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Assessment of Wild Edible Plant Diversity in Fringe Forest Areas of Kinnaur District, Himachal Pradesh, India

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ABSTRACT

Wild edible plant diversity in fringe forest areas in Kinnaur District, Himachal Pradesh, India, was assessed using stratified random sampling by the quadrat method. A total of 115 plant species comprised 19 trees, 31 shrubs and 65 herb species were found growing in the habitat. Of the total species recorded, the people in the district use 91 plant species (79.1% of the total species) for various edible purposes. Among the edible plants recorded, 16 were trees, 23 shrubs, and the remaining 52 were herbs. Wild edible trees had a higher density (70 trees/ ha) than non-edible tree species (11.25 trees/ ha). Among trees, *Prunus persica* was recorded with the highest density of 13.75 trees/ha, with a basal area of 1.27 m^2/ha and an IVI value of 51.56. Wild edible shrub species had a very high contribution of 75.53% (0.71 bushes/9m^2) to the total shrub species density (0.94 bushes 9/m^2). The density of all edible shrub species was <1 bush/ m^2, and the highest density was of *Berberis aristata* (0.18 bush/ 9m^2). The density of wild edible herbs was (12.07 individuals/ m^2) lower than the density of non-edible herb species (17.25 individuals/ m^2). *Thymus serphyllum* a rarely used herb, had the highest density of 5.49 individuals/ m^2, frequency (17.28 %) and IVI (26.00) among herbs. Most of the other edible herb species had density <1 individual/ m^2. It was observed that the indigenous people in the region frequently visit fringe forest areas for various purposes, which affect the population of wild edible plant species. Further, wild edible plant species knowledge is getting eroded, especially among the younger generation. Hence, public awareness and community based management need to be encouraged at all levels. In addition, forest department and various other government agencies should include important wild edibles in their plantation program.

Keywords Conservation, Density, Wild edible, Population status, Tribal region.

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INTRODUCTION

Wild edible plants have played an important role

in human life since time immemorial, even after the advent of agriculture, constituted an important part of the human diet, especially among poor rural communities. Rural people throughout the world, especially in developing countries, depend on this natural resource, and the knowledge of such edible plants was important for communities during wars and famine. In India, most rural inhabitants depend on wild edible plants to meet their additional food requirements. The edible plants offer variety in the family diet, contribute to household food security, and provide different bioactive chemicals that protect us from various diseases. In the Himalayan region also, wild edible plants have formed an important constituent of traditional diets and medicine for thousands of years, particularly in the tribal and rural areas of the Himalayas. These plants play a significant role in the livelihoods of rural communities as an integral part of the subsistence strategy of people (Negi and Subramani 2015). It is estimated that about 800 plant species are consumed as wild edible plants in India (Chandra *et al.* 2013). In the Indian Himalayan region, out of 675 recorded wild edible plant species , 344 occur in the Western Himalayan region (Pal *et al.* 2014). Large numbers of these plants are collected from forests and other wild areas to meet the subsistence food needs of the people (Negi *et al.* 2011). Such dependence is even greater in the Himalayan region (Ballabha *et al.* 2013). Wild plant species producing the edible product may play a prominent role in increasing the income of farm households if cultivated or harvested sustainably (Negi *et al* 2013).

Kinnaur district of Himachal Pradesh has peculiar topography, vegetation, people and traditions. Natural resources play an important role in the livelihood of the local communities in the region. Because of small land holdings and subsistence agriculture, the local people utilize many wild edible plants. They collect wild edible plants growing in various landscapes, including forests, fallow lands, and fringe forest areas. Fringe forest areas generally refer to peripheral areas outside the main forest, which contribute to the production of wild edible plants. Several authors have documented the wild edible plant diversity in the state of Himachal Pradesh (Rajasekaran *et al.* 2018, Gautam *et al.* 2011, Singh *et al.* 2016, Thakur 2017, Kishor *et al.* 2018, Jhamta *et al.* 2019, Thakur *et al.* 2019, Thakur *et al.* 2020). The studies on documentation of wild edible plants of Kinnaur district have been carried out by some researchers (Chauhan *et al.* 2013, Singh *et al.* 2014, Chauhan *et al*. 2014, Chauhan *et al.* 2014, Singh *et al.* 2016, Rajasekaran *et al.* 2018, Singh *et al.* 2019), however many more wild species believed to be edible are yet to be reported.

