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ORIGINAL ARTICLE **OPEN ACCESS**

Ecological Status of Wild Edible Plants in Chopta-Mandal Forest in Garhwal Himalayas, Uttarakhand.

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ABSTRACT
Western Himalayas are enriched with many useful plant species for the native people as they have diverse geographical and ecological conditions. Wild Edible Plants (WEP) provide local communities with basic and supplementary food and cash income to support food security. However, in land use planning and implementation, economic development and biodiversity conservation, WEPs are largely ignored. In addition, the traditional knowledge associated with WEP is rapidly disappearing. The present study documented the 64 species of WEP belonging to 47 genera and 36 families. Information is gathered through focus group discussions and interviews with key insiders. The method used in the study aims to provide baseline information on the use of plant species in the local system in the Garhwal Himalayan forests through village surveys and field visits to various areas of the Chamoli district villages within the Mandal Chopta range, Uttarakhand. Ecological information about WEP was collected using random quadrats in a random sampling technique along an altitudinal gradient in Chopta Mandal Forest. The present study documented the ecological status and importance of WEP in the largest protected area with high biodiversity. Other studies have shown that WEP is mainly threatened by habitat destruction, land use changes, and overexploitation. Some of these plants are wild relatives of crops, so they can be used for crop improvement.
Key Words: Biodiversity, Traditional knowledge, Random sampling, Economic development.

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INTRODUCTION

Plants are an important source of human food, condiments, medicines, shelter, fuel and fodder for livestock, pollinators, and prey, and they provide a wide range of ecosystems and additional cultural services for humans[1,2,3]. Wild plants collected from their natural habitat are the major source of food and nutrients for many rural communities particularly in Asia. Importance of wild edible plants has been recognised in Thailand[4], Laos[5,6], Vietnam[7], Cambodia[8], China[9] and the Philippines[10].

Many papers have emphasized the diversity and traditional uses of wild plants in the Garhwal Himalayas. Vegetation analysis and systematic research on the vascular plants in Mandal-Chopta forest were also carried out[11,12]. Many studies have been conducted on the ecological status, ethnobotanical aspects and traditional knowledge of medicinal plants in the Kedarnath Wildlife Sanctuary. During the study period, a total of 433 plant species in 234 genera and 71 families were recorded throughout the subalpine and alpine regions [13,14,15,16].

Unfortunately, many useful plants are threatened by habitat destruction and degradation, invasive species, climate change, pollution, overexploitation[17,18,19,20] and under representation in ex situ conservation pools[21,22,23,24].

The Kedarnath Wildlife Sanctuary (KWLS) is the most important and biodiversity rich area of the Garhwal Himalayas. Present study is particularly done in remote area and the native people residing in the study area are mostly dependent on forest resources for their daily needs. The aim of the present study was to assess the ecological status of wild edible plants as it is one of the largest protected area of the Garhwal Himalayas, Uttarakhand.

Study Area:

Kedarnath Wildlife Sanctuary (KWLS; latitude 300 25`300 45` latitude 780 55`790 22` east) is one of the most abundant and largest protected areas of plant resources in Uttarakhand, covering an area of 975 square kilometers. It is located in the northern catchment area of Alaknanda, the main tributary of the Ganges. An intensive study area of around 100 km2 was selected along the Southern fringe of Kedarnath WLS (Figure 1). Nearly 70% of the intensive study area lies in Mandal valley with in

Alaknanda catchment. Upper part of the study area is marked by famous Hindu shrine Tungnath (3550m). The local inhabitants are settled in scattered villages along lower fringes (< 2200m) who are basically agro-pastoralists. The study area includes substantial areas of Makku Reserve Forest with the altitude ranging between 1,500-3,680 m. The area was selected as it has a wide altitudinal range, different habitat and vegetation types mainly dominated by the oaks, varied aspect and slope categories. Six villages, namely Siroli, Mandal, Khalla, Koteshwar, Bandwara, Bairagana in the Mandal Valley and five villages namely Makku, Hudu, Daira, Kanda and Jagpura, were selected for an in-depth study from Chopta[16].

