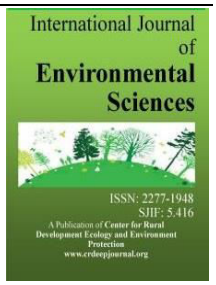
Vol. 9. No. 1. 2019

Contents available at:
www.crdeepjournal.org

International Journal of Environmental Sciences (ISSN: 2277-1948)



Full Length Research Article

Diversity, Utilization pattern and indigenous uses of useful plant resources in Nanda Devi Biosphere Reserve, West Himalaya, India

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ARTICLE INFORMATION

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Article history:
Received: 27-12-2019
Accepted: 31-12-2019
Revised: 05-01-2020
Published: 13-01-2020

Key words:
Himalaya, Nanda Devi Biosphere Reserve, Alpine Meadows, Resource Utilization Pattern, Indigenous Uses

ABSTRACT

Alpine meadows of Nanda Devi Biosphere Reserve (NDBR) are very rich in terms of species diversity. There are many useful and economically important species found in NDBR such as medicinal, edible, fuel, fodder, religious etc. are used by humans since time immemorial. The present study was conducted to find out the diversity, utilization pattern and indigenous uses of these plant resources in Nanda Devi Biosphere Reserve, West Himalaya, India. To determine diversity, utilization pattern and indigenous uses of plant resources, Participatory Rural Appraisal (PRA) and extensive surveys have been conducted in the six representative buffer zone villages i.e., Khati, Lata, Tolma, Phagti, Malari and Milam to generate information on plants used by the inhabitants. Knowledgeable persons from each village were interviewed. Among the village experts, one person was hired to survey and collect the useful plant species from wild habitats. Information on the local names, altitudinal range, life forms, part(s) used, and use values including indigenous knowledge and practices was gathered. Fresh samples of the useful species were collected and identified with the help of floras (Rau, 1975; Naithani, 1984; 1985; Rawat, 1984; Pangtey et al., 1988; Hajra & Balodi, 1995; Samant, 1993 and Samant et al., 2000a). The information on the indigenous uses of the species is based on primary as well as secondary information (Rawat & Pangtey, 1989; Pangtey et al., 1989; Jain, 1991; Samant & Mehta, 1994; Samant et al., 1996a, 1998b, 2001; Joshi et al., 1999, 2001). The species, which are under cultivation at present, and not recorded from the natural habitats, have also been considered for the study.Overall 202 useful species (26 shrubs, 176 herbs including 3 pteridophytes) belonging to 51 families and 128 genera from the Pindari, Latakharak, Malari and Milam alpine areas of NDBR have been recorded. These species have been used as medicine (142 spp.), wild edible/food (66 spp.), fodder (71 spp.), fuel (7 spp.), religious (12 spp.) and various other uses (19 spp.). Among the useful species, 23 species had multipurpose utility and 117 species had single utility. Considering the richness of the species, the family Asteraceae (17 spp.) was the richest, followed by Ranunculaceae (16 spp.), Apiaceae, Poaceae and Rosaceae (13 spp., each), Lamiaceae and Polygonaceae (11 spp., each), Cyperaceae (9 spp.), Gentianaceae (7 spp.), Boraginaceae, Brassicaceae and Scrophulariaceae (6 spp., each) and Ericaceae, Fabaceae and Liliaceae (5 spp., each). Whole plant of 55 species, aerial parts of 49 species, roots/rhizomes/bulbs/tubers of 29 species, leaves of 14 species, fruits of 6 species, flowers of 3 species, fronds, seeds and stems of 1 species, and combination of different parts of 43 species have been used for various purposes. Based on the findings, conservation measures have been suggested for these species and their habitats in alpine meadows of NDBR.

Introduction

The dependence of mankind on the plant resources is well known since the evolution of mankind on the earth. Man has been using plants as medicine, edible/food, fodder, fuel, timber, agricultural tools and various other purposes (Samant & Dhar, 1997). In the Indian Himalayan Region dependence of mankind on plants resources is very well known since the Vedic time. About 1748 species of medicinal plants (Samant et al., 1998b), 675 species of wild edibles (Samant & Dhar, 1997) and 279 species of fodder (Samant, 1998a) have been recorded from the IHR. Like other part of the Himalaya the inhabitants of are dependent on plant resources for medicine, food/edible, fodder, fuel and various other purposes (Samant et al., 1996a, 2000a; Joshi et al., 1999, 2001). Studies carried out on the human dependence on plant resources in the alpine meadows of NDBR have been poorly attempted and the complete databse on useful plant resources is not available. This invites a proper study on the diversity and ecology of the economically and ecologically important plants of the reserve. The available information on the human dependence on plant resources particularly in NDBR is restricted to certain areas (Shah, 1974; Rawat & Pangtey, 1987; Pangtey et al., 1989; Samant, 1993, 1998a; Samant et al., 1993, 1996a; Badola, 1998; Maikhuri et al., 1998a, 1998b; Joshi et al., 1999, 2001), and indicates that there is a great need to survey the unexplored and underexplored areas of the alpine region and, prepare a

comprehensive inventory of the useful species and document their indigenous uses. Therefore, the present paper deals with; (i) diversity, distribution, utilization patterns and indigenous uses of economically important species; (ii) extraction trends of useful species; (iii) species preference; and (v) suggest conservation strategies based on the existing status and utilization trend of the species.

Materials and methods

The Study Area

Nanda Devi Biosphere Reserve (NDBR) (30°05'-31°02'N to 79°12'-80°19'E) covering a total of 6,407.03 km^2 (Core zone 712.12 km^2; Buffer zone 5,148.57 km^2 and Transition zone 546.34 km^2), is situated in the northern part of west Himalaya (Fig. 1) and is among the World Heritage Sites. The reserve includes parts of Bageshwar and Pithoragarh districts in Kumaun region, and Chamoli district in Garhwal region. The buffer and transition zones are inhabited by over 100 villages. Most of the inhabitants belong to two main ethnic groups namely Indo-Mongoloid (Bhotia) and Indo-Aryans. They have been using plants as medicine, edible/food, fodder, fuel, timber, agricultural tools and various other purposes (Samant, 1996b; Joshi *et al.,* 1999, 2001).Geologically, the area falls within the Greater Himalaya or Himadri System and Zanskar range. Climatically, the area is dry with low annual precipitation. The core zone of the reserve remains snow covered almost throughout the year except mid May to October. Present study has been conducted in the alpine meadows of Pindari Catchment of the NDBR. It is located in the northern part of Bageshwar district. The area is inhabited by two buffer zone villages i.e., Khati and Leh Bagar. The major river is Pindar that originates from the Pindari Glacier. The main tributaries of the river Pindar are Sunderdhunga, Pindar and Kaphni Pindar.

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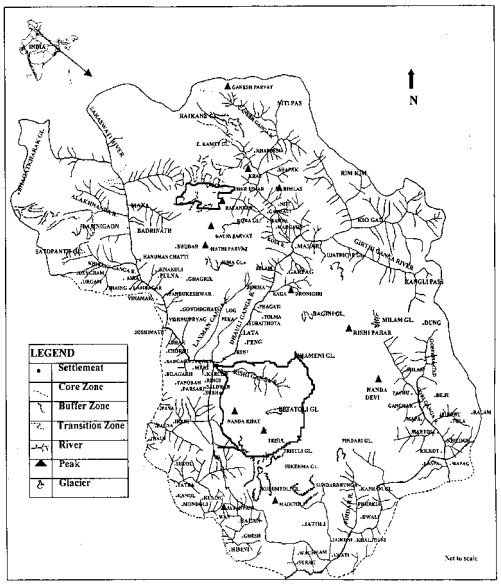

Fig 1. Location of Nanda Devi Biosphere Reserve. *(Prepared by Lead Office, GBPIHED, Kosi-Katarmal, Almora)*