Further, rapid decline in traditional knowledge about wild edible plants among the inhabitants of the district and increased reliance on processed food, documentation and evaluation of the traditional knowledge related to the diversity, usage, and status of wild edible plants becomes more critical. Further, deforestation, habitat degradation and other developmental activities affected wild edible plant diversity in the region. Among the different landscapes, fringe forest areas have been under tremendous change due to anthropogenic pressure for the last two or three decades (Rawat *et al.* 2010). In addition, the recent expansion of horticultural orchards viz., apple (*Malus domestica*), pear (*Pyrus communis*) and almond (*Prunus amygdalus*) also affected the diversity of wild edible plants growing in the region. Though few studies on the population status at different places in the Himalayan region have been conducted (Verma and Kapoor 2010, Joshi *et al.* 2018, Sharma *et al.* 2018, Gajurel and Doni 2020), however studies on the population structure of wild edible plant species are scanty in the Himalayan region and lacking in Kinnaur district of Himachal Pradesh (Singh *et al.* 2016). Therefore, the present study was conducted to assess the diversity of wild edible plants in fringe forest areas of Kinnaur district, Himachal Pradesh.

MATERIALS AND METHODS

Study area : Kinnaur district is a tribal region of Himachal Pradesh and lies between 77° 45' 00" to 79° 00' 35" East Longitudes and 31°55'50" to 32°05'15" North Latitudes. The entire district is spread over the Himalayan mountainous terrain, covering 6,679 km^2 area with altitudes ranging from 1500 to > 6770 meters above mean sea level. The district's economy is predominantly agrarian and about 64% of the population are dependent on agriculture. The Neoza or Chilgoza (*Pinus gerardiana*) is the district's major

forest produce. It is one of the most important cash crops of tribal people residing in the region.

Population status of wild edible plants: Population status of all edible plant species in the habitat was assessed by quadrat method in four different fringe forest areas of Kinnaur district i.e., Akpa, Dakho, Pangi and Rispa. These sites represent all the possible landscape heterogeneity in the district using stratified random sampling during the monsoon season, when all plant species were in the active growth stage. At each site, quadrats were laid down randomly and the size of the quadrat was determined by the species area curve (Misra 1968). To enumerate trees, 10 x 10 m quadrats were laid, and two sampling quadrats of 3 x 3m were diagonally positioned and laid in each 10 x 10 m quadrat to enumerate the shrub species. Besides this, two quadrats of 1 x 1m size were laid in each 3 x 3m quadrat to enumerate the herbs. Accordingly, a total of 200 quadrats for trees, 400 quadrats for shrubs and 800 quadrats for herbs were laid at the above four study sites. Woody plants with more than 31.5 cm GBH were recorded as trees, while tree species between 10.5 and 31.5 cm GBH were recorded as shrubs/ saplings and species having less than 10.5 cm were considered as herbaceous plants (Knight 1963,Verma and Kapoor 2010). For tree species data on GBH (Girth at Breast Height, 1.37 m above the ground) and the number of tree species in each quadrat was recorded individually. The number of bushes was recorded for shrubs species. In the case of herb species, numbers of individuals were noted. The recorded vegetation data was quantitatively analyzed for frequency, density, abundance, total basal area (for trees) and IVI following Curtis and McIntosh (Curtis and McIntosh 1950, Misra 1968). The relative values of parameters viz. Relative Frequency (RF), Relative Density (RD) and Relative Basal Area (RBA) were determined following (Phillips 1959). In the case of trees, density and basal area was calculated per hectare basis, and in the case of shrubs, density was calculated as the number of bushes/9m^2 and for herbs, density was represented as number of individuals/m^2.