Figure 1: Map of Study Area

MATERIAL AND METHODS

The vegetation analysis of wild edible plants was carried out following the stratified random sampling technique involving random quadrats. The study area was divided into three altitudinal zones along the altitudinal gradient, to assess the availability status of wild edible species. The frequency, density and abundance of all species was determined.

A quadrats of 10 m X 10 m (100 sq m) size were randomly laid to study tree species, a plot of 5 m X 5 m (25 sq m) within the larger plot for shrubs and four 1 m X 1 m (1 sq m) quadrats in each direction (east, west, north, south) within 10 m X 10 m (100 sq m) quadrats were laid for herbs. A total of 176 plots were laid for trees and shrubs and 704 quadrats for herbs in the forested land and in the alpine region keeping in view the area and extent of anthropogenic pressures. Many rare and threatened species of wild edible plants were not recorded during the sampling, because of the restricted habitat availability in the region, and then the whole list of wild edible plants has been prepared.

A total of thirty five species of wild edible plants were found in the quadrats from the study area. Sixteen of these were herbs, twelve shrubs and seven trees belonging to 28 genera and 20 families (figure 2). Among the families of Angiosperms Rosaceae was the dominant family with 9 species and 7 genera, followed by Polygonaceae with 3 species with and 2 genera and Berberidaceae with 3 species and 1 genera, Urticaceae with 2 species and 1 genera while Asparagaceae, Cannabaceae, Brassicaceae, Saxifragaceae, Lauraceae, Athyriaceae, Juglandaceae, Oxalidaceae, Ericaceae, Asteraceae, Lythraceae and Rutaceae with 1 species each. Recently many studies has been conducted on floristic diversity of the Mandal Chopta forest recorded Asteraceae, Lamiaceae, Rosaceae, Orchidaceae, Poaceae, Urticaceae, Polygonaceae, Fabaceae are the 9 dominant families[11,12,13,25].

RESULTS

Altitudinal zone-I (1550 – 2200m):

In this altitudinal zone six trees were reported as wild edibles. The highest density (0.35 trees/100m2) and frequency (25%) was found for *Rhododendron arboreum* followed by highest abundance (1.59). The lowest density (0.06 trees/mm2) and frequency (5%) was observed for *Juglans regia* (table 1). Eight wild edible shrubs species were found in this altitudinal zone. The highest density and frequency (0.56

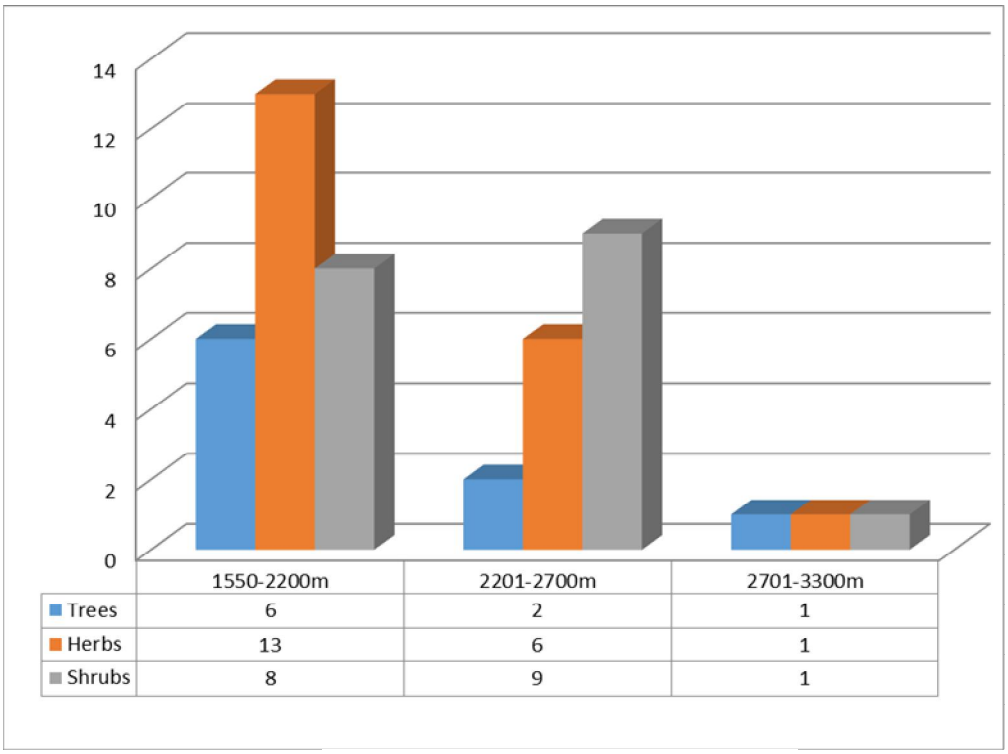
plants/25m2 and 41.3% respectively) was recorded for *Berberis aristata* followed by *Rubus ellipticus* (0.46 plants/25m2 and 21%) and *Woodfordia fruticosa* with highest abundance (2.92), *Prinsepia utilis* and *Rubus niveus* were found with lowest density and frequency (0.03 plants/25m2 and 4%, 0.20 plants/25m2 and 10%) followed by *Prinsepia utilis* with lowest abundance (1.30) (table 2). A total of 13 herb species of wild edibles were found. Among herb species highest density (0.98 plants/m2) was observed for *Duchesnea indica* followed by *Oxalis corniculata* (0.90 plants/m2). The highest frequency was again reported for *Duchesnea indica* (24.5%) followed by *Rumex hastatus* (18.7%) and *Oxalis corniculata* (18.6%). The lowest density and frequency (0.2 plants/m2 and 2.7% respectively) for *Urtica doica* (table 3) (figure 3, 4 and 5).

