle, Dodhal	Asteraceae	Kurram, Peshawar, Swat, Gilgit, Murree, Rawalpindi, Islamabad, and Kashmir	Young leaves are cooked in diluted milk (Lusii) and used as culinary vegetable	Leaves are boiled in water and decoction is taken orally against fever, constipation (Saxena and Kumar 2020)
Taraxacum officinale	Cankerwort, Milk witch, Sheshehaund	Asteraceae	Northern area of Pakistan	Young leaves are cooked in diluted milk (Lusii) and used as culinary vegetable. Used as fodder for cattle	Fresh rhizomes are boiled in water and decoction is taken orally against jaundice (Mir et al. 2013)
Bombax malabaracum	Silk Cotton tree, Dug sumbal	Bombacaceae	Islamabad, Hazara, Muzaffarabad	Young flowering buds are cooked as vegetables. Wood is used in furniture and as fuel, also cultivated as ornamental plant. Branches are used for fencing	Fresh bark is crushed and applied topically to cure skin eruptions, pimples, and joint pain (Abbasi et al. 2013)
Nasturtium officinale	Shepherd's purse, Saag	Brassicaceae	Chitral, Hazara, Kashmir, Islamabad, Murree, Margalla Hills	Young leaves are cooked in water as vegetables	Fresh leaves are cooked in water and taken orally to cure constipation (Shaheen and Ahmad 2020)
Bauhinia variegate	Orchid tree, Kalyar/ Kichnar	Caesalpiniodeae	Hazara, Kashmir, Islamabad, Margalla Hills	Flowering buds are cooked with meat, while flowers are cooked in diluted milk and used as vegetables. Leaves are used as fodder, wood is used as fuel, in construction, making tool handles; plant is also cultivated for ornamental purpose	Leaves and flowers are crushed and paste is given to cattle against diarrhea (Parekh et al. 2006)

Silene conoidea	Sand catchfly, Doda	Caryophyllaceae	Hazara, Kashmir, Islamabad, Margalla Hills	Young leaves and unripe fruits are cooked in water as well as in diluted milk as vegetable. Aerial parts are also used as fodder for cattle	Paste of fresh leaves is applied topically to cure skin infections (Ullah 2019)
Stellaria media	Chickweed, Makhni	Caryophyllaceae	Hazara, Kashmir, Swat, Islamabad, Margalla Hills	Young leaves are cooked in water as vegetable. Aerial parts are also used as fodder for cattle	Fresh leaves are crushed and paste is applied topically to treat swelling joints, broken bones. Leaves decoction is taken orally against constipation (Bukola and Bernard 2011)

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Medicinal Plants and their Contribution in Socio-Economic Upliftment of the Household in Gurez Valley (J&K)]

5

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Abstract

Gurez is situated along the Kishanganga river in Kashmir valley. It is remotely located but the most beautiful valley. Owing to connectivity problems, this valley has largely remained unexplored and thereby its various features have generally gone unnoticed. This beautiful valley harbors a diversity of the medicinal plants. These medicinal plants are not only used in traditional health care system for the treatment of various diseases but also provide an edge for socio-economic upliftment for households. The socio-economic profile of the people of this remote area depicts that these people live in underprivileged conditions. The medicinal plants indigenous to Gurez, like *Bunium persicum*, *Achillea Millefolium, and Carum carvi* besides others, have high commercial value and can be utilized as a source of income. These phytochemically rich plant species can contribute to the development of various formulations of herbal therapies. However, overexploitation of these plant species has caused a decline in the frequency of these species in the past few years. Planned cultivation, proper exploitation, and the commercialization of these medicinal plants can serve as a primary source of income to the people of this downtrodden community of Gurez, particularly marginalized farmers and landless poor people. These plants have the potential to broaden livelihood opportunities of these people by framing proper policy that can give topmost priority to proper exploration of these plants.

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Keywords

Household · Economic · Medicinal plants · Gurez

5.1 Introduction

Medicinal plants form the basis of traditional health care needs by the majority of people worldwide (Karunamoorthi et al. 2013). The indigenous knowledge of medicinal plants forms the backbone of the healthcare system and is likely to contribute the sustainable developments of society and its economy (Bekalo et al. 2009; Patra 2009; Rana 2011). Globally, about 60–80% of the people rely on medicinal plants for their primary health care needs (World Health Organization 2005). These plants are not only the basic pillars of health care system but also provide a valuable source of income for millions of people worldwide. According to WHO, about 70–80% of emerging Asian/African population depend on traditional medicines for their primary health care needs. Traditional herbal remedies account for 30–50% of total medicinal utilization in china. People in developing countries have strong convection and faith in traditional system of medicine, with India (80%), Bangladesh (90%), Myanmar (85%), and Nepal (75%) (Manzoor and Ali 2017). There are about 1300 medicinal plants used in Europe, of which around 90% plants are collected from wild source. In the USA around 118 of the top 150 prescription drugs are based on natural resources (Balunas and Douglas Kinghorn 2005). China and India are the countries where the highest number of medicinal plants are used (11,146 and 7500 species, respectively) followed by Columbia, South Africa, and the USA. India is the highest consumer of these medicinal plants (44%) (Hamilton 2004; Mahmoud and Rafieian-Kopaei 2012; Srujana et al. 2012).

With an ever-increasing demand for herbal medicine, natural health products and secondary metabolites, the use of medicinal plants is growing rapidly (Cole et al. 2007; Nalawade et al. 2003). The Indian Himalayan region, which is the richest source of plants, contributes about 1748 of medicinal plants (Joshi et al. 2016). The region known for its biodiversity is also bestowed with diverse ethnic communities, each with their own culture and traditional knowledge. The medicinal plant related trade in India is approximately about 1 billion $ per year (Joshi et al. 2004). However, overutilization of these plant species has resulted in their decrease, and if unchecked may ultimately lead to species extinction and loss from their natural habitats. Furthermore, the increasing push for economic development and the socio-cultural transformation, the biodiversity in the Himalayan region is going to face a very high risk of extinction (Dad and Khan 2011).

Kashmir valley, endowed with implausible beauty, is a treasure trove of herbs with high medicinal value. About 81 plants growing here have been reported for their medicinal use in traditional healthcare system (Tali et al. 2019). However, a recent study in Jammu & Kashmir territory, has documented more than 1123 plant species, with ethno-medicine use (Dad and Khan 2011). Of these Family *Asteraceae* constitutes around 151 species, *Fabaceae* 69, *Lamiaceae* 66, and *Ranunculaceae* 53.

These species are used to treat a wide range of illnesses. Due to the presence of diverse phytoconstituents, these medicinal plants gain significance and importance in formulation and development of various dosage forms for different types of ailments.

5.2 Impact of Medicinal Plants on Socio-Economic Upliftment in Gurez Valley

Gurez valley located in the high Himalayas in Kashmir valley is about 86 km from district Bandipore of Kashmir Province. Located on the banks of the river Kishenganga, Gurez valley extends between 34°30–4°41 North and 74°37–74°46 East latitudes at an average altitude of about 2370 m above sea level. One of the coldest and dangerous peaks Razdan located above 4000 m above sea level has to be crossed to reach the valley of Gurez. The valley has got very cold climate, which is too harsh in winters. It has a diverse topography with varying habitats that contribute to its rich biodiversity. Gurez houses a Shina-speaking tribe of Dards. The other tribes of Shina-speaking Dards live in Chilas, Gilgit and other adjoining areas that come under Pakistan-controlled part. Although the area has been influenced much by Kashmiri culture, still whole of Gurez has a distinct socio-cultural and linguistic identity. According to census 2011, it covers an area of above 57,842 hectares having a population roughly around 37,992 (45 km^2) (Rather and Baba 2015). The population consists of *Dard* (predominant, Shina-speaking tribe), *kashmiris*, *Gujars*, *Bakarwals,* and *Pathans* (Kapahi et al. 1993). Shina is the main language spoken in Gurez. The literacy rate and the level of education in the population is less, (26.22%) with large household size (74.76%) (India 2011). Among the sample households, the prevalence of marginal landholders is higher about 57.29% (India 2011). As per the survey done in 2018, the average family income of the household was Rs 89094.28 with medium annual income ranging between Rs 60,001 and Rs 90,000/ annum (Kapahi et al. 1993). The road leading to the Gurez generally remains closed for more than 5 months. Main occupations of these people are agriculture, livestock production, and non-timber forest products (NTFPs) collection. Besides, poor socio-economic conditions and lack of proper marketing, the area faces acute shortage of Doctors and other health care services. The NTFPs collection, processing, and utilization/selling of these forest resources must be given topmost priority. This can serve as an important strategy in reducing the poverty of the area and thereby uplifting the socio-economic status of these backward tribal people (Atta et al. 2018).

Like other Himalayan savanna, Gurez is rich in diverse medicinal plants. Around 50 medicinally important herb species have been regularly collected and used by the *Gujjar* and *Bakarwal* pastoral communities of Gurez. A large proportion (75%) of these people use these plants for treating health problems. The elderly and traditional healers of this land have a sound knowledge about the use of these plants in treating ailments in both humans and livestock. All the three ethnic tribes (especially the elders and women folk) possess as well as have maintained within their communities the knowledge of habitat distribution, life history features, regeneration, uses and mode of use of these plants. The continued belief of these communities on these high-altitude plants (traditional medicine) and the absence/scarcity/high cost of alternative modern medicine in the area is the driving force that greatly affects their source of medicine. These plant species are used for treating common ailments like cough, cold, asthma, bronchitis, headache, fever, and stomach pain by all three ethnic tribes. Furthermore, various species are used for some specific cases, e.g., *D. hatagirea* and *A. heterophyllum*. Likewise *F. roylei* is known for the broad range of medicinal applications suggestive from its vernacular name "Sheetkar" which in Kashmiri language means that it can cure 80 diseases. In terms of their ethno-medicinal properties and uses, species like *A. heterophyllum, D. hatagirea,* and *P. kurroa* are the most important medicinal plants for these people, as these species are used to treat common ailments as bacterial infections, inflammatory conditions, and fever. Besides, these possess a high market value, which makes them species of choice with regard to collection among all Gurezian communities. Various medicinal plants are also used frequently by these people for their ethnoveterinary applications. *R. webbianum* and *P. kurroa* are notable species in this regard, as these are used to cure different diseases of the livestock. Specifically, *R. webbianum* is used to cure many animal diseases including skin and eye diseases, respiratory tract diseases like cough, gastrointestinal problems, mastitis, hoof diseases, internal and external injuries, etc., while *P. kurroa* is used by nomadic people including *Bakerwals* and *Gujjars* in conditions of gastrointestinal disorders, inflammatory conditions of tonsils, and intestinal worms of their livestock. Similarly, *P. hexandrum* and *D. hatagirea* are specifically used for healing wounds and to treat bone fractures. The purpose and pattern of collection of these plants differ within the communities. *Gujjars* and *Bakerwals* collect these plants for both household and commercial purposes, the semi-sedentary *shepherds* collect these mainly for their household use. Furthermore, the pattern of collection also differs between the communities. The women of the *Gujjars* and *Bakerwals* seasonally migrate with their men to these high-altitude grasslands, where they collect these medicinal plants. However, semi-sedentary *Chopans* (shepherds), do not have such a division, as their women folk do not migrate. Furthermore, these medicinally and economically important species have got varied distribution. Species like *P. hexandrum* have a wide distribution in different habitat types, species like *P. kurroa* and *R. webbianum* at the same time are heavily localized. Others like *F. roylei* and *D. hatagirea* have low distribution and density. The high frequency of some species like *P. hexandrum* stems and their ability to grow in varied habitat types and complete their life cycle makes them candidates for planned cultivation. In addition, the part used frequently, e.g., fruit, which does not require damaging or cutting of plant also adds to their high frequency and density. However, the other species are highly localized and prone to grazing and trampling besides the part used being that which damages the plant or necessitates its cutting or destructive harvesting (e.g. rhizomes and tubers). These factors are responsible for the low density and availability of such plants (Kunwar et al. 2013). The two important steps for the long-term sustenance of these medicinal plants are to ensure the protection of these wild plant populations, without having an adverse effect on the livelihood of local communities and to promote cultivation of these plant species, for commercial purposes (Government of Jammu and Kashmir 2019). These plants are regarded as free commodity by these people and are collected from nature (Kunwar et al. 2013). These medicinal herbs do not merely add value to health care, but they can be a good source of income for the households. On an average, a household harvests about 5–7 kg of medicinal plants of varied nature in a year; however, the amount of extraction varies across the zones. Due to frequent snowfall, extended winter, and belief of people on the traditional medicine, these remain the only reliable curative option. Furthermore, due to the scarcity of the allopathic practitioners and medicine, these people usually depend on their own traditional system of medicine based on the herbs found in nearby areas. These plants are usually collected during the summer season and are normally prescribed by elderly people who have inherited the knowledge of medicinal value of these plants. These plants were earlier widely distributed in the alpines, but because of overgrazing and overharvesting, their distribution and abundance has thinned down. Unsustainable anthropogenic activities are also posing serious threat to these precious plant resources (Andriamparany et al. 2014).

Through traditional plant knowledge, people can cure various diseases and ailments for successful life in their local environment (Singh and Rai 2017). The income of the people of Gurez valley mainly depends on agriculture, animal husbandry, and the collection from forest resources, which is mainly the collection of medicinal plants. There is an increasing demand for the medicinal plants in the traditional system and in pharmaceutical industries. Due to restricted activity, lack of basic facilities and infrastructure, the livelihood of farmers and their economic development is severely hampered. The cultivation and commercialization of these diverse medical plants can provide new avenues for social and economic upliftment of households in this part of the world. These plants not only add immediate value to the health care, but can be a good source of income for poor to medium families. The proper exploitation, preservation, and cultivation of natural medicinal plants can lead to biodiversity conservation and livelihood enhancement in the area. Moreover, it can also suffice the social and cultural needs of the people.

Medicinal plants indigenous to Gurez include *Achillea millefolium, Bunium persicum, Aconitum chasmanthum, Carum carvi, Betula utilis, Atropa acuminata* Royle, and many others as listed in Table 5.1. However, the most widely reported and used medicinal plants are *Bunium persicum, Carum carvi, Achillea millefolium, Hyoscyamus niger, Taraxacum officinale, Viola sylyatica, Fritillaria royle, Lavatera kashmiriana, Mentha arvensis and Rheium spiciforme*. These medicinal herbs are used by locals either as a decoction, dried powder or as a cold aqueous extract.

5.2.1 *Bunium persicum*

Bunium persicum is an economically and medicinally important grassy plant belonging to family *Apiaceae*. It is commonly called as wild cumin, wild caraway, shahi-zeera, jira, kala zeera (Mandegary et al. 2012; Sofi et al. 2009). Several

Table 5.1 Indigenous Medicinal plants of Gurez valley

S. No	Medicinal Plants/ family (local names)	Uses
1.	*Aconitum heterophyllum* /Ranunculaceae (Patees)	Diarrhea, fever, and dysentery.
2	*Aconitum. Violaceum* Stapf/Ranunculacea (Bishmool)	Tooth ache.
3.	*Angelica archangelica/* Apiaceae (Chora)	Expectorant.
4.	*Arctium lappa/* Asteraceae (Cheer Kachh)	Diurectic.
5.	*Artemisia absinthium* /Asteraceae (Chhuma-Jom)	Epilepsy and fever.
6.	*Atropa acuminate* Royle /Solanaceae (Bellodona)	Sedative, diuretic, and analgesic.
7.	*Bergenia ciliata* /Saxifragaceae (Pahend/ Korasadun)	Tonic in bladder and kidney stones.
8.	*Betula utilis* /Betulaceae (Burz)	Antiseptic.
9.	*Prunella vulgaris* /Lamiaceae (Kal-veoth)	Fever and as an expectorant.
10.	*Bupleurum falcatum* /Apiaceae (Gureinala)	Liver tonic.
11.	*Cichorium intybus/* Asteraceae (Kasini)	Liver, spleen, and menstrual disorders.
12.	*Corydalis ramose/* Papaveraceae (Ralkul)	Eye diseases.
13.	*Epipactis latifolia/* Orchidaceae (Ikchha-neuli)	Heart pain.
14.	*Euphrasia officinale/*Scrophulariaceae (Pushi-kachh)	Jaundice.
15.	*Fritillaria roylei/*Liliaceae (Sheetkar)	Tuberculosis and broncho-asthma.
16.	*Hyoscyamus niger* Linn. /Solanaceae (Bazarbang)	Asthma and whooping cough.
17.	*Inula racemosa* hook. F. /Asteraceae (Poshkar).	Asthma and bronchitis.
18.	*Jurinea macrocephala/* Asteraceae (Dhup).	Colio pain.
19.	*Lavatera kashmiriana* /Malvaceae (Resha khatmi)	Rheumatic pain.
20.	*Mentha arvensis* /Lamiaceae (Pudinakachh)	Carminative.
21.	*Orchis latifolia/* Orchidaceae (Nar-Mada)	Aphrodisiac.
22.	*Origanum vulgare/* Lamiaceae (Marzanjosh).	Menstrual suppression.
23.	*Picrorhiza kurroa/* Scrophulariaceae (Kutki)	Jaundice.
24.	*Pimpinella diversifolia* /Apiaceae (Hyo-kachh)	Carminative.
25.	*Plantago lanceolata* /Plantaginaceae (Phatal Kachh)	Purgative.
26.	*Podophyllum hexandrum/* Berberidaceae (Chhamadeh)	Hepatic enlargement.
27.	*Polygonum viviparum/* Polygonaceae (Churkee)	Diarrhea and dysentery.
28.	*Rubia cordifolia/* Rubiaceae (Manjithi).	Stomach ache.
29.	*Saussurea lappa/* Asteraceae (Koth)	Rheumatism and joint pain.
30.	*Senecio jacquemontianus/*Asteraceae (Khalar)	Nervine tonic.
31.	*Taraxacum officinale* weber/Asteraceae (hand)	Hepatic stimulant.
32.	*Taxus baccata/* Taxaceae (Postul).	Asthma and bronchitis.
33.	*Thymus serpyllum/* Lamiaceae (Javen).	Menstrual disorders.
34.	*Trifolium pretense/* Fabaceae (Lalchopati).	Expectorant.
35.	*Valeriana hardwickii/* Valerianaceae (Mushk Bala)	Hysteria and epilepsy.
36.	*Viola sylvatica* / Violaceae (Banafsha)	Cough and cold.
37.	*Viscum album/* Viscaceae (Banada)	Rheumatism and joint pain.

therapeutic effects have been attributed to this plant, which include brain tonic, anticonvulsant, anti-helminthic, anti-asthma, in the treatment of urinary tract infections, jaundice, and dyspnea (Miraj and Kiani 2016). The plant has been evaluated for its anticonvulsant (Miraj and Kiani 2016), diuretic, antifertility (Thakur et al. 2009), antidiabetic (Dhandapani et al. 2002; Srinivasan 2005), immunomodulatory (Chauhan et al. 2010), anticancer (Gagandeep et al. 2003), antioxidant (Shah et al. 2018), antifungal (Gani et al. 2015), and antibacterial (Rather and Baba 2015), activities, etc. In local folklore, its decoction is used to treat various digestive ailments and to increase milk flow in breast feeding mothers (Kapoor et al. 1951; Srivastava et al. 1984). Kala zeera is rich in iron (above 600 mg in each 100 grams) and can be a nutritious additive to daily diet for lactating mothers, menstruating women, pregnant ladies, and anemic people (Metropulos 2019). 100 gm of kala zeera contain 900 mg of calcium, which contributes about 90% of daily requirements of calcium. Being rich in calcium, it can be used in osteoporosis and by lactating mothers (Metropulos 2019). On commercial basis, Gurez valley has high potential to produce quality zeera which has got a tremendous popularity, because of its fragrance and taste. The present scientific data and the historical evidence of its medicinal uses support future research as well as its use as an aromatic plant. Because of having rich phytochemical, pharmacological, aromatic, and nutritious properties, the plant has a huge potential for economic development of Gurez valley through its planned cultivation.

5.2.2 *Achillea millefolium*

Achiella millefolium commonly known as "Pahhlegasse," "Monudnu" in Kashmiri, Yarrow or Thousand leaf in English, is native to Northern hemisphere in Asia, Europe, North America, and Northern Kashmir, especially Gurez valley (Cheers 1999; Kapoor et al. 1951; Srivastava et al. 1984). The tribal people of Gurez valley use decoction of this dried herb to cure fever, cold, and liver disorders. The field surveys carried out in North Kashmir have reported that *Gujjars* and *Bakkerwals* use crushed leaves of *Achillea millefolium* with boiled water three times a day to cure cold, eye infection, headache, toothaches, inflammation of gums, kidney pain, and urinary tract burning sensation (Khan et al. 2016). The main traditional remedial properties and pharmacological profile of *Achillea millefolium* show that it is a magical herb that holds the excellent promise for its incorporation in drug industry in novel drug development for the treatment of various diseases. The plant has been evaluated for various pharmacological activities presented in Table 5.2.

5.2.3 *Hyoscyamus niger*

Hyoscyamus niger or Black henbane commonly known as Bazar bhang in Kashmiri belongs to the family *Solanaceae*. It has been used in the treatment of various ailments since previous centuries (Kaul 1997). It grows wild in Kashmir including

Table 5.2 Reported pharmacological activities of *Achillea Millefolium*

S. No	Pharmacological activity	Animal used	Type of extract	References
1.	Anti-ulcer	Rodent	Ethanol	Baggio et al. (2002)
2.	Antispermatogenic	Swiss mice	Ethanolic and hydroalcoholic	Montanari, de Carvalho, and Dolder (1998)
3.	Hepatoprotective	Wistar rats	Aqueous	Gadgoli and Mishra (2007)
4.	Analgesic	Rats	Aqueous	Noureddini and Rasta (2008)
5.	Anxiolytic activity	Mice	Hydroalcoholic	Baretta et al. (2012)
6.	Cardiovascular activity	Wistar rats	Aqueous, ethanol	Niazmand and Saberi (2010)
7.	Antinociceptive	Mice	Hydroalcoholic	Pires et al. (2009)
8.	Hypotensive, vasodilatory, and bronchodilatory activities	Rats	Aqueous, ethanol	A Khan et al (2011)

Table 5.3 Reported pharmacological activities on *Hyoscyamus niger*

S. No	Pharmacological activity	Type of extract	Animal used	References
1.	Cardiovascular activity	Crude extract	Rat	Vallabi and Elango (2016)
2.	Anti-inflammatory analgesic and antipyretic	Crude extract	Mice	Khan and Gilani (2010)
3	Anti-parkinsonian	Ether and aqueous methanol	Mice	Sengupta et al. (2011)
4	Anticonvulsant	Methanolic	Mice	Reza et al. (2009)
5	Antidepressant	Ethanolic	Mice	Patil et al. (2013)

Gurez valley and is commonly found in Fakirpur area of Gurez, at an altitude of 2425 m. Traditionally the plant is used in toothaches. Its smoke is inhaled through mouth without swallowing and expelled out after half a minute. Traditionally it has been extensively used as sedative, in mental disorders, in epileptic mania, convulsions, neuralgia, and asthma (Matsuda et al. 1991; Patil et al. 2013). Planned cultivation, collection, and extraction of this plant, which is found in abundance in Gurez valley grass lands can be beneficial in the upliftment of the socio-economic status of local community. *Hyoscyamus niger* has been evaluated for pharmacological activities presented in Table 5.3.

5.2.4 *Saussurea lappa*

Saussurea Lappa, locally known as “Kuth,” is naturally found in Kashmir’s upper reaches of Chenab valley, Suru valley, Kishenganga, and Gurez (Butola and Samant

2010; Kapoor et al. 1951; Srivastava et al. 1984). Kuth is a plant of great economic value. Its economic importance can be well understood by Stewart's book, "Punjab plants" (published in 1864). In this book, the author states that in the year 1873, 7000 maunds of Kuth were exported via Calcutta to China. *Saussurea* is one of the best known herbs in several indigenous systems of medicine for the treatment of various diseases, viz., urinary problems, joint pain, sole ulcers, dysentery, and fever (Khan et al. 2004; Mir 2013; Pandey et al. 2012). Traditionally the paste prepared from roots of this plant is used to cure skin diseases, arthritis, and paralysis of body parts (by messaging it over skin in sun light) (Nalawade et al. 2003). For the economic Upliftment of people of state especially Gurez valley, experts are of the opinion that the extraction and export of drug should be carried out on large scale. For the obvious reason, government has banned unauthorized possession of Kuth. Provided appropriate measures are carried out for the proper cultivation, collection, extraction, and isolation of important phytoconstituents in this regard, Gurez valley in particular can find a place in the economic map of world. The plant has been evaluated for pharmacological activities presented in Table 5.4.

5.2.5 *Fritillaria roylei*

Fritillaria roylei commonly known as "Sheetkar" belongs to family *Liliaceae.* It is distributed from Kashmir to Uttarakhand with in an altitude range of 2400 – 4000 m. In Gurez valley, it mostly grows at Paatalwan at an altitude of 3636 m(Shah et al. 2018; Singh and Rawat 2011; Srivastava et al. 1984). *Fritillaria roylei* has been reported for ethano-medicinal properties like antitumor (Ping et al. 1995), antiulcer (Muto et al. 1994), and antihypertensive (Kang et al. 2002). Traditionally it is used for the treatment of asthma, stomach problems, bronchitis, and in burns (Singh and Rawat 2011). In Jammu and Kashmir the bulb is boiled with orange peel and is used traditionally in the treatment of asthma and tuberculosis (Shaheen et al. 2012).

Table 5.4 Reported pharmacological activities of *Saussurea Lappa*

Pharmacological activity	Experimental model	Extract used	References
Hepatoprotective activity	Mice	Aqueous, methanolic extract	Yaeesh et al. (2010)
Anti-diarrheal activity	Wistar rats		Negi et al. (2013)
Cardiovascular disease	Rat	Aqueous extract	Akhtar et al. (2013)
Anti convulsant activity	Mice	Petroleum ether, alcoholic extract	Ambavade et al. (2009)
Antiinflammatory activity	Mice and rat	Water and Ethanolic	Moeslinger et al. (2000)
Anti-ulcer	Mice	Acetone	Yamahara et al. (1985)

Fritillaria roylei has been evaluated for antioxidant and antiproliferative properties (Shah et al. 2014). It is used in preparation of the Ayurvedic tonic “Chyawanprash” (Krishnamurthi 1969). The market demand of this species is increasing while supply is gradually decreasing because of overexploitation. Because of this, the plant has been categorized as endangered by International Union for Conservation of Nature (Kroemer et al. 1997; Ved 2008). Though the herb is a source of income for local inhabitants, but over exploitation of this plant from the wild has rung the alarm bell for the conservators. In situ conservation and ex situ cultivation are the remedial measures ought to be carried out in order to fulfill the ever-increasing demand for this phytochemically rich plant species having potential to boost the economy of region.

5.2.6 *Betula utilis*

Betula utilis commonly known as “Burz” family *Betulaceae* is found mostly in Afghanistan, China, Bhutan, and India. In Kashmir it is found in Gurez valley (Rajdhani pass) at an altitude of 3630 m (Bean 1980; Shah et al. 2018; Srivastava et al. 1984). The plant contains important constituents like oleanoic acid, lupeol, botulin, lupeonone, sitosterol, methyl betulate, and betulitic acid (Pal et al. 2015). In ayurvedic and Unani system of medicine, plant bark is used in the treatment of diseases like convulsions, leprosy, blood, and ear diseases. Bark infusion is used as an antiseptic (Singh et al. 2012). Owing to excessive use of the plant as fuel and medicinal purposes, the plant is considered threatened. The immense medicinal uses and its religious importance necessitate a two-prong approach of conservation and extensive research on this plant both phytochemically as well as medicinally. Well planned conservation, cultivation, and collection can be good for the economic upliftment of the region. The plant has been evaluated for various activities enlisted in Table 5.5.

5.2.7 *Mentha arvensis*

Mentha arvensis commonly known as Pudina-kachh (Kashmiri), Pudana (Unani), and Corn Mint (English) family *Lamiaceae* is commonly found in Europe, Western central Asia, and Eastern Siberia. In India, it is distributed in Kashmir parts including Markoot area of Gurez valley at an altitude of 2425 mtr (Kapoor et al. 1951; Rastogi et al. 1990). The important constituents reported in mint plant are isomenthone, menthofuran, menthylacetate, carvomenthone, cineol, pipertone, carvacrol, α-pinene, α-phellandrene, dipentene, cardinene, quercetin, vitamin K, menthoside, eugenol, and thymol (Imai et al. 2001; Nair and Chanda 2007). *Mentha arvensis* is traditionally used in stomach problems, dysentery, asthma, jaundice, arthritis, rheumatic pain, and ischemic heart diseases (Biswas et al. 2014; Farnaz Malik 2012). It is used in food, pharmaceutical, and aroma industries (Sharangi and Datta 2015). Traditionally decoction of dried leaves is used as carminative and to relieve digestive

Table 5.5 Reported pharmacological activities of *Betula utilis*

Pharmacological Activity	Active constituent Used	Mechanism of action
Anticancer activity	Botulin	In lung and liver cancer it induces apoptosis by disrupting mitochondrial functions Mishra et al. (2016)
Anti HIV activity	Botulin	Betulin inhibits protease enzyme and reverses transcriptase Kroemer et al. (1997)
Antioxidant activity	Botulin	Scavenging of free radicals Shukla et al. (2017)
Anti-inflammatory activity	Botulin	Inhibition of lipoxygenase enzyme Kumaraswamy and Satish (2008)

Table 5.6 Reported pharmacological activities of *Mentha arvensis*

Pharmacological activity	Experimental model used	Active constituent	Mechanism of Action
Antibacterial activities	H. Pylori and S. aureus E. Coli	Menthol	Bacteriostatic and Bactericidal Fatih et al. (2017)
Antioxidant activities	Rat	Eugenol, terpenes, and flavonoids	Inhibition of enzymes-glutathione-s-transferase, and glutathione Evans (2009)
Antifertility activities	Albino mice	Petroleum ether	Reduces fructose level due to which viability of spermatozoa is altered; Thawkar et al. (2016)
Anti-inflammatory and anti-allergic activity	Mice	Ethanolic and aqueous	Inhibition of histaminerelease Malik (2012)

ailments (Thawkar et al. 2016). *Mentha arvensis* has been studied for various actions presented in Table 5.6.

5.2.8 *Bergenia ciliata*

Bergenia ciliata (Haw) commonly called as “Zakhnlehayati” (Kashmiri) belongs to family *Saxifragaceae* (Kour et al. 2019). It is mostly distributed in Himalayas from Kashmir to Bhutan at an altitude of 900-3000 m (Mir et al. 2019). In Gurez valley it is located in Sheetal bagh (2425 m) (Dhandapani et al. 2002; Srivastava et al. 1984). There is a paucity of data regarding phytochemical work on this plant. The phyto-chemical investigation of the aerial parts (whole) and leaves have led to the isolation of hydroquinone (benzenoids) (+) afzelechin, (+) catechin, arbutin,quercetin-3-O-α-L-arabinofuranoside,quercetin-3-O-β-D-xylopyranoside, eryodictiol-7-O-β-D-

Table 5.7 Reported pharmacological activities of *Bergenia ciliata*

Pharmacological activity	Extract used	Animal Used	Mechanism
Anti-pyretic activity	Methanolic	Rats	Lowers body temperature for up to 4 h in a dose-dependent manner Sinha et al. (2001)
Anti-diabetic activity	Hydroalcoholic	Rats	Inhibition of enzymes- α-glucosidase and porcine pancreatic α-amylase Bhandari et al. (2008)
Anti-inflammatory activity	Methanolic	Rats	Inhibition of inflammatory mediator; Sinha (2001)
Anti-tussive activity	Methanolic	Mice	Inhibition of cough reflex Kakub and Gulfraz (2007)
Anti-ulcer activity	Aqueous-methanol	Rats	Cytoprotective effects conferred by enhancement of the mucosal barrier Kakub and Gulfraz (2007)
Antimalarial activity	Leaf extract	Mice	Antiplasmodial activity Walter, Bagai, and Kalia (2013)
Antioxidant activity	Methanolic	In vitro	Free radical scavenging Rajkumar et al. (2010)
Anti-antiurolithic activity	Aqueous-methanolic	Albino rats	Mimics the urinary stone formation Bashir and Gilani (2009), Saha and Verma (2011)

glucopyranoside, 6′-O-p-hydroxybenzoylar-bergenin, 4-O-galloylbergenin, 11-O-galloylbergenin, p-hydroxybenzoic acid and protocatechuic acid 6′--O-protocatechuoylarbutin, 11-O-p-hydroxybenzoylbergenin,11-O-protocatechuoylbergenin and 6′-O-phydroxybenzoyl parasorboside՚ (3-O-galloylepicatechin and (−)-3-O-galloylcatechin (Chandrareddy et al. 1998; Khan and Kumar 2016; Sticher et al. 1979). In Jammu and Kashmir, traditionally the plant is used in the treatment of diarrhea, asthmatic disorders and locally as an application to boils and bruises (Ishtiyak and Hussain 2017). Powdered rhizome is used as tonic and to break stones in kidney and bladder (Saha and Verma 2013). From religious point of view, plant is used as a good luck gesture in the local festival called “Phool Sangran” in Uttaranchal state of India. The plant has been evaluated for various pharmacological activities presented in Table 5.7.

5.2.9 *Lavatera kashmiriana*

Lavatera kashmiriana belonging to family *Malvaceae* is commonly known as Saza-kul (full plant), sazposh (flower), Sazmool (root), and Wan sotsal (leaves) in Kashmiri language(Pimenta 2003; Vidyarthi and OP. 2010). Traditionally it is an important herb used by people of Kashmir to treat various types of ailments. Crude roots of plant are sold by herbalists for abdominal disorders, common cold, pain killer, and laxative (Dar et al. 2013a; Kaul 2010). Important compounds found in *Lavatera kashmiriana* are lavateral, lavaterone, lavateronic acid, lavaterpene, and lavaterosterol (Parveen 2013). Other compounds isolated from *Lavatera kashmiriana* include caffeic acid, gallic acid, vanillic acid, dodecanoic acid, ferulic acid, tetradecanoic acid, rutoside, n-hexadecanoic acid, chlorogenic acids, etc. (Skalicka-Woźniak et al. 2007). The high chemical profile of this plant makes it a potential herb in the treatment of various diseases. Gallic acid, an important phytoconstituents present in *Lavatera kashmiriana* possesses a wide range of biological activities including anti-viral, antiulcer, hepatoprotective, and anti-inflammatory activity (Sajeeth et al. 2010). The plant has been evaluated for many biological activities including anticancer (Dar et al. 2004), anti- lipoxygenase, antibacterial, and protease Inhibitor activity (Rakashanda et al. 2013).

5.2.10 *Taraxacum officinale*

Taraxacum Officinale commonly known as "Hand" in Kashmiri, family *Asterceae,* thrives in a wide range of conditions (Manzoor and Ali 2017). *Taraxacum Officinale* is an essential medicinal plant used by tribal people of Gurez for joint, kidney and inflammatory ailments (Seo 2005). The plant has been used ethanomedicinally in conditions of common cold,chest infection and back pain. Decoction and infusion of plant is used as a tonic, digestive stimulant, diuretic, and mild laxative (Schütz et al. 2006). Traditionally leaves are used as salad and in the form of soup, both recommended as natural source of vitamin C. The roots are used as infusion or coffee substitute. In addition, plant contains higher amounts of β-carotene, iron, and calcium along with macro and micronutrients (Jassim et al. 2012). Phytochemistry of the plant has revealed the presence of carotenoids (Singh et al. 2008), flavonoids (Schütz et al. 2005), sterols (Trojanová et al. 2004), and polysaccharides. Extracts of *Taraxacum officinale* have been evaluated for hypoglycemic (Cho et al. 2002), anti-inflammatory, antioxidant (Hu and Kitts 2005) diuretic, hepatoprotective, and antibacterial activity. The phytochemical constituents and therapeutic effects of *Taraxacum officinale* suggest that the herb can be a valuable addition in the pharmaceutical industry for compounding of newer formulations for various diseases and its planned cultivation, collection, and extraction can be a valuable in the upliftment of socio-economic state of people of Gurez.

5.2.11 *Aconitum heterophyllum*

Aconitum commonly known as "Monkshood" or "Atish" comprises of 250–300 species of which 24 species are found in India. These species are distributed widely in Northern Temperate Zone and cold-temperate regions of the Northern Hemisphere. There are a number of species found in Kashmir Himalaya, including Gurez valley. However, there is a lack of convincing criteria for species delimitation (Dar et al. 2013b). *Aconitum heterophyllum* belongs to family *Ranunculaceae* is listed in Ayurveda (Indian system of alternative medicine) as an ingredient of many formulations. It is one of the most valued medicinal plants and is a source of many useful drugs (Dar et al. 2007). The plant has been reported for a number of activities like antidiarrheal, expectorant, diuretic, hepatoprotective, antioxidant, alexipharmic, anodyne, antiflatulent, antiperiodic, and carminative, besides having antiphlegmatic action. The plant is also claimed to have beneficial effects in reproductive disorders (Verma et al. 2010). The plant has been used both externally and internally in conditions of rheumatism, and for relieving pain and fever (Ameri 1998). Three main alkaloids found in the aconite root, mesaconitine, aconitine, and hypaconitine, have shown analgesic activities (Evans 2009). *A. heterophyllum* root extract has been reported to have anti-viral activity (Hikino et al. 1979; Zaidi et al. 1988), whereas *A. chasmanthum* for antifungal activity (Patwardhan et al. 1990). Owing to its unique properties, it has been facing the indiscriminate and ruthless exploitation by tribals, local people, forest contractors, various drug development agencies and other anthropogenic pressures since ages, resulting in speedy decline in its natural populations in the entire northwest Himalayan range (Anwar et al. 2003). Unabated exploitation has brought some of the species nearer to extinction and are now declared as critically endangered (Krishnamurthi 1969; Mamgain et al. 1998; Pandit 2002). Earlier, the Kashmir's Himalayan Aconites used to be collected from low and sub-alpine areas, but presently, they are only found and collected from alpine areas. So, it is the need of hour to undertake the commercial cultivation of the plant in different zones of alpine region, so that the stress is reduced on wild populations on one end, and revenue for both local people and the State is generated at the same time.

5.2.12 *Arctium lappa* Linn

Arctium lappa Linn., Family: *Asteraceae*, commonly called as Burdock is considered a healthy and nutritive food. The plant is popularly used in Chinese folklore and its roots, seeds, and leaves have been investigated for medicinal benefits. Antioxidants and antidiabetic compounds have been found in the root. These compounds are said to promote blood circulation to the skin surface, improve the skin quality/texture, and cure skin diseases like eczema. Some active seed constituents possess anti-inflammatory and potent inhibitory effects on the growth of tumors such as pancreatic carcinoma. Similarly, the bioactive leaf compounds have the property of inhibiting the growth of micro-organisms in the oral cavity. Burdock has been found to be effective in chronic diseases as cancers, diabetes, and AIDS (Chan et al. 2011). Arctigenin (AR) and its glycoside, arctiin, are two major active ingredients of *Arctium lappa* L. AR, the most potent bioactive component has shown potent anti-inflammatory activity, based on the mechanism of inhibition of inducible nitric oxide synthase (iNOS) via modulation of several cytokines. Thus, AR can serve as a therapeutic compound against both acute inflammation and various chronic diseases (Gao et al. 2018). The plant is also a rich source of lignans, sesquiterpene lactones, polyynes, sulfur derivatives, caffeic acid derivatives, polysaccharides, mucilage's, triterpenes, phytosterols and their esters, tannins, and lignans. Burdock leaves, fruits, and seeds have been found to contain various important principles like arctigenin, arctiin, trachelogenin, lappaol F, diarctigenin, terpenoids, polyphenols, beta-eudesmol, caffeic and chlorogenic acid, tannins, inulin and sterols, amino acids, metal elements, vitamins, particularly vitamin C, A, B1, and B2), crude fiber, phosphorus, carotene, sulfur-containing acetylenic compounds (Angerhofer 2002; Chan et al. 2011; Fleming 2000; Jeelani and Khuroo 2012; Kato and Watanabe 1993; Kemper 2010; Maruta et al. 1995; Matsumoto et al. 2006; Park et al. 2007; Schulte 1967; Wang and Yang 1993; Washino et al. 1986. The plant also contains a good amount of total phenolic content (Predes et al. 2011).

5.2.13 *Atropa acuminata* Royle

Atropa acuminata Royle Ex Lindl (*A. acuminata*), commonly known as maitbrand or Indian belladona, belongs to family *Solanaceae*. It is a critically endangered species, endemic to northern Pakistan, Kashmir, and India found mostly in western regions of Himalayan subcontinent, starting from Kashmir at an altitude of 1.8–3.6 kilometers (km) to the connecting hills of the Himachal Pradesh up to 2.5 km. The plant has been reported from Kashmir, Muzaffarabad, and Chakrata (Mehraj et al. 2018a, b). The plant grows abundantly in Gurez. In traditional medicine, the rhizome and aerial parts of the plant have been used over a period of time, for the relief of joint pain, muscle pain, and muscle spasms. The plant parts have also been used in the treatment of arthritis, pancreatitis, peritonitis, scarlet fever, Parkinson's disease, and neuro disorders (Kahn et al. 1991; King 1966; Matsuda et al. 1991). The ethanolic extract has shown anti-arthritic activity (Nisar et al. 2015). *Atropa acuminata* is an extremely poisonous plant valued for its richness in tropane alkaloids such as atropine, hyoscyamine, and scopolamine. These alkaloids possess anticholinergic activity and have diversified therapeutic uses in medicine in the fields of ophthalmology, cardiology, and gastroenterology (Cardillo et al. 2016; Kursinszki et al. 2005). Besides these, monoterpenes, sesquiterpenes, phenyl propanoids, flavonoids, saponins, quinine (Butt et al. 2015), highly oxygenated triterpenes (Mehmood et al. 2002) have also been isolated from the plant. DART (Direct Analysis in Real Time) and HPLC analysis of hairy root culture has revealed the presence of high amount of different alkaloids. (Fatemeh Ashtiania 2011). The average active alkaloid content of leaves has been found to be 0.4%, whereas the root alkaloidal content is around 0.96%. The alkaloid content has been found to vary with age and developmental stage of the plant. At early age, the plant contains low alkaloidal content, but the content increases at the flowering stage (Dräger and Schaal 1994). The ethanolic leaf extract has been found to contain approximately 188 micro grams of phenolic compounds per ml, which is a huge amount compared to other plants in the family (Nisar et al. 2013). Since *A. acuminata* is under tremendous threat of extinction in its natural habitat, biological conservation of the plant as well as knowledge of its active ingredients is of paramount importance. Proper planning, preservation, and cultivation of the plant may bring laurels to Gurez communities economically.

5.2.14 *Prunella vulgaris*

Prunella vulgaris L. commonly called as "heal-all" or heart of the earth belongs to *Labiatae* family of perennial plants and is widely distributed in Asia and Europe (Psotová et al. 2003; Tutin et al. 2010). The dried spikes of the plant are often utilized in Traditional Chinese Medicine. In the Chinese Pharmacopeia, *Prunella vulgaris* is recommended for treating headaches, high blood pressure, diseases of the lymphatic system, goiter, and tuberculosis. In Kashmir it is used in the conditions of inflammatory disease and forms an important ingredient of the herbal extract, used for bathing by women after delivery. In a study, Liang Feng et al. (Feng et al. 2010) extracted, separated, and purified two polysaccharides from the plant (P31 and P32). The main polysaccharide P32 was found to possess anti-lung cancer activity and could increase the thymus index and spleen index in tumor-bearing mice. The study concluded that anti-lung adenocarcinoma activity was possibly one of the mechanisms responsible for immunomodulation effect. Currently *Prunella vulgaris* is considered more compatible with other antitumor herbs in lung cancer treatment because of its bioactive principles as terpenoids, flavonoids, polyphenols (Liang et al. 2009), and polysaccharides, that have known tumor inhibitory effects. Polysaccharides from the plant have been reported for immunoregulatory (Han et al. 2009; Harput et al. 2006) anti-inflammatory (Fang et al. 2005a, b), anti-viral (Tabba et al. 1989) and antioxidant (Dehua 2006) activities.

5.2.15 *Angelica archangelica*

Angelica archangelica, commonly known as garden angelica, wild celery, or *Angelica officinalis* Moench) is a biennial plant from the family *Apiaceae*. It was originally found in Syria but now has spread to many Europe countries and western Asia. In India, it grows from Kumaon and Garhwal in Uttarakhand to Kashmir Valley including Gurez valley of J&K. The dry rootstocks of the plant yield 0.35–1% of essential oil, which contains mainly β-phellandrene. The roots contain several furocoumarins and phenols that include angelicin, bergapten, xanthotoxin, umbelliprenin. The dried roots are used mainly in food and confectionery industry, perfumery, and medicine. Cakes, candy beverages, jams, omelettes (Jelen 2011), and gin are flavored with the root essential oils. The age of the roots determines their essential oil content. They possess stimulant, expectorant, and diaphoretic properties. The activity is attributed to high levels of terpenes, including α-pinene and β-phellandrene (Burdock 2016). Out of more than eighty aroma compounds found in the plant, Cyclopentadecanolide, is particularly of interest to perfumers and aroma chemists, which although present in small quantities ($< 1\%$ in roots, and $< 0.5\%$ in seeds), is primarily responsible for the distinctive musky aroma (Jelen 2011). Both the seeds and roots contain coumarins and furocoumarins. Anjelica roots and leaves are said to stimulate the blood flow to the peripheral parts of the body, and thus are valuable in treating poor circulation. The plant is specifically used in the treatment of Buerger's disease, a condition that narrows the arteries of the hands and feet (Culpeper 1995). An essential oil from the seeds is sometimes used as a rub to relieve rheumatic conditions (Chevallier 1996). Angelica fruit has been approved by The German Commission E Monographs (a therapeutic guide to herbal medicine) for fevers and colds, infection of the urinary tract, dyspeptic complaints, and loss of appetite. The root has been approved for dyspeptic complaints and loss of appetite. The plant is used in the form of combination product "iberogast" for stomach problems like acid reflux, stomach pain, cramping, nausea, and vomiting. It is claimed that breathing its vapors for two minutes, few times daily can reduce tobacco carvings. Taking it orally is said to reduce the frequency of nocturnal urination in men with small bladders, however, the plant does not seem to be of any use in other men. It is one of the components of a combination product cream, which, when applied directly to the skin of the penis, helps in the condition of premature ejaculation. Besides Angelica root, the cream also contains Panax ginseng root, *Cistanches deserticola*, Zanthoxyl species, torlidis seed, clove flower, asiasari root, cinnamon bark and toad venom.The herb also helps in faster healing of bed sores. The plant is currently considered to be crucially endangered due to overactivity of man and needs to be conserved for its continued existence in nature. With proper planning and conservation, the plant has the potential for upliftment of economic status of people of Gurez.

5.2.16 *Picrorhiza kurroa*

Picrorhiza kurroa Royle ex Benth commonly known as Kutki or Kutka is a small, self-propagating, perennial alpine herb, belonging to family *Scrophularaceae*. It is prevalent at high altitudes in the Himalayan regions of China, Pakistan, India, Bhutan, and Nepal. It is an endangered medicinal plant species. Owing to its folklore and medicinal value, its requirement is ever increasing but, the supply is rather inconsistent and inadequate. The reason for inconsistant and inadequate supply is harvesting and deforestation. Phytochemically *P. kurroa* has been extensively studied and around 132 active ingredients have been found from different parts of the plant such as roots, stem, leaf, and seeds. Kutkin is the major chemical constituent of the species. The plant has been found to contain picrosides I, II, and III, kutkoside. Veronicoside, pikuroside, cucurbitacins, 4-hydroxy-3-methoxy acetophenone, phenolic compounds (Husain et al. 2014; Nisha 2012), apocyanin and drosin. Apocynin belongs to catechol group and can check neutrophil oxidative burst as well as act against inflammation. Curcubitacins are cytotoxic in nature and exhibit antitumor activity (Simons et al. 1990). Cucurbitacins extracted from *P. kurroa* include cucurbitacin B, D, and R. Different extracts and individual bioactive compounds of the plant have been found to possess a range of pharmacological effects. *P. kurroa* is extensively used by locals in Gurez valley for the treatment of diseases like high fever and stomach problems. Owing to its choleretic property, its rhizome extracts are also used in hepatic injury in livestock. In Bhutan, its rhizome extract is recommended for colds, coughs, and fever. In China the plant extract is used in jaundice, digestive disorders, diarrhea, and dysentery. In Nepal, the plant is commonly used to treat hepatitis and jaundice. In Kathmandu, the rhizome extract is used as an antidote against scorpion bite. It is also used in the treatment of high blood pressure, eye disease, colic pain, bile disease, gastritis, and sore throat (Mulliken 2000). In India, the rhizome extract is considered as an antibiotic and is widely used in Ayurvedic and Unani medicine. It is used as a foremost ingredient in Arogyavardhini; an ayurvedic medicine to cure liver diseases. A survey of literature shows that thorough pharmacological appraisals have not been carried out on the pharmacological claims. Different extracts and bioactive compounds from *P. kurroa* have shown therapeutic potential in various in vivo and in vitro studies. The activities include antioxidant (Deshpande et al. 2015; Rajkumar et al. 2011), immunostimulatory Immunomodulatory activity of biopolymeric fraction, anti-inflammatory (Gupta et al. 2006; Kantibiswas et al. 1996; Kumar et al. 2016), antimicrobial (Laxmi and Preeti 2015; Sharma and Kumar 2012; Shubha et al. 2016), antidiabetic (Husain et al. 2009), antiasthmatic (Sehgal et al. 2013), analgesic (Shid et al. 2013), cardioprotective (Nandave et al. 2013), anticancer (Mallick et al. 2015), and hepatoprotective (Dwivedi et al. 1992; Jia et al. 2015; Kaur et al. 2012; Siddiqi et al. 2015). The plant is valued by herbalists as hepatoprotective, stomachic, antiperiodic, anti-amoebic, cholagouge, anthelmintic, antioxidant, cardio-tonic, anti-inflammatory and carminative, etc. (Gaddipati et al. 1999; Prajapati 2013; Singh et al. 1993). It is also effective in gastrointestinal and urinary disorders, scorpion sting, snake bite, leukoderma, and inflammatory affections (Dey et al. 1980).

5.2.17 *Rheum webbianum*

Rheum webbianum Royle commonly known as "Himalayan Rhubarb" in English, and "Pumbachalan" in Kashmiri belongs to family *Polygonaceae*. It is native to Asia-Temperate to Asia-Tropical, from China to India, Nepal, and Pakistan. In Jammu and Kashmir, it grows on open slopes and shrubberies in the valleys of Kashmir, Gurez, Leh, and Zansker between 3105 and 3920 m above mean sea level (Chaurasia et al. 2007; eFloras 2020). The roots, stems, leaves, and leaf-stalks of the plant are used in various conditions like constipation, indigestion, abdominal diseases, wounds, boils, and flatulence (Huang et al. 2007). The plant has been studied for the management of gastrointestinal (GI) and renal function disorders, and for the treatment of hyperlipidemia and cancer (Huang et al. 2007; Srinivas et al. 2007). As per traditional Chinese system of medicine, rhubarb is thought to improve the memory in senile patients (Tian et al. 1997). Rhubarb extract has been suggested as an adjunct to chemotherapy in tumors and has shown antiangiogenic action (Cai et al. 2008; Cui et al. 2008; Huang et al. 2007; Lin et al. 2003; Srinivas et al. 2007; Wang et al. 2007). The plant has been used GI bleed cases to eliminate extravasated blood (Dong-hai et al. 1980; Srinivas et al. 2007). It is a potential source of dietary fiber, with a lipid-lowering effect (Abe et al. 2000). The plant has also shown anti-inflammatory activity (Atta et al. 2018) and its anthraquinone derivatives have been used as antifungal and molluscicidal agents. The active constituent Rhein has demonstrated in vitro antimicrobial activity against a wide spectrum of gram-negative and gram-positive bacteria (Agarwal et al. 2000; Huang et al. 2007; Jong-Chol et al. 1987; Liu et al. 1997; Tegos et al. 2002). An extract of rhubarb stalk has been used as a dental desensitizer. In vitro and in vivo studies in fish have proposed that the herb possesses estrogenic activity (Usui et al. 2002). Rheum emodi roots possess hepatoprotective principles that can prevent and/or treat paracetamol induced liver damage (Akhtar et al. 2009). Its roots give yellow color and are thus used to dye wool and silk fibers. The main coloring component is chrysophanic acid, which is found associated with a number of compounds. The plant has been found to contain a number of Anthraquinone derivatives, viz., rhein, emodin, aloe-emodin, physcion, and chrysophamol. Stilbene glycosides as rhaponticin and the metabolite rhapontigenin, Tannins, Sennosides, Catechins, Gallic, and cinnaminic acid (Li et al. 2000; Misiti et al. 2006; Xiao et al. 1984; Zhu et al. 2005) besides Lindleyin, having estrogenic activity (Usui et al. 2002), oxalic acid, as well as 2-methylbutanol and 4-methylhexanol (Dregus et al. 2003; Lust 1983). Human activity has been responsible for extinction of this species from lower reaches of Gurez, and is now limited to high altitudes. The importance and usefulness of the plant in traditional medicine demands the consevation and sustainable utilization of this rare species. This will not only provide raw material but also provide resource generation for economic upliftment for the local population in the cold arid high-altitude regions like Gurez.

5.3 Conclusion

This study concludes that even living in the area having a very rich diversity of NTFPs, the main communities of Gurez valley are living in underprivileged conditions in all aspects as depicted by their socio-economic profile. Today in this modern world in the era of "Digital India" movement, the people of Gurez valley are still isolated from the rest of the world because of the lack of basic amenities of life, like electricity, proper market, inaccessible roads, and absence of highspeed internet even mobiles, given the proximity to the border and the current prevailing situation. This has led to migration of people to other areas. Also acute poverty, debt, substandard quality of life, lack of awareness, and exposure, etc. contribute further to the problem. In such circumstances, forests in general and proper exploitation of medicinal herbs in particular can play a crucial role in the upliftment of socio-economic status and livelihoods of a majority of these people. The forest-based livelihoods mainly collection, processing, and utilization/selling of various medicinal herbs can prove detrimental in this regard and should be given topmost priority as important strategy of poverty reduction and socio-economic upliftment of these backward tribal people.

In recent years, there is growing awareness globally that apart from being safer, economical, and easily available, phytochemicals and herbal products can affect the course of inflammatory diseases and may provide an amalgamation of nutritional substances, which help in re-establishing and maintaining wear and tear of tissues. Medicinal plants and herbs are not only the prime and effective source of health care for the people of Gurez but also have the potential to uplift the socio-economic state of these people. The high diversity and commercialization of these medicinal plants can provide edge for social and economic upliftment of households in Gurez. To fulfill their primary health care needs, these medicinal plants have an important role to play because these people treat their common ailments with these locally available herb-based medicines instead of allopathic drugs which are scarce in this part of the world, costly as per their living standard, and full of side effects as per their belief. Considering the geographical constrains, and connectivity problem, especially in long and harsh winters (there is no road connectivity at least for 5–6 months due to heavy snow fall), when there is scarcity of everything including medicine and food items (though they may be available, but there is restriction in movement due to heavy snow fall and below freezing temperatures), conservation of these herbs is of paramount importance in those testing times. Besides, these herbs are phytochemically much superior in constitution than the herbs found in other parts of the world and thus can form an important tool for the development of various important medicine and nutritional supplements. Thus, their planned cultivation and conservation can bring laurels to the economy of this backward area and uplift the economic status of the local tribal community. Scientific data reveals that if these herbal plants are exploited effectively and properly, Gurez valley could become a hub in the future not only for herbal medicine but also for aroma compounds. Since the faith in herbal drugs is growing day by day as, they are considered to be devoid of side effects, such an endeavor would be detrimental in socio-economic upliftment of these people. With appropriate measures Gurez valley of Jammu and Kashmir can find a place in the economic map of the world and the need of the hour is that Government should provide technical and marketing assistance to these poor farmers living in underprivileged conditions in this regard.

Conflict of Interest Authors declare no conflict of interest.

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6 Comprehensive Overview of Some Edible Medicinal Plants from Kashmir Valley: Cultural, Economic, and Pharmacological Importance

Yasmeena Akther, Jahangir Nabi, and Nahida Tabassum

Abstract

Medicinal plants serve as the backbone of conventional healthcare systems of medicine and have been used since decades for the treatment of various diseases. Globally, around 50,000 species of medicinal plants are employed in traditional healthcare system of which Asia contributes a major part. These medicinal plants provide income to millions of people in both developing and developed countries. According to the World Health Organisation (WHO), around 80% population of the world depend on medicinal plants to meet their primary healthcare needs. During the past few decades, the use of herbal drugs has increased considerably because they are relatively cheap, more cost-effective, and less toxic than synthetic medicine.

The Indian subcontinent has a wide variety of medicinal plants species and the Himalayan region supports a considerable proportion of this rich floristic diversity. The valley of Kashmir is well known across the globe for its snow-covered mountains, spectacular lakes, green meadows, and pasture lands. The valley is also considered as a treasure vault of medicinal herbs that have been used in traditional system of medicine since decades. This traditional knowledge of healthcare is rapidly eroding due to rapid modernization. Furthermore, the Kashmir Himalayan medicinal plants have not been documented and if documented, attention has largely remained on their ethnobotany or strategies for conservation and management. The present chapter therefore attempts to gather information from a range of literature sources on some important edible medicinal plants from Kashmir valley with regard to their morphology, habitat and distribution, common and local names, traditional uses, and reported

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pharmacological activities. The findings of this chapter may help in identifying high-value traditional medicinal plant specifies for future drug development, promoting economic boost associated with locally available medicinal plants, and increasing public awareness from government agencies.

Keywords

Ethnomedicine · Kashmir Himalaya · Kashmir valley · Medicinal plants · Pharmacological activity

6.1 Introduction

According to a Chinese proverb, "Every plant is a medicinal herb." So, the company of nature in itself is a big healer and has remained an integral part of the medicinal systems since prehistoric times (Assefa et al. 2010). Recent estimates propose that more than 9000 types of plant species have known therapeutic properties, and this is without thorough scientific study among various indigenous communities (Farnsworth and Soejarto 1991). According to the World Health Organization (WHO), about 80% of the world population living in developing countries rely on the traditional plant-based system of medicines to fulfill their primary healthcare needs (WHO 2002).

During the last quarter-century, there has been a renewal of interest in herbal drug therapies as these are comparatively less toxic and more cost-effective than synthetic medicine (Chakraborty 2018). Given the high cost associated with synthetic drugs, herbal medicines have become an important trade and commercial sectors and are contributing greatly towards the socio-economic developments of various countries across the globe. The traditional system of medicine could not be the complete solution for human disease conditions; however, the ethnobotanical study remains one of the most potential approaches in drug discovery; approximately 25% of the drugs prescribed globally come from plant sources (Jabbar et al. 2007; Rates 2001).

The Indian subcontinent is a vast repository of medicinal plants and covers nearly 27% of the world's total known medicinal plant species (Krishna Kumar and Katakam 2002). In India, 90% of medicinal plants diversity is spread across broad range of forests, and only about 10% is confined to non-forest ecosystems. The Indian Himalayan Region (IHR) shares a significant part of this diversity, as can be seen in the literature reporting around 1748 species in this region (Joshi et al. 2016). There is a very high awareness of herbal drugs in ethnic communities from Trans-Himalayas to southern and western tips to four north-eastern corners. Kashmir Himalayas, one of the most spectacular regions of the IHR is located at the Northwestern tip of the Himalayan region and harbors rich biodiversity of medicinal plants (Fig. 6.1) (Jeelani et al. 2018). These plants form an important part of folk medicine and have been used since ages as home remedies for treating various ailments. However, this traditional knowledge of healthcare is eroding due to rapid socio-cultural changes. Until now, a limited number of studies have been carried out

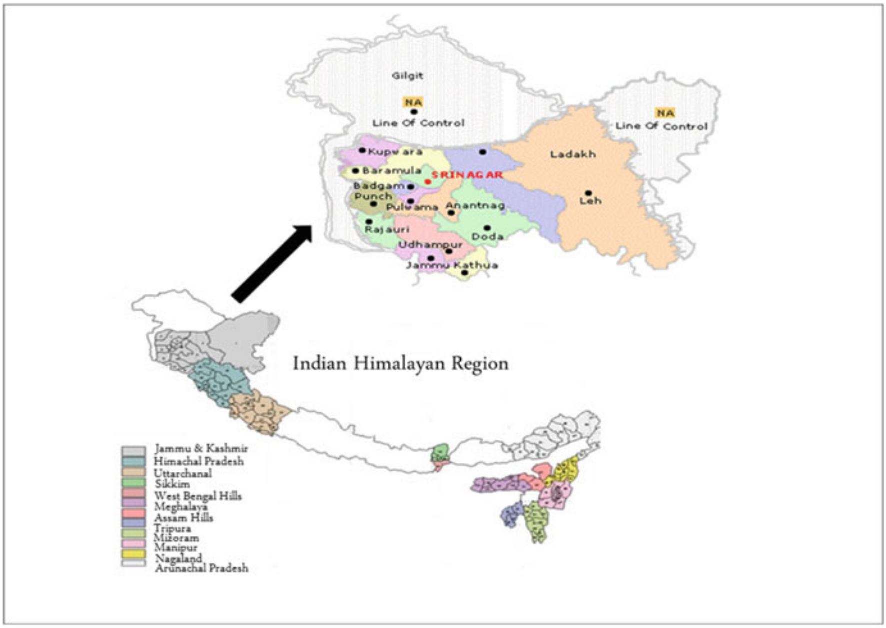

Fig. 6.1 Geographical hotspots of selected medicinal plants, image source, (ENVIS Centre on Himalayan Ecology 2020)

to comprehensively document the scientific information on the medicinal plant species of the Kashmir valley (Khan et al. 2004; Malik et al. 2011), which necessitates a need of comprehensive scientific documentation of these plants species. This chapter, therefore, documents some of the important medicinal plants of Kashmir valley concerning their accurate scientific information on morphology, common and local names for easy collection, distribution, and traditional uses across different indigenous communities. Additionally, the biological activities of these medicinal plants have been summarized using findings from published pharmacological and phytochemical studies. The findings of this work may not only help to boost the local economy of this region but also help to promote a base for future drug research and the utilization and protection of indigenous medicinal plants.

The appropriate literature was searched for relevant information through different electronic databases (PubMed, NISCAIR, Embase, Medline, and Google Scholar) using various keywords such as "medicinal plants," "Kashmir Himalaya,", "Kashmir valley," "ethnobotany," "ethnomedicinal uses," "ethnopharmacological properties," "medicinal uses," "pharmacological properties," and "biological properties." Studies selected for this chapter included medicinal plants that were: traditionally used across different indigenous communities of Kashmir valley; having ethnopharmacological evidence to support for local use; and having demonstrated in vitro or in vivo pharmacological activities. All the scientific names were validated using the plant name index databases, such as Envis Centre on Medicinal Plants, National Gardening Association, and Medicinal Plants in India.