Methods

To determine diversity, utilization pattern and indigenous uses of plant resources, Participatory Rural Appraisal (PRA) and extensive surveys have been conducted in the six representative buffer zone villages i.e., Khati, Lata, Tolma, Phagti, Malari and Milam between 1998-2000 to generate information on plants used by the inhabitants. Knowledgeable persons from each village were interviewed. Among the village experts, one person was hired to survey and collect the useful plant species from wild habitats. Information on the local names, altitudinal range, life forms, part(s) used, and use values including indigenous knowledge and practices was gathered. Fresh samples of the useful species were collected and identified with the help of floras (Rau, 1975; Naithani, 1984; 1985; Rawat, 1984; Pangtey et al., 1988; Hajra & Balodi, 1995; Samant, 1993 and Samant et al., 2000a). The information on the indigenous uses of the species is based on primary as well as secondary information (Rawat & Pangtey, 1989; Pangtey et al., 1989; Jain, 1991; Samant & Mehta, 1994; Samant et al., 1996a, 1998b, 2001; Joshi et al., 1999, 2001). For the external use, the useful part is crushed and converted into paste. The paste is used to cure the diseases. But, for internal use the paste is mixed with 4-5 teaspoonful of water and given to patients. For the preference of fodder species grazed by the sheeps, five sheep graziers were interviewed. Also, observations were taken on the grazing pattern of the sheeps. Samples of the grazed species were collected and identified with help of floras. For the extraction trend of the medicinal plants information was generated through semi-structured questionnaires. On an average three collection trips were undertaken by the villagers the quantum collection of one trip has been multiplied by 3 to obtain the total collection of the species. The species, which are under cultivation at present, and not recorded from the natural habitats, have also been considered for human dependence study.

Results

Diversity and utilization pattern

The present study recorded 202 useful species (26 shrubs, 176 herbs including 3 pteridophytes) belonging to 51 families and 128 genera from the Pindari, Latakharak, Malari and Milam alpine areas of NDBR. These species have been used as medicine (142 spp.), wild edible/food (66 spp.), fodder (71 spp.), fuel (7 spp.), religious (12 spp.) and various other uses (19 spp.). Among the useful species, 23 species had multipurpose utility and 117 species had single utility (Annexure 1).

From the Pindari alpine meadows, 158 economically important species (14 shrubs, 144 herbs including 1 pteridophyte) belonging to 43 families and 107 genera had been recorded. These species were used in a variety of purposes such as medicine (106 spp.), wild edible/food (48 spp.), fodder (64 spp.),

fuel (1 spp.), religious (8 spp.) and various other purposes (9 spp.). Amongst the species, 14 species had multipurpose utility whereas 96 species had single utility (Annexure 1).From the Latakharak alpine meadows, 125 economically important species (10 shrubs, 115 herbs including 2 pteridophytes) belonging to 39 families and 91 genera had been recorded. These specices were used for various purposes such as medicine (86 spp.), wild edible/food (38 spp.), fodder (48 spp.), fuel (3 spp.), religious (10 spp.) and various other purposes (11 spp.). Amongst the species, 15 species had multipurpose utility whereas 74 species had single utility (Annexure 1).From the Malari alpine meadows, 117 economically important species (11 shrubs, 106 herbs including 1 pteridophyte) belonging to 40 families and 91 genera have been recorded. These species were used as medicine (78 spp.), wild edible/food (35 spp.), fodder (50 spp.), fuel (2 spp.), religious (9 spp.) and various other purposes (12 spp.). Amongst the species, 13 species had multipurpose utility whereas 64 species had single utility (Annexure 1).From the Milam alpine meadows, 119 economically important species (16 shrubs, 103 herbs including 1 pteridophyte) belonging to 40 families and 85 genera have been recorded. These species were used in a variety of purposes such as medicine (78 spp.), wild edible/food (37 spp.), fodder (52 spp.), fuel (6 spp.), religious (9 spp.) and various other purposes (13 spp.). Amongst the species, 18 species had multipurpose utility whereas 67 species had single utility (Annexure 1).

Considering the richness of the species, the family Asteraceae (17 spp.) was the richest, followed by Ranunculaceae (16 spp.), Apiaceae, Poaceaeand Rosaceae (13 spp., each), Lamiaceae and Polygonaceae(11 spp., each), Cyperaceae (9 spp.), Gentianaceae (7 spp.), Boraginaceae, Brassicaceae and Scrophulariaceae (6 spp., each) and Ericaceae, Fabaceae and Liliaceae (5 spp., each). Species within the genera were poorly represented. The dominant genera were *Carex* (7 spp.), *Anemone* and *Polygonum* (5 spp., each), *Allium*, *Artemisia* and *Bupleurum* (4 spp., each), and *Aconitum*, *Berberis*, *Bromus*, *Corydalis*, *Gentiana*, *Juniperus*, *Pedicularis*, *Potentilla*, *Rheum*, *Rosa*, *Stellaria* and *Swertia* (3 spp., each). Whole plant of 55 species, aerial parts of 49 species, roots/rhizomes/bulbs/tubers of 29 species, leaves of 14 species, fruits of 6 species, flowers of 3 species, fronds, seeds and stems of 1 species, and combination of different parts of 43 species have been used for various purposes (Annexure 1).

Distribution pattern

Altitudinal distribution

Among all the useful species, maximum number of species were distributed between3000-3800m zone and minimum number of species in the >3800m zone. Altitudinal distribution of species within different use categories has been presented (Fig. 4.1).

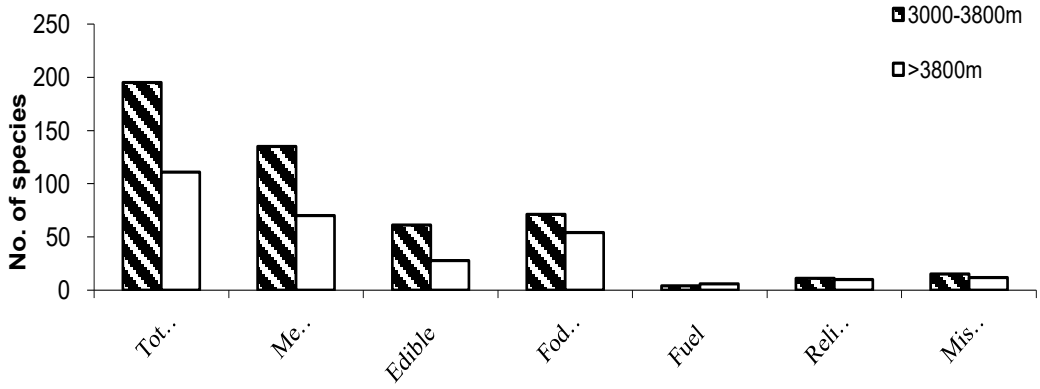

Fig.2 . Altitudinal distribution of useful plant resources in alpine meadows of NDBR

Among all the species, some species e.g., *Anaphalis contorta*, *Carex obscura*, *Clinopodium umbrosum*, *Cortia depressa*, *Danthonia cachemyriana*, *Polygonum affine*, *Primula denticulata*, *Sibaldia cuneata*, and *Trachydium roylei* (3000-4270m), *Anemone rupicola*, *Carex nubigena*, *Carex stracheyi*, *Poa alpina*, *Ranunculus hirtellus*, and *Viola biflora* (3100-4270m), *Potentilla atrosanguinea* (3000-4160m), *Anemone polyanthes* (3000-4140m), *Cardamine impatiens* (3140-4270m), *Selinum vaginatum* (3000-4075m), *Anemone elongata*, *Corydalis cashmiriana*, *Delphinium vestitum*, *Geranium polyanthes*, and *Tanacetum tomentosum* (3200-4270m), *Polygonum polystachyum* (3000-4060m), *Selinum tenuifolium* (3100-4160m), *Artemisia maritima* (3220-4270m), *Phlomis bracteosa*, and *Poa pratensis* (3100-4140m), *Pedicularis pectinata* (3000-4015m), *Aconitum voilaceum* (3900-4000m), *Carum carvi*, and *Saussurea costus* (2500-3500m), *Rhododendron campanulatum* (3000-4000m), *Sedum ewersii* (3140-4140m), *Fragaria nubicola* (3100-4075m), *Caltha palustris*, and *Salix lidleyana* (3300-4270m), *Anemone obtusiloba*, *Epilobium latifolium*, *Festuca kashmiriana*, and *Potentilla argyrophylla* (3100-4060m), *Dactylis glomerata* (3200-4160m), *Cerastium cerastioides* (3100-4050m), *Kobresia duthiei* (3200-4140m), *Brachypodium sylvaticum* (3340-4270m), *Bromus himalaicus*, and *Thalictrum reniforme* (3140-4060m), *Galium elegans*, and *Valeriana hardwickii* (3100-4015m), *Bupleurum candollei*, and *Potentilla peduncularis* (3100-4010m), *Juniperus recurva*, and *Lonicera obovata* (3250-4160m), *Kobresia laxa*, and *Oxygraphis polypetala* (3360-4270m), *Gentiana argentea* (3200-4075m), *Parnassia nubicola*, and *Parnassia pussila* (3140-4010m), *Corydalis govaniana*, *Rheum australe*, and *Rhododendron anthopogon* (3400-4270m), *Iris kumaonensis*, and *Taraxacum officinalis* (3200-4060m), *Cotoneaster microphyllus*, and *Polygonum amplexicaule* (3000-3850m), *Carex setosa* (3200-4050m), *Juniperus indica* (3220-4060m), *Carex haematostoma* (3440-4270m), *Geranium wallichianum* (3200-4010m)and *Thymus linearis* (3200-4000m)had wide altitudinal distribution (Table 4.3).