Altitudinal zone – II (2201 – 2700m):

In this altitudinal zone two wild edible tree species were reported. Among these wild edible tree species highest density (0.90 plants/ 100m2) and frequency (58%) was observed for *Rhododendron arboreum* with a highest abundance (1.64), followed by *Taxus baccata* with density (0.26 plants/ 100m2) and 12% frequency (table 1). Nine shrub species of wild edibles were found in this altitudinal zone. The highest density and frequency (17.5 plants/25m2, 35%) was recorded for *Rubus niveus* with highest abundance (5.45), while the lowest density and frequency (0.04 plants/25m2, 3.8%) was registered for *Berberis asiatica* with *Asparagus curillus* with lowest abundance (table 2). In the herb layer six species were found, among these *Rumex nepalensis* had the highest density and frequency (0.6 plants/m2, 23.8%) followed by *Duchesnea indica* (0.41 plants/m2, 16%). The lowest density and frequency (0.08 plants/25m2, 2.6%) recorded for *Bergenia ciliata* followed by *Duchesnea indica* with lowest abundance (table 3) (figure 3, 4 and 5).

Altitudinal zone – III (2701 – 3300m)

In this altitudinal zone only *Rhododendron arboreum has* been reported with density (1.10 plants/ 100m2) and frequency (50%) (table 1) followed by one shrub species *Cotoneaster microphylla* with density (0.6 plants/ 25m2) and frequency (13.5%) (table 2). In herb layer only one species has been found. Among herb *Rumex nepalensisis* reported with density and frequency (0.7 plants/m2, 20.7%) with abundance (2.50) (table 3) (figure 3, 4 and 5)



	1550-2200m	2201-2700m	2701-3300m
Trees	6	2	1
Herbs	13	6	1
Shrubs	8	9	1

Figure 2. Availability status of wild edible plants

Table 1. Wild edible tree species in study area (F - Frequency %, D - Density trees /100m2, A – Abundance)

Species	Zone - I (1550m - 2200m)			Zone - II (2201m - 2700m)			Zone - III (2701m – 3300m)		
	F	D	A	F	D	A	F	D	A
Cinnamomum tamala (Buch.-Ham.) Nees & Eberm.	20	.30	2.6	-	-	-	-	-	-
Juglans regia L.	5	0.06	1.25	-	-	-	-	-	-
Myrica esculenta Buch.-Ham. ex D. Don	14.2	0.23	2.35	-	-	-	-	-	-
Prunus cornuta (Wall. ex Royle) Steud.	6.67	0.07	1.57	-	-	-	-	-	-
Pyrus pashia Ham.	10	0.12	1.12	-	-	-	-	-	-
Rhododendron arboreum Smith	25	0.35	1.59	58	0.90	1.64	50	1.10	1.02
Taxus wallichiana Zucc.	-	-	-	12	0.26	2.2	-	-	-

DISCUSSION

Efforts to increase the representation of these wild edible plants in *ex situ* conservation areas should be done, especially considering the effects of biodiversity loss[3,26]. Climate change is likely to affect the efficiency of existing protected areas due to shifting species ranges[27,28,29,30].