6.2 Distribution at Different Altitudes

The present study investigated a total of 30 species (Fig. 6.2) of indigenous edible medicinal plants grown at different altitudes in the Kashmir valley (Fig. 6.3a). Twelve species were found at altitudes of 1600-2800 m, 3 species at altitudes of 1700-3500 m, 3 species at altitudes of 2000-4500 m, 2 species at altitudes of 2100–3900, 2 species at altitudes of 2300-3800 m, 2 species at altitudes of 2400-4800 m, 2 species at altitudes of 2500-3500 m. The remaining 4 species were located at altitude ranges of 1500-3000 m, 1800-2600 m, 1900-3000 m, 3200-3900 m, respectively. Therefore, it can be concluded that the altitude range of 1600-2800 m represents the best sampling spot.

Fig. 6.2 Images of selected medicinal plants, image source, (Envis Centre on Medicinal Plants 2020; National Gardening Association 2020; Medicinal Plants in India 2020; Plants For A Future 2020)

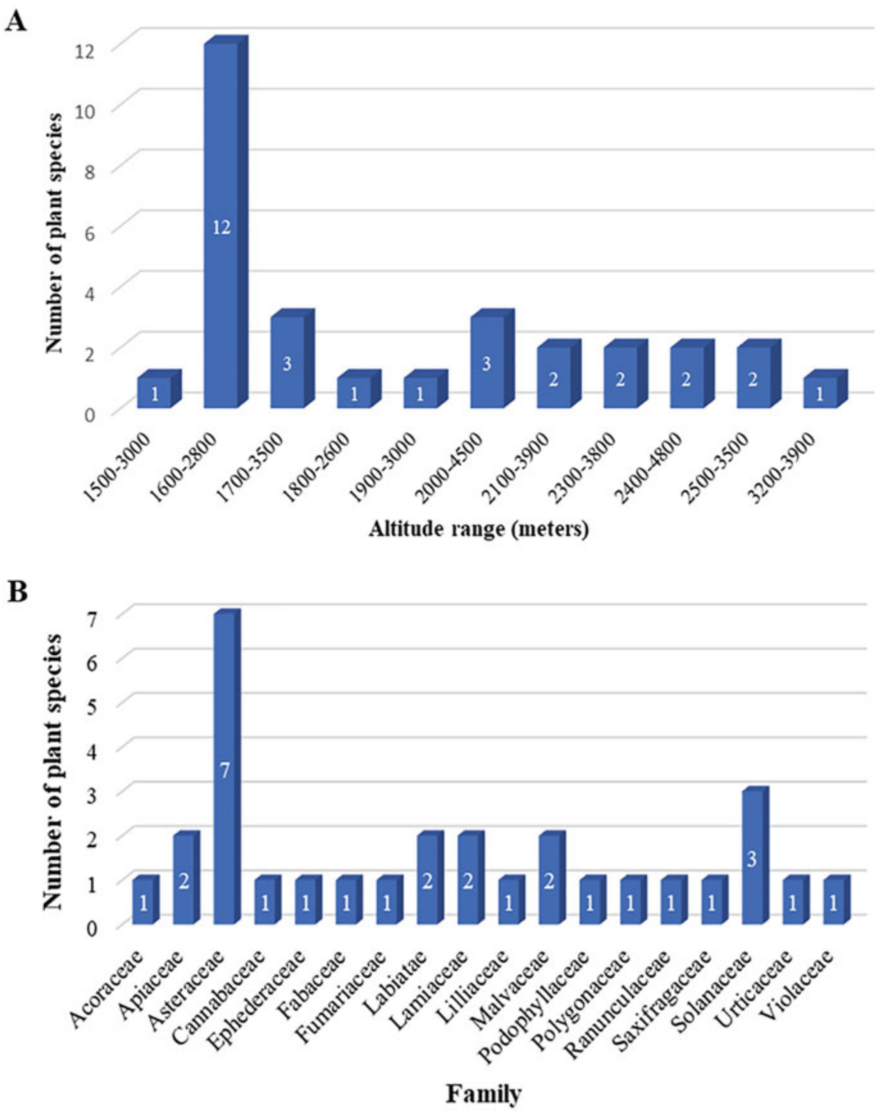

Fig. 6.3 (**a**) Altitude range frequencies (number of species); (**b**) Family distribution of selected medicinal plants

6.3 Taxonomic and Morphological Description

All of the plant species reviewed were angiosperms belonging to 18 families (Fig. 6.3b). Asteraceae was the most dominant family representing 7 (23.3%) plant species. Based on morphology (Table 6.1), it was found that 27 (90%) plant species were herbs, while 3 (10%) were shrubs.

6.4 Plant Part Used for Traditional Use

Herbal remedies for traditional use were found to be prepared from almost all plant parts including leaves, roots, seeds, flowers, fruits, rhizomes, stem, or the whole plant (Fig. 6.4). The most commonly used part was the leaf (26%), followed by roots (22%), seeds (15%), whole plant (14%) rhizome (9%), and flowers (8%). Medicinal formulations are usually made after shade drying these parts rather than using their fresh forms. Oral administration of these herbal formulations was the commonest.

6.5 Ailments Treated

Considering the ailments treated by these medicinal plants, the common ones included gastrointestinal problems, respiratory problems, infections, musculoskeletal problems, dermatological problems, CNS problems, wounds, cough/cold, dental, fever, and headache (Fig. 6.5a). The vast majority of plant species were used for treating gastrointestinal and respiratory problems (16 species each), followed by infections (13 species) and cough/cold (10 species). The least treated ailments were alopecia, menstrual irregularities, cardiac, circulatory, and liver problems (3, 3, 2, 2, 2 species, respectively). Herbal remedies were generally prepared by using techniques such as boiling, paste making, squeezing, decoctions, infusions, and grinding to powder (Table 6.2).

6.6 Reported Pharmacological Activities

By reviewing the pharmacological and phytochemical literature on the selected medicinal plants, it was revealed that these plant species possess a diverse range of pharmacological properties as listed in Table 6.2.Major pharmacological actions reported were antimicrobial and antioxidant (20 species each), followed by anticancer (16 species), antidiabetic (10 species), analgesic (7 species), and hepatoprotective (9 species) (Fig. 6.5b).

Table 6.1 List of selected medicinal plants from Kashmir valley with their botanical names, local names, family, altitude distribution, and habitat

Botanical name and Family	Local name (s)	English name(s)	Altitude range (meters)	Habitat/ Morphology	References
Achillea millefolium Asteraceae	Berguer or Pahal gassa	Common yarrow or Giant yarrow	1600–2800	Erect herbaceous perennial flowering plant (Fig. 6.2a)	Jeelani et al. (2018); Malik et al. (2011); Rather and Baba (2015)
Allium sativum Liliaceae	Rohun	Garlic	1600–2200	Bulbous herbaceous perennial plant (Fig. 6.2b)	Malik et al. (2011); Wagay (2018)
Arnebia benthamii Asteraceae	Kahzaban or Gawzaban	Macrotomia benthamii	2700–3500	Herbaceous perennial erect flowering plant (Fig. 6.2c)	Malik et al. (2011); Rather and Baba (2015); Wagay (2018)
Dioscorea deltoidea Asteraceae	Krath or Krees	Elephant's foot or yam	2300–2800	Perennial climbing herb (Fig. 6.2d)	Jeelani et al. (2018); Malik et al. (2011); Rather and Baba (2015)
Hyoscyamus niger Solanaceae	Van tamok or bazar bhang	Henbane or black henbane	1600–2100	Annual, biennial, or perennialherb (Fig. 6.2e)	Jeelani et al. (2018); Malik et al. (2011); Wagay (2018)
Lavetera kashmiriana Malvaceae	Jungli sonchal or Soz posh	Kashmir mallow	2100–2500	Perennial herbaceous plant (Fig. 6.2f)	Malik et al. (2011); Rather and Baba (2015)
Malva sylvestris Malvaceae	Gur Sachal or Sotsal	Mallow, high mallow, common mallow, or tall mallow	1600–1900	Annual or perennial herb (Fig. 6.2g)	Malik et al. (2011); Rather and Baba (2015);

(continued)

Table 6.1 (continued)

Botanical name and Family	Local name (s)	English name(s)	Altitude range (meters)	Habitat/ Morphology	References
					Wagay (2018)
Mentha arvensis Labiatae	Yan or Pudina	Corn mint, wild mint	1700–2500	Perennial erect branched aromatic (Fig. 6.2h)	Jeelani et al. (2018); Malik et al. (2011)
Rheum emodi Polygonaceae	Pumbchalan	Himalayan rhubarb	2500–3500	Perennial (Fig. 6.2i)	Jeelani et al. (2018); Malik et al. (2011); Rather and Baba (2015); Wagay (2018)
Taraxacum officinale Asteraceae	Handd	Dandelion-kukraundha, Kanphool, or dandelion	1600–2400	Herbaceous perennial weed (Fig. 6.2j)	Malik et al. (2011); Rather and Baba (2015); Wagay (2018)
Artemisia absinthium Asteraceae	Chawoo or Tethwan	Wormwood	1700–2200	Perennial shrub (Fig. 6.2k)	Jeelani et al. (2018); Malik et al. (2011); Wagay (2018)
Thymus serpyllum Lamiaceae	Jungle javind	Wild thyme, Breckland thyme, or creeping thyme	2000–2730	Perennial shrub (Fig. 6.2l)	Jeelani et al. (2018); Malik et al. (2011); Wagay (2018)
Urtica dioica Urticaceae	Kandyari or Soi	Stinging nettle	1600–2400	Perennial herb (Fig. 6.2m)	Malik et al. (2011); Rather and Baba (2015); Wagay (2018)
Viola odorata Violaceae	Numposh or Bunfsha	Sweet violet, English	1800–2600		Jeelani et al.

(continued)

Table 6.1 (continued)

Botanical name and Family	Local name (s)	English name(s)	Altitude range (meters)	Habitat/ Morphology	References
		violet, or garden violet		Flowering perennial herb (Fig. 6.2n)	(2018); Malik et al. (2011); Rather and Baba (2015); Wagay (2018)
Prunella vulgaris Labiatae	Kulwauth	Self-heal, common selfheal, or lance selfheal	1600–1900	Herbaceous plant (Fig. 6.2o)	Jeelani et al. (2018); Malik et al. (2011); Rather and Baba (2015); Wagay (2018)
Trigonella foenum-graecum Fabaceae	Meth	Fenugreek or sickle fruit fenugreek	1600–1900	Erect herbaceous plant (Fig. 6.2p)	Jeelani et al. (2018); Rather and Baba (2015)
Aconitum heterophyllum Ranunculaceae	Paewakh	Atees or Patris	2300–3800	Herbaceous plant (Fig. 6.2q)	Jeelani et al. (2018); Rather and Baba (2015); Wagay (2018)
Corydalis govaniana Fumariaceae	Sangi-harb	Govan's corydalis	2400–4800	Erect tufted perennial herb (Fig. 6.2r)	Dar et al. (2018); Rather and Baba (2015); Wagay (2018)
Datura stramonium Solanaceae	Datur	Thorn apple, jimsonweed, or Devil's snare	1600–2700	Erect annual herb (Fig. 6.2s)	Jeelani et al. (2018); Dar et al. (2018); Rather and Baba (2015);

(continued)

Table 6.1 (continued)

Botanical name and Family	Local name (s)	English name(s)	Altitude range (meters)	Habitat/ Morphology	References
					Wagay (2018)
Ephedra gerardiana Ephederaceae	Asmani buti	Ma Huang or Gerard jointfir	2000–4500	Perennial low-growing rigid tufted shrub (Fig. 6.2t)	Wagay (2018)
Podophyllum hexandrum Podophyllaceae	Van wangun	Himalayan Mayapple, Devil's apple, or Duck's foot	2400–4000	Succulent erect herb (Fig. 6.2u)	Jeelani et al. (2018); Dar et al. (2018); Wagay (2018)
Tussilago farfara Asteraceae	Watpan	Coltsfoot	1600–2500	Perennial herbaceous plant (Fig. 6.2v)	Jeelani et al. (2018); Dar et al. (2018); Wagay (2018)
Lamium album Lamiaceae	Zakhmi Dawa	White nettle or dead nettle	3200–3900	Herbaceous perennial plant (Fig. 6.2w)	Jeelani et al. (2018); Dar et al. (2018); Wagay (2018)
Atropa acuminata Solanaceae	Chella Lubbar	Deadly nightshade, Indian belladonna, or Indian atropa	2000–3600	Herbaceous perennial plant (Fig. 6.2x)	Jeelani et al. (2018); Dar et al. (2018); Wagay (2018)
Acorus calamus Acoraceae	Wia-gander	Sweet flag or Calamus	1600–2300	Semi-aquatic or marshy perennial herb (Fig. 6.2y)	Jeelani et al. (2018); Dar et al. (2018); Wagay (2018)
Anthemis cotula Jeelani et al. (2018); Wagay (2018) Asteraceae	Fackgasa	Mayweed or stinking chamomile	1500–3000	Annual glandular herb (Fig. 6.2z)	

(continued)

Table 6.1 (continued)

Botanical name and Family	Local name (s)	English name(s)	Altitude range (meters)	Habitat/ Morphology	References
Bergenia Saxifragaceae	Zakhm-i-Hayat	Hairy Bergenia	1900–3000	Rhizomatic herb (Fig. 6.2AA)	
Bupleurum falcatum Apiaceae	Bormuje	Thorow-wax, sickle hare's ear, or sickle-leaved hare's-ear	2100–3900	Herbaceous perennial plant (Fig. 6.2AB)	Jeelani et al. (2018); Wagay (2018)
Cannabis sativa Cannabaceae	Bhang	Marijuana, hemp, or Gallow grass	1600–2400	Erect annual herb (Fig. 6.2AC)	Jeelani et al. (2018); Dar et al. (2018); Wagay (2018)
Angelica glauca Apiaceae	Choora	Smooth Angelica	1700–3500	Glabrous aromatic perennial or biennial herb (Fig. 6.2AD)	Jeelani et al. (2018); Dar et al. (2018); Wagay (2018)

6.7 Economic Importance

Over the last two decades, medicinal plants have gained considerable interest within the pharmaceutical sector as they are deemed safe and cost-effective in contrast to synthetic medicines. According to WHO, the current market for herbal medicine is nearly US$14 billion per year which is expected to rise to US$ 5 trillion by the year 2050 (Sharma 2004). In India, the trade associated with herbal medicine is currently around US $1 billion per year, of which Northern Himalayas contribute a large part with unique flora from the Kashmir Himalayas (Joshi et al. 2004). The herbal medicine sector in India employs around 1.5 million traditional practitioners. Therefore, effective cultivation of medicinal plant species has a great advantage in raising the herbal drug industry (Pandey et al. 2013).

Considering the rich agro-ecological conditions of Kashmir Himalayas, its indigenous medicinal plant species produce high amounts of essential secondary metabolites than those found in other regions of India. Around 171 of 675 Himalayan edible medicinal plants are used by locals for treating several ailments (Samant et al. 2001), and about 81 aromatic medicinal plants are used to obtain essential oils (Kala et al. 2006). Notable among the aromatic species are *Lavandula officinalis*, *Rosa damascena*, *Dioscorea deltoidea*, *Podophyllum hexandrum*, *Mentha arvensis*,

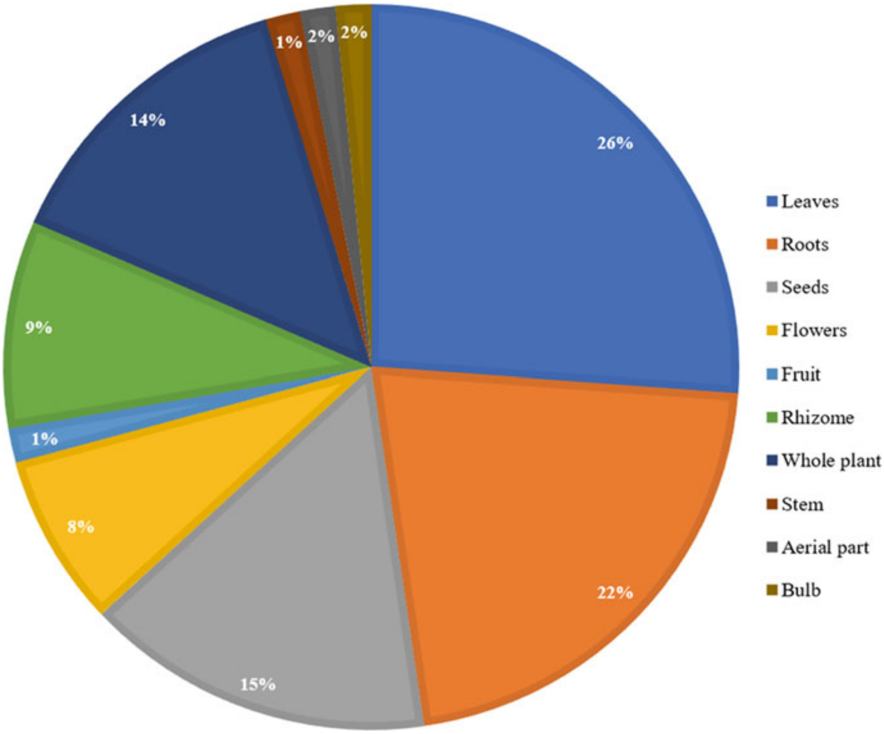

Fig. 6.4 Percentage distribution of plant parts used

Rosmarinus officinalis, *Artemisia absinthium*, and *Atropa acuminata.* The essential oils derived from these herbal plants are among the world's top 10 essential oils in aromatherapy (Khan et al. 2016). Considering these high-value medicinal plants, the valley of Kashmir offers a significant potential to establish the essential oil, perfumery, and pharmaceutical sector (Shawl and Kumar 2000). As discussed in the above sections of this chapter, many medicinal plant species are being used by folklore for treating various ailments like gastrointestinal problems, respiratory problems, infections, musculoskeletal problems, dermatological problems, cardiac problems, etc. This traditional knowledge of herbal drugs may generate significant economic benefits by providing a base for future drug research (Pandey et al. 2013).

6.8 Future Perspectives

Kashmir valley harbors a rich diversity of medicinal plants, with Kashmir division accounting for around 3000 such species (Dar et al. 2017). This chapter documented 30 medicinal plants from Kashmir valley having been used in the traditional system of medicine. Considering the current pharmacological and phytochemical investigations, it is evident that these herbal species possess a broad range of

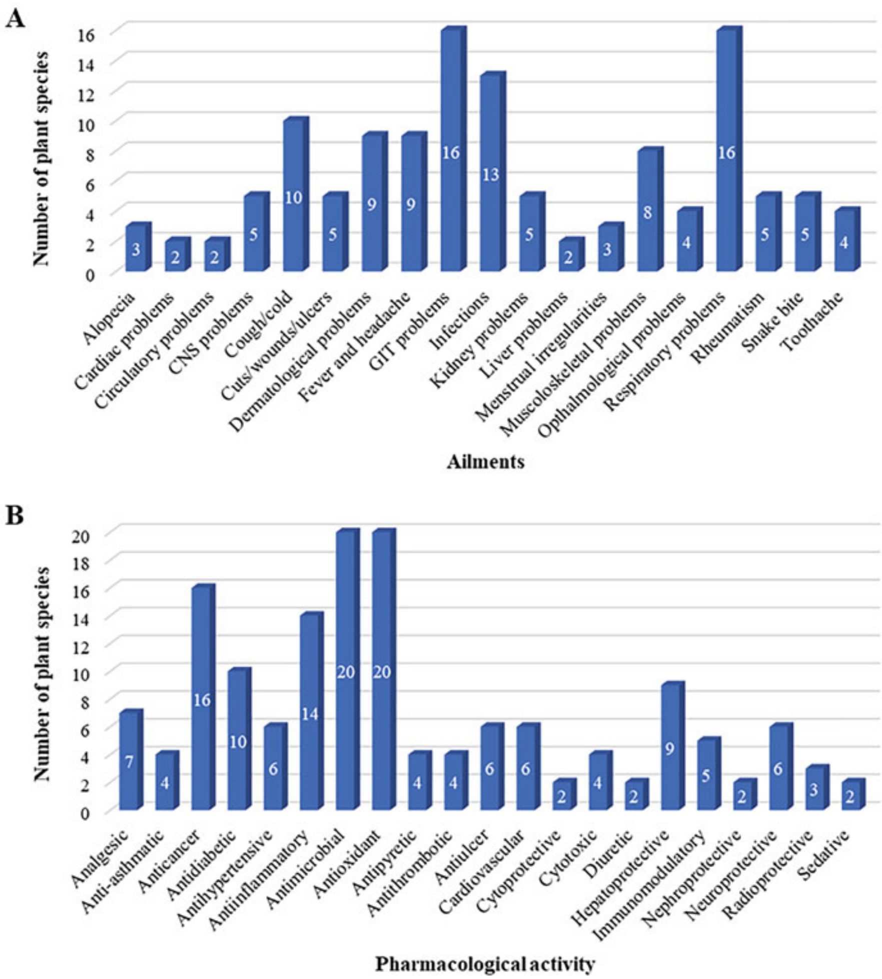

Fig. 6.5 (**a**) Frequency use of plant species based on different ailments; (**b**) Frequency distribution of plant species based on reported pharmacological activity

pharmacological activities that align with the traditional use. Since traditional use and chemical analysis of medicinal plants have generated valuable insights towards the discovery of new therapeutic agents (Cotton and Wilkie 1996), a comprehensive phytochemical and pharmacological research of locally used herbal species is needed which may lead to the development of novel biologically active compounds for the treatment of diseases which currently do not have the suitable cure.

Furthermore, the traditional knowledge of healthcare is eroding due to rapid socio-cultural changes. Moreover, indiscriminate and unscientific harvesting techniques have brought most of these species on the verge of extinction. Therefore,

Table 6.2 List of selected medicinal plants from Kashmir valley with their ethnomedicinal uses and reported pharmacological activities

Plant	Plant part (s) used	Ethnomedicinal uses	Pharmacological activities
Achillea millefolium	Whole plant, leaves, and flowers	It is used as antipyretic and for healing the bruises of snakebite. The flower is used as a laxative, diuretic, stimulant, and brain tonic. The decoction of leaves is used as a diaphoretic, stimulant, and also in colds. Leaves are chewed to treat toothache (Malik et al. 2011; Wagay 2018; Dar et al. 2018).	Antiulcer, hepatoprotective, anticancer, anti-inflammatory, antioxidant, antiproliferative, antimicrobial, antiparasitic, antispasmodic, cardiovascular, immunosuppressive, analgesic, and gastroprotective activity (Ali et al. 2017; Lakshmi et al. 2011).
Allium sativum	Bulb	Crushed bulbs when boiled in mustard oil are used to treat alopecia. Fresh bulb poultice is rubbed along the effective part of the body to cure skin diseases. The paste of bulb is used in the uterus to enhance conception and fertility. Crushed clove, taken along a glass of water is used for weight loss. The paste of bulb is applied externally on snake bite (Malik et al. 2011; Wagay 2018).	Antibacterial, antimicrobial, antihypertensive, anti-atherosclerotic, anti-thrombotic, antiulcer, hypolipidemic, antiulcer, anticancer, antidiabetic, hepatoprotective, radioprotective, neuroprotective, anti-inflammatory, antioxidant, and immunomodulatory activities (Tesfaye 2015; Mikaili et al. 2013; Bhandari 2012).
Arnebia benthamii	Whole plant, rhizome and roots	The decoction of the rhizome is used as a blood purifier and to treat fever, cough and cold. Extract of the whole plant in lukewarm water is used to enhance lactation in nursing mothers. Root extract mixed with hair oil is used for preventing hair fall (Malik et al. 2011; Rather and Baba 2015; Wagay 2018).	Antioxidant, antimicrobial, and cytotoxic activity (Ganie et al. 2014; Shameem et al. 2015).
Dioscorea deltoidea	Leaves and rhizome	The rhizome is given orally for curing snake bite. The paste of tuber powder mixed with edible oil is used by women to kill lice. The decoction of leaves is used to treat eye infections (Dar et al. 2018; Malik et al. 2011; Rather and Baba 2015; Wagay 2018).	Cardiovascular, neuroprotective, anticancer, antidiabetic, antimicrobial, antithrombotic anti-inflammatory, and immunological, activity (Mustafa et al. 2018).
Hyoscyamus niger	Leaves and seeds	Dried leaf powder is smoked in cigarettes as sedative.	Cerebro-spinal stimulant, hypotensive, cardio

(continued)

Table 6.2 (continued)

Plant	Plant part (s) used	Ethnomedicinal uses	Pharmacological activities
		Powder made from seeds is used to treat toothache. Seed paste mixed with oil is used to treat joint arthritis and eyelid abscesses (Malik et al. 2011; Rather and Baba 2015; Wagay 2018).	suppressant, and vasodilator, analgesic, anti-oxidant, anti-inflammatory, antipyretic, cytotoxic, neuroprotective, and antimicrobial activity (Aparna et al. 2015; Al-Snafi 2018).
Lavatera kashmiriana	Flower	Seeds are used as antiseptic. The paste made from dried flowers is used to treat mumps in children. (Malik et al. 2011; Rather and Baba 2015).	Anticancer and antibacterial activity (Rakashanda et al. 2012; Rakashanda et al. 2013).
Malva sylvestris	Whole plant, seeds, and roots	Powder of roots or extract of the whole plant is used for stomach cramps, dysentery, and diarrhea. Boiled seeds are used to treat cough and fever (Malik et al. 2011; Rather and Baba 2015; Wagay 2018).	Anticancer, hepatoprotective, antioxidant, and antimicrobial activity (Paul 2016).
Mentha arvensis	Aerial parts and leaves	It is used as a carminative and as a flavoring agent. Leaves are useful in headache and gastric upsets. Powder made from aerial parts is taken with curd to treat cough, sore throat, constipation, and indigestion (Jeelani et al. 2018; Wagay 2018).	Antibacterial, antioxidant, anti-inflammatory, antifertility, cardioprotective, antiallergic, and radioprotective activity (Thawkar 2016).
Rheum emodi	Rhizome and roots	Powder made from rhizomes is used to treat burns and ulcers. The root extract is used for abdominal discomfort and for treating prolonged cough (Malik et al. 2011; Wagay 2018).	Antiulcer, hepatoprotective, antidiabetic, anticoagulant and immunomodulatory, activity (Kaur et al. 2015).
Taraxacum officinale	Leaves and roots	Cooked dried leaves are given to ladies after childbirth to prevent blood loss. Dried roots are used as diuretic and tonic. The paste of leaves is mixed with turmeric and salt for treating fractures of bones (Dar et al. 2018; Malik et al. 2011; Rather and Baba 2015; Wagay 2018).	Anticancer, antidiabetic, choleretic, hypolipidemic antithrombotic, antioxidant, anti-inflammatory, and prebiotic activity (Choi et al. 2010; Koo et al. 2004).
Artemisia absinthium	Leaves and flowers	Leaves and flowering tops are used as an expectorant and for relieving joint pain and sprain	Anticancer, antiulcer, neuroprotective, anthelmintic, antidepressant, antibacterial,

(continued)

Table 6.2 (continued)

Plant	Plant part (s) used	Ethnomedicinal uses	Pharmacological activities
		swelling. The paste made from inflorescences and dried leaves is taken with water to treat worm infections and stomach upsets (Dar et al. 2018; Malik et al. 2011; Wagay 2018).	antimalarial, antiprotozoal, antipyretic, antioxidant, and hepatoprotective activity (Hussain et al. 2017).
Thymus serpyllum	Leaves and seeds	Leaves are used as a tonic, laxative, and for treating kidney and eye diseases. Infusion of leaves is used to treat skin ulcers. Powder made from seeds is used to treat worm infections in children. Leaf juice is used to cure alopecia (Dar et al. 2018; Malik et al. 2011; Wagay 2018).	Antihypertensive, antimicrobial, and anticancer activities (Jaric et al. 2015).
Urtica dioica	Leaves and roots	The paste of roots and oil is used to treat rheumatoid pain and for the healing of minor wounds. Extract of young leaves is used as diuretic and stomachic. The paste of roots boiled in mustard oil is used to cure cysts of hands and feet (Malik et al. 2011; Wagay 2018).	Antioxidant, antidiabetic, hepatoprotective, antimicrobial, antiviral, diuretic, cardiovascular, anticancer, anti-inflammatory, analgesic, and antiarthritic activity (Joshi et al. 2014).
Viola odorata	Leaves, seeds, and flowers	A mixture of flower powder and sugar is taken at bedtime daily for a week to treat respiratory infections, fever, and hoarseness of voice. The herb is also used to treat body swellings and muscular pains (Jeelani et al. 2018; Malik et al. 2011; Wagay 2018).	Antimicrobial, antipyretic, anticancer, cytotoxic, molluscicidal, sedative, hepatoprotective, laxative, antihypertensive, and antidyslipidemic activity (Mittal et al. 2015).
Prunella vulgaris	Leaves, seeds, and flowers	Seeds are used as antipyretic, diuretic, and laxative. A hot water bath of leaves and flowering is used to alleviate muscular pain, fever, and headache. The paste made from flowers is used to treat chest problems. Leaf powder is used as hypotensive, antispasmodic, and vermifuge (Jeelani et al. 2018; Malik et al. 2011; Wagay 2018).	Antimutagenic, antiviral, anticancer, antimicrobial, cardioprotective, antidiabetic, antistress, antiallergic, immunosuppressive, antioxidant, and anti-inflammatory activity (Rasool and Ganai 2013).

(continued)

Table 6.2 (continued)

Plant	Plant part (s) used	Ethnomedicinal uses	Pharmacological activities
Trigonella foenum-graecum	Leaves and seeds	The herb is used to treat back pain and throat infections (Jeelani et al. 2018; Rather and Baba 2015).	Antioxidant, antidiabetic, antilipidemic, anticancer, antimicrobial, anti-inflammatory, hepatoprotective, nephroprotective, and antiulcer activity (Yadav and Baquer 2014).
Aconitum heterophyllum	Roots	The decoction of roots is used for treating abdominal disorders. Crushed dried roots are mixed with oil and used for headache, skin problems, and joint pains. Roots are also used for urinary infections, throat infections, dyspepsia, vomiting, diabetes, diarrhea, and cough (Jeelani et al. 2018; Wagay 2018).	Hepatoprotective, antioxidant, anodyne, anti-flatulent, anti-periodic, analgesic, antipyretic, and carminative activity (Paramanick et al. 2017).
Corydalis govaniana	Roots and seeds	Seeds and roots are used in the treatment of eye infections (Wagay 2018).	Analgesic and antioxidant activity (Muhammad et al. 2015; Shrestha and Adhikari 2017).
Datura stramonium	Whole plant, leaves, and seeds	Sun-dried seed powder is used to treat respiratory diseases when taken with water. Seed powder mixed with mustard oil is used to treat rheumatism. Seed smoke is used to cure toothache. The decoction made from leaves and petals is used for treating skin eruptions. The plant is also used for intestinal problems, boils, and headache (Jeelani et al. 2018; Dar et al. 2018; Wagay 2018).	Antiasthmatic, anticholinergic, antimicrobial, anticancer, larvicidal, antimicrobial, anti-inflammatory, acaricidal, repellent, and oviposition deterrent activities (Soni et al. 2012; Gaire and Subedi 2013).
Ephedra gerardiana	Whole plant	Acts as a source of ephedrine which is used in the treatment of asthma and to prevent heart block. It is also used in cold, cough, bronchitis, arthritis, blood infections, bile complaints, and as an expectorant (Wagay 2018).	Anti-asthmatic, antioxidant, antimicrobial, anti-arthritic, cytotoxic, antitumor activities (Khan et al. 2017; Uttra 2017; Jamil et al. 2012; Chaitanya et al. 2014).
Podophyllum hexandrum	Whole plant, rhizome,	The paste of rhizome is applied externally for treating snake bite. The rhizome is also used as purgative in	Anticancer, antiviral, radioprotective, antifungal, antioxidant, immune-stimulatory, and

(continued)

Table 6.2 (continued)

Plant	Plant part (s) used	Ethnomedicinal uses	Pharmacological activities
	roots, and fruits	chronic constipation. Fruit juice is taken against stomach ulcers and dyspepsia. Root powder taken with water is used against heart burns. The plant is also used for treating skin diseases, tumors, menstrual irregularities, urinary infections, and back pain (Jeelani et al. 2018; Wagay 2018).	antirheumatic activities (Rather and Amin 2016).
Tussilago farfara	Leaves and roots	Leaves and roots are used as an expectorant, stimulant, and tonic, in asthma, bronchitis, chest problems, and inflammation. (Jeelani et al. 2018; Dar et al. 2018; Wagay 2018).	Antioxidant, anti-inflammatory neuroprotective, and antimicrobial activities (Cho et al. 2005; Hwangbo et al. 2009; Kačániová et al. 2013).
Lamium album	Whole plant	Extract of whole is used to treat burns, wounds, and uterine bleeding (Jeelani et al. 2018; Wagay 2018; Rather and Baba 2015).	Antioxidant, antimicrobial, antidiabetic, cytoprotective, and anti-inflammatory activities (Kelayeh et al. 2019).
Atropa acuminata	Roots and leaves	The decoction of roots is used in cough and abdominal problems. The root powder is mixed with ghee and applied externally on affected portions to treat rheumatism. It is also used as narcotic, sedative, antispasmodic, and for treating cough and asthma (Jeelani et al. 2018; Dar et al. 2018; Wagay 2018).	Analgesic, antispasmodic, hallucinogenic, mydriatic, narcotic, and sedative activities (Maqbool et al. 2014).
Acorus calamus	Rhizome and roots	Extract of roots is used as stomachic and to treat diarrhea and cough. Root paste is mixed with ghee and applied to treat swelling of joints. It is also used to treat wounds and worm infections (Jeelani et al. 2018; Dar et al. 2018; Wagay 2018).	Anti-inflammatory, immunomodulatory, hypotensive, anticancer, cardioprotective, anti-asthmatic, hypolipidemic, antidiabetic, anticholinesterase, antimicrobial, and pesticidal activities (Rajput et al. 2014).
Anthemis cotula	Whole plant, leaves, and seeds	Whole plant extract is used for muscular pains. Leaves are rubbed onto the insect bite or relieve pain. Seeds are used as	Antioxidant, acetylcholinesterase, butyrylcholinesterase, tyrosinase, amylase, and

(continued)

Table 6.2 (continued)

Plant	Plant part (s) used	Ethnomedicinal uses	Pharmacological activities
		insect repellents (Jeelani et al. 2018; Wagay 2018).	glucosidase activities (Sut et al. 2019).
Bergenia ciliata	Rhizome, roots, and leaves	The root extract is used as a tonic in fever, diarrhea, and cough. Leaf juice is used to treat earache. Rhizome decoction is used as a diuretic, and for treating asthma and gastric problems, bladder stones, menstrual irregularities, skin diseases, and wounds (Jeelani et al. 2018; Wagay 2018).	Antioxidant, antimicrobial, and cytoprotective activities. (Singh et al. 2017; Hendrychova and Tumova 2012)
Bupleurum falcatum	Whole plant, roots	Whole plant powder is given orally for snake bite. Root extract is beneficial in liver diseases and abdominal pain (Jeelani et al. 2018; Wagay 2018)	Antiulcer, anti-asthmatic, anti-nephroprotective (Chen et al. 2008; Matsumoto et al. 2002).
Cannabis sativa	Leaves, seeds, and stem	Dried leaf powder mixed with egg yolk in small quantities is used to treat excessive urination in children and menstrual irregularities. Powder of stem and leaves mixed with ghee is used to treat skin diseases. Leaves are smoked as sedative. It is also used to treat rheumatism, cholera, blood problems, diarrhea, gastric problems, piles, and urinary infections (Jeelani et al. 2018; Dar et al. 2018; Wagay 2018)	Abortifacient, analgesic, anaphrodisiac, anti-anaphylactic, anti-androgenic, antibacterial, anticonvulsant, anti-Parkinsonian, anti-estrogenic, antifertility, antiglaucomic, antigonadotropin, anti-inflammatory, antispasmodic, anti-spermatogenic, Anticancer, CNS depressant, cataleptic, DNA synthesis inhibition, estrous cycle disruption, hypotensive, hypoglycemic, and mutagenic activities (Lohar and Rathore 2013).
Angelica glauca	Roots	The root powder is applied to treat toothache. It is also taken with water to treat stomach disorders (Jeelani et al. 2018; Dar et al. 2018; Rather and Baba 2015; Wagay 2018).	Broncho-relaxant, antioxidant, antimicrobial, and phytotoxic activities (Sharma et al. 2017; Irshad et al. 2011).

appropriate guidelines and strategies for the conservation and sustainable use of medicinal plants need to be formulated and implemented. Also, strenuous efforts should be made to encourage the mass cultivation of medicinal plants which in turn would ensure the continuous supply of these medicinal plants, both for indigenous and commercial use. Finally, joint efforts between the government and local people and the implementation of education programs aimed at conveying the importance of traditional medicinal plants are of utmost importance in boosting the economic development associated with these medicinal plants.

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High Altitude Edible Plants: A Great Resource for Human Health and their Socio-Economic Significance

7

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Abstract

As the name suggests, edible plants are those plants which can be eaten. Out of the twenty thousand species of edible plants found around the world, only twenty species make up the majority of our food. However, there are still numerous plants which are lesser known but can be eaten and also have nutritional and medicinal value. These natural products have been an important part of food, economy and health care for most of the population. Traditional knowledge of high altitude edible and medicinal plants has served as the base for many breakthrough discoveries especially in the medicinal field. Organized and systemic cultivation of high altitude of medicinal plants with efficient procession and

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marketing strategies may boost up the economy of not only the tribal people but also to the nation's economy. This chapter discusses about the traditional knowledge about the edible and medicinal plants, edible plants of high altitude regions of Himalayas, high altitude medicinal plants as a source for treating major health ailments, modern drugs derived from traditional medicines derived from high altitudes, biological radioprotection by high altitude plants, wealth of ethnic and medicinal high altitude medicinal plants, ethnic veterinary medicinal plants from high altitude regions, description some of the wild edible plant species of the high altitude regions of Himalayas, high altitude medicinal herbs as socio-economic resource, cultivation of high altitude edible medicinal plants of Himalayas for economic growth and management, conservation and prospect of high altitude medicinal plants.

Keywords

Edible plants, Himalayas · Socio-economic · Traditional medicine · Medicinal plants

7.1 Introduction

As the name suggests, edible plants are those plants which can be eaten (Ju et al. 2013). Out of the twenty thousand species of edible plants found around the world, only twenty species make up the majority of our food. However, there are still numerous plants which are lesser known but can be eaten and also have nutritional and medicinal value. Through thousands of years humans have survived by managing and utilizing the available bioresources around him. Humans have been around the forest ecosystem since ancient times (Coates 2013). Being an integral part of this dynamic ecosystem humans have acquired immense knowledge about this ambient biosystem by trial and error, instinct and experimentation to better understand different varieties of flora to meet their basic requirement of food, fibre, fuel, medicines, etc. Humans by its intelligence and innovation carved a better habitat with the available resources. They later build civilization and developed villages, towns and cities. However, still a large population of humans choose to live near or around the forest ecosystem. Communities living in modern cities lost association with the forest and nature and eventually lost the hard-gathered knowledge about the wild edible plants which their forefathers had gained. Further development lead to shrinking of the forests which lead to the disrupted, disturbed and destabilization of the forest peoples causing an imminent danger of their extinction and with them the culture and knowledge they have gained through their peculiar lifestyle. People who got settled in different habitat began to select certain species of plants and perfected them according to their need. Furthermore, globalization occurred which brought its own advantages and disadvantages. Most undesirable of these were narrowing down of edible foods by the world population. The whole world is now dependent upon only 20 edible plants (Despommier 2010; Bidve et al. 2018). With the increase in knowledge and understanding of edible plants it is now a well-known fact that location and climate specific foods are the best ones for humans. The traditional system of medicine like the Unani, Ayurveda, Siddha and other makes the use of only 2500 plants out of 10,000 listed in the database requiring validation for its use (Sreedevi et al. 2013; Garg et al. 2017). Tribal people use around eight thousand wild edible plants with potential medicinal effect out of which only 950 makes the list with new claims and are marked as worthy for undergoing scientific scrutiny (Chopra and Chopra 1994).

The mighty Himalayan range with its enormous variety of flora and fauna have a long list of high altitude plant which are edible and have life sustaining and medicinal value (Abbasi et al. 2015). Himalayas serve as a reservoir of medicinal herbs for not just people who live in its foothills and nearby villages but also to the mankind who sustains in the far away towns and cities. The Himalayan range in India can be categorized into three different regions, namely the: North Western, Western and Eastern Himalayan range (Kala 2005). The climate of the North Western region is characteristically mild in summer and extremely cold in winter. Alpine vegetation is commonly found in this region which is characterized by the species like- *Juniperus communis, Bunium persicum, Ephedra gerardiana, Picrorhiza kurroa,* etc. The climate of the western Himalayan region warm and humid during summer season and during winter it is cold and humid. *Colchicum luteum, Physochlaina praelta, Sassurea costus, Atropa acuminata,* etc. are some of the most important medicinal herbs indigenous to Western Himalayan region (Chhetri 2014). The climate is warm during summer and cool during winter in the Eastern Himalayan region characterized by some important medicinal herbs like *Panax pseudoginseng, Coptis teeta, Aquilaria malaccenisi,* etc. There is an ever-increasing demand of medicinal herbs from Himalayan region (Yang et al. 2013).

A large population of people still lives in hunger and are malnourished (FAO 2012, 2013). Although this issue has been well debated by UN forum across the globe but the safety and availability of food in the high altitude region has been rarely discussed (Dame and Nusser 2011). In the high altitude region, the wild edible plants play an important part in the livelihood and medicinal needs of people living in such regions (Afolayan and Jimoh 2009). The ethnic communities are solely dependent on wild edible and medicinal plants which are now gaining attraction of many researchers from around the globe. The study of wild edible plants has led to the discovery of many potential compounds which have high medicinal and nutritional value. Proper domestication and application of such wild edible plants could serve as a potential platform to uplift the economic scenario of poor farmers from such rural areas (Bharucha and Pretty 2010). The high altitude of Eastern Himalayan region is quite rich in the wild varieties of flora and fauna which are mainly endemic to this specific part of the Himalayan region (CEPF 2005). Alpine flora is abundant in this Himalayan region of India with its one third alpine floras being endemic to Eastern Himalayan region (Dhar 2002). This region has been ranked as the most species rich temperate forest in the world by the ICIMOD and World Wide fund for Nature (WWF) (WWF and ICIMOD 2001). The Eastern region of Himalaya serves as the cradle of the flowering plants (Takhtajan 1969). It is home to some of the rarest species like *Sapria himalayana, Coptis teeta* and *Magnolia* (Takhtajan 1969). The cultural biodiversity of Eastern Himalayan region makes it a hub of traditional herbal knowledge. *Diplazium esculentum, Ribes* *orientale, Centella asiatica, Fragaria vesca, Houttuynia cordata, Litsea cubeba, Mentha arvensis, Elaeagnus umbellata, Zanthoxylum armatum, Panax bipinnatifidus, longum, Potentilla peduncularis, Phyllanthus emblica, Piper Psidium guajava, Pyrus pashia, Rhododendron arboreum, Plantago major, Urtica dioica, Zanthoxylum rhetsa, Rubus ellipticus* etc. are some of the wild edible medicinal plants of the Eastern region of Himalayas (Tag and Tsering 2012).

7.2 High Altitude Edible and Medicinal Plants of the Great Himalayas

Arid, cold climate with scanty rainfall and high velocity winds, high ultraviolet radiation and snowstorm are characteristics of the climatic condition of high altitude regions of Himalayas. The vegetations in these regions have got adapted to extreme environmental conditions. Many microhabitat regions get created in these regions leading to diversity in habitat. These microhabitats act as hotspots for biodiversity of medicinal plants (Effo et al. 2018; Kaul 2010; Pei 1998). Countries like India, Pakistan, China, Nepal, Bangladesh are very strong in traditional system of medicine and possess rich diversity of medicinal plants. China has been very successful in promoting the use of its traditional medicines in the developing countries. Very few countries have capitalized on their herbal wealth by promoting its application in the developing world. The information about medicinal plants found in the high altitude regions is very mere. Indian drug industry uses around 700 medicinal plants out of which 350 are from Himalayan medicinal plants (Ved et al. 1998; Purohit 1997; Dhar et al. 2000). In the high altitude regions of Himalayas, the specific climate and geological conditions there is high possibility of having large quantities of novel active biocompounds (Dhawan 1997; Hazlett and Sawyer 1998). High altitude region has abundant medicinal plants which could promise great therapeutic efficiency. These herbal drugs are in great demand in the USA and the European nations. Drugs derived from plants held a special place in the Russian and German Pharmacopoeias. Even today a large population of the world depends on crude plant drugs to treat their health issues. Many more people are turning towards herbal medicines day by day. The economic turnover of herbal medicines in India is huge as classical, ethical and over the counter herbal remedies of Unani, Ayurveda and Siddha system of medicines makes up about $1 billion with export of $80 million (Kamboj 2000). The export of herbal medicines can be considered as negligible despite the fact that India has a rich source of herbal drugs and tradition knowledge. This is due to lack of quality control and standardization of herbal products. Herbal pharma sector is controlled by Himalaya, Hamdard, Dabur, Baidyanath, Zandu, Maharishi, etc. (Sen et al. 2011).

7.3 Therapeutic Possibilities of High Altitude Plants

The therapeutic possibility of medicinal plants of high altitude may be categorized into five major sections:

- High altitude medicinal plants as a source for treating major health ailments.
- Modern drugs derived from traditional medicines derived from high altitudes.
- Biological radioprotection by high altitude plants.
- Wealth of ethnic and medicinal high altitude medicinal plants.
- Ethnic veterinary medicinal plants from high altitude regions.

7.3.1 High Altitude Medicinal Plants as a Source for Treating Major Health Ailments

Hypericum perforatum, Ephedra gerardiana, Ginkgo biloba, Panax species, Echinacea species are some of the most selling herbal medicines which are grown in the high altitude regions. Germany lists more than 300 herbs as individual monograph based on their therapeutic benefits. Sixteen of them are Indian medicinal plants which have innovative characteristics and eminent therapeutic potential (Vaidya 1996). *Podophyllum hexandrum* is a high altitude medicinal herb, podophyllotoxins derived from these plants are used to develop etoposide and teniposide are developed which has proven therapeutic efficiency in lymphoma, testicular cancer and small cell lung cancer (Gerhart 1986; Jahangir et al. 2020a). Another high altitude species *Taxus wallichiana*, taxol is derived from these plants which are chemically diterpenoid and has potential therapeutic effects on malignant melanoma, metastatic breast cancer and lung cancer (Suffness 1995; George et al. 1995). They have been rated as critically endangered species due to destructive harvesting along their wild habitats. It is the need of the hour to promote large scale cultivation of this outstanding high altitude species to protect them from getting extinct. *Hypericum perforatum* with its unique spectrum of constituent and clinical and pharmacology profile makes them stand as one of the most important high altitude plants. Hyperforin 10 and hypericin derive from these plants have potent antidepressant activity (Erdelmeier et al. 2000; Jahangir et al. 2020b). Apart from that the extracts of *Hypericum perforatum* has been reported with antiviral and antibacterial activity.

7.3.2 Modern Drugs Derived from Traditional Medicines Derived from High Altitudes

Since ancient times, people have relied on herbal medicine and have also documented their traditional knowledge in the form of paintings and writings. These documentations acted as the base for the modern-day pharmacopoeias. Enormous number of currently used medicines like morphine, codeine, hyoscyamine, atropine, quinine, ephedrine, digoxin, colchicine, reserpine, strychnine, artemisinin, ergot, taxol, etc. have herbal origin. Modern drug discovery is relying on the indigenous cure in different cultures. Belladonna was quite a famous drug in Babylonian culture which served as a base for its modern-day application. In the Chinese culture of medicine Ephedra has been extensively used for asthma and other respiratory disorders. Many other high altitude edible and medicinal plants have been used in different cultures for various ailments. Many classical drugs like Artemisinin, extracted from *Artemisia annua* have been found to be highly effective against both chloroquine resistant and chloroquine sensitive *Plasmodium vivax* and *Plasmodium falciparum* parasites causing malaria. Many reports also suggest their effectiveness against cerebral malaria (Huang 1984). Similarly, digoxin a strong cardiac stimulant and hyoscyamine a potent anticholinergic is still being considered in modern medical system. The Chinese Pharmacopoeia of the 1990s had enlisted more than 750 traditional Chinese medicines of which more than 600 were from herbal origin (Chang et al. 1985; Xiao 1981). Many of them were from high altitude regions. The roots of *Sophora substrata* and sophoradin extracted from the same have been extensively used in the treatment of stomach trouble and gastric ulcer, respectively (Sankawa 1992). Another high altitude plant *Huperzia serrata* has been extensively used in Chinese traditional culture to treat memory disorders of the geriatric patients. Huperzine A isolated from *Huperzia serrata* is a powerful acetylcholine esterase inhibitor and has immense application in Alzheimer's disease. In Indian traditional system like the Ayurvedic and Siddha system of medicine, plants hold an important position in their pharmacopeial preparations. Charaka Samhita stands as one of the oldest recorded documents which was fully devoted to the Ayurveda. It classifies herbals drugs according to their therapeutic action. Charaka divides them into fifty groups while Sushruta put them into thirty-seven different categories (Ray and Gupta 1965; Krishnamurthy 1991). More than 750 plants are being used to prepare more than 1000 Ayurvedic preparations (Anand 1990).

7.3.3 Biological Radioprotection by High Altitude Plants

Some of the high altitude plants have radioprotection activity. They act by increasing the body resistance against exposure to radiation (Goel et al. 2001). In research for the radioprotective agent their non-toxic nature is of outmost importance. For the purpose a number of biological and chemical agents have been screened and studied (Maisin 1992). The extracts of high altitude plant having radioprotective efficacy also contain various bioactive molecules like immunostimulants, cytokines, antioxidants, cell proliferators, etc. which are expected to perform radioprotective efficiency as single entity on in combination. *Hippophae rhamnoides* is a high-altitude shrub having strong antioxidant and radioprotectant activity which is attributed to the presence of large number of molecules like flavonoids, Vit-A, Vit-C, Vit-E, flavones, Vit-K, tannins and trace elements like Cu, S, Zn and Se (Ianev et al. 1995).

7.3.4 Ethnic Veterinary Medicinal Plants from High Altitude Regions

The tribal people of Himalayas majorly depend on the livestock and animal husbandry for their livelihood. Veterinary doctors are seldom available to them, so they mostly depend on herbal plants for treating their animals. Colic, red water, diarrhoea and black water are some of the most common veterinary diseases in the high altitude northern Himalayan region. It has been reported that eighteen different herbs are used to treat diseases in animals in these regions (Sharma and Singh 1989). However, extensive research is required to provide data related to bioactive molecules available from these hers.

7.4 Wealth of Ethnic and Medicinal High Altitude Medicinal Plants

It is complex to understand the wealth of the ethnic and medicinal high altitude plants. Individual different models can be hypothesized. All India Coordinated Research Project on Ethnobiology conducted between 1982 and 1992 has revealed that more than 8000 plant species have ethnic and medicinal significance. More than 300 of them are from high altitudes (Kaul 1997). Many of these high altitude plants are used in combination or as individual as food or medicinal agents. These high altitude plants of Himalayan region are available in most of the households of that area to ensure food security and healthcare during long winter seasons. Some of these high altitude edible plants with medicinal value of Himalayan region are hereby discussed.

Urtrica hyperborea also known as Himalayan Nettle or Zachut in Tibetian culture are wild plants which are extensively used by tribes living in the Himalayas. They are collected and drying is done in shading after which it is stored. They are very highly nutritious and is very healthy to be used for pregnant women both before and after childbirth. It provides vitality and is a strong post-natal energizer. These plant samples have high nutritional value and are rich source for protein, sodium, phosphorous, calcium, fibre and iron.

Dipsacus inermis It is also known as Wopal hack in Kashmiri culture. The leaves of this plant are edible and used in auspicious events, they are collected in large quantity and shade dried. They have potent carminative and stomachic property. They are rich source of starch, fibre, protein, potassium, calcium, iron, sodium and phosphorous (Kaul et al. 1985).

Polygonum alpinum In Kashmiri language it is also known as Chita hola. It has very potent anti-arthritis effect. Water extracts are prepared from the dried roots powder and is consumed by arthritic patients. These plants are abundantly found in the alpine sloped of the Himalayas and are rich source of protein, starch, fibre, potassium, calcium and phosphorous (Kaul et al. 1990).

7.5 Description of some of the Wild Edible Plant Species of the High Altitude Regions of Himalayas

Some of the wild edible high altitude plants of Himalayas having medicinal property is discussed in this section (Table 7.1).

Angelica glauca Edgew: It is known as Hanw or Choru in native language and belongs to the family of Apiaceae. It is cultivated throughout India and is used as herb and vegetables. The root powder is used as veterinary medicine to cure toxic effects in livestock (Tiwari and Pande 2010). It has application in constipation and dyspepsia. Essential oils are also extracted from the dried roots of *Angelica glauca* (Chopra et al. 2002).

Arisaema speciosum mart.: It is known as Bankh in native language and belongs to the family of Araceae. It is cultivated in the temperate Himalayan region and is used in snake bites. The root is considered to have antidote against snake venome (Mhaskar and Caius 1931).

Asparagus filicinus: It is known as Kairua in native language and belongs to the family of Liliaceae. It is cultivated in temperate and tropical Himalayas. It is an evergreen tree with moderate size. The root has astringent properties and is also considered as tonic. It is also used as prophylactic agent in smallpox. The roots have also taeniafuge and vermifuge properties. It has powerful diurectic action and is also given in cholera. It has potent effect in rheumatism (Kiritikar and Basu 1994). The roots have also application in diabetes, dysentery and diarrhoea (Dhiman 2005; Tiwari et al. 2010).

Berberis asiatica: It is known as Kilmora in native language and belongs to the family of Berberidaceae. It is widely available between 500 and 3000 metre in Himalayas and other hilly regions. It is a shrub, and its fresh root has anti-diabetic ability and is able to cure jaundice (Uniyal et al. 2006). The stem has anti-rheumatic effect. Roots also possess anticancer effects. The berries of the plants have laxative effect and are used in children.

Dioscorea bulbifera: It is known as Genthi in native language and belongs to the family of Dioscoraceae. It is found at an elevation of about 2000 metres in Himalayas. The tubers of the herbs are used as vegetable. It is used in syphilis, dysentery and piles. The tubers are dried and powdered and are applied to ulcers. The rhizomes of the plant have anorexic effect. Diuretic effect was reported in the ethanolic extract of aerial parts of *Dioscorea bulbifera* (Asolkar et al. 1992).

Fagopyrum cymosum: It is known as Jhangar in native language and belongs to the family of Polygonaceae. It is found in the elevation of about 4000–10,000 ft. Its seeds are used as vegetable. The grains of the plants are used in fluxes, diarrhoea, abdominal obstructions and colic. The rhizome of the plants is used in pulmonary abscess (Asolkar et al. 2000).

Ficus palmata Forssk: It is known as Bedu in native language and belongs to the family of Moraceae. It is found in the elevation of about 3000 ft. in the Himalayas. The fruits are edible with laxative and demulcient activity. It is also used in constipation and diseases of bladder and lungs (Chopra et al. 2002).

Table 7.1 Plant name, Local name, family, active constituent, therapeutic effects of some of the high altitude edible medicinal plants

Plant Name	Local Name	Family	Active constituents	Therapeutic effect	References
Angelica glauca	Hanw or Choru	Apiaceae	Trans-ligustilide, Z)-3-butylidenephthalide, α-phellandrene, β-phellandrene, p-cymene, (−)-spathulenol	Constipation and dyspepsis	Chopra et al. (2002)
Arisaema speciosum	Bankh	Araceae	n-alkanes, n-alkanols, sitosterols, stigmasterols, cholesterol, campesterol, choline chloride, staychydrine hydrochloride	Antidote against snake venome	Mhaskar and Caius (1931)
Asparagus filicinus	Kairua	Liliaceae	Asparagine, arginine, tyrosine, flavonoids (kaempferol, quercetin and rutin), resin and tannin.	Taeniafuge and vermifuge, diurectic, diabetes, dysentery and diarrhoea	Dhiman (2005); Tiwari et al. (2010)
Berberis asiatica	Kilmora	Berberidaceae	Alkaloids, flavanoids, terpenoids, anthocyanins, sterols, vitamins, lignins, carotenoids, proteins and lipids	Anti-diabetic, anti-cancer	Uniyal et al. (2006)
Fagopyrum cymosum	Jhangar	Polygonaceae	2-Pentadecanone, eugenol, 1,2-benzenedicarboxylic acid, bis (2-methylpropyl) ester, (E,E)-farnesylacetone	Fluxes, diarrhoea, abdominal obstructions, colic, pulmonary abscess	Asolkar et al. (2000)
Ficus palmata	Bedu	Moraceae	Triterpene- germanicol acetate, furanocoumarins-psoralene, bergapten, aromatic acid-vanillic acid, flavone glycoside-rutin	Laxative and demulcient, constipation	Chopra et al. (2002)
Phytolacca acinosa	Jarag	Phytolaccaceae	Alkaloids, flavanoids and glycosides	Narcotic, joint pain, Phytolacca toxin	Chopra et al. (2002)
Rhododendron arboreum	Burash	Ericaceae	Ericolin and glucoside	Stomach diseases, headaches	Uniyal et al. (2006); Tiwari et al. (2010)

(continued)

Table 7.1 (continued)

Plant Name	Local Name	Family	Active constituents	Therapeutic effect	References
Urtica urens	Bichchhughas	Urticaceae	Flavonoids, tannins, volatile compounds and fatty acids, polysaccharides, isolectins, sterols, terpenes, protein, vitamins and minerals	Vesicant and rubefacient, bleeding nose, uterine haemorrhages, blood vomiting and to regulate menstrual periods, scurvy, anti-pyretic, gout and rheumatism	Dhiman (2005), Gangwar and Joshi (2008); Chopra et al. (2002)
Illicium griffithii	Lissi, star anise and Munsheng	Schisandraceae	Linalool, limonene, α-pinene, 1,8-cineole, ρ-methoxyphenyl acetone, terpinen-4-ol, (E)-anethole, safrole, germacrene B, cadinol, myristicin, α-selinene, δ-selinene, α-santalene, β-phellandandrene,(2–4) elemicin, (E)-caryophyllene and eugenol derivatives	Abdominal pain, food poisoning, dyspepsis, stomachic, vomiting, antifungal and preservative properties	Singha (2008); Mukhia et al. (2006); Kirtikar and Basu (1997)
Taxus wallichiana	Teyshing	Taxaceae	Paclitaxel	Anticancer	Wilson et al. (1996); Shukla et al. (1994)

Phytolacca acinosa: It is known as Jarag in native language and belongs to the family of Phytolaccaceae. It is found in the temperate regions of Himalayas at an altitude of 4000–10,000 ft. The plant has narcotic properties. From the roots oil is extracted which is used in the joint pain. It is also reported to have Phytolacca toxin (Chopra et al. 2002).

Rhododendron arboreum Smith: It is known as Burash in native language and belongs to the family of Ericaceae. It is found in the temperate region of Himalayas at an elevation of about 4000 to 12,000 feet. The leaves of the plant contain ericolin and glucoside. The flowers of the plants are eaten raw and juice are extracted from it to be used in stomach diseases. Young leaves are applied externally for headaches (Uniyal et al. 2006; Tiwari et al. 2010).

Urtica ardens: It is known as Bichhoo ghas in native language and belongs to the family of Urticaceae. It is also found in the temperate regions of the Himalayas at a maximum elevation of about 6000 metres. Fruits, flowers and leaves of the plant are used as vegetables. The bark of the root as well as roots of young trees is reported to have vesicant and rubefacient activity. Leaves are used to cure bleeding nose, uterine haemorrhages, blood vomiting and to regulate menstrual periods (Dhiman 2005; Gangwar and Joshi 2008). Leaves of the plants are rich source of Vit-A and Vit-C and thus have application in catarrhal and scurvy. They are also used as emetic agents. Flowers have cholagogue, tonic diuretic properties. Seeds of the plants have antipyretic properties. Oils extracted from seeds are used for external application in gout and rheumatism (Chopra et al. 2002).

Illicium griffithii: It is known as Lissi, Star anise and Munsheng in native language and belongs to the family of Schisandraceae. It is found in the temperate to sub-tropical regions of the Himalayas at a maximum elevation of about 1700–3000 metres. It has star shaped fruits having refreshing flavours. Fruits and dried seeds have commercial and economic importance. The fruits have anethol rich essence and thus have medicinal application. They are used as carminative and stimulant. They also have application in abdominal pain, food poisoning, dyspepsia, stomachic, vomiting, etc. (Singha 2008; Mukhia et al. 2006). Oil extracted from the fruits of the plants have anti-fungal and preservative properties (Kirtikar and Basu 1997).

Taxus Wallichiana: It is known as Teyshing in native language and belongs to the family of Taxaceae. It is found in the temperate to tropical regions of the Himalayas at an elevation of about 900–3700 metres. Leaves of the plants are used by local people for its nutritious value and are also used as fodder for the livestock. It is also used to make tea by the tribal people. They are the chemical precursor of the paclitaxel which is an anticancer drug (Wilson et al. 1996; Shukla et al. 1994).

7.6 High Altitude Medicinal Herbs as Socio-Economic Resource

Asian countries along with Africa and Latin America are heavily dependent on traditional system of medicine to meet their healthcare requirements. A major portion of the African population utilizes traditional drugs for meeting up their primary healthcare need. In developed nations this traditional system of medicine is known as alternative or complementary medicinal system. In India Ayurveda, Unani and Siddha makes up the traditional medicinal system with a huge number of traditional practitioners registered with the governing authority of Government of India. Herbal medicine market in India is enormous. However, this has not been capitalized for potential export to other countries.

A major portion of modern medicines are derived from herbal source especially from the Himalayan region. *Digitalis purpurea* which is commonly known as foxglove are used for its derived drugs, namely digoxin and digitalin which are potent cardiac drugs. Similarly, an anticancer drug Taxol is derived from *Taxus wallichiana* (Malik et al. 2011). There are many herbal drugs which acts as prototype molecules derived from different plants are used for the development of their synthetic analogues. They are also registered in different pharmacopoeias (Gurib-Fakim 2006). Many of them are derived from high altitude medicinal plants. The global impact and market response of traditional medicines must be considered in designing an imperative economic strategy. India is rich in terms of climate, soil and geographical distribution all these factors assist in producing herbal medications used in both modern and alternative system of medicine (Kala et al. 2006). The high altitude plants are usually harvested from the wild thus endangering many wild species and many of them have already extinct (Rai et al. 2000). Places which are economically backward with limited opportunities of education, poor infrastructure and limited commercial activity these medicinal plants could provide potential opportunities in creating new job opportunities and eventually economic growth. Converting indigenous knowledge and socio-cultural traditions into economic opportunities indirectly provide the advantage of conserving the vanishing cultural practices and knowledge due to globalization. Himalaya is a treasure house of cultural and biological diversity and is in a dire need to protect the cultural and indigenous diversity on priority basis. It can be only achieved by mixing the economic factor with the indigenous and traditional knowledge (Bengwayan 2003). Compounds like taxol, digoxin have awakened the interest towards indigenous knowledge for guiding drug discovery. In the recent times allopathic system of medicine is showing interest in the traditional medicines for healing and is thus assisting in the revival of alternative medical approaches. Accounting the diversity of high altitude medicinal plants there are a number of new therapeutic molecules still waiting to be discovered (Siwach et al. 2013). The great Himalayan region offers an advantage of higher possibility of providing new entity or molecules due to the extreme conditions they face throughout their lifetime (Moore et al. 1998). Drug discovery could be more successful if a selective search on medicinal plant based on traditional knowledge is done rather going on for random search. This technique could be more economic and productive (Patwardhan et al. 2004). There is vast scope of research on the pharmaceutical, pharmacological and biochemical aspects of high altitude plants of the Himalayas. The rich diversity of high-altitude medicinal plants of Himalayas could provide multiple herbal remedies for a single disease for example more than 30 species of plants have been reported to possess antipyretic property and more than 20 species of herbs were reported with hepatoprotective effect (Kaul 2010).