All the plant species encountered in the quadrats were enumerated. Data on wild edible plants was collected through semi-structured interviews mainly on the plant names, parts used, plant uses, method of collection, mode of consumption. To verify the identity of plant species mentioned by the respondent's field visits were undertaken with the respondent. In case of his or her inability, another person of their family or village was taken for identification. All wild plant species used for various edible purposes by the local people of the district have been considered edible plants.

RESULTS AND DISCUSSION

A total of 115 plant species, comprising of 19 trees, 31 shrubs and 65 herb species, were found growing in the habitat. Out of the total species recorded, the people in the district use 91 plant species (79.1%) for various edible purposes. Among the edible plants recorded, 16 were trees, 23 were shrubs, and the remaining 52 were herbs.

The tree species with edible fruits include *Ficus palmata, F. roxburghii, Juglans regia, Malus baccata, Pinus gerardiana, Prunus armeniaca, P. persica and Pyrus pashia* were mainly recorded from fringe forest areas. A total of 19 tree species, including 16 wild edibles, were recorded from the area, and it had a total density of 81.25 trees/ha with a total basal area of 6.69 m^2/ha. Wild edible trees had a higher density (70 trees/ ha) than non-edible tree species (11.25 trees/ha) Table 1. Wild edible tree species together contributed 86.15% towards the total density, 87.46% (5.81 m^2/ha) of the total basal area and 87.76% of the total IVl. Among wild edibles tree species, *P. persica* had the highest density of 13.75 trees/ha, which contributed 19.64% stand density of the wild edible trees, followed by *J. regia* (10 trees/ ha), *P. armeniaca* (8.75 trees/ha), *Morus serrata* (6.25 trees/ha) and *M. baccata* (5 trees/ha). These species also had a relatively higher frequency of occurrence than other edible tree species. *Prunus persica* occupied the first position with 11.25% frequency of occurrence, closely followed by *J. regia* (10%) and *P. armeniaca* (8.75%). Other wild edible trees species had low density ranging between 1.25 to 3.75 trees per hectare. Some species such as *Aesculus indica*, *Celtis australis*, *Ficus roxburghii* and *Pyrus pashia* had very low density (1.25 tree/ha each). *Aesculus indica* had the highest abundance (2), which was followed by *P. cornuta* (1.50) and *P. persica* (1.22). However, *J.*

Table 1. Population status of wild edible and non-edible tree species and their uses recorded from fringe forest areas.

