J Biodiversity, 12(1-2): 24-31 (2021)
PRINT: ISSN 0976-6901 ONLINE: ISSN 2456-6543
DOI: 10.31901/24566543.2021/12.1-2.088

Spatial Distribution and Ethno-botanical Aspect of Edible Plant from Foothill Region of Dhauladhar Range, Kangra Valley, North-Western Himalaya, India

Praveen Kumar

Department of Environmental Sciences, Central University of Himachal Pradesh, Dharamshala-176 215, Himachal Pradesh, India
Present address: *Department of Soil Science, CSK Himachal Pradesh Agricultural University, Palampur 176 062, Himachal Pradesh, India*
E-mail: pk.hpkv@gmail.com

KEYWORDS Diversity and Distribution of Wild Fruits. Ethnobotanical Status. Kangra Valley. Spatial Distribution

ABSTRACT Traditional medicine is a part of health care practice by local inhabitants residing in the peculiar landscape of the Himalaya. The edible plant species are used to fulfill dietary requirements as well as to cure various ailments. The present study represents the diversity, distribution and ethnobotanical aspect of wild fruit species from the foothill region of Dhauladhar Range, Kangra Valley, northwestern Himalaya, India. Total 37 edible plant species belong to 28 genera and 20 families were noticed, where family Rosaceae, Rutaceae and Muraceae are the most dominant. The GIS-based classification showed a high diversity of the edible plants in the south-eastern part of the study area, while isolated patches in low and high plant diversity reveal the effect of the habitat diversity and regional microclimate. The studies based upon indigenous knowledge are very important for searching for new potential and resource management. The data collected for the potential use and the spatial distribution will provide new insight into modern research for sustainable management of resources.

INTRODUCTION

At the global level, human activities have caused the loss of biodiversity and threatening indigenous knowledge. The complex geo-botanical landscape of the Himalaya provides an exceptional floral assemblage. The climatic conditions are responsible for unique habitat diversity and vegetation association making the area a hotspot of biological diversity (Myers et al. 2000). The Himalayan region covers 11 percent geographical area with more than 50 percent forest cover of India (Ignacimuthu et al. 2006; Sharma et al. 2013). The ecosystem services for livelihood in their day-to-day life, where plants are the main source for food, shelter, and medicine. The ethnobotany not only comprises the indigenous use of the plant but also covers all aspects of plant conservation for sustainable management of resources. Many plant species need to be explored facing a threat due to urbanization and habitat loss. The studies focus on ethnobotanical resources and traditional medicine are very important in the upcoming hilly urban center for sustainable management. As an estimate, the life of 300 million people is still dependent upon wild food throughout the modern world (Abbasi et al. 2013). With the pace of civilization, some of these plants cultivated in conservation or on commercial demand, and still, a large number of wild plants were the natural habitats for their sustenance.

Most of the available literature studies are based on the diversity, distribution and ethnobotanical aspect of available plant species in some specific area of Indian Himalaya (Chauhan 1999; Uniyal et al. 2006; Samant et al. 2007; Arya et al. 2012; Vidyarthi et al. 2013; Jyoti et al. 2014; Kumar et al. 2014; Mir and Sehgal 2021). Some studies also try to focus on edible plant species (Samant and Dhar 1997; Tiwari et al. 2010; Sharma et al. 2013; Sharma et al. 2020), still, many noteworthy locations seem to have a rich diversity to explore edible plant species. In addition, the use of a GIS platform can provide an effective tool to represent the spatial distribution of results for effective resource management. The present study documents the traditional use of edible plant species and represents the spatial distribution to identify the current trend of species diversity for proper resource management. The present study will also explore the potential for new drug discovery and alternative food resources.