7.7 Cultivation of High Altitude Edible Medicinal Plants of Himalayas for Economic Growth

Mountains provide an efficient ecosystem which could support its diverse inhabitants, but these systems are also very fragile (Lebel et al. 2006). As globalization impacts almost every part of the world, the farming land in these areas have been fragmented. Apart from that connectivity to roads due to huge number of landslides, scarcity of water, absence of assistance in marketing and lack of communication also hamper the economic growth of farmers who cultivate herbal medicines. Cultivating medicinal plants requires specialized techniques. Local who have been doing this for generations are well equipped for this task (Kala 2009). Traditional knowledge related to many herbal plants are still only confined to the native people of high altitude region due to less accessibility of the regions and very slow rate of development (Kala et al. 2006). During the recent times, the demand of the extracts of medicinal plants is increasing day by day and could be able to give a steady source of income to the native people and provide them an incentive for conserving their nature. For underprivileged communities cultivating medicinal plants could be an alternative source of income (Shinwari 2010). Even the cosmetic industries are now relying on natural ingredients in their products, many of these natural ingredients are extracted from the high altitude medicinal plants (Alamgir 2018). Thus, cultivating high altitude medicinal plants needs special consideration.

Cultivation of medicinal plants in the Himalayan region provides the advantages of: fallow and barren land, requires zero maintenance, less susceptibility to pests and diseases, negligible chance of damage caused by wild animals, cultivation is based on local resources, high economic return, cold climate is convenient for storage, packaging and transportation, limited competition, less incubation period, possibility of organic cultivation, etc. However, people lack awareness about the cultivation of medicinal plants, their scope and importance (Wiersum et al. 2006). Conducting seminars, workshops, field demonstration, exhibitions, etc. by NGOs and small community based organizations as well as government agencies could play an important role in bringing awareness to the native tribal communities in these regions. As more and more native tribes start adopting the cultivation of medicinal herbs, the government must support them with initial finance in the form of grants and loans. The forest rule must be made flexible and more people friendly to promote cultivation. Transit pass must be provided to cultivators of herbal medicines and strict rules must be made to stop illegal extraction of herbal medicines from the wild. Developing agro-technology must be promoted for research. Apart from meeting the demand of herbal medicines, cultivation of the same may help in conserving wild genetic diversity of herbal plants. Uniform material is produced by farming from which standardized products can be obtained consistently. It also provides the advantage of better quality control, species identification and genetic advancement.

Proper and accurate selection of planting material is one of the most important steps. It should be of good quality and rich with active ingredient. It should be resistant to diseases and pests and must have ability to tolerate the stressed environment. Knowledge of monoculture and polyculture is also important in making accurate decision for high yield of product. Continuous research and development must be done in order to get high production. Apart from cultivation area, processing area must also be developed in the nearby regions. These developments will create new economic source for underprivileged high altitude regions. Converting agricultural land into medicinal plant cultivation area is not recommended. However, tribal people can be encouraged to grow medicinal plants in their household garden. Thus, it will help in linking the economic growth of tribal and rural areas with the medicinal plant sector (Mazid et al. 2012). It has become important to secure the farmers economy by allowing them to grow cereals, grains along with medicinal herbs. If by any chance the alternate farming trials fails, then farmers may rely on the cereals for their livelihood (Lithourgidis et al. 2011). The ever rising demand for some specific high value medicinal plants is creating the danger of over-harvesting. Thus, making them more prone to being extinct as most of them have slow growing rate, narrow geographical range and less density in terms of population (McKinney 1997). Factors which affect the medicinal plant sector are: long gestation of some of the medicinal plants, slow growth rate, lacklustre cultivation technology, small quantity of production, inefficient processing technique, unscientific harvesting methods, poor quality control, hampered marketing strategy, etc. (Kala et al. 2006). To overcome these factors, awareness about cultivation, conservation, proper implementation of harvesting, processing, research and development and marketing strategies must be done. Apart from this cultivation of commercially important plants must also be promoted to support economic constraints. It is a known fact that cultivating food grains in the hilly region is not economically friendly. So, it is the need of the hour to immediately diversify ourselves to more economically viable alternatives. Cultivation of wild medicinal plant provides a potential alternative for this (Kremen et al. 2012). On one hand it can serve to save the forests of the high altitude Himalayan region and also it can help to meet the on-going demand of medicinal herbs. The tribal people must adopt the law of comparative advantage according to which the regions which are specialized in producing some specific good at lower rate must adopt to the same rather than opting to produce some other product which can eventually lead to loss. Thus, it is imperative to take the advantage of climatic characteristics of high altitude mountainous region to produce low cost medicinal crops. India has already established itself as a manufacturer of high quality drugs at low cost in the global market. The medicinal plant sector seems to be boon for the growing economy of the country (Mazid et al. 2012).

7.8 Management, Conservation and Prospect of Medicinal Plants

There is a sudden positive drift in the demand of herbal medicines and natural products. This surge has increased our dependence on forests for its natural products (Chivian 2002). But unorganized exploitation has put many of the herbal plants in the danger zone and some of them are even close to extinction. Apart from that excessive deforestation for fuel wood and woods for construction have added additional pressure to the on-going issues. Most of herbs are extracted from destructive harvesting. This aspect needs special attention considering the criticality of the situation as it severely impacts not only the sustainable regeneration process but also the ecological balance of the ecosystem. Most of the people involved in the collection of herbal medicines from wild sources are greedy and do not involve scientific techniques in their methods of harvesting. The forest staffs, research institutions could play an important role in creating awareness by providing scientific information to the collectors on different healthy methods of harvesting wild herbal medicines (Shinwari 2010). The knowledge gained by the local people could play a pivotal role in this regard. The local tribal people mostly who live around the forest knows better about sustainable maintenance of the ecosystem. They are quite familiar with the medicinal plants in their area. This traditional knowledge must be effectively implemented by ecologists, forest officers and policy makes for a sustainable ecological system and wise use of resources simultaneously. Awareness is important because forest product as a wholesome not only add up to the nation economy but also are a reliable source of income for the poor tribal people. Technology based farming must be promoted for more yield and profits. It thus becomes extremely important to involve local people into the forest management system for a more holistic approach in having a sustainable ecological system. A diagrammatic representation of sustainable use of high altitude edible medicinal herbs is shown in Fig. 7.1.

It can be understood from the example that in most of the cases either the rhizome or roots are used from a medicinal plant. So, digging out entire plant has a negative effect on the biomass and regeneration capacity of the wild plants. Uncontrolled and over-grazing has also diminished the forest regions at many places. If such conditions remain persistent, then in the very near future many of the medicinally valuable and economically important plants may get close to extension. For such endangered species of plants propagation and cultivation techniques must be implemented on a priority basis (Schippmann et al. 2002). Knowledge of in situ and ex situ conservation techniques must be passed on to the local people also in order to maintain a valuable and rich biodiversity of that specific region. Thus, mass awareness for economically important medicinal plants and promotion of large scale cultivation in the natural habitat of the species will influence not only the economy output but will also assist in meeting the rising market demand of the herbal plant along with conservation of the species.

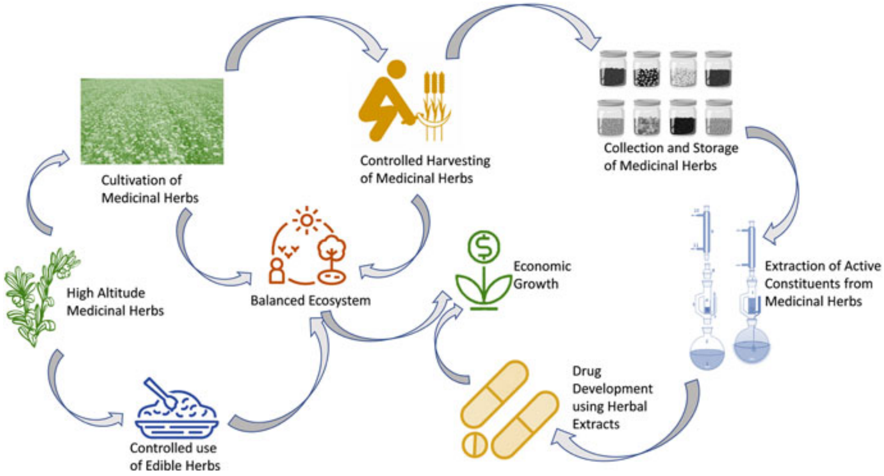

Fig. 7.1 Diagrammatic representation of sustainable use of high altitude edible medicinal plants

7.9 Conclusion

The demand for high altitude medicinal herbs is increasing day by day. Researchers and even common people are moving towards herbal medicines. However, excessive harvesting of high altitude medicinal herbs may cause ecological imbalance or even take some of the plant species on the verge of extension. It becomes important to create awareness among tribal people about scientific methods of cultivation, importance of sustainable ecological system, controlled harvesting, large scale cultivation, new marketing strategies may open new avenues for the income of rural people. Thus, organized and systemic cultivation of high altitude of medicinal plants with efficient procession and marketing strategies may boost up the economy of not only the tribal people but also to the nation's economy.

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Cultural, Practical, and Socio-Economic Importance of Edible Medicinal Plants Native to Central India

8

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Abstract

The medicinal plants have made a significant contribution to human health from the origin of life. Central India contains a wide variety of medicinal plants, these medicinal plants are used by tribal communities to treat their various ailments and their role in health care and the local economy was important. These medicinal plants are needed to complete their rituals, ceremonies, festivals, and religious work but most of them do not know the medicinal value of these types of plants that work in their daily lives. Our publications provide information on a number of medicinal plants used by the tribal communities of Madhya Pradesh and Chhattisgarh to treat various ailments. Traditional medicine remains an integral part of the health system in the Central India region. Research shows that medicinal plants from Central India cure life-threatening diseases such as cancer, diabetes, cardiovascular diseases, inflammation, viral diseases, neurological dysfunction and renal disorders, so medicinal plants demand in the global market was increasing gradually. Phytochemicals present in medicinal plants make the plants valuable as vincristine and vinblastine obtained from vinca plant are costlier, 1gm value several thousand and have great importance in the preparation of drug molecules. Most of the dosage forms are prepared in Central India according to the traditional medical system such as Ayurveda, Unani, Siddha. Knowledge of economic medicinal plants should be provided to a new generation that preserves medicinal plants and provides employment opportunities, improving and enhancing the health of the indigenous and rural communities of Central India.

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Keywords

Medicinal plants · Central India · Socio-cultural · economic · Tribal communities · Traditional system

8.1 Introduction

Edible medicinal plants have been reported using tribal practices and the use of various diseases. (Suroowan et al. 2017) Wild edible medicinal plants have special significance for livelihoods of Central Indian. (Rana et al. 2012; Goswami et al. 2016) Edible medicinal plants were reported for existing traditional practices, customs or traditions. In central India, starch-based foods are a staple food that provides energy and protein as well as antibodies to various ancient diseases. Wild plants have a better nutrition or can be compared to that of new research based varieties.(El-Anssary 2018) These wild species secure food, therapeutics requirement of the geographically remote regions of people from ancient times. Edible medicinal plants constitute an important alternative to conventional medicine (Huie 2002) (Hamza and Azmach 2017), especially for poor communities without access to basic health care services. The World Health Organization (WHO) showed that approximately 80% of the world's inhabitants rely on traditional system of medicine for health care services. (Cazap 2012) Economic, culture, religious beliefs of central Indian are based on edible medicinal plants. Traditional culture and folklore tend to have immense knowledge about the use of wild plant species (Von Lewinski 2008), which are localized to the remote region of central India. The traditional life is based on nature and natural resources, so ancient people explored the importance of wild species in cultural, medicinal, religious, and economic benefits better than a recent generation. The medicinal importance of some plants are not tested in modern laboratories but their therapeutic property, efficacy, and safety profile cannot be denied based on daily use by local communities (Bandaranayake 2006; Guerrini and Sacchetti 2013). Central India mainly includes states of Madhya Pradesh and Chhattisgarh. Madhya Pradesh has 1, 35, 164 km^2 of forests which accounts for 30.48% of total geographical area of the state. Particularly, in Satpura plateau contains the more tribal population due to the presence of dense forests with a lot of rare medicinal plants (Mall et al. 2005; Pande 2005; Rajasekhar and Mishra 2008). Pandey et al. described a different 92 medicinally importance plant used by local communities in Central India.

8.2 History of Edible Medicinal Plants in Central India

The concept of medicinal plant is not new in the Indian scenario. Since pre-historic times a human has known to identify plants useful for their medicine and food from nature (Srujana et al. 2012). However, the oldest literature available is Kautilya's Arthashastra of the fourth century deals with vast information regarding emergency food and medicine (Muniapan and Shaikh 2007). 5000 years old evidence of medicinal plants has been found on a Sumerian clay from Nagpur which had information about the preparation of 12 recipes of a drug referring to over 250 different medicinal plants, such as poppy, henbane, and mandrake (Hermann 2017). The holy books of India Vedas mention treatment with plants, which are abundant in central India, such as nutmeg, pepper, clove, etc. Ayurveda, Siddha, Unani, and Amchi, has strong evidence of their effectiveness and medicinal herbs derived ingredients are major components of these systems. It was estimated that Ayurveda, Unani, and Siddha use more than 1200, 900, and 700 species of medicinal plants (Dixit et al. 2016; Selvi and Paramasivam 2017). About 8000 medicinal plants were believed to be used in folk medicine with more than 25,000 plant-based formulations (Spałek et al. 2019).

Central India is rich in edible medicinal plants, these plants have direct medicinal value or indirectly beneficial for human health. Different medicinal plants used as drugs, pharmaceutical, nutraceutical and health benefits are rigorously explored nowadays because of the adverse effects associated with synthetic drugs. These plant-based drugs can be classified as follows.

8.2.1 Direct Medicinal Value

The chemical constituents present in these plants are extracted, isolated and formulated and used to cure diseases (Negulescu and Uglea 2006; Ahmad et al. 2017). Different parts (leaves, roots, bark, fruit, seeds, flowers, etc.) of the same plant may have different medicinal values. Some of the medicinal plants present in central India are Aloe Vera, Senna Alexandrian, Saraca ascoa, etc. (Shil et al. 2014).

8.2.2 Pharmaceutical Importance

Different plant parts are used to achieve definite therapeutic outcomes that improve the quality of life (Farnsworth et al. 1987). Medicinal plants are recognized as a mainstream product for herbal medicine, utilized in API as well as excipients (Azmir et al. 2013). For example, *Ocimum canum*, *Cyamopsis teragonoloba*, etc.

8.2.3 Nutraceutical Importance

Nutraceuticals are food or part of food and the normal nutritional value provides health benefits such as prevention and controlling of diseases (de Sousa Araújo et al. 2016). Numerous nutraceuticals are present in the form of vitamin, minerals, antioxidant, etc. Macro and micronutrient are the key components for the prevention of diseases. For example, *Allium sativum, Capsicum annum, Curcuma longa, Commiphora wightii*, etc. (Keservani et al. 2017).

8.2.4 Cosmeceutical Importance

Cosmeceutical is a cosmetic product containing ingredients that have medicine or drug-like effect and apply to the skin to improve the aesthetic property of the skin. Herbal cosmeceuticals are traditional remedies or preparation applied in the skin to treat skin diseases or glowing skin. For example, *Phyllanthus emblica, Acacia concinna, Curcuma longa,* etc. (Dweck 2009; Dorni et al. 2017).

8.2.5 Immuno Booster

Different edible medicinal herbs have an activity to boost the immune system that provides immunity for different diseases (Archana et al. 2011). Researches have shown that phytochemicals such as flavonoids, lignans, terpenoids, polyphenol, sulfides, saponin, carotenoids, curcumins, have immune-stimulating activity. For example, *Curcuma longa, Tinospora cordifolia, Cucurbita moschata,* etc. (Yadav et al. 2017).

8.2.6 Economic Importance

The forest of Central India is the reservoir of medicinal plants, which provides the raw material for different drugs. Forests of central India are rich in medicinal herbs (more than 100) rare medicinal plants are present, the economy of rural areas people was based on these medicinal plants. For example, *Acacia catechu, Eclipta alba, Rauvolfia serpintina,* etc. (Mishra 2016; Pradesh et al. 2017).

8.2.7 Cultural and Religious Importance

Plant species are necessary to complete the rituals, festival, religions and celebration purpose. Most of the plants used in cultural and religious purpose have medicinal value in India. The some medicinal plants from central India having culture value are *Ocimum sanctum, Aegle marmelos, Santalum album,* etc. (Ramesh Kumar Ahirwar 2015).

8.3 Cultural and Religious Importance of Edible Medicinal Plants

Nature and plant worship is an ancient central Indian tradition (Gupta and Sharma 2013). This tradition of linking medicinal plant with the culture of that society showed socio-cultural biodiversity of medicinal plants in that particular area. Central India is one of the major areas of socio-cultural biodiversity in India. Traditionally used plants of central India express out the socio-cultural roots of various medicinal plants (Verma 2014). These plants not only express their medicinal value but also asserting, they are ecologically important to our survival. Several species of medicinal plants in central India considered as scared due to their medicinal, economic, cultural, and religious value (Verma 2014). Thus, one of the ancestors linked these plants to the god or goddess for their conservation. Traditional beliefs of linking medicinal plants to the god were helpful for the conservation of vulnerable species (Singh et al. 2019). This type of socio-cultural biodiversity is rare to observe, people are using various medicinal plants at their ceremony, religion, culture, and so on (Pandey and Pandey 2016).

8.4 Socio-Cultural Adverse Effects

However, the socio-cultural effect also causes the depletion of medicinally important plants in different rural areas of Central India (Walter 2011). Increasing population and urbanization of rural areas causing flood irrigation problems in medicinally important crops. Sometimes poor drainage of flood results in the development of salinity in the soils (Arora and Sharma 2017). Acid-raining and global warming is another challenge, which is creating extinction and reduction of medicinal plants. Most of the medicinally important plant in the rural area of Central India is destroyed by the local due to unaware of their medicinal value (Bhardwaj et al. 2011). Some plants are used in almost all rituals of Central Indian over use of medicinal plants creating vulnerability of particular species (Verma 2014; Sharma et al. 2016) (Table 8.1).

8.5 Geographical Distribution of Medicinal Plants

Central India mainly includes middle part of India and states like Madhya Pradesh, Chhattisgarh, some parts of Jharkhand and Uttar Pradesh, while the Madhya Pradesh is considered as the land of tribes. Madhya Pradesh contains nearly 60 tribal communities and about 24% of the total population of the state of Madhya Pradesh (Sujatha 2002). The major tribes of Madhya Pradesh are Gonds, Bhils, Bhilala, Abujhmaria, Marias, Murias, Korku, Kols, Bajgas, Mariagonds, Khsssond, Birhors, Dhanwars, Halbas, Kamars, Bhumia, Bharia, Urave, Oraon, Kareba, Pradhans, Durgonds, Dorlas, Bhaina, Hijwars, Majhwars/Majhi, Sawar, and Sahariya. The major tribal districts are Sheopur, Morena, Shivpuri, Guna, Gwalior, Hoshangabad, Betul, Shahdol, Jhabua, and Ashoknagar (Sujatha 2002; Pandey and Tiwari 2001). The medicinal plants in the forests of Central India are not uniform (Tripathi et al. 2012). Medicinal plants of highly dense districts of Madhya Pradesh and Chhatisgarh are Jhabua, Dhar, Indore, Neemuch, Mandsoure, Ratlam, Ujjain, Shajapur, Shivpuri, Gwalior, Bhopal, Sehore, Raisen, Narsimhapur, Hoshangabad, Dewas, Harda, Betul, Sagar, Damoh, Jawalpur, Katani, Umaria, Shahdol, Mandla, Annuppur, Bilaspur, Jaspur, Durg districts are mention in the Fig. 8.1 (Dwivedi et al. 2020; Khare 2007).

Table 8.1 List of Medicinally important plants linked with religion and culture of people of Central India.

S. N.	Local Name	Biological Name	Religious/ Cultural belief	Medicinal value
1.	*Bel Sriphla, Bilva*	*Aegle marmelos*	*Bel* leaves are used in enchanments and twings are essential for scared fire in *Yagyas* and it is believed that without bel leaves and fruits worship of lord *Shiva* and *Ganesh* is incomplete.	The pulpy parts of fruits are given to children during anastigmatic for diarrhea. Ripe fruits juice is used during mild laxative. Every morning chewing and swallowing of leaves help in healing of ulcer and sugar in diabetic patients.
2.	*Neem*	*Azadirachta indica*	Hindus believes that eating leaves of neem will acquire freedom and also used in religious ceremonies.	The twigs of A. indica are tooth cleaner and toothache. Leaves are useful in skin and eye diseases.
3.	*Palash, kinsuka, Palasa*	*Butea monosperma*	In Hindu mythology, it is believed that *Navagraha* (nine planets) pacification was done by using dry twigs of *B. monosperma*. Dried powder is useful in making dye for celebration of *Holi* and *Rang Panchami.*	Bark and seeds are used in snakebite antitoxin. Ringworm infection in children are cured by giving leaves of *B. monosperma* with honey.
4.	*Safed Aak, Arka*	*Calotropis gigantea*	Flowers are useful in *Mahadev* and *Hanuman* worship. Plant is believed to modify from sun in ancient time.	Latex is applied on skin during boils and wounds after scorpion sting.
5.	*Bhang*	*Cannabis Sativa*	Plants leaves with milk are used during *Mahashivratri* festival.	Mixture of bhang oils of *C. sativa* and camphor are used in boils. Plant is also useful in curing diarrhea with coconut water.
6.	*Haldi*	*Curcuma longa*	Turmeric paste is applied in face during marriage festival and other ceremonies in Central India.	Rhizome with milk is taken for cough, cold, and healing injuries.
7.	*Doob*	*Cynodon dactylon*	*Doob* are essential for lord *Ganesh Pooja*, without it *Ganesh Pooja* is incomplete.	Plant decoction gives cooling effect as well as reduces the blood pressure. Washed leaves paste applied in cut for quick healing. Whole plant juice is used as an antidote for cobra bites.

(continued)

Table 8.1 (continued)

S. N.	Local Name	Biological Name	Religious/ Cultural belief	Medicinal value
8.	*Amla*	*Embelica officinalis*	*Amla* is worship on *Amla Navami* by the women of Central India on the month of *Kartik.* In *Kartik* month food should be cooked and eaten under this tree and also feed to *Brahmin* to washed sins.	Root bark of *Amla* is astringent and useful in ulcerative stomatitis and gastric ulcer. Fruits have cooling, laxative, diuretic, carminative, digestive, aphrodisiac, antipyretic effects.
9.	*Kusha*	*Desmostachya bipinnata*	This grass ring is worn in all auspicious occasions of *Hindu* culture in Central India.	It increases the concentration power and promotes the intellect. It also acts as an antimicrobial agent. Herb is also called as detoxifying herb.
10.	*Coconut*	*Cocos nucifera*	It is called fruit of aspiration, a coconut is split in any inauguration ceremonies to invite the god in Central Indian culture.	Fibres, vitamins and minerals contained in coconut are useful in burns, hair growth, blood pressure, heart diseases and dissolving kidney stones.

The present study is based on various already published literature giving information of flora found in Central India having Medicinal value.

8.6 Medicinal Plants from Central India

The World Health Organization (WHO) estimates that about 80% of people in developing countries rely heavily on traditional medicine systems such as Ayurveda, Siddha, Unani, etc. (Dixit et al. 2016). The major portion used by them was medicinal plant extracts or their active ingredients (Palombo 2006). In India, there are about one million traditional medicine practitioners and 10,000 licensed pharmacies manufacturing plant drugs (Wakdikar 2004). Edible medicinal plants are considered to be rich resources of active medicinal ingredients, these can be used in the manufacture of drugs either pharmacopoeial, non-pharmacopoeial or synthetic. Medicinal plants play a vital role in the treatment of deadly diseases. As we already classified, some plants have high nutritional value with power of preventing from getting ill so, that they are called as nutraceutical. Some of these medicinal plants include ginger, green tea, walnuts, and turmeric. Various drugs preparation are mentioned in traditional system of medicine for treating some common diseases such as diarrhea, constipation, etc. (Bassam Abdul 2012). The detailed study of

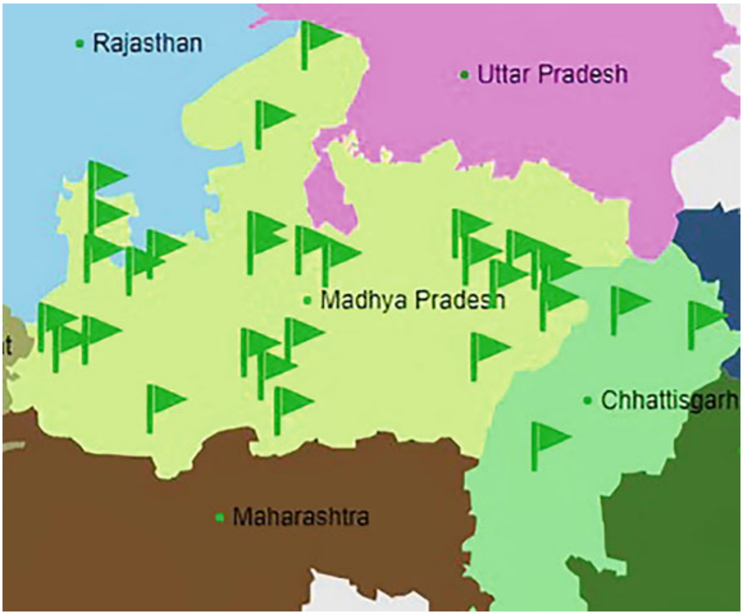

Fig. 8.1 Geographical distribution of medicinal Plants from various districts of Madhya Pradesh and Chhattisgarh

30 species from Central India with major phytoconstituents and pharmacological activity were elucidated in Table 8.2 and Fig. 8.2.

The wild flora of central India contains a great variety of useful plants, which have been used in either for treatment or prevention of disease. Millions of people in Central India still do not reach modern medicine and are dependent on medicinal plants (Pandey and Savita 2017). Different plant parts are used in medicinal value such as leaves, fruits, flowers, seeds, rhizome, juice, oil, root, husk, stem, tuber, etc. (Kumari et al. 2011). These medicinal plants contain terpenoids, flavonoids, alkaloids, coumarins, glycoside, essential oils, sterols, phenolic acids, etc. as secondary metabolites (Teoh and Das 2018). The specific phytochemicals present in plants determined the medicinal value of particular medicinal plant so, scientists attention towards natural/herbal medicine was increases and race to find out harmless herbal medicine increased (Kambli et al. 2014). These medicinal plants have a variety of medicinal properties and are used in the treatment of various diseases such as cancer, diabetes, high blood pressure, heart disease, severe ulcer, memory, Alzheimer's disease, age-related neurological disorders, kidney disorders, cognitive function, etc. (Thatoi et al. 2016; Karar and Kuhnert 2017). Most of the medicinal plant's pharmacological *activities* were proved in modern *laboratories,* e.g. vincristine, vinblastine is the chemical constituents of Vinca used for the treatment of cancers (Lee et al. 2015). Various other medicinal plants present in Central India are elucidated in Table 8.3.

Table 8.2 Detailed summary of medicinal plants used in daily basis from Central India.

S. N.	Medicinal Plants	Family	Useful parts	Medicinal value	Major Phytochemical	References
1	*Ashwagandha (Withania somnifera)*	Solanaceae	Root	Anti-stress, skin disease, blood pressure, anti-anxiety, swelling, wounds, filler, joint pain	Withanine, Somniferine	Mirjalili et al. (2009); Candelario et al. (2015)
2	*Sarpagandha (Rauvolfia serpentina)*	Apocynaceae	Root	High blood pressure, psychiatric, hysteria	Reserpine, Rescinnamine	Mittal et al. (2012); Singh (2017); Mahalakshmi et al. (2019)
3	*Kalmegh (Andrographis paniculata)*	Acanthaceae	plant	Skin disease, anti-pyretic, malaria, fever, anti-inflammatory, antibacterial, blood purifier	19-norandrographolides A, B and C	Chao and Lin (2010); Niranjan et al. (2010)
4	*Safed musli (Chlorophytum borivilianum)*	Liliaceae	Rhyzome, root	Diabetics, arthritis, cancer, improving sexual performance	Hecogenin	Adhikari et al. (2018)
5	*Satawar (Asparagus racemosus)*	Liliaceae	Root	Ulcer, skin disease, eye disease, increase milk production in cow.	ShatavarinI,II	Sharma et al. (2014); Shah et al. (2014)
6	*Senna (Cassia angustifolia)*	Leguminosae	leaf	Stomach disease	Sennoside A and B	Mehrafarin et al. (2012)
7	*Gudmar (Gymnema sylvestre)*	Apocynaceae	leaf	Liver tonic, diabetics, heart disease, fever, white spot, reduce itching, burning sensations, snake bite, stomach pain, eye pain	Gymnemic acid and gymnema saponins	Spasov et al. (2008); Sarker et al. (2019)
8	*Chandrasur (Lepidium sativum)*	Brassicaceae	Leaf, seed	Useful in production of milk in mother, cow and buffalo, digestion, eye disease, loose	Gallic acid, protocatechuic acid, 7,10- hexadecadienoic acid, caffeic acid, 11- octadecenoic	Alqahtani et al. (2019)

(continued)

Table 8.2 (continued)

S. N.	Medicinal Plants	Family	Useful parts	Medicinal value	Major Phytochemical	References
				motion, ladies disease, asthma, piles, leaf-anti scorbutic	acid, 7,10,13- hexadecatrienoic acid and behenic acid	
9	*Ratanjot (Jatropha curcas)*	Euphorbiaceae	Plant branch	Skin disease	Pyrogallol, Gallic acid, vanillic acid	Laxane et al. (2013)
10	*Isabgol (Plantago ovata)*	Plantaginaceae	Husk	Piles, constipation, loose motion.	Aldobionic acid, pentosans	Shojaii and Abdollahi Fard (2012)
11	*Tulsi (Ocimum sanctum)*	Labiatae	Leaf	Cough syrup, insect bites, respiratory problems, digestion, ear pain	Eugenol, methyl eugenol, Carvecrol	Cohen (2014); Verma (2016)
12	*Bhui Aonla (Phyllantus amarus)*	Phyllanthaceae	Plant	Urinary disease, antioxidant, hepatoprotective, jaundice, stomach pain, ulcer.	Phyllanthin, Securinine, Amarosterol A and B	Gbadamosi (2015); Danladi and Idris (2018)
13	*Mulaithi (Glycyrrhiza glabra)*	Leguminosae	Underground stem	Heart disease, anti-inflammatory, antioxidant.	Glycrrhizin,18-B-glycyrrhetinic acid	Sharma et al. (2018)
14	*Kalihari (Gloriosa superba)*	Liliaceae	Rhizome	Anticancer, antipyretic, antimalarial, anti-jaundice, piles, asthma	Colchicines and Gloriosine	Ravi et al. (2011); Misra et al. (2020)
15	*Giloy (Tinospora cordifolia)*	Menispermaceae	Root, stem, Leaf, fruit	Leprosy, stem-jaundice, cough, fever, white discharge, control of heart beating, control blood pressure, jaundice, chicken pox, immune booster, jaundice, tonic	Amristoside A, B, C and D, 1-diphenyl, 2-picrylhydrazyl	Sharma et al. (2019)

16	*Brahmi (Bacopa monnieri)*	Scrophulariaceae	Plant	Alzheimer's disease, nerve tonic, allergic conditions, hysteria	Bacosides A and B	Al-snafi (2013)
17	*Pattharchur (Coleus aromaticus)*	Lamiaceae	Leaf	Stomach pain, carminative, kidney stone, urine disease.	Rosmarinic acid, carvacrol	Khare et al. (2011)
18	*Makoy (Solanum nigrum)*	Solanaceae	Plant	Fruit-fever, burns, itching, stomach irritation, loose motion, eye disease, plant-piles, liver disease	Solanine, Sapogenin, Diosgenin	Chauhan et al. (2012)
19	*Bia vidung (Embelia ribes.)*	Myrsinaceae	Fruit	Anti-worms, loose motion, , acne, tonic snake and crabs bites	Tigogenin, christembine, Embelin, Embelia	Bist and Prasad (2016)
20	*Ajwain (Hyoscyamus niger)*	Solanaceae	Seed	Loose motion, lower blood pressure, ulcer, anti-inflammatory, teeth pain relief, eye disease, asthma, cough, urine, infection	Atropine, Scopolamine hyoscine	Sajeli (2010); Jun et al. (2011)
21	*Pan (Piper betle)*	Piperaceae	Leaf	Aphrodisiac, cough, digestion, heart disease	Eugenol, allylpyrocatechol	Rekha et al. (2014)
22	*Kanghi (Abutilon indicum)*	Malvaceae	Seed, leaf	Seed-laxative, leaf-ulcer, boils	Fumaric, p-coumaric acid	Saraswathi et al. (2011)
23	*Khair (Acacia catechu)*	Leguminosae	Bark	Chronic diarrhea	Acacatechin, quercetin	Hazra et al. (2017)
24	*Vasaka (Adhatoda vasica)*	Acanthaceae	Leaf	Asthma and bronchial troubles	Vasicine and Vasicinone	Ullah et al. (2013)
25	*Bel (Aegle marmelos)*	Rutaceae	Fruit	Dysentery, diarrhea, intermittent fever	Marmelosin and Furocouram	Ruhil et al. (2011); Patkar et al. (2012)

(continued)

Table 8.2 (continued)

S. N.	Medicinal Plants	Family	Useful parts	Medicinal value	Major Phytochemical	References
26	*Neem (Azadirachta indica)*	Meliaceae	Seed and bark	Skin disease, malaria fever	Azadirechtin, Nimbin, Nimbidin	Babu et al. (2016)
27	*Sadabahar (Catharanthus roseus)*	Apocynaceae	Leaf and flowers	Diabetes	Vincristine, Vinblastine	Tiong et al. (2013)
28	*Harjori (Cissus quadrangularis)*	Vitaceae	Stem	Bone fractures	Sigma-Amyrin acetate, Hexadecanoic acid, Trans-resveratrol-3-0 glucoside	Rao et al. (2011); Suhashini and Chandra (2015)
29	*Nirgundi (Vitex negundo)*	Lamiaceae	Leaf	Body pain, skin diseases, diabetic	P-cymene, Beta-curcumene	Suganthi and Dubey (2016)
30	*Keotic (Ventilago calyculata)*	Rhamnaceae	Bark and seed	Diabetic rheumatic pain	Ventiloquinone, 2-hydroxyislandicin	Yadav and Joshi (2011)

Fig. 8.2 Edible medicinal parts of 1. Ashwagandha, 2. Sarpgandha, 3. Kalmegh, 4. Safed musli, 5. Satawar, 6. Senna, 7. Gud mar, 8. Chandrasur, 9. Ratanjot, 10. Isabgol, 11. Tulsi, 12. Bhui Aonla, 13. Mulethi, 14. Kalihari, 15. Giloe, 16. Brahmi, 17. Pattharchur, 18. Makoy, 19. Bia vidung, 20. Ajwain, 21. Pan, 22. Kanghi, 23. Khair, 24.Vasaka, 25. Bel, 26. Neem, 27. Sadabhar, 28. Harjari, 29. Nirgundi, 30. Keotic

Fig. 8.2 (continued)

8.7 Economic Value of Medicinal Plants

In recent years, the demand for medicinal plants has increased worldwide, leading to the indiscriminate collection of these plants in their natural habitat (Alam and Belt 2009; Iqbal et al. 2017). Approximately 6000–7500 species are used as medicine in

Table 8.3 Summary of Medicinally important plants from Central India

S. N.	Medicinal plants	Family	Useful parts	Medicinal value	References
31.	*Chironji (Buchananialanzan)*	Anacardiaceae	seeds	Blood purification, Scabies, Leprosy, Abdominal discomfort and acne vulgaris.	Pattnaik et al. (2013)
32.	*Vayvidang (Embelia ribes)*	Myrsinaceae	Whole plant	Worm infection, wound healing, and lymphadenopathy.	Srinath and Jyothi (2010)
33.	*Dikamali (Gardenia gummifera)*	Rubiaceae	leaf	Wound healing, splenomegaly, encephalitis, anorexia, flatulence.	Chen et al. (2020)
34.	*Jivanti (Leptadenia reticulata)*	Asclepiadaceae	root	Gynecological disorders, UTI, and used to produce milk (lactogenic)	Verma et al. (2014)
35.	*Dhai (Woodfordia fruticosa)*	Lythraceae	Flower	Ulcer, wound, cough, and pneumonia.	Das et al. (2007)
36.	*Sarphonka (Tephrosia purpurea)*	Fabaceae	Leaf and root	Dental infection, dental pain, oral cavity infection, ulcers, splenomegaly, cough, cold, and various other skin diseases.	Sahayaraj et al. (2015)
37.	*Shami (Prosopis cineraria)*	Fabaceae	Bark	Leprosy, dysentery, bronchitis, asthma, leukoderma, and piles.	Islam et al. (2018)
38.	*Malkangni (Celastrus paniculatus wild)*	Celastraceae	Seed	Arthritis	Kulkarni et al. (2015)
39.	*Dhaman (Grewia tilifoliavohile)*	Tiliaceae	Bark	Cancer	Chang et al. (2018)
40.	*Moyen (Rubia Cordifolia Linn.)*	Rubiaceae	Bark	Cancer	Verma et al. (2016)
41.	*Amarbel (Cuscuta reflexa Roxb.)*	Convolvulaceae	Panchang	Dysentry	Saeed et al. (2014)
42.	*Punarnava (Boerhavia diffusa Linn.)*	Nyctaginaceae	Panchang	Jaundice	Oburai et al. (2015)
43.	*Apamarg (Achyranthes aspera Linn.)*	Amaranthaceae	Root	Headache	Bhosale et al. (2012b)

(continued)

Table 8.3 (continued)

S. N.	Medicinal plants	Family	Useful parts	Medicinal value	References
44.	*Satawar (Asparagus racemosus wild)*	Liliaceae	Root	Joint pain	Singla and Jaitak (2014)
45.	*Hathphan (Leea macrophylla Roxb.)*	Vitiaceae	Root	Ulcer	Al Mahmud et al. (2017); Mawa et al. (2019)
46.	*Apamara (Amaranthus aspera Linn.)*	Amaranthaceae	Root	Toothache	Bhosale et al. (2012a, b)
47.	*Akarkara (Spilanthes aspera Linn.)*	Areaceae	Flower	Stomach worm	Morshed et al. (2011)
48.	*Karanj (Pongamia pinnata (L.) pierre*	Fabaceae	Seed	Skin disease	Jayaram and Shashidhara (2011)
49.	*Punarnava (Boerhavia diffusa Linn.)*	Nyctaginaceae	Leaf	Skin disease	Mishra et al. (2014)
50.	*Kaunch Safed (Mucuna pruriens (L.) DC)*	Fabaceae	Seed	Skin disease	Manyam et al. (2004)
51.	*Baichandi (Dioscorea bulbifera Linn)*	Dioscoreaceae	Rhizome	Memory loss	Galani Varsha (2017)
52.	*Van tulsi (Eranthemum purpuras Nees.)*	Acanthaceae	Stem	Piles	Mathew (2006)
53.	*Shankhpushpi (Evolvulus alsinoides Linn.)*	Convolvulaceae	Whole plant	Memory loss, jaundice	Naikawadi et al. (2016)
54.	*Bahera (Terminalia bellirica (Gaertn.) Roxb.)*	Combretaceae	Fruit	Migraine	Abraham et al. (2014); Jayesh et al. (2017)
55.	*Harsingar (Nyctanthes arbor tristis Linn.)*	Oleaceae	Leaf	Malaria fever	Nirmal et al. (2012); Santosh and Manojkuma (2016)

56.	*Badi indrayan (Citrullus colocynthis (L.) schrad)*	Cucurbitaceae	Seed	Malaria fever, Jaundice	Hussain et al. (2014)
57.	*Anantmool (Hemidesmus indicus Linn.)*	Apocynaceae	Root	Loss of appetite	Desai et al. (2017)
58.	*Ramdatun (Smilax perfoliata Lour.)*	Smilaceae	Stem	Leucorrhea	Borkataky (2014)
59.	*Buch/Sweet flag (Acorus calamus)*	Acoraceae	Rhizome	Rheumatoid arthritis and stroke	Rajput et al. (2014)
60.	*Lemon grass (Cymbopogon flexuosus)*	Poaceae	Leaf and oil	Fever, diabetes, rheumatism, bone fracture, hypertension, wounds healing	Silveira et al. (2012)
61.	*Nagarmotha (Cyperus rotundus)*	Cyperaceae	Rhizome	Diuretic, carminative, analgesic, antispasmodic	Peerzada et al. (2015)
62.	*Arjuna (Terminalia arjuna)*	Combretaceae	Bark	Asthma, bile duct disorders.	Kapoor et al. (2014); 1999
63.	*Harra (Terminalia chebula)*	Combretaceae	Fruit	Dysentery, Respiratory cough, and sore throat	Jokar et al. (2016)
64.	*Khus (Vetiveria zizanioides)*	Poaceae	Root	Blood purifier, ringworm, indigestion, and loss of appetite	Bhushan et al. (2013)
65.	*Mentha (Mentha arvensis L.)*	Lamiaceae	Oil	Carminative, flatulence, anorexia, expectorant, stomach disease, cough and cold, throat infection, fever, and gas.	Pandey et al. (2003)
66.	*Panchouli (Pogostemon cablin Bentham)*	Lamiaceae	Oil and juice	Anti-worms and T.B.	Chakrapani et al. (2013)
67.	*Jasmine (Jasminum grandiflorum)*	Oleaceae	Leaf, flower or whole plant	Mouth ulcer, Ear disease, crab bite, skin disease, loose motion, aphrodisiac, urine disease.	Demole et al. (1962); Umamaheswari et al. (2007)
68.	*Ghughuchi (Abrus precatorius L.)*	Fabaceae	Root, seed & leaf	Contraceptives, Purgative, emetic.	Garaniya and Bapodra (2014)

(continued)

Table 8.3 (continued)

S. N.	Medicinal plants	Family	Useful parts	Medicinal value	References
69.	*Bach (Acorus calamus L.)*	Araceae	Rhizome	Stimulant, stomachache, anti-emetic.	Zahin et al. (2009); Sharma et al. (2014)
70.	*Gheekumar (Aloe vera L.)*	Liliaceae	Leaf, pulp and dried juice of leaf	Enhancement of sexual vitality, stomachictonic.	Mukherjee et al. (2013)
71.	*Bichiya Kanta (Acanthospermum hispidum)*	Asteraceae	Whole plant	Scorpion sting	Lagnika et al. (2011)
72.	*Kulanjan (Alpinia Galanga (Linn.) Swartz)*	Zingiberaceae	Rhizome	Bronchial troubles, cough and cold	Tang et al. (2018)
73.	*Bhandari (Anisomeles indica Linn)*	Lamiaceae	Leaf	Cough and cold	Singh and Kumar Singh (2019)
74.	*Sitaphal (Annona Squamosa Linn)*	Annonaceae	Leaf	Reduce blood sugar	Pandey and Barve (2011)
75.	*Dhawara (Anogeissus latifolia (Roxb.))*	Combretaceae	Leaf and gum	Anti-diarrheal and tonic	Kala (2016)
76.	*Palas (Butea monosperma (Lom.) Taub)*	Fabaceae	Seed and petioles	Ringworms, skin disease, and avoid skin stroke	Sutariya and Saraf (2015)
77.	*Gataran (Caesalpinia bonduc (Linn.) Roxb)*	Leguminosae-Caesalpinioideae	Seed	Stomach disorders	Kakade et al. (2017)
78.	*Chitrak (Plumbago Zeylanica Linn.)*	Plumbaginaceae	Seed	Boils and ulcer	Jalalpure (2011)
79.	*Jamun (Syzygiumcumini (Linn.))*	Myrtaceae	Seed	Diarrhea, dysentery, and diabetes.	Bijauliya et al. (2017)
80.	*Sanjana (Moringa oleifera Lam)*	Moringaceae	Leaf	Application in wounds.	Goyal et al. (2007)

Table 8.4 Economical value of Medicinal plants in local market of Central India

S.N.	Botanical Name	Hindi Name	Medicinal part	Price Rs./kg
1.	*Jatropha curcas*	*Ratanjot*	Seed	5-6
2.	*Phyllanthus amarus*	*Bhumi Amla*	Leaf	40
3.	*Rauwolfia serpentina*	*Sarpagandha*	Root	1195
4.	*Terminalia bellerica*	*Bahed*	Seed	15
5.	*Tinospora cordifolia*	*Giloy*	Stem	150-200
6.	*Withania somnifera*	*Ashwagandha*	Root	1,200
7.	*Aegle marmelos*	*Bel*	Fruit/leaf	10
8.	*Andrographis paniculata*	*Kalmegh*	Whole plant	30-75
9.	*Terminalia arjuna*	*Arjuna*	Bark	600
10.	*Terminalia chebula*	*Harra*	Seed	50
11.	*Embelia ribes*	*Baibidung*	Seed	520
12.	*Cymbopogon martini*	*Lemon grass*	Plant	1
13.	*Gymnema sylvestre*	*Gudmar*	Leaf	40
14.	*Cassia tora*	*Chirota*	Seed	20
15.	*Dioscorea daemia*	*Bechadi*	Root	75

India in various traditional herbal remedies, such as Ayurveda, Siddha, Unani, Homeopathy, Herbo-mineral, traditional, etc. (Khyade et al. 2014; Parasuraman et al. 2014). India's medicinal herbs were estimated Rs. 2300 crore and which is expected to reach Rs. 5000 crore by the turn of the century (Phondani 2011).

Various literatures showed that the tribal community of Central India is rich in ethnobiological knowledge. Elder people have more knowledge on season, date, and time to harvest medicinal plants. The plants that harvested at that particular date and time have better therapeutics value and contain an optimum quantity of active ingredients. Medicinal plants have enormous opportunities for local tribal communities as well as the government because medicinal plants demand in the global market at premium prices. (Kala 2009). The tribal communities are collecting gums, leaves, bark, seeds, flowers, fruits, and rhizome of medicinal plants to manage their economic income (Tiwari et al. 2012). However the proper study of these medicinal herbs in modern laboratories to extract the detailed knowledge about the active ingredients and optimum time for harvesting may increase the economic income of tribal community as well as government and this will also helpful for the farmer to commercial production of medicinal plants. (Premila and Conboy 2007; Pant 2011) Some of the medicinal plants and their prices in local market was elucidated in Table 8.4.

8.8 Conclusion

In a recent study, it was found that the forest of Central India is rich in medicinal plants and tribal communities are still collecting gum, bark, leaf, the root of different plants based on traditional ethnobiological knowledge, which has been transferred from one to another generation. Medicinal plants of Central India covered an important position in the socio-cultural, spiritual, and religious arena of rural and tribal of Central India. Medicinal plants used are found different in communities because of their religious and cultural value. The people of Central India are dependent on their ecological surrounding to cure disease, celebrate the religious and cultural festival, which seems conservative.

The people of Central India have traditional knowledge relating to the collection, processing, storage, and utilization of medicinal plants. However, the knowledge of medicinal herbs (planting, processing, collecting, and storage) should be given to newer generation to improve economic status and to attract youth. The government need to decide the minimum support price of medicinal plants that avoid the involvement of a mediator.

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9 Cultural and Socio-Economic Perspective of Some Promising Edible Plants from Uttarakhand Himalaya

Uzma Zehra, Nafeesa Farooq Khan, Manzoor Ahmad Shah, and Zafar Ahmad Reshi

Abstract

Uttarakhand Himalaya (Uk) occupies a geographically favorable position in terms of topography, microclimate, and a wide range of altitudes. This advantage benefits the region and supports varied biodiversity and rich reserves of edible plants. Traditionally, wild edible plants are crucial as a source of food and nutrition, additionally are important in the socio-economic and health domains, therefore are also an integral part of culture and traditions of the Himalayan societies. The historical, cultural, environmental, religious, and spiritual aspects of culturally salient plants from the region have become important predictors of socio-economic factors of the local population. These factors and the availability of a huge biodiversity in the state of Uttarakhand has fascinated and attracted a lot of researchers. Subsequently, ample research has been carried out on various aspects of edible plants of the region which include conservation and bioprospecting, phytochemical analysis, and studies evaluating distribution and their use. While some plant species are being harvested at a commercial scale, some provide small scale livelihood for far-flung communities. Besides, in Indian mythology, several entities of biodiversity have been recognized with certain characteristics of the Hindu gods and are idolized and worshipped. Many plants and animals have everlasting symbolic importance, presence on flags, national emblems, mentions in folk stories and religious manuscripts, and as such are kept in close accordance with the lifestyles of the people of the region. This tradition over generations has been preserved and has become an integral part of the rituals and customs of this mountain region; although various anthropogenic activities,

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commercial farming, and lack of the supply chain for these plants have restricted their application outside the region.

Keywords

Uttarakhand Himalaya · Wild plants · Edible · Socio-economic · Cultural

9.1 Introduction

It is well-established that mankind has been sustaining biodiversity from ancient times to draw the energy from plants in the form of food. As the *Homo sapiens* started to settle, the domestication of wild species also started with both animals and plants. Humans started to domesticate all kinds of wild plants and after evolving through generations led to several cultivated plant species throughout the world. The Himalayas, the world's largest mountain range have always been considered as a hotspot of biological diversity inhabiting 10,503 plant species, including 8765 native angiosperm species. Of which Uttarakhand hosts 184 species belonging to 56 families of the wild edible plants of angiosperms and gymnosperms (Rana et al. 2019; Upreti et al. 2010). There occur 21 forest types, with species richness declining threefold from the east to the northwest of the Himalaya (Shah and Board 2015; Rana et al. 2019). The Uttarakhand State (hereafter denoted as Uk) due to highly varying altitudes (300-4500 m altitudes) is eco-rich with enormous demand and heritage of wild edible plants (Upreti et al. 2010). Traditionally, wild edible plants are important in the socio-economic and health domains and similarly are of high significance in the rural Uk (Upreti et al. 2010). As such, the historical, cultural, environmental, religious, and spiritual aspects may be important predictors of socio-economic factors to explain the importance of culturally salient plants. In terms of biological well-being, edible plants also have some traditional and modern use in nutraceuticals (Kumar et al. 2018; Namrata et al. 2011). Therefore, the impact of socio-economic and cultural aspects on the knowledge and use of plant species has been the focus of several ethnobotanical studies. Several studies have assessed the role of the plants found in the diverse region of Uk, initially known as Uttaranchal (Uniyal 2007; Gaur 2008; Upreti et al. 2010; Sekar et al. 2012; Shah and Board 2015; Rana and Rawat 2017; Rana et al. 2019) suggesting the presence of edible flora and their importance in Uttarakhand, but their work has focused mainly on the taxonomic and phyto-geographical aspect of the biodiversity. The purpose of this chapter is to broadly indicate the economic, cultural, and socio-economic perspectives of certain edible plants in the Uk Himalaya.

9.2 Background of the Area

Uttarakhand is situated between 77°34′27″ and 81°02′22″ E longitude and 28°53′ 24″ to 31°27′ 50′‘N latitude. It is partitioned into 13 districts and two administrative provinces, Garhwal and Kumaon. The total area covered by Uk is 53,566 km^2that occupies 17.3% of India's total land area. Mostly, the area comprises hills (92.57%) while a small part also forms plains (7.43%) (Anthwal et al. 2010). This state is also known as Dev Bhumi, or the home of gods, and therefore is dotted with many religious places for worship (Singh et al. 2017). Uttarakhand is a tourist attraction with millions of travelers coming every year for pilgrimage as well as for leisure owing to its exquisite landscape and forestry. The land embodies 161 plant species that are known as rare or threatened by the IUCN (International Union for Conservation of Nature). Among the known orchids reported from the north-western Himalayas, over 150 have been documented solely from Uttarakhand.

9.3 Economic Importance of Plants

Among the various economic benefits of forests, the most obvious value is from direct services, such as the timber and non-timber products or obtaining plants and animals for sustenance. There may also be the provision of indirect services, such as watershed regulation or non-derivative uses such as their importance for recreational activities or travel and tourism. So, indirect services of biological diversity comprise of the role of organisms in supporting the ecosystem services such as management of floods, pests, or conservation of soil against erosion and/or fighting climate change. There are other surplus uses of resources that may have significance in the future. Other than the above stated important uses of plants, they are also a source of various important unidentified or uncharacterized chemical ingredients. Given these important roles that forests play generally, in India especially forests have major roles in the economic, survival, and market development.

9.4 Agriculture and Livelihood

Agricultural biodiversity has continually shaped the structure of man's food production and preparation manner (Brush 2008) and has offered social, sacred religious, and ornamental importance to humankind and civilizations (Mace et al. 2012; Clark et al. 2014). The major contributor to the economy of the Uk is agriculture, almost 80% of the population draw their livelihood from agriculture and agriculture-related practices, and is also a traditional way of living in this part of India (Negi et al. 2009). Certain factors such as topography and geography, biological, socio-cultural, and economic factors have played a major role in determining the course of living and source of income-generating occupations. In this part of the Himalayas, the varied biological diversity and variability in climate have led the way for agronomy and crop production. The extending topographies have allowed the farmers to grow as many as 97 agricultural crops among which 11 horticulture plants are also cultivated (Mehta et al. 2010; Mehta et al. 2012; Sati and Wei 2018). These communities have helped in sustaining and preserving the agro diversity of the state. The farmers not only oversee and cater to the plant, they also manage the diversity of the crops and uphold the indispensable process of evolution. Farming is the main occupation of the people of the Uk, a decline in employing traditional cultivation practices has been seen in recent years attributed to changes in climate, culture, and socio-economy (Maikhuri et al. 2001). Besides, the production and diversity of crops are decreasing at an alarming rate that may result in the loss of floral diversity in the coming years (Maikhuri et al. 2000). However, some types of plant species are still preserved due to their cultural, religious, and medicinal significance.

Uk state is considered as an enormously huge reservoir of edible wild plants as well as ethnomedicinal plants. People of the Uk widely depend on vegetables as their primary food while the staple food is wheat. Crops most commonly affiliated with Uttarakhand are buckwheat (*Fagopyrum esculentum*) locally known as Kuttu and among the regional crops, finger millet (*Eleusine coracana*) locally known as Maduwa (Shah et al. 2008) and barnyard millet (*Echinochloa frumantacea*) known as Jhangora (Pandey et al. 2019), are cultivated in the inner regions of Kumaon and Garhwal, respectively. It has been documented that this state represents a total of 94 wild edible species of which 67 are edible fruits and 27 edible vegetables. Additionally, cereals, pseudocereals, oil seeds, spices, and condiments have also been reported (Arora and Pandey 1996).

With respect to the economic frame, expanding the financial ground is the prime opportunity for small farmworkers predominating in highland regions of Uttarakhand Himalaya to boost their revenues and to set a framework of financial security. The forests bring many prospects for varied terrestrial occupations resulting in the socio-economic progress of the native people. Being home to an exceptional biological diversity, the plant and animal reserves are also an integral part of the livelihood of the residents of the Uk state.

9.5 Plant Resources of Uttarakhand and their Economic Importance

India's ecosystem diversity encompasses a wide variety of habitats that include tropical rainforests, alpine vegetation, temperate forests, and coastal wetlands that have provided treats for thousands of years in the form of wild plants being used for various purposes (food, fodder, timber, medicinal purposes, and other environmental services, etc.). Procuring food from the wild has been closely associated with humankind for ages (Gosden and Hather 2004). This practice accustomed humans to develop a profound knowledge base and expertise about the environment and supplied them with an assorted collection of animal and plant-derived foods, acquired through various innovative ways (Anderson 2011; Chevalier et al. 2014; Harris and Hillman 2014). At the same time, thousands of edible plant species continued to remain wild or semi-wild that remained undomesticated. And these uncultivated edible species have the capacity to convert our diet habits into more balanced, nutritional, sustainable, and buffer against climate change (Hunter and Fanzo 2013; Powell et al. 2015). A large and diverse assortment of wild uncultivated plants and their parts (such as leaves, shoots, roots, fruits, seeds, flowers) are still being consumed on a daily basis that supports human adaptability and complements a range of human gastronomic choice. They are rich in fiber, proteins, essential minerals, micronutrients, and vitamins that improve food quality and variety (Ogle 2001) and thus provide an economical source to fulfill dietary needs for rural and semi-urban civilizations across cultures and regions (Jones 2017; Rowland et al. 2017). Wild food acceptance and its consumption still exist in the present time, particularly in far-flung areas that are economically depleted (Angelsen et al. 2014; Wunder et al. 2014; Ickowitz et al. 2016). The state of the Uk is an excellent example of the above-stated framework regarding food cultivation and acquisition from the wild. Crop cultivation is practiced as a major source of livelihood, but at the same time, residents make great use of the available wild flora for consumption and trading.

The extending topographies with variability in climate types results in distinct floral diversity along its altitudinal gradient (Joshi et al. 2018). Therefore, Uk is one of the eco-richest regions in India in terms of natural resources which this belt encompasses. Particularly, its plant resources have immense diversity and high levels of endemism, thus indicate its rich biotic wealth. Numerous ecologically and economically valuable plants, that are also culturally and traditionally important, have resulted in conserving the great Indian Himalayan region. Hence, this is clear that among the different biogeographical regions of the Himalayas, Central Himalaya (mainly consisting of Uttarakhand state) is identified as having the richest diversity (344 species) of edible wild plants (Samant and Dhar 1997). Mostly these edible wild plants are consumed directly by the local people as fruits and vegetables (Sundriyal and Sundriyal 2001; Orech et al. 2007), while others are processed and value-added. In the context of Himalayan biodiversity, it is well-established that the edible wild plants are not only acquired to meet the nutritional requirements of the resident communities but are also an adequate source of generating income.

The edible plants among the forest vegetation have conventionally established an important place in socio-cultural, spiritual, and health domains of rural and tribal lives of India. With India having one of the oldest forms of the traditional systems of medicine (Ayurveda), using more than 2000 wild and cultivated plant species is likely because of rich and most diverse reserves of floral vegetation (Anthwal et al. 2010).

Similar to most of India, the agricultural sector is among the most important industries supporting approximately 70–80% of the population for their livelihood in the Uk (Negi and Maikhuri 2013; Sati 2017). Among the widely grown crops, rice, wheat, millets, minor millets, sugarcane, pulses, oil seeds are means of income-generating crops. Apart from the cereals and cash crops, fruits like apples, oranges, pears, peaches, are commonly grown as a significant constituent in the food processing and manufacturing industry. The land under cultivation of certain traditional crops has diminished by 20–25% owing to the apple cultivation from the past few decades (Negi et al. 2009). Agricultural export zones have been established in the state for the trading of economically important plants like lychees, herbs and medicinal plants, and basmati rice. According to a report, the major cash crops production between 2010 and 2015 were highest for sugarcane (6275.1 MT) followed by fruits and vegetables (1136.6 MT) and wheat (860.2 MT) (Sati and Wei 2018). In addition to that, a GI (Geographical Indication) tag has been granted to Uk based *Cinnamomum tamala,* commonly known as Tejpatta or Indian bay leaf, a spice known to add flavor to food and is also known to hold some therapeutic properties (Bisht 2020). On the other hand, some plant species like *Myrica esculenta* that is collected from the wild are retailed in the local marketplace at a price of Rs. 200–300 per kg (Joshi et al. 2018). Furthermore, some other plant species (such as *Hippophae spp*., *Rhododendron arboretum,* and *Prunus armeniaca*, etc.) are used at a commercial scale for making squash and other beverages. In Central Himalayas, the local edible plants such as *Paeonia emodi*, *Fagopyrum esculentum*, and *Dryopteris cochleata* that are fetched from the forests sell at a very high price (80–150/kg). While other species like *Dioscorea bulbifera* and *Urtica dioica* L. are also traded in the markets for generating revenue. Local people have started collecting economically important plants like *P. emodi* and *D. cochleata* used to treat various illnesses, at large scales.

The Garwhal Himalaya is colonized by folks from Gujjar, Bhoxas, Tharus, Jaunsaris tribes (Gaur et al. 2010). In the tribal communities of the Uk, the wild plants offer a variety of family provisions and domestic food security. The use of wild plants in these households is significant, especially when most of the plant food of an individual is comprised of a limited number of crops. Often the nutritional value of wild plants exceeds the commonly known vegetables and fruits.

The tradition of utilizing wild plants as food, in medicine, and other non-essential use, has been extensively exploited by the locals and tribal groups living in rural and semi-urban landscapes of the Uk Himalayas. Especially, the availability of plants that are harvested from anthropogenic settings like, the surrounding rice paddy, farms, forest areas, or uncultivated fields, and their easy accessibility have indulged a large section of the population to depend on them as a valuable dietary source. Despite a unique diversification of wild plants in India and their unrestricted use and consumption, extensive studies that explain the universal patterns of the range and scope of the diversity of wild food spectra are missing.

9.6 The Cultural Importance of Plants

Besides, the consumable sources of biodiversity like food, materials, and labor, human beings have been attaching cultural importance to biodiversity for thousands of years (Pretty et al. 2009). The cultural significance of biodiversity has been widely accepted throughout the world by regular ecosystem assessments (Albon et al. 2014), which suggest that the cultural interest linked to biological diversity support human health. Many plants and animals have everlasting symbolic importance, present on flags, national emblems, in the folk stories, and religious manuscripts

(Kellert and Wilson 1993; Mabey 1996; Sinha and Mishra 2015). Especially, in Indian mythology since prehistoric times, several entities of the flora and fauna have been recognized with certain characteristics of the Hindu gods and are idolized and worshipped (Sinha 1995). There are several herbs and trees like tulsi, neem, peepal, coconut, tamarind, mango, etc., and among fauna, animals like cow, elephants, lions, mice that are highly revered (Anthwal et al. 2006; Mabey 1996; Cocker 2014; Kellert and Wilson 1993). This ideology and faith continues even today in several divisions of Indian society in one manner or another, mainly in the rural communities and the local tribes inhabiting the forest belt. This kind of belief among aboriginal folk and worship of nature has assisted in preserving numerous natural ecosystems in India. They have conserved many primitive forests—called "sacred groves" in their initial forms (Sinha 1995). About 14,000 sacred groves are known to be scattered all over India, and are an abode to rare flora and fauna, amid rural, and semi-urban areas. Besides, being of religious importance and featuring in various cultures, they are rich in biodiversity. Sacred groves have become part of the "biosphere reserves" of India. Earlier, these groves were not sanctioned under any law, but in 2002 an amendment was made in the Wildlife Protection Act, 1972 to include Sacred Groves under the act.