Habitat wise distribution

In general, the richness of economically important species among the habitats ranged from 3-91. In Pindari alpine medows, the richness of such species among the habitats ranged from 11-91. The highest useful species were distributed in shady moist (91 spp.) habitat, followed by dry (87 spp.), bouldery (81 spp.) and riverine (63 spp.), habitats. The least useful species were distributed in marsh-wet land (11 spp.) habitat. In Latakharak

alpine meadows, the richness of economically important species among the habitats ranged from 3-83. The highest species were distributed in dry (83 spp.), followed by bouldery (55 spp.), shady moist (50 spp.) and riverine (43 spp.), habitats. The least useful species were distributed in camping site (3 spp.), habitat.In Malari alpine meadows, the richness of economically important species among the habitats ranged from 17-59. The highest species were distributed in dry (59 spp.), followed by bouldery (40 spp.), habitats. The least useful species were distributed in rocky (17 spp.), habitat. In Milam alpine meadows, the richness of economically important species among the habitats ranged from 13-57. The highest species were distributed in dry (57 spp.), followed by riverine (43 spp.) and shrubberies (39 spp.), habitats. The least useful species were distributed in camping site (13 spp.), habitat.

Community wise distribution

In general, the richness of economically important species among the identified communities ranged from 3-81. In Pindari alpine medows, the richness of such species among the identified communities ranged from 6-81. The highest useful species were distributed in *Danthonia cachemyriana* (81 spp.) community, followed by *Agrostis pilosula-Poa alpina-Carex nubigena-Poa pratensis* mixed (44 spp.), *Cortia depressa-Poa alpina* mixed, and *Danthonia cachemyriana-Cortia depressa* mixed (43 spp., each), *Danthonia cachemyriana-Agrostis pilosula* mixed, *Danthonia cachemyriana-Poa pratensis-Carex obscura-Poa alpina* mixed, *Kobresia duthiei-Poa alpina-Carex nubigena* mixed (38 spp., each), *Poa alpina-Carex nivalis-Poa pratensis-Bupleurum candollei* mixed (36 spp.) and *Carex stracheyi-Poa pratensis-Carex haematostoma-Aconitum balfouri* mixed (32 spp.), communities. The least useful species were distributed in *Rumex nepalensis-Cardamine impatiens* mixed (6 spp.) community. In Latakharak alpine meadows, the richness of economically important species among the identified communities ranged from 3-27. The highest species were distributed in *Carex stracheyi* (75 spp.), followed by *Danthonia cachemyriana-Carex stracheyi* (71 spp.), *Danthonia cachemyriana* (51 spp.) and *Carex obscura* (27 spp.) communities. The least useful species were distributed in *Polygonum polystachyum* community (3 spp.).In Malari alpine meadows, the richness of economically important species among the identified communities ranged from 8-44. The highest useful species were distributed in *Danthonia cachemyriana* (44 spp.), followed by *Saxifraga pulvinaria* (36 spp.), *Carex setosa* (32 spp.) and *Danthonia cachemyriana-Saxifraga pulvinaria* mixed (24 spp.), communities. The least useful species were distributed in *Rumex nepalensis-Poa alpina-Geranium wallichianum* mixed, *Rumex nepalensis-Agrostis munroana-Anemone rivularis* mixed, *Danthonia cachemyriana-Leontopodium himalayanum-Kobresiaduthiei* mixed (8 spp., each), communities.In Milam alpine meadows, the richness of economically important species among the identified communities ranged from 7-63. The highest useful species were distributed in *Danthonia cachemyriana* (63 spp.), *Carex atrata* (36 spp.), *Kobresia duthiei* (31 spp.), *Danthonia cachemyriana-Saxifraga pulvinaria* mixed (29 spp.) and *Ligularia amplexicaulis* mixed (27 spp.), communities. The least economically important species were distributed in *Rumex nepalensis-Carex obscura* mixed (7 spp.), communitiy.

Indigenous uses

Of the total 202 species, 142 species were used for curing various diseases/ailments. For example, fronds of *Adiantum venustum* were used in fever; roots of *Angelica glauca* were used for curing dysentery, gastric complaints and stomach disorder; and *Cortia depressa* in abdominal disorder, rheumatism and stomachache; whole plant of *Carum carvi* in cold, cough, fever and stomach complaints; roots and leaves of *Suassurea costus* in asthma, dysentery, rheumatism, skin disease, stomachache, ulcer, and toothache; roots/rhizomes of *Picrorhiza kurrooa* in abdominal pain, anaemia, antispasmodic, cold, dyspepsia, diarrhoea, influenza, jaundice, promotes bile secretion, purgative, dysentery and fever (Annexure 1).Among all the species, 23 species had multipurpose utility (Annexure 1), for example, *Juniperus communis* was used for medicine, edible (food), fuel, religious and various other purpos; *Hippophae rhamnoides* was used for medicine, edible (food), fuel and various other purposes; *Rhododendron campanulatum* was used for medicine, edible (food), fuel and religious purposes; *Ephedra gerardiana* was used for medicine, edible and various other purposes; *Rhododendron anthopogon* was used for medicine, fodder and religious purposes; *Jurinella macrocephala*, *Nardostachys grandiflora* and *Tanacetum tomentosum* were used for medicine, religious and various other purposes; and *Rumex nepalensis* as medicinal, edible and fodder. The indigenous uses of the remaining species have been presented (Annexure 1).

Fodder resources preference

Of the total 71 fodder species grazed by the sheeps & horses, some of them *i.e.,Cortia depressa*, *Trachydium roylei*, *Carex obscura*, *Poa pratensis*, *Carex nubigena*, *Kobresia duthiei*, *Poa alpina*, *Taraxacum officinale*, *Danthonia cachemyriana*, *Potentilla atrosanguinea*, *Carex stracheyi*, *Brachypodium sylvaticum*, *Fragaria daltoniana*, *Fragaria nubicola*, *Plantago himalaica*, *Carex haematostoma*, *Capsella-bursa-patoris*, *Festuca kashmiriana*, *Bupleurum lanceolatum*, *Bromus himalaicus*, and *Chaerophyllum villosum*, *respectively* were highly prefered.

Extraction trends of medicinal plants

Twelve species have been collected by the Anwals (sheepgragers) and local inhabitants of the Buffer zone. The area wise average extraction (kg./year) of these species have been given in (Table. 1).

Table 1. Average collection of important medicinal plants in NDBR

S.N.	Species	Average collection of medicinal plants (Kg/Year)				
		Pindari	Latakharak	Malari	Milam	Total collection (Kg./year)
1.	*Aconitum balfourii*	1.50	0.90	0.00	0.00	0.60
2.	*Aconitum heterophyllum*	3.00	1.50	1.50	3.00	2.25
3.	*Angelica glauca*	15.00	3.00	9.00	9.00	9.00
4.	*Arnebia benthamii*	3.00	3.60	3.00	9.00	4.65
5.	*Dactylorhiza hatagirea*	4.50	3.00	0.75	4.50	3.18
6.	*Nardostachys grandiflora*	15.00	12.00	7.50	15.00	12.39
7.	*Picrorhiza kurrooa*	9.00	7.50	3.00	9.00	7.14
8.	*Podophyllum hexandrum*	0.75	0.60	0.60	0.90	0.72
9.	*Rheum australe*	4.50	3.00	3.00	15.00	6.39

10.	*Rheum webbianum*	4.50	3.00	3.00	9.00	4.89
11.	*Rhododendron anthopogon*	3.00	1.50	1.50	1.50	1.89
12.	*Tanasetum tomentosum*	7.50	6.00	6.00	15.00	8.64

In general, among the species maximum quantum of *Nardostachys grandiflora* was extracted (12.39 Kg/year). This was followed by *Angelica glauca* (9.00 kg/year), *Tanasetum tomentosum* (8.64 kg/year), *Picrorhiza kurrooa* (7.14 kg/year) and *Rheum australe* (6.39 Kg/year). The species wise extraction varied from area to area (Table 1).