Sl. No.	Species	Uses	Density (trees/ha)	Frequency (%)	Basal area (m^2/ha)	IVI
	Edible Species					
1.	*Aesculus indica* (Wall ex Jacquem) Hook. f.	Nuts are processed into flour and used for making '*Roti*'/ breads	2.50	1.25	0.15	7.07
2.	*Celtis australis* Linn.	The ripe fruits are eaten raw & people used to prepare flour from seeds in the past.	1.25	1.25	0.02	3.63
3.	*Corylus colurna* Linn.	Nuts/kernels are eaten raw	2.50	2.50	0.09	7.85
4.	*Ficus palmata* Forsskal	Ripe fruits are eaten raw. Tender leaves are used as vegetables	3.75	3.75	0.11	11.40
5.	*Ficus roxburghii* Wallich ex Miq.	Ripe fruits are eaten raw	1.25	1.25	0.06	4.13
6.	*Juglans regia* Linn.	The nuts are eaten and sold in the market. People used to collect and sell stem and root bark to traders in the past	10.00	10.00	2.39	62.02
7.	*Malus baccata* (L.) Borkh.	Fruits are eaten raw when ripe	5.00	5.00	0.13	14.96
8.	*Morus alba* Linn.	Ripe fruits are eaten raw	1.25	1.25	0.02	3.59
9.	*Morus serrata* Roxb.	Ripe fruits are eaten raw	6.25	6.25	0.22	19.61
10.	*Prunus cerasoides* D.Don	Fruits eaten when ripe	2.50	2.50	0.06	7.48
11.	*Prunus armeniaca* Linn.	Edible oil is extracted from the seeds. Ripe fruits are consumed fresh and used for making local wine	8.75	8.75	0.87	35.89
12.	*Prunus cornuta* (Wallich ex Royle) Steud.	Ripe fruits are mixed with salt and eaten	3.75	2.50	0.25	11.86
13.	*Prunus persica* (Linn.) Batsch.	Ripe fruits are eaten raw and also used for making local wine	13.75	11.25	1.27	51.56
14.	*Pyrus communis* Linn.	Ripe fruits are eaten raw	2.50	2.50	0.06	7.48
15.	*Pyrus pashia* Buch-Ham. ex D.Don	Ripe fruits are eaten raw	1.25	1.25	0.03	3.75
16.	*Robinia pseudacacia* Linn.	Floral buds are boiled, water squeezed and fried in oil to make vegetable	3.75	3.75	0.08	10.99
	Sub total		**70.00**		**5.81**	
	Non-edible species					
17.	*Alnus nitida* Endl.	Fuel-wood	1.25	1.25	0.26	7.10
18.	*Populus ciliata* Wall. ex Royle	Furniture and fuel-wood	7.50	5.00	0.56	24.50
19.	*Salix alba* Linn.	Furniture and fuel-wood	2.50	1.25	0.02	5.14
	Sub total		**11.25**		**0.88**	
	Grand total		**81.25**		**6.69**	

regia had the highest IVI value (62.02) followed by *P. persica* (51.56) and *P. armeniaca* (35.89). Other important tree species of the habitat included *Corylus colurna, Ficus palmata, Malus baccata, Morus serrata, Prunus cornuta, Pyrus communis* and *Robinia pseudo-acacia* (Table 1). Among non-edible tree species, *Populus ciliata* had the highest density (7.50 trees/ha), basal area (0.56 m^2/ha) and frequency of occurrence (5%). While, *Salix alba* and *Alnus nitida* had 1.25 trees/ha each.

Table 2. Population status of wild edible and non-edible shrub species and their uses recorded from fringe forest areas.