Forests, certain trees, and plant species hold a very special status in the ideologies and beliefs of the folks in Uttarakhand. In their mindsets, trees that are revered indicate specific arrays of ethnological and individual conditions, prospects, and, expectations (Chandrakanth and Romm 1991). Various tree species are considered sacred and are worshipped in many ways, as an illustration of gods and divinities or in sentimental ways pertaining to their religion. There are cases where civilizations have controlled the exploitation of a resource by limiting the entry to resources and imposing obligation through religious or sacramental beliefs, and social practice which actually helped in biodiversity management (Pandey 2003). The association of rural people to the forest and their interests in its protection have been cultivated through various social and cultural means (like taboos). Regardless of their obvious impracticality, religious constraints may thus be regarded as highly reasonable ways of preserving resources. Similar to Garhwal Himalaya, *Ficus bengalensis* is considered to be sacred in Indonesia as well. While in Dodital and Devariyatal lakes in Uttarkashi and Rudraprayag regions of Uttarakhand, fishing is completely prohibited to preserve the sanctity of these water bodies. Besides, species such as *Ficus religiosa* (sacred fig, Somvati Amavasya), *Azadirachta indica* (Sheela Asthami, Nimb Saptami), *Ficus bengalensis* (Vat Savitri), *Aegle marmelos* (Bilvamengal sawan ke somvaar), *Musa paradisiaca* (Kadii Vrat) are protected by Hindus' taboo and have also been associated with religious festivals across the Indian sub-continent (Anthwal et al. 2006; Colding and Folke 2001). In agreement with preserving cultural integrity, management of biological resources through religious practices and belief has a long history in Uk Himalaya and will continue to be.

9.7 Some Known Edible Plants of the Uttarakhand State

Cinnamomum tamala (Ham.) Nees & Eberm. (Family. Lauraceae): Indian Bay Leaf or Tejpata. *C. tamala* is an average-sized perennial tree growing 10–20 meters tall, and a thickness of 150 cm. Concerning its cultural importance, Uk holds the GI tag for this plant. It is used as a spice in cooking, beverages, and food items in the Indian sub-continent (Bisht 2020).It is generally found in the wild or is often cultivated by the people of northern India, Pakistan, and Nepal for the multiple benefits this tree provides. At about the age of 10 years the leaves of the tree can be harvested and can continue to produce the crop for another 100 years, thus serves as a good source of income for the generations. On average, the tree can yield between 50 and 100 kgs of leaves annually. Moreover, the leaves are also used by the Indian people as an alternative to the betel leaves in the preparation of paan. The bark is used as a pseudo-spice instead of the true cinnamon (*Cinnamomum verum*) and is usually added as an adulterant to it (Upadhyay 2017; Al-Mamun et al. 2011).

The dried bark is used to cure stomach pain as a home remedy while the leaves are used to treat colic disease and diarrhea. In traditional medicine, *C. tamala* plant is an excellent source of chemical ingredients mainly found in bark essential oils. The hydro-distilled essential oils possess antifungal activity against ringworm diseases. Plant bark, fruits, and leaves show nematicidal, termiticidal, larvicidal, microbicidal, antipyretic, and anxiolytic activity. The bark is a good source of essential oils and is used as a perfuming agent in the soap industry and cosmetic preparations. It also contains phenolic compounds that have beneficial effects for Alzheimer's disease and arteriosclerosis. (Sharma and Nautiyal 2011). The plant also shows therapeutic effects against cancer and inflammation, cardiac, and neurological disorders. In broader terms, the plant is used as an antidiarrheic, antitumor, anti-inflammatory, anti-arthritic, antiparasitic, antioxidant, chemopreventive, and gastroprotective agent (Ahmed et al. 2000).

Myrica esculenta Buch.-Ham. ex. D. Don (Family. Myricaceae): Hairy Bayberry Kaiphal or Kataphala. *Morella esculenta* (Buch.-Ham. ex. D. Don) I.M. Turner newly accepted name for *M. esculenta* is a small, evergreen, dioecious tree, a well-known plant for its medicinal properties (Patil et al. 2016). This plant is native to the sub-tropical Himalayas and temperate zones (Jeeva et al. 2011; Kabra et al. 2019a). It is the most popular and selling edible fruit in Indian Himalaya and has industrial use as well (Pandey et al. 1993; Makdoh et al. 2014). The berries are used for making syrups, jams, pickling, and preparation of juices (Makdoh et al. 2014).Its bark is used against the treatment of several illnesses such as asthma, cough, chronic bronchitis, ulcers, inflammation, anemia, fever, diarrhea (Kabra et al. 2019c; Kabra et al. 2019a). Due to its multiple uses in treating various diseases and for its therapeutic effects, it is well documented in the ayurvedic pharmacopeia. Additionally, on a large scale, its bark is used in paper and rope industries (Kabra et al. 2019c). The tannins derived from its bark are used as a coloring agent (Dawang et al. 1988). Myricetin, a key compound obtained from this plant, has the potential to guard against cancer, diabetes, inflammation, and jaundice (Agnihotri et al. 2012; Patel et al. 2010; Kabra et al. 2019b; Kabra et al. 2019a). In general, all the plant parts of *M. esculenta* possess high nutritional value in addition to the therapeutic effect (Kabra et al. 2019a). Despite being a valuable and beneficial tree, its cultivation is highly restricted and its conventional and industrial uses are exclusively dependent on acquiring from the wild by native people (Kala 2007).The plant parts of *M. esculenta* are highly priced and are a potential source for generating income in tribal communities (Bhatt and Dhar 2004). Its use in various Ayurvedic and Unani formulations has led to the over-exploitation of this plant that may result in its extinction from the wild (Kabra et al. 2019b; Patil et al. 2016).

Rhododendron arboretum (Family. Ericaceae) Burans or Buransh in Garhwal, Brons in Almora, Bras in Kumaon. *R. arboretum*, the state tree of Uttarakhand, also holds the Guinness Record for World's Largest *Rhododendron* (Srivastava 2012). It is an economically and pharmaceutically significant plant (Rawat et al. 2017). It is an evergreen tree that looks highly attractive due to its crimson or pink flowers (Purohit 1960; Solanki et al. 2013). The flowers have religious importance and are used as an offering in temples (Srivastava 2012). Its flowers are used to treat heart diseases and have anticancer properties (Dhar et al. 1968) and are also eaten raw in times of famine. In domestic setups, the flowers are used to prepare juices, jellies, squashes, teas, syrups, and sauces (barah ki chutney), also used to prevent high altitude sickness by the local people (Bhatt et al. 2017; Srivastava 2012). In common households, the extract of the leaves is sprinkled over the mattresses and beds to get rid of bed lice and bugs (Srivastava 2012). The flowers of this plant can be considered as a good source of ascorbic acid (Vitamin C) along with sugar, pectin, and anthocyanin (Krishna et al. 2014).In terms of its pharmacological importance, *Rhododendron* has been reported to be effective as an antioxidant, diuretic, choleretic, antispasmodic, chronic eczema, diarrhea, dysentery, anti-irritable bowel syndrome (IBS) therapy, antidiabetic, anti-hyperlipidemic, anti-inflammatory, and anti-nociceptive (Nisar et al. 2013; Matin et al. 2001; Rawat et al. 2017; Sahu et al. 2011; Verma et al. 2011). It is rich in alkaloids, flavonoids, steroids, glycosides, tannins, and saponins (Prakash et al. 2007; Dhan et al. 2007; Kiruba et al. 2011). In traditional medicine, the concoction of the dried leaves has been used to treat gout rheumatism, diarrhea, and blood dysentery (Raut and Khanal 2011; Laloo et al. 2006) while the young leaves are known to be poisonous when taken in large quantities. The textured/grained wood is used in buildings and construction while the old wood is used as a fuel (Paul et al. 2005; Srivastava 2012).

Prunus armeniaca L. (Family. Rosaceae) Apricot or locally known as Khumani. *P. armeniaca* is a fruit, which is a rich source of several vitamins and minerals. Apricot trees are not abundant since they can only thrive in specific regions where the environmental settings are suitable. Several species of the genus Prunus are grown in the Uk state such as *P. cerasoides*, *P. cornuta*, *P. persica,* etc. but *P. armeniaca* is widely known for its use in traditional medicine for treatment against various diseases (Upreti et al. 2010). The bark extract is used as an astringent, antibacterial, antifungal, protection against hemorrhages, infertility, eye inflammation, constipation, cough, asthma, and the seed paste can cure vaginal infections (Durmaz and Alpaslan 2007; Akin et al. 2008; Yiğit et al. 2009). The apricot seed oil has widely been used in cosmetics, medicines, and confectionaries (Joshi et al. 2018). It is used to make purees, jams, juices, syrups, and the kernels are rich in dietary proteins, oil, and fiber (Abd El-Aal et al. 1986; Nout et al. 1995). A significant amount of phenols, esters, and terpenoids have also been detected (Ruiz et al. 2005a; Ruiz et al. 2005b; Riu-Aumatell et al. 2005; Sefer et al. 2006). Fruits when ripened are eaten and traded fresh or dried in local markets.

Ficus religiosa *Linn* (Family. Moraceae) sacred fig, bodhi tree, peepal tree. *F. religiosa,* a tree native to the Indian sub-continent, is believed to have a religious connection to three main religions originated from there, i.e. Hinduism, Buddhism, and Jainism (Khumbongmayum et al. 2006). It is also cultivated for its fig fruit and the small fruits are generally eaten at the time of famine (Orwa et al. 2009).In terms of devotion to one's system of beliefs, Buddha attained enlightenment under this tree, hence, Buddhist monks meditate underneath this tree while Hindu ascetics conduct pradakshina around this tree (Spradling 2019). Pradakshina is performed by reciting a chant translated as- "greeting to the king of trees." It is also claimed that 27 stars are represented by 27 trees and of worship, and *F. religiosa* symbolizes a star named Pushya (Sharma et al. 2019). Also, prayer rosaries are made from the seeds of the bodhi tree. Many local tribes and communities of various regions of the Uk state regard this tree as a mark of worship by symbolizing it with the abode of Deities. Many grooves encompassing this tree by its own nature are fundamentally considered as scared. Besides, *F. religiosa* is used in folk medication since ancient times for more than 50 types of diseases such as asthma, diabetes, diarrhea, epilepsy, digestive problems, inflammatory complaints, sexual and transmitting disorders (Iqbal et al. 2017; Prasad et al. 2006; Singh et al. 2011).

Azadirachta indica A. Juss. (Family. Meliaceae) Indian lilac, Neem, Sheela Asthami, Nimb Saptami. *A. indica* is an evergreen tree native to the Indian sub-continent. Neem has been used in various Ayurvedic and Unani products for the past 2000 years. It is known to be anthelmintic, antifungal, antidiabetic, antibacterial, contraceptive, and sedative (Khadda et al. 2018).It is used in the commercial production of soap. This plant species is also known to cure snakebites, scorpion bites, and insect bites in Uk state. Traditionally, the local people have used the leaf of neem to determine the type (venomous or non-venomous) and quantity of the snake poison inflicted in the human body (Kala 2015).The paste of leaves is also applied to the wounds to prevent infection. The storage containers used for storing seed/grain are protected against insects and pests by coating the containers with a paste of this plant material along with other items that aboriginal people have learn from their ancestors (Mehta et al. 2010). Neem seeds are used as a pesticide, insecticide, and neem extract or cake is used as a fertilizer (Sidhu et al. 2004). Neem oil is also used for a number of purposes such as in polymeric resins (Siddiqui 1942; Chaudhari et al. 2015) to stabilize blood sugar levels, for promoting hair growth, etc. Neem products are highly prescribed for skin diseases like eczema, psoriasis, and in detoxification of blood (Kala 2011). In some parts of India and Southeast Asia, neem is used as a vegetable in a variety of dishes. Also, *A. indica* has been used as an indicator in measuring elevated air pollution in Uttarakhand Himalaya (Madan and Verma 2015).

Saccharum officinarum L., (Family. Poaceae) Sugarcane, ganna. *S. officinarum* is a widely cultivated plant in the Uk state, India being the second-largest producer of sugarcane in the world. In the Uk sugarcane is mainly grown in four districts of the state, namely, Udamsingh Nagar and Nainital districts having 62.6 MT/ha combined productivity of sugarcane, while Haridwar and Dehradun have 60.3 and 58.7 MT/ha productivity, respectively (Sati and Wei 2018). The production of sugarcane in the Tarai region where it is mostly grown, in the year 2010 decreased to 5.05 MT. However, the highest production was recorded at 7.68 MT in the year 2008 (Singh and Bhosale 2014). People's source of revenue and socio-economic growth, largely depends on this crop, as it has a high yield (59.2 MT/ha) (Sati and Wei 2018).

Dioscorea bulbifera *L.*, (Family. Dioscoreaceae) air potato, Gethi. *D. bulbifera* is a widely cultivated perennial food crop, it is a traditional medicinal plant native to Asia, America, and some parts of Africa and Australia (Guan et al. 2017) and in some parts of the world considered invasive. This plant is known to have beneficial effects against certain diseases such as hemoptysis, epistaxis, pharyngitis, scrofula, trauma, cancer, goiter, skin infections, and orchitis (Kundu et al. 2020). It acts as antibacterial, antiviral, antidiabetic, anti-obesity, and protects against neurological disorders and is used in Ayurvedic, Unani, and traditional Chinese medicine (Xu and Ding 1998; Hu et al. 2007; Ahmed et al. 2009; Mbiantcha et al. 2011; Guan et al. 2017). In Uk, it is used as a vegetable, however, its toxicity effects are also documented (Kapkoti et al. 2014; Mehta et al. 2010) that are known to cause damage to the liver, and kidneys (Guan et al. 2017).It is also used by local people to treat diarrhea and dysentery (Gairola et al. 2013). It is used by the Gujjar tribes of the Uk to treat their cattle affected with worm-inflicted wounds (Gaur et al. 2010). More than 100 compounds have been found in this plant, most of which are valuable pharmaceutically. It is rich in phenols, organic acids, flavonoids, terpenoids, steroids (Guan et al. 2017). (Table 9.1)

Adapted from Singh 2017, Joshi et al. 2018, Anthwal et al. 2006, Namrata et al. 2011

9.8 Biodiversity Conservation

In the past few decades, the perception of biodiversity, i.e. diversity of species, genes, and ecosystem, has initiated certain social, economic, and cultural reforms. The recent biotechnology gene reserves have recognized and supported the benefits and awareness of biodiversity and its elements (Demir 2009). The idea of biodiversity conservation has been used commonly in the current time period and has drawn the attention of many ecologists and environmentalists around the globe with the

Table 9.1 Showing some edible plants of Uttarakhand

Plants consumed as vegetables			
Plant species	**Local name**	**Family**	**Type**
Acacia modesta	Phulai	Fabaceae	Deciduous tree
Achyranthes aspera	Perkanda, Latjiri	Amaranthaceae	Herbaceous
Agave americana	Rambans	Agavaceae	Shrub
Albizia lebbeck	Siris tree, koko	Fabaceae	Deciduous tree
Allium atropurpureum	NA	Amaryllidaceae	Herbaceous bulb
Allium jacquemontii	Pharna	Amaryllidaceae	Herbaceous bulb
Allium roylei	NA	Amaryllidaceae	Herbaceous bulb
Allium stracheyi	Keer, Jambu	Amaryllidaceae	Herbaceous bulb
Allium tuberosum	Zimu	Amaryllidaceae	Herbaceous bulb
Allium wallichii	Jimbur	Amaryllidaceae	Herbaceous bulb
Alternantheasessilis	Garundi, Guroo	Amaranthaceae	Herbaceous
Amaranthus blitum	Shandalio	Amarnthaceae	Herbaceous
Amaranthus caudatus	Marchhu	Amarnthaceae	Herbaceous
Amaranthus viridis	Jungalichaulayi	Amarnthaceae	Herbaceous
Angelica glauca	Choru, Hanw, Gandraini	Apiaceae	Herbaceous
Arisaema speciosum	Bankh	Araceae	Herbaceous bulbous
Asparagus adscendens.	Sens, satavar	Asparagaceae	Shrub
Asparagus filicinus	Jhinjan, Kairua	Asparagaceae	Evergreen tree
Asparagus polypodioides		Asparagaceae	Herbaceous
Atriplex hortensis	Arrach	Amaranthaceae	Herbaceous
Bambusa arundinacea	Kalak	Poaceae	Grass/tree
Bambusa variegata		Poaceae	Shrub
Bauhinia purpurea	Guiral, Khairwal	Fabaceae	Evergreen shrub/ tree
Bauhinia variegata	Guiral, Kuira	Fabaceae	Deciduous tree
Benincasahispida	Petha	Cucurbitaceae	Herbaceous climber
Bidens pilosa		Asteraceae	Herbaceous
Ceiba pentandra	Semal	Bambacaceae	Deciduous tree
Chaerophyllum villosum	Ganziadi, jangligazar	Apiaceae	Herbaceous
Chenopodium album	Bathua	Amaranthaceae	Herbaceous
Colocasia esculenta	Gadpaper,Arbi	Araceae	Herbaceous
Cynoglossum glochidiatum	Lichkura	Boraginaceae	Herbaceous
Cyperus rotundus	Motha	Cyperaceae	Herbaceous
Dendrocalamus harmitonii		Poaceae	Culms
Dendrocalamus strictus	Nar bans	Poaceae	Culms
Deparia acrostichoides		Athyriaceae	Herbaceous
Dioscorea bulbiflora	Genthi	Dioscoreaceae	Herbaceous
Dioscorea deltoidea	Tairu	Dioscoreaceae	Herbaceous climber
Dioscorea glabra	Tarur	Dioscoreaceae	Herbaceous climber

(continued)

Table 9.1 (continued)

Dioscorea rotunda		Dioscoreaceae	Herbaceous
Diplazium esculentum	Lingura	Dryopteridaceae	Fern
Dipsacus inermis	Phulee	Dipsaceae	Herbaceous
Fagopyrum cymosum	Jhangar	Polygonaceae	Herbaceous
Indigofera pulchella	Sakina	Fabaceae	Shrub
Lactuca dissecta		Asteraceae	Herbaceous
Lepidium sativum	Halang	Cruciferae	Herbaceous
Nasturtium officinale	Machhai/Padya	Cruciferae	Aquatic herb
Ophioglossum reticulatum		Ophioglossaceae	Fern
Origanum vulgare	Ban tulsi	Lamiaceae	Herbaceous
Oxalis corniculata	Bhilmori, Chalmosi	Oxalidaceae	Herbaceous
Paeonia emodi	Ud-salap	Paeoniaceae	Herbaceous
Phytolacca acinosa	Jarag	Phytolaccaceae	Herbaceous
Polystichium aculeatum	Quathode	Dryopteridaceae	Fern
Pueraria tuberosa	Birau, Bilikand, kudzu	Fabaceae	Herbaceous twiner
Rheum australe	Archa	Polygonaceae	Herbaceous
Rheum moorcroftianum	Dolu	Polygonaceae	Herbaceous
Rumex hastatus	Kilmoru, Almoru	Polygonaceae	Herbaceous
Rumex nepalensis	Khatura	Polygonaceae	Herbaceous
Salvia lanata	Ghanyajhar	Lamiaceae	Herbaceous
Silene conoides	Chotatakla, thumriya	Caryophyllaceae	Herbaceous
Stellaria media	Badyalu	Caryophyllaceae	Herbaceous
Taraxacum officinale	Dudheri	Asteraceae	Herbaceous
Typhonium diversifolium	Rugi	Araceae	Herbaceous
Urtica ardens	Bichchhughas	Urticaceae	Herbaceous
Urtica dioeca	Kandali	Urticaceae	Herbaceous
Urtica parviflora		Urticaceae	Herbaceous
Vigna vexillata	Janglee Mung	Fabaceae	Herbaceous tuber
Plant species consumed as fruits			
Plant species	**Local name**	**Family**	**Type**
Aegle marmelos	Bel	Rutaceae	Tree
Aesandra butyracea	Chura/Baehni	Sapotaceae	Tree
Aesculus indica	Pangar	Hippocastanaceae	Tree
Amaranthus caudatus	Marchhu	Amarnthaceae	Herbaceous
Amaranthus viridis	Jungalichaulayi	Amarnthaceae	Herbaceous
Bauhinia vahlii	Malu	Fabaceae	Shrub/creeper
Benthamedia capitata	Bhamora Hara	Cornaceae	Tree
Berberis aristata	Chatur	Berberidaceae	Shrub
Berberis asiatica	Kilmora, kingor	Berberidaceae	Shrub
Callicarpa macrophylla	Daya	Lamiaceae	Shrub
Carissa opaca	Karaunj	Apocynaceae	Shrub
Castanea sativa	Meethapangar	Fagaceae	Tree
Catunaregam spinosa	Mainphal	Rubiaceae	Deciduous tree

(continued)

Table 9.1 (continued)

Celtis australis	Kharik	Cannabaceae	Deciduous tree
Chenopodium album	Bathua	Amaranthaceae	Herbaceous
Citrus medica	Jamir	Rutaceae	Shrub/small tree
Cornus capitata	Bhamor	Cornaceae	Evergreen tree
Corylus jacquemontii	Kabasi, BhotiaBadam	Betulaceae	Tree
Debrigeasia longifolia	Tushar/ Tushiyari	Urticaceae	Shrub
Dendrophthoe falcata	Banda	Loranthaceae	Parasitic shrub
Diospyros melanoxylon	Taidua/ Taidu	Ebenaceae	Tree
Diploknema butyracea	Phalwara	Sapotaceae	Tree
Elaeagnus augustifolia	Giwain	Elaeagnaceae	Shrub
Elaeagnus conferta		Elaeagnaceae	Shrub
Elaeagnus umbellata	Ghain	Elaeagnaceae	Shrub
Eleagnus parvifolia	Giwain, kanal	Elaeagnaceae	Shrub
Emblica officinalis	Aonla	Phyllanthaceae	Deciduous tree
Ficus auriculata	Timla/ Timila/Timul	Moraceae	Tree
Ficus carica	Anjir	Moraceae	Tree
Ficus cunia	Dudila	Moraceae	Tree
Ficus glomerata	Gular	Moraceae	Tree
Ficus palmata	Bedu	Moraceae	Deciduous shrub
Ficus religiosa	Peepal	Moraceae	Tree
Ficus sarmentosa	Paakhuree	Moraceae	Shrub/tree
Ficus semicordata	Khiriya	Moraceae	Tree
Flemingia vestita	Sohphlang	Fabaceae	Herbaceous
Fragaria indica	Kaphai/Bhekaphal	Rosaceae	Herbaceous creeper
Fragaria nubicola	Gand-kaphal	Rosaceae	Herbaceous
Fragaria vesca	Bhuinkaphal	Rosaceae	Herbaceous
Garuga pinnata	Titmar	Burseraceae	Tree
Grewia optiva	Vimal/ Bhimal	Tiliaceae	Tree
Hedera nepelensis	Laguli	Araliaceae	Shrub
Hippophae rhamnoides		Elaeagnaceae	Shrub
Hippophae salicifolia	Ameous	Elaeagnaceae	Tree
Hippophae tibetana	Turuchuk	Elaeagnaceae	Shrub
Holboelia latifolia	Gomphal	Lardizabalaceae	Climbing shrub
Indigofera heterantha	Sakina, kathi	Fabaceae	Shrub
Juglans regia	Akhroat	Juglandaceae	Tree
Leea aspera	Kurmali	Vitaceae	Shrub
Madhuca indica	Mahua	Sapotaceae	Tree
Maytenus rufa		Celastraceae	Shrub
Melia azedarach	Bakain	Meliaceae	Tree
Melothria heterophylla	Amantamul	Cucurbitaceae	Herbaceous climber
Moringa oleifera	Sonjal	Moringaceae	Tree
Morus serrata	Kimu	Moraceae	Tree
Myrica esculenta.	Kaphal	Myricaceae	Tree
Parthenocissus himalayana		Vitaceae	Deciduous climber

(continued)

Table 9.1 (continued)

Phoenix humilis	Thankal	Arecaceae	Short tree
Pistacia integerrima	Kakra	Anacardiaceae	Tree
Polygonum nepalensis		Polygonaceae	Herbaceous
Polygonum nepalensis		Polygonaceae	Herbaceous
Prinsepia utilis	Bhikal, bekkra	Rosaceae	Shrub
Prunus armeniaca	Chulu	Rosaceae	Tree
Prunus cerasoides	Paiya, Paya, Padam	Rosaceae	Tree
Prunus cornuta	Jamun	Rosaceae	Deciduous tree
Prunus napaulensis	Bamhalu	Rosaceae	Tree
Punica granatum	Darim, Anar	Lythraceae	Deciduous shrub
Pyracantha crenulata	Ghingaru	Rosaceae	Shrubs
Pyrus lanata	Mole	Rosaceae	Tree
Pyrus pashia	Mehal	Rosaceae	Tree
Randia tetrasperma	Kamoli	Rubiaceae	Shrub
Rhamnus triquetra	Galodan, Gaunt	Rhamnaceae	Shrub
Rhus parviflora	Titnulya	Anacardiaceae	Shrub
Ribes alpestre	Sirkuti	Grossulariaceae	Deciduous shrub
Robus elliptica	Hisalu	Rosaceae	Shrub
Rosa macrophylla	Phelalo	Rosaceae	Shrub
Rosa moschata	Kunji, Kwiala	Rosaceae	Climbing shrub
Rosa sericea	Dhurkunja/ Sepala	Rosaceae	Shrub
Rubus biflorus		Rosaceae	Shrub
Rubus ellipticus	Hisalu	Rosaceae	Shrub
Rubus foliolosus	Kala Hisar	Rosaceae	Shrub
Rubus fruticosus	Kathula	Rosaceae	Shrub
Rubus macilentus		Rosaceae	Shrub
Rubus nepalensis	Lal hisol	Rosaceae	Shrub
Rubus niveus	Kala hisalu	Rosaceae	Shrub
Rubus paniculatus		Rosaceae	Shrub, woody climber
Schleichera oleosa	Kusum	Sapindaceae	Tree
Smilax glaucophylla	Kanjolya	Smilacaceae	Herbaceous creeper
Solanum erietinum	Ban-tambakhu	Solanaceae	Herbaceous
Solanum nigrum	Makoi	Solanaceae	Herbaceous
Solena amplexicaulis	Mat kakari	Cucurbitaceae	Herbaceous climber
Sorbus cuspidata	Nepalo/ Nepala	Rosaceae	Tree
Spondias pinnata	Ambara	Anacardiaceae	Tree
Tamarindus indica	Imli, amlika	Fabaceae	Tree
Taxillus vestitus	Bani/Ban	Loranthaceae	Shrub parasitic
Terminalia chebula	Harra, haritak	Combretaceae	Tree
Tulipa clusiana stellata	Mijhau	Liliaceae	Herbaceous bulb
Viburnum cordifolium	Bhatnoi, guya	Adoxaceae	Shrub
Viburnum cotinifolium	Caprifolaceae	Adoxaceae	Shrub
Viburnum cotinifolium	Ghatmila	Adoxaceae	Deciduous shrub

(continued)

Table 9.1 (continued)

Viburnum mullah	Titmalewa	Adoxaceae	Shrub
Vitis lanata	Purain	Vitaceae	Deciduous climber
Ziziphus jujube	Baryan, Unnab.	Rhamnaceae	Tree
Ziziphus mauritiana	Badar	Rhamnaceae	Shrub
Ziziphus vulgaris		Rhamnaceae	Shrub
Cereals and pseudo-cereals			
Plant species	**Local name**	**Family**	**Type**
Amaranthus caudatus	Marchhu	Amaranthaceae	Herbaceous
Amaranthus viridis	Jungalichaulayi	Amaranthaceae	Herbaceous
Chenopodium album	Bathua	Amaranthaceae	Herbaceous
Fagopyrum esculentum	Buckwheat/ Kuttu	Polygonaceae	Herb
Hordeum vulgare	Barley/Jau	Poaceae	Grass
Oryza sativa	Chawal	Poaceae	Herbaceous
Triticum aestivum	Gehoon	Poaceae	Herbaceous
Zea mays	Makai,bhutta	Poaceae	Herbaceous
Millets			
Plant species	**Local name**	**Family**	**Type**
Echinochloa crus-galli	Sanwa/ Samvat	Poaceae	Herbaceous
Eleusine coracana	Mandua	Poaceae	Herbaceous
Panicum miliaceum	Chena	Poaceae	Herbaceous
Paspalum scrobiculatum	Kodo/ Kodon	Poaceae	Grass
Setaria italica	Kangni / Kakum	Poaceae	Herbaceous
Sorghum vulgare	Jowar	Poaceae	Herbaceous grass
Oilseeds			
Plant species	**Local name**	**Family**	**Type**
Linum usitatissimum	Alsi	Linaceae	Herbaceous
Litsea elongate		Lauraceae	Tree
Perilla frutescens	Bhangjiri	Lamiaceae	Herbaceous
Spices and condiments			
Plant species	**Local name**	**Family**	**Type**
Allium carolinianum	Laut, Arum	Amaryllidaceae	Herbaceous bulb
Allium griffthianum	Neolagu, Keer	Amaryllidaceae	Herbaceous bulb
Allium humile	Duna	Amaryllidaceae	Herbaceous bulb
Allium roylei		Amaryllidaceae	Herbaceous bulb
Allium rubellum		Amaryllidaceae	Herbaceous bulb
Allium stracheyi	Keer, Jambu	Amaryllidaceae	Herbaceous bulb
Allium tuberosum	Zimu	Amaryllidaceae	Herbaceous bulb
Alpinia galanga	Galangal	Zingiberaceae	Herbaceous
Bombax ceiba	Semwal	Malvaceae	Tree
Cinnamomum tamala	Kirkiria	Lauraceae	Tree
Cleome viscosa	Jakhya	Cleomeaceae	Herbaceous
Zanthoxylum armatum	Timur	Rutaceae	Shrub

Adapted from Singh (2017), Joshi et al. (2018), Anthwal et al. (2006), Namrata et al. (2011)

idea of conserving resources especially with respect to biological diversity. In the face of the growing risk of climate change, and various economic crises, there has been a fear and at the same time interest in provisioning of food security with agronomy and food production in its current shape (Lichtfouse et al. 2009). This can be a challenge predominantly in the rural areas of the Uk state given the soil security and stability of landscapes in the area. Generally speaking, the aboriginal communities residing near the bio-rich areas rely mainly on the wild flora for their subsistence and everyday needs. In this part of the Himalayas, the ethnic groups show high dependency, familiarization, and respect (traditional attachments, value recognition, and spiritual association) for the wild flora with respect to their food supply (Haridasan et al. 1990). Thus, the state presents an excellent opportunity of harvesting these wild resources and yet conserving and preserving the biodiversity. In this context, many plant species have great applicability as a food source in the coming years.

The current world scenario like frequent floods, famines, organic and natural food orientation, demand, variety, have driven a lot of pressure on the wildlife to meet the needs of the growing population. Some wild plants are consumed at the time of famine, some are consumed for treating certain ailments and disorders while some support the poor population as a primary source of nutrition. Such conditions raise the burden on wild edible species. In addition, unnecessary and involuntary selection, urbanization, industrialization, chemical use, etc., create a substantial danger to wild edible plants. In terms of edible wild plants, Uk has abundant and now these species are commonly eaten in the remote regions of the state. The edible biodiversity in Uk is critical in the economic sense, which supports these species' yield and their interaction with the socio-cultural framework. Studying the economic value and appraisal of biodiversity globally and in the Uk has seen a spike in recent years. This intensive discourse and research on the economics of biodiversity have also been included in the literature on environmental economics (Nijkamp et al. 2008).

The huge diversity in the mountain region has been maintained through a variety of crop compositions, the indigenous method of maintaining soil fertility, socio-cultural, and religious rituals. The Garhwal Himalayas, of Uk state, has been the capital of spiritual and theological awareness, and pilgrimage from prehistoric periods, also cited in the religious texts and scriptures, and numerous elements of flora and fauna biodiversity are being utilized by masses for idolization and for rituals pertaining to one's beliefs (Gairola and Biswas 2008). Popularly, the inhabitants of Garhwal district, Uk have a practice of nature preservation by means of socio-religious restrictions on dissipated usage of public resources (Anthwal et al. 2006). The significance of socio-cultural principles in preserving biodiversity is an intimate part of the residents of Uk, this was possible by the efforts from old generations who had set certain rules and instructions for the management of agricultural biodiversity, such practices are still followed. The objective is to recognize the collective roles of environmental and social aspects of agricultural biodiversity, regulate its influence on ecological goods and services and benefit society at large, and take into account the possibilities for the sustainable use and conservation of biodiversity.

Approximately 65 percent of Uttarakhand Himalayas is under forests out of which 12 percent is under protected areas, six national parks, and six wildlife sanctuaries (Gokhale et al. 2011). Various measures are been taken by the state's tourism division to promote ecotourism activities, in particular, a draft "*Uttarakhand Ecotourism Policy 2020*" is proposed to promote ecotourism while preserving natural diversity in the region. This policy ensures a sustainable source of revenue for the indigenous people living in the rural parts of the Uk state. This policy proposes adopting large areas of the forests for the ecotourism industry. However, this plan has provoked opposition from resident people and conservationists who consider that such reforms can destroy wildlife besides harming many rare and endangered species. The disapproval by the common people and local environmentalists indicates the intimate association of indigenous people to the culture and tradition linked to the biodiversity of the UK.

9.9 Socio-Cultural Factors

Socio-culture highlights values, customs, rituals, behaviors, and laws that are created by people engaging in society and the interactions that arise from the influence of this system on people's lives. In brief, it is the community and institutions where people communicate with the culture in which they live. The dynamics of human nutrition are influenced by the ethnic, spatial, environmental, and economic systems and the historical phase. Factors such as the range of food types, rituals, and practices have produced diverse food consumption habits within these cultural exchanges. Such a confluence, described as the culture of diet, encompasses the subjects of how people choose what to eat, when the chosen food is eaten, cooking techniques and varieties are based on the dietary behaviors of the society in which the person lives (Gidalar and Kitabi 2010). People in Uk have been acquainted with many cultures since ancient times, different areas within Uk have different cultures and beliefs. The species are eaten and their methods of processing, cooking, and how they are consumed vary across various cultures. Generally, there are variabilities in how various sections of the society or region assume various food habits or roles in the food chain. For example, among the 5 tribal communities of Arunachal Pradesh consuming alga, *Prasiola crispa* in the form of a vegetable was found in only tribes—Monpa and Sherdukpens (Saha et al. 2014). Similar patterns of distinct social behaviors can be seen in the Uk as the bulk of those who gather and market the wild plant species were from a certain lower societal stratum (Saha et al. 2014). This has led to various communities being involved in different levels of the food systems in the past thus driving that part of the economic value chain. Such impressions can still be seen in Uk communities.

Given that the socio-cultural infrastructure of this area is comprised of varied ethnic communities that formed and fashioned its own traditions thus making the area culturally rich. It is also observed that the formation of these communities and the various social statuses are largely influenced by the food system and its association with procuring, cultivating, processing, and marketing of local products and needs. The eco-diversity, remoteness, and ethic people's reliance on the plant resources for treating diseases, are also factors leading to cultural uniqueness. The indigenous tribes have shown a close dependence on the environmental resources and thus exist alongside in accord with the environment. At higher elevations, more utilization of plant species has been seen indicating the intimate dependence on wild flora (Saha et al. 2014). In the last few decades, various nutraceutical plant sources are harvested on a large scale for trading nationwide and around the global markets, this has led to another development of such communities whose livelihood now is linked to cultivating such plants for these companies. They cultivate similar or related crops, fight the same challenges in cultivation, access the same supply chain, and sell at the same market place, this creating and following a set-up that links them together and bring in a new sense of community.

The major contributor to the economy of the Uk is agriculture and almost 80% of the population are farmers while 90% are low-income with land-holdings less than 1 ha (Alam and Verma 2008). Thus, the socio-economic development of the people chiefly depends on crop production. Sometimes, this leads to the dependency of the people on the wild plants of the Uk Himalayas. With increasing altitudes, the crop production and productivity decreases which results in more dependence of the local communities on the wild flora. The major setbacks apart from the remoteness of the area and the less production per ha. are the limitations in the promotion of agricultural produce owing to the poor roads and lacking proper supply chains (Kala 2014). In this economically weak and ecologically delicate area, sustainable agriculture is needed for reasonably enhancing crop production and land-use planning.

9.10 Conclusion

Socio-culture dynamics of a community though beneficial for the protection of certain floral species has also detrimental impacts on wild edible species. Such results can be observed more distinctly in rural areas. Young individuals who travel for purposes like higher education, better employment opportunities, marriages are not able to fully comprehend and value the consumption of these herbs possibly because they are not acquainted with them. Thus, culture and food habits in rural areas are steadily changing. Analyzing the socio-cultural framework allows one to assess the edible wild native populations from an economic viewpoint, and also helps to recognize and adopt the best techniques by looking at the components that affect them. It is really important to hand over and monitor conventional uses from down the generations to ensure sustainable consumption. There is a need for standardizing the documentation regarding the use, conservation, and cultivation of all the local and traditional plants including medicinal, wild, religious, spices, condiments, cash crops, and other functional and miscellaneous plants. This will promote the awareness of the impacts of these plants on human health, economic, cultural, and traditional domains of life. The specific tribal familiarity with various plants should be highlighted for their use as food and sources of other human needs. At the same time, the over-exploitation of wild plants should be regulated and the conservation of biodiversity of the area should be promoted at the national scale. Since a balance of utilizing wild resources along with commonly cultivated crops is important, the production, trading, and supply chain of the cash crops should be improved to achieve this balance.

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10 Edible Medicinal Plants from Chhattisgarh (India) and their Economic Significance

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Abstract

The utilization of herbal drugs and phytonutrients or nutraceuticals keeps on extending quickly around the globe with many people now depending on these products for the management of different health afflictions in various national healthcare settings. From the past decade, enormous spike in acceptance and people's interest in natural remedies have been observed in both developing and developed countries. Diversity, adaptability, easy accessibility in edible form, low cost, relatively fewer side effects, increasing economic importance, and low levels of technological input are some of the positive features of herbal medicine. It is believed that up to four billion people (accounts for about 80% of the world's population) residing in the developing countries rely on herbal medicines as a primary source of healthcare. In this context, there is a basic need to standard conventional drugs into public healthcare to accomplish the objective of enhanced access to healthcare facilities. India has a distinct status in the world owing to the richness in medicinal plant diversity. About 17,000 species of higher

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plants are identified in India, of which 8000 are considered to have medicinal value. Chhattisgarh state located in East-Central India is considered as “Herbal state” because of its vast diversity of medicinal plant species that are used by its unique tribal population for treating various health ailments since time immemorial. This chapter aims to explore the indigenous knowledge of locally available edible medicinal plants being used by the traditional community of Chhattisgarh state along with their documentation to expand the scope and scientific value of local use of these medicinal plant species.

Keywords

Edible medicinal plants · Chhattisgarh · Herbal state · Economical importance

10.1 Introduction

Nature has been very kind to humanity and offers services for its long-term survival and continuous regeneration. The future of the human race is difficult to foresee if the earth does not have plants. From ancient times, plants have been considered as valuable and esteemed bio-resource that work in manifold ways and are used for food, fuel, and medicinal goals (Dixena and Patel 2019b; Aslam and Ahmad 2016). Plants are actually “natural industries” and act as a source of raw material to perfumery, pharmaceutical, and cosmetics industry without having any harmful impact on the environment (Jain et al. 2006). Before the chemical drug species were introduced to the world, people were dependent on the healing properties of the medicinal plant species (Ahvazi et al. 2012).

Medicinal plants are being used in health care systems since prehistoric times (Samal 2016). According to the World Health Organization (WHO), “a medicinal plant is a plant which in one or more of its organs, contains a substance that can be used for therapeutic purposes, or which are precursors for chemo-pharmaceutical semi-synthesis”(Husain et al. 2008). Owing to their high therapeutic effectiveness, low toxicity, local availability, and economic feasibility, herbal drugs are being explored in recent scientific advancements worldwide. People are globally returning to nature, i.e. shifting from the use of synthetic drugs to the herbal medicines (Shakya 2016; Bandaranayake 2006; Ekor 2014). As per the reports of the world health WHO, almost 8 billion people comprising about 80% of the global population particularly in developing countries largely rely on herbal medicines (Faruque et al. 2018; Ekor 2014; Calixto 2000). Therapeutic medicinal plants are an important part of research advancements in the pharmaceutical industry. This research focuses on identifying, isolating, and using either the active medicinal products directly or to develop semi-synthetic drugs or screening of natural products to obtain synthetically pharmacological active ingredient (Singh 2015; Süntar 2020). The therapeutic effectiveness of the medicinal plants is mainly due to secondary metabolites produced by them, including alkaloids, glycosides, terpenoids, flavonoids, steroids, saponins, tannins, and volatile oils (Dar et al. 2017; Shakya 2016; Larayetan et al.

2019; Seca and Pinto 2019). In present times, the pharmacological efficacy of various medicinal plants is found to be a potential future drug candidate to combat various ailments (Shakya 2016; Pan et al. 2013). Various institutions have followed a "reverse pharmacology" strategy to examine the clinical efficacy or therapeutic effectiveness of medicinal plants and their functional utility in health services (Samal 2016; Atanasov et al. 2015).

Medicinal plants also generate revenue for millions of people around the world (Dar et al. 2018). The global market approaches many billion dollars per year for plant-based pharmaceuticals, flavors, chemicals, coloring components, and fragrances. Global trade in medicinal plants is believed to be around US$ 800 million per year (Singh 2015).

Nature has blessed an incredible richness of medicinal plants to India and hence it is often referred to as "World's medicinal garden"(Shakya 2016). Medicinal plants had attained an important place in the spiritual, social, cultural, and health aspects of Indian people living in rural and tribal areas (Gupta and Gupta 2017). India is considered as Asia's one of the leading nations as far as the indigenous herbal knowledge system is concerned (Malik et al. 2018). India houses several medicinal plant species and is listed in the seventh position among the 17 mega-diversity centers of the world. India has a range of ecosystems including forests, desert, marine, coastal, and wetlands that habitats various plant species which contribute towards the well-being (Singh and Shahi 2017). India has a distinctive status in the world because of its well renowned traditional system of medicine such as Ayurveda, Siddha, homeopathy, and Unani (Shakya 2016; Samal 2016; Mukeshwar et al. 2011). About 95% of the medicinal formulations used in these traditional systems of medicine are plant-based products (Balamurugan et al. 2017; Pandey et al. 2013). There are around 17,000 higher plant species in India of which 8000 are recognized to have medicinal value and are used by the people living in villages and tribal communities (Singh 2015). Over 70% of the Indian population depends on herbal medicines to address health related issues (Samal 2016). In India, there are approximately 550 tribes inhabited with 227 ethnic groups living in 5000 villages within forest areas (Sahu et al. 2014; Pandey et al. 2018). Since times immemorial these tribal people have been practicing the usage of medicinal plants for treating various health ailments. This traditional knowledge of medicinal plants has been disseminated over generations and has contributed greatly to the conservation of biodiversity and its sustainable use. Chhattisgarh state located in East-Central India came into existence on 1 November 2000 after separation from Madhya Pradesh. It is bordered by Uttar Pradesh to the north, Jharkhand to the north-east, Orissa to the west, Andhra Pradesh to the south-east, Maharashtra to the south-west, and Madhya Pradesh to the west and north-west. The state is spread over the area of 192,000 $km^2$with 59,772km^2 under forest coverage. Chhattisgarh has approximately 44% forest cover of its total geographical area which accounts for about 8% of India's total forest cover. Chhattisgarh is considered as an "Herbal state" because of its rich biodiversity of medicinal plants. The state is also renowned for its distinctive tribal people such as Baiga, Gongs, Sahu, Ahir, Oraon, Kunbi, Gwalas, Kols, Korwa, etc. These indigenous people have the accessibility of plants with medicinal and nutraceutical advantage and gather the valuable parts of these plants for their service (Gupta and Gupta 2017; Pandey et al. 2018; Patel et al. 2019).

The present book chapter provides a compilation of existing information of various edible medicinal plants used in some selected districts (Durg, Jashpur, Balod, Janjgir-Champa, Korea, Bastar, Bilaspur, Gariaband, Dhamtari, Kabirdham, and Surguja) of Chhattisgarh. We emphasized on the knowledge that researchers can easily access and do not assert to have included all the existing information or claim to have done a comprehensive review of all the published literature on the medicinal plants of Chhattisgarh state. The purpose of documentation is to expand the scope and scientific value of the local use of these medicinal plants that may help to raise awareness among people and the scientific community so that conservative initiatives can be implemented for their sustainable use.

The present chapter documents 149 medicinal plant species used traditionally by the tribal people of Chhattisgarh state for treating various ailments. The results are provided in Table 10.1 with botanical name, local name, family, habitat, parts used, and ethnomedicinal use.

10.2 Taxonomic Categories

The vast majority of edible medicinal plant species were angiosperms belonging to 59 families. The highest number of medicinal plant species reviewed were found to belong to Fabaceae (13 species) followed by Euphorbiaceae and Lamiaceae (08 species each), Solanaceae and Caesalpiniaceae (07 species each), Apocynaceae (06 species), Apiaceae and Liliaceae (05 species each), Combretaceae, Moraceae, Rutaceae, and Zingiberaceae (04 species each), Acanthaceae, Amaranthaceae, Annonaceae, Asclepiadaceae, Asteraceae, Brassicaceae, Poaceae, Rhamnaceae, Verbenaceae (03 species each), Araceae, Cleomaceae, Convolvulaceae, Cucurbitaceae, Dioscoreaceae, Malvaceae, Meliaceae, Menispermaceae, Mimosaceae, Sapotaceae (02 species) (Fig. 10.1**).** The rest of the plant species reviewed were represented by 01 species each.

Based on the morphology (Fig. 10.2) of medicinal plant species, 67species were found to be herbs, 44 species of trees, 22 species of shrubs, and 16 species of climber.

10.3 Plant Parts Used for Medicinal Purpose

The most commonly used plant parts in the preparation of herbal formulations were found to be roots, rhizomes, fruits, flowers, seeds leaves, stems, or the whole plant (Table 10.1). The use of multiple plant parts was also observed for some plant species. These plant parts were found to be consumed either fresh or cooked or used in the form of decoction or infusion. The use of specific plant parts indicates that these parts may be associated with potent biological properties and further phytochemical screening is needed to validate the ethnomedicinal claims scientifically.

Table 10.1 Edible plants of used traditionally by the tribal people of Chhattisgarh state for treating various ailments

Botanical name	Local name	Family/habitat	Part used	Ethnomedicinal uses	References
Abelmoschus esculentus	Bhindi	Malvaceae/herb	Fruit	Improve eight sights, control blood sugar level	Sharma et al. (2016)
Acacia catechu	Khair	Mimosaceae/tree	Bark	Cough, cold, diarrhea	Tiwari and Mehta (2013)
Acacia leucophloea	Bambary	Leguminosae/tree	Bark	Diabetes	Ekka and Dixit (2007)
Acacia nilotica	Babul	Fabaceae/tree	Bark, fruit	Urine-genital disease, mouth ulcers	Sharma et al. (2016)
Acalypha indica	Kuppi	Euphorbiaceae/herb	Leaves, root	Diarrhea, anthelmintic, dysentery Antidyslipidemic	Sharma (2016)
Acorus calamus	Bach	Araceae/herb	Rhizome	Cough, cold, menstrual disorders epilepsy	Tiwari and Mehta (2013); Kurre (2015)
Adhatoda vasica	Adusa	Acanthaceae/shrub	Leaf	Asthma, tuberculosis, fever, bronchitis, cough, antidote	tiwari and Mehta (2013); Ahirwar (2015); Sinha et al. (2012)
Aegle marmelos	Khotta, Bael, bel	Rutaceae/tree	Leaf, fruit, bark, pulp	Diarrhea, diabetes, jaundice, stomach troubles, dysentery	Sahu et al. (2014); Sharma et al. (2016); Tiwari and Mehta (2013); Ekka and Dixit (2007)
Albizia lebbeck	Segta/Siri	Fabaceae/tree	Leaf	Blood purifier, night blindness	Sahu et al. (2014)
Albizia procera	Karhi	Fabaceae/tree	Bark	Cough and cold	Dixena and Patel (2019a)
Allium cepa	PyajBhaji	Liliaceae/herb	Leaf and bulb	Vomiting, cardiovascular disease, diabetes, antioxidant, cancer, osteoarthritis, ulcer	Sharma et al. (2016); Sharma (2016); Sharma (2019)
Allium sativum	Lahsun	Liliaceae/herb	Bulb	Heart disease, ulcer, osteoarthritis, cancer	Sharma et al. (2016)
Aloe barbadensis	Ghikuwire	Liliaceae/herb	Leaf	Jaundice	Ekka and Dixit (2007)
Amaranthus spinosus	KantaBhaji	Amaranthaceae/herb	Root, leaves	Anti-fertility, scorpion bite, and snake bite	Rai and Nath (2005); Sharma (2019)
Amaranthus tricolor	Lal Bhaji	Amaranthaceae/herb	Leaf	Maintains good kidney function, diabetes digestion, dysentery	Prabhas et al. (2016)

(continued)

Table 10.1 (continued)

Botanical name	Local name	Family/habitat	Part used	Ethnomedicinal uses	References
Amaranthus viridis	ChaulaiBhaji	Amaranthaceae/herb	Whole plant, leaves, roots, seeds, and stem	Gonorrhea, heart trouble, diuretic, dysentery, inflammation, constipation, laxative	Sharma (2019); Shrivastava et al. (2017); Prabhas et al. (2016)
Andrographis paniculata	Bhuai neem, kalmegh	Acanthaceae/herb	Whole plant, root, leaf	Malaria, diabetes, respiratory disease, blood purifier, antihelminthic, stomachic	Gupta and Gupta (2017); Sharma et al. (2016); Shrivastava and Kanungo (2013b)
Anethum graveolens	Soay	Annonaceae/herb	Seed	Hypertension, digestive disorders	Shrivastava (2019)
Annona reticulate	Ramphal	Annonaceae/tree	Fruit, seeds, leaves, bark	Diarrhea, dysentery treatment of intestinal worms, diabetes, cancer, tumor	Sahu et al. (2014); Lal et al. (2015); Sharma et al. (2017)
Annona squamosa	Sitaphal	Annonaceae/tree	Leave, fruit	Tumor, cancer, antidepressant, epilepsy	Sahu et al. (2014); Sharma et al. (2017)
Asparagus adscendens		Liliaceae/climber	Tuberous parts	Restore fertility	Rai and Nath (2005)
Asparagus racemosus	Satawari	Liliaceae/climber	Root, whole plant	Lactogogue, blood pressure, nervous disorders, tuberculosis, weakness, dyspepsia uraemia, fever, tumors, nervous disorders	Gupta and Gupta (2017); Ekka and Dixit (2007); Ahirwar (2015); Sharma et al. (2017)
Asteracantha longifolia	MokhlaBhaji	Acanthaceae/herb	Leaves	Blood disease, liver problems, diabetes	Sharma (2019)
Azadirachta indica	Neem	Meliaceae/tree	Seed, bark	Diabetes, diarrhea, piles, antidote	Sinha et al. (2012); Kujur and Ahirwar (2015); Shrivastava and Kanungo (2013a); Shrivastava and Kanungo (2011)
Azima tetracantha	Menasu Uppimullu	Salvadoraceae/shrub	Leaves	Antidote	Sinha et al. (2012)

Bacopa monnieri	Brahmi	Scrophulariaceae/ herb	Leaves	Constipation, weakness, bronchitis, blood purifier, anemia, anticancer, ulcer, epilepsy, tumor, asthma	Tiwari and Mehta (2013); Sinha (2017); Ekka and Ekka (2016a); Sharma (2016)
Bambusa arundinacea	Bans	Poaceae/tree	Leaves	Fever	Gupta and Gupta (2017)
Basella alba	Poi Bhaji	Basellaceae/ climber	Leaves, root	Gonorrhea, intestinal disorders, constipation,	Sharma (2019); Sahu et al. (2014)
Bauhinia racemosa	Kachnar	Caesalpiniaceae/ shrub	Bark, fruit	Diarrhea, diabetes, worms, tutor	Gupta and Gupta (2017)
Bauhinia vahlii	Mohlain	Caesalpiniaceae/ climber	Root	Syphilis, gonorrhea, respiratory disease	Kujur and Ahirwar (2015); Shrivastava and Kanungo (2013b)
Boerhavia diffusa	Khapra sag, PatharriBhaji	Nyctaginaceae/ herb	Root, whole plant	Dysentery, typhoid, tetanus, kidney stone, jaundice, antidiabetic, indigestion, antioxidant, diuretic, inflammation	Ekka and Dixit (2007); Tiwari and Mehta (2013); Sharma (2016)
Bauhinia purpurea	KoliaariBhaji	Caesalpiniaceae/ tree	Leaves, stem, flower, and bark	Diabetes, piles, asthma, dysentery, ulcer, leprosy, diarrhea, cough, rheumatic pain	Sharma (2016); Sharma et al. (2017); Sharma (2019)
Bauhinia variegate	Kachanar	Caesalpiniaceae/ tree	Root, leave, flower, seeds	Stomach disorders, dyspepsia, diarrhea, dysentery,	Chandel et al. (2018); Toppo et al. (2016)
Brassica campestris	SarsoBhaji	Brassicaceae/ herb	Leaves and seeds	Menstrual disorders, fever, internal pains	Sharma (2019)
Brassica oleracea var. capitata	Bandhgobhi Bhaji	Brassicaceae/ herb	Leaves	Pneumonia, gastritis, rheumatism, bone weakness, anemia	Sharma (2019)
Bryophyllum pinnatum	Patharchata	Crassulaceae/ herb	Leaf	Kidney stone	Vinodia et al. (2019)
Caesalpinia bonducella	Gataran	Caesalpiniaceae/ shrub	Leaf	Asthma and cough related disorders	Ahirwar (2015); Kujur and Ahirwar (2015)

(continued)

Table 10.1 (continued)

Botanical name	Local name	Family/habitat	Part used	Ethnomedicinal uses	References
Calotropis gigentea	Safed aak	Apocynaceae/ shrub	Flower	Lactogogue	Ahirwar (2015); Vinodia et al. (2019)
Caltropis procera	Aak/ Akwan	Asclepiadaceae/ shrub	Fruit, flower, whole plant	Whooping cough, asthma, leprosy, rheumatoid pain, bronchitis	Kujur and Ahirwar (2015); Sharma (2017)
Canscora diffusa	Shank puli	Gentianaceae/ herb	Whole plant	Diarrhea	Shrivastava and Kanungo (2014)
Capsicum annum	Mirchi	Solanaceae/herb	Fruit, leave	Carminative, rheumatism	Sharma et al. (2016)
Carissa carandus	Karonda	Apocynaceae/ tree	Root, fruit	Anemia, constipation	Sharma (2017)
Carica papaya L.	Pavitar, Papita	Caricaceae/tree	Root, leaf, fruit, seed, latex	Tetanus, piles, heart problem, skin problems, Antihelmintic, stomachic, diuretic.	Ekka and Dixit (2007); Sharma (2017); Sharma et al. (2016)
Carthamus tinctorius	Kera/ BurreBhaji	Asteraceae/shrub	Flower, leaves, seeds	Heart disease, menstrual pains, tumors, rheumatism, decreases cholesterol level	Sharma (2019)
Cassia fistula	Sonarkhi	Leguminosae/ tree	Bark, flower, fruit	Diabetes, laxative	Shrivastava and Kanungo (2013a); Sinha (2017)
Cassia tora	Charota, Chakora	Caesalpiniaceae/ herb	Leaves, roots, and seeds	Respiratory disease, arthritis, leprosy, skin diseases	Sharma (2019); Shrivastava and Kanungo (2013b); Sharma et al. (2017)
Catharanthus roseus	Sadabahar	Apocynaceae/ shrub	Leaf	Diabetes, dysentery, high blood pressure, leukemia, stomachic	Tiwari and Mehta (2013); Ekka and Dixit (2007); Gupta and Gupta (2017)
Celastrus paniculatus	Peng/ Malkangini Bhaji	Cleomaceae/ climber	Leaves and seeds	Memory enhancer, leprosy, asthma, fever,	Sharma (2019)
Centella asiatica	Mukhaadkha, Brahmi	Apiaceae/herb	Leaf, whole plant, flowers	Epilepsy, insomnia, memory enhancer, liver tonic, stomachic, constipation	Sharma et al. (2016); Kujur and Ahirwar (2015); Sharma (2017); Sharma (2019)

Cicer arietinum	Chana Bhaji	Fabaceae/herb	Leaves and seeds	Dyspepsia, stomachic, constipation	Chauhan et al. (2014); Sharma (2016)
Cissampelos pareira	Pathar/ Paat, Korea	Menispermaceae/ climber	Root	Fever, diuretic, tonic, diarrhea	Ahirwar (2015); Kujur and Ahirwar (2015); Shrivastava and Kanungo (2014)
Citrus medica	Nimbu/ limbu	Rutaceae/tree	Fruit, leaf, root, whole plant	Constipation, cough, digestive, antiseptic, throat disorder, fever, dyspepsia, rheumatic	Sharma (2017); Sharma (2016)
Citrus reticulate	Santara	Rutaceae/herb	Fruit	Blood purifier, diarrhea	Sharma et al. (2016)
Cleome viscosa	Balakut/ HurhurBhaji	Cleomaceae/herb	Leaves	Dysentery, diarrhea, ulcers, stomach pain, piles, indigestion	Sharma (2019); Shrivastava et al. (2017)
Clitoria ternatea	Aparajita	Fabaceae/climber	Flower	Diabetes	Shrivastava and Kanungo (2013a)
Cocculus hirsutus	Nappakand	Menispermaceae/ climber	Tuber, root, leaves, stem	Stomach and abdominal pain, female sterility, fever, diuretic, tonic	Ekka and Dixit (2007); Sharma (2019)
Cocos nucifera	Nariyal	Arecaceae/tree	Fruits	Liver weakness	Gupta and Gupta (2017); Lal et al. (2015)
Coleus aromaticus benth	Pathorcur	Labiatae/shrub	Leaf, tuber	Cough, cold, cancer, weakness,	Ekka and Dixit (2007)
Colocasia esculenta	Kochai	Araceae/herb	Leaves corm	Alopecia, weakness and constipation, cancer, neurological disorder, arthritis, asthma	Sharma (2017); Sharma et al. (2017)
Coriander sativum	Dhania	Apiaceae/herb	Leaf, seed	Liver tonic, vomiting, digestive	Sharma et al. (2016)
Cordia dichotoma	Lasoda	Boraginaceae/ tree	Bark	Diarrhea	Shrivastava and Kanungo (2014)
Crataeva nurvala		Capparidaceae/ tree	Bark	Antifertility	Rai and Nath (2005)
Calotropis gigantea	Junjhuni	Fabaceae/herb	Seed, roots	Blood pressure, anti-fertility drug	Vinodia et al. (2019); Rai and Nath (2005)

(continued)

Table 10.1 (continued)

Botanical name	Local name	Family/habitat	Part used	Ethnomedicinal uses	References
Curcuma aromatica	Vanhaldi	Zingiberaceae/herb	Rhizome	Diarrhea, fever, blood purification,	Gupta and Gupta (2017); Lal et al. (2015); Yadav et al. (2019); Cha et al. (2017)
Curcuma longa		Zingiberaceae/herb	Rhizome	Anti-fertility	Rai and Nath (2005)
Cucumis sativus	Khira	Cucurbitaceae/climber	Fruit, seed	Tonic, diuretic	Sharma et al. (2016)
Cuscuta reflexa	Amarbel	Convolvulaceae/climber	Leaves	Anti-fertility	Rai and Nath (2005)
Cynodon dactylon	Dubi	Poaceae/herb	Leaf	Cough, cold	Vinodia et al. (2019); Sharma (2016)
Cyperus rotundus	Kissilattee	Cyperaceae/herb	Tubar	Stomachic, abdominal pain	Ekka and Dixit (2007)
Dalbergia paniculata	Dhobni	Fabaceae/tree	Bark	Respiratory disease	Shrivastava and Kanungo (2013b)
Datura stramonium	Dhatura	Solanaceae/shrub	Leaf	Joint complaints	Ahirwar (2015)
Desmodium diffusum, DC	Sabarbhanj	Fabaceae/herb	Root	Respiratory disease	Shrivastava and Kanungo (2013b)
Dioscorea bulbifera	Gurudnaar	Dioscoreaceae/climber	Stem	Jaundice, anti-fertility, cancer, diabetes	Vinodia et al. (2019); Rai and Nath (2005); Sharma et al. (2017)
Dioscorea hispida		Euphorbiaceae/climber	Tuber	Ulcer, bites of rabbit and dog, diabetes	Sharma et al. (2017); Chandel et al. (2018); Toppo et al. (2016)
Diospyros melanoxylon	Tela, Tendu	Ebenaceae/tree	Root, pulp, fruit, leaf, bark, seed	Blood clotting, dysentery, asthma, diarrhea, skin diseases	Sinha (2017); Ekka and Dixit (2007); Cha et al. (2017)
Daucus carota	Gagger	Apiaceae/herb	Root	Carminative, stimulant, diuretic	Sharma et al. (2016)
Elephantopus scaber	Meejurchundi, anola	Compositae/herb	Tuber	Abdominal pain	Ekka and Dixit (2007)

Emblica officinalis	Amla.	Euphorbiaceae/ tree	Fruit, leaf, bark, root	Indigestion, respiratory disease, diarrhea, vomiting, cough, anemia, asthma, cardiotonic, chronic constipation	Kujur and Ahirwar (2015); Sharma et al. (2016); Shrivastava and Kanungo (2013b)
Euphorbia hirta	Dudhia grass, Dudhi	Euphorbiaceae/ herb	Whole plant, latex, fruits	Snake bite, diarrhea, piles asthma, skin disease,	Tiwari and Mehta (2013); Ekka and Dixit (2007)
Euphorbia prostate	Chottadudhia grass	Euphorbiaceae/ herb	Whole plant	Lactogogue	Ekka and Dixit (2007)
Ficus hispida		Moraceae/tree	Fruit	Cancer, skin diseases	Sharma et al. (2017)
Ficus racemosa	Dumar, gular	Moraceae/tree	Fruit, root, latex	Piles, dysentery, diarrhea, urinary trouble, diabetes, and ulcer, antifertility	Gupta and Gupta (2017); Rai and Nath (2005)
Ficus religiosa	Pepal	Moraceae/tree	Bark, leaf, fruits	Gonorrhea, skin diseases, anti-fertility	Ahirwar (2015); Rai and Nath (2005)
Galium aparine	Goosegrass	Rubiaceae/herb	Leaf	Kidney infection, hypertension, anticancer, diuretic	Prabhas et al. (2016)
Gmelina arborea	Gamari	Verbenaceae/tree	Fruit	Dyspepsia, fever, skin disease	Raj and Toppo (2014)
Helicteres isora	Attain	Sterculiaceae/ shrub	Root	Diarrhea	Shrivastava and Kanungo (2014)
Hemidesmus indicus	Anantamul	Asclepiadaceae/ herb	Root	Antidote	Sinha et al. (2012)
Helianthus annus	Surajmukhi	Asteraceae/shrub	Leaves, seed, flower	Kidney stone, cough, cold, fever	Sharma et al. (2016)
Hibiscus sabdariffa	Jhirra/ KhattaBhaji	Malvaceae/shrub	Leaves	Hypertension, dysentery, diarrhea, liver disease, stomach pain,	Sharma (2019)
Ipomoea batatas	Kanda Bhaji Mitha aloo	Convolvulaceae/ herb	Leaves and tubers	Asthma, tumors, fever, antidiabetic, fever, hypertension, heart disease, reduce cholesterol	Sharma (2019); Sharma et al. (2016); Sharma et al. (2017)
Jussiaea suffruticosa	Parsauti.	Onagraceae/herb	Root	Fever	Sinha (2017)