Discussion

Since time immemorial, the inhabitats have been using plant resources in the form of medicine, food (edible), fuel, fodder, timber, agricultural tools, religious and various other purposes (Samant & Dhar, 1997; Samant *et al.,* 1996a, 1998b). The inventory of useful resources of the protected areas provides an array of existing information (Samant *et al.,* 1998b). Attempts have been made to explore, identify and prepare an inventory of plant resources of protected areas of the Himalaya (Samant, 1993; Samant *et al.,* 1993, 1996a, 1996b, 1998a, 2000; Dhar *et al.,* 1997, 1998; Kala *et al.,* 1998; Pandey & Well, 1997; Singh & Rawat, 2000). Such studies give an idea about the existing status of plant resources of a protected area. The Nanda Devi Biosphere Reserve is one of the unique ecosystems, which harbours a wide range of useful species (Samant *et al.,* 1996a). The present study provides comprehensive information on the diversity, distribution and utilization patterns, and species preference and extraction trends of useful species growing in the alpine area of buffer zone of NDBR. Such baseline information on the useful species is very much important to assess the population in wild, and identify their economic and conservation values. This will help in developing strategies for the conservation and management of species that are under high anthropogenic pressures. About 90% of the plant species used in the herbal industry today are extracted from the wild, majority of which comes from the sub-alpine and alpine zones of the Himalaya (Uniyal *et al.,* 2002). Among the alpine species, *Picrorhiza kurrooa*, *Aconitum heterophyllum*, *Dactylorhiza hatagirea*, *Nardostachys grandiflora*, *Angelica glauca*, *Podophyllum hexandrum*, *Arnebia benthamii*, *Rheum australe*, *Rheum webbianum*, *Rhododendron anthopogon*, *Tanasetum tomentosum*, etc. are high value species and traded by the local communities. The high preference of these species and continous extraction from the wild for trade has caused increased pressure. The alpine meadows have been subjected to grazing both by the migratory animals of transhumance *i.e.,* horses, sheeps and goats of the inhabitants of adjacent lower valleys during snowfree period (Ram & Singh, 1994). The grazing starts in the alpine area from the beginning of summer and continues in the snow free period *i.e.,* (May-September). Effect of livestock grazing on the alpine meadows has been discussed earlier by (Ram *et al.,* 1989; Singh, 1991; Negi *et al.,* 1993; Rawat & Uniyal, 1993; Kala *et al.,* 1998; Kala & Rawat, 1999; Sundriyal *et al.,* 1988). Due to unplanned grazing, ecology of the alpine meadows has been seriously affected (Ram & Singh, 1994). The pastoralist generally called the Anuwals in the different areas migrate with their animals. After reaching in the meadows, they reconstruct their huts on the cost of tree line plants. Every year some (1-2 ha) bare sites are created within the alpine meadows as a result of night camping of animals (Ram & Singh, 1994). The alpine meadows have also been subjected to trampling due to the human and animal activities. Trampling affects the composition, structureand soil characteristics of plant communities. The alpine meadows are the source of good quality fodder for goats, sheeps and horses. There are a number of species grazed by the sheeps & horses but some of them *i.e*, *Cortia depressa*, *Trachydium roylei, Carex obscura*, *Poa pratensis*, *Carex nubigena*, *Kobresia duthiei*, *Poa alpina*, *Taraxacum officinale*, *Danthonia cachemyriana*, *Potentilla atrosanguinea*, *Carex strecheyi*,etc. are highly preferred by these animals. These species do not attain their maximum growth in these areas.

Conclusion

The occurrence of maximum species in *Danthonia cachemyriana, Carex stracheyi, Danthonia cachemyriana-Carex stracheyi* mixed*, Danthonia cachemyriana-Saxifraga pulvinaria* mixed*, Kobresia duthiei, Agrostis pilosula-Poa alpina-Carex nubigena-Poa pratensis* mixed*, Saxifraga pulvinaria, Cortia depressa-Poa alpina* mixedand *Danthonia cachemyriana-Cortia depressa* mixed, communities, respectively indicates high conservation value of these species. Similarly, occurrence of maximum useful species in dry, bouldery, riverine and shady moist habitats identifies these habitats as potential habitats and merit priority attention for conservation. Therefore, conservation measures have to be taken to maintain the current status of these species/communities/habitats. The over exploitation of some of the high value species such as *Picrorhiza kurrooa*, *Angelica glauca*, *Dactylorhiza hatagirea*, *Nardostachys grandiflora*, *Podophyllum hexandrum*, *Aconitum heterophyllum*, *Allium stracheyi*, etc. for trade has caused severe threat to these species. Promotion of cultivation of such medicinal herbs in the buffer zone villages may reduce the human pressure on the wild habitats. Success of such practices will provide enough time for these species to regenerate in the natural conditions (Kala *et al.*, 1998; Maikhuri *et al.*, 1998a&b; Joshi *et al.*, 1999, 2001; Samant *et al.*, 1996a, 2002a). The inhabitants of the NDBR have been cultivating some of the important medicinal plants in a small scale. To conserve the habitats, and maximum population of these species in the wild, it is now essential to promote the cultivation of such species. Further, large-scale cultivation of these species may help in socio-economic upliftment of the inhabitants. However, proper market linkages are urgently required. Livestock grazing, trampling and other human activities are the major problems for the ecological imbalance of alpine meadows. Therefore, rotational grazing may be allowed to slow down grazing and trampling pressure on the alpine meadows of NDBR.

Acknowledgements

The authors are thankful to the Director of the Institute for facilities and encouragement. Help received from Dr. H.C. Joshi during field surveys and preparation of the paper, Dr. K.K. Kothari, Mr. S. Pant and Mr. B.M. Joshi during the preparation of this paper is highly acknowledged. Ministry of Environment & Forests, New Delhi and Council of Scientific and Industrial Research, New Delhi, are greatly acknowledged for financial assistance.

References

Badola, R. 1998. *Nanda Devi Biosphere Reserve: a study on socio-economic aspects for the sustainable development of dependent population*. Final Report. WII, Dehradun.

Dhar, U., Rawal, R. S. & Samant, S.S. 1998. Wild plant resources and use pattern in Askot Wildlife Sanctuary of Kumaun in Indian Himalaya. Manifestations of commonness and rarity. In P.C. Kotwal & S. Banerjee (eds.) *Biodiversity Conservation in Managed Forests*

and Protected Areas. Agro Botanica, Bikaner. pp. 128-142.

Dhar, U., Rawal, R.S. & Samant, S.S. 1997b. Structural diversity and representativeness of forest vegetation in a protected area of Kumaun Himalaya, India: implications for conservation. *Biodiversity and Conservation***6**: 1045 -1062.

Dhar, U., Samant, S.S., Rawal, R.S. & Sharma, S. 1997a. Studies on the biota and resource utilization pattern of the natives in Askot Wildlife Sanctuary of Kumaun in west Himalaya, India. *Tiger Paper***24 (4):** 12-18.

Jain, S.K. 1991. *Dictionary of Indian Folk Medicine and Ethnobotany*. Deep Publications, New Delhi.

Joshi, H.C., Arya, S.C. & Samant, S.S. 1999. Diversity, distribution and indigenous uses of medicinal and edible plants in a part of Nanda Devi Biosphere Reserve I. *Himalayan Biosphere Reserves* **1(1&2):** 49-65.