Sl. No.	Species	Uses	Density (Bushes/ 9 m^2)	Frequency (%)	IVI
	Edible species				
1	*Berberis aristata* DC.	Sweet sour fruits are eaten by mixing with salt to improve taste	0.18	15.00	37.56
2	*Berberis chitria* D. Don	-Do-	0.01	1.25	2.91
3	*Berberis lycium* Royle	-Do-	0.03	2.50	5.82
4	*Celtis australis* Linn.*	The ripe fruits are eaten raw and people used to prepare flour from seeds in the past	0.01	0.63	1.45
5	*Cotoneaster microphyllus* Wall. ex Lindl.	Ripe fruits are eaten	0.01	1.25	2.91
6	*Debregeasia salicifolia* (Don) Rendle.	Ripe fruits are eaten	0.01	0.63	1.45
7	*Elaeagnus umbellata* Thunb.	Ripe fruits are eaten	0.09	8.75	21.02
8	*Hippophae salicifolia* D. Don	Ripe fruits are eaten and used for making juice and chutney	0.17	10.63	31.39
9	*Indigofera gerardiana* Wall.	Floral buds are used for making vegetables	0.05	4.38	10.85
10	*Lonicera angustifolia* Wall ex DC	Ripe fruits are eaten	0.01	0.63	1.45
11	*Prinsepia utilis* Royle	Edible oil is extracted from the seeds	0.01	0.63	1.45
12	*Prunus armeniaca* Linn.*	Fruits edible and edible oil extracted from seeds	0.02	1.88	4.36
13	*Prunus persica* (Linn.) Batsch*	Ripe fruits are eaten raw and are also used for making local wines.	0.01	0.63	1.45
14	*Rhamnus* sp.	Ripe fruits are eaten	0.01	0.63	1.45
15	*Ribes alpestre* Wallich. ex Decne.	Ripe fruits are eaten	0.01	0.63	1.45
16	*Rosa moschata* Miller	Ripe fruits are eaten	0.02	1.25	3.58
17	*Rubus biflorus* Buch-Ham. ex. Smith	Ripe fruits are eaten	0.02	1.88	4.36
18	*Rubus fruticosus* Linn.	Ripe fruits are eaten	0.01	1.25	2.91
19	*Rubus ellipticus* Smith	Ripe fruits are eaten	0.01	0.63	1.45
20	*Rubus niveus* Wallich.	Ripe fruits are eaten	0.04	3.75	8.72
21	*Sageratia theezans* Brogn	Ripe fruits are eaten	0.01	0.63	1.45
22	*Sageretia parviflora* G. Don.	Ripe fruits are eaten	0.01	0.63	1.45
23	*Viburnum cotinifolium* Don	Ripe fruits are eaten	0.01	0.63	1.45
	Sub total		**0.71**		
	Non-edible species				
24	*Desmodium tiliaefolium* G. Don	Fuel-wood	0.02	1.88	4.36
25	*Lonicera hypoleuca* Decne.	Fuel-wood	0.01	1.25	2.91
26	*Myrsine africana* Linn.	NA	0.01	0.63	1.45
27	*Rabdosia rugosa* (Wall. ex Benth.) Hara	Making broom	0.07	3.75	12.06
28	*Salix alba* Linn.*	Fuel-wood and timber	0.02	1.25	3.58

Table 2. Continued.

Sl. No.	Species	Uses	Density (Bushes/ 9 m^2)	Frequency (%)	IVI
29	*Sorbaria tomentosa* (Lindl.) Rehder	Fuel-wood	0.04	4.38	10.18
30	*Spiraea canescens* D.Don	Fodder	0.03	2.50	5.82
31	*Rhamnus virgatus*	Fodder	0.03	3.13	7.13
	Grand total		**0.94**		

*Saplings.

Thirty-one shrub species, including four tree saplings, were recorded from the habitat, of which 23 species were used for edible purposes and the remaining are non-edible. The total shrub species density was 0.94 bushes 9/m^2 in this habitat, of which wild edible shrub species had a very high contribution of 75.53% (0.71 bushes/9m^2). *Berberis aristata* and *Hippophae salicifolia* had a higher density of 0.18 bushes/9m^2 and 0.17 bushes/9m^2 respectively. Similarly, these two species had also higher frequency of occurrence i.e., 15% and 10.63% and IVI values of 37.56 and 31.39, respectively (Table 2). Other important edible shrubs such as *Elaeagnus umbellata* and *Rubus niveus* had a low density of 0.09 and 0.04 bushes 9/m^2 and 21.02 % and 8.72% frequency of occurrence, respectively. Among all the edible and non-edible species, *Rabdosia rugosa* had the highest abundance value of 1.83, followed by *H. salicifolia* (1.59) and *B. aristata* (1.17). On the other hand, tree saplings such as *C. australis*, *P. armeniaca* and *P. persica* had low densities of 0.01, 0.02 and 0.01 saplings/9m^2, respectively (Table 2).