METHODOLOGY

Study Area

The present study explores the diversity, distribution, and ethnobotanical aspect of edible plant species under the foothill region of Dhauladhar Range, Kangra Valley of northwestern Himalaya, India. The area is a matter of concern due to its unique geo-botanical landscape and habitat diversity between the snow-capped Dhauladhar Range to the fan area with moderate topography. The fan area has alluvial rich Quaternary sediments derived from the batholithic hilly mountain of Dhauladhar Range (Mahajan and Kumar 2018). The region also faces the burden of developing urban center on the southern flanks of the Dhauladhar Ranges. The Dhauladhar Range is a part of lesser Himalaya, characterized by three coalescing alluvial fans, namely Rait-Rihlu Fan (RF) in the west, Kangra Fan (KF) in the center, and Palampur Fan (PF) in the east (Srivastava et al. 2009). The present study covers the southern fringes of the Dhauladhar Range and the area under RF and KF (Fig. 1). The southern flank of the Dhauladhar Ranges is a part of a developing urban center with a large fan area having a structural terrace of moderate topography in the center (Mahajan and Kumar 2018). The annual rainfall (~2500 mm) in the area is very high (Ahmad et al. 2018) which brings huge sediment from the tributaries flowing from north to south. The climatic condition varies from sub-tropical on the southern side and temperate to alpine toward the northern extreme.

Field Survey

Numerous field surveys were carried out to document edible plant diversity in the study area from October 2017 to March 2018. The survey includes stratified random sampling followed by semi-structured interviews and group discussion to document the traditional use of edible plant species available as the wild, home garden crop that require slight processing for making various preparations (*chatni, murabba and churan*). The selection of sites covers a variety of habitats near Manai, Tatvani, Shahpur, Rait, Salol, Kangra, Tanda, Garoh, and Dharamshala (Fig. 1). At each site, the total number of plant species was recorded in 400-500 m transect in the particular habitat. The information about the common use of the edible plant species was recorded from inhabitants in their local dialect, *Kangri* and *Hindi*. The unidentified plant species were collected and temporarily preserved for further identification using local available flora and published papers (Chowdhery and Wadhwa 1984; Polunin and Stainton 1984). The information on plant species was collected by a discussion with local health professionals reviewed by secondary information of herbal medicine for potential use.

RESULTS AND DISCUSSION

Diversity Status

The present study record 37 edible plant species belonging to 28 genera and 20 families. The tree species were dominant with total diversity of 22 species, followed by shrub species (11 species) and then herb species (4 species). The family Rosaceae was dominant followed by Rutaceae and Muraceae. The low diversity for the herb species can be correlated with the winter (December–February) season. Some of the dominant species in wild, are *Flacourtia indica*, *Ficus racemosa*, *Berberis aristata*, *Rubus* spp. and *Zizyphsus mauritiana,* whereas and in the home garden crop, that is, *Averrhoa carambola, Mangifera indica, Musa paradisiaca, Juglans regia,* and *Citrus* spp. recorded. The edible plant species are presented with their scientific name, vernacular/local name, life form, part used, and their utilization with indigenous and medicinal use (Table 1), while Table 2 represents the taxonomic diversity of edible plant species in the study area. The wild fruit is used as unripe/ripe, fresh/dry to prepare juice, paste, and decoction for indigenous use.

Spatial Distribution of Edible Plant Species

The previous studies cover some specific area to explore diversity, distribution, and ethnobotanical aspect of plant species without much application of remote sensing and GIS techniques (Samant and Dhar 1997; Sood and Thakur 2004; Kumar and Hamal 2009; Arya et al. 2012; Jyoti et al. 2014; Kumar et al. 2018). The present study utilizes a GIS platform to show the spatial distribution of edible plant species