Above study shows that many wild edible plants such as *Berberis asiatica, Berberis aristata, Urtica* spp, *Bergenia ciliata* have low frequency and density as they are under heavy pressure due to deforestation, overgrazing, overexploitation and irrational ways of collection[31,32].

Because wild plants provide a variety of important ecosystems and cultural services, including helping to mitigate the effects of climate change[1,2]. The development of the protection of these useful wild plants in their natural habitats is also well worth it. In order to adequately conserve these species in the area, a network of protected areas will require significant investment and possibly required expansion [33,34,35,36].

Improve popularity of the importance of wild edible plants. Despite being crucial for thousands of livelihoods, wild-harvested plant products have not often been recognized raising consciousness in their significance among coverage makers and across society could be an essential first step in growing effective policies that apprehend multiple land uses and guide sustainable wild plant use[37].

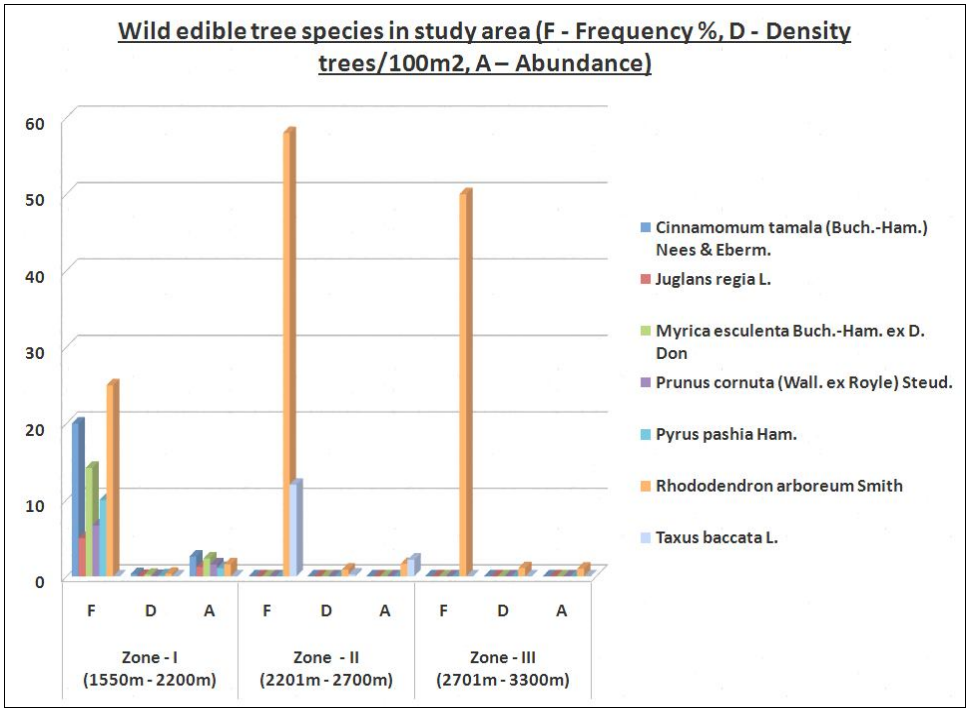


Figure 3. Wild edible Trees species in study area

Table 2. Wild edible shrubs species in study area (F - Frequency %, D - Density trees /25m2, A - Abundance