Of the 65 herb species recorded from the habitat, 52 species are used by the people for various edible purposes (Table 3). However, the density of wild edible herbs was (12.07 individuals/m^2) lower than the density of non-edible herb species (17.25 individuals/m^2). Most edible herb species had a density of less than one per square meter. Some important edible herb species viz., *Brassica juncea, Cannabis sativa, Diplazium esculentum, Fragaria vesca, Urtica dioica* were represented with significantly less density of 0.16, 0.54, 0.01, 0.14 and 0.04 individual /m^2, respectively. *Thymus serphyllum*, a rarely used herb, had the highest density (5.49 individuals /m^2), frequency of occurrence (17.28 %) and IVI (26.00). *Cucurbita pepo* and *Circium arvense* had the lowest density (0.01 density /m^2 each) and frequency (0.62 % each). Among non-edible herb species, *Plantago major* had the highest density (6.99 individuals/ m^2), frequency of occurrence (38.27 %), followed by *Trifolium repens* with density at 6.41 individuals/m^2 and 32.41% frequency of occurrence. Other non-edible species also had low density. Pteridophytes such as *Adiantum lunulatum* and *Pteris cretica* growing near moist places had a density of 0.35 and 0.22 individual/m^2, respectively (Table 3).

The diversity index value for trees, shrubs, and herbs was 2.67, 2.80, and 2.48, respectively, in the habitat under study (Table 4). The range of diversity index values recorded in the present study are comparable with the values of other Himalayan forests (0-3.037) (Singh *et al.* 2016). The difference in species diversity could also be influenced by several factors such as grazing, competition by weed and human interferences .

The differences in terms of species composition suggest a high degree of variation in the physical settings of the landscape and disturbance regimes. It is also reported that the regional patterns of species richness are consequences of many interacting factors such as plant productivity, competition, geographical area, historical or evolutionary development, regional species dynamics, regional species pool, environmental variables and human activity (Huston 2014).

The wild edible plants face threats in their natural habitats from various human activities as observed during the present study. Grazing, habitat degradation,

Table 3. Population status of wild edible and non-edible herb species and their uses recorded from fringe forest areas.

Sl. No.	Species	Uses	Density (Indls./m²)	Frequency (%)	IVI
	Edible species				
1	*Allium humile* Kunth	Leaves are used for making vegetable	0.02	0.93	0.45
2	*Allium stracheyi* Baker	-do-	0.02	0.93	0.46
3	*Amaranthus caudatus* Linn.	-do-	0.06	2.47	1.23
4	*Amaranthus paniculatus* Linn.	-do-	0.04	2.16	1.04
5	*Arabidopsis glabra* Bernh.	Tender leaves are washed, cut, boiled and fried to make vegetables	0.02	0.93	0.44
6	*Berberis aristata* DC.* *	Ripe fruits are eaten	0.02	1.54	0.72
7	*Bistorta affinis* Greene	Flour prepared from seeds was used in the past, especially during famine period	0.13	1.85	1.23
8	*Brassica juncea* Linn.	Leaves are used for making vegetable	0.16	2.16	1.46
9	*Brassica rapa* Linn.	Leaves are used for making vegetable	0.05	1.85	0.96
10	*Cannabis sativa* Linn.	Seeds are edible	0.54	7.72	5.08
11	*Chaerophyllum reflexum* Lindl.	Roots are used for salad and vegetable	0.07	1.24	0.76
12.	*Chaerophyllum villosum* Wall ex DC	-do-	0.06	0.93	0.60
13	*Chenopodium album* Linn.	Leaves are used for making vegetable	0.18	3.40	2.05
14	*Chenopodium botrys* Linn.	-do-	0.04	1.24	0.65
15	*Chenopodium foliosum* Asch.	-do-	0.05	1.54	0.81
16	*Cicer microphyllum* Benth.	Unripe seeds are eaten by children	0.01	0.62	0.29
17	*Cirsium arvense* (Linn.) Scop.	Tender roots are eaten raw	0.01	0.62	0.28
18	*Cirsium wallichii* DC.	-do-	0.03	1.54	0.77
19	*Cucurbita pepo* Wall.	Ripe fruits are eaten	0.01	0.62	0.28
20	*Diplazium esculentum* (Retz.) Sw.	Used for making vegetables	0.01	0.31	0.16
21	*Elaeagnus umbellata* Thunb. **	Ripe fruits are eaten	0.19	1.54	1.30
22	*Equisetum* sp	Young shoots are consumed raw by children	0.03	0.31	0.21
23	*Fagopyrum esculentum* Moench.	Tender leaves are used for making vegetable	0.08	1.54	0.91
24	*Fagopyrum tataricum* (Linn.) Garten	-do-	0.02	0.62	0.33
25	*Fragaria indica* Andr.	Ripe fruits are eaten	0.03	0.93	0.47
26	*Fragaria vesca* Linn.	Ripe fruits are eaten	0.14	2.78	1.65
27	*Hippophae salicifolia* D. Don**	Fruits are eaten and used for making juice	0.03	1.54	0.76
28	*Indigofera gerardiana* Wall. **	Floral buds are used for making vegetables	0.01	0.31	0.16
29	*Juglans regia* Linn. **	Nuts are eaten	0.001	0.31	0.14
30	*Lactuca sativa* Linn.	Leaves are used for making vegetables	0.20	1.85	1.47
31	*Laportia terminalis* Wight.	Leaves are used for making vegetables	0.03	0.31	0.21
32	*Latyrus sativus* Linn.	Tender leaves are used for making vegetable and immature seeds are edible	0.07	1.54	0.87
33	*Lepidium latifolium* Linn.	Tender leaves are used for making vegetables	0.02	0.31	0.18
34	*Malva rotundifolia* Linn.	Sour fruits are eaten raw rarely	0.04	1.24	0.66
35	*Malva sylvestris* Linn.	Tender leaves are used for making vegetables	0.16	1.24	1.08