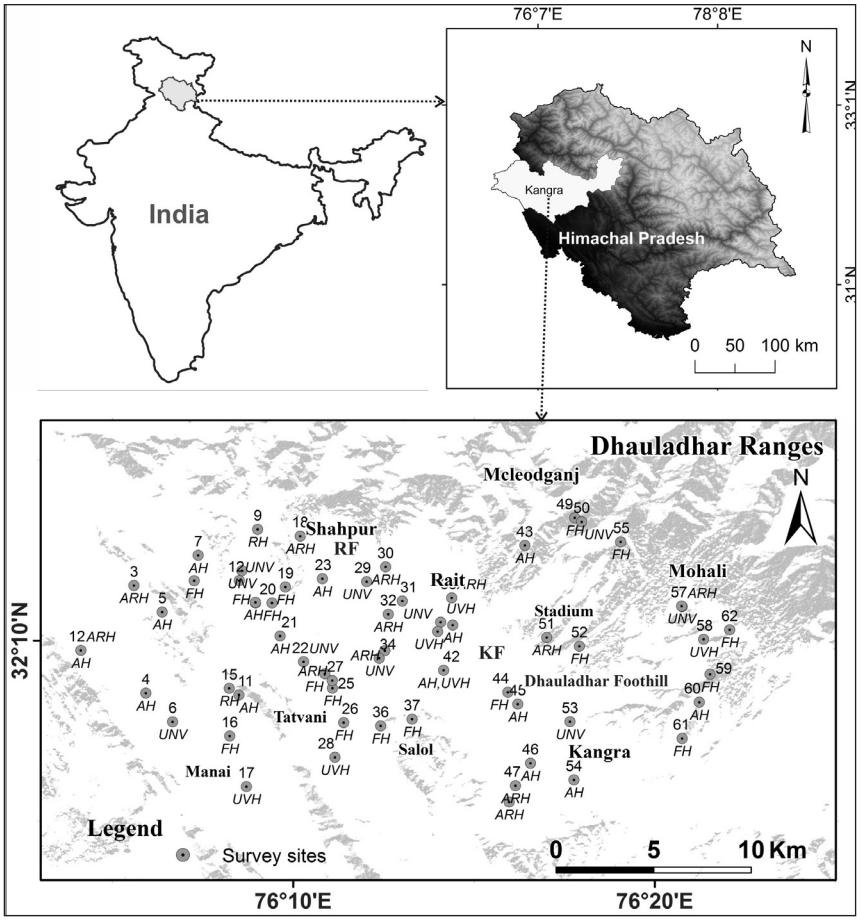

Fig. 1. Location map of the study area, showing the spatial distribution of survey sites with their respective habitats Abbreviations: AH= agricultural habitat; FH= forest habitat; RH= rural habitat; ARH= agricultural rural habitat; UNV= urban area with less vegetation; UVH= urban area with vegetation
Source: Author

using the interpolation method. The spatial distribution of the total number of plant species (tree and shrub) indicates high diversity toward the south-eastern part of the study area, while the rest of the area is accompanied by patches of low diversity (Fig. 2a). These patches also notice in the classification of edible plant species, which directly correlate with regional microclimate and vegetation association (Fig. 2b). The GIS classification data revealed a high number of edible plant species-near home garden as a crop, while low diversity near agricultural grassland and under patches of *Pinus* sp. community. This has also been noticed in other studies, which shows the vegetation association affected by the altitudinal range and habitat diversity (Singh and Samant 2010; Kumar et al. 2018).

Ethno-botanical Uses of Edible Plants

Many studies have indicated leaves and fruits as the main source of herbal medicine (Silambarasan and Ayyana 2015; Shah et al. 2015; Krupa et al. 2017) and the *Ayurvedic* system of herbal medicine. Most wild edible fruits are used by children, which provides a great source

Table 1: Ethno-botanical aspect of wild edible plant species from the foothill region of Dhauladhar Range, North western Himalaya, India