Joshi, H.C., Arya, S.C. & Samant, S.S. 2001. Diversity, distribution and indigenous uses of plant species in Pindari area of Nanda Devi Biosphere Reserve-II. *Indian Journal of Forestry* 24 (1): **514-536.**

Kala, C.P. & Rawat, G.S. 1999. Effects of livestock grazing on the species diversity and biomass production in the alpine meadows of Garhwal Himalaya, India. *Tropical Ecology* 40(1): **69-74.**

Kala, C.P., Rawat, G.S. & Uniyal, V.K. 1998. *Ecology and conservation of the Valley of Flowers National Park, Garhwal Himalaya*. Report, Wildlife Institute of India, Dehradun.

Maikhuri, R.K., Nautiyal, S., Rao, K.S. & Saxena, K.G. 1998. Medicinal plant cultivation and Biosphere Reserve management: a case study from Nanda Devi Biosphere Reserve. *Current Science***74 (2):** 157-163.

Maikhuri, R.K., Nautiyal, S., Rao, K.S. & Saxena, K.G. 1998. Role of medicinal plants in traditional health care system: a case study from Nanda Devi Biosphere Reserve. *Current Science***75 (2):** 152-157.

Naithani, B.D. 1984 & 1985. *Flora of Chamoli district. Vol. I & II*. Botanical Survey of India, Howrah.

Negi, G.C.S, Rikhari, H.C. & Singh, S.P. 1993. Plant re-growth following selective horse and sheep grazing and clipping in an Indian central Himalayan alpine meadow. *Arctic & Alpine Research* **25 (3):** 211-215.

Pandey, S. & Well, M.P. 1997. Eco-development planning at India's great Himalayan National Park for biodiversity conservation and participatory rural development. *Biodiversity & Conservation***6:** 1277-1292.

Pangtey, Y.P.S., Samant, S.S. & Rawat, G.S. 1988. Contribution to the flora of Pithoragarh district, Kumaun Himalaya. *Himalayan Research and Development***7:** 24-46.

Pangtey, Y.P.S., Samant, S.S. & Rawat, G.S. 1989. Ethnobotanical notes on the Bhotia tribes of Kumaun. *Indian Journal of Forestry* **12(3):** 191-196.

Ram, J. & Singh, S.P. 1994. Ecology and Conservation of alpine meadows in Central Himalaya. India. In Y.P.S. Pangtey & R. S. Rawal (eds.) *High altitudes of the Himalaya: biogeography, ecology and conservation.* Gyanodaya Prakashan, Nainital. pp. 33-35.

Ram, J., Singh, J.S. & Singh, S.P. 1989. Plant biomass, species diversity and net primary production in a central Himalayan high altitude grassland. *Journal of Ecology***77:** 456-468.

Rau, M.A. 1975. *High altitude flowering plants of western Himalaya.* Botanical Survey of India, Calcutta.

Rawat, G.S. & Pangtey, Y.P.S. 1987. A contribution to the ethnobotany of alpine regions of Kumaun. *Journal of Economic & Taxonomic Botany* **11(1)**: 139-148.

Rawat, G.S. & Pangtey, Y.P.S. 1987. Floristic structure of snowline vegetation in central Himalaya, India. *Arctic and Alpine Research***19 (2)**: 195-201.

Rawat, G.S. 1984. *Studies on the high altitude flowering plants of the Kumaun Himalaya.* Ph.D. Thesis, Kumaun University, Nainital.

Rawat, G.S., & Uniyal, V.K. 1993. Pastoralism and plant conservation. The Valley of Flowers dilemma. *Environmental Conservation***20:** 164-167.

Samant, S.S. & Dhar, U. 1997. Diversity, endemism and economic potential of wild edible plants of Indian Himalaya. *International Journal of Sustainable Development & World Ecology***4:** 179-191.

Samant, S.S. & Mehta, I.S. 1994. The folklore medicinal plants of Johar Valley. *Higher Plants of Indian Sub-continent (Additional Series of Indian Journal of Forestry)* **3:**143-159.

Samant, S.S. 1993. Diversity and status of plants in Nanda Devi Biosphere Reserve. In *Scientific and Ecological Expedition to Nanda Devi*. Report, Army Head Quarters, New Delhi. pp. 54-85.

Samant, S.S. 1998b. Diversity, distribution and conservation of fodder resource of west Himalaya, India. In B. Misri (ed.) *Proceedings of the Third Temperate Pasture and Fodder Network (TAPAFON)*, Pokhra, Nepal, 9-13 March, 1998, sponsored by F.A.O. Rome. pp. 109-128.

Samant, S.S., 1998a. Forest types and diversity of fodder resource in Kumaun Himalaya. In *Proceeding of the Seminar Foodder Problems Faced by the Himalayan Region in India*. SHERPA, Lucknow. pp. 111-123.

Samant, S.S., Dhar, U. & Palni, L.M.S. 1998b. *Medicinal Plants of Indian Himalaya: Diversity Distribution Potential Values.* Gyanodaya Prakashan, Nainital.

Samant, S.S., Dhar, U. & Palni, L.M.S. 2001b. Himalayan Medicinal plants: Potential and Prospects. Gyanodaya Prakashan, Nainital.

Samant, S.S., Dhar, U. & Rawal, R.S. 1993. Botanical hot spots of Kumaun Himalaya: Conservation Perspectives. In U. Dhar (ed.) *Himalayan Biodiversity Conservation Strategies*. Gyanodaya Prakashan, Nainital. pp. 377-400.

Samant, S.S., Dhar, U. & Rawal, R.S. 1996a. Natural resource use by some natives within Nanda Devi Biosphere Reserve in west Himalaya.*Ethnobotany***8:** 40-50.

Samant, S.S., Dhar, U. & Rawal, R.S. 1996b. Conservation of rare endangered plants: The context of Nanda Devi Biosphere Reserve. In P.S. Ramakrishnan, A.N. Purohit, K.G. Saxena, K.S. Rao & R.K. Maikhuri (eds.) *Conservation and Management of Biological Resources in Himalaya*. Oxford & IBH Publishing Company Private Limited, New Delhi. pp. 521-545.

Samant, S.S., Dhar, U. & Rawal, R.S. 1998a. Biodiversity status of a protected area of west Himalaya. 1-Askot Wildlife Sanctuary. *International Journal of Sustainable Development & World Ecology***5:** 194-203.

Samant, S.S., Dhar, U. & Rawal, R.S. 2001. Diversity, rarity and economic importance of wild edible plants of west Himalaya. *Indian Journal of Forestry***24 (2):** 256-264.

Samant, S.S., Joshi, H.C. & Arya, S.C. 2000a. Diversity, nativity and endemism of vascular plants in Pindari area of Nanda Devi Biosphere Reserve-II. *Himalayan Biosphere Reserves* **2(1&2):** 1-29.

Samant, S.S., Joshi, H.C. & Arya, S.C. 2002a. Studies on the structure, composition and changes of vegetation in Nanda Devi Biosphere Reserve, west Himalaya. In J.K. Sharma, P.S. Easa, C. Mohanan, N. Saudharan & R.K. Rai (eds.) *Biosphere Reserves in India and their Management.* Kerala Forest Research Institute and Ministry of Environment & Forests, New Delhi. pp. 133-139.

Shah, N.C. 1974. A Botanical Survey in the Nanda Devi Sanctuary. *Himalayan Journal* 35: **210-214.**

Singh, S.K. & Rawat, G.S. 2000. *Flora of Great Himalayan National Park.* Bishen Singh Mahendra Pal Singh, Dehradun.

Singh, S.P. 1991. *Structure and function of the low and high altitude grazing ecosystems and impact of the livestock component in the central Himalaya*. Final Technical Report. Ministry of Environment and Forests, Government of India, New Delhi.

Sundriyal, R.C., A.P. Joshi and S.K. Gupta, 1988. Effect of free grazing on population distribution of primary producers compartment in a alpine ecosystem. *Bangladesh J. of Bot*., **17:** 13-18.

Uniyal, S.K., Awasthi, A. & Rawat, G.S. 2002. Current status and distribution of commercially exploited medicinal and aromatic plants in upper Gori Valley, Kumaon Himalaya, Uttaranchal. *Current Science* **82(10):** 1246-1252.