Species	Zone - I (1550m - 2200m)			Zone - II (2201m - 2700m)			Zone - III (2701m –3300m)		
	F	D	A	F	D	A	F	D	A
Asparagus curillus Buch. –Ham. ex Roxb.	5.97	0.12	2.25	6.6	0.09	1.20	-	-	-
Berberis aristata DC	41.3	0.56	1.86	5	0.09	1.4	-	-	-
Berberis asiatica Royle	-	-	-	3.8	0.04	1.30	-	-	-
Berberis lycium Royle	-	-	-	6.1	0.08	1.78	-	-	-
Cotoneaster microphylla Wall. Ex Lindl	-	-	-	-	-	-	13.5	0.6	1.54
Prinsepia utilis Royle	4	0.03	1.30	10	0.22	3.4	-	-	-
Rosa brunonii Lindl	12.5	0.22	1.80	5	0.12	2.25	-	-	-
Rosa macrophylla Lindl.	-	-	-	8	0.17	2.60	-	-	-
Rubus ellipticus Sm.	21	0.46	1.60	4	0.17	5.30	-	-	-

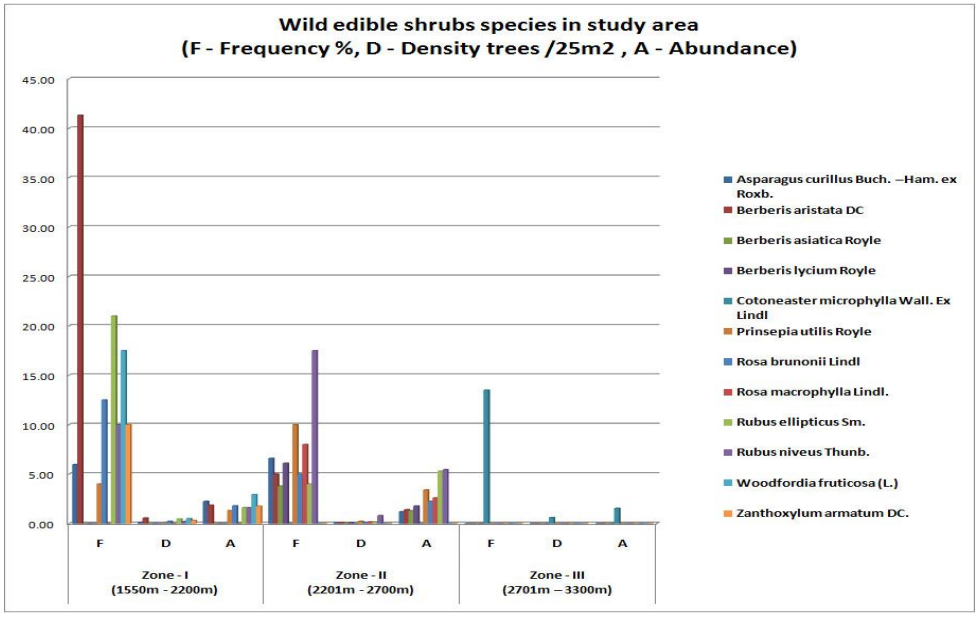


Figure 4. Wild edible Shrubs species in study area

Table 3. Wild edible herb species in study area (F - Frequency %, D - Density trees /m2, A - Abundance

Species	Zone - I (1550m - 2200m)			Zone - II (2201m - 2700m)			Zone - III (2701m –3300m)		
	F	D	A	F	D	A	F	D	A
Bergenia ciliata (Haw.) Sternb	5.3	0.2	3.75	2.6	0.08	3	-	-	-
Cannabis sativa L.	6.25	0.2	2.7	-	-	-	-	-	-
Capsella bursa- pastoris (L)	4	0.06	1.3	-	-	-	-	-	-
Centella asiatica (L.) Urban	9.3	0.30	3.2	-	-	-	-	-	-
Chenopodium album L.	8.75	0.35	4.6	-	-	-	-	-	-
Diplazium esculentum (Retz.)Sw.	12.5	0.2	3.8	-	-	-	-	-	-
Duchesnea indica (Anders.) Fock.	24.5	0.98	5.3	16	0.41	1.72	-	-	-
Fagopyrum dibotrys (D.Don) Hara,	11.2	0.20	4.7	7.5	0.10	3.75	-	-	-
Oxalis corniculata L.	18.6	0.90	6.2	15	0.20	5.6	-	-	-
Rumex hastatus D.Don	18.7	0.6	3.6	-	-	-	-	-	-
Rumex nepalensis Spreng	10.8	0.30	3.2	23.8	0.6	6.90	20.7	0.7	2.50
Stelleria media L.	7.50	0.40	4.8	-	-	-	-	-	-
Taraxacum officinale Weber	-	-	-	-	-	-	-	-	-
Urtica ardens Link.	2.50	0.2	2.7	-	-	-	-	-	-
Urtica dioca L.	7.50	0.40	6.25	-	-	-	-	-	-