(continued)

Table 10.1 (continued)

Botanical name	Local name	Family/habitat	Part used	Ethnomedicinal uses	References
Lantana camara	Lantana	Verbenaceae/ shrub	Seed, fruit, flower	Fever, asthma	Chandel et al. (2018); Toppo et al. (2016)
Leucas aspera		Lamiaceae/herb	Leave	Rheumatism, skin disease	Sharma et al. (2017)
Limonia acidissima	Kaith	Rutaceae/tree	Fruit	Stomach related disorder	Dixena and Patel (2019a)
Litsea glutinosa	Madabokla	Lauraceae/tree	Bark	Diarrhea, dysentery	Sinha (2017)
Leucas cephalotes	GumeeBhaji	Lamiaceae/herb	Leave	Cough cold	Prabhas et al. (2016)
Lycopersicon esculentum	Tamater	Solanaceae/herb	Fruit, seed	Stimulate, bronchitis, secretion, dyspepsia	Sharma (2016)
Madhuca longifolia	Mahua	Sapotaceae/tree	Flower, bark	Diabetes	Shrivastava and Kanungo (2013a)
Madhuca indica.	Mahua	Sapotaceae/tree	Barks, fruit	Diabetes, bleeding gums, diarrhea, headache, vomiting, stomach pain, intrinsic hemorrhage	Tiwari and Mehta (2013); Vinodia et al. (2019); Yadav et al. (2019)
Mangifera indica	Aam	Anacardiaceae/ tree	Fruit	Vomiting, stomach pain, syphilis, diphtheria	Dixena and Patel (2019a); Toppo et al. (2016); Raj and Toppo (2014); Chandel et al. (2018)
Marsdenia tenacissima	Chinhor	Asclepiadaceae/ climber	Tuber	Diarrhea	Shrivastava and Kanungo (2014)
Melia azedarach	Bakain	Meliaceae/tree	Leaves	Respiratory disease	Shrivastava and Kanungo (2013b)
Mentha arvensis	Pudina	**Lamiaceae/**herb	Leaf	Antihelminthic, rheumatism, irregular menstruation, diuretic	Sharma et al. (2016)
Mentha longifolia	Mint	Lamiaceae/herb	Leaf	Intestinal worms	Gupta and Gupta (2017)
Mentha piperita	Piperment	Lamiaceae/herb	Leaf	Analgesic, antioxidant, bronchitis	Prabhas et al. (2016)
Mentha spicata	Pudina	Lamiaceae/herb	Leaf	Gastrointestinal disorder, cough, cold fever, cholera	Sharma (2017)
Mimosa pudica	Chunimui	Mimosaceae/ herbs	Seed	Veneral disease	Ahirwar (2015)

Momordica charantia	Karela	Cucurbitaceae/ climber	Fruit, leave,	Diabetes, kidney stones, laxative, carminative, leprosy, jaundice	Gupta and Gupta (2017); Sharma (2016); Sharma (2019); Shrivastava and Kanungo (2013a)
Moringa oleifera	Munga	Moringaceae/tree	Bark	Cough and cold, diabetes, anemia, liver disease, respiratory disease, arthritis	Vinodia et al. (2019); Sharma et al. (2017)
Morus alba	Shahtoot	Moraceae/shrub	Roots, leaves, fruits	Hypertension, jaundice	Yadav et al. (2019)
Musa paradisiaca	Kela	Musaceae/herb	Leaves, roots, fruits	Diabetes, diarrhea, dysentery, bronchitis, cough, asthma	Yadav et al. (2019)
Ocimum basilicum, L.	Vantulshi	Lamiaceae/herb	Root, stem	Respiratory disease	Shrivastava and Kanungo (2013b)
Ocimum sanctum	Tulsi	Lamiaceae/shrub	Leaf, seed, roots	Cough and cold, antidote, asthma, common cold, bronchitis	Vinodia et al. (2019); Sinha et al. (2012); Yadav et al. (2019)
Oxalis corniculata	AwaliBhaji	Oxalidaceae/herb	Leaves, stem, root	Urinary infection, dysentery, fever, diarrhea, insect bites, dyspepsia, anemia	Sharma (2016); Sharma (2019)
Phyllanthus emblica	Amla	Euphorbiaceae/ tree	Fruit	Purgative, cooling agent to stomach	Lal et al. (2015)
Phyllanthus niruri	Bal aawla	Euphorbiaceae/ herb	Root	Jaundice	Vinodia et al. (2019)
Phyllanthus simplex	Bhuiaonla	Euphorbiaceae/ herb	Whole plant	Diarrhea	Shrivastava and Kanungo (2014)
Picrorhiza kurroa	Kutkichirat	Plantaginaceae/ herb	Leaf, stem	Fever	Vinodia et al. (2019)
Plumeria rubra		Apocynaceae/ shrub	Leave	Anti-fertility	Rai and Nath (2005)
Portulaca oleracea	Non/dal/ GholBhaji	Portulacaceae/ herb	Leave	Diuretic, stomach pain, skin diseases,	Sharma (2019)

(continued)

Table 10.1 (continued)

Botanical name	Local name	Family/habitat	Part used	Ethnomedicinal uses	References
Psidium guajava	Amrud	Myrtaceae/tree	Leaf, fruit	Diabetes and blood pressure control, asthma,	Vinodia et al. (2019); Yadav et al. (2019)
Pterocarpus marsupium	Beeja	Fabaceae/tree	Bark	Diabetes	Shrivastava and Kanungo (2013a)
Punica granatum	Anar	Punicaceae/shrub	Fruits	Diarrhea	Tiwari and Mehta (2013)
Raphanus sativus	MooliBhaji	Brassicaceae/herb	Leaves, seeds and roots	Asthma, indigestion, bronchitis, stomach pain, diarrhea, rheumatism, purgative	Sharma (2019); Sahu et al. (2014)
Rauvolfia serpentina	Chotachand	*Apocynaceae/*shrub	Root, plant	Hypertension, epilepsy, insomnia, fever, urinary retention, nervous disorders	Sinha (2017); Gupta and Gupta (2017); Sahu et al. (2014); Yadav et al. (2019)
Saraca asoca	Ashok	Caesalpiniaceae/tree	Barks	Menstrual disorders	Tiwari and Mehta (2013); Sharma (2017)
Senna tora	Charota	Fabaceae/herb	Leaf	Anemia	Vinodia et al. (2019)
Smilax Zeylanica	Ram Dataun	Smilacaceae/climber	Roots	Menstrual disorders, blood pressure	Tiwari and Mehta (2013)
Solanum nigrum	Bhatkatayi	Solanaceae/herb	Whole plant	Liver disorder, skin disease, dysentery	Yadav et al. (2019)
Solanum tuberosum	Aloo Bhaji	Solanaceae/herb	Leaves and tubers	Tumors, diuretic	Sharma (2019)
Solanum xanthocarpum	Chaskatiya	Solanaceae/herb	Flower	Cough and cold	Sinha (2017); Vinodia et al. (2019)
Terminalia alata	Sajja	Combretaceae/tree	Bark	Diarrhea	Gupta and Gupta (2017)
Terminalia arjuna	Kuaha	Combretaceae/tree	Bark	Heart disease, liver disease	Sahu et al. (2014); Yadav et al. (2019)

Terminalia bellirica	Baheda	Combretaceae/ tree	Fruit/pulp, leaf	Respiratory disease, digestive trouble, gastric troubles, cough and cold, asthma, diarrhea	Sahu et al. (2014); Sharma et al. (2016); Dixena and Patel (2019a); Shrivastava and Kanungo (2013b)
Terminalia chebula	Harra	Combretaceae/ tree	Fruit	Digestive disorders snake bite, fever, constipation, high cholesterol	Sahu et al. (2014); Sharma et al. (2016); Yadav et al. (2019)
Trachyspermum ammi	Ajwain	Apiaceae/herb	Fruit, seed	Stomach disorder, carminative, antispasmodic, diarrhea	Sharma et al. (2016); Shrivastava (2019)
Tribulus terrestris	Gokharu	Zygophyllaceae/ herb	Whole plants, fruits	Skin disease, weakness, spermatorrhea, diuretic, tonic	Tiwari and Mehta (2013); Ahirwar (2015); Sahu et al. (2014)
Trigonella foenumgraceum	MethiBhaji, fenugreek	Fabaceae/herb	Leaves, seeds, fruit, stem	Rheumatism and diabetes, reduce blood cholesterol, reduce labor pain, anemia, lactogogue, asthma, bronchitis	Sharma (2019); Sahu et al. (2014); Sharma et al. (2016); Prabhas et al. (2016)
Triticum aestivum	Ganhu	Poaceae/herb	Leaves, seed	Jaundice, constipation, ulcerative colitis	Sharma et al. (2016)
Ventilago madraspatana	Kewati	Rhamnaceae/ climber	Root	Respiratory disease	Shrivastava and Kanungo (2013b)
Vitex negundo		Verbenaceae/ shrub	Seed	Anti-fertility	Rai and Nath (2005)
Vitex quadrangularis	Hadjod	Vitaceace/herb	Stem, whole plant	Irregular menstruation, bone fracture	Ahirwar (2015); Gupta and Gupta (2017)
Withania somnifera	Asgandh	*Solanaceae*/tree	Root, plant	Impotency, nerve weakness, Oligospermia, aphrodisiac	Gupta and Gupta (2017)
Woodfordia fruticosa	Dhawai	Lytharaceae/ shrub	Flower	Dysentery, stomach related problems	Dixena and Patel (2019a)
Wrightia tinctoria	Safed Korea	Apocynaceae/ tree	Leaves	Diabetes	Shrivastava and Kanungo (2013a)
Xanthium strumarium	Chotadhatura	*Asteraceae*/herb	Root, fruit	Digestive, laxative, antipyretic, memory enhancer, appetizer	Gupta and Gupta (2017)

(continued)

Table 10.1 (continued)

Botanical name	Local name	Family/habitat	Part used	Ethnomedicinal uses	References
Zingiber cassumunar	Vansonthi	Zingiberaceae/ herb	Rhizome	Respiratory diseases, diarrhea	Shrivastava and Kanungo (2013b, 2014)
Zingiber officinale	Ginger and Adrak	Zingiberaceae/ herb	Root	Cancer, cough, breast	Gupta and Gupta (2017)
Ziziphus jujube	Ber	Rhamnaceae/tree	Fruit, leaf, bark, stem	Ulcer, abdominal pain, fever and asthma, dysentery, ulcer,	Sharma (2017); Sahu et al. (2014)
Ziziphus oenoplia	Makoi	Rhamnaceae/ shrub	Root	Dysentery and diarrhea	Shrivastava and Kanungo (2014)

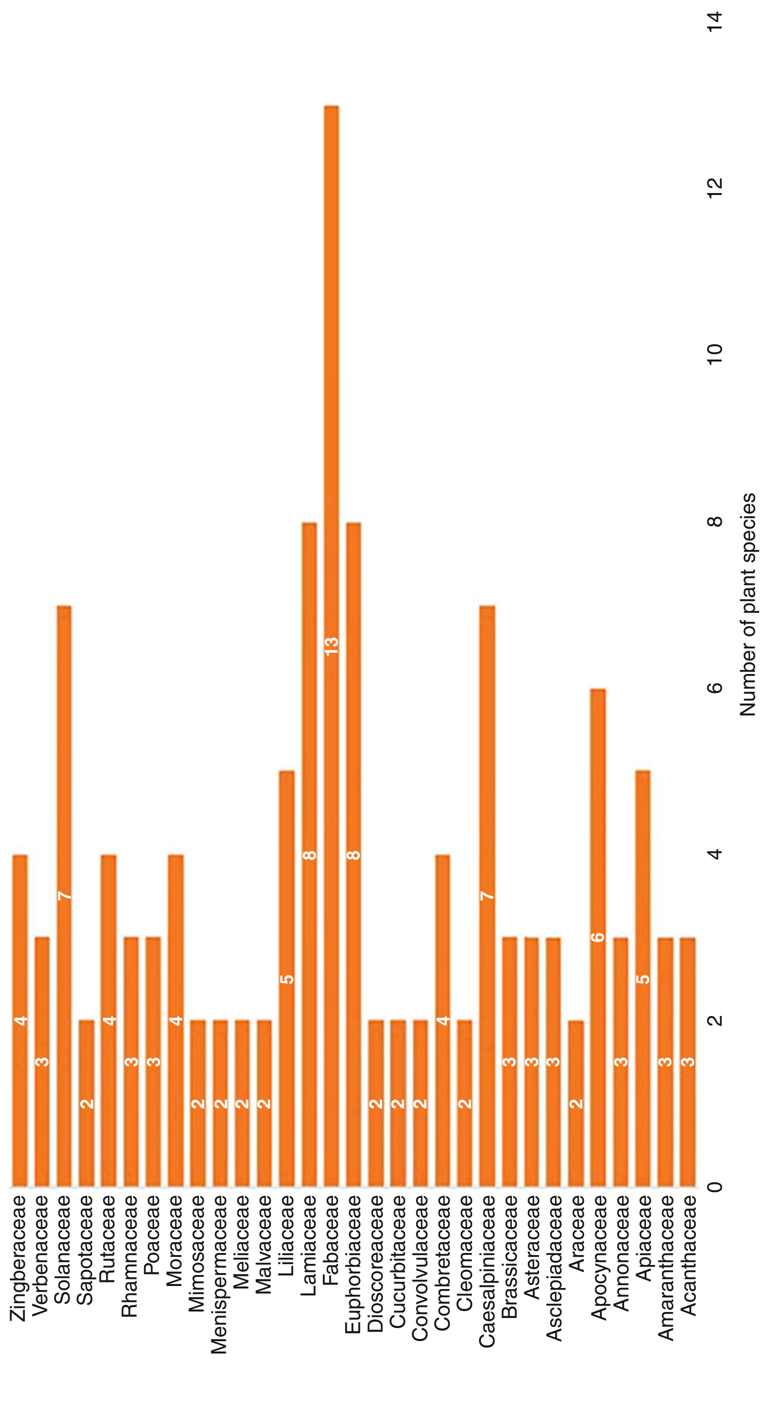

Fig. 10.1 Family distribution of medicinal plants

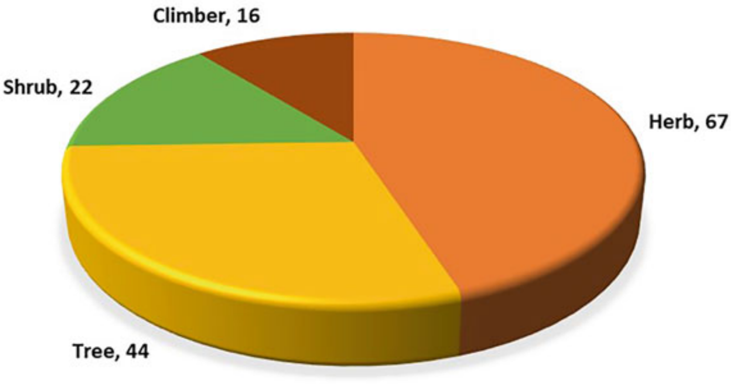

Fig. 10.2 Morphological distribution of medicinal plant species

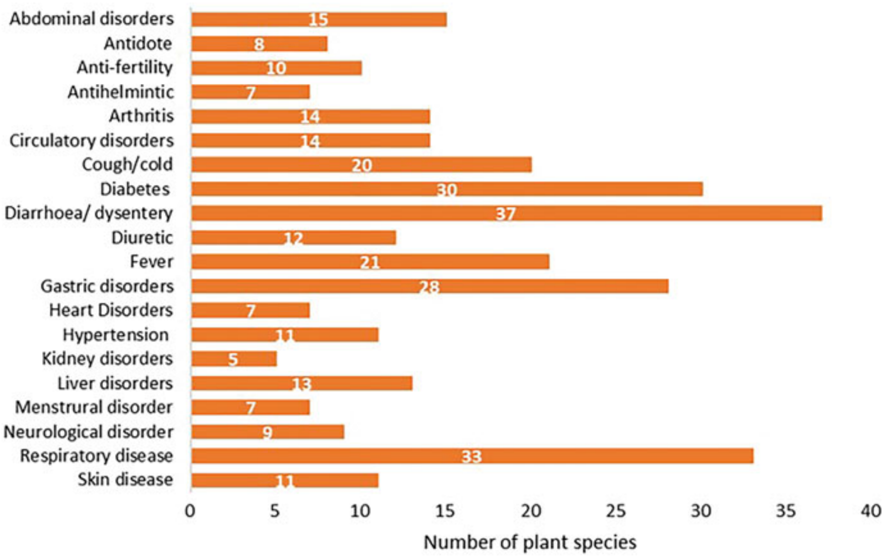

Fig. 10.3 Ailment categories treated by medicinal plants

10.3.1 Ailment Categories Treated

A total of 20 major ailment categories were treated with medicinal plant species (Fig. 10.3). The main ailment categories that are treated include diarrhea (37 species), respiratory disease (33 species), diabetes (30 species), gastric disorders (28 species), Fever (21 species), cough/cold (20 species), abdominal disorders (15 species), circulatory problems and arthritis (14 species each), liver disorders (13 species), diuretic (12 species), skin problems, and hypertension (11 species each). The majority of plant species were used to treat multiple ailments, some were used to treat few ailments, while only a small proportion of plant species were used to treat only a single ailment (Table 10.1).

10.4 Economic Importance

The world has witnessed the scientific and commercial interests in edible plant and plant-based products due to their immense economic potential and widespread cultural acceptability, but only less than 5 percent of species have been analyzed as potential medicinal products while rest of the plant remain to be unexplored. Varieties in family diet and food security in houses are due to the diversity in edible plants. It is clear that edible plant use is not negligible in many parts of the world, but this is the truth that today human plant foods are based on a very small number of crops (Hood 2010).

The cultural consumption of wild edible plants by various tribal and non-tribal groups living in rural and semi-urban areas as food and medicine has been extensively exercised. Particularly, the accessibility of plants collected from anthropogenic landscapes (i.e., homesteads, forest patches, the vicinity of rice fields, or fallow lands) which allows large group of people to rely on them as a valuable nutritional resource due to their easy access. The nutritional value of conventional edible plant is often higher than many known fruits and vegetables. Edible plants throughout the world, and especially in developing countries, make a marked contribution to the local community life (Ray et al. 2020).

The actual guardians of nature's wealth and herbal medicine experts are mainly the ethnic groups of various regions of the world. For centuries, the traditional native knowledgepassed orally is disappearing rapidly due to the developments in technologies and cultural change of ethnic groups. Despite all these disruptions, the ancient phytocure methods among the various tribes are being restored, as it is a part of their culture. Besides, ethnic tribal people the people in ethnic tribes are against cultural changes and changing mode of their life. Also, there is a need to preserve this traditional medical knowledge in various forms for future generation as it is diminishing slowly. The native ethnic groups possess their own evident religious rituals, culture, food habit, and a rich knowledge of traditional medicine. Due to the topographic diversity and variable climatic condition, Chhattisgarh has a rich and varied flora. In four different zones like Eastern, Western, Central, Northern, and Southern zones around 20–25 tribes are living either isolated or in combination. About one-third (10%) of the total population of the state in India is contributed by tribes of Chhattisgarh. Among all the tribes found in Jashpur region of Chhattisgarh, Oraon is one of the populous areas (Painkra et al. 2015). Agriculture is the major occupation of tribal people, even though forest and their products are also essential livelihood of tribal's and folk people, which meets their numerous day-to-day requirements like fibers, food, medicine, etc. Food requirement is fulfilled mainly through agriculture, but flowers, fruits, leaves, roots, and tubers are also collected from the forest as supplementary foods (Ekka and Ekka 2016b). For deprived communities, medicinal plants acts as the alternate income generating source

(Lacuna-Richman 2002; Myers 1990). Thus, this sector helps to improve socio-economic with living standard of rural people/tribes.

10.5 Conclusion and Future Prospective

The worldwide utilization of medicinal plants particularly in India is inevitable. Around 80% of world's population relies primarily on medicinal plants as a first source of therapy. Chhattisgarh is considered as an "Herbal state"because of its rich biodiversity of medicinal plants. These medicinal plants not only provide food but also are the promising source of future drug candidates. Further these plants have high economic importance and acts as a source of income for the people. In this chapter an attempt is made to review the details of edible medicinal plants of Chhattisgarh used by tribal communities to cure many ailments such as respiratory disorders, digestive disorders, etc. The aim of documentation of these medicinal plants is to broaden the scope and importance of the local use of medicinal plants. With time the knowledge of medicinal plants among tribal people is disappearing, therefore it is imperative to record traditional knowledge about the medicinal plants. Measures aimed at improving the efficacy, effectiveness, and appropriate use of the medicinal plants must be implemented mainly by incorporating them in regional, national, and health policies and programs. In view of economic significance of the medicinal herbs, it is crucial to cultivate them consistently and save them from extinction by taking conservative measures for their sustainable use. Research need to be conducted to further analyze the nutritional and medicinal values of the plants.

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Ethno-Botanical and Economic Significance of Edible Plants Used as Food by Tribal Community of the Western Himalaya 11

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Abstract

Nature has been very kind to humanity and offers services for its long-term survival and continuous regeneration. From the past decade, enormous spike in acceptance and people's interest in natural remedies have been observed in both developing and developed countries. Diversity, adaptability, easy accessibility in edible form, low cost, relatively fewer side effects, increasing economic importance, and low levels of technological input are some of the positive features of herbal medicine. It is believed that up to four billion people residing in the developing countries rely on herbal medicines as a primary source of healthcare. In this context, there is a basic need to standard conventional drugs into public healthcare to accomplish the objective of enhanced access to healthcare facilities. India has a distinct status in the world owing to the richness in medicinal plant diversity. About 17,000 species of higher plants are identified in India, of which 8000 are considered to have medicinal value. Western Himalaya region because

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of a wide range of altitudes, topography, and climatic conditions has vast diversity of medicinal plant species that are used by its unique tribal population for treating various health ailments since time immemorial. This chapter aims to explore the indigenous knowledge of locally available edible medicinal plants being used by the tribal community of western Himalaya region along with their documentation to expand the scope and scientific value of local use of these medicinal plant species.

Keywords

Edible medicinal plants · Phytoconstituents · Western Himalaya · Economical importance · Biological activities

11.1 Introduction

The Himalayas are known for its wide range of altitudes, topography and climatic conditions, is a rich repository of more than eight thousand species of tracheophyta, among which 1748 are acknowledged for their therapeutic wealth, which occupies an important place in Vedic treatise (Sharma et al. 2011). The people of countryside dwelling in hilly and mountain zones consume wild and uncultivated edible plants that constitutes a portion of their eating habits in several civilizations and closely related to nearly all characteristics of their wellbeing, socio-cultural and spiritual existence (Aryal et al. 2009; Hawksworth 2006). Wild edibles extensively include roots, shoots, leaves, flowers, fruits, seeds, nuts, and entire plants gathered from woods, hedgerow, grassland, and as weed that grow on their own besides the usual crop (Rijal 2011). Wild edible plays a key role to fulfill the dietary prerequisite of the tribal community in distant areas of the nation all around the year (Grivetti and Britta 2000). Plants of Himalayan region significantly contribute to monetary prospects for billions of people living in mountains. Tribes consuming plants in numerous ways as raw in salads and pickle fried and steamed depending on taste and boiled in kadha preparation, curries, and soups (Pieroni et al. 2005; Piya et al. 2011). The edible plants of the wild hold significant position in the sustenance of countryside or tribal societies in numerous emergent nations (Britta et al. 2003). Numerous wild and cultivated florae have lately acquired significance, not only as herbal remedies, but also as natural constituents for the cosmetic industry (Joshi et al. 2016).

The present chapter documents 33 medicinal plant species (Fig. 11.1) used traditionally by the tribal Community of the Western Himalaya for treating various ailments. The results are provided in (Table 11.1) with botanical name, local name, family, habitat, constituents, and ethnomedicinal use.

Fig. 11.1 Edible medicinal plants of Western Himalaya

11.2 Phytogeographical Distribution

Phytogeographic point of view, Western Himalaya region is comprises with the Indian states Jammu & Kashmir, Ladakh and Himachal Pradesh. This chapter intended to study the wide range of plant reserves in Jammu and Kashmir region exploited by native tribes for curative properties against numerous disorders and their socio-economical aspect. Jammu, Kashmir valley, and Ladakh union territories in the Western Himalayas cover a region of 2, 22,236 km^2, which is 6.76% of the geographical area of the country. Its elevation varies from 327 to 8611 meters to the sea level (Sharma et al. 2012a, b). Commonly referred as Terrestrial Paradise on Earth (Malik et al. 2011), the valleys of the Himalayas in Kashmir is furtherdistributed into 10 districts with a total region 15,948 km^2, formed by the rope chain of Pir Panchal Mountains of the Lesser Himalayas in the south, Zanskar range in to the south east and Western part of the Greater Himalaya (Dar and Khuroo 2013). The vegetation and species of forest can be classified into 4 groups: alpine

Table 11.1 Phytochemical constituents and traditional uses of Western Himalayan medicinal plants

S. No	Name of Plant with Family	Major Chemical Constituents	Traditional Uses	References
1	*Abies pindrow* (Pinaceae)	**Triterpenoid (pindrolactone)**: Ianosta-7,9(11)-dienes **flavonoids (chalcones)**: Okanin, Okanin-4′-b-d-glucopyranoside, Butein-4′-b-d-glucopyranoside, 2′,3′,4′,3,4-Pentahydroxychalcone-4′-1-arabinofuranosyla-1,4-b-d-glucopyranosid**carbohydrate**: Tricosane, Eicosane, Heneiocosane, Docosane, Tetracosane, Nonadecane, Octadecane, 1-Docosene, Heptadecane, 1-Octadecene, Tetramethylhexadecane **Fatty acids**: n-Tetradecanoic acid, 14-methyl-hexadecanoic acid, n-Pentadecanoid acid, 14-methyl-hexadecanoid acid, 16-methyl-heptadecanoic acid, Cis-9 Octadecenoic acid, 5,9-Octadecadienoic acid, Cyclopentane Undecenoic acid, 17-methyl-octadecanoid acid, Docosanoic acid, Tetracosoic acid. **Other**: Pinitol	Antidiabetic, antiulcerogenic, anti-inflammatory, analgesic, antispasmodic, remedy for fever, asthma, bronchitis, carminative, expectorant, cough, bronchitis, headache, hypoglycemic activity, increases appetite, dyspepsia	(Majeed et al. (2013); Sinha (2019); Singh et al. (2000)
2	*Achillea millefolium* (Asteraceae)	**Flavonoids**: Cynaroside, cosmosiin, casticin, centaureidin, apigenin, luteolin, artemetin, rutin, 1,8-cineole, quercetin, artemetin **Phenols**: Thymol, carvacrol, caffeic acid, salicylic acid, pyrocatechol,	Spasmodic gastrointestinal disorders, hepatobiliary, gynecological disorders, anti-inflammatory, wound healing, gastric problems, fever, hemorrhoids, diuretic, sedative, appetite enhancer, skin inflammation, diaphoretic,	Akram (2013); Ali et al. (2017)

		chlorogenic acid **Sesquiterpenoids:** Achimillic acids A, B, and C. **Oxygenated monoterpenes**: Camphor, borneol **Hydrocarbon monoterpenes**: Camphene, limonene, α-pinene, β-pinene, **Oxygenated sesquiterpenes**: Bisabolol, **Sesquiterpene hydrocarbon--s**: Germacrene-D, **Prozaulenes**: Chamazulene.	gastritis, diarrhoea, stop bledding, snake bite, tuberculosis.	
3	*Aconitum ferox (Ranunculaceae)*	**Alkaloids -** Aconitine, Pseudoaconitine, Chasmaconitine, Indaconitine, Hypoaconitine, Mesoaconitine, etc. **Flavanoids-** Clovin, robinin **Free fatty acids**	Body pain, diabetes, debility, asthma, ear and nose discharge, leprosy, Paralysis, rheumatism, and typhoid. Diaphoretic, diuretic, expectorant, Febrifuge, and dyspepsia.	Deore et al. (2013); Tamilselvan et al. (2014)
4	*Aconitum heterophyllum (Ranunculaceae)*	**Alkaloids –** Diterpenoid, **Flavonoids -** kaempferol and quercetin, phenylpropanoids, phenolics, and acids, **Terpenoids -** atisenol, Steroids, free fatty acids (FFAs), and polysaccharides	Expectorant, anti-inflammatory, diuretic, hepatoprotective, antipyretic and analgesic, antioxidant, alexipharmic, Anodyne, anti-atrabilious, anti-flatulent, anti-periodic, Anti-phlegmatic, and carminative propertet aies.	Paramanick et al. (2017); Yin et al. (2019)
5	*Arnebia benthamii (Boraginaceae)*	**Naphthaquinones** - Acetylalkannin, β, β- dimethylacrylalkannin, β-hydroxyisovalerylalkannin, **Benzoquinones**,	Free radical scavenging activity, antioxidant and cytotoxic activity, antimicrobial activity, hepatotoxic activity, antiseptic, antibacterial,	Hosseini et al. (2018)

(continued)

Table 11.1 (continued)

S. No	Name of Plant with Family	Major Chemical Constituents	Traditional Uses	References
		Alkaloids, **triterpenoids, steroids, and flavonoids**. **Essential oil**- Arnebinus. **Others-** artemidiol, hoslundal, shinkonin, ganoderiol, and 2-hexaprenyl-6-hydroxyphenol	antifungal and anti-inflammatory, diuretic and expectorant	
6	*Artemisia annua L. (Asteraceae)*	**Sesquiterpenoid artemisinin -** artesunate, artemether, arteether **Flavonoids-** artemetin, rutin, quercetin, casticin, eupatin, luteolin and their glucosides **Coumarins-** scopoletin **Essential oils-** cineole, camphene, a-pinene, germacrene, camphor, and ketone. **Others –** Phenolic acids, polysaccharides, and saponins, Phytosterols, potassium, selenium, gallium, bicarbonates, and nitrates.	Antihemorrhage, diarrhea, anemia, damp summer heat with nausea, intense fever, stifling sensation in chest, malaria, asthma, eye infections, bronchitis and sore throat, cholera, dengue fever, lupus erythematosus, Athlete's foot and eczema, Chagas disease, Schistosomiasis, viral hepatitis, chills and fever, skin disease, parasitic disease.	Koul et al. (2017); Mesa et al. (2015)
7	*Artemisia dracunculus L. (Asteraceae)*	**Flavonoids -** 5,6,7,8, 40 pentahydroxymethoflavone estragoniside 7-O-β-D-glycopyranoside 5,7-dihydroxyflavavone pinocembrin, 7-O-β-D-glucopyranoside, luteolin, quercetin, rutin, kaempferol, annangenin 5,7-dihydroxyflavone, naringenin, 3,5,40 trihydroxy-7-methoxyflavanone, 3,5,4 -trihydroxy-	Improve a malfunctioning digestive system by increasing appetite, to flush toxins from the body, and as a digestive stimulant, insomnia, anesthetic for aching teeth, sores, and cuts. Antiepileptic, laxative, antispasmodic, and carminative remedy	Aglarova et al. (2008)

		7,30-dimethoxyflavanone 20,40 -dihydroxy-4-methoxydihydrochalcone davidigenin sakuranetin **Phenylpropanoids-** chicoric acid, hydroxybenzoic acid (E)-2-hydroxy-4-methoxycinnamic chlorogenic acid caffeic acid 5-O-caffeoylquinic acid 4,5-di-O-caffeoylquinic acid. **Chromones/coumarins-** (−)-(R)-20-methoxydihydro-artemidin, (+)-(S,R)-epoxyartemidin dracumerin, (+)-(R)-(E)-30-hydroxyartemidin, capillarin isovalerate, 7,8-methylenedioxy-6-methoxycoumarin γ,γ-dimethylallyl ether of esculetin, scopoletin, scoparone, daphnetin methylene ether, daphnetin 7-methyl ether, artemidiol **Alkamides**- pellitorine, neopellitorine A, neopellitorine B		
8	*Asparagus racemosus (Liliaceae)*	**Isoflavones, polysaccharides, and Steroidal saponins-** Shatavarin I-IV, **Others-** 8-methoxy-5, 6, 4′-trihydroxyisoflavone 7-O-beta-D-glucopyranoside. Asparagamine, Racemosol, 9, 10-dihydrophenanthrene), Shatavaroside, Secoisolariciresinol Shatavari	**Roots-**Galactagogue, estrogenic, Antioxytoxin Immunomodulators, Antidyspepsia, Antiallergic, anticancer, Anti-inflammatory, antidiabetic, antioxidant, antitussive, Hepatoprotective, antibacterial, antiulcer, anti-diarrheal, Antilithiatic **Leaves-**cholinesterase, Antiparasitic. **Shoots-**Antiinflamatory, antidiabetic,	Alok et al. (2013); Singh et al. (2018)

(continued)

Table 11.1 (continued)

S. No	Name of Plant with Family	Major Chemical Constituents	Traditional Uses	References
			and diuretic. Whole plant-antimicrobial and cytotoxic, Nephroprotective, Hepatoprotective **Aerial parts** urolithiasis, Hypolipedimic, Antiasthmatic, and Antifertility **Seeds**-Antiparasitic **Flower**-diuretic	
9	*Bergenia ciliata* (Saxifragaceae)	**Phenol**: Bergenin, tannic acid, gallic acid, catechin, Alcohol: **Volatile organic compound**: Glucoside-2-pentanone, 2,4-dimethyl-3-pentanone, hexanal, 2-methyl-1-propanol, acetic acid, hexanol, **Terpenoids**: Camphor, limonene, linalool, β-phellandrene, α-terpineol, β-caryophyllene. **Fatty acids**: Decanoic acid, nonanoic acid methyl ester, 2-methyl butanoic acid. **Sterol**: β-sitosterol, **Glycosides**: Arbutin, Leucoanthocyanidin-4-(2-galloyl) **Flavonoids**: Afxelechin, quercetin-3-o-β-D-xylopyranoside, quercetin-3-o-α-L-arbinofuranoxide glycosides, **Carboxylic acids**: Pentanoic acid,	Gastrointestinal, skin diseases, renal/urinary disorders, muscular/skeletal disorders, respiratory diseases, fever, eye diseases, oral infections, worm infections, gynecological disorders, ENT, fever, cancer, stomach diseases, kidney stone	Ahmad et al. (2018); Kumar and Tyagi (2013); Yousaf et al. (2018)

		hexanoic acid, hexalactone, **Nitro compounds**: 2-notropropane		
10	*Bunium persicum* (Apiaceae)	**Essential oil:** Hydrocarbon monoterpenes, oxygenated monoterpenes, sesquiterpenes: γ-terpinene, cuminaldehyde, α-terpinene-7-al, caryophyllene, γ-terpinene-7-al, p-cymene, limonene, β-pinene, α-terpinene, camphor, terpinolene, cumin alcohol, 2-carene-10-al. **Carbohydrates**: Glucose, fructose, mannitol, sucrose, raffinose, pectin, hemicellulose. **Fatty acids**: Linoleic acid, octadecanoic acid, palmitic acid, petroselinic acid, 8,11,14-eicosatrienoic acid. **Phenolic compounds**: Caffeic acid, p-coumaric acid. **Flavonoids**: Kaempferol **Others:** Caryophyllene, gamma-terpene, cuminyl acetate, cuminaldehdye, gamma-terpene-7-al, trans-3-caren-2-ol, acetic acid, methatriene, p-cymene, cuminyl acetate, limonene.	Stimulant, carminatives, remedy for abdominal and colic pain, joint pain, tuberculosis, hiccup, hemorrhoids, antidiarrheal, dyspepsia, stomachache, fever, cold, headache, flatulence, heart problems, asthma, abdominal pain, diuretic, anticonvulsant, liver and kidney tonic, antihelmintic, toothache, eye diseases.	Bashir et al. (2014); Majidi et al. (2020); Shah et al. (2019)
11	*Costus speciosus* (Zingiberaceae)	**Saponins -** sapogenin, diosgenin, steroids, tigogenin**alkaloids**, sitosterol-β-D-glucoside, dioscin, α-tocopherol, 5α-stigmast-9(11)-en-	Antidiabetic activity, Hypolipidemic activity, hepatoprotective, antifertility, antioxidant activity, and antifungal	Bahshwan and Aljehany (2020); Pawar and Pawar (2014); Srivastava et al. (2011)

(continued)

Table 11.1 (continued)

S. No	Name of Plant with Family	Major Chemical Constituents	Traditional Uses	References
		3β-ol, prosapogenins A and B of dioscin, quinones, curcumin, gracillin, tricontanol, and tricontanoic acids, **acids-** oleic acid, linoleic acid, palmitic acid, stearic acid, and arachidic acid **Quinines-** dihyrophytilplastoquinone and its methyl derivatives including α-tocopherol quinone.**Sesquiterpene-** costunolide	activity. Various traditional uses are in rheumatism, Bronchial asthma, leprosy, and cardiotonic.	
12	*Curculigo orchioides (Amaryllidaceae)*	**Saponins –** Curculigenin A,B,C,K,L, **Mphenolic compounds-** Curculigol, Curculigoside A,B, C, E & D, Xylopyranosyl-B-glyconoside, 25-Hydroxy-33-methyl pentatriconta-6-one, Orchioside A & B, 2,6-dimethoxy benzoic acid **Esters-** n-decan-3-olyl pent-3′-en-1′-oate, n-hexadec-9, 11-dienyl cinnamate, n-tridecanyl-hex-2′, 4′-dien-1′-oate, n-heneitriacont-13-en-5, 10 diol, hex-2′-en-1-oate	Adaptive activity, Immunostimulatory effect, Antiosteoporotic activity, vasoconstrictor activity, taste-modifying and sweet-tasting activities, estrogenic activity and the effect on sexual behavior, antioxidant activity, mast cell stabilization, antihistaminic activities and antiasthmatic activity, Hepatoprotective activity, neuroprotective effect, antibacterial activity, anti-inflammatory activity	Chauhan (2010); Kumari and Singh (2017); Nie et al. (2013)
13	*Curcuma zedoaria* (Zingiberaceae)	**Phenolic compounds –** Curzerenone, 1,8 cineole, Germacrone, cymene, a-Phellandrene, b-Eudesmol **Terpenes-** monoterpene hydrocarbon, oxygenated monoterpene, Sesquiterpene hydrocarbon, oxygenated sesquiterpene	Antiangiogenic activity, Antitumor activity, hypoglycemic activity, anti-gingivitis activity, Anti-inflammatory activity, activity, antifungal activity, insecticidal effect, Larvicidal effect. Antioxidant acitivity.	Dosoky and Setzer (2018); Lobo et al. (2009)

		Volatile oil- Epicurzerenone, Curzerene		
14	*Digitalis purpurea* (Plantaginaceae)	**Cardenolides:** Aglycone digitoxigenin, aglycone gitoxigenin, gitoxin, gitaloxigenin, glucogitaloxin, glucoverodoxin, diginin, digitalonin, digipurpurin	Used to treat ulcers, headaches, paralysis, boils, abscesses, external wounds. And it is also a life-saving cardiac drug.	Al-Snafi (2017)
15	*Ephedra geradiana* wall. (Ephedraceae)	**Alkaloids:** Ephedradine A,B,C,D, pseudoephedrine, norephedrine, methylephedrine, transtorine, kynurenic acid, ephedralone. **Flavonoids:** Herbacetin, kaempferol, quercetin, rutin, pollenitin, dihydroquercetin, catechin, epicatechin, hesperidin, tricin, luteolin, vitexin. **Tannins:** Ephedrannin **Lignans:** Syringaresinol, Sesquipinsapol B **Esters:** Ethyl caprylate **Phenolic acids:** Nebrodenside A, B, syringing, vanillic acid, caffeic acid, chlorogenic acid, physcion, rhein.	Hay fever, rheumatism, asthma, rashes originating out of allergy	Anonymous (1989); Zhang et al. (2018)
16	*Gloriosa superba* (Colchicaceae)	Conigerine, cholidonic acid, 3-demethyl colchicines, luteolin and its glucosides, lumicolchicine, colchicines, β-sitosterol.	Abortifacient, antipyretic, cure STD's, anthelmintic, expectorant, emetic, purgative, stomachic, treats dyspepsia, debility, hemorrhoids, anti-rheumatic, anti-asthamatic	Kavina et al. (2011)
17	*Hedychium spicatum* (Zingiberaceae)	α-Pinene, 1,8-cineole, 2-alkanones, linalool, camphor, limonene, β-pinene, linalyl acetate, γ-cadinene, terpinolene, benzyl cinnamate, lindylacetate, methyl	Anti-microbial, laxative, stimulant, stomachic, vasodilator, expectorant, emmenogogue, carminative, anti-pyretic, diarrhea, indigestion, asthma,	Sravani and Padmaa (2011)

(continued)

Table 11.1 (continued)

S. No	Name of Plant with Family	Major Chemical Constituents	Traditional Uses	References
		paracumarin acetate, β-phellandrene, p-cymene, d-sabinene, spicatanoic acid, spictanol, spicatanolmethyl ether.	bronchitis, used as a dye and in female impotency.	
18	*Hippophae rhamnoides* (Elaeagnaceae)	Oleanolic acid, 19-α-hydroxyursolic acid, 5-hydroxymethyl-2-furancarboxaldehyde, octacosanoic acid, 1-O-hexadecanolenin, ursolic acid, dulcioic acid, cirsiumaldehyde, palmitic acid.	Digestive tonic, abdominal dysfunctions, amenorrhea, expectorant, cough suppressant, anti-inflammatory, herbal remedy for ulcers, eczema, vulvitis, colon ulcers, trophic ulcers, wounds, colpitis, proctitis, anti-microbial, heral treatment for influenza	Panossian and Wagner (2013)
19	*Juglans regia* (Juglandaceae)	**Phenolic compounds:** Gallic acid, syringic acid, ellagic acid, caffeic acid, ferulic acid, p-coumaric acid, sinapic acid **Tannins:** Glansrins A, B, and C, stenophyllarin, casuarinin **Diarylheptanoides:** Juglanin A,B,C, sclerone Hydrocinnamic acid, palmitic acid, oleic acid, stearic acid, erucic acid, mono and polyunsaturated fatty acids.	Used for hyperhidrosis, ulcers, diarrhea, anti-microbial, astringent, chemoprotective, dysentery, aphrodisiac, brain tonic, constipation, wound healing property, arthritis, toothaches, skin diseases.	Al-Snafi (2018)
20	*Junipers communis* (Cupressaceae)	**Flavonoids:** Rutin, apigenin, luteolin, quercitrin, nepetin, scutellarein, bilobetin, bioflavones **Volatile oil:** α-pinene, myrcene, limonene, myrcene, glycolic acid, camphene, β-pinene, dihydrojunene, cadinene, camphor	Used as carminative, diuretic, digestive, anti-inflammatory, sudorific, emmenagogue, urinary antiseptic, stimulant. Used for rheumatism, infantile tuberculosis, piles, nephritic dropsy, gonorrhea, asthma, cough, chronic pyelonephritis, skin disorders.	Bais et al. (2014)

		Coumarins: Umbelliferone **Bicyclic Diterpenes:** Isocupressic acid, junicedral, imbricatolic acid, lignin deoxypodophyllotoxin, aryltetralin, 7α-hydroxysandaracopimaric acid.		
21	*Leucas aspera* (Lamiaceae)	Oleanolic acid, 3-sitosterol, ursolic acid, galactose, leucasperones A, B, maslinic acid, asperphetamate, nectandrin B, linifolioside, acacetin, macelignan, apigenin, chrysoeriol, u-farnesene, x-thujene, menthol, isoamyl propionate, linoleic acid, palmitic acid, oleic acid, linolenic acid, 3-ceryl alcohol, 3-sitosterol	Diaphoretic, stimulant, laxative, stimulant. Treats asthma, bronchitis, jaundice, dyspepsia, psoriasis, scabies, cough, cold, anti-malarial, anti-pyretic	Das et al. (2012a, b)
22	*Meconopsis aculeata* (Papaveraceae)	Phenols, phlobatannins, phytosterols, terpenoids, flavonoids, cardiac glycosides, alkaloids, carbohydrates.	Narcotic, febrifuge, analgesic, anti-inflammatory, cooling potency	Ahmad et al. (2016)
23	*Nardostachys jatamansi* (Valerianaceae)	Jatamansone, angelicin, alpha-patcho-ulense, β-atchoulense, β-eudesemo, β-sitosterol, elemol, calarene, n-hexaco-sanyl, oroselol, jatamansone, jatamansinol, valeranal, patchouli alcohol, nardostachone, seychelane, valeranal, valeranone, nardostachnol	Induces sleep, brain tonic, rejuvenative to the mind, digestive, alleviates mental dysfunctions, ceases burning sensations, stimulates hair growth, benefits complextion.	Purnima et al. (2015)
24	*Ocimum basilicum* L. (Lamiaceae)	**Monoterpene hydrocarbons:** Camphene, limonene, myrcene, sabinene, thujene, borneol, camphor, carvacrol, estragol, eugenol, fenchone, geraniol, linalool, nerol. **Sesquiterpene hydrocarbons:** Cadinene, germacrene A,B,D,	Treats cough, constipation, headache, diarrhea, kidney disorders, warts.	Sarfaraz and Faizal (2011)

(continued)

Table 11.1 (continued)

S. No	Name of Plant with Family	Major Chemical Constituents	Traditional Uses	References
		isoledene,δ-selinene, valencene **Triterpene:** Betulin, alphitolic acid, pomolic acid, oleonolic acid, ursolic acid, basilol, ocimol. **Flavonoids:** Quercetin, isoquercetin, kaempferol, rutin. **Polyphenols:** Rosamarinic acid, chicoric acid		
25	*Panax pseudoginseng* (Araliaceae)	**Saponins:** Prosapogenins, prosapgenin, ginsenosides, aglycones, 3-dammarane saponins. **Polysaccharides:** Poly furanosyl-pyranosylsaccharides, quinquefolans A, B,C **Others:** Polyacetylenes, Panaxydol, panaxynol, kaempferols.	Promotes vitality, improve physical performance, enhances resistance towards aging and stress, and causes immunomodulation.	Kim (2012)
26	*Picrorhiza kurroa* (Plantaginaceae)	**Iridoid glycosides**: Picroside I, II, III, IV, cucurbitacins (B,D,R), kutkoside **Flavonoids**: Vanilic acid **Carbohydrates**: D-mannitol Aromatic acids: Vanillic acid, cinnamic acid, ferulic acid **Others**: Veronicoside, 4-hydroxy-3-methoxy acetophenone, pikuroside, drosin, apocyanin	Stomachaches, antipyretic, to cure colds and cough issues, diarrhea, jaundice, dysentery, hepatic injuries, eye, blood, lung, metabolic disorders.	Arya et al. (2013); Kumar et al. (2013); Mulliken (2000); Salma et al. (2017); Sharma et al. (2012a, b)
27	*Piper longum* (Piperaceae)	**Alkaloids**: Piperine, piperlonguminine, piperlongumine, dehydropipernonaline, cepharadione A, norcepharadione A,	The long and pungent flavored pepper helps in provoking phlegm. Also it has potential to increase semen. It also is	Das et al. (2012a, b); Dutta et al. (1975); Liu et al. (2009); Mustafa et al. (2010); Varughese et al. (2016)

		cepharanone B, aristolactam AII, tetrahydropiperine, piperolactam A, tumerone, aphanamol, coumaperine, demethoxycurcumin, bisdemethoxycucurmin, pipercide, pellitorin, retrofractamide C, guineesine, piperloein B, dehydrofractamide C, pipyahyine **Lignans**: Sylvatin, diaeudesmin, sesamin **Essential oils**: α-pinene, myrcene, limonene, sabinene, δ-3-carene, a-copaene, 6-elemene, p-caryophyllene, o-elemene, 9-octadecene, 6-cadinene, p-selinene, caryophyllene oxide, eucalyptol, trans-ocimene, terpinyl acetate, heptadecane, β-phellandrene, δ-cadinol. **Flavonoids**: Luteolin, catechin, quercetin, kaempferol, naringenin, apigenin, epicatechin, myricetin. Amides: Sarmentine	used as antidote for hemlock and serves in people suffering from suffocation. It is capable of serving as a stimulating tonic. Its medicinal properties help in treating digestive ailments. It also serves as an important medicine in bronchitis, rheumatism, fever, leprosy, parasitic infections, and spleen dysfunctions.	
28	*Plantago ovata* (Plantaginaceae)	**Carbohydrates**: Glucose, xylose, fructose, rhamnose, sucrose, planteose, arabinose, galacturonic acid, galactose, raffinose, stachyose, galactoarabinan, galactan, plantaglucide, glucomannan **Lipids**: Arachidic acid, 9-hydroxy-cis-11-octadecenoic acid, palmitic acid, triterpene acids, oleanolic acid, ursolic acid **Alkaloids**: Indicain, plantagonin	Hypnotic, stimulant, in toothaches, antihelmintic, antimalaria, as an antidote to snake poison, as an anti-tumor agent, ailing skin burns, acne, bee stings, bruises, leishmaniasis, dermatitis, emollient, for pulmonary diseases, dysentery, urinary tract infections, diuretic, stimulant.	Ahmad et al. (1980); Bakker et al. (1998); Yokozawa et al. (1997); Yuting et al. (1990)

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Table 11.1 (continued)

S. No	Name of Plant with Family	Major Chemical Constituents	Traditional Uses	References
		Caffeic acid derivatives: Ethyl and methyl esters of caffeic acid, chlorogenic acid, neochlorogenic acid, plantamajoside, plantamajoside, acteoside **Flavonoids**: Luteoin-7-glucoside, hispidulin-7-glucuronide, luteolin-7-diglucoside, apigeni-7-glucoside, luteolin-6-hydroxy-4′-methoxy-7-galactoside, plantaginin, homoplantaginin, baicalein, hispidulin Iridoidglycosides: Asperuloside, aucubin, catapol, gardoside, geniposidic acid, majoroside, 10-actoxymajoroside, 10-hydroxymajoroside, melittoside Terpenoids: Glycyrrhetinic acid, sitosterol		
29	*Podophyllum hexandrum* (Berberidaceae)	Podophyllotoxin, podophyllin, lignans, epipodophyllotoxin, aryltetrahydronaphthalene lignans, podophyllotoxone **Flavonoids**: Quercetin, quercetin-3-glycoside, kaempferol, podophyllotoxin glycoside, kaempferol-3-glucoside **Lignans**: 4′-demethyl podophyllotoxin, podophyllotoxin-4-O-glucoside	Resin: Purgative, tumor necrotizing property. Roots, rhizomes and fruits: Anti-cancer, for treatment of ulcers, skin wounds and cuts, hepatic dysfunction, TB and gastric related issues. Whole plant: Cholagogue, cytostatic. For treatment of neoplasms and skin warty lesions, dermatological infections, inflammatory conditions of skin. Anti-malarial, anti-fungal and	Haddadian et al. (2014); Kamil and Dewick (1986); Sarfraz et al. (2017)

			anti-pyretic activities. Roots: Anti-rheumatic.	
30	*Potentilla fulgens* (Rosaceae)	**Triterpenoids:** Fulgic acid A, Fulgic acid B **Polyphenolic compounds**: Afzelechin, Epiafzelechin, catechin, epigallocatechin, epicatechin, epigallocatechin, catechin (4α-8) epicatechin, afzelechin (4β-8), epicatechin, epiafzelechin (4β-8) epicatechin **Phenolic compounds**: Ellagic acid, kaempferol, quercetin	Anti-diarrheal property. Used to treat high blood pressure. Astringent and tonic. Roots are used for wound treatment. Stomachic and aphthae. Some regions use it for curing peptic ulcer	Bhattari (1993); Choudhary et al. (2017); Rosangkima et al. (2010)
31	*Rheum emodi* (Polygonaceae)	**Anthraquinones with carboxyl group**: Rhein **Anthraquinones without carboxyl group**: Aloe-emodin, emodin, chrysophanol, physcion, emodin glycoside, chrysophanein **Alkyl derivatives of anthraquinones**: 6- methyl aloe emodin, 6-methyl rhein **Anthrone-C-glucosides**: 10-hydroxycascaroside D, 10-hydroxycascaroside C, cascaroside D, cascaroside C, 10R-chrysaolin-1-O-β-D-glucopyranoside, cassialoin. Tannins and condensed tannins Flavone derivatives: Catechin, leucocyanidin	Purgative, stomachic, astringent, diuretic, emmenagogue, aperients. Root: Expectorant, appetizer. Anti-inflammatory, alexentric, anti-dysentry	Aslam et al. (2012); Malik et al. (2010); Ye et al. (2007)

(continued)

Table 11.1 (continued)

S. No	Name of Plant with Family	Major Chemical Constituents	Traditional Uses	References
32	*Rubia cordifolia* (Rubiaceae)	Glycosides: 1-hydroxy-2-methoxy anthraquinone, rubiadin, 3-dimethoxy-2-carboxy anthraquinone, ruiearbonls, rubiprasin A,B,C Triterpenoids: Aborane triterpenoids Mangistin, alizarin, mollugin, furomollugin, garancin. Anthraquinones: Purpurin, pseudopurpurin, munjistin New anthraquinones: 2-hydroxy-6-methyl anthraquinone, 1-hydroxy-2,7-dimethyl anthraquinone, 1-hydroxy-2-methyl anthraquinone, 2,6-dihydroxy anthraquinone, physcion, nordamnacanthal, 1,4-dihydroxy-2-methyl anthraquinone, 1,4-dihydroxy-6-methyl anthraquinone, 1,5-dihydroxy-2-methyl anthraquinone, 1,4-napthoquinone, 3-prenyl methoxy-1,4-napthouinone, rubiadin Anthracene derivatives: Rubiasins A-C	Ailing skin diseases as well as in the disorders related to the spleen, healing major skin burns, fractured bones and ulcers, antitussive, antipyretic, protective effect against hemorrhages, abnormal uterine bleeding, rheumatism, bronchitis, kidney and gall bladder stones, dysentery, styptic, diuretic, expectorant and astringent.	Kannan et al. (2009); Pandey et al. (2007)
33	*Saussurea costus* (Asteraceae)	**Terpenes:** Costunolide, Dihydrocostunolids, Dihydrocostus lactone, Dehydrocostus lactone, 12-methoxy dihydrocostus lactone, α-cycloCostunolide, β-cycloCostunolide, Lappadilactones, β-hydroxyDehydrocostus, Cynaropicrin, Betulinic acid, Betulinic	Antispasmodic activity, asthmatic conditions, skin disorders, cholera, cough remedy, leprosy, ailing stomach issues, typhoid fever, snake repellent, for insence purposes.	Pandey et al. (2007)

		acid methyl ester, Mokko lactone, Saussureal **Sesquiterpenoids and its dihydro derivatives:** β-sitosterol, 12-methoxy dihydroCostunolide, aplotoxin, costol, α and β-costenes, betulin, stigmasterol, Costusic acid, β-elemence. Other constituents also contain flavonoids glycosides, and glucofructans.		

sub-alpine zone, temperate coniferous forest, and moderately broad-leaved forests. Work has been conducted on several tribes such as Gujjar, Bakarwal, Kashmiri, Pahari, and Boto in western region of Himalayas in India (Champion and Seth 1968; Singh and Bedi 2017).

11.2.1 Forest Collection Season

Collection of plants from forests that are edible varies from the month of May to August, being suitable for juvenile leaves, roots, and tubers; and from the month of August to October being suitable for the fruits and seeds. During cold season, the plants mostly perish owing to the heavy snow-fall in high elevation areas; hence, the natives dry edible parts and store them for their consumption during the wintertime.

11.3 Economic Significance of Wild Edible Plants

Over the past four-five decade studies, established the wild florae consumed by tribals happen to provide a suitable source of low cost nutrient content and herbal medicines, still demand popularization and recommendation for marketing purpose (Murugkar and Susbulakhmi 2005; Maikhuri 1991). It has been established that edibles from wild play a significant part in the rural progress in the central Mountains of Himalaya. People settled in the high altitude areas have restricted opportunities to earn money for their day-to-day necessities, due to low agricultural and industrial growth, poverty, and unemployment, majority of peoples are sidelined and survive on existence level (Rakesh et al. 2004). Ladakh plateau and Gilgit district of Kashmir, areas are characterized by mild summer to severely cold winter. The average annual temperature is 8 °C and annual rainfall is less than 150 mm. (Singh 2006). In the central part of west-Himalayas, florae is the primary basis of economy and health security. Nevertheless, the knowledge about traditional usage of plants as medications from the central parts of west-Himalaya such as Chhota Bhangal has not been acknowledged yet. It is pristine area with around 3500 plants described, out of which 500 plants are supposed to be of medicinal value (Chowdhery 1992). Chhota Bhangal is rich in moist temperate forests of Himalaya with some of *Quercus* species being dominant. Whereas, dry temperate forests of Himalaya lead with *Cedrus deodara* combined with certain additional species of trees like *Abies pindrow*, *Betula utilis, Picea smithiana,* and *Rhododendron campanulatum* forming the tree line. This area is also rich with canopy layer, viz. *Berberis lycium*, *Viburnum nervosum,* and *Prinsepia utilis*. Bhangalis represent a tribal community of this areafollow the religion of Hinduism and are extremely fearful of God. Owing to isolation and shortage of modern-day health amenitiesdependency by local tribes on florae for treatment is extremely elevated (Uniyal et al. 2006). *Podophyllum hexandrum* is an endangered species and export of parts and derivatives of plant are prohibited from India under CITES except for the formulation based products. However, artificially raised species are not prohibited. Existing annual supply is less in comparison to 50–80 tonnes in 1970 and approximated rate per kg is Rs 60. Owing to growing marketable requirement for PPT, abstraction of *P. hexandrum* has adversely disturbed its wild inhabitants over the previous 20 years (Gupta and Dutta 2011; Lv and Xu 2011). The dried root of *Saussurea costus* was available as wild plant since 1920s. Its dried roots present value is Rs 150 per kg. Indian market required approximated 100–200 MT annually. Conversely, international market is even in larger demand. This is presented as an extremely economically potential crop in Western Himalaya. Phytoconstituents and traditional uses of some important plants of western Himalayan are tabulated under Table 11.1.

11.4 Conclusion

This chapter deduces that various parts of the wild plants are exploited as food and medication by the tribes of western Himalaya, which supports their existence. The most commonly exploited parts comprise stems, leaves, tubers, and fruits. Appropriate conservation and harvesting methods if employed for wild plants in this region might be the basis of extra revenue for the residents. Amid increasing requirement for bioceuticals of natural origin, wild plants that are edible have fascinated worldwide attention as they can act as a source of several micronutrients and active pharmacological ingredients. However, owing to steadfast revolution and urbanization, the conventional knowledge on the usage of plants is endangered. Consequently, there is a critical requirement to manuscript the conventional information allied with a specific tribe or else such customs and ethnic information would be vanished persistently. The efforts of tribal populations to safeguard must be acknowledged and both on-site and off-site conservation of critical documented plant species of wild origin must be rejuvenated.

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Cultural, Practical, and Economic Value of Edible Plants Used by Mizo Tribes of Mizoram

12

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Abstract

Plant resources occupy an important role in societies and have facilitated in improving the lives of people since the early days. Mizoram is an abode with a variety of resources including plants. The state's populace comprises of a few ethnic clans who are either socially or semantically connected. These ethnic gatherings are aggregately known as Mizos. They are the mongoloid racial stock who communicate in the Mizo language and has a place with the Sino-Tibet-Burman gathering. Reckoning the use and tradition of the perspective of plant knowledge tends to provide an insight into the cultural and practical magnitude of plant resources. We develop techniques in ethnobotany and human sciences to build up another approach to esteem plant species along with three measurements: social, down to earth, and monetary. Different overviews and observational information on the utilization of eatable plants by the Mizo Clans of Mizoram show a connection between's reasonable and the social estimations of the species. Lists of social, functional, and monetary worth measure various components of the significance of plant species to society. Protection, use, and practical advancement of plant assets are of principal significance concerning the customary information framework. The ethnomedicinal plants assume a significant part among the ancestral and provincial individuals in their custom. The indigenous arrangement of treatment dependent on eatable plants frames a significant segment in Mizo public activity, culture, and medical

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care. This huge conventional information on the indigenous individuals has been given verbally from age to age with no appropriate documentation. In this communication, we further reemphasized the relationship between traditional culture and the use of plants by Mizo communities and their impact on their social activities as well as in their health care. The need to preserve the traditional practice and the value it has in society, in general, is also being highlighted.

Keywords

Mizo · Cultural · Practical · Economic · Edible plants

12.1 Introduction

Several studies in the domain of ethnobotany and ethnopharmacology underline the significance of phytotherapy for people across the world (Kujawska et al. 2017). The use of herbals is most prevalent and considered the primitive form of treatment. Approximately two billion people (34% of the population at the end of the twentieth century) of the world depend on plants for the treatment of illness (Lambert et al. 1997). However, there is a deficiency in the precise estimations about the use of plants by indigenous people throughout the world (Pouliot 2011). Quantifying the use and tradition of the potential of plant knowledge can provide an insight into the cultural and practical magnitude of plant resources. This understanding will signify the recognition of certain species as effective, acceptable, and reported with major frequency. Apart from the compilation of a list of useful plants there exist a close relationship between the cultural activities of the people and the plants around their vicinity. In a highly bio-diverse region of the globe, the use of plants often tends to differ depending on the ethnic group of the population. It also often occurs that certain migrants, who happen to settle in a remote area, tend to adapt to local circumstances and integrate native plants for treating disease and also for day to practical applications. So in another way, the availability of certain or specific flora drives the functionality of its use.

Plants play a vital role in societies and have facilitated in improving the lives of people since ancient times. Ancient people become conscious of the worth and charisma of plants in and around them. Early books on the use of plant resources have been found in diverse parts of the world, such as Greece, China, the Middle East, and India, demonstrating that all these ancient societies used native floral resources for the improvement of their lives in own perspectives as per traditions before being shared. So it is fitting to state that the act of the standard sort of medication including plants in India structures probably the most established treatment in human advancement and involves significant duty in reducing well-being related issues (Ravishankar and Shukla 2007). Ayurveda, Siddha, Unani and Yoga, Naturopathy, and Homeopathy are the center plan of the standard Indian act of meds that are utilized for improving numerous illnesses (Gomathi et al. 2020). Every society adopts their conviction of customary practice concerning health and diseases, follows their management methods.