Annexure 1. Diversity, distribution and utilization pattern of vascular plants in alpine meadows of Nanda Devi Biosphere Reserve

Family/taxa	**Local name**	**Locality of utilization**	**Altitudinal range (m)**	**LF**	**Part/s used**	**Indigenous uses**
1	**2**	**3**	**4**	**5**	**6**	**7**
Acanthaceae						
Strobilanthes wallichii Nees	-	A	3300	H	Lf	Edible
ADIANTACEAE						
Adiantum venustum D. Don	Sun raj	A	3140	Pt	Frd	Medicinal (fever)
Alliaceae						
Allium carolianum DC.	-	A, C	3200-3690	H	Bb, Lf	Medicinal (stimulant, diuretic); edible
A. humile Kunth.	Dum, Kotsi	B	3675-3850	H	Lf	Edible
A. stracheyi Baker	-	A, B, C, D	3510-3740	H	Bb, Lf	Edible
A. wallichii Kunth.	-	B	3685	H	Bb, Lf	Edible
Apiaceae						
Angelica glauca Edgew.	Gandhrayan, Chhipi	A, B, C, D	3600	H	Rh, Rt	Medicinal (dysentery, gastric complaints, menorrhoea, stomach complaints, vomiting); edible (flavouring agent)
Bupleurum candollei Wall. ex DC.	-	A, B, C, D	3100-4010	H	AP	Fodder
B. falcatum L.	-	A, B, C, D	3470-4010	H	Rt	Medicinal (abdominal inflamation, fever, liver complaints); edible; fodder
B. lanceolatum Wall. ex DC.	-	A, B	3000-3720	H	AP	Fodder
B. longicaule Wall. ex DC.	Kala-ajwain	A	3590	H	Rt	Medicinal (liver complaints); fodder
Carum carvi L.	Kala Jeera	B, C, D	2500-3500	H	WP	Medicinal (carminative, cold, cough, dyspepsia, fever, rheumatism, stomach disease); edible
Chaerophyllum villosum Wall. ex DC.	Ginzari, Shankara	A, D	3140-3550	H	WP	Edible; fodder
Cortia depressa (Don) Norman	Sunak	A, B, C	3000-4270	H	WP	Medicinal (abdominal disease, antiinflamatory, rheumatism, sedative, stomachache); fodder
Pleurospermum angelicoides (DC.) Cl.	Choru	A, B	3100-3600	H	Rt	Medicinal (anthelmintic, gastric, stomachache); edible
Selinum elatum (Edgew.) Hiroe	Bhutkesh	A, B, C, D	3100-4160	H	Rt	Medicinal (nervine sedative); fodder; miscellaneous (insecticidal, incense); religious
S. vaginatum Cl.	Bhutkesh	A, B	3000-4075	H	Rt	Medicinal (nervine sedative); edible; fodder
Seseli sibiricum (L.) Boiss.	Takkar	B, C, D	3600-4140	H	Lf, Rt	Medicinal (mental disease); miscellaneous (incense & dhoop preparation)
Trachydium roylei Lindl.	Bugi grass	A, B, C	3000-4270	H	AP	Fodder

Araceae						
Arisaema flavum (Forsk.) Schott.	Bang	A	3140-3540	H	Bb	Medicinal (skin disease)
A. jacquemontii Bl.	Bang	A	3000-3600	H	Bb	Medicinal (ring worm, skin disease); edible
Asteraceae						
Ainsliaea aptera DC.	Karu-buti	A, D	3000-3550	H	Rt, Lf	Medicinal (stomacheache); fodder
A. triplinervis (Sims.) Cl.	Bukki	B	3740	H	WP	Medicinal (diuretic)
Arctium lappa L.	-	C	3600	H	Rt	Medicinal (gastric, burns); miscellaneous (repeal rodents)
Artemisia capilaris Thunb.	-	C	3300	H	WP	Medicinal (earache, purgative)
A. maritima L.	-	A, C, D	3220-4270	H	WP	Medicinal (anthelmintic, antiseptic on cuts, gastric, blood purifier)
A. nilagarica (Cl.) Pamp.	Pati, Kunj	A	3100	H	WP	Medicinal (abscess, analgesic, anthelmintic, antiseptic, antipasmodic, asthama, ear complaints, epilepsy, haemostat, headache, menstrual complaints, nervous disease, peptic ulcer, skin disease, sores, stomachache, tonic, vermifuge, wounds); miscellaneous (incense, insect repellant); religious
A. roxburghiana Wall. ex Besser	-	A, D	3000-3770	H	Lf	Medicinal (eczema, pimples, sore)
Cirsium wallichii DC.	Kanya	A, B, C, D	3100-3850	H	St	Edible; fodder
Gerbera gossypina (Royle) Beauv.	Kapasi	B, C	3310-3810	H	Rt	Medicinal (blood pressure, gastric disease)
Jurinella macrocephala (Royle) Aswal et Goel	Dhup lakkar	A, B, C	3300-3850	H	Rt	Medicinal (antiseptic, colic, fever and laxative); miscellaneous (incense, dhoop & agarbatti preparation); religious
Saussurea costus (Falc.) Lipsch.	Kuth	B, C, D	2500-3500	H	Rt, Lf	Medicinal (asthama, dysentery, rheumatism, skin disease, stomachache, ulcer, toothache)
S. obvallata Wall.	Brahmkamal	A, B, C, D	3800-4270	H	WP	Medicinal (bruises, cuts); religious
Senecio chrysanthemoides DC.	Zerjum	A, B, C, D	3100-3780	H	WP	Medicinal (inflamation of mouth, sore throat)
Sonchus oleraceus L.	-	C	3690	H	Lf, Latex	Medicinal (febrifuge, jaundice, galactagogue, liver complaints, tonic); fodder
Tanacetum tomentosum DC.	Gogul	A, B, C, D	3200-4270	H	WP	Medicinal (colic, diarrhoea, earache); miscellaneous (incense); religious
Taraxacum officinalis Webber	Kanphul	A, B, C, D	3200-4060	H	WP	Medicinal (blisters, blood purifier, bowels, diuretic, dislocation of joints, dysentery, foment, gastric ulcers, headache, kidney disease, liver complaints, tonic vertigo, wounds); edible; fodder

Balsaminaceae						
Impatiens racemosa DC.	Temchee	B, C, D	3540-3770	H	Lf	Edible
1	**2**	**3**	**4**	**5**	**6**	**7**
Berberidaceae						
Berberis jaeschkeana Schneid.	-	D	3520	Sh	Rt, Fr	Medicinal (astringent, blood purifier, diuretic, eye disease, jaundice, menorrhoea, skin disease); edible
B. kumaonensis Schneid.	Chwater, Kingora	C, D	3250-3750	Sh	Rt, Fr	Medicinal (astringent, blood purifier, diuretic, eye disease, jaundice, menorrhoea, skin disease); edible
B. umbellata Wall. ex G. Don	-	D	3470-3800	Sh	Rt, Fr	Medicinal (cholagogue, stomachic, laxative, diaphoretic, antipyretic, antiseptic, eye infections, indolent ulcers, haemorrhoids, blood pressure, oriental sores, leprosy); edible; miscellaneous (dye for cloths)
Boraginaceae						
Arnebia benthamii (Wall. ex G. Don) John.	Ratanjot, Laljari, Baljari	A, B, C, D	3340-4060	H	Rt	Medicinal (antiseptic, boils, cuts, wounds, hair tonic, fungal hair infection); miscellaneous (red dye for hair)
A. euchroma (Royle) John.	Baljari	C	3600	H	WP	Medicinal (back bodyache, tonic for brain); miscellaneous (dye for hair)
Eritrichum canum (Benth.) Kitamura	-	A, B, C, D	3270-3900	H	WP	Medicinal (facilitates children birth)
Maharanga emodi (Wall.) DC.	Shankuli	A, B	3300-3720	H	WP	Medicinal (leprosy, rheumatism, urine complaints, skin disease)
Microula tibetica Benth.	Charokhenma	A	3000-3140	H	WP	Medicinal (cough, pulmonary trouble)
Onosma hispidum Wall.	Laljari, Ratanjot	A	3200-3360	H	WP	Medicinal (alternative, stimulant, blood purifier, cuts, swells, ulcer, wounds); miscellaneous (red dye)
Brassicaceae						
Arabidopsis thaliana (L.)Heynh.	-	A, B, D	3510-3875	H	WP	Medicinal (treatment of sores in the mouth)
Capsella bursa-pastoris (L.) Medic.	-	A, C, D	3200-3850	H	WP	Medicinal (blood pressure, diarrhoea, dropsy); fodder
Cardamine impatiens L.	-	A, B	3140-4270	H	WP	Medicinal (stimulent, diuretic); fodder
Lepidium ruderale L.	-	A	3200-3540	H	Lf	Medicinal (skin disease); edible
Megacarpaea polyandra Benth.	Rugi, Barmao	A, B	3600	H	WP	Medicinal (fever); edible
Thlaspi arvense L.	-	A, B	3300-3700	H	WP	Medicinal (backache, gonorrhea, pulmonary & renal disease, swelling, wounds, cuts)
Caprifoliaceae						
Lonicera angustifolia Wall. ex DC.	-	A	3600	Sh	Fr	Edible
L. obovata Royle ex Hk. f. & Th.	-	A, B, C, D	3250-4160	Sh	Fr	Edible