Table 3. Continued.

Sl. No.	Species	Uses	Density (Indls./m^2)	Frequency (%)	IVI
36	*Melilotus alba* Medicus ex Desr.	-do-	0.02	0.62	0.31
37	*Mentha longifolia* (Linn.) Hudson	Leaves are used for making chutney and also as a flavoring agent	0.07	0.93	0.63
38	*Perilla frutescens* (Linn.) Britt.	Seeds are edible	0.01	0.31	0.16
39	*Phytolacca acinosa* Roxb.	Leaves are used for making vegetables	0.01	0.31	0.15
40	*Prunus armeniaca* Linn. **	Fruits are eaten	0.01	0.93	0.43
41	*Prunus persica* (Linn.) Batsch.**	Fruits are eaten	0.07	0.62	0.48
42	*Rumex nepalensis* Sprengel.	Tender leaves used for making vegetables	0.73	19.44	10.66
43	*Rumex hastatus* D.Don	Leaves used for making chutney	0.11	1.85	1.15
44	*Silene vulgaris* (Moench.) Garcke	Tender leaves are used for making vegetables	0.03	0.93	0.48
45	*Solanum nigrum* Linn.	Ripe fruits are eaten	0.03	1.85	0.86
46	*Sparassis crispa* Fr.	Fruiting bodies are used as vegetable	2.02	13.27	12.47
47	*Stellaria media* (Linn.) Vill.	Leaves are used for making vegetables	0.11	2.47	1.40
48	*Taraxacum officinale* Wigg.	Leaves are used for making vegetables	0.28	3.70	2.53
49	*Thymus serpyllum* Linn.	An aromatic tea is made from the leaves	5.49	17.28	26.00
50	*Urtica dioica* Linn.	Leaves are used for making vegetables	0.04	1.24	0.67
51	*Urtica hyperborea* Jacquem. ex Wedd	Leaves are used for making vegetables	0.05	0.62	0.43
52	*Viola serpens* Wall. ex Roxb.	Flowers are eaten raw	0.46	4.94	3.65
	Sub total		**12.07**		
	Non- edible species				
53	*Adiantum lunulatum* Burm.	NA	0.35	2.47	2.23
54	*Artemisia maritima* Linn.	NA	0.55	9.57	5.90
55	*Galium elengans* Wall. ex. Roxb.	NA	0.15	1.24	1.01
56.	*Cynodon dactylon* (Linn.) Pers.	NA	0.82	5.56	5.15
57	*Euphorbia emodi* Hook. f.	NA	0.11	1.85	1.14
58	*Geranium nepalense* Sweet	NA	0.85	9.88	7.06
59	*Geranium pratense* Linn.	NA	0.09	1.85	1.10
60	*Phleum paniculatum* Huds.	Fodder	0.62	6.17	4.70
61	*Morina coulteriana* Royle	NA	0.09	4.01	2.00
62	*Plantago major* Linn.	NA	6.99	38.27	39.95
63	*Pteris cretica* Linn.	NA	0.22	1.54	1.39
64	*Salvia nubicola* Sw.	NA	0.01	0.62	0.29
65	*Trifolium repens* Linn.	Fodder	6.41	32.41	35.5
	Sub total		**17.25**		
	Grand total		**29.32**		