12.2 Geographical Distribution of Medicinal Plants in North-East India

Wild eatable plants allude to fundamental consumable species which are accessible from characteristic territory to defeat lack of healthy sustenance for everyday life necessity and are a valuable endowment of nature to the ethnic networks. In non-industrial nations, the backwoods is the main wellspring of wild nourishments for provincial individuals and woods occupants involve the biggest landmass after horticulture (Balemie and Kebebew 2006; Ratul et al. 2013). Ancestral people group are viewed as backwoods tenants living incongruity with their current circumstance. They rely vigorously upon plants and plant items for food, scrounge, fiber, development of homes, making family unit executes, and so forth a nearby relationship with nature has empowered ancestral individuals to notice and examine the rich verdure around them for building up their customary information and throughout the long term, they have built up a lot of information on the utilization of plants and plant items as homegrown solutions for different infirmities.In North-East India, an aggregate of 450 ancestral networks lives, out of which half are of ethnic networks (Sajem and Gosai 2006), however, the rural item does not give adequate food prerequisite for the ancestral and rustic individuals living in India, by burning-through the different wild eatable plant assets, a general country and ancestral populace can defeat dietary necessity through unusual methods (Singh and Arora 1978). There exists gigantic plant variety in Upper east India. Albeit no information is accessible on the specific number of restorative plants happening in Upper east India, posting 419 types of therapeutic plants from Arunachal Pradesh, 228 species from Assam, 86 species from Manipur, 74 species from Meghalaya, 83 species from Mizoram, 86 species from Nagaland, 73 species from Tripura, and 70 species from Sikkim (Anonymous 2002). The northeastern locale of India is a piece of the Indo-Burma Biodiversity problem area that has rich therapeutic just as a wild eatable assortment of plants having ethnobotanical significance. Mizoram is honored with plenty of bio assets including plants. Society has a special culture and convention. Ethnomedicine is polished for medical care by a few ethnic gatherings occupying the globe and India has large amounts of the indigenous customary information on therapeutic plants since antiquated occasions. This customary information on medical services has been sent starting with one age then onto the next age for a great many years. Local individuals regularly are wary to pass on their indigenous data acquire from their precursors. Their agreement depends on their prerequisites, instinct, reconnaissance, experimentation, and broad encounters. Conventional information includes the way of giving them food security and safe house, custom, and medical care practice.

12.3 Historical and Socio-Economic Importance of Medicinal Plants in Mizoram

Mizoram, the northeastern state of India is no exception when it comes to the practice of the traditional or ancient system of medicine using the available plant assets.The uses of these plants in their day-to-day life as well as in treating various illnesses are significantly depicted as per their culture and customs. A few investigations have created and applied quantitative strategies to ethnobotanical information to test various speculations about the connection between plant species and people (Turner 1988). Studies have created files of social hugeness that catch the significance of plants; these files consider social viewpoints, for example, kinds of employments or taste of eatable plants (Pieroni 2001). Different investigations have proposed the utilization of records that get partially from biological hypothesis and to decide the overall significance of various types of plant families (Begossi 1996; Benz et al. 2004; Phillips 1996). While in an alternate gathering of studies it has assessed the monetary estimation of backwoods products for various ethnic gatherings (Godoy et al. 2002; Hecht et al. 1988). A more thorough valuation of the significance of plant species for human social orders having various methodologies examines are as yet inadequate. As of late, Pieroni (2001) proposed the consideration of social factors, for example, taste, to assess the significance of eatable plants in culture. Even though analysts have joined social and useful elements of plant utilization, we do not have a list that likewise incorporates the financial estimation of plants. The lists to be considered are the social centrality, the viable every day esteem, and the financial estimation of plant species.

Mizoram is one of the eight conditions of North-East India which is situated in the all-encompassing Himalayan reach circumscribed by Myanmar in the East and South, Bangladesh in the West, and Cachar Region of Assam in the North. It is situated between latitudes 21°15′ - 24°35’ N and longitudes 92°15′- 93°29′E, and the all-out topographical territory is 21,081 sq. km. The state primarily involves undulated rocky blue-green variegated geography with the most noteworthy top at 2157 m in the Blue Mountain and least at 20 MASL in Tlabung and the normal stature is around 1000 MASL. The climatic condition goes from soggy tropical to the mid-damp sub-tropical and the higher mild in the eastern edges. The temperature fluctuates from 10 to 24 °C during winter and 21 to 30 °C during summer with weighty precipitation from 2000 to 3500 mm for every annum. Mizo (Duhlian), Hmar, Paite, Pawi, Lai, Mara, Chakma, Bru, Bawm, and Tlanglau are the principal ancestral gatherings of the state. Mizos are mongoloid racial stock and communicate in the Mizo language that has a place with the Sino-Tibet-Burman gathering (Lalramnghinglova 2016). “*Mizo*” alludes to the name of the local occupants and “*Ram*” implies land, so Mizoram signifies “*land of the Mizos.*” These ethnic gatherings are all things considered known as Mizos (*Mi* alludes to the People, *Zo* implies the name of a progenitor; thus Mizo is people of Zo inception). The state has the most elevated ancestral populace (94.43%) and second-most noteworthy education (91.33%) in the nation. Mizos are spread everywhere in the northeastern conditions of India, Burma, and Bangladesh. A per data available, the population of around 52% is covered with government-run health center amenities with meager services. The situation due to its landscape accounts for the underdeveloped communication scheme in the landlocked state. In such a scenario, the rural inhabitants fail to avail or depend on the modern system of treatment and hence rely on traditional practice employing plants. Therefore their belief in nature and the search for natural resources is quite deep-rooted. Their custom, traditional viewpoints are very much intake and can seldom be distracted. The shifting system of agriculture occupies the majority of the economy of the state. No major industries are there so far. Forest resources contribute significantly to the financial status of the State. Farming is the prevalent livelihood in the rural set up with meager income. The use of plants as medicine not only serves benefit for health care but also is an important income generation for the local populace and plays a vital component for the identity of the community.Some of the plants are grown commercially while most of them are collected from natural habitats. Information concerning the harvest, preparation, the know-how about the uses of the plants are unique and are worthy not just for the native communities who are accustomed to the plants, but also for making an effort for export to utilize beyond the native environments. It may also lead to expanding the knowledge spread of the community to the outside world. Indigenous practice or the system is the collective and composite form of comprehensive knowledge, traditions, and expression that remains up hold and planned by native folks enshrined with an extensive account of contact with the niche environment (Anonymous 2003).Every indigenous society across the globe has a well-established form of plant-based traditional practice either for medicine or for specified rituals or day-to-day activities. The know-how of plants for treatment purposes or rituals or culture or tradition is inherent among native ethnic people of Mizoram and carried forward from their grand ancestors by way of verbalism. In the current creation, an exertion has been done to verbalize the employments of wild consumable plants of Mizoram with regard to their convention, social practice, restorative reason, and its depended on an incentive in their composite society in general.

Table 12.1 highlights the list of 272 edible plants spread over 50 genera and 92 families which are commonly used in their society by the ethnic people of Mizoram. Among the authorize plant species, the Leguminosae family turns out to be repetitively spoken to with a sum of 16species, followed by Asteraceae (13), Solanaceae (10), Zingiberaceae (10), Euphorbiaceae (9), Lamiaceae (8), Rubiaceae (8), Mimosaceae (7), Cucurbitaceae (7), Apiaceae (6), Moraceae (6), Acanthaceae (6), Verbenaceae (6), Melastomataceae (5), Meliaceae (5), Bignoniaceae (5), Poaceae (5), Lauraceae (5), Amaranthaceae (5), Araceae (4), Phylanthaceae (4), Brassicaceae (4), Fabaceae (4), Anacardiaceae (4), Apocynaceae (4), Myrtaceae (4), Malvaceae (4),Compositae (3), Caesalpiniaceae (3), Combretaceae (3), Amaryllidaceae (3), Elaeagnaceae (3), Clusiaceae (3), Lythraceae (3), Proteaceae (3),Arecaceae (2), Campanulaceae (2), Gesneriaceae (2), Saxifragaceae (2), Costaceae (2), Urticaceae (2), Dilleniaceae (2), Dioscoreaceae (2), Molluginaceae (2), Araliaceae (2), Papilionaceae (2), Scrophulariaceae (2), Polygonaceae (2), Piperaceae (2), Polypodiaceae (2), Aceraceae (1), Adoxaceae (1),Agavaceae (1),

Table 12.1 List of palatable plants utilized by the ethnic ancestral gathering of Mizoram

SI No.	Scientific name	Local name	Family	Part used
1	*Acmella oleracea* (L.)R.K. Jansen	Ansapui	Compositae	Inflorescence
2	*Acmella paniculata*(wall. Ex DC.) R.K. Jansen	Ansa-te	Compositae	Inflorescence
3	*Acacia concina* DC	Khangthur	Mimosaceae	Leaves
4	*Acacia pennata* (L.) Willd	Khanghu	Leguminosae	Leaves, shoots
5	*Acer laevigatum* wall.	Thingkim	Aceraceae	Leaves
6	*Achyranthes bidentata* Bl.	Vangvat-tur	Amaranthaceae	Leaves
7	*Justicia adhatoda L.*	Kawldawi	Acanthaceae	Leaf, root
8	*Aeschynanthus parviflorus* (D.Don) Spreng	Bawlte-hlan-tai	Gesneriaceae	Flower
9	*Aganope thyrsiflora* (Benth.) Polhill.	Hulhu	Leguminosae	Leaves, shoots
10	*Agave Americana* L.	Saidai	Agavaceae	Leaves, roots
11	*Ageratum conyzoides* L.	Vaihlenhlo	Asteraceae	Leaves, roots
12	*Albizzia chinensis* Osbek. Merr.	Vang	Mimosaceae	Bark
13	*Allium cepa* L.	Purunsen	Amaryllidaceae	Flower
14	*Allium chinense* G. Don.	Purunvar	Amaryllidaceae	Flower
15	*Allium hookerii* Thwaites	Mizo-Purun	Amaryllidaceae	Flower
16	*Alocasia fornicata* (Roxb.) Schott	Baibing	Araceae	Flower bud
17	*Alpinia officinarum* Hance.	Aichhia or dum aidu	Zingiberaceae	Rhizome
18	*Alternanthera sessilis* (L.) R.Br.Ex DC.	Nghateril	Amaranthaceae	Leaves
19	*Alstonia scholaris* R.Br.	Thuamriat	Apocynaceae	Bark, roots, leaves
20	*Amaranthus spinosus* L.	Lenhling	Amaranthaceae	Leaves, shoots
21	*Amaranthus viridis* L.	Lenhlinghlingneilo	Amaranthaceae	Leaves
22	*Amomum dealbatum* Roxb.	Aidu, Aihri	Zingiberaceae	Inflorescence
23	*Amomum subulatum* Roxb.	Ailaidum	Zingiberaceae	Rhizome
24	*Amorphophallus campanulatus* Roxb.	Telhawng	Araceae	Rhizome
25	*Ananas comosus* (L.) Merr.	Lakhuih	Bromeliaceae	Leaf
26	*Andrographis paniculata* (Burm.f.) Nees	Hnahkhapui	Acanthaceae	Leaves, stem, root
27	*Anethum graveolens* L.	Masala	Apiaceae	Inflorescence
28	*Annona squamosa* L.	Theiarbawn	Annonaceae	Leaves, seed, fruit, root
29	*Anodendron paniculatum* (Rox.)A.DC.	Theikelki	Melastomataceae	Leaves, fruits

(continued)

Table 12.1 (continued)

SI No.	Scientific name	Local name	Family	Part used
30	*Anogeissus acuminata* (Roxb. Ex DC.) wall. Ex Guillem. &Perr.	Zairum	Combretaceae	Leaf, bark
31	*Anthocephalus cadamba* Miq.	Banphar	Rubiaceae	Bark, leaf
32	*Aporosa octandra* (Buch.-ham. Ex D. Don) Vickery	Chhawntual	Phyllanthaceae	Bark
33	*Aquilaria malaccensis lam.*	Thingrai.	Thymelaeaceae	Stem bark
34	*Areca catechu* L.	Kuhva kung	Arecaceae	Seeds
35	*Artemisia indica*Willdenow	Sai	Asteraceae	Roots, leaves
36	*Artemisia nilagirika* Clarke	Sai	Asteraceae	Leaves
37	*Artocarpus chama* Buch.-ham.	Tatkawng	Moraceae	Bark
38	*Artocarpus lakoocha*Roxb.	Theitat	Moraceae	Stem
39	*Artocarpus heterophyllus* lam.	Lamkhuang	Moraceae	Roots
40	*Asparagus racemosus* Willd.	Arkebawk, Thingribuk	Asparagaceae	Shoot
41	*Averrhoa carambola* L.	Theiherawt	Oxalidaceae	Fruit
42	*Azadirachta indica* A. Juss.	Neem	Meliaceae	Leaf, bark, fruits
43	*Baccaurea ramniflora* Lour.	Pangkai	Euphorbiaceae	Raw fruit
44	*Bauhinia purpurea* L.	Vau-fa-vang	Leguminosae	Flowers
45	*Bauhinia variegata* L.	Vaube	Caesalpiniaceae	Bark, leaves
46	*Begonia inflate* cl.	Sekhupthur	Bignoniaceae	Leaves and stem
47	*Begonia longifolia* Blume	Sekhupthur	Bignoniaceae	Flower
48	*Benincasa hispida* (thumb.) Cogn.	Maipawl	Cucurbitaceae	Fruit
49	*Bergenia ligulata* wall.	Pandamdawi kham-damdawi	Saxifragaceae	Root
50	*Bischofia javanica* Bl.	Khuangthli	Euphorbiaceae	Leaves
51	*Blumea balsamifera* DC.	Buarthau	Asteraceae	Leaves, stem, root
52	*Blumea lanceolaria* Roxb.	Buarze	Asteraceae	Leaves
53	*Bombax ceiba* L.	Pang	Bombacaceae	Leaves, bark
54	*Brassica oleracea* var. *botrytis* L.	Parbawr	Brassicaceae	Leaves, inflorescence
55	*Brassica oleracea* L.var. *italica*	Broccoli	Brassicaceae	Flowers, leaves
56	*Brassica juncea* (L.)Czern	Antam	Brassicaceae	Flowers, leaves

(continued)

Table 12.1 (continued)

SI No.	Scientific name	Local name	Family	Part used
57	*Brugmansia suaveolens* (Humb. & Bonpl. Ex Willd.)Bercht. & J.Presl	Tawtawrawt par.	Solanaceae	Leaves
58	*Butea monosperma* (lam.) Taub.	Tuahpui	Leguminosae	Flower, leaf, seed
59	*Callicarpa arborea* Roxb.	Hnahkiah	Lamiaceae	Bark, leaf
60	*Canarium resiniferum* Bruce ex king	Berawthing	Burseraceae	Fruit, bark
61	*Canavalia ensiformis* (Linnaeus) DC	Fangra	Leguminosae: Papilionoidae	Seeds
62	*Capsicum frutescens* L.	Anhling	Solanaceae	Leaves, fruits, stem
63	*Carica papaya*L.	Thingfanghma	Caricaceae	Fruit
64	*Caryota urens* L.	Tum (palm tree)	Arecaceae	Stem
65	*Cassia fistula* L.	Makhazang	Caesalpiniaceae	Leaves
66	*Castanopsis tribuloides* (Sm.) A.DC.	Thingsia	Fagaceae	Stem
67	*Catharanthus roseus* L.	Kumtluang	Apocynaceae	Leaves
68	*Centella asiatica* (L.) Urb.	Lambak	Apiaceae	Leaf
69	*Cheilocostus speciosus*(J. Koenig) C.D.Specht	Sumbul	Costaceae	Leaves
70	*Chenopodium album* L.	Kawlbuh	Amaranthaceae	Inflorescence, leaves, and tender shoots
71	*Chikrassia tabularis* A. Juss.	Zawngtei	Meliaceae	Fruit and bark
72	*Chonemorpha fragrans* moon	Phungtheikelki	Apocynaceae	Fruit, root, and leaf
73	*Chromolaena odorata* (L.) king & Robinson	Tlangsam	Compositae	Leaf, seed, stem.
74	*Cinnamomum glanduliferum* Meissn	Khianzo	Lauraceae	Stem bark, leaves
75	*Cinnamomum tamala* (Buch.-ham.) T.Nees & Eberm.	Tespata, Hnahrimtui	Lauraceae	Bark, stem, and root.
76	*Cinnamomum verum* J. Presl	Thakthing	Lauraceae	Root, stem, leaves
77	*Cirsium chinensis* Gard	Lenhling	Asteraceae	Root
78	*Cissus javana* DC.	Sangharhmai	Vitaceae	Leaves, roots, stem
79	*Clerodendrum bracteatum* wall. Ex Walp.	Phuihnamchhia	Verbenaceae	Leaves
80	*Clerodendrum colebrookianum*Walp.	Phuihnum	Verbenaceae	Leaves

(continued)

Table 12.1 (continued)

SI No.	Scientific name	Local name	Family	Part used
81	*Clerodendrum glandulosum* v Lindl.	Phuihnam	Lamiaceae	Leaves, inflorescence
82	*Clerodendrum infortunatum* L.	Phuihnamchhia	Verbenaceae	Root, leaves
83	*Coccinia indica* W.	Arakhaum or nau-awimu	Cucurbitaceae	Leaves, fruits, stem
84	*Colocasia esculenta* L.	Dawl	Araceae	Stem
85	*Cordia wallichii* G.	Muk	Boraginaceae	Leaves, bark
86	*Coriandrum sativum* L.	Dhania / Nannan	Apiaceae	Leaves, inflorescence
87	*Costus speclosus* Kelnlg	Sumbul	Costaceae	Rhizome
88	*Crassocephalum crepidioides* (Benth.)S. Moore	Buar	Asteraceae	Inflorescence, tender shoots
89	*Cratoxylum neriifolium* Kurz.	Thing-sir	Hypericaceae	Leaves
90	*Crotolaria juncea* L.	Tumthang	Leguminosae	Flowers
91	*Crotalaria tetragona* Roxb. Ex Andrews	Tumthang	Leguminosae	Flowers
92	*Cucurbita maxima* Duchesne	Mai	Cucurbitaceae	Flowers
93	*Curcuma angustifolia* Roxb.	Ai chhia	Zingiberaceae	Flowers
94	*Curcuma caesia*Roxburgh	Ailaidum	Zingiberaceae	Root
95	*Cucurma longa* L.	Aieng	Zingiberaceae	Flowers
96	*Curcumorpha longifera* (wall.) Rao & Verma	Ailur	Zingiberaceae	Rhizome
97	*Curcuma longa* L.	Ai-eng	Zingiberaceae	Whole plant
98	*Cynodon dactylon* Linnaeus	Phaitualhnim	Gramineae	Whole plant
99	*Dalbergia pinnata* Lour.	Tengtere	Fabaceae	Fruit
100	*Datura stramonium* L.	Tawtawrawt-par	Solanaceae	Leaf
101	*Dendrocalamus hamiltonii* Nees.	Phulrua	Poaceae	Fruit
102	*Dendrocnide sinuata* (Blume) chew	Thakpui	Urticaceae	Root
103	*Derris robusta* (DC.) Benth	Thingkha	Leguminosae	Bark
104	*Desmodium sequax* wall.	Chabet	Leguminosae	Leaves
105	*Dichroa febrifuga* Lour.	Khawsik-damdaw	Saxifragaceae	Root
106	*Dillenia indica* Linn.	Kawrthindeng	Dilleniaceae	Fruit
107	*Dillenia pentagyna* Roxb.	Kaizwal	Dilleniaceae	Stem bark
108	*Dinochloa compactiflora* Kurtz.	Sairil	Poaceae	Stem

(continued)

Table 12.1 (continued)

SI No.	Scientific name	Local name	Family	Part used
109	*Dioscorea alata* L.	Rambachim	Dioscoreaceae	Tuber
110	*Dioscorea bulbifera* L.	Ram-bahra	Dioscoreaceae	Leaf
111	*Dolichos lablab* L.	Bepui	Papilionaceae	Leaf
112	*Dregea* *volubilis* Benth. Ex. hook. f	Ankhapui	Asclepiadaceae	Leaf, bark, root
113	*Drimycorpus racemosus*	Vawmbal	Anacardiaceae	Bark
114	*Drymaria cordata* Linnaeus	Changkalrit	Caryophyllaceae	Whole plant
115	*Dysoxylum excelsum* Blume	Thingthupui	Meliaceae	Flowers
116	*Dysoxylum gobara* (Buch.-ham) Merr.	Thingthupui	Meliaceae	Leaves
117	*Dysoxylum procerum* Hiern.	Thingthupui	Meliaceae	Leaves
118	*Duabanga grandiflora* (DC.) Walp.	Zuang	Lythraceae	Bark
119	*Phyllanthus emblica* L.	Sunhlu	Phyllanthaceae	Fruit, bark, root
120	*Elaeagnus caudata* Schlechtendal ex Momiyama	Sarzuk.	Elaeagnaceae	Roots
121	*Elaeagnus conferia* Roxb.	Sarzuk	Elaeagnaceae	Leaves
122	*Elaeagnus latifolia* L.	Sarzuk	Elaeagnaceae	Root
123	*Elsholtzia griffithii* Hook.f.	Lengser	Lamiaceae	Inflorescence
124	*Embelia nagushia* D.	Thing	Myrsinaceae	Leaves
125	*Eryngium foetidum* Linn.	Bahkhawr	Apiaceae	Root
126	*Erythrina stricta* Roxb.	Fartuah	Leguminosae	Bark and leaf
127	*Eucalyptus globulus* Labillardière	Nawhalhthing	Myrtaceae	Leaves
128	*Eugenia jambolana* lam.	Lenhmui	Myrtaceae	Seeds, leaves, fruit, bark
129	*Eulophia nuda* Lindl.	Nauban	Orchidaceae	Tuber
130	*Eupatorium odoratum* L.	Tlangsam	Asteraceae	Leaves
131	*Euphorbia royleana* Boissier	Chawng	Euphorbiaceae	Pith, milky juice, and leaves
132	*Ficus hispida* L.	Thei-pui	Moraceae	Root
133	*Ficus religiosa* L.	Bung	Moraceae	Bark, root, fruits
134	*Ficus semicordata* Roxb.	Theipui	Moraceae	Stem bark
135	*Garcinia cowa* Roxburgh ex Choisy	Chengkek	Clusiaceae	Leaves, latex juice, fruit
136	*Garcinia lanceifolia* Roxb.	Chengkek	Clusiaceae	Fruits, leaves

(continued)

Table 12.1 (continued)

SI No.	Scientific name	Local name	Family	Part used
137	*Gelsemium elegans* Gardner	Hanamtur	Loganiaceae	Roots, leaves
138	*Gleditsia assamica* Bor	Hluk-ral	Leguminosae	Fruit, seed, bark.
139	*Glinus opositifolius* (L.) Aug. DC.	Bakkhate	Molluginaceae	Whole plant, inflorescence
140	*Gmelina arborea* Roxb.	Thlanvawng	Lamiaceae	Flower, root, leaf, fruits.
141	*Grevillea robusta* A. Cunn. Ex R. Br.	Silver oak	Proteaceae	Leaves, bark
142	*Gynura conyza* Cass.	Buar-ze	Asteraceae	Leaf
143	*Hedychium spicatum* Buch-ham. Ex Sm.	Kelhnamtur	Zingiberaceae	Leaf
144	*Hedyotis scandens* Roxburgh	Laikingtuibu*r*	Rubiaceae	Roots, leaves
145	*Helicia excelsa* Bl.	Sialhma	Proteaceae	Leaf
146	*Helicia robusta* Hk.	Pasaltakaza	Proteaceae	Rhizome, root bark
147	*Heteropanax fragrans* (Roxb.) seem.	Chang-khen seem.	Araliaceae	Root, bark
148	*Hibiscus sabdariffa* L.	An-thur	Malvaceae	Leaves, fruits, flower
149	*Hibiscus surattensis* L.	Leitha	Malvaceae	Stem, leaves
150	*Hodgsonia heteroclita Roxb.*	Khaum	Cucurbitaceae	Seed
151	*Homalomena aromatic* (Spreng.) Schott	Anchiri	Araceae	Root, bark
152	*Houttuynia cordata* Thunb.	Uithinthang	Saururaceae	Flowers, stem
153	*Hydrocotyle asiatica* L.	Lambak/ Darbengbur	Apiaceae	Leaves
154	*Impatiens chinensis* L.	Haeirlo	Balsaminaceae	Whole plant
155	*Inula cappa* DC	Buarthau	Asteraceae	Leaves
156	*Jatropa curcas*	Kangdamdawi	Euphorbiaceae	Leaves
157	*Jasminum nervosum* Loureiro	Maufim hrui/ Hlokha	Oleaceae	Leaves
158	*Kyllinga monocephala* Rottb.	Artelubawk	Cyperaceae	Root
159	*Lagerstroemia speciosa* (Linn.) Pers.	Chawnpui	Lythraceae	Root
160	*Lantana camara* L.	Shillong tlangsam	Verbenaceae	Whole plant
161	*Laportea crenulata* gaud.	Thak-pui	Urticaceae	Root, leaf
162	*Lepidagathis incurva* Buch.-ham. Ex D. Don	Vangvattur	Acanthaceae	Leaves
163	*Lepionurus sylvestris* Blume	Anpangthuam	Opiliaceae	Leaves

(continued)

Table 12.1 (continued)

SI No.	Scientific name	Local name	Family	Part used
164	*Lindernia ruellioides* (Colsm.) Pennell	Thasuih	Linderniaceae	Leaves, flower.
165	*Litsea monopetala* (Roxb.) Pers.	Nauthak	Lauraceae	Leaf, root, bark.
166	*Livistona chinensis* (Jacq.) Pers. R.Br.Ex Mart.	Buarpui	Arecaceae	Inflorescence
167	*Lobelia nummularia* Lamarck	Choaka thi	Campanulaceae	Whole plant
168	*Lonicera macrantha* D. Don	Leihruisen	Caprifoliaceae	Leaf
169	*Mallotus roxburghianus* Mull. Arg.	Zawngtenawhlung	Euphorbiaceae	Bark, leaves
170	*Mangifera indica*L.	Theihai	Anacardiaceae	Bark
171	*Manihot esculenta* Crantz	Pangbal	Euphorbiaceae	Root
172	*Melastoma malabathricum* L.	Builukhampa	Melastomataceae	Leaves
173	*Melia azedarach*Linnaeus	Neem suak	Meliaceae	Leaves
174	*Melocalamus compactiflorus* Benth.	Sairil	Poaceae	Stem
175	*Melocanna baccifera* Roxb.	Mautak	Poaceae	Stem
176	*Mesua ferrea* L.	Herhse.	Clusiaceae	Fruits and flower
177	*Michelia champaca* L.	Ngiau	Magnoliaceae	Leaf, bark
178	*Mikania micrantha* Kunth.	Japan hlo	Asteraceae	Leaves
179	*Millettia pachycarpa* Sm.	Rulei	Fabaceae	Root
180	*Mimosa pudica* Linn.	Hlonuar	Mimosaceae	Root
181	*Mirabilis Jalapa* L.	Artukhuan	Nyctaginaceae	Whole plant
182	*Mollugo pentaphylla* L.	Vahmim bung	Molluginaceae	Whole plant
183	*Momordica charantia* Linn.	Changkhate	Cucurbitaceae	Leaves, fruits
184	*Morus alba* L.	Theihmu (Hlingnei)	Moraceae	Fruit, bark
185	*Mussa* sp.	Changel	Musaceae	Flower, fruit, stem
186	*Mussaenda macrophylla* wall.	Vakep	Rubiaceae	Leaves, root
187	*Myrica esculenta* Buch. Ham.	Keifang	Myricaceae	Bark
188	*Nicotiana tabacum* Linn.	Vaihlo	Solanaceae	Leaf
189	*Ocimum americanum* L.	Runhmui	Lamiaceae	Inflorescence
190	*Oriza sativa* L.	Buh/ buh-pawl	Poaceae	Straw
191	*Oroxylum indicum* (Linnaeus) Kurz	Archangkawm.	Bignoniaceae	Stem, bark, root.

(continued)

Table 12.1 (continued)

SI No.	Scientific name	Local name	Family	Part used
192	*Orthosiphon aristatus* Bl.	Zunthlum-kung	Lamiaceae	Leaf
193	*Osbeckia rostrata* Don.	Builukhampa	Melastomataceae	Root
194	*Osbeckia stellata* Buch.-ham. Ex Ker Gawl	Builukham	Melastomataceae	Flowers
195	*Oxyspora paniculata* D.C.	Khampa	Melastomataceae	Root
196	*Paederia foetida* Linnaeus	Vawihuihhrui.	Rubiaceae	Whole plant
197	*Paederia scandes* Lour.	Vawihuih hrui	Rubiaceae	Leaves and stem
198	*Parkia roxburghii* G. Don	Zawngtah	Mimosaceae	Bark, flower, seed.
199	*Parkia timoriana* (DC.) Merr.	Zawngtah	Leguminosae	Fruit, flower, seed.
200	*Passiflora nepalensis*Walp.	Nauawimu	Pasifloraceae	Root
201	*Pavetta crassicaulis* Bremek.	Thai-nu rual	Rubiaceae	Flowers
202	*Persea odoratissima* (Nees) Kosterm	Bulfek	Lauraceae	Flower, root, bark.
203	*Persicaria chinensis* (L.) H. gross	Taham	Polygonaceae	Flower
204	*Phlogacanthus pubinervius* T. Anderson	Va te zu	Acanthaceae	Flower
205	*Physalis minima* L.	Kelasairawphit	Solanaceae	Leaf, stem, fruit
206	*Picrasma javanica* Bl.	Thingdamdawi	Simaroubaceae	Bark, leaves
207	*Pisum sativum* L.	Chana	Leguminosae	Flower, shoots, leaves
208	*Piper betle*Linnaeus	Panruang	Piperaceae	Leaf, stem
209	*Piper longum* L.	Voko-hrui	Piperaceae	Fruit
210	*Pithecolobium angulatum* Benth.	Ardah-pui	Mimosaceae	Leaf
211	*Pithecolobium bigeminum* Benth.	Ardah	Mimosaceae	Leaf
212	*Plantago major* L.	Kelbe-an	Plantaginaceae	Leaf
213	*Polygonum barbatum* L.	Anbawng	Polygonaceae	Root
214	*Pratia begonifolia* Lindl.	Choakathi	Campanulaceae	Leaf
215	*Prunus cerasoides* D. Don.	Tlaizang	Rosaceae	Bark
216	*Pseudodrynaria coronans* Ching.	Awmvel	Polypodiaceae	Rhizome
217	*Psidium guajava* L.	Kawiam/Kawlthei	Myrtaceae	Leaf
218	*Pteridium aquilinum* Kuhn.	Katchat	Polypodiaceae	Rhizome, fronds
219	*Phyllanthus emblica* Linnaeus	Sunhlu	Phyllanthaceae	Bark, fruit.

(continued)

Table 12.1 (continued)

SI No.	Scientific name	Local name	Family	Part used
220	*Phyllanthus fraternus* G. L. Webster	Mitthisunhlu	Euphorbiaceae	Bark, leaves
221	*Portulaca oleracea* L.	Hlo-thau	Portulaceae	Leaves
222	*Raphanus sativus* L.	Mula	Brassicaceae	Flower, shoots, and leaves
223	*Ricinus communis* Linnaeus	Mutih	Euphorbiaceae	Leaves
224	*Rhododendron arboreum* Sm.	Chhawkhlei par sen	Ericaceae	Flower
225	*Rhus semialata* Murray	Khwamhma	Anacardiaceae	Leaves, raw fruit
226	*Rotheca serrata* (L.) Steane & Mabb.	Phuinhamshak	Lamiaceae	Flowers, shoots
227	*Rhynchotoechum ellipticum* A	Tiarrep	Gesneraceae	Leaves
228	*Sapindus mukorossi* Gaertn.	Hlingsi	Sapindaceae	Seed
229	*Saraca asoca*(Roxb.) Willd.	Mualhawih	Caesalpiniaceae	Leaves
230	*Saraca indica* Linnaeus	Mualhawih	Leguminosae: Caesalpinioidae	Bark
231	*Sarcandra glabra* (Thunb.) Nakai	Senthet	Chloranthaceae	Root, leaves
232	*Schima wallichii* Choisy	Khiang	Theaceae	Fruits, bark
233	*Scoparia dulcis* L.	Perhpawngchaw	Scrophulariaceae	Whole plant
234	*Securigina virosa* Roxb.	Saisiak	Euphorbiaceae	Leaves
235	*Senecio scandens* Buchanan-Hamilton ex D. Don	Saiekhlo	Asteraceae	Leaves
236	*Senna alata*Linnaeus Roxburgh	Tuitur, Tuihlo, Kelbepui, Dadu hlo	Leguminosae: Caesalpinioidae	Leaves
237	*Sida acuta.* Burm. f.	Khing-khih	Malvaceae	Root, leaves
238	*Smilax perfoliata* Lour.	Kaiha	Smilacaceae	Flower
239	*Solanum americanum* P. miller	Anhling	Solanaceae	Leaves, juice of berry
240	*Solanum khasianum* cl.	At lho	Solanaceae	Seeds
241	*Solanum nigrum* L.	An-hling	Solanaceae	Fruit, leaf
242	*Solanum torvum* Linn.	Tawkpui	Solanaceae	Dried seeds
243	*Solanum xanthocarpum* Schrad. Et. Wendl.	At-hlo	Solanaceae	Seeds
244	*Spathodea stipulata* wall.	Zih-haw	Bignoniaceae	Stem
245	*Spondias pinnata* Linn.	Tawitaw	Anacardiaceae	Bark
246	*Sterculia _illosa* Roxb.	Khau-pui	Sterculiaceae	Bark

(continued)

Table 12.1 (continued)

SI No.	Scientific name	Local name	Family	Part used
247	*Stereospermum colais* (Dillw.)	Zihnghal	Bignoniaceae	Leaf
248	*Stereospermum tetragonum* DC	Zihnghal	Bignoniaceae	Leaves, bark
249	*Strobilanthes cussia* Nees.	Mizo-thing	Acanthaceae	Leaf
250	*Syzygium cumini* (L.) Skeels.	Len-hmui	Myrtaceae	Bark, seed, fruit.
251	*Tabernaemontana divaricata* (L.) R.Br. Ex Roem. & Schult.	Pararsi	Apocynaceae	Root, leaf, flower
252	*Tagetes erecta* L.	Derhken	Asteraceae	Flowers, leaves
253	*Tamarindus indica* L.	Chhimakelek	Leguminosae	Seed
254	*Tectona grandis* L. f.	Teak	Lamiaceae	Root, bark, flower
255	*Terminalia bellerica* Roxb.	Thingvandawt	Combretaceae	Bark, flower, fruit
256	*Terminalia chebula* Retz.	Reraw	Combretaceae	Fruits
257	*Thunbergia grandiflora* Roxb.	Zawngafian	Acanthaceae	Leaves
258	*Tinospora cordifolia* wild.	Theisawntlung	Menispermaceae	Leaf, stem
259	*Trachyspermum roxburghianum* (DC.) H. Wolff	Par-di	Apiaceae	Flowers, leaves
260	*Trevesia palmata*(Roxb. Ex Lindl.) Vis.	Kawhtebel	Araliaceae	Leaf, root
261	*Trichosanthes anguina* L.	Berul	Cucurbitaceae	Fruit
262	*Uncaria lae_igata* wall.	Ralsamkuai	Rubiaceae	Root
263	*Urena lobata* L.	Sehnap	Malvaceae	Leaf, root, bark
264	*Vaccinium sprengelii* (G. Don) Sleumer.	Sir-kam	Ericaceae	Flowers
265	*Viburnum mullaha* Buch. -ham. Ex. D. Don.	Vawngser	Adoxaceae	Root
266	*Viscum articulatum* Burm.	Lengpat	Loranthaceae	Whole plant
267	*Vitex peduncularis* wall. Ex Schauer	Thingkhawi-Hlu	Lamiaceae	Leaf, root, bark
268	*Wendlandia budleioides* Wall.Ex Wight & Arn.	Batling	Rubiaceae	Inflorescence
269	*Woodfordia fruticosa* Linnaeus	Ainawn	Lythraceae	Leaves, flowers
270	*Zanonia indica*	Lalruanga dawibur	Cucurbitaceae	Fruit cover
271	*Zingiber officinale* Rosc.	Sawhthing	Zingiberaceae	Rhizome
272	*Ziziphus jujuba* mill.	Bawrai	Rhamnaceae	Fruit, bark, root, leaf

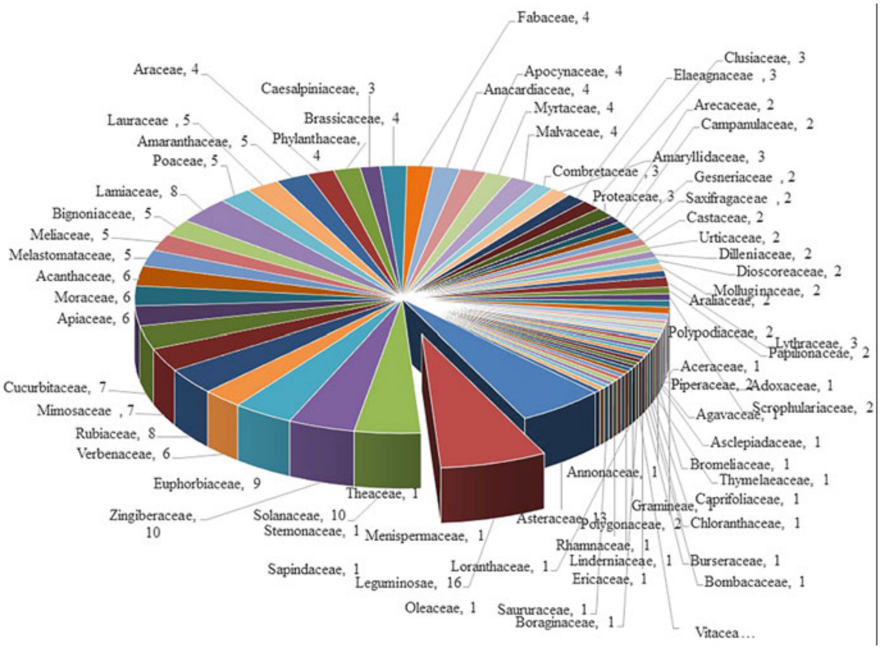

Fig. 12.1 The pie chart showing percentages of families of edible plant species utilized by the Mizo Clans of Mizoram

Asclepiadaceae (1),Boraginaceae (1), Bromeliaceae (1), Annonaceae (1), Bombacaceae (1)Burseraceae (1), Chloranthaceae (1), Caprifoliaceae (1), Ericaceae (1),Gramineae (1),Loranthaceae (1),Linderniaceae (1),Menispermaceae (1), Oleaceae (1), Rhamnaceae (1), Sapindaceae (1),Saururaceae (1),Thymelaeaceae (1), Theaceae (1),Vitaceae (1).The plant species or the family which are used frequently tend to be important in any society and hence their economic value is higher. In our present study, plants belonging to the family Asteraceae occupy high value in the Mizo society followed by Zingiberaceae and others as mentioned in Fig. 12.1**.**The reason for the resourcefulness of a particular group of plants uses in society may be taken into account as a cultural approach or tradition. Additionally, more use of specific plant species may be linked to the cultural knowledge delivery mechanism, which seems to be very distinctive among the Mizo tribes rather than using many plants with lesser significance.

Wild plants as food have always been unnoticed in comparison to the cultivated ones. Wild edible plants are available in the vicinity, so local people are fully accustomed to how to collect and make preparation as foods. To depend on minimally developed plant species limits the food randomness and will in general rely upon restricted assets. In different situations, examinations on wild consumable plants call attention to that over 7000 species have been utilized for food in human progress (Grivetti and Ogle 2000). Individuals of nations, for example, India, Thailand, China, and Bangladesh burned-through numerous wild eatable plants alongside developed plants (Mazhar et al. 2007). Upwards of 600 wild eatable plant species have been reported in India (Rathore 2009). These figures show the close connection between wild eatable plants and the eating regimens of numerous individuals, subsequently, wild edibles can be viewed as helpful assets regarding food security. Notwithstanding their functions in food security, numerous wild consumable plants are recognized for their therapeutic, social, search, and monetary qualities (Johns et al. 1996; Ogle et al. 2003; Reyes-Garcia et al. 2005; Shrestha and Dhillon 2006). Wild consumable plants assume a significant function as a wellspring of energy and micronutrients (Afolayan and Jimoh 2009; De Caluwe et al. 2010).

12.4 Conclusion

Since many of the precious plants are under persistent danger because of continuing anthropogenic events, conservation to safeguard the high-value resources is indeed needed and must be emphasized on a priority basis before getting extinct. The pursuance of ethno practice has also been ultimately affected due to the loss of the indigenous cultural population and their customary know-how. The indiscriminate and non-systematic collection of plants has direct pressure on the availability of these plants. Wild plants may become seriously endangered because of their small population size, restricted distribution, and/or preciseness of habitat. Mizoram being in the Northeastern district of India, which falls under the Indo-Burma hotspots, is affluent as far as the way of life and ethnomedicinal plant variety. A few examination articles and books have been archived; in any case, there exists a colossal chance of clan insightful record of examination and recording of the local data on wild plants.

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Isoflavones of Soy: Chemistry and Health Benefits

13

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Abstract

Nutrients impart an essential role in the prevention of various diseases. The biological activity of plant derived compounds allows their use to treat to various diseases. Isoflavones of Soy whose structure is analogous to 17-β-oestradiol are considered healthy in cardiovascular diseases and various types of cancer, such as prostate and breast cancer. It creates an immense need for further exploration of isoflavones. This can be achieved in the form of high quality clinical trials considering different perspectives. This would add to and enhance the present

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knowledge regarding them and ascertain their proper application to ameliorate different pathologies. This chapter has concisely tried to acknowledge and highlight all the crucial areas where application of soy Isoflavones has been studied keeping in view its chemistry as well.

Keywords

Bone loss · Hot flashes · Isoflavones · Soy · Antioxidant · 17-β-oestradiol

13.1 Introduction

Isoflavones are polyphenolic compounds belonging to flavonoids compounds synthesized by plants and are classified as phytoestrogens. Soy isoflavones are non-steroidal bioactive compound present as abounding amount in soybean and soybean-based food products (Zaheer and Humayoun Akhtar 2017a, b). Soy isoflavones predominantly contain genistein, daidzein and glycitein (Fig. 13.1) (Křížová et al. 2019). These flavones are referred as "*phytoestrogens*" because of their structural similarity to that of main female reproductive hormone 17-estradiol (E2). This structural resemblance enables them to bind to the estrogenic receptors (ERα, ERβ) and prompted the estrogenic or antiestrogenic effect (Křížová et al. 2019; Pabich and Materska 2019a, b). Isoflavones exert low estrogenic activity in comparison to estradiol and exhibited more affinity towards ERβ oestrogen receptor (Pabich and Materska 2019a, b). Genistein is a most circulating and well-studied soy isoflavone and has 20–30 times more affinity for ERβ receptors than ERα (Xiao et al. 2018).

Isoflavone containing foods had gained worldwide popularity. Asian countries such as Japan and China utilize more dietary intake of soy and soy-based foods than western population like North America and hence shows low propensity of certain cancers such as colon cancer, breast cancer and prostate cancer that may be attributed to the estrogenic activity of soy isoflavones (Xiao et al. 2018). Isoflavones are therapeutically beneficial in many hormone related disorders like menopausal symptoms (hot flashes), obesity, diabetes, osteoporosis, cardiovascular disease, cognitive functions and even effective in certain viral infections also. The isoflavones have exhibited anticancer potential against certain cancer types like breast cancer and prostate cancer (Křížová et al. 2019; Zaheer and Humayoun Akhtar 2017a, b). Dietary isoflavones are used as a substitute to the hormonal replacement therapy by women (Zaheer and Humayoun Akhtar 2017a, b). Apart from the estrogenic property, the antioxidant activity of soy isoflavones has been reported both in in vivo and in vitro studies (Lee et al. 2005; Yen and Lai 2003).

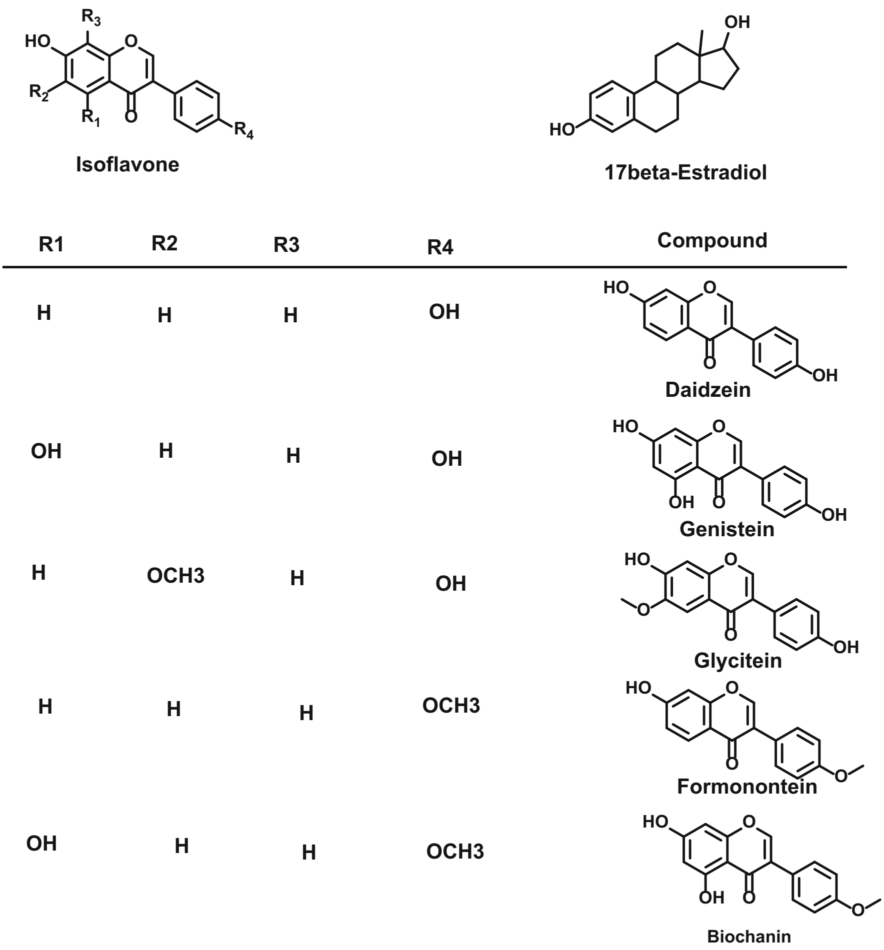

Fig. 13.1 Chemical Structures of Isoflavones

13.2 Source and Occurrence

Isoflavones are primary present in family Leguminosae notably in Soy beans (*Glycine max*) containing the isoflavone glycitein, daidzein and genistein and red clover (*Trifolium pretense*) as a source of biochanin and formononetin (Křížová et al. 2019). The other sources of isoflavones are Japanese arrowroot, mung bean sprouts, kidney beans, navy beans. The main source of isoflavones in human diet are soy and soy products including soy beans, soy flakes, tofu, soy milk, soy flour, soy paste, soy sauce, fermented products of soybean such as miso, tempeh (Zaheer and Humayoun Akhtar 2017a, b). The isoflavones are present in the soybean at a concentration range of 1.2 to 4.2 mg/g, however in soy derived products the flavone content is lower

(Křížová et al. 2019; Xiao et al. 2018). Red clover and white clover contain the phytoestrogens in the concentration range of 12–25 mg/kg and 0.5–0.6 mg/g body weight, respectively, of which formononetin isoflavone accounts for 0.8–11 mg/g dry weight. Likewise the alfalfa contains isoflavone content of 0.05–0.3 mg/g (Křížová et al. 2019).

Isoflavone concentration in soy vary according to the type of soybean, the climate and cultivation area. Soybean cultivation is conducted around the world and about 90% of soybean production is clustered in tropical and semi-arid areas, with lower or erratic rainfall and elevated temperatures. The top soybean producing countries of world include the USA (33%), Brazil (29%), Argentina (19%), China (5%) and India (4%). The levels of isoflavones in soybeans vary greatly within various countries such as Romania (21 mg. 100 g^{-1} to 134 mg. 100 g^{-1}), the USA (1176 μg. g^{-1} to 3309 µg. g^{-1}), Eastern Canada (360 to 2241 mg. g^{-1}), India (525 to 986 mg.kg^{-1}) (Zaheer and Humayoun Akhtar 2017a, b). *Apios americana*, American groundnut a popular East Coast native diet of Americans contains higher amount, i.e. 8 mg.g^{-1} (Zaheer and Humayoun Akhtar 2017a, b).

In soybean, about 90% of the isoflavones are present in glyosidic form as sugar conjugates and little amount is present as free form. Soybeans and soy products are digested or fermented, resulting in the removal of sugar moiety from the glycoside (genistein, daidzein and glycitein) and release of aglycone part (genistin, daidzin and glycitin) (Zaheer and Humayoun Akhtar 2017a, b). Some isoflavone aglycon moieties are absorbed, where others such as daidzein are metabolized into Equol by β-glucosidases present in the gut (Pabich and Materska 2019a, b; Zaheer and Humayoun Akhtar 2017a, b).

13.3 Chemistry

As mentioned already, isoflavones are natural occurring phytoestrogenic compounds whose chemistry is identical to 17-β-estradiol (Kurzer and Xu 1997). Considering endocrine estrogenic levels, these can function as estrogenic or antiestrogenic (Kurzer and Xu 1997), however, their activities are convoluted owing to diverse structural and functional dissimilarities. These secondary metabolites are found in abundance in the Fabaceae/Leguminosae family (Dixon and Sumner 2003), formed due to symbiotic association with rhizobial bacteria and defensive response from leguminous plants (Yu et al. 2000). Isoflavones synthesis follows phenylpropanoid pathway (Barnes 2010). Phenylalanine combines with malonyl CoA to convert 4-hydroxycinnamoyl CoA. The intermediate formed is catalysed by Chalcone synthase and converted to (naringenin chalcone), and the combined enzyme actions of chalcone synthase and reductase converts this intermediate to (isoliquiritigenin). And then, closed ring structure of heterocycle is catalysed by chalcone isomerase to form (liquiritigenin) and (naringenin). The B-ring is transferred by isoflavone synthase from the 2-position to the 3-position. Isoflavone dehydratase eliminated water in the heterocyclinc ring to produce the 2,3 double bond, which leads to formation of compounds genistein and daidzein (Fig. 13.2).

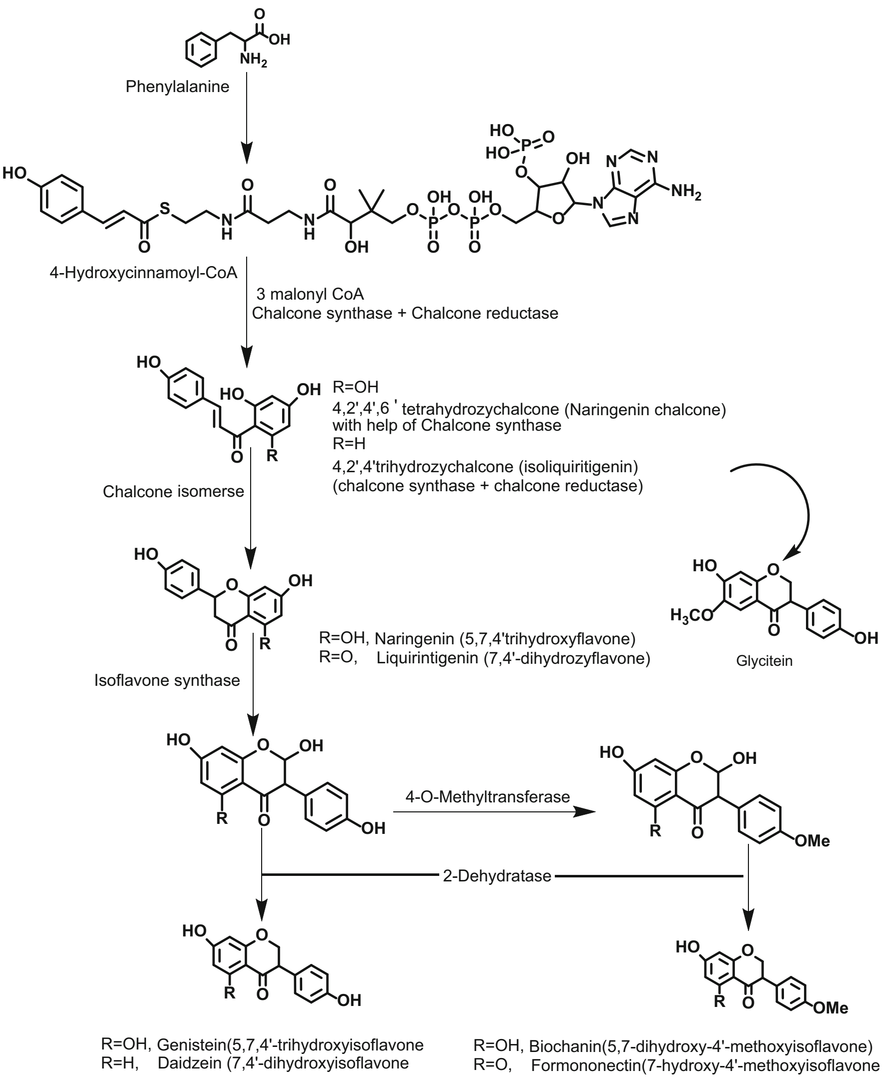

Fig. 13.2 Biosynthetic pathway of Isoflavones

13.4 Chemical Change by Processing

Natural occurring isoflavones as such are inactive glycosidic conjugates but few of them like unconjugated aglycones are naturally active. Isoflavones are normally altered by glucosyltransferase to 7-O-β-glucosides and then by malonyl transferase to their 6"-Omalonates.The primary type of harvested soybeans is the 6"-Omalonates. The proportion of conjugated glycosides to

non-conjugated aglycones varies between food types and depends on the soybeans processing conditions. The processing of soybeans to create foods influences the chemical composition of isoflavone and leads to the variations in the quality of soy isoflavone. The glucosidic group from the isoflavone structure was extracted during fermentation, and the lengthy fermentation period for producing miso, doenjang or soy sauce across many months causes additional oxidative processes to produce hydroxylated derivatives (Esaki et al. 1999). Decarboxylation of malonyl glucosides leads to the formation of acetyl glucosides upon dry heat treatment to create dry compounds. These glycosides can be further converted to aglycones and glycosides (Mathias et al. 2006). Due to β-glucosidases, soy foods undergoing fermentation make higher amounts of free aglycones (Nakajima et al. 2005). The absorption of these foods in the small intestines becomes easy due to higher aglycone content (Patisaul and Jefferson 2010). Under hot water extraction to produce soymilk, reduction to glycosides and aglycones occurs.

13.5 Isoflavone Metabolism

Being inactive glycosides by nature, the isoflavones are transformed into active form by its hydrolysis in the gut. This hydrolysis is facilitated by the β-glucosidases bacteria (Cederroth and Nef 2009; Das et al. 2018; Pabich and Materska 2019a, b). In this manner the O-desmethylangolensin or equol is obtained from dihydrodaidzein that actually gets formed from daidzein. The quantity of bioavailable glycones and consequent presence in urine and serum of humans and animals is determined by the rate of fermentation (Bhathena and Velasquez 2002; Hüser et al. 2018; Pabich and Materska 2019a, b). Isoflavones have half-life ranging from six to eight hours and maintain its plasma levels for about a day (Pabich and Materska 2019a, b; Sivoňová et al. 2019). By virtue of higher absorption and longer half-life, daidzein is highly bioavailable than genistein as it is swiftly degraded (Kalaiselvan et al. 2010; Pabich and Materska 2019a, b). Being phytoestrogens, isoflavones exhibit affinity towards ER-α and ER-β receptors, thus exerting both estrogenic and antiestrogenic effects (Messina 2016; Pabich and Materska 2019a, b). The distribution of isoflavones thus is determined by the kind of tissue in question. For instance, in the tissues with plenty of oestrogen receptors like uterus, isoflavones exhibit immense affinity towards ER-β receptor. This phenomenon is responsible for the agonistic as well as antagonistic approach of isoflavones (Castelo-Branco and Cancelo Hidalgo 2011; Pabich and Materska 2019a, b). Thus, the exploration and exploitation of antagonistic property of isoflavones attributes towards its antiestrogenic property that holds vital importance for the treatment of malignancies (Pabich and Materska 2019a, b; Ward and Pasinetti 2016) (Fig. 13.3).

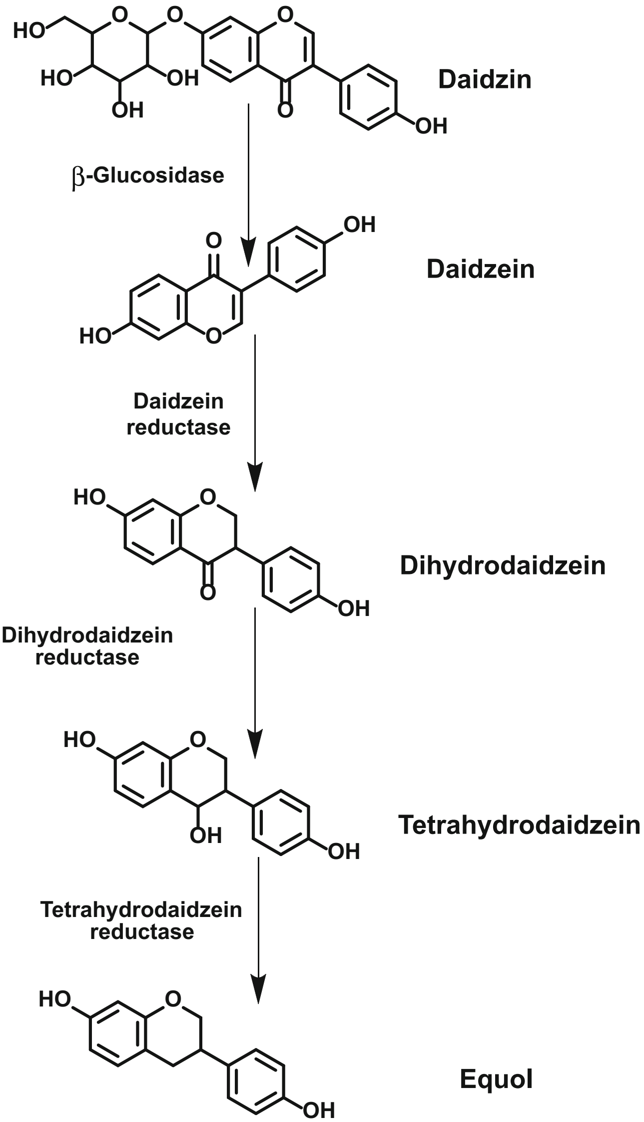

Fig. 13.3 Formation and metabolism of daidzein

13.6 Health Benefits of Isoflavones

13.6.1 Hot Flashes

Hot flash is a vasomotor event characterized by an impulsive feeling of heat in chest, neck and face accompanied with prolific sweating and fast heartbeat during menopause or post-menopause in women. Hot flashes are generally ascribed to the low levels of oestrogen during this period and hence oestrogen replacement therapy exists as the most practical treatment (Freedman 2014; Judd et al. 1981). A number of studies have implicated isoflavones of soy (e.g. genistein and daidzein also known as phytoestrogens) for the treatment of hot flashes. Soy isoflavones have been shown to possess oestrogen receptor binding ability and hence exhibit oestrogen like (both agonist and antagonist) activity. In hot flashes, where the oestrogen levels are low, these isoflavones find minimum competition and hence display high potency. There are several studies showing the effect of consuming soy rich diet on the occurrence of hot flashes. For example, the incidence of hot flashes in Caucasian women, African, American and Asian women being 70–85%, 53% and 18–25%, respectively, is due to the dietary differences in these areas. In Japanese women the incidence of hot flashes has been found to be very low which is attributed to the consumption of phytoestrogen enriched diet. In fact studies are suggesting that consuming soy foods may reduce the occurrence of hot flashes (Nagata et al. 2001). A number of researchers have made systemic reviews and meta-analyses and evaluated the effectiveness/efficacy of soy in hot flashes. A systematic review and meta-analysis carried out by Taku et al. demonstrates that isoflavones synthesized or extracted from soy have significant effect on the frequency and severity of hot flashes. The use of soy isoflavones reduced the frequency of the hot flashes by 20.6% ($P < 0.00001$) while the severity was reduced by 26.2% ($P = 0.001$) when compared with the placebo. Other studies indicating the effectiveness of soy isoflavones in the treatment of hot flashes are those carried out by Thomas et al. (Thomas et al. 2014), Chen et al. (Chen et al. 2015). The studies reported reduction in the frequency of the hot flashes with no adverse effects. Certain other studies have even reported soy isoflavones as being more effective than some other drugs gabapentin, venlafaxine, paroxetine, sertraline, etc. (Li et al. 2016).

13.6.2 Bone Loss

Bone loss (or osteoporosis) in postmenopausal women is a common condition occurring as a result of severe bone resorption attribute to the decrease in the levels of oestrogen. Therefore, oestrogen replacement therapy has been indicated appropriate for the purpose. However, researchers are seeking an alternative therapy in the form of phytoestrogens (e.g. soy isoflavones) as well. This is especially beneficial in women of 60+ years of age or postmenopausal 10+ years. Many studies have evaluated the efficacy of soy isoflavones in the treatment of menopausal and postmenopausal bone loss. In a meta-analysis of 608 individuals from 10 studies the effect of soy isoflavones intake on the mineral density of the spine bones was evaluated and it was found that the isoflavones significantly augmented the bone density by 20.6 mg/cm^2 (Ma et al. 2008). As demonstrated by Alekel et al. in a randomized double blind study in perimenopausal women, isoflavone rich soy proteins can significantly reduce lumbar spine bone loss. In the study the subjects were scheduled to consume soy proteins (containing 80.4 mg/d isoflavones) for 24 weeks. It was observed that the soy significantly increased the bone mineral density (BMD) and content (BMC). The soy treated groups also demonstrated higher levels of bone specific alkaline phosphatase in serum which is an indicator of high osteoblast activity (Alekel et al. 2000). Another prospective study conducted by Matthews et al. in postmenopausal women found that daily consumption of soy milk reduced the likelihood of getting osteoporosis (Matthews et al. 2011). Tousen et al. carried out a pilot randomized double blind study on postmenopausal Japanese women to evaluate the effect of soy isoflavones on the bone loss. These workers found that with the use of soy isoflavone (S-equol) tablets (10 mg/day) for 12 months the bone resorption marker (deoxypyridinoline) was reduced by 23.94% compared to 2.87% in groups that received placebo (Tousen et al. 2011). Another study carried out by Morabito et al. in postmenopausal women showed the effect of genistein (soy phytoestrogen) on bone metabolism and BMD. The study showed that genistein significantly reduced the levels of bone specific alkaline phosphatase and osteocalcin either at 6 or 12 months. The soy isoflavone also significantly increased the BMD femur and lumbar spine hence revealing a significant positive effect on bone formation as well as negative effect on bone resorption (Morabito et al. 2002).