1	2	3	4	5	6	7
Caryophyllaceae						
Cerastium cerastioides (L.) Britton	Pangein	A, B, C, D	3100-4050	H	WP	Medicinal (backache, bodyache, headache, renal pain, cough)
Stellaria decumbens Edgew.	-	A, B, C, D	3540-4270	H	Lf	Edible
S. himalayensis Majumdar	-	A, D	3200-3520	H	AP	Fodder
S. media (L.) Vill	-	A	3540-3570	H	WP	Medicinal (bone fracture); edible
CHENOPODIACEAE						
Chenopodium foliolosum (Moench.) Asch.	Van palak	A, C	3300-3560	H	Lf	Edible
Crassulaceae						
Sedum ewersii Ledeb.	Churuppa	A, B, D	3140-4140	H	Lf, St	Medicinal (toothache, appetite)
Cupressaceae						
Juniperus communis L.	-	B, D	3850-3900	Sh	Fr, Lf, St, Br	Medicinal (aromatic); edible (along with alcohol); fuel; miscellaneous (incense); religious
J. indica Bertol	Chilla, Gyeshunk	B, C, D	3220-4060	Sh	Fr, Lf, St, Br	Medicinal; fuel; miscellaneous (incense); religious
J. recurva Buch.-Ham. ex D. Don	-	C, D	3250-4160	Sh	Lf, St, Br, Tw	Medicinal (kidney disease, aromatic); fuel; miscellaneous (incense); religeous
Cyperaceae						
Carex atrata L.	-	A, D	3570-4060	H	AP	Fodder
C. haematostoma Nees	-	A, C, D	3440-4270	H	AP	Fodder
C. nivalis Boott	-	A, B, C	3250-3850	H	AP	Fodder
C. nubigena D. Don	-	A, B, C, D	3100-4270	H	AP	Fodder
C. obscura Nees	-	A, B, C, D	3000-4270	H	AP	Fodder
C. setosa Boott	-	A, B, C, D	3200-4050	H	AP	Fodder
C. stracheyi Boott ex Cl.	-	A, B, D	3100-4270	H	AP	Fodder
Kobresia duthiei Cl. ex Hk. f.	-	A, B, C, D	3200-4140	H	AP	Fodder
K. laxa Nees	-	A, B	3360-4270	H	AP	Fodder
Dipsacaceae						
Morina longifolia Wall. ex DC.	Biskandara	A, B, C, D	3140-3800	H	Rt	Medicinal (boils)
Elaeagnaceae						
Hippophae rhamnoides Serv.	-	D	3850-4140	Sh	Fr, St, Tw, Sd	Medicinal (aphrodisiac, lung disease); edible; fuel; miscellaneous (clean ornaments);
H. tibetana Schlecht.	-	D	3880	Sh	Fr, St	Medicinal (appetite); edible; fuel
Ephedraceae						
Ephedra gerardiana Wall. ex Stapf.	-	D	3900	Sh	WP	Medicinal (asthama, blood purifier, headache, hepatic disease, rheumatism, snuff); edible; miscellaneous (toothbrush)
Equisetaceae						
Equisetum arvense L.	-	B, C, D	3200-3760	Pt	Ashes of plants	Medicinal (diuretic haemostatic, haemopoitic, kidney affection, dropsy, gravel affection, acidity, dyspepsia)

1	2	3	4	5	6	7
Ericaceae						
Casiope fastigiata (Wall.) D. Don	-	B, C, D	3490-4140	Sh	WP	Medicinal (itching); fodder; miscellaneous (incense, stuffing)

Gaultheria fragrantissima Wall.	Jalan-thrait	A	3000	Sh	Lf, Fr	Medicinal (cough, cold); edible
G. trichophylla Royle	-	A	3360-3600	Sh	Fr	Edible
Rhododendron campanulatum D. Don	Chimula	A, B	3000-4000	Sh	Rt, Lf, Fl	Medicinal (boils cold, cough, headache, rheumatism, sciatica, skin disease, syphilis, tonic, fever); edible; fuel; religious
R. anthopogon D. Don	Tali	A, B, C, D	3400-4270	Sh	Lf	Medicinal (bronchitis, cold, cough, aromatic incense); fodder; religious
Euphorbiaceae						
Euphorbia pilosa L.	-	B	3685-3720	H	WP	Medicinal (fistular sores)
E. stracheyi Boiss.	Dudhibish	A, B, C, D	3320-4010	H	AP, Latex	Medicinal (rheumatism); fodder
Fabaceae						
Astragalus himalayanus Koltz.	-	A	3200	H	Sd	Medicinal (colic, leprosy)
A. candolleanus Royle ex Benth.	Rudravanti	A, C	3560-3800	Sh	Rt	Medicinal (blood purifier, cough, skin disease, tuber)
Cicer microphyllum Benth.	-	D	3470-3800	H	Fr, Lf, Sd	Medicinal (veterinary); edible
Parochetus communis Buch.-Ham. ex D. Don	Khia-knoi	A, D	3300-3740	H	Lf	Medicinal (stomach disease of babies, earache)
Trigonella emodi Benth.	Tuljima	A, B, C, D	3300-3700	H	Fl	Medicinal (aromatic); miscellaneous (repels wood borer from bean plants)
Fumariaceae						
Corydalis cashmiriana Duthie & Prain	-	A, B, C, D	3200-4270	H	AP	Fodder
C. govaniana Wall.	Butkeshi, Indrajata	A, B, C	3400-4270	H	WP	Medicinal (antipyretic, diuretic, eye disease, gastric pain, liver complaints, muscle pain, skin disease, syphilis, tonic)
C. meifolia Wall.	-	A, C	3300-3630	H	WP	Medicinal (headache, liver and stomach pain, rheumatism, leprosy)
Gentianaceae						
Gentiana argentea (D.Don) Cl.	-	A, B	3200-4075	H	AP	Fodder
G. kurrooa Royle	-	A, B, D	3340-4060	H	WP	Medicinal (appetite, gastric secretion, stomachic, fever, urinary complaints)
G. stipitata Edgew.	-	C, D	3600-3780	H	WP	Medicinal (appetite, stimulant)
Lomatogonium carinthiacum (Wulf.) Br.	Tikta	A, B, D	3540-4270	H	WP	Medicinal (antipyretic, blood purifier, cold, cough)
Swertia angustifolia Buch.-Ham.	Chiraitu	A, B	3340-3740	H	WP	Medicinal (malaria, fever)
S. ciliata (D. Don) Burtt.	Chirata	A, B	3560-3925	H	Lf	Medicinal (fever)
S. cordata Wall.	Chirata	A	3200-3360	H	WP	Medicinal (anthelmintic, antiperid, appetite, laxative, stomachic)