Family/Scientific name	*Vernacular/ Local name*	*Life form*	*Part used*	*Indigenous use*	*Medicinal use from dominant herbal system*
Anacardiaceae					
Mangifera indica L.	Amb	T	Lf, Fr, Sd	Fruits are used in various preparations raw as well dried	Tonic, appetizers, nutritious, bloating
Pistacia integerrima J. L. Stewart ex Brandis	Kakarsinghi	T	Fr	Dried fruits are eaten in cough	Expectorant, cough, asthma, fever, chronic pulmonary infection, vomiting and diarrhoea
Apocynaceae					
Carissa opaca Stapf ex Haines	Garna, Kharnu	Sh	Lf, Fr	Fruit eaten raw, milk from fruits is used for making chew-gum	Nutritional, appetizer, indigestion, Antimicrobial, Antitumor, Antioxidant, Asthma, Jaundice
Arecaceae					
Phoenix humilis Royle	Khajoor	T	Rt, Fr, Lf	Fruits are eaten	Cardio tonic, fever, vomiting, constipation, toothache, heart problem
Asparagaceae					
Asparagus racemosus Willd.	Sansarpali	Sh	Tu	Tender shoots are used as vegetables, cladode as anticancer	Menstrual disorder, avoid abortion, Leucorrhoea, aphrodisiac, urinary complaints, ulcer
Berberidaceae					
Berberis aristata DC.	Kshamal	Sh	Wp	Fruits are eaten raw and root are used in diabetes	Malaria, piles, skin diseases, antipyretic, eye, ear complaints
B. lycium Royle	Kshamal	Sh	Rt, Fr	Fruits are eaten raw and roots are used in jaundice	Jaundice, eye disease, Dysentery, diarrhoea
Caesalpiniaceae					
Bauhinia variegata L.	Karyalae, Kachnar	T	Lf, Fr, Fl	Bud and flowers are used to prepare vegetables	Scrofula, diabetes, tuberculosis gland, diarrhoea, piles, snake bite,
Combretaceae					
Terminalia bellirica (Gaertn.) Roxb	Baheda	T	Br, Fr	Fruits are dried and can be used as raw or with honey as laxative	Used in cough and asthma, used as bronchial sedative, laxative, pile, diarrhoea
T. chebula Retz	Harad	T	Fr, Br	Fruits are used to prepare *churan* and pickle and used 8in cough	Carminative, digestive, anorexia, appetite, tonic
Flacourtiaceae					
Flacourtia indica (Burm. f.) Merr.	Kangu	T	Lf, Br, Fr, Rt	Ripen fruits are eaten	Cough, throat and mouth disease, snake bite
Juglandaceae					
Juglans regia L.	Khod	T	Fr, Lf, Wd	Nuts are eaten and leaf and bark used in toothbrush	Provide strength to muscle and brain tonic as its shape, astringent, blood purifier, cancer
Moraceae					
Ficus palmata Forsk	Dagla	T	Fr	Fruits are eaten	Digestive disorders, cough, constipation, diabetes
F. racemosa Roxb.	Gular	T	Lf, Br, Fr, Rt	Fruits are eaten	Cooling, blood purifier, diarrhoea, fracture, genital disorder
Morus alba L.	Toot, chimu	T	Fr , Lf	Fruits are eaten as laxative	Cooling, laxative, carminative, expectorant
Musaceae					
Musa paradisiaca L.	Kela	H	Fr, Lf	Fruits are eaten	Stomachic, cooling, hypertension, gout

Table 1: Contd.....