13.6.3 As Antioxidants

Isoflavones have been investigated for their antioxidant activities in a number of studies (Mujić et al. 2011; Tyug et al. 2010; Yue et al. 2010). Through their antioxidant activity, soy isoflavones have been shown to play role in prevention of number of diseases including cardiovascular diseases, cancer, chronic inflammation, etc. Soy isoflavones impart a similar antioxidant action in tissues as many other isoflavones, i.e. through free radical activity. The soy isoflavone, genistein in this way alters DNA stability by acting on enzyme, topoisomerase II. Yousef et al. evaluated the antioxidant activity of soy isoflavones in rabbits by determining the effect on the levels of lipids, lipoproteins and free radicals in plasma, liver, brain, testes and kidneys. The isoflavones were reported to significantly decrease the concentration of free radicals as well as cholesterol, triglyceride and low density lipoprotein, etc. (Yousef et al. 2004). Frtiz et al. conducted a study to determine the antioxidant activity in humans by determining secondary lipid peroxidation products in urine. The subjects were given soy isoflavones for 13 weeks and the lipid peroxidation products were quantified in urine using HPLC. The levels of six nonpolar compounds in urine of the subjects that consumed soy with high isoflavone content were significantly lower than that of the control (Fritz et al. 2003). The anticancer activity of soy isoflavones is also attributed to their antioxidant activity which has been demonstrated by many researchers. Davis et al. have demonstrated that the anticancer activity of genistein in vitro in prostate cancer cells through inhibition of the of the NF-κB (redox-sensitive transcription factor) activation (Davis et al. 1999). In a separate study in cultured human lymphocytes these workers demonstrated the inhibition of TNF-α-induced activation of NF-κB (Davis et al. 2001). Dixit et al. studied the antioxidant effect of soy isoflavones in Wistar rats against the oxidative stress induced by gamma irradiation. The activity of various antioxidant enzymes like catalase, superoxide dismutase and Glutathione-S-transferase was found to increase when the rats were pretreated with soy isoflavones. Also the survival rate of the rats was also found to increase (Dixit et al. 2012).

13.6.4 Lowering of Cholesterol Levels and Cardiovascular Disease

Phytoestrogens that are present in soy like genistein and daidzen have been attributed with cardioprotective tendencies. Numerous studies have demonstrated that these isoflavones decrease the plasma cholesterol concentration in cases of hypercholesteremia but there is minimum to no significant impact in normocholesteremic individuals. The isoflavones also intervene in the endothelial function and alleviate the atherogenic condition by virtue of the antioxidant and antiproliferative property of these compounds. This has been backed by numerous studies that have exhibited antioxidant, antiproliferative and anti-atherogenic potential of Soy isoflavones (Wang et al. 2013; Zaheer and Humayoun Akhtar 2017a, b). A strong LDL lowering trend as compared to initial status was demonstrated by studies meta analysed by Anderson et al. In the study it was stated by Anderson that when the subjects were kept on low fat and cholesterol diet as compared to high fat diet there was minimum impact on LDL concentrations. Two percent similar reduction as compared to full group was observed in LDL irrespective of the fat and cholesterol content of diet (Sacks et al. 2006). Equol, an active metabolite of daidzen has been suggested to possess inverse relation with congestive heart disease in women. Daidzen is converted to equol by gut bacteria with the help of reductase enzymes. Numerous studies have also supported the role of soy products in improvement of health status of postmenopausal women (Cassidy et al. 2006; Sacks et al. 2006). Short-term randomized controlled trials report that equol reduces coronary heart disease by virtue of its significant anti-atherogenic, antihyperlipedemic and cardioankle vascular index improving potential (Mayo et al. 2019).

13.6.5 Isoflavones and Epigenetic Changes

Epigenetic changes take place when there are changes in the phenotype but the DNA sequences are not altered. Despite being heritable epigenetic changes are reversible. Different molecular pathways like DNA methylation, histone tail modifications, nucleosome positioning and non-coding RNAs mediate the epigenetic changes. All of these pathways coordinate with one another to establish an epigenetic landscape governed and regulated by different enzymes (Pudenz et al. 2014). The isoflavones (IF) intervene in these epigenetic changes especially hypermethylation of tumour suppressor genes. Also the phytoestrogens by demethylation and acetylation attain transcription modulation and hence exert its effect on chromatin (Dagdemir et al. 2013; Greathouse et al. 2012; Pudenz et al. 2014).

13.7 Lowering Risk of Breast Cancer

Soy has been attributed with the ability to lower the risk of breast cancer. Studies have reported that the populations that consume soy in their diet have decreased chances of breast cancer. The soy isoflavones like glycetin, daidzen and genistein exert their effects by binding with ERs in a similar fashion breast cancer treating agent's tamoxifen or raloxifene follow. Also it has been observed that due to regular soy intake the incidence of breast cancer is minimum in Asian countries as compared to Western countries. In North America also soy consumption is attributed with decreasing the chances of breast cancer. The isoflavone intake has eventually caused reduced mortality. Soy consumption can benefit the females that are at high risk of developing breast cancer. Even after the cancer diagnosis is ascertained the soy consumption can help greatly in alleviating the condition. Epidemiological studies also support that dietary soy consumption in adolescence exert protection against breast cancer in adulthood (Kelsey and Horn-Ross 1993; Kucuk 2017; Wiseman 1997). This is point mentioning that there is twenty times more estradiol found in breast tumours in postmenopausal women than in the circulation. Soy Isoflavones exert protection in the preliminary stage of breast cancer as the local oestrogen production is inhibited from the breast tissue precursors. Isoflavones inhibit aromatase and 17 hydroxysteroid dehydrogenase that are responsible for production of estradiol (Pasqualini and Chetrite 2005). Significant inverse associations have been found between soy Isoflavones and breast cancer recurrence with restricted oestrogen and progesterone receptor positive cancers that are supported by studies conducted by various researchers (Guha et al. 2009; Touillaud et al. 2007).

13.7.1 Lowering Risk of Prostate Cancer

Androgen dependent tissues that possess androgen receptors are the prime targets of Cancer initiation. Androgens have a critical role in the progression and development of prostate cancer. Thus assuring that prostate cancer (PCa) depends on hormones (Kim and Ryan 2015). Studies have confirmed that in high risk groups of PCa, soy isoflavone administration reduced the incidence (van Die et al. 2014). On further evaluation in other studies conducted it was seen that soy Isoflavone administration efficiently delayed the progression of PCa. There are a number of factors that determine role of Isoflavones in PCa which are as follows (Zhang et al. 2016).

- Presence of equol converting bacteria in gut is crucial in determining the impact and intervention of Isoflavones on PCa.
- Specific ER gene polymorphic variation can impact phytoestrogen functioning greatly. In certain study higher intake of phytoestrogens has been reported to reduce the PCa risk with the specified variation in ER gene while as in other study homozygous carriers with wild type alleles showed no relation between phytoestrogens and PCa.
- CYP19 gene polymorphism influences and modulates the IF levels and androgens in men. Equol levels in both serum as well as urine are related with testosterone and FAI in TT genotype men but not in CC or CT genotype men.
- The long repetitions of TTTA and rs10046 minor alleles in CYP19A1 and rs2077647 in ER-α are responsible for higher incidences of PCa irrespective of the ISOFLAVONE intake while as short TTTA repetition and homozygous major alleles of rs10046 are responsible for lower incidence of PCa in the presence of ISOFLAVONE intake. The concentration of serum and prostate Isoflavones can be attributed with this property of reducing PCa risk.

Isoflavones are believed to be biphasic in their function against PCa depending upon the concentration present. Lower concentrations of genistein for instance increase PSA expression while as higher concentration reduces and retards the expression (Davis et al. 2002; Mahmoud et al. 2013).

13.7.2 Obesity and Diabetes

Obesity is a metabolic disorder that encompasses distortion in energy balance and has crucial relation with hyperinsulinemia, insulin resistance, abnormal lipid metabolism. It is a contributing factor in the development of Type II diabetes, CVD, atherosclerosis and cancers (Ørgaard and Jensen 2008). Prolonged insulin resistance, loss of mass and function of beta cells of pancreas contribute significantly towards the diabetes (Gilbert and Liu 2013) 0.17-β Estradiol is the major modulator of adipocyte development (Misso et al. 2003). Inhibition of lipogenesis takes place when lipoprotein lipase (LPL) activity is retarded by the binding of estradiol to ER. Isoflavones like genistein are reported to cause decrease in LPL mRNA in the adipose tissues (Naaz et al. 2003). Also hormonal intervention via CCAAT/enhancer binding protein (C/EBP), SREBPs and peroxisome proliferator-activated receptor (PPAR) leads to expression of numerous adipogenetic effector genes. Isoflavones via numerous pathways especially PPARs modulate the adipocyte formation (Rosen 2005). Soy Isoflavones especially daidzen and genistein modulate osteogenesis and adipogenesis in a biphasic scheme. Daidzen decreases adipogenesis at concentrations below 20 μ but increases osteogenesis and adipogenesis is triggered with decrease in osteogenesis at concentrations higher than 30 μ (Dang and Löwik

2004; Horton et al. 1998). Another study on the effect of Isoflavones in obese Zucker rats has reported the improvement in lipid metabolism, anti-diabetic effect and activation of PPARs (Mezei et al. 2003). The anti-diabetic and insulinotropic potential of Isoflavones especially genistein is supported by various studies in addition to it being a phytoestrogen, tyrosine kinase inhibitor, lipolytic and antioxidant (Behloul and Wu 2013; Grossini et al. 2018; Liu et al. 2006). Apoptosis in addition to halt in growth due to daidzein and genistein at similar concentration was observed in a study in human preadipocyte cells. This has been supported by the study conducted for impact of genistein in 3T3-L1 cell lines with respect to apoptosis (Choi et al. 2014; Hirota et al. 2010). Three month long clinical evaluation conducted in postmenopausal caucasian and African women has reported significant abdominal and subcutaneous fat reduction due to Soy Isoflavones as a result of IL-6 downregulation triggered by NF-κ B (Christie et al. 2010). Obesity phenotype is modulated by Isoflavones which in turn is dependent on the ISOFLAVONE metabolite producing tendency. This is greatly influenced by the gut microbiota and hence Isoflavones do serve as bioactive agents against obesity and diabetes (Garg et al. 2016).

13.7.3 Skin

The health of the skin is enhanced by oestrogen. Oestrogen causes improvement in the quality and quantity of collagen, skin thickening, wrinkle reduction, vascular improvisation, reduction in activity of sebaceous glands and hastens injury recovery (Shah and Maibach 2001). It has been found that in women after menopause, the use of oestrogen can improve the dermal thickness (Maheux et al. 1994). Recently the use of soy isoflavones and an isoflavanadiol estrogen, (S)-equol has gained importance in the maintenance of healthy skin in women after menopause and in elderly women (Gopaul et al. 2012; Irrera et al. 2017; Lephart 2017; Magnet et al. 2017; Oyama et al. 2012). In studies conducted on animals and cultured cells, isoflavones have been found to be defensive towards the skin damage caused due to UV light (Widyarini 2006; Sitarina Widyarini et al. 2005; Widyarini et al. 2001). On evaluation it has been found that isoflavones exert favourable actions on the skin due to elevated manifestation of androgen and oestrogen receptors along with properties like anti-inflammatory and antioxidant (Lund et al. 2004). It has been observed that isoflavones administered topically and orally exhibited promising effects on diminishing wrinkles and boosts collagen production (Accorsi-Neto et al. 2009; Izumi et al. 2007; Jenkins et al. 2014; Juto and Holm 1991). In experiments, isoflavones are mostly given as mixture and not in pure form. In a study, (S)equol was administered topically in monolayer cultures of human fibroblast. The effect was compared with that of the (R) equol and the racemic mixture of (R) and (S)equol. The results revealed that (S) equol enhanced the regulation of elastin, collagen, etc. (Gopaul et al. 2012; Lephart 2013). A study was conducted in Japan on women after menopause for about 3 months. The women were administered (S) equol orally as a supplement. It was observed that there was a considerable reduction in wrinkles in the treatment group in comparison to the control group (Pflugbeil 1990).

13.7.4 Cognitive Functions

The cognitive processes comprise of thinking, knowledge, memorizing and problem solving. With the process of ageing various cognitive factors are significantly affected. One of the most common disorders related with the ageing is Alzheimer's disorder. It has been observed in a study conducted on women post-menopause that oestrogen replacement therapy can considerably help in enhancing memory in case of Alzheimer's disorder. Isoflavones due to their property of resemblance to 17-beta estradiol help in improving memory of postmenopausal women (Henderson et al. 2000; Neese et al. 2012). In a study conducted on health women after menopause receiving isoflavones as a supplement exhibited improvement of various cognitive factors including visual working memory (VWM) (Casini et al. 2006; Ferreira Galduróz et al. 2010; Greendale et al. 2012; Henderson et al. 2012).

13.7.5 Inflammation

Daidzein and genistein, naturally occurring isoflavones, at a dose of 100 μM studied on macrophage cell lines (J774) restrained manufacture of nitric oxide, expression of messenger RNA and stimulated nuclear factor kappa B, signal transducer and activator of transcription 1 (Hämäläinen et al. 2007). In a study conducted on RAW 264.7 cell lines it was observed that equol and genistein, at concentrations 10 μM and 20 μM, respectively, considerably constrained expression of nitric oxide and dinoprostone (Blay et al. 2009). In a study, lipopolysaccharide stimulated human lung epithelial cell lines (BEAS-2B) were treated with genistein and daidzein at a concentration of 10 μM. It was observed that chemokines, interleukins (IL), viz., IL 6 and IL 8, inflammatory cytokines, CCL2 (monocyte chemo-attractant protein-1) were inhibited leading to expression of anti-inflammatory properties (Zhang et al. 2019). The isoflavones from soy, viz., biochanin A and genistein were studied on RAW 265.7 cell lines stimulated by lipopolysaccharide. It was observed that peroxisome proliferator-activated receptors, involved in the regulation of inflammation were activated, demonstrating anti-inflammatory property of biochanin A and genistein (Mueller et al. 2010) 0.8-hydroxydaidzein (8-HD), a daidzein metabolite isolated from soy, at a concentration of 50 μM was observed to reduce the quantity of TGF-β- activated kinase 1 (TAK1), extracellular signal-regulated protein kinase ½ (ERK1/2), mitogen-activated protein kinase kinase 4 (MAP 2K4) and mitogen-activated protein kinase kinase7 (MAP 2K7) (Kim et al. 2018). In an in vivo study conducted on rats genistein/daidzein was administered at a dose of 20 mg/kg. It was observed that there was decrease in quantity of interleukin-6, tumour necrosis factor-alpha, adipoQ and leptin, which helped in reducing inflammation associated with rheumatoid arthritis (Mohammad-Shahi et al. 2011). In a study "C57 black 6" mice were fed with high-sugar and high-fat diet. They were given daidzein at 1000 mg/kg diet in order to prevent fat cell enlargement and build-up of macrophages in them. It was observed that the inflammation of adipose tissue due to obesity was reduced due to rise of adipoQ concentration and decline of tumour necrosis factor-alpha (TNF-α) and monocyte chemo-attractant protein-1 (MCP-1) concentrations (Sakamoto et al. 2014). In an in vivo study conducted on mice suffering from endometriosis, daidzein was given at varying doses of 0.2–20 μM. It was observed to prevent cell proliferation along with decreasing activities of interleukins (IL-6 and IL8), prostaglandin (PGE2) andcyclo-oxygenase-2 (COX-2). All these factors are responsible for the anti-inflammatory activity of the daidzein (Takaoka et al. 2018). A study was conducted on 75 women post-menopause to observe the effect of soy. It was observed that 20 gm of soy or 160 mg of isoflavones (64 mg genistein, 62 mg daidzein and 34 mg glycitein) caused increase in adipoQ concentrations that prevented inflammation of adipose tissue (Charles et al. 2009).

13.7.6 Colon Cancer

Numerous studies have proposed that the colon cancer development is related to the inflammatory bowel disease (IBD), which is linked with prolonged inflammation of the immune system (Monteleone and Caprioli 2010). Genistein, a naturally occurring isoflavone derived from soy at a concentration of 70 μM causes activation of certain proteins involved in apoptosis viz., BAX (BCL2) and caspase (CASP3); thereby inhibiting immigration of human colorectal adenocarcinoma cell (HT-29) (Shafiee et al. 2016). Also, genistein at a concentration of 200 μM, causes rise in epithelial cadherin (cadherin-1/CDH1) and reduces neural cadherin (cadherin-2/CDH2) response leading to suppression of epithelial to mesenchymal transition (Zhou et al. 2017). In a study it has been found that naturally occurring isoflavone, viz., daidzein and genistein at the concentration of 200 μM decrease the quantity of certain proteins, viz., adipophilin (adipose differentiation-related protein/ADRP/ADFP), perilipin-1 (PLIN1), tail-interacting protein of 47 kD (TIP47) and vimentin. Thus, daidzein and genistein help in stimulating apoptosis of cell by decreasing the build-up of lipid droplets in cell (Liang et al. 2018). In a study conducted on human colon cancer *cell* lines (HT29), genistein at a concentration of 60 μM helped in enhancing removal of methyl group of WIF1 (WNT inhibitory factor 1) and decreased the quantity of beta-catenins and cyclin D1. Thus, it was concluded that genistein helps in inhibiting colon cancer (Zhu et al. 2018).

13.8 Economic Importance

Throughout the world, plants and plant based products gain wider attention due to their immense economic potential. However, only less than 5% of species have been analysed as prospective medicinal products while rest of plant remain to be unexplored. Varieties in family diet and food security in houses are due to the diversity in plants. It is clear that Soybean use is not negligible in many parts of the world, but this is the truth that today human plant foods are based on a very small number of crops. The cultural consumption of soybean by various tribal and non-tribal groups living in rural and semi-urban areas as food and medicine has been extensively exercised. Particularly, the accessibility of soybean collected from anthropogenic landscapes, which allows large group of people to rely on them as a valuable nutritional resource due to their easy access. The nutritional value of soybean is often higher than many known fruits and vegetables. Soybean throughout the world, and especially in developing countries, make a marked contribution to the local community life. Brazil, Argentina, China and the USA are the main soybean producing countries in the world, making up 86% of the worldwide production. In soy, oil and protein are the main commercial interests and their composition varies depending on location, farming practices, variety and climate. Studies on soy provide a much deeper understanding into soy's health benefits at molecular level. The various products of soy can impart an essential and positive role in improving our health if being included into our diet, however, there are still much to be understood, especially the mechanisms involved.

13.9 Conclusion

Soy Isoflavones exert potential biological effects as evident and supported by the numerous in vitro and in vivo studies. Some of these have been discussed in this chapter. The studies range from the role isoflavones play with respect to obesity, diabetes, cancer forms, skin health, inflammation, etc. The wide range of potential exhibited by isoflavones being mostly attributed to the structural similarity to estrogens. Although some data provides conflicting information about the isoflavones still that does not devalue its significance. It creates an immense need for further exploration of isoflavones. This can be achieved in the form of high quality clinical trials considering different perspectives. This would add to and enhance the present knowledge regarding them and ascertain their proper application to ameliorate different pathologies. This chapter has concisely tried to acknowledge and highlight all the crucial areas where application of soy Isoflavones has been studied keeping in view its chemistry as well.

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Account of Some Important Edible Medicinal Plants and Their Socio-Economic Importance 14

Adil Farooq Wali, Salma Jabnoun, Maryam Razmpoor, Fatima Najeeb, Hadeel Shalabi, and Imra Akbar

Abstract

Plants are incredibly significant in the lives of people around the world. People rely on plants to satisfy basic human needs like food, clothing, shelter, and health care. Because of a rising world population, increasing wages, and urbanization, these needs are growing rapidly. Of course, plants provide food directly and often feed livestock that is then eaten on their own. The value of plants is likely to become fairer among countries as world economies become more accessible and market-oriented through trade agreements such as those from the World Trade Organization. The socio-economic significance of such an understanding of plants is defined in this chapter by providing evidence of the multiple benefits of plant breeding in and beyond agriculture based on reproducible findings and scientific evidence for arable crops.

Keywords

Citrus Limon · *Cananga odorata* · Socio-economic · Hollyhock · Anthraquinones

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14.1 Introduction

Most of the known plant species have been left to grow in the natural habitats of forests, villages, and rural households, contributing directly or indirectly to the country's rural economy through the provision of forest products, fruit, fodder, and fuel. From a socio-economic perspective, medicine, often seen as a life-saving item, is a major commodity in our lives. Around 90% of all medicinal items come from the plant kingdom (Rahman 2003). Plants have been used for treating various illnesses since ancient times. Herbal plants belonging to 60 out of 206 families are used for medicinal purposes, according to specialists. Medicinal plants form the basis of conventional and indigenous health care standards used by much of the world's population, according to the World Health Organization (WHO). Modern Pharmacopeia also involves synthetic analogs in at least 25% of plant-based drugs based on prototype compounds derived from plants (Silva 1997).

14.2 *Aloe Vera*

Aloe vera botanical name is *Aloe Barbadensis* Miller. *Aloe vera* is a shrubby or arborescent plant, permanent, succulent, Xerophytic, pea-green in color. It is from the Asphodelaceae family (Liliaceae). It mainly grows in Asian, African, American drylands, and European. *Aloe vera* is used in different cultures over the years for medicinal purposes. It was used in countries such as Greece, Egypt, Mexico, Japan, and China. Thailand was *Aloe Vera's* largest producer, representing about a third of the global production. Mexico, the Dominican Republic, the USA, and Costa Rica are among the most prominent producers in the North and South American region. The largest producer of *Aloe Vera* products in the world today is Forever Living Products. The latest figures on the Aloe market size were published in 2012. At the time, sales of *Aloe Vera* products were estimated to be $13 billion worldwide. Compared to the demand for *Aloe vera*, the demand for other species is expected to below. To illustrate, *Aloe vera* is assumed to contain 90% of food supplements based on *aloes*. *Aloe vera* represents an even higher market share for cosmetic products (Marshall 1990). The organic *Aloe vera* cultivation is based in Greece. The key benefit is that poor agricultural land can be used, and thus rural growth in marginal areas can be encouraged by this crop. The study examining *aloe vera* crops' economic sustainability shows that organic allow-farming in Greece is a promising replacement to the "traditional" crops, particularly in rural families. By comparison, the most entrepreneurial form of agriculture is not advisable unless their crop size makes scale savings (Tzouramani et al. 2014). A forex industry in South Africa has broad socio-economic benefits, from the poorest people with *Aloe* tapping to itinerant agricultural workers and other part-time *aloe* tappers, families, and communities. Their income is only generated by *Aloe* (Newton and Vaughan 1996). According to reports in 2004 in the global market for *Aloe Vera*, the largest source of mesophyll leaves was US $125,000,000, which had a projected 35% growth annually and therefore US $300,000,000 today. According to 2011

International *Aloe* Science Council statistics, 24,000 ha of *Aloe vera* are grown worldwide, in Africa with 300 ha that can contain plants supplies to Nigeria's local markets. Despite the fact that *Aloe vera* is a natural product with industrial interest (Schmelzer and Gurib-Fakim 2006). *Aloe's* economic scales differ from the rural poor by magnitude, whose sole livelihood is based on a specific Aloe plant, farm economies based on multiple plants of crops of Aloe, and the world's extraordinary production of *Aloe Vera*. It has been used as part of Egyptian queens' daily beauty regimes, including Nefertiti and Kleopatra. Columbus and Alexander the Great used it to treat wounds of the soldiers. It was also used in the early 1800s in the USA as a laxative. However, in the mid-30s, chronic and serious radiation dermatitis was successfully treated with a turning point (Davis 1997). The plant has three leaves with edges clamped, tubular flowers yellow, and many fruit seeds. Each leaf comprises three layers: (1) Amino acids, Glucomannans, lipids, vitamins, and sterols are a clear internal gel containing 99% water. (2) The middle layer of latex contains Glycosides and anthraquinones, which is a bitter yellow sap. (3) The 15–20 external thick layer, called a protein rind, synthesizing proteins and carbohydrates. The vascular bundles are present in the rind, which transport substances like starch (phloem) and water (xylem) (Tyler 1993). *Aloe vera* has 74 potentially active ingredients: enzymes, vitamins, minerals, fatty acids, sugars, anthraquinones, amino acids, lignin, saponins, and salicylic acids. Table 14.1 shows the components and uses of each potential active ingredient.

Based on the scientific researches made on human and animals studies, *Aloe vera* has shown to treat many different diseases such as Seborrheic dermatitis (Vardy et al. 1999), psoriasis vulgaris (Paulsen et al. 2005; Syed et al. 1996a, b), genital herpes (Syed et al. 1996a, b, 1997), skin burns (Shelton 1991; Visuthikosol et al. 1995), HIV infection (Montaner et al. 1996), diabetes type 2 (Yeh et al. 2003), ulcerative colitis (Langmead et al. 2004), cancer prevention (Furukawa et al. 2002; Fenig et al. 2004), wound healing (Fulton 1990), pressure ulcers (Thomas et al. 1998), mucositis (Su et al. 2004), radiation dermatitis (Bosley et al. 2003), acne vulgaris (Bassett et al. 1990), lichen planus (Hayes 1999), frostbite (McCauley et al. 1990), aphthous stomatitis (Garnick et al. 1998), and constipation (Ishii et al. 1994).

14.3 *Althaea Rosea*

Althaea Rosea belongs to the Malvaceae family (Grieve 1984). Hollyhock is its common name (Sinhg and Panda 2005). *Althaea Rosea* is a magnificent ornamental herb, which produces large single flowers of many colors (semi-double, double, or frilled) (Pullaiah 2006). Hollyhock is a genus herb that is distributed to Central Asia from the eastern Mediterranean region. It is originally from China and Greece, cultivated most frequently in Indian gardens. China is the largest producer of the hollyhockplant worldwide and transports it to different countries. China has built the world's largest hollyhock plant garden. Sometimes found in waste sites and on roadsides as an escape (Sinhg and Panda 2005; Kirtikar and Basu 1987).

Table 14.1 Uses of different components present as potential active ingredient

Active ingredient	Components and uses	References
Vitamins	It consists of vitamins A, B12, C, and E that prevent free radicals from being neutralized by antioxidants.	Atherton (1997, 1998), Shelton (1991)
Enzymes	This comprises eight enzymes, such as alias, alkaline phosphatases, amylases, bradykinase and carboxypeptides, catalases. Bradykinase when applied topically to the skin can minimize unnecessary inflammation, while others may help break down fats and sugars.	Atherton (1997, 1998), Shelton (1991)
Minerals	It provides chromium, calcium, copper, magnesium, selenium, potassium manganese, zinc, and sodium that are essential for metabolic pathways to function properly in many different enzyme systems.	Atherton (1997, 1998), Shelton (1991)
Sugars	It provides monosaccharides and polysaccharides. The mucopolysaccharides are extracted from the plants mucilage layer. Mannose-6-phosphate is the most prevalent monosaccharide, and the most common polysaccharides are glucomannans. Acemannan has been found to be a popular glucomannan. Recently, Aloe Vera gel has been isolated from a C-glucosyl chromone, a glycoprotein that has anti-allergic properties which is known as alprogen and a new anti-inflammatory compound.	Ro et al. (2000), Hutter et al. (1996)
Anthraquinones	This comprises 12 anthraquinones. Phenolic compounds are used as laxatives traditionally. Emodin and Aloin function as an antibacterial, antiviral, and analgesic	Atherton (1997, 1998), Shelton (1991)
Fatty acids	It comprises four plant steroids: lupeol, cholesterol, campesterol, and β-sisosterol. These also have anti-inflammatory effects, and lupeol is also an analgesic and an antiseptic.	Atherton (1997, 1998), Shelton (1991)
Hormones	Gibberellins and Auxins help to cure wounds and are anti-inflammatory	Atherton (1997, 1998), Shelton (1991)
Salicylic acids	It provides anti-inflammatory and antibacterial effect	Atherton (1997, 1998), Shelton (1991)
Lignin	It increases the penetrative effect of the other ingredients into the skin in topical preparations	Atherton (1997, 1998), Shelton (1991)
Saponins	It possesses cleansing and antiseptic properties	Atherton (1997, 1998), Shelton (1991)

Hollyhock is an erect, straightforward, or sparingly branched herb of 0.5–2.0 m high, stellate hairy and annual or biennial herb. This plant is usually 2.4–3 m tall, erect, stout, simple, and more or less hispid with branching, fascicled hairs. The

Table 14.2 Different parts of hollyhock plants that have different pharmacological uses

Parts of the plant	Uses	References
Flowers	Diuretic, emollient, demulcent, chest pain management, blood circulation improvement, hemorrhage, and constipation	Nadkarni (1989), Lim (2012)
Seeds	Chest pain, asthma, burns, abscesses, diarrhea, skin cuts, hemoptysis, constipation, intestinal colic, peptic ulcers, renal calculi, micturitis, cough, dysphagia, dysuria, thirst, arthritis, skin inflammation and ulcers, enteritis, cystitis, gastritis, proctitis, mastitis	Sinhg and Panda (2005), Pullaiah (2006), Kirtikar and Basu (1987), Chopra et al. (1958), Asolkar et al. (1992), Khare (2007), Mhaskar et al. (2000), Perry (1980), Biswas (2006)
Roots	Appetite loss, ulcers, severe coughs, fiebre, bronchitis, and inflammation	Kirtikar and Basu (1987), Khory (1981), Nadkarni (1989)
Flowers and roots together	Kidney and uterus inflammations and vaginal and seminal discharge	Chopra et al. (1958)
Entire plant	Asthma, jaundice, cough, irritating stomach, throat pain and swelling, renal pain, urinary irritation, and dandruff	Khan et al. (2016)

blades are wide, 7.5–12.5 cm diameter, long petty, cordate ovate, and 5–7 lobed acutely. The flowers are wide, sometimes 10 cm in diameter, purple, short-pedicelled, rose, or white, forming long terminal racemes. The membranes are monopolies, wide, cup-shaped, 6–9, obtuse segments, and sometimes bifid. The calyx is broad, divided into five segments, downy and acute. The petals are large, waxy, and overlapping. The tube of the stem is short and pale yellow. Each cell of the Ovary is numerous with one ovule (Kirtikar and Basu 1987). Disc-shaped fruit divided into one when ripe, seeded nutlets. It is brownish-black in color, kidney shape seeds are approximately 6 mm with rough and marginal hair. When immersed in water, the seeds are mucilaginous (Sinhg and Panda 2005). Hollyhock was a diuretic, anti-inflammatory, demulcent, astringent, febrifugal, and emollient in traditional medicines.

Hollyhock is used to wash the mouth and control the bedwetting and inflammation. It is also used in milk decoction to make delivery easier for pregnant women (Fahamiya et al. 2016). Roots, herbs, and seeds are used in Iranian Herbal Medicine to cure cough and lung diseases. This is also used in respiratory and cough disorders. It has other uses, such as external skin inflammation and ulcers (Ammar et al. 2013). In Tibetan, the flowers and roots are also used in Medicine, where neutral potency, sweet taste, and acrid are identified. Hollyhock also treats Loss of appetite, womb and kidney inflammation, and seminal discharge (Yashaswini et al. 2011). Hollyhock is an excellent calcium source. It may be used to treat conditions such as blood clotting, muscle contraction, and the weakening of the teeth and bones. The hairy leaves, stems, and pollen are irritants (Table 14.2).

Hollyhock plant has shown many pharmacological effects that has been reported. It is helps in treating many diseases because it has various properties such as Antiurolithiatic Activity (Ahmadi et al. 2012), Immunomodulatory Activity (Mukherjee et al. 2014), Antimicrobial Activity (Lim 2012), Anticancer/Cytotoxicity Activity (Lim 2012), Analgesic and Anti-inflammatory Activity (Lim 2012), and Antiulcer Activity (Lim 2012).

14.4 *Hibiscus sabdariffa* (Roselle)

Hibiscus sabdariffa, is also called roselle, can be grown as part of the multiple growing methods and can be used as foods and fibers, as it is fairly easy to grow for developing countries. In China, the seeds are used for oil and the plant for its medicinal properties, while in West Africa, the leaves and crushed seeds are used for food. It is used throughout the food and pharmaceutical sectors. Their distribution is confusing, with some of them suggesting that before 4000 BC *Hs* was domesticated by black people in the Western Sudan or India (Ismail et al. 2008), and Murdock showed evidence (Murdock 1959). Around 15,000 metric tons are currently entering world trade annually. Many countries produce roselle, but quality differs significantly. The biggest producers are China and Thailand, and much of the supply is managed worldwide. Thailand has made significant investments and developed high-quality roselles, while China's products are less consistent and reputable, with poorer quality control practices. The world's best roselle has received from Sudan, but it is small in quantity and weak in processing. Almost all production in Sudan has been exported to Germany. U.S. importers like the product from Sudan, but because of a trade embargo, there is a significant price increase in importers forced to supply this product through Germany. Therefore, the Sudanese product is much less used in the USA, and China and Thailand are the main suppliers. Also, important suppliers are Mexico, Senegal, Tanzania, Mali, and Jamaica, but mainly domestic production (McCaleb 2000). Today, it is broadly cultivated in tropical and subtropical areas such as Saudi Arabia, India, China, Indonesia, Malaysia, Philippines, Sudan, Vietnam, Egypt, México, and Nigeria (Ismail et al. 2008; Eslaminejad and Zakaria 2011). It is stated that roselle is a multifunctional crop that can supply food and Cash income as vegetables and domestic and consumer goods production. For exports and local markets, dried calyces have strong business potential. Regular demand for this plant product is growing as caffeine-free as a natural herbal product. Malaysia now supplies a large part of the world's raw materials from roselle. In Kenya, herbal tea and drinks are sold on specialized herbal product markets and in others. Throughout India, this plant is grown as fruit. It can be easily developed in most drained soils but tolerates poor soils. It takes 4–8 months with night-time temperatures of 20 °C or 13 h of sunlight and a monthly rainfall of 5–1000 (130–250 mm) to prevent premature blooming. Rain or high humidity will reduce the yield and lower the calyces' quality during the harvest and the drying process. *Hs* quality is determined according to seed stocks, local cultivation conditions, time for harvest, handling after harvest, and mainly drying steps. It is susceptible to viral, bacterial and fungi, attacks and insects as it develops as a supplement crop. One plant produces approximately one and a half kilograms of fruit, about 8 t/ha. Off leaves will yield about 10 t/ha (Plotto 2004). *Hs* was commonly used in local medicinal products. In Africa, Mexico, and India, traditionally, infusions of leaf or calyx occur to degrade the blood viscosity and boost bowel peristalsis, as they cause diuretic, choleretic, febrifugal, and hypotensive effects. In Senegal, hypotensive therapies are also recommended. Calyx preparations were used in Egypt to treat heart and nerve diseases and enhance urinary production (diuresis). The injection of “Karkade” calyces also minimizes the body in Egypt and Sudan (Leung and Foster 1996). It is used for drunkenness care in Guatemala. Calyces formulations have been used in North Africa to treat both sore throats and cough and problems of genital, while emollient leaf pulp is used to treat outer injuries and abscesses (Neuwinger 2000). A seed decoction was used in urination and indigestion to relieve pain in India. In Chinese traditional medicine, it is used to treat high blood pressure and liver disorders. The effects of the root are considered in Brazil to have stomach and emollient properties. Sour *hibiscus* tea in Iran is historically used to treat high blood pressure (Burnham et al. 2002), while seed decoction in Nigeria typically improves or causes lactation in low milk, weak letting, and maternal mortality (Gaya et al. 2009). In addition to its importance, hibiscus flora is today traded worldwide as a major ingredient in industrial teas and beverages as traditional medicine or as a food in the countries of its geographical origin. The USA and Germany have the largest dried *Hs* markets. The importation of herbal teas in Germany satisfies much of its consumer’s needs (Plotto 2004). Statistics were not available on the value and volume of hibiscus imported into such markets. The main customers are manufacturing herbal tea for hibiscus importers since this plant is used in many fruit or herbal, together with apple peel, oranges, and lemon twisting (R.S. 2000). The quality of hibiscus largely depends on its geographical origin. Thailand and Sudan have the most desirable product. Nevertheless, China and Thailand are the world’s top suppliers. In Sudan, the best *Hs* are grown, but their quality is often affected by poor processing. The best Hs are grown in Sudan, although their quality is frequently harmed by inadequate processing. Thailand has been spending extensively on hibiscus development in compared to China, where the product is less dependable and respectable due to tight quality controls. Nevertheless, China is the dominant American supplier. Hibiscus has a variety of pharmacological properties and is used to cure a variety of ailments. It is mainly used to treat diseases because it has antibacterial, antifungal, antiparasitic activity (Nwaiwu et al. 2012; Fullerton et al. 2011), antinociceptive, Antipyretic, and anti-inflammatory activities (Ali et al. 2011; Kao et al. 2009), Antioxidant activity (Sayago-Ayerdi et al. 2007; Mossalam et al. 2011), Hepatoprotective activity (Adaramoye et al. 2008; Ajiboye et al. 2011), Nephroprotective activity (Mossalam et al. 2011; Wang et al. 2011), Renal effects/diuretic effect (Laikangbam and Damayanti Devi 2012; Herrera et al. 2004), Cancer-preventive activity (Lo et al. 2007; Hou et al. 2005).

Lipid metabolism—anti-cholesterol effects (Carvajal-Zarrabal et al. 2005; Ochani and D’Mello 2009), Anti-obesity activity (Dickel et al. 2007; Perez-Torres et al. 2012), Lactating activity (Gaya et al. 2009), Anti-diabetic activity

(Adisakwattana et al. 2012; Lans 2006), Anti-hypertensive activity (Inuwa et al. 2012; Shehata and El Menoufy 2008), Anti-anemic activity (Falade et al. 2005; Umar et al. 2009), and conjunctivitis (Fraunfelder 2004).

14.5 *Glycyrrhiza Glabra* (Liquorice)

Glycyrrhiza Glabra is one of the most famous plants that belong to the family of *Fabaceae*. *G. Glabra* is a typical perennial herbaceous leaf with a length of 7–15 cm and reaching up to 1 m in height. The flowers are purple to light white blue and arranged in a hermaphrodite inflorescence, while the fruit is an oblong legume 2–3 cm long with many seeds. *Glycyrrhiza glabra* is one of the most popular medicines in the world. It is also known as licorice, licorice, glycyrrhiza, and Liquiritiae radix. It is native to the Mediterranean region but is present now in Russia, China, and India. Due to the lack of local production of licorice in Japan, licorice from countries such as China, Afghanistan, Turkmenistan, Uzbekistan, and the Pacific are imported into Japan. Although the total amount of licorice imported into Japan in 1987 was 10,723,342 kg, it decreased in 2007 to 1,377,213 kg. Most glycyrrhizin is currently extracted and then purified in manufacturing plants in China and other licorice-producing countries. Thus the import of glycyrrhizin licorice for processing is declining in Japan. Medicinal licorice, used in Kampo medicines, is a proportion of the licorice imported from China. Medicinal licorice is more expensive than licorice used in the manufacture of glycyrrhizin and other licorices; Countries like Afghanistan and Australia grow licorice. Remarkably, there was 144,710 kg of *licorice* in 2007 imported from Australia. Licorice is currently being grown on a farm named maruzen Pharmaceuticals Co. Ltd, owned by a Japanese producer of glycyrrhizin and is used in the production of glycyrrhizin and other licorice. Spain is the country where most licorice is made. In Europe, 35% of all licorice is made in Spain, while 19% is made in the Netherlands. The remainder is in other countries that eat licorice. Many European manufacturers in Spain have companies that produce licorice. Almost all of these factories make a great amount of licorice more than in the Netherlands. Until recently, the Netherlands was Europe's largest drop producer, with sweets worth EUR 1.3 billion per year, including licorice. With Spain first and Germany as third producing countries, the Netherlands is now in second place. The extracts are currently used in the pharma, dairy, foods, and dietary supplements industries (Herrera et al. 2009). The use of licorice goes back to the empires of Roman and Greek and has a great history of traditional medicine and traditional folk medicines. The earliest texts come from the ancient civilizations of Assyria, Egypt, China, and India. Theophrastus and Pedanius Dioscorides have written and described their treatment effects on licorice as a medicinal plant (Armanini et al. 2002). The plant is a popular remedy for bronchitis, cough, gastrointestinal problems, and arthritis, for example, in traditional Chinese medicine. Also, peptic ulcers, gastritis, respiratory infections, and tremors in folk medicine are still widely used. *G. glabra* roots are commonly used to make tea, a great quencher of thirst. The dried root is defined as a purification tool for the tooth (Armanini et al.

Table 14.3 Some important pharmacological activities reported for *G. glabra*, its compounds as well as its *glabra* extracts.

Compounds/ extracts	Uses	References
Glabridin	Neuroprotective activity—improvement of learning and memory, oestrogenic activity, sedative activity, anticarcinogenic activity, antioxidant activity, antimicrobial activity, anti-inflammatory activity	Hasanein (2011), Jin et al. (2013), Cho et al. (2010), Su et al. (2004), Tamir et al. (2001), Hsieh et al. (2016), Jiang et al. (2016), Singh et al. (2015), Carmeli and Fogelman (2009)
Glycyrrhiza glabra aqueous extract	Antidepressant activity	Parle et al. (2004), Dhingra and Sharma (2006)
Glycyrrhiza glabra extract	Neuroprotective activity	Dhingra and Sharma (2006)
18β-Glycyrrhetinic acid	Oestrogenic activity	Sharma et al. (2012a, b)
Glycyrrhetinic acid	Skin effects such as itching scores, erythema reduction, and edema, antimicrobial activity, hepatoprotective activity	Halder and Richards (2004), Nerya et al. (2003), Chakotiya et al. (2016), Liu et al. (2017)
Liquorice root extract	Oestrogenic activity	Tamir et al. (2000)
Liquiritigenin	Oestrogenic activity	Somjen et al. (2004)
Isoliquiritigenin	Oestrogenic activity	Tung et al. (2014)
Glycyrrhizin	Antiviral activity, anti-inflammatory activity	Soufy et al. (2012), Yasui et al. (2011), Michaelis et al. (2011)
Licochalcone E, A	Anticarcinogenic activity	Yu et al. (2017), Xiao et al. (2011)
Licochalcone	Antioxidant activity	Haraguchi et al. (1998)
Liquorice aqueous extract	Hepatoprotective activity	Huo et al. (2011)
G. glabra aqueous root extract	Hepatoprotective activity	Hajiaghamohammadi et al. (2012), Yin et al. (2017)

2002). The big industrial application of *G. glabra* is the production of food additives such as sweetening agents and flavors (Mukhopadhyay and Panja 2008). The root is used in chewing gum, tobacco, sweets, baked products, ice cream, and flavoring agents as in soft drinks (Rizzato et al. 2017). Root extracts are used in beers and extinguishers as foaming agents, and root fibers are used to absorb medicinal and flavoring constituents in insulation, wallboard, and boxboard products. In cosmetics, *G. Glabra* is termed as an agent of skin depigmentation and is used for this purpose in topical products. *G. glabra* contains many constituents. The most important components are Glycyrrhizin, Liquiritin, isoliquiritin, 18β-Glycyrrhetinic acid, Liquiritigenin, Isoliquiritigenin, Liquiritin apposite, Glycyrrhetic acid, Licochalcone A, and Glabridin (Hayashi et al. 2016; Siracusa et al. 2011). The world's oldest and most widely used herbal medicines are *licorice*. The most important pharmacological activities reported for *G. glabra*, its compounds, and its *glabra* extracts are summarized in Table 14.3.

It has been reported that *G. glabra* has many pharmacological effects and it used to cure many diseases. It is mainly used to treat diseases because it has antioxidant activity (Rackova et al. 2007), anti-inflammatory activity (Yang et al. 2017), antitussic and expectorant activity (Damle 2014), antiulcerative activity (Armanini et al. 2002), antimicrobial activity (Gupta et al. 2008), antiviral activity (Wang et al. 2015), hepatoprotective activity (Huo et al. 2011), Anticarcinogenic and antimutagenic activity (Lee et al. 2008), Neuroprotective activity (Dhingra and Sharma 2006), sedative activity (Hoffmann et al. 2016), antidepressive activity (Dhingra and Sharma 2006), Oestrogenic and androgenic activity (Kim and Park 2012), skin effects (Saeedi et al. 2003), and use to treat bone problems and bone disorders (Kumar et al. 2015). *Liquorice* can also reduce diabetes symptoms (Bahmani et al. 2014).

14.6 *Sambucus nigra* (*Elderberry*)

Sambucus nigra is a flowering complex plant species in most of North America and Europe. It is produced mostly in Europe, Africa, and southwest Asia, then distributed to other countries. The main economic use of elderberry in Britain was consumed in 1995 in the UK by approximately fifteen million liters of elderly natural beverages. In comparison with 1991, this represents a 500% increase. A few kilometers from processing plants, most of the material used has been picked from naturally occurring bushes to lead the authors to speculate about future impacts of wild populations. The fruits are used to color fruit juice and the wine's preparation from elderberry and jelly (Prendergast and Dennis 1997). Local people often well utilized *S. nigra* as a valuable flower and fruit crop to have a positive social impact. It comes from the Adoxaceae native family. The elder, elderberry, black elder, and black elderberry are all common names of *Sambucus nigra*. It grows under various conditions, mostly in sunny areas, including wet and dry fertilized soils (Miraj 2016; Nsimba-Lubaki and Peumans 1986). It is a small tree or shrub that grows up to 6 m tall and broad. The leaves are arranged with 5–7 leaflets in opposite pairs of 10–30 cm long (Miraj 2016; Lee and Finn 2007). In late spring through mid-summer, in broad flat corymbs, the hermaphrodite flowers contain 5–6 mm in size, with 5 petals (Shahidi-Noghabi et al. 2009). The fruit is 3–5 mm in diameter, from bright dark purple to black. For many fruit-eating birds, particularly blackcaps, they are important food (Hidayati et al. 2000). When fully mature but slightly poisonous in its unripe state, the dark blue and purple berries can be eaten. Cyanogenic glycosides are present in the green parts of the plant, and they are poisonous. After cooking, the fruit is edible and can prepare jam, jelly, chutney, and contact (Atkinson and Atkinson 2002; Finn et al. 2008). The floral heads are also used in infusions and are popular in Northern European and Balkan countries for a refreshing drink. The flowers are produced in Europe as a cordial or syrup. This famous traditional drink has recently inspired some commercial soft drink manufacturers to launch elder flower-flavored products (Jørgensen et al. 2000). The jelly ear fungus is also present on elderly trees, which has culinary and medicinal uses. Dried *Sambucus nigra* flowers are used in herbal tea. Indigenous people and herbalists use this herb as a medicinal plant. The flowers, leaves, stem bark, fruit, and root extracts of *Sambucus nigra* are used in cough, bronchitis, upper respiratory cold infection, and fever (Manganelli et al. 2005; Mohammadsadeghi et al. 2013; Harokopakis et al. 2006). *Sambucus nigra* fruits and flowers were used internally as a way of treating respiratory, digestive, gastrointestinal tract diseases, viral infection, influenza, and skin disorders in traditional Austrian medicines (Dawidowicz et al. 2006; Abuja et al. 1998; Veberic et al. 2009; Zakay-Rones et al. 1995; Hearst et al. 2010; Serkedjieva et al. 1990). Elderberry has shown to treat many different diseases due to its different properties such as Antioxidant effect (Ciocoiu et al. 2016; Kaack and Austed 1998), Photoprotective effect (Jarzycka et al. 2013), anti-inflammatory, antiglycosylation activity, antiosteoporosis effects (Badescu et al. 2012), Antivirus effect (Gregorio-Jauregui et al. 2014), Anti-allergy effect (Förster-Waldl et al. 2003), Antiurolithiasic effect (Crescenti et al. 2015), Anti-Toxoplasma activities effect (Daryani et al. 2015), and Anti-diabetic activity effect (Coupe et al. 1995).

14.7 *Thymus vulgaris* (Garden Thyme)

Thymus vulgaris is a member of the mint family Lamiaceae with an estimated 150 species widely present in Asia, North America, and Africa. *Thymus vulgaris* has also extended to the Iberian Peninsula (Baser 1995). They are herbaceous perennials in small shrubs containing large amounts of phenolic substances that possess antioxidative properties and essential oils (WHO 1999). Thymus genus is widely utilized to flavor food, taken in the form of herbal tea and most importantly as medicinal plants as they possess many documented therapeutic effects, and these properties have turned it one of the most recognized and commercial plants around the globe (Stahl-Biskup and Saez 2002). *Thymus vulgaris* L. (Garden Thyme) is utilized in medicine as an expectorant, antispasmodic, antibroncholitic, antitussive, diuretic, anthelmintic, as carminative. Recent studies indicated the presence of potent antibacterial, antifungal, antiparasitic, spasmolytic, antiviral, and antioxidant activities (Stahl-Biskup and Saez 2002). Thyme has also been documented to assist in the treatment of inflammation and laryngitis. When applied, topically thyme soothes bites and stings and alleviates neuralgia and rheumatic aches (ESCOP 2007). In addition to many therapeutic actions, thyme contains antitumor effects observed in four different cell lines HCT15, MCF7, HepG2, and HeLa, where 50% growth inhibition was observed (GI50) (Nikolic et al. 2013). Besides, a study performed concluded that thyme extracts can bring about anxiolytic effects when introduced per oral for 1 week to rats as the percentage of both the entries and the time spent in the open arms of the maze improved after the administration of *Thymus Vulgaris* extract (Komaki et al. 2016). The main component of *Thymus vulgaris* is thymol it has a concentration of 20–54% (Ozguven and Tansi 1998); the active constituent thymol has its own documented therapeutic effects such as antibacterial specifically coccid bacteria and is applied to combat skin problems like oily skin, sciatica, dermatitis, acne as well as bug bites (ESCOP 2007). The other active ingredients include carvacrol (15%), thymol methyl ether (2%), cineol, pinene, cymene, myrcene, borneol, borneol, linalool, and *p*-cymene and esters (Ozguven and Tansi 1998; Azaz et al. 2004). Due to *thymus vulgaris's* wide variety of uses, it created a socio-economic impact where a study performed in Ethiopia laid out the different uses of thyme. Mainly used as a food additive where it is added for additional flavor, aroma, and increased shelf life of the food. It is also used for honey bee forage, animal forage where it is utilized for fattening of the animals, also, used for cleaning and fumigating household utensils such as buckets for milking and the concoction of dough as to avoid rancidity and ensure the best flavors (Damtie and Mekonnen 2016). The versatility of thyme and its different uses around the house and part of the day creates a marketplace where there are supply and demand, therefore having economic significance (Damtie and Mekonnen 2016).

14.8 *Cucumis sativus* (Cucumber)

Cucumis sativus, commonly known as the cucumber is an edible fruit botanically classified as berries from the family Cucurbitaceae; there are various shapes and sizes that the plant comes in. They could be stubby, thick little fruits that range from 10 to 12 cm long or could be from the Dutch greenhouse variety where it can grow up to 50 cm long. There are 30 different Cucumis species mostly found in Africa and Asia and are native to the tropics. Cucumis has 3000 years' worth of history, making it one of the oldest cultivated vegetable crops (Yawalkar 1985). *Cucumis sativus* flowers are monoecious yellow and have five lobed. The fruits are commonly used in the everyday kitchen and eaten commonly in salads and used as a cooling food; the fruit is used to relieve constipation and enhance digestion (Chakravarty 1982). The leaves are similar to cumin seeds given in throat affections (Yusuf et al. 1994). Cucumber is mostly composed of water, making up 96% of its content. Other constituents include amino acids, vitamins, minerals, fatty acids, phenolic acids, phytosterols, and cucurbitacin in addition to Glycosides, steroids, flavonoids, carbohydrates, triterpenoid, and tannins; with trace amounts of essential oil, pectins, amino acids, sugars, starch, and vitamin C (Rang and Dale 2007; Ankita et al. 2012). *Cucumis sativus* exhibits many pharmacological actions, including cytotoxic activity, antibacterial activity, antifungal activity, Antacid and Carminative activity, Activity in the inhibition of ulcerative colitis, Hypoglycemic and Hypolipidemic activity, wound healing as well as Hepatoprotective activity (Tripathi 2008; Rang and Dale 2007; Ankita et al. 2012). A study was conducted using *Cucumis sativus* to prove its antimicrobial activity. The methanolic extract had the highest potency, however, ineffective on *E. coli* and *P. aeruginosa*; therefore, it has been concluded that the plant contains broad-spectrum antimicrobial activity. Another study conducted by the same scientist has documented effective antifungal effects (Ankita et al. 2012). This was proven again by Jony Mallik et al., where the inhibition zone was found to be 80 μg/disc, the ethanol extract compared to the standard

Griseofulvin (30 μg/disc) (Mallik and Akhter 2012). Patil et al. documented and proved effective action against ulceration colitis using the fruit's aqueous extract when tested on laboratory animals (Patil et al. 2012). Patil et al. extended their research to wound healing where he found that the aqueous extract is efficacious in wound healing never less Herbal paste preparation showed a higher level of improvement in wound contraction, maturation as well as epithelialization ($P > 0.05$) (Patil et al. 2012). It has been investigated by Swapnil Sharma et al. that the fruit pulp aqueous extract of *C. sativa* substantially neutralized acid and exhibited resistance in opposition to alteration in pH with additional carminative properties (Sharma et al. 2012a, b). It has been exhibited that cucumber contains Hypoglycemic and Hypolipidemic activity; the extract decreased blood glucose level by 67%, reduced low-density lipoproteins level by 87%, and reduced the overall cholesterol level to 29%; besides, *Cucumis sativus* reduced triglycerides levels to 72% with significant enhancement of glycogenesis was observed (Sharmin et al. 2013).

Around the world, *Cucumis sativus* is one of the highest economically significant plants around the globe (Innark et al. 2013). This fruit is sourced and sold worldwide, making up the income of many farmers around the world and providing for them and their families that are an average of five individuals. A study performed to understand better the socio-economic importance of *Cucumis Sativus* in Rural Communities of Jos; North-Central Nigeria derived that the biggest population of farmers yielded lower quantities of crops, gaining a mean income of USD 384 per individual per harvest season with a maximum of USD 629 when receiving support from agroforestry and vegetable production project increasing their income by 39%. Furthermore, the biggest number of farmers of cucumber (41.27%) produced a range of 1800–4455 kg, albeit the biggest amount of cucumber (4500 kg-above) was yielded by 20.63% of the farmers (Yilangai et al. 2015). The production of profit remains difficult even after using high-quality hybrid seeds that produce high and efficient productivity. This is due to the continuous tillage of soil without fallow periods, which has decreased the soil fertility and decreased crop yield (Yilangai et al. 2014). As the standards of living around the world increase, it places a high demand on the low-income farmers earn with exhausting labor, it becomes increasingly strenuous for them to increase yield without intervention and support from professional bodies and experts (Yilangai et al. 2015). A study performed in Turkey shows that cucumber production's total costs were found to be € 3470 (€ 3.47 m^{-2}). Variable cost being was 39.1%, and a fixed cost of 60.9% of the total costs; therefore, the cost of production of 1 kg of cucumber is € 0.11 according to the mathematical calculations performed; however, the estimate of the production cost was found to be € 0.14 in a 1035 m^2 greenhouse (Engindeniz 2004). An alternate study performed in it was documented that the production cost of 1 kg was € 1.52 in an 1860 m^2 greenhouse (Hickman and Klonsky 1993). The total gross revenue produced from cucumbers was found to be € 5315 (€ 5.31 m^{-2}); hence the total net return was found to be € 1845. The percentage variable costs and fixed costs for the gross revenue were 25.6% and 39.7%, respectively (Engindeniz and Gül 2009).

14.9 *Silybum marianum* (Milk Thistle)

Silybum marianum is a plant/herb that belongs to the Asteraceae family (Corchete 2008). *Silybum marianum*, also known as milk thistle, is domestic to Southern Russia, Southern Europe, Northern Africa, and Asia Minor and is naturalized in South Australia and South America (Abenavoli et al. 2010). Its leaves are identified by its leaves containing white veins and purple flowers borne at the branch tip with black or dark brown seeds and produce silky white pappus (Corchete 2008). The plant extracts contain huge amounts of chemical components inclusive of multiple flavonolignans in sum known as silymarin (Pepping 1999). The potent antioxidant property of milk thistle is attributed to silymarin. It leads to various benefits, including various hepatic disorders, including chronic viral hepatitis, mushroom poisoning, and hepatotoxicity secondary to acute (Flora et al. 1998; Sonnenbichler et al. 1986). Milk thistle contains numerous documented therapeutic effects; it is used in the treatment of Alzheimer's disease anticirrhotic, anticarcinogenic, an antidote to mushroom poisoning, as a galactagogue, emetic, antidepressant, control of food and seasonal allergies, dyspepsia, eczema, cough, elimination of abscesses, gastrointestinal problems, gallbladder disorder, hypocholesterolemic, immunity enhancement, kidney disorders, liver disorders, lung ailments, motion sickness, migraine, psoriasis, skin and spleen disorders, skin cancer, sweat-inducing, to cure menstrual problems, to cure constipation, tonic and diuretic as well as treating infections, and so on (Corchete 2008).

Furthermore, nursing mothers have used milk thistle to stimulate breast-milk production and used in the therapy of patients with depression and used as a neuroprotective agent (Post-White et al. 2007). The most widely used silymarin in patients who suffer from liver diseases, especially alcoholics whose excessive alcohol intake led to liver cirrhosis; even though silymarin has a respected safety record, few reports have documented skin allergies and GIT disturbances (Bean 2002). The mechanism of action of milk thistle is not known; however, it has been proposed that it competes with toxins for hepatocyte binding and penetration; therefore, it has been recommended for healthier patients with liver cirrhosis (Boerth and Strong 2002). Silymarin secondary products yield anti-inflammatory activity in lower doses. It inhibits the thrombocyte functioning in mice, albeit in larger doses, the body's inflammatory process can be stimulated (Johnson et al. 2003).

Furthermore, the flavonolignans such as silydianin, silybin, and silychristin are studied for their antiarthritic action against inflammation induced by papaya latex and arthritis that has been brought about by mycobacterial adjuvant in rats. The antiarthritic and anti-inflammatory activities exhibited have been attributed to the hindrance of 5-lipoxygenase (Gupta et al. 2000). Including all the therapeutic effects that *Silybum marianum* possesses, it has also been utilized in cosmetics such as creams and lotions to defend the body from multiple skin infections due to its powerful antioxidant actions its photoprotective agents. However, investigations are still being performed to discover the long-term effects of *Silybum marianum* in cosmetics. Herbs that are effective, affordable, and safe have been sought after in the cosmetics industry, and more study is being done to recognize herbal ingredients as photoprotective agents (Malhotra and Singh 2003) (Chanchal and Swarnlata 2009). Multiple research avenues have been opened for *Silybum marianum* due to its high economic rank, although its cultivation should be motivated further to implicate maximum health benefits. This could be achieved by the use of biotechnology techniques to develop better roles for high yielding varieties. Also, the marketing of the product that has been presented at this moment has been deemed insufficient, and the increase of said marketing would lead to an increase in the plant's availability. Silymarin the active constituents are Milk Thistlewater-insoluble and is often administrated in a capsule dosage form; however, studies have reported that silybinin absorption is low when the route of administration is oral; therefore, an alternate route of administration is needed to administer the active constituent (Sidhu et al. 2012).

14.10 *Citrus Limon* (Lemon)

Citrus limon, commonly known as lemon, is a tree that reaches 2.5–3 m tall with bisexual flowers colored white with a purple tinge at the corners of the petals and produces the commonly used culinary yellow colored fruits that belong to the Rutaceae (Mabberley 2004). The fruit is well known for its nutritional properties and known biological activities; however, underrated in its recent phytotherapy and cosmetology (Goetz 2014). Before the discovery of lemons rich quantity of vitamin C, it has been used for the therapy of scurvy; its traditional use includes the treatment of the common cold and coughs, high blood pressure as well as irregular menstruation (Papp et al. 2011; Clement et al. 2015; Bhatia et al. 2015). *C. limon* is rich in beneficial chemical constituents, most importantly the secondary metabolite flavonoids and other constituents like phenolic acids, carboxylic acids, coumarins, vitamins, and amino acids. D-limonene the monoterpenoid is the major compound in limon essential oil (Abad-García et al. 2012; García-Salas et al. 2013). The therapeutic effects of *citrus* are vast and well documented; they include antioxidant, anti-inflammatory, anticancer, antimicrobial, and antiparasitic activity. Moreover, it contains anti-allergic, hepatoregenerating, anti-obesity, anti-diabetic effects with additional effects on the cardiovascular, digestive, nervous, and skeletal. It is also a corrigent in pharmacy, showing a vast range of actions increasing its economic impact (Klimek-Szczykutowicz et al. 2020). *C. limon* has documented action suppressing chronic myeloid leukemia (CML) tumor growth, the nanovesicles reaches the tumor location and activates TRAIL-mediated apoptotic cell activities (Raimondo et al. 2015). In addition to suppressing CML, *C. limon* can inhibit the proliferation of human breast adenocarcinoma (MCF-7) cells, it is suggested that the aglycones and glycosides of the limonoids and flavonoids present in the extract could act as a chemopreventive agent for breast cancer (Kim et al. 2012). Furthermore, the antioxidant activity attributed to *Citrus limon* is sourced from the flavonoids present, such as hesperidin and hesperetin, which works in two ways: free radical scavenging and utilizing the ERK/Nrf2 signaling pathway and also augmenting the antioxidant cellular defenses (Parhiz et al. 2015). The abundant amount of Vitamin C present inhibits free radicals' production and protects DNA from mutations; further studies documented a decrease in lipid peroxidation in seizures and the induction of status of people with epilepsy in adult rats by pilocarpine (Xavier et al. 2007). D-limonene is an active constituent present in limon. Some of its therapeutic uses include anti-inflammatory effects, digestive system effects as well as anti-diabetic effects. D-limonene reduces nausea, relieves gastric reflux, neutralizes stomach acids, and increases gastric motility (Millet 2014). D-limonenes' anti-inflammatory action is brought by decreasing cell migration, protein extravasation initiated by carrageenan, and cytokines' production (Amorim et al. 2016). D-limonene in fibroblast cultures can inhibit TNFα-induced NF-κB translocation. In colonic HT-29/B6 cell monolayers, increased epithelial resistance is observed when D-limonene is applied, with additional evidence of the reduction of IL-6; the oil of *Citrus limon* exhibited moderately inhibited soybean 5-lipoxygenase with 32.05 μg/mL IC50 value (Hamdan et al. 2013). As for the active constituents, the anti-diabetic effect is achieved by increasing the activities of gluconeogenic enzymes like fructose 1,6-bisphosphatase and glucose 6-phosphatase with a reduction of activity of glucokinase, a glycolytic enzyme as well as glycogen; it has been stated that the effects observed are comparable with glibenclamide (Murali and Saravanan 2012). In chronic liver poisoning, the use of *C. limon* essential oil has been studied, which showed positive stimulation of liver detoxification by activating liver enzymes and cytochrome P450 (Millet 2014). Due to *C. limon's* antibiotic and flavoring properties, it has been used to formulate many cosmetical products such as toothpaste, shampoos, topical ointments as well as used to yield anti-aging effects on the skin as it is a powerful antioxidant (Parhiz et al. 2015; Xavier et al. 2007). A study run in Mizoram identifies *citrus* as one of the crucial fruit crops cultivated there. Therefore, the third major fruit crop cultivated in India is known to be in a significant position amid the subtropical fruits (Anonymous 2008). The study looked into increasing the productivity of intercropping systems, where the highest profit was found by incorporating lemon + French bean (3.94) in contrast to the gross return that scored the lowest being the production of *C. limon* for 2 years, therefore incorporating the two fruits produced optimum results for equivalent yield and economics (Hnamte et al., 2013). Furthermore, another study performed in morocco where the socio-economic impact of different medicinal plants in the Rissani oasis area was assessed deduced that the people who lived there used *C. limon* in the treatment of fevers, angina as well as an additive where the percentage frequency was found to be 0.34% (El Mansouri et al. 2011). For the rural occupants of the Nhema communal area, Zimbabwe home gardens contribute to their livelihoods no matter how small the income might be. It assists them in meeting their needs and improves their quality of life, and may foster growth in the economy in the future that is sustainable; after the collection of information, it was observed that the *Citrus limon* fruit had been sed by the occupants as edible plants as well as for its medicinal effects with 78% frequency (% of home gardens in which the species are found out of 18). The fruit has been widespread and used in a mixture with different plants, including *Psidium guajava* leaves and Eucalyptus sp. leaves for the treatment of fevers and flu cases, hence identified as one of the recorded significant fruit trees in

Nhema communal area found in many homes, home fields, and orchards (Maroyi 2009). *Citrus limon* in Bahour, Puducherry, India has a frequency of 1.6%; in this case, the farmers observed that organic was more beneficial and increased their profit while inorganic farming increased their cost without a substantial increase in profits, therefore only stuck to organic farming where the abundance was found to be 6 and 2.3% proportion. *C. limon's* Yield and price (Rs)/individual/year was reported to be 600 nos @1800/year, the cost spent (Rs) being 600 and finally, with a B:C ratio of 3 (Padmavathy and Gopalsamy 2013).