Viola betonicifolia var. nepalensis (Ging) Back	-	-	-	10	0.1	6.25	-	-	-

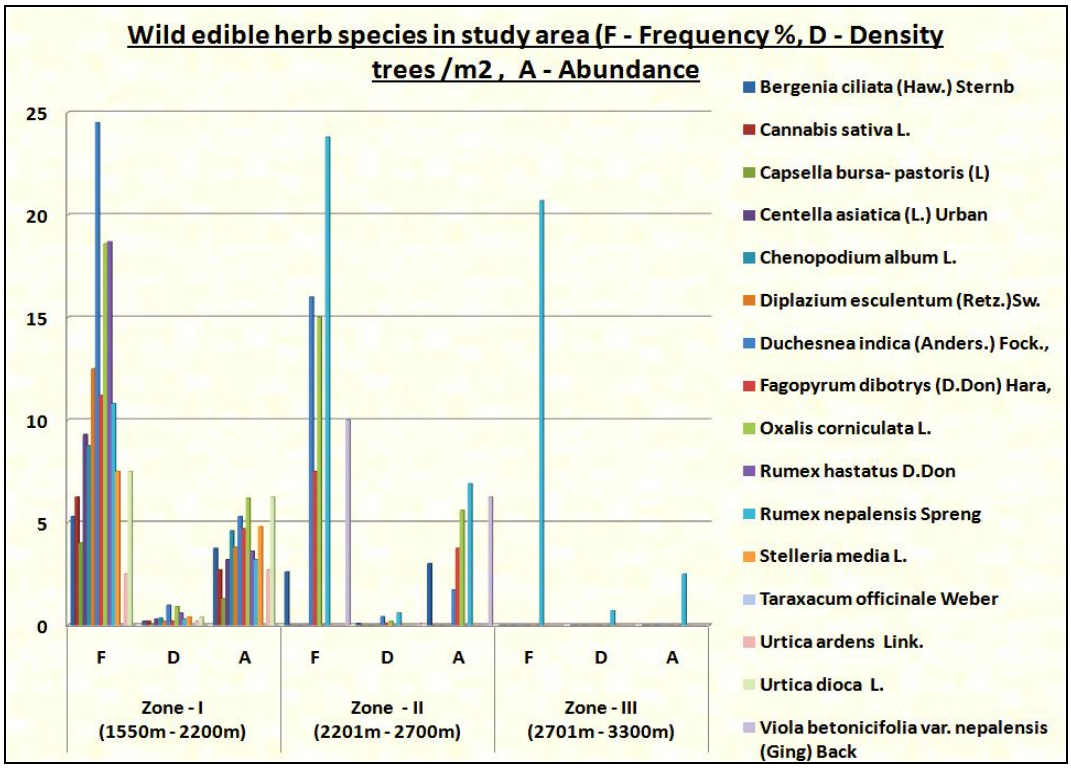


Figure 5. Wild edible herb species in study area

CONCLUSION

The results of this study shows that wild edible plants are used frequently by native people in the study area. Overexploitation of wild plants from their natural habitat, land use practices for agriculture, encroachment and climate change put these wild plants under threat. The majority of the people residing in the study area is unaware of the substantial risk to wild plants. In view of ecological status and declining population of wild edible plants species, it is recommended that the preparation micro-plans should be done for each species and sustainable harvesting practice.

Conventional methods and plant tissue culture techniques should be used to conserve wild species into their niche areas and natural habitat. Agro-production techniques can be used for some wild species which can help in obtaining the raw material for commercial use thus pressure on natural habitat can be minimised.

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