Family/Scientific name	*Vernacular/ Local name*	*Life form*	*Part used*	*Indigenous use*	*Medicinal use from dominant herbal system*
Myrtaceae					
Psidium guajava L.	Amrood	T	Fr, Lf	Fruits are eaten	Mouth sores, anthelmintic, wound infection, aphrodisiac, expectorant
Syzygium cumini Skees	Jamun	T	Fr, Lf, Sd	Fruits are eaten used in diabetes	Blister in mouth, Astringent, piles, pimples, diabetes
Oxalidaceae					
Averrhoa carambola L.	Chamark, Kamrakh	T	Fr	Fruits are eaten to cure fever	Used to treat constipation, anti-oxidant, cough, sore throat, ulcer, hangover, eczema and ulcer
Phyllanthaceae					
Phyllanthus emblica L	Amala	T	Fr, Bk	Fruits are eaten and *murabba*	Rejuvenator, appetizing, skin disease, cough, asthma
Pinaceae					
Pinus roxburghii Sarg.	Chil	T	Sd, Wd,	Fruits are eaten	Bone fracture, cracks in sole of feet, asthma, skin disease
Polygonaceae					
Rumex hastatus D. Don	Khati-mithi	H	Lf	Leaves are used in *chatni*	Dysentery, purgative, stomachic, carminative
R. nepalense Meissn.	Trod	H	Lf	Leaves are used to prepare *saag*	Swellings, colds, influenza, hemorrhoids, rheumatism, abortion, diuretic
Rhamnaceae					
Zizyphus mauritiana Lam.	Ber	Sh	Fr, Rt, Br	Fruits are eaten	Blood purifier, antiemetic, astringent, purgative, cholera, dysentery
Rosaceae					
Fragaria nubicola Lindl. ex Lacaita	Bumbra	H	Fr	Fruits are eaten	Menstrual problems, laxative, diabetes, anemia, rheumatic gout, kidney and liver disorder
Prunuspersica Benth. & HK.	Aadu	T	Fr, Rt, Sd	Fruits are eaten	Laxative, diuretic, antiemetic, piles, purgative, scabies
Pyrus pashia Buch Ham.ex D. Don	Kainth	T	Fr, Wd	Fruits are eaten	Diarrhoea, anthelmintic
Rubus biflorus Buch.-Ham. ex Sm	Baer	Sh	Fr, Rt, Br	Fruits are eaten	Appetizer, blood purifier, cholera, dysentery, diarrohea
R. ellipticus Sm.	Aakhae	Sh	Fr, Rt	Fruits are eaten	Dysentery, malaria, stomachache, worms
R. foliolosus D. Don	Aakhae	Sh	Fr	Fruits are eaten	Dysentery, stomach disorder
Rutaceae					
Citrus aurantium L.	Khatta	T	Fr	Fruits are eaten	Stomachic, carminative
C. limon (L.) Burm.f.	Neembu	T	Fr	Fruits are eaten in *pit* disorder	Stomachic, carminative, rheumatism, diarrhoea,
C. reticulate Blanko	Santra	T	Fr, Lf, Wd	Fruits are eaten	Blood purifier, thirst tonic, improves appetite
Aegle marmelos (L.) Corr.	Bill	T	Fr	Fruits are eaten	Digestive disorder
Zanthoxylum armatum DC	Tirmir	Sh	Fr, Sd	Fruits are eaten and stem are used in toothbrush	Cough, cholera, eczema tooth complaints
Murraya koenigii Spr	Gandela	Sh	Rt, Lf, Fr	Leaves are used as flavoring agent in *Kadhi*	Anthelmintic, diarrhoea, dysentery, tonic, lactation, malaria fever
Urticaceae					
Urtica dioica L.	Bichubuti	Sh	Wp	Leaves are used to prepare *saag*	Anthelmintic, antiseptic, dandruff, gout, nephritis sprain, throat disease

Abbreviations used: H= herb; Sh= shrub; T= tree; Br= bark; Fl= flower; Fr= fruit; Lf= leaf; Rt= root; Sd= seed; Tu= tuber; Wp= whole plant; Wd= wood.