14.11 *Viola tricolor* (Pansy)

Viola tricolor L. also known as a pansy or Heartsease is an edible plant/herb in the Violaceae family that has been recognized for its many medicinal uses that have been documented in the Pharmacopeia (European Pharmacopoeia (EP) 2011); it is used as traditional therapy for skin diseases such as the treatment of scabs, itching, ulcers, psoriasis or eczema due to its anti-inflammatory activity. It's also used to treat lung and chest irritation, such as asthma and bronchitis (Hellinger et al. 2014); the herb is also used in the cases of cradle cap in babies and the treatment of cystitis that is frequent and painful. The abundant salicylates and rutin present in wild pansies are what causes the anti-inflammatory effects observed. The rutin present can prevent bruising and broken capillaries, assist in the reduction of blood pressure, and check the tissues for fluid buildup; rutin is mildly laxative. Also, it has been documented that rutin has been used to treat epilepsy and many other complaints. *Viola tricolor* L. had obtained its common name Heartsease from its reputation of use in treating heart diseases. The name Heartsease has also claimed to be derived from an alternate mythical belief of it being a love potion. It has also been successfully used post-surgery to prevent reoccurring tumors. However, extreme caution should be exercised when administering excessive doses, as this may result in vomiting or nausea (Scharfetter 1953; McGuffin et al. 1997). A study documented potential cytotoxic activities observed when using the ethyl acetate fraction of *Viola tricolor* was achieved by reducing tumor cells' proliferation, inhibiting angiogenesis on CAM, and stimulating apoptosis. *Viola tricolor* is known for its flavonoid concentration (Vukics et al. 2008a, b), phenylcarbonic acids, coumarins, polysaccharides, and catechins, in addition to rutin and salicylates (Czygan and Wichtl 2002; Schopke et al. 1993; Goransson et al., 2004). *Viola tricolor* is native to and naturalized in various parts of the Middle East, Europe, throughout the USA and Central Asia; a study conducted showed that their habilitates are reducing at a high velocity, therefore limiting their medical and pharmaceutical uses, causing a menace to the survival of species. Four natural habitats Kaunas, Jonava, Lazdijai, Vilnius districts, have disappeared due to human action and nature protection where competition is observed with other herbs. Wild pansies have been grown for many years; however, they are sensitive to displacement and movement from one location to another (Rimkiene et al. 2003). A study performed in southern Ecuador to observe medicinal plants sold in traditional markets observed that the vendors relayed on 11 different plants to treat medical ailments, and the top 7 plants sold with a frequency FL > 60%. This list included *Viola tricolor* L. (Tinitana et al. 2016). An alternate study conducted by Bahmani et al. showed that *wild pansy* is widely used in Iran, especially in two provinces called Mobarakeh and Isfahan, where they utilized the flower and the whole plant to treat diarrhea (Bahmani et al. 2016).

14.12 *Cananga odorata* (*Ylang-ylang*)

Ylang-ylang is commonly called *Cananga odorata* (Hook. F. & Thomson). It is a rapidly growing tree native to Malaysia, the Philippines, Indonesia, and some other Indian Ocean islands. This plant was renowned for its flower fragrant and was introduced in India, China, America, and Africa. It has a deeply sweet fragrance close to jasmine (Goodrich 2012). *C. odorata* belongs to the Annonaceae family, with 125 genera and 2050 species. Nowadays, the Cananga genus has been composed of two types of plant, namely *C. latifolia* and *C. odorata. C. odorata* is a perennial tropical tree native to Malaysia and the Philippines. It exists in several pacific islands, including Australia. This plant extracted a large variety of chemical substances such as phenylpropanoids, monoterpene, and sesquiterpenes. *C. odorant* extract contains anti-inflammatory, antimicrobial, lentivector, antibiofilm, insect-repellent, antifertility, anti-diabetic, and antimelanogenesis activities. The popular name of *C. odorara* is *Ylang-ylang. Many other names are there, such as perfume tree, cadmium, and Cananga* (*Manne*rand and Elevitch 2006). *C. odorata* is used to treat malaria, stomach problems, asthma, rheumatism, and gout. Oil of ylang-ylang is used in aromatherapy to combat insomnia, elevated anxiety, and blood pressure. The Essential Oil derived from Cleaves of *C. odorata* utilizing the hydrodistillation extraction process has been shown to have a sedative impact and some degree of physiological control on humans (Wang 2012). It was traditionally used by the tribal people and the Northern Mariana Islands to combat pneumonia and stomach ache. The pounded fresh flower paste has also been recorded to treat asthma (Nandwani et al. 2008). The dried flowers of *C. odorata* in Java are used for managing infections and signs identical to infection same it is also known in Vietnam as medicinal plants to use against malaria (Nguyen-Pouplin et al. 2007). It has also been reported to have a lower blood pressure action, which suggests its potential use in hypertension management (Saedi and Crawford 2006). The leaves of *C. odorata* are assumed that by direct topical application, the itchiness is calming down and also to treat hair dandruff (Jain and Srivastava 2005). In Indian, they used the Oil of ylang-ylang for headache relief and treat gout and eye inflammation (Holdsworth 1990); the ancient Papua New Guinean healers claim that drinking the decoction of the hot inner bark of *C. odorata* will cure gout (Holdsworth and Corbett 1988). It is assumed that the plant is involved in the treatment of stomach ailments. The cultures of tonga and samosas also use it as a laxative. Indian used plant bark decoction for the therapy of rheumatism, fevers, phlegm, ulcers, and ophthalmia (Rolo et al., 2012). The production of essential ylang-ylang oil is a significant economic factor because Oil is, after clovers, the second-largest export product in the Comoros Islands (Benini et al. 2010).

14.13 *Roman chamomile* (Chamomile)

Chamomile is a very common plant used widely for ages ago for medicinal use; mostly, chamomileis used for many Curing technologies (Astin et al. 2000). Chamomile is native to the Ancient World and is a member of the *daisy* family. There are two famous types: *German camomile* (*Chamomile Matricaria*) and *Roman chamomile* (*Chamaemelum Nobile*) (Hansen and Christensen 2009). The plant contains several different oil containing 0.24–1.9% volatile oils. When exposed to steam distillation, the oil varies from blue to deep green in fresh conditions, but it turns into dark yellow after storage. About 120 secondary metabolites, including 28 terpenoids and 36 flavonoids, were found in chamomile (Mann and Staba 1986; McKay and Blumberg 2000). In alcoholic tinctures, chamazulene and bisabolol are extremely toxic and retained. The *Roman Chamomile* essential oil contains less chamazulene and consists mostly of the angel and tiglic acid esters. Farnesene and α-pinene are also found. *Roman chamomile* is composed of 0.6% of the germacra-nolide type sesquiterpene lactones, mainly nobilin and three epinobilins.

Both α-bisabolol and bisabolol oxides A and B and chamazulene or azulenesse, farnesene, and spiro-ether sesquiterpene lactones, glycosides, hydroxycoumarins, flavonoids, coumarins, terpenoids, and mucilage are considered to be the major bioactive ingredients (lemberkovics et al. 1998; Baser et al. 2006). The drug is a traditional one for wounds, ulcers, eczema, gout, skin irritations, bruise, cancer sores, neuralgias, sciatica, hemorrhoids, mastitis, and other diseases. Aqueous extract chamomile has also been used as a mild sedative to relax the nerves, decreasing anxiety in treating hysteria, nightmares, insomnia, and other sleeping problems (Forster et al. 1980). It was valued as a relaxant digestive agent and used in various gastrointestinal disorders such as flatulence, indigestion, diarrhea, anorexia, sickness of motion, nausea, and vomiting (Crotteau et al. 2006; Sakai and Misawa 2005). The treatment of colic, croup, and fever in children is also being used with chamomile (Peña et al. 2006). It has also been used in women as an emmenagogue and uterine tonic. It also helps to relieve arthritis, soreness, back pain, and cramps of the stomach. For more than 2000 years, Chamomile flowers have been part of the medicines of various cultural groups. It is undoubtedly one of the world's most interesting medicinal plants, even though the "true camomile" is only European and northeasterly native but naturalizing in many other regions and is also called the *German camomile*. The Chemiewerke Homburg company had already been awarded a patent for the first *chamomile* extract in 1921. In a wide variety of products, Europeans use chamomile. *German camomile* is common in herbal teas, which consumes over one million *chamomile* teacups every day (Srivastava and Gupta 2010). Chamomile flowers are consumed several thousand tons annually (Salamon and Sudimakova 2007). Chamomile tea is used to treat gastrointestinal tract spasms and inflammatory conditions, ulcers and menstrual disorders, and so on

(Kato et al. 2008). It is a leading global commodity, and the market for this herbal raw material is continuously rising. This trend makes it possible to plan, invest, and increase the volume of production of chamomile for a long period. Intensive chamomile farming countries in which all technological methods of cultivation and processing are performed mechanically in an excellent way and with rational energy consumption achieve an increase in chamomile production. Mexico, Argentina, and Egypt were the main producing countries for chamomile. Central Europe has been an important source in the past, but it has become increasingly costly over the years.

14.14 *Allium tuberosum* (Garlic Chive)

The Allium genus belonging to the Amaryllidaceae family contains approximately 700 species of plants, like *Allium sativum* (garlic), *Allium tuberosum* (garlic chive), *Allium schoenoprasum* (chive), *Allium cepa* (onion), etc. They are all important due to their commercial and nutritional importance. *Allium tuberosum* is a perennial herbaceous plant that blooms late in the season, usually found in Southeast Asia. The plant is also known as "garlic chive" because of the leaves' mild garlic flavor. The grey-green foliage can grow up to 20 inches tall, with the bulb remaining attached to the robust meaty rhizome and producing 4–9 leaves. The bulbs are 4–6 m long and cylindrical. *Allium tuberosum* grows well in summer, and they dry up in winter, blossoming in late summer or early fall. Flowers are white stars with a mild fragrance that attracts pollinators (Susan 2010; Shah 2014) (Table 14.4).

Allium tuberosum is used in folk medicine for treating asthma, abdominal pain, diarrhea, nocturnal emissions, and diabetes (Nandwani et al. 2008); this plant helps to reduce blood glucose levels and serum cholesterol; it has anticoagulant influence,

Table 14.4 Uses of *Allium tuberosum*

Region (country)	Usage	References
China	– It is widely used both for its aphrodisiac properties and for nocturnal emissions. – They belief that *Allium tuberosum* root prevent gastric ulcer and treat dyspepsia	Lakshmi et al. (2012), Huang et al. (2006)
Manipur, North East India	– The plant is known as Maroi nakuppi and decoction of garlic peppers or whole plants are used as a vegetable for the treatment of different hepatic disorders and gastrointestinal disorders. – Treatment of spermatorrhoea	Anita et al. (2018), Xin et al. (2015)
Zamboanga Peninsula, Philippines	– They use whole-plant poultice to treat fever. – Treatment of asthma.	Lady et al. (2014), Chichioco-Hernandez and Paguigan (2010)
Thailand	– They are using the plant seeds as an antiseptic mouthwash 8	The Plant List (2019)

as well. *Allium tuberosum* juice will manage excessive bleeding, and the bulbs contain weak properties. Seeds are used to treat problems with the renal, liver, and digestive systems. *Allium tuberosum* grows a lot in Asian countries. People of China, the Philippines, Korea, and Thailand eat this plant as a vegetable; the plant is found hugely in these countries, it is also considered a medicinal plant in these countries (Katarzyna and Joanna 2016). Locals in Arunachal Pradesh, India, used the plant leaves, roots, bulbs, and cloves for cold and cough treatment. This plant is often used for ornamental purposes due to appealing colored flowers (Ashalata et al. 2014). It is a very common spice and taken in traditional Chinese medicine for growing libido (sexual urge) and curing erectile dysfunction.

Consequently, it acts as an aphrodisiac (Tanq et al. 2017). *Allium tuberosum* is also used locally in India to reduce cholesterol and hair tonic (Anjula et al. 2014). Chemical experiments have shown that vitamin, rugged fibers, mineral compounds, or sulfur compounds are found in various parts of the *Allium tuberosum* and antibacterial properties in human consumption (Zhang et al. 2016; Moon et al. 2003; Imahori et al. 2004). *Allium tuberosum* is becoming more economically valuable due to its nutritional and functional components (Gao et al. 2018; Putnik et al. 2019), so the planters in Wushan, China (hometown of *Allium tuberosum*), increase its output potential in winters also by the implementation of multi-layered plastic green houses (Song et al. 2017).

14.15 *Mimosa pudica* (Shameplant)

The *Mimosa pudica* encourages scholars worldwide to pay heed to its pharmacological activities like the antitoxin, antihepatotoxic, anti-diabetic, antioxidant, and wound healing activities. All the parts of the plant have considered too has medicinal properties (Chauhan et al. 2009). This plant is native to Central America and South America. South Asia and other Pacific Islands are considered the plant as invasive species. The first description of *Mimosa pudica* was in 1753 by Carl Linnaeus. Mimosa is usually a short plant that grows near the ground and its branches. This rises to around 0.5 m in height and stretches to 0.3 m. The mimosa tree is upright, slim, compact, and flat. Leaves are bipinnate (Saraswat and Pokharkar 2012). The plant's flowers are axillary and lilac-pink shaped, typically found in globose heads. Calyxes are campanulate, and petals crenate to the bottom. Blossoming takes place in Indian conditions from August to October. Mimosa fruit caps, 1.5–2.5 cm wide, falcate, and sutured (Saraswat and Pokharkar 2012).

The extract from the *Mimosa pudica* plant contains up to 17% green, yellow fatty oil. *Mimosa pudica* plant is used for dysentery, leprosy, uterine and vaginal complaints, burning sensation, inflammation, asthma, fatigue, leucoderma, and blood diseases. The whole plant is used internally to treat a blood purifier and vesicle calculi. Externally is used for rheumatism, myalgia, edema. It is useful in vitiated pitta conditions, dysentery, enteropathy, fistula, ulcers, hemorrhoids, spasmodic, smallpox, strangury, affections, and fevers. *Mimosa pudica* fastens the wound healing process, and arrests are bleeding. It is also primarily used in the gynecological condition. This plant is used for bronchitis, defects, and impotence. It will serve as contraceptive pills. Due to its capacity to promote healthy cell development, the onset of baldness can be reduced by mimosa. It helps to reduce rheumatoid arthritis symptoms. It has emetic, sedative, tonic features, and it can treat insomnia, alopecia, dysentery, diarrhea, tumor, and various urogenital infections. The entire plant is used for uterine tumors and scabies. The plant root decoction is used to minimize toothache as a gargle. Mimosa root is used in Western medicine to treat premenstrual syndrome (PMS), insomnia, menorrhagia, irritability, skin wounds, hemorrhoids, and diarrhea. Roots are used in the Philippines and are applied in dysentery and diuretics dysmenorrhoea.

The leaves and roots are also used in the Sagar District, Madhya Pradesh, India, to gravel and other kidney diseases, including piles and fistula. For oral snakebite treatment, the roots are also used. The root decoction of Rahba in West Bengal has been used as gargled for gum and toothache and leaves used in the Kurukshetra District of India to increase sexual potency in men. For stomach ache and intestinal worms, and in Orissa, the honey with leaf paste is prescribed twice a day on an empty stomach for 3–4 days (Behera et al. 2006). In Ecuador, it is used in pillows to induce sleep in children. Phytochemical literature-based tests have demonstrated *M. pudica* is rich in secondary medicine; samples of metabolites include carbohydrates, fat, amino acids, flavonoids, mucilage, alkaloids, fixed oil tannins, and phenolic (Pal et al. 2015). It is easily available, economically viable, and a reservoir of significant medicinal properties (Muthumani et al. 2010).

14.16 *Alpinia galanga* (Greater Galangal)

Alpinia galanga is a plant that belongs to the family of Zingiberaceae (Jirawan 2005). It grows to about 5 ft in height; the leaves are oblong and long, the root is tuberous, the plant is slightly aromatic. Rhizome height is 3.5–7.5 cm, though occasionally above 2 cm. Ligules are rounded and short. Flower's color is greenish-white, and bracts are ovate-lanceolate. *Alpinia galanga* is a significant herb in various traditional medicines applications for treating various illnesses and diseases. The plant shows that it has several chemicals that are present in it, and these chemicals have large pharmacological and medicinal properties. Several famous names are known, including Kulanjan in Hindi, Kannada dhumarasmi and Bengali kulingjan and Gujrati kulinjan, Malayalam Aretha, and greater galangal in English. The rhizome is commonly used as an essential oil source and a spice. The plant's rhizome is used as antidementia, digestive tonic, carminative, anti-emetic, antitumor, antifungal, Anti-helminthic, anti-diuretic, antiulcerative. The rhizome is used as flavoring, anti-microbial and antibacterial agents (Thuy et al. 2002). *Alpinia galanga* flowers are treated as a vegetable or spice (Arambewela and Wijesinghe 2006). The plant has been extensively documented in terms of dietetic and traditional medicinal products, and its daily consumption may serve as an enhancement to conventional TB therapy within achievable limits. *Alpinia galangal* is a significant herb in various traditional medicines systems to treat various diseases, including microbial, inflammatory, rheumatic, chest, and dyspepsia, fever, etc. Alpinia galangal is a common herb used in traditional medicine to treat a variety of ailments, including microbiological, inflammatory, rheumatic, chest, and dyspepsia, fever, and so on. Cancers of the liver, kidneys, and tumors, as well as HIV and diabetes (Ramesh et al. 2011). It plays a major role in eczema, bronchitis treatment, coryza, moving, versicolor, pityriasis, internal otitis, gastritis, and cholera. The plant is widely used for dietary consumption and the traditional medicinal system. Since the rhizome has a distinctive scent and pungency, it is commonly used in China and Thailand as a condiment to food and national medicine (Chudiwal et al. 2010). This plant is used to treat multiple diseases, including diabetes mellitus, in traditional Asian medicine (Unani) (Ikram and Fazal 1978; Kirtikar and Basu 1996). In Malaysia, cough, bronchitis, asthmas, inflammatory, rheumatoid arthritis, and colic are treated by *Alpinia galanga* rhizomes (Burkill 1966). *Alpinia Galanga* is a reputation for medicines in Indian indigenous systems and is widely used as a domestic remedy in Southern India (The Wealth of India 1985). The species is widely cultivated in Southeast Asia for its rhizomes as spice.

14.17 *Taraxacum officinale* (Dandelion)

The *Taraxacum officinale* (Dandelion) is a herbaceous permanent tap root that grows from a thick taproot. The deeply dental leaves are basal, which means that they are not grown on stems but are ground-level from the plant crown. The profoundly dental leaves are basal, meaning they don't grow on stems and are found at ground level from the plant crown. Bright yellow flowers with hollow stalks that can grow up to 70 cm long and hug the ground. The flower head is a near pack of several small flowers, typical of the entire plant family, the Asteraceae. The flowerhead is very large. The plants have a milky latex, which is released by splitting leaves or trunks. Dandelions are propagated by seeds and therefore are not asexually lengthened by stolons or runners. However, they may and do reproduce asexually by seed. They can produce viable seed without cross-fertilization. The resulting progeny are essentially clones of the parent plant and are also apomixis-capable. This cycle is responsible for the majority of seed production in Dandelions (Esser 1993). The leaves of the Dandelion are used for appetite stimulation and digestion assistance. Dandelion flora has the characteristics of antioxidants. Dandelion can also cause the immune system to be strengthened. Herbal remedies are used by using the roots of the Dandelion to purify the liver and gall bladder (Choi et al. 2010). Many dandelions scientific investigations were performed out in animals rather than humans. Dandelion was commonly seen as a diuretic to raise the urine and expel fluid from the body. It is used in many situations, such as liver problems and high blood pressure, where diuretic diseases might help. The root of its dandelion plant can function as a mild laxative during digestion (Wirngo et al. 2016). Dandelion root has long been utilized to treat abdomen and liver damage in traditional Chinese and Native American medicine. Herbalists now feel that this could help to alleviate the symptoms of far too many diseases, including acne, psoriasis, high cholesterol, heart and stomach problems, diabetes, and cancer (Schutz et al. 2006). Diuretics are used to treat hypertension, heart failure, liver disease, and other kidney diseases. While the medication is beneficial, it might induce adverse effects such as muscle tension, headaches, dizziness, and blood sugar fluctuations. In folk medicine, usually, they get the dried dandelion root and ground it until it forms a paste, then add water and mix it to create a soothing paste and help in skin diseases, eczema, and acne, such as rashes (Yang and Li 2015). In underprivileged countries, diabetes treatment can be quite expensive, meaning that the medical treatment inaccessible, resulting in a weak healthcare system and leading to alternative medicine (Din 2011). Alternative medicine requires using the bioactive plants of the Dandelion that have shown potential to reduce diabetes symptoms and enhance health (Marles and Farnsworth 1995). North America has the greatest market for dandelion root extract, with Europe coming in second. The market also has a large Dandelion root extract in Latin America. China is the top manufacturer and customer in the Asia-Pacific world. During the forecast period, the rest of the Market for Asia-Pacific Dandelion root extract will increase as people choose herbal products. It is predicted that the dandelion root extract market will increase in the Middle East and Africa in the upcoming years. In Austria, Italy, Poland, and Turkey, Dandelion is considered a significant weed epidemic. It is a major weed in 8 countries like the USA, a small weed in 21, and many other areas. Taraxacum comprises 50–60 species, and hundreds of variants have been described as species from time to time (Baily and Bailey 1976).

14.18 *Hemerocallis lilioasphodelus* (Daylilies)

Even though *Hemerocallis lilioasphodelus* (Daylilies) are cultivated yearly; unfortunately, they do not reach the consumer market due to its limited supply (Pounders and Garton 1996). *Daylilies* or "*Hemerocallis*" are classified into seven phases. From phase 1–3, the bud is developed, and the fresh and dry weight would have increased. When the flower is opening, which occurs during phases 3 and 4, the fresh weight would have increased to a maximum in which the flower becomes fully open at phase 4. As the plant reaches the last phases 5–7, the flower's fresh and dry weight starts decreasing (Lay-Yee et al. 1992). Although daylilies are well-known for its magnificent beauty, it also has other uses. Almost all the parts of the daylilies are edible. Daylilies are nutritious, have a strong protein, fat, and carbohydrate supply. The Hemerocallis roots have shown to have antitumor compounds; on the other hand, the flowers and leaves possess a mild laxative effect and are known to treat inflammation and jaundice. They also alleviate pain, inhibit vomiting, and give a sedative effect. Daylily extracts have demonstrated that cancer cell proliferation has been prevented, and cell differentiation has been induced (Zhang et al. 2004). They help to prevent the erosion of soil along roads and waterways (Munson 1989). The historical record of home use by human beings is exceptional. There has been evidence that the species was grown in China for many centuries. In the Far East, they are treated as a vegetable by drying the daylilies and adding them to their soup

(Bor et al. 2006). However, the leading diversity is focused on China, Korea, and Japan. The Chinese monitored the material's concentration, and due to hunger and diseases spreading around them, they have found out the value of all parts of the daylilies for maintenance of health by drying them and using it as medicine. Traditionally, the Chinese use daylilies to purify the blood.

The daylilies are usually cooked; however, they can be eaten raw. The young shoots make an excellent cooked vegetable. In various preparations, Daylilies may be eaten, with the chicken as with the meat, daylily soup, sausage, deep-fried daylilies, and steamed daylily (Knight et al. 2004). One must be careful not to consume large quantities as they can cause hallucinations. The root extract makes an excellent antidote for arsenic poisoning (American Hemerocallis Society. 2008). There is also a myth that some people believe the root extract can be used to treat cancer.

Studies proved that the flower buds of the daylily contain a higher percentage of antioxidants than other vegetables (Bor et al. 2006). The plant is resistant to drought and requires low maintenance to expand its use in the landscape. However, it was difficult to satisfy market demand for new cultivars due to the asexual distribution of slow-dividing crowns during the day (Gulia et al. 2009).

14.19 *Dianthus caryophyllus* (Dianthus)

Dianthus caryophyllus L., the Caryophyllaceae family, was brought up in the Mediterranean region. The name of the genus derives from Theophrastus's writings on the gods of God Anthos. Linnaeus chose the name of the genus, clove-type caryophyllus, as it resembles clove from carnations. This is possibly the word carnation originating from the old Greeks' usage as a floral coronation. The results of over 200 years of breeding today are consumer carnations. Carnations are growing throughout the year and have a greater variety of colors, larger flowers, and stems than their wild predecessors. It consists of two or three-style monoecious flowers and ten stamens (Deno 1993). The flora has five flattened petals that can be used as a lonely or thick clustered floral head. The petals vary in color from white to tints and in red, with the unusual exception that would be yellow. The flowers can be very fragrant themselves.

Dianthus caryophyllus phytochemical research has shown triterpenes, alkaloids, coumarins, cyanogenic glycosides, cyanidin, and pelargonidin yellow isosalipurposide, basic petroleum, volatile oils, and many other chemical compounds are found there. The plant had anticancerous, antiviral, antibacterial, antifungal, insecticidal, repellent, antioxidant, reno-protective, analgesic, and anesthetic effects (AlSnafi 2017). The injection of *carnation* is used for the diagnosis of angina. Also, this food infusion as tea encourages metabolism and improves the cardiovascular and nervous system. *Carnation* oil is used to prevent discomfort, and it is helpful to paralyze the affected region. In cavities, cotton is impregnated with the same oil to alleviate tooth pain. *Carnation* syrup is used to improve the nerve's fragile sound and heart (Pérez Arbeláez 1996). *Dianthus* was traditionally used to treat diseases of the mouth and gum and cardiotonic, diaphoretic, alexiteric, and vermifuge fractures and gastrointestinal disease therapies. China, Japan, and Korea usually used the plant for wound management and gastrointestinal disorder (Chandra et al. 2016). It has also been recommended for treating coronary and nervous disorders in European herbal medicine. Flowers were alexiterin, cardiotonic, and nervous, diaphoretic, and antispasmodic.

The plant was used in China as an anthelmintic. In 1949, Pennsylvania was sixth among the state's incarnation production. Seeley (1956) recorded that only 6 of the 331 growers were specialist's incarnation that yield an annual total of 550,000 blooms. The remaining 325 farmers produced 67,000 blooms a year per plant. In 195, when 10 counties created over a million blooms anywhere, Pennsylvania ranked 4th in carnations. In line with the U. S. D. A. Survey 1965 (U. S. D. A. 1966) showed small improvements in incarnation production in Pennsylvania and New Jersey, while the rate in New York had declined. Several small growers who may cultivate many other greenhouse plants along with carnations are characteristic of these states. A substantial proportion of small farmers market their flowers while larger companies market a smaller proportion via wholesale (Metz and Trotter 1963).

14.20 *Rose damascene* (Rose)

Rose (Rosa family) is a family of about 100 permanent rose shrubs (Rosaceae). Rose damascene is mostly found in temperate areas in the Northern Hemisphere. Numerous roses are grown for their pretty colors, differing in colors, including white, yellow, rose, brown, and black, including delicious fragrance which depends largely on the type and environment. The bulk of rose species come from Asia, with minor percentages from North America, some are from Europe and northwest Africa. Roses from various parts of the world easily cross-pollinate, creating types that overlap parental forms and make it nearly impossible to identify fundamental species. In the crossbreeding, which had already basically produced numerous garden roses, there were far less than ten species, mostly originating from Asia (Nanda and Das 2015). The round segment underneath the rose petals, which happens to contain a rose plant's seeds, is also defined as a seed plant. New rose hips are rich in vitamin C concentrations that can be used for cold, flu, and C deficiency treatments. They are already used in stomach acid disorders, gallstones and gall bladder ailments, kidney disorders, greatly enhancing the immune function, etc. They are also used as a natural vitamin C supply in the food and manufacturing industry for tea, jam, and much more (Chrubasik et al. 2006).

For many countries, long have been documented cultural and medicinal uses of rosehip. Routine rosehip has identified about 129 biochemical compounds. The fruit contains many major active ingredients such as flavonoids, tannins, anthocyanin, fatty acids, phenolic acids, organic acids, and inorganic ingredients. A large variety of pharmacological activity in rosy hips has been indicated by experimental research, antioxidant, anti-inflammable, anti-obesity, anticancer, and anti-hepatoprotective contained (Ayati et al. 2018). The aqueous extract of flowers for chest and stomach cramps therapy was used in Iranian traditional medicine. An Iranian Scientist discovered *Rose* essential oils in the tenth century for the cure of multiple diseases. It is generally viewed as a cardiotonic heart enhancer (Shahriari et al. 2006).

Rosewater has traditionally been used as an antibacterial to wash the eyes and mouth (Gochev et al. 2008). To ease stomach cramps and respiratory and chest congestion, rose water has also become used antispasmodic agent (Akhmadieva et al. 1992). Throughout Traditional Iranian medicine, rose petals were used to soothe the soul and heart with a sweetening agent. Also, rose petals are used to treat the body's diseases, such as improving fever, menstrual discomfort, and breast pain (Foster and Duke 1990). The liquid extracts used for the dry rose water were also used as a diuretic. Rose hips are used as a blood cleanser and often used with bread by Iranians. Previously, Iran is perhaps one of the first rose oil producers, although the main product they were known for was rose water. This sacred rose water, so critical culturally for this region, was first created in the tenth century by the Persian physician Avicennia. *Rosedamascene* is generally referred to as the Prophet Mohammed's Flower appearing prominently in religious and medicinal ways. There have been estimating that some 500 farmers tend anywhere between 13,000 and 15,000 ha; the number of people interested in real harvest and production is uncertain. Such farms usually are small farmers around Kashan, Kerman, Shiraz, and Kerminsha, as in Bulgaria and Turkey. Oil production can be just 200 kg per year, but rose water supply is immense ±75/85 mL (Primrose Wilson 2017). Major economic sanctions inflation has also impacted prices and production, but most of their products have been eaten domestically rather than exported. Morocco is a significant producer of *Rose Centifolia*. About 2000 MT of flowers, which sustains 6000 smallholders, are produced annually. Petal prices increased in 2017 to US $1.80 kg, with the female consumers paying $0.40 per kg (Charaf 2017). Their primary development is not oil but concrete.

14.21 *Rhus coriaria* (Sumac)

The generic name of the genus is Sumac (*Rhus coriaria*), which constitutes more than 250 different floral species in the Anacardiaceae family. Such plants have a long tradition for native people to use for medicinal and other purposes and mostly grow in the world's warm and temperate areas in marginal agriculture areas. Using environmentally friendly solvents that permit food and business end-users, the plant material can remove bioactive components. Sumac's worldwide availability also indicates that at the source with minimal transport requirement from source to end-user, desirable bioproducts may be generated. A major work gap exists between leading chemical exploration and process creation and advancement to enhance our understanding of the Rhus genus' full capacity as part of the global bio-process and bio-process research initiatives focused on green technologies (Rayne and Mazza 2007). The antimicrobial and antifungal activity of rhus coriaria is high (Alwan et al. 2009). Sumac is a critical resource in the food market because it can be used as a natural conservator for shelter extension of products and ensuring their consistency (Gulmez et al. 2006). Other than the therapeutic effects of the antioxidant compounds, Sumac is very effective in helping to prevent the oxidative cycle which harms the quality and taste of the food. Sumac can also be used as a feed additive. Alternatives for the use of herbs were being investigated due to the prohibition of food additive antibiotics in Europe. Medicinal herbs are especially reviewed as safer, affordable, and faster alternative to toxic substances for humans (Salih and Gurbuz 2015). Sumac can also be used as a colorant, and the leaf powder of Sumac can be utilized for the fortification of goat milk yogurt enabling new nutritional food production (Perna et al. 2018). Sumac became one of the most easily identifiable spices in the Middle East, with its red color and labeled citrus tarts. Apart from the rich cuisine that goes far beyond Roman Empire, the health benefits of that ancient spice were first recorded in Greek medicinal texts centuries ago, which illustrated the antiseptic positive attributes of sumacs. The precise source of this Sumac remains mysterious, but since the middle ages, Sumac was used as a source of acidity in Roman kitchens in Europe, Africa and Middle East, even before the arrival of lemons. Sumac has traditionally been seen in ceremonial occasions by native American tribes in North America to make medicinal products. In order to make za'atar spice mix, Sumac is blended with sesame seed, salt, and thyme in certain Arab countries, especially in the eastern Mediterranean (Ravindran and Divakaran 2012). In the Arasbara area, and even more so the Horand County, Sumac is a highly versatile indicator species, with an extraordinary amount of fruit being historically harvested every year. The average number of sumac stems per hectare was 3928, with a yield of 428.16 kg per hectare. The average amount of sumac gathered by a rural family was 8455 kg and 422,75 kg, respectively. The mean annual household income from the raw and dried Sumac has measured at 7740 and 46,480 Thousand Rial, accordingly. The average household income of sumac collection ranged from 0.9 to 100% across different households at 44% of overall household income. Through manufacturing, the total added value was 332,500 Rials (Gholizadeh et al. 2018).

14.22 Conclusion

Informant consensus revealed that many plants are prioritized to supplement monotonous diets for their caloric content and dietary structure. Non-native weed introductions, indicators of mechanisms to cope with environmental and socio-cultural changes, were found to be some of the reported edibles. Preferences have also shown that non-food variables underlie food choices for some edible plants. Nevertheless, it was stressed by determining informant trust in plant selection that preferences are determined based on socio-economic, cultural, and ecological conditions.

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15

Cultural, Practical, and Economic Significance of Some Edible Medicinal Plants from Gilgit-Baltistan Pakistan

Shabbir Hussain, Sibtain Ali, Gul Raiz, and Shamsher Ali

Abstract

This chapter explored medicinally, culturally, and economically important edible plant species of Gilgit-Baltistan (GB). GB is in extreme north of Pakistan with diverse mountain landscapes 72,971 km^2 on earth. The area is surrounded by three important countries: India to the east, China to the north, and Afghanistan to the west. It constitutes one of the world's highest mountain regions. The junction of three great mountain systems, i.e. Himalayas, Karakoram, and Hindukush (HKH), meets at Juglot, Gilgit. The region is known for highly enriched natural resources and appeared as a hotspot for global tourism. Among the natural resources, endemic flora, minerals, glaciers, forests, rare fauna, and freshwater rivers are ranked as highly valuable assets of the area. The diverse climatic conditions of Gilgit-Baltistan reflect in distinctive biodiversity and ecosystem. Almost 6000 plants species represented by 222 families, out of them almost 30% of the endemic plants grow in Gilgit-Baltistan with therapeutic and nutritional value. Most of these plants are used as folk medicines for treatment of various diseases. In addition, many plants species are part of cultural practices and rural economy of the region. The area is needed to be explored for important medicinal plants through which a certain life challenging ailments can be addressed.

Keywords

Gilgit-Baltistan · Edible medicinal plants · Pakistan

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15.1 Introduction

Gilgit-Baltistan (GB) is a highly mountainous region in the northern part of Pakistan, covers an area of 72,971 km^2. It was formerly known as Northern Areas of Pakistan later in 2009, it was renamed as Gilgit-Baltistan (GB) (Awan et al. 2013). It shares borders with China to north, east with India, and south with Afghanistan (Fig. 15.1).

Gilgit-Baltistan is governed under 14 districts in administration setup, viz. (Fig. 15.2) Gilgit, Skardu, Nagar, Kharmang, Hunza, Ghizer, Diamer, Shigar, Astore, Gupis-Yasin, Tangir, Darel, Rondu and Ghanche (Salim et al. 2019). The four highest and most famous mountain ranges in the World i.e. the Himalayas, the

Fig. 15.1 Map of Pakistan

Fig. 15.2 Fourteen districts of Gilgit-Baltistan

Hindukush, the Pamir and the Karakoram, are on the credit of Gilgit Baltistan (Zain 2010) and the confluence of three main mountain ranges which are Himalayas, Karakoram, and Hindu Kush (HKH) is also located near Jaglot valley of Gilgit. The Deosai plain is also known as roof of the World, with an altitudinal range of 13,000–14,500 ft above sea level, while the Khunjarab Pass, at altitudinal range of 16,000–17,000 ft, is the most popular feature of Gilgit-Baltistan (Awan et al. 2013). GB has many other salient features like largest non-polar glaciers of the World, the second world's highest peak, K-2 and top 5 among the top 14 peaks in the World are situated in Gilgit-Baltistan (Ahmed 2016). The area is home to diverse cultures and many languages. The major languages that are spoken in the region are Shina, Brushashki, Balti, Khowar and Wakkhi (Zain 2010).

The region is blessed with natural beauty, fauna and flora remain a hotspot for global tourism. Among the natural resources, endemic flora, minerals, glaciers, forests, rare fauna, and freshwater rivers are counted (Malkani 2020).

When we glance at the relationship between humans and plants, it is extremely surprising that it is as old as human civilization began in prehistoric times (Jabeen et al. 2015). Plants have always been recognized as a highly valued commodity on the basis of multiple roles in our life and culture. In fact, human beings depend on plants directly or indirectly to meet their food, fuel, and shelter needs. Most importantly, being a highly rich pool of diverse bioactive and novel chemical entities, the plants serve as the source of medicines. Almost 300–315 thousand species of plants so far explored, of which, a large number of medicinal species are used as folk medicines for the treatment of several diseases all over the world. According to WHO, around 70–80% of world's population, especially in Asian and African countries use traditional herbal medicine for treatment of primary health care. Indeed, plant-based natural products have always played a significant role in the process of drug discovery and development. For example, about 25% of the synthesized drugs have been derived from medicinal plants (Ozioma and Chinawe 2019).

Since the human dependency on plant is attributed to a spectrum of needs like food, medicine, nutraceuticals, shelter, and for other related accessories (Shedayi and Gulshan 2012).

The variable weather conditions and climate changes in Gilgit-Baltistan lead the potential sources of distinctive biodiversity and diverse flora. The wild food ethnobotanical analysis was conducted in some areas of district Ghizer, in which the 40 mycological taxa and botanical wild food were identified. The comparative investigation of different cultural, religious, and linguistic groups revealed that the congregated wild food plants were used, homogenously. This could be a sociocultural of study area, containing an Ismaili Shia Muslim faith population that might be determined by the multifaceted adaptation system and the exchange of attributes of the distinct pre-existing food customs (Aziz et al. 2020).

The flora of GB contains a large number of plants with therapeutic values, i.e. used to cure different diseases and as well as for nourishment (Awan et al. 2013; Shedayi et al. 2014). Locally, the medicinal plants are not limited to being used for curing diseases and nutrition. Furthermore, people of the region use these plants as fired wood, fodder for livestock, shelter and timber, etc. (Shedayi et al. 2014; Awan et al. 2013; Hussain et al. 2011).

Previous studies reported edible and non-edible plant species in Gilgit-Baltistan, in which some wild plants that have never been reported as food resources earlier, including the *Saussurea lappa*, *Lepidium didymum*, *Iris hookeriana*, *Hedysarum falconeri,* and *Artemisia annua* (Awan et al. 2013).

Earlier, different studies were conducted to examine the use of medicinal plants in different regions of Gilgit-Baltistan. Following are the most common edible medicinal plants which are used by natives of GB:

Allium cepa L. (Alliaceae) locally known as Ghashue in Brushashki and Kashoo (Fig. 15.3) in Shina language. It has multi-purpose application, i.e. in cooking foods, salads, and as medicine.

Its oil extract is extensively used to clear off the throat in flue season, especially for kids in winter season (Hyder et al. 2013). It is also used to cure vomiting and indigestion problems (Abbas et al. 2017). It is a cultural belief that to get adaptation to climatic conditions in a new area, first and foremost thing to eat is *Allium cepa* L.

Allium carolinianum DC (Alliaceae) locally named as Kachpauk in Brushashki and Khush (Fig. 15.4) in Shina language. It is whole as an edible plant due to nutraceutical value. Its bulbs and leaves are used as vegetables to treat fever, cough, and flu (Khan et al. 2011) as well as abdominal pain (Abbas et al. 2017).

Allium sativum L. (Alliaceae) Pokhpa or Bukpa (Fig. 15.5) is the local name. Bulbs are used in **cooking and are considered a highly** valued medicinal plant. It can control blood pressure. Remedies for stomach disorders and medicine for Paralysis (Hyder et al. 2013).

Fig. 15.3 *Allium cepa*

Anaphalis triplinervis (sims) C.B. Clarke (Asteraceae) is known as Yeepwoosh. It's leaves and dried flowers are used to make herbal tea to treat flu, fever and nausea (Khan et al. 2011). Culturally, the flowers are used for aesthetic purposes.

Artemisia maritima Lin (Asteraceae) commonly known as Zoon (Fig. 15.4) in Shina language or Afsanteen in different regions of Gilgit-Baltistan. It is used to treat dysentery, stomachic, anthelmintic, flatulence extraction, and dyspepsia by the people of Shigar valley (Shedayi et al. 2014). It is most frequently used to treat fever and stomach pain in Ghizer Valley (Jabeen et al. 2015).

Tragopogon dubius scop (Asteraceae) locally known as Kreel woosh, typically 20–60 cm but sometimes almost a metre. The basal leaves can be eaten raw or cooked. The juice of the flowers of this plant is used for the treatment of ear infections (Khan et al. 2011).

Berberis lycium Royle (Berberidaceae) locally known as Zolg in Brushashki and Ishkeen (Fig. 15.5) in Shina language. *Berberis* found almost in all areas of Gilgit-Baltistan. It is one of the important medicinal edible plants in which the fresh leaves, fruits, and dry roots are given to cure backache and for wound healing (Khan et al.

Fig. 15.4 *Artemisia maritime*

2011). Additionally, it is used to treat chronic diarrhea, piles, and swollen and sore eyes. It is extensively used by locals to heal fractured bones (Jabeen et al. 2015). Culturally, it is a common practice in GB that the roots of Berberis derived from desert areas supposed to be more valuable for wound healing medicine, this may be due to potential secondary metabolites in this plant in harsh conditions. Berberine, an alkaloid found in the stems and the roots of Berberis species, has remarkable antibacterial properties. The another species *Berberis chitria Lindl* is known as Eshkeen in the Hunza-Nagar areas. Its fruit act as Blood Purifier. It heals broken bones (Hyder et al. 2013). Juices of the bark are most commonly used to treat peptic ulcers disease (PUD).

Valeriana wallichii (Caprifoliaceae) locally known as mushk-bala. Cough, asthma and heart patients are given root powder as remedy (Khan et al. 2011; Salim et al. 2019).

Capparis spinosa L. (Capparidaceae) locally called as Kappar in Brushashki and Kavir (Fig. 15.6) in Shina language, available mostly in mountainous harsh areas of GB. Floral buds and fresh fruits are consumed as vegetables to treat typhoid and malaria. While its herbal tea can be used to treat various types of flu and fever (Khan et al. 2011; Jabeen et al. 2015).

Chenopodium botrys L. (Chenopodiaceae) locally known as Khord in the Upper Hunza and Hamamo in the central Hunza and Nagar district GB. Its seeds are cooked, soaked in water systematically rinsed in order to confiscate any saponins-type compounds. While it can be minced into meal or mixed in when making bread, the leaves of *Chenopodium botrys are* used as an alternative to tea. Grinded

Fig. 15.5 *Berberis lyceum*

flowers and leaves are frequently used to treat stomach and digestive diseases (Khan et al. 2011). It is also used for Uterus problems, disturbed menstruation, abdominal pain, and related diseases (Hyder et al. 2013). Another specie, *Chenopodium album* L. (Chenopodiaceae), is known as Khunnah in Shina language, while in Brushiski it is known as Sheleet. Its aerial parts are used as folklore treatment for gastrointestinal and stomach diseases. Boiled extract from leaves used to cure constipation (Khan et al. 2011; Abbas et al. 2014). It is a common practice that leaves and young shoots of *Chenopodium album* used as wild vegetable alone or in mixed, sometimes as a starvation food. This can be dried and stored for use in winter seasons.

Artemisia sieversiana Ehrh. Ex Willd. (Compositae) locally known as Khakhas in Brushashki and in Shina language it is known as Kakamush (Fig. 15.7). It can treat gastrointestinal problems, stomach disorders, and blood pressure. It also eliminates intestinal worms in children (Hyder et al. 2013; Khan and Khatoon 2008).

Carthamus tinctorius L. (Compositae) Pong is the local name. For the treatment of cough and chest congestion its flower bud is boiled with milk and that boiled milk is used (Hyder et al. 2013; Abbas et al. 2014). It is common cultural practise that its

Fig. 15.6 *Capparis spinosa*

petals are are used in bread (local name *Shreek*) for the appearance of colour and as preservative, especially used in Eid festivals (Abbas et al. 2014).

Cichorium intybus L. (Compositae) Eshkanagi is the local name of this plant. It controls Blood Pressure (Hyder et al. 2013). Arial parts of this plants are also used to treat liver problems including jaundice and hepatitis and digestive problems including constipation (Abbas et al. 2014).

Cucumis sativus L. (Cucurbitaceae) is a cultivated medicinal plant. Locally, it is called as Laye or Lawh. Medicinally it is used for indigestion and to down fever. It is widely used by sugar patients. It controls Blood Pressure (Hyder et al. 2013; Khan and Khatoon 2008).

Diospyros kaki L. (Ebenaceae) locally known as Hermit a Japanese based fruit, cultivated almost in many urban areas of GB. It is considering medicine for pregnant women, cure headaches, back pains, and foot ache. Additionally, it is a remedy for stomach disorders (Hyder et al. 2013). *D. kaki* leaves are high in phytochemicals and have a wide range of medicinal applications. Hepatocyte growth factor (HGF) and the receptor met lead to poor prognosis through elevation of metastasis and the chemoresistance in hepatocellular carcinoma (HCC) (Ko et al. 2020).

Elaeagnus angustifolia L. (Elaeagnaceae) is common fruit found in overall GB, known as Gonair in Shina language and Sisk in Upper Hunza. Traditionally, it has been used to treat liver and dysentery problems. It is also considered as a source of Vitamin C for deficient children. It cures Jaundice and hepatitis A, B, and C (Jabeen et al. 2015). In the Baltistan region, especially in Turmic valley, dried fruits of *Elaegnus* are used to cure coughs and stomach problems (Khan et al. 2015).

Fig. 15.7 *Artemisia sieversiana*

Fig. 15.8 *Hippophae rhamnoides*

Hippophae rhamnoides L. (Elaeagnaceae) locally known as Buroh (Fig. 15.8) in Shina language and mainly known as "Sea buckthorn" (Jabeen et al. 2015) while Zakh in the local zones of Hunza-Nagar (Khan et al. 2011). Sea buckthorn (*Hippophae rhamnoides* L.), often referred to as a "miracle plant," has many therapeutic and nutritional benefits. Seabuckthorn (*Hippophae rhamnoides* Lsub-species Turkistanica) is widely found throughout Gilgit-Baltistan and has the capacity to produces 6000 metric tons (fresh berries) and 2020 metric tons (dry berries) per annum. The plant contains a series of biologically active compounds and other important nutrients. These substances exhibit biological and therapeutic potential, including antioxidant, antitumor, hepatoprotective, and immunomodulatory properties. Berries can reduce high blood pressure (BP), Palpitations, kidney, urinary, and reproductive disorders in women (Khan et al. 2011; Jabeen et al. 2015). Despite having a high Economic value locally, it is not being used as effectively as it could be due to lack of proper scientific formulation training for local farmers.

Astragalus strictus Grah. ex Benth (Fabaceae) is called locally as Zhop Thope. Its fruit is food for livestock for the production of milk (Khan et al. 2011). This is supposed to be a miracle herb and a powerful extract from its root has been used as a medicine, and it is also used as the natural diet supplement. The health benefits of Astragalus include boosting the immune system and maintaining energy levels. Additionally, it is useful for curing upper respiratory problems, cold, diabetes, asthma and the blood pressure.

Ribes. alpestre Decne. (Grossulariaceae) Shumlooh is the local name. Fruit can treat Jaundice (Khan et al. 2011; Jabeen et al. 2015), joint pain, and backache (Jabeen et al. 2015).

Juglans regia L. *(*Juglandacea) is an edible nut. Nuts as a whole, locally known as Khakie (Fig. 15.9) while fruit is known as ashooh and renown as walnut plant internationally. Fruit is used as emollient and good for the brain problems (Awan et al. 2013*;* Khan and Khatoon 2007). Culturally, the roots, leaves, and bark of this plant are used for the brushing of teeth in some regions (Jabeen et al. 2015*;* Khan and Khatoon 2007). The walnut nuts have great economic importance as it exports internationally due to high nutritional and medicinal importance (Khan and Khatoon 2008).

Mentha Longifolia L. (Labiatae) locally, it is known as Whadan in Brushashki language, pheelel (Fig. 15.10) in Shina language and Folling in Balti language in GB. It is an edible plant used in multiple ways as powder form, green tea, and as a whole plant. Dried leaves and flowers are used to treat Jaundice, control high BP, and asthma. Aerial parts were used to cure gastric troubles, stomach problems, cough, and fever. Additionally, it is a good source of blood purifier (Khan et al. 2011; Khan et al. 2015). It is used to make green tea. Mentha tea increases bile secretions and encourages bile flow which fast the digestion. Mentha has antimicrobial properties and house fly repellent properties as well. There potential may be due to the Pulegone, menthone, and piperitinone type compounds found in Mentha.

Mentha royleana Wall. ex Benth. (Labiatea) Local name in Shina Pheelel. For digestive disorders, Backache and Maternal Deliveries flowers and leaves are used (Khan et al. 2011). Its powder form most frequently used for making herbal tea, cough, headache, blood pressure, rheumatic, and asthma disease (Abbas et al. 2014).

Nepeta floccosa Bth (Lamiaceae) locally, known Buzlanj in Shimshal Khunjerab valleys. Leaves and Flowers water are used to burn fats and reducing temperature (Khan et al. 2011).

Thymus linearis Benth (Lamiacae) commonly known as Tumoro in Gilgit region while Tumburug in Baltistan region. It is also known internationally as thyme. This

Fig. 15.9 *Juglans regia*

plant has ever-growing number of uses in contemporary medicine due to its pharmacological properties: antioxidative, antimicrobial, and anticancerogenic activities. The dried leaves are used to make tea which is beneficial against blood pressure and headache (Hyder et al. 2013). Entire plants are used to treat indigestion, cold cough, and fever (Khan et al. 2015; Abbas et al. 2017). Thymol and Carvacrol are the main compounds found in thyme. According to World's Healthiest Foods, thymol helps to increase omega-3 fatty acids which are healthy fats, in brain. It is extensively used to make green tea. It is readily available in the Gilgit-Baltistan. Due to lack of awareness, people in the region are not aware of the economic importance of thyme. It has great economic value as well by selling thyme to other countries one may flourish a good business. China is one of the main importers of thyme.

Malva neglecta wall. (Malvaceae) Shanishah (Fig.15.11) is its local name. It is a commonly cultivated vegetable in the Gilgit region due to its nutraceutical value. For digestive problems and constipation decoction form of plants is used (Khan et al. 2011; Abbas et al. 2014).

Fig. 15.10 *Mentha longifolia*

Ficus carica Linn (Moraceae) locally known as Faag (Fig.15.12) in Shina language, a fruit used to treat different heart problems, constipation, skin troubles, abdominal problems (Shedayi et al. 2014) along with other digestive problems (Abbas et al. 2014).

Different species of *Morus* (Moraceae) widely used by the inhabitants of GB, locally known as Marooch (Fig. 15.13) in the Shina and Bernach in the Brushashki language. The delicious berries are considered as anti-diabetic and remedy for sore throat and other such ailments (Hyder et al. 2013; Jabeen et al. 2015). The dry fruit of *Morus* is used for cough and chest problems, while the fresh fruit is used for feeding women as it enhances the milk. Different medicines also available in market produce mainly from *Morus* like syrup tootsiah.

Papaver somniferum L. (Papaveraceae) it is a cultivated medicinal plant. Mardakhay is the local name of this edible plant in Brushashki, while in Shina language it is known as Burdakha. For the treatment of dysentery, chronic fever and bleedings seeds of the plant are used (Hyder et al. 2013).

Fig. 15.11 *Malva neglecta*

Glycyrrhiza glabra L. (Papilionaceae) locally known as Chelghas in Brushashki, while in Shina language it is known as Shalaco. Especially the root of this is used by local to treat chronic cough, asthma, urinary tract infection. Regarded as an anti-Ulcer(Hyder et al. 2013; Khan and Khatoon 2008).

Plantago lanceolata L. (Plantaginaceae) Sepgilk/Yeep is the local name of this fruit. Seeds of this plant cure diarrhea and fever (Khan et al. 2011).

Plantago major L. (Plantaginaceae) Isabgol is the local name. It has great medicinal importance. It kills cholesterol in blood. It can also be treated against stomach disorders like diarrhea, dysentery, and constipation (Hyder et al. 2013; Jabeen et al. 2015).

Hordeum vulgare L. (Poaceae) a cultivated medicinal plant. Locally, it is called York or Hari in Hunza-Nagar and Nus in Shigar region GB. The grains of flour used to treat jaundice and high blood pressure (Khan et al. 2011). Locals of Shigar used this plant to treat hypertension and stomach ulcer (Abbas et al. 2017). Its seed cooked as a whole grain or ground up while used as the flour for making porridges and bread, etc. The seed also used for the development of the fermented products.

Fig. 15.12 *Ficus carica*

Fig. 15.13 *Morus alba*

Rheum tibeticum Maxim. ex Hook. f. (Polygonaceae) locally known as Sheepod. Its young stem is edible and used for reliving constipation (Khan et al. 2011).

Fig. 15.14 *Punica granatum*

Primula macrophylla D.Don. (Primulaceae) locally known as Lelo or Lilio. Mature roots can treat throat infection. It also cures tonsil problems (Hyder et al. 2013).

Punica granatum (Punicaceae) locally known as Danooh (Fig. 15.14). Its fruit acts as prophetic medicine, while its various parts can be used for different medicinal purposes. The edible parts of fruits are used for the energy enhancement and blood pressure control. Its roots used by masses as wormicide (Abbas et al. 2014*;* Awan et al. 2013).

Clematis Orientalis L. (Ranunculaceae) locally known as murghushi in Shina language and Chindrik in Brushashki. To cure diarrhea and dysentery dried fruits and flowers are used traditionally. Leaf extract and plant paste used as insecticide and antiseptic, respectively (Khan et al. 2011; Khan and Khatoon 2007).

Fragaria nubicola Lindl. ex Lac. (Rosaceae) locally known as Groose or Gruzal. For Increased sexual power in men (Hyder et al. 2013) and for asthma and heart problems, the roots of this plant are used (Khan and Khatoon 2008).

Prunus armeniaca L. (Rosaceae) is an edible fruit and cultivated almost in all regions of GB. It is known as Jaroty in the Shina language and Joo in Burushaski language. Fruit enhances formation of blood in the body and very helpful against liver and cardiac problems. Its seeds are used for abdominal and stomach disorders (Hussain et al. 2011). Locals think that it relieves headache, anxiety, and stomach disorders (Hyder et al. 2013). There is enormous commercial importance for *Prunus armeniaca*, as it is supplied to the market in different forms, like dry fruits, juices, seed oils, and jams. Locals used wood from *Prunus armeniaca* as a major source of fuel as well as for making different wood ornaments (Khan and Khatoon 2007*;* Hussain et al. 2011).

Rosa webbiana Wallich ex Royle (Rosaceae) Chereer is the local name in Brushashki, while in Shina it is called as Shinghaye. Fruit can treat digestive problems and seeds are used for veterinary diseases, while tea is made from its aerial parts which are used against fever, sore throat, and cough (Khan et al. 2011; Jabeen et al. 2015).

Datura stramonium L. (Solanaceae), Daturaa or daturoo, is the local name. Medicinally it leaves and flowers take part in fighting against salivation, muscular rigidity, and asthma (Hyder et al. 2013). Its leave extract and paste are used externally for wounds, pains, injuries and bleedings. Its leave extract is also used against baldness (Khan and Khatoon 2008).

Solanum nigrum L. (Solanaceae) locally known as Gabilo or Ghabily. Fruit and seeds cure throat inflammation (Khan et al. 2011). Ripe berries and leaves of *Solanum nigrum L. are used to treat* cardiac diseases and joints problems (Khan and Khatoon 2008).

Carum carvi L. (Umbelliferae) in Brushashki it is known as Hayave (Hyder et al. 2013), while in Shina language it is called as Filizooh (Khan and Khatoon 2008). It can treat stomach disorders in children, ulcer dysentery, and uterine tumors (Hyder et al. 2013; Khan and Khatoon 2008).

Coriandrum sativum L. (Umbelliferae) is cultivated plant, locally known as Thon in Brushashki, while in Shina language it is known as Nasky. Leaves are used in Salad for garnishing. Medicinally, it is used for indigestion, vomiting and intestinal problems and flatulence (Hyder et al. 2013; Khan and Khatoon 2008).

Peganum harmala L. (Zygophyllaceae) Ispandur (Fig. 15.15) is the local name. Juice of fresh roots is given to treat jaundice and menorrhagia (Hyder et al. 2013; Jabeen et al. 2015). *Peganum harmala* has a cultural importance in the area of Gilgit. It is believed that in order to remove evil eyes, the dried plant is burned, and houses are fumigated. It is also used as disinfectant (Abbas et al. 2013).

Traditional and practical importance of Edible Medicinal plants:

As we know, herbivores are older companion of human life and rely on plants for diet. Since plants are the reason behind the existence of human being and other animals. The lives we are cherishing wouldn't exist without plants. Plants convert sunlight into useable energy and endlessly provide oxygen (Tilford 1997). An exhaustive literature survey revealed that green plants are employed as vegetables, ornamentals, medicines, fuel wood, timber wood, agricultural tool, structural material and edible fruits (Ijaz et al. 2017). A number of health issues are frequent in locals like cancer, bone pains, BP, muscle Pain, and many more are addressed by the use of these medicinal plants. There were 27 plants species traditionally used to antidote diseases. A survey was supervised in the vicinity of Gilgit-Baltistan for

Fig. 15.15 *Peganum harmala*

identification of medicinal plants. The elders of about 60 > age have incredible knowledge of the proper usage of medicinal plants. The inhabitants of this place either apply the whole plant directly or grind the different parts and make a paste or powder form in the light of ethnomedicinal uses of plant resources in GB, Pakistan (Shedayi and Gulshan 2012). In a traditional system of medicine, people of Baltistan used crude extract of medicinal plants for treatment of various aliments especially infectious diseases (Hussain et al. 2011). Additionally, a survey based research was conducted in the region of Gilgit to find out medicinal plants that only cure Gynecological disorders in women (Akhter et al. 2016). One hundred ninety-two medicinal plant species were reported in a study which are considered as anti-hypertensive (Malik et al. 2018). Furthermore, in the north of Pakistan there are 106 species which are specifically consumed for the treatment of skin diseases (Malik et al. 2019).There are many practical uses of herbs in preventing disorders and relieving pains. It is reported that 98 herbaceous plants are in the Bagrote and Haramosh valleys of Gilgit region are used for therapeutic purposes (Khan and Khatoon 2008). In the Shinaki locale of Hunza and Gilgit, there are some familiar plant species like *Morus alba* L., *Morus nigra*, *Prunus armeniaca*, *Elaeagnus anustifolia*, *Ficus carica* L., *Prunus persica, Punica granatum, Prunus avium* L., *Malus pumila, Prunus amygdalus, Linum usitatissimum* have extensive and momentous uses (Khan et al. 2013). It is important to record cultural heritage of medicinal plants, otherwise they will be lost in the highly dense population of flora in Gilgit Baltistan (Shinwari et al. 2017).

15.2 Economic Significance of Edible Medicinal Plants

Mostly, inhabitants found the folklore treatment as one of the cheapest remedies locally (Awan et al. 2013). Though, Gilgit and Skardu are among the gigantic consumers and densely populated areas of medicinal Plants, however, peripheral communities have enriched knowledge of medicinal plants (Salim et al. 2019).While in Skardu, there are hundreds of medicinal plants amidst the ample green plants with highest pharmaceutical values. For the natives, traditional plants are economical wells. To generate the livelihood, they greatly involved in preserving medicinal plants (Bano et al. 2014). In the Bulashbar valley, Astore, District Diamer, a plant species known as *Hippophae rhamnoids* has consumed over the years, improving the socio-economic conditions of its inhabitants (Shinwari and Gilani 2003).There are number of important species of wild plants in Skardu that have economic value (Bano et al. 2014). Sea Buckthorn (*Hippophae rhamnoides* ssp. *turkestanica*) is one of the edible Medicinal Plants in Gilgit-Baltistan. Currently its small orange berries had captivated researchers towards itself due to its nutritional, medicinal and economical value. *Vitis vinifera* play a vital role in lifework of people living in the north of Pakistan, apart from their medicinal significance (Kausar et al. 2017).In the zone of Astore, plants resources fulfill the needs of locals and also generate livelihood. To produce other source of earning, farmers should be given trainings regarding the importance of medicinal plants on commercial basis and for trading purposes.(Khan et al. 2018).

In Gilgit-Baltistan only the sellers of edible medicinal plants get benefited due to the poor merchandising (Abbas et al. 2016). It is concluded that due to modernization, the economic value of medicinal plants is vanishing (Khan et al. 2011).

15.3 Conclusion

In this chapter, medicinal and nutritional uses of 44 edible plant species representing 29 families are discussed. Some species such as *Peganum harmala* L.*, Allium cepa,* and *Carthamus tinctorius* L. are used in cultural practices in the region for a variety of purposes. For livelihood generation, C*arithamus trictorius, Hippophae rhamnoides* L.*, Diaspyras kaki* L.*, Elaeagnus angustifolia* L.*, Juglans regia* L.*, Thymus linearis* Benth*, Ficus carica, and Punica granatum*are are utilised. A number of plants species are used as folk medicine for treatment of various disorders like cancer, bone pains, blood pressure, cough, fever, muscle Pain. Besides, there is great potential in secondary metabolites for drug development that use for various disorder. Still a major proportion of flora is yet to be investigated for identification and biological application. These plants will be useful to generate potential income for the ruler community if they engaged in production, selling and value addition, and also increase the self-employment opportunities of mountain custodians. Additionally, this study is expected to provoke young minds to undertake endeavors related to plant sciences.

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