**Regeneration.

expansion of horticultural and agricultural areas, fuel wood collection, construction of roads and other anthropogenic pressure are important threats affecting the wild edible plant abundance and diversity.

Table 4. Diversity index, concentration of dominance, richness index and evenness index of wild edible and non-edible plant species recorded from fringe forest areas.

Habitat / Form	Diversity index (H')	Concentration of dominance (C)	Richness index (R)	Evenness index (E)
Trees	2.67	0.11	4.31	0.14
Shrubs	2.80	0.08	6.19	0.81
Herbs	2.48	0.10	6.99	0.60

Besides, selective harvesting of some exceptionally beneficial edible plant species has also caused the depletion of the species. The present study observed that wild edible tree density is very less (70 trees/ha) in the habitat. Wild edible tree species such as *Prunus armeniaca, P. persica, Pyrus pashia* and *Pyrus* spp. get low priority among the local people as compared to commercial horticultural crops as they feel they cause hindrance in the growth and development of horticultural crops, so they are removing these trees from this habitat. Moreover, due to high anthropogenic threats, the regeneration and recruitments of wild edible species are also very low and sporadic in this habitat. Though the horticultural and agricultural expansions affect the wild edible plant diversity, some of the important edible species are still being retained by the residents. Such maintenance of valuable plant species in community areas was a common practice in the Himalayan region (Singh *et al.* 2016, Singh *et al.* 2019). Rawat *et al*. (2010) reported higher species richness under the agroforestry system followed by forestry and forest in Lahaul and Spiti district of Himachal Pradesh.

The people in the region retain some of the naturally growing useful species along the edges of their agricultural fields, horticultural orchards and species such as *Juglans regia, Malus baccata, Prunus armeniaca, P. persica* and *Pyrus pashia* are planted in community lands. Growing useful trees along the edges of the agricultural field is an age-old practice in other parts of the Indian Himalayas. Mostly species with multipurpose uses (fuel-wood, medicine, fodder, timber, fruits) are grown and managed for subsistence requirements of local communities.

The study revealed that knowledge about the edibility, habitat distribution, harvesting time, and uses of most wild edible plant species is eroded, especially among the younger generation. The results also revealed that many wild species are under growing pressures from various anthropogenic factors. Thus, public awareness and community-based management need to be encouraged at all levels. The findings suggest further investigations into nutritional profiles and processing methods of all reported species under the study. Pharmacological properties of the nutraceutical species need analysis due to their use in medicinal applications. Various state forest departments often neglect the management of most Non-Timber Forest Products, including wild edibles, though it annually contributes significantly to rural income and livelihood. Information about the actual availability and status of edible plants and the impact of extraction on forest structure and composition are required to manage and conserve these valuable natural resources effectively. Considering the importance of this natural resource, the state forest department and various other government agencies should include these species in future forestry/rural plantation program.

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