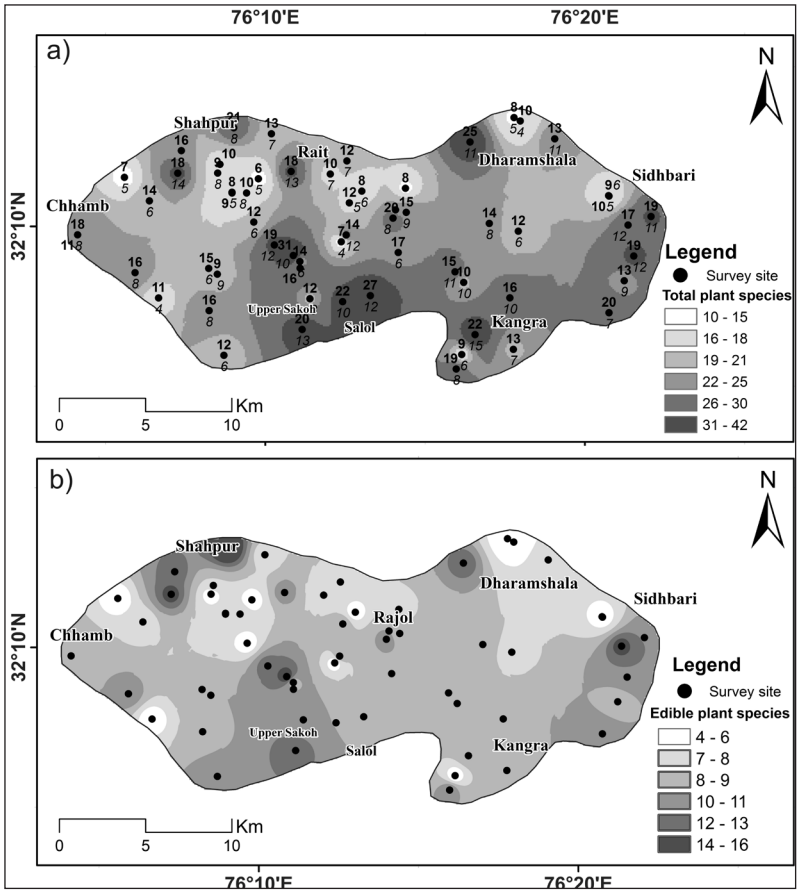

Fig. 2. GIS classification showing a) classes for total number of plant species with total number of tree species (above site legend) while, total number of shrub species (below site legend) in italic font, b) total number of edible plant species recorded from the study area
Source: Author

of nutrients, however, use among the elder is based on the medicinal value of edible plants available in the area. The local community also understands the principle of *Ayurveda,* which considers the cause of ailments, is due to an imbalance between three biological principles, that is, "*vat*", "*pit*" and "*kuff*". These plants are used in the same way to bring balance and to reach a state of complete health. The ethno-botanical aspect of the edible plant species is given in table 1. The use of these plant species is almost similar as noticed in previous studies (Samant et al. 2007; Arya et al. 2012; Sharma et al. 2013; Jyoti et al. 2014). The indigenous use of the plant species recorded in the survey is almost similar to the past literature and the other studies in neighboring areas. However, in the present study effort has been made to collect potential use of the plant species from the available literature.

CONCLUSION

The edible plant species are an important source of supplement to the local community in the study area. The local inhabitants are depen-

Table 2: Taxonomic diversity of edible plant species from the study area

Family	*Number of species*
Anacardiaceae	2
Apocynaceae	1
Arecaceae	1
Asparagaceae	1
Berberidaceae	2
Caesalpiniaceae	1
Combretaceae	2
Flacourtiaceae	1
Juglandaceae	1
Moraceae	3
Musaceae	1
Myrtaceae	2
Oxalidaceae	1
Phyllanthaceae	1
Pinaceae	1
Polygonaceae	2
Rhamnaceae	1
Rosaceae	6
Rutaceae	6
Urticaceae	1
Total	**37**

dent on edible plant diversity for their livelihood and to cure various ailments. The current status of edible plant species and their indigenous healthcare system provides them a new options of food and health effective conservation strategy. The spatial distribution of the number of edible plant species in the GIS platform will help to understand the current status and future requirements for the sustainable management of resources. The edible plant species, wild as well as present with home garden crops need to explore with physiochemical analysis for recommending in commercial use to cure various ailments. The documentation for the multiple-use pattern of edible plant species helps to know current utilization pressure and safeguarding valuable information, while the spatial distribution maps in the GIS platform provide input for proper monitoring, ecosystem resource management, and sustainable development.

ACKNOWLEDGEMENTS

The author acknowledges the local inhabitants for sharing their valuable knowledge and support. The author is also grateful to the editor and anonymous reviewers for their valuable suggestions for the improvement of the manuscript.

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Paper received for publication in January, 2019
Paper accepted for publication in May, 2019