1	2	3	4	5	6	7
Geraniaceae						
Geranium polyanthes Edgew.	-	A, C, D	3200-4270	H	AP	Fodder
G. wallichianum D.Don ex Sw.	-	A, B, C, D	3200-4010	H	Rt	Medicinal (astringent, ear & eye diseases, toothache); fodder
Hypoxidaceae						
Curculigo orchioides Gaertn.	Talmuli, Turum	A	3200-3360	H	WP	Medicinal (antidote to poison, cough dysentery, fever, nose bleeding, scorpion & snake bite, cuts,

						eye complaints, itching, piles bleeding, wounds); edible
Iridaceae						
Iris kumaonensis D. Don ex Royle	-	A, B, C, D	3200-4060	H	Rt, Lf	Medicinal (fever, urine complaints); edible
Juncaceae						
Juncus himalensis Klotz.	-	A, D	3540-3570	H	AP	Fodder
Lamiaceae						
Clinopodium umbrosum (Fisch. et May.) Ktze.	-	A, B, C, D	3000-4270	H	WP	Medicinal (astringent, carminative, heart tonic)
C. vulgare L.	-	C	3320	H	WP	Medicinal (astringent, carminative, heart tonic)
Elsholtzia strobilifera Benth.	Ruli	A, C	3100-3810	H	Lf, Infl	Medicinal (internal burns)
Hyssopus officinalis L.	-	C	3340-3440	H	WP	Medicinal (stimulant, carminative, pectoral, nervous disorder, toothache, digestive, uterine and urinary troubles, resolvent, vulnerary, vermifuge, fomentation for wounds, sprains, strains, muscular rheumatism)
Mentha longifolia Host.	Podina	C	3200-3320	H	WP	Medicinal (antiseptic, carminative, digestive, on wound to kill maggots); edible
Origanum vulgare L.	Van Tulsi	A, B, C, D	3000-3560	H	WP	Medicinal (cold, diarrhoea, fever, hysteria, influenza, menstrual complaints, stimulant, tonic); edible
Phlomis bracteosa Royle ex Benth.	Jamtikle	A, B, C, D	3100-4140	H	Fl	Medicinal (eye disease)
Plantago depressa Willd.	-	A	3300-3560	H	AP	Medicinal (dysentery); fodder
P. himalaica Pilger	-	A, C, D	3000-3740	H	WP	Medicinal (diarrhoea, dysentery); edible; fodder
Prunella vulgaris L.		A	3300	H	WP	Medicinal (breath problems, lung complaints, cerebral complaints, cold, fever, gastric complaints, headache, liver complaints)
Thymus linearis Benth.	Vanajwain	A, B, C, D	3200-4000	H	WP	Medicinal (anthelmintic, eye disease, heating affect, labour, postnatal, liver complaints, skin disease, stomacheache, vermicidal); edible

1	2	3	4	5	6	7
Liliaceae						
Fritillaria roylei D.Don ex Hk.	Shithkar	B	3800	H	Bb	Medicinal (asthama, bronchitis, burns, stomach disease, tonic); edible
Polygonatum cirrhifolium (Wall.) Royle	Salam misri	A, B	3200-3850	H	Tu, St	Medicinal (fever); edible
P. verticillatum (L.) All.	Khol, salam misri	A, B, C	3000-3750	H	Tu	Medicinal (aphrodisiac, appetite, nervine tonic); edible
Smilacina purpurea Wall.	Puyon	A, B, C	3000-3700	H	AP	Edible
Trillidium govanianum Kunth.	Satwa	A	3000	H	Tu	Medicinal (dysentery)
Onagraceae						
Epilobium angustifolium L.	-	A, C, D	3100-3630	H	AP	Medicinal (abdominal pain, hepatic, intestinal, and renal complaints); fodder

E. latifolium L.	-	A, B, C, D	3100-4060	H	AP	Fodder
Orchidaceae						
Dactylorhiza hatagirea (D. Don) Soo	Hattajari, Salampanja, Panch anguli	A, B, C, D	3200-3750	H	Rt, Tu	Medicinal (astringent, bone fracture, expectorant, tonic, wounds); edible
Osmundaceae						
Osmunda claytoniana L.	-	B	3680-3690	Pt	AP	Fodder
Papaveraceae						
Meconopsis aculeata Royle	Achatsarmun	A, B, D	3550-4060	H	WP	Medicinal (backache, colic, renal pain, tonic)
Parnassiaceae						
Parnassia nubicola Wall.	Nirbis	A, B, C, D	3140-4010	H	Tu	Medicinal (food poisoning, snake bite)
P. pussila Wall.	Nirbis	A, B	3140-4010	H	Rt	Medicinal (washing burns & other wounds)
Poaceae						
Agrostis munroana Aitch. & Hemsl.	-	A, C, D	3300-3880	H	AP	Fodder
A. pilosula Trin.	-	A, B, D	3100-3850	H	AP	Fodder
Brachypodium sylvaticum Beauv.	-	A, C, D	3340-4270	H	AP	Fodder
Bromus himalaicus Stapf.	-	A, B, C, D	3140-4060	H	AP	Fodder
B. japonicus Thunb.	-	B, D	3540-4050	H	AP	Fodder
B. ramosus Huds.	-	C	3250-3800	H	AP	Fodder
Dactylis glomerata L.	-	A, B, C, D	3200-4160	H	AP	Fodder
Danthonia cachemyriana Faub. & Spach.	Mamool	A, B, C, D	3000-4270	H	AP	Fodder
Festuca kashmiriana Stapf.	-	A, C, D	3100-4060	H	AP	Fodder
Melica persica Kunth.	-	C, D	3470-3780	H	AP	Fodder
Poa alpina L.	Samria	A, B, C, D	3100-4270	H	AP	Fodder
P. pratensis L.	-	A, B, D	3100-4140	H	AP	Fodder
Stipa roylei (Nees) Mez.	-	A, C	3000-3690	H	AP	Fodder
Podophyllaceae						
Podophyllum hexandrum Royle	Bankakri	A, B, C, D	3100-3140	H	Rt, Rh, Fr, Sd	Medicinal (cancer, cough, cuts, wounds, diarrhoea, fever, gastric ulcers, hepatic disease, purgative, skin disease, tumor); edible
Polygonaceae						
Oxyria digyna (L.) Hill.	-	A, B, C, D	3300-3925	H	WP	Medicinal (appetite, fever, laxative); edible
Polygonum nepalense Meisn.	Ratnala	D	3550	H	WP	Medicinal (swelling)
1	**2**	**3**	**4**	**5**	**6**	**7**
P. affine D. Don	-	A, B, C, D	3000-4270	H	Rt, Sd	Medicinal (cold, diarrhoea); edible
P. amplexicaule D. Don	-	A, B	3000-3850	H	Rt, Rh, Lf	Medicinal (cough, dysentery, haemostasis, tonic); edible; fodder
P. polystachyum Wall.	Durfi	A, B, C, D	3000-4060	H	AP	Edible; fodder
P. rumicifolium Royle ex Bab.	Khakjari	A, B, C, D	3600-4160	H	Lf, Rt, Fl	Medicinal (abscess, antidote to aconite poison, diarrhoea, giddiness, headache, thirst, deodoriser for armpits); edible; fodder
Rheum speciforme Royle	Taturi	A, D	3600-4270	H	Pet, Infl	Edible
R. australe D. Don	Dolu	A, B, C, D	3400-4270	H	Rt, Rh, Pet	Medicinal (abdominal pain, appetite, asthma, bronchitis, fever, cuts, dysentery, laxative, eye disease, piles skin disease, sprain, swelling ulcer, wounds); edible
R. webbianum Royle	Taturi	A, B, C, D	3550-4270	H	Rt, Lf	Medicinal (abdominal disease, appetite, boils,

						astringent, purgative, wounds); edible
Rumex nepalensis Spreng.	Khuldia	A, B, C, D	3100-3880	H	Lf, Rt, Tw	Medicinal (boils, colic, cooling diuretic, purgative, scurvy, swelling of muscle); edible; fodder
R. acetosa L.	Chuk	B	3685-4060	H	Lf, Fr	Medicinal (laxative, stomach disease); edible
Primulaceae						
Primula denticulata Sm.	-	A, B, C, D	3000-4270	H	AP	Fodder
Ranunculaceae						
Aconitum voilaceum Jacq.	Dudh Atees, Jhimba	A, B	3900-4000	H	Rt	Medicinal (gastrointestinal complaints, renal pain, rheumatism, stomachache)
A. balfouri Stapf.	Mitha, Bis,Vatsanabh	A, B	3600-3680	H	Tu, Rt	Medicinal (gastritis, leprosy, rheumatism, tonsil, swelling, wounds)
A. heterophyllum Wall. ex Royle	Atis	A, B, C, D	3200-3600	H	Rt	Medicinal (anthelmintic, cough, diarrhoea, digestive complaints, dysentery, fever, gastric, stomachache, vomit)
Anemone elongata D. Don	-	A, C, D	3200-4270	H	AP	Fodder
A. obtusiloba D. Don	-	A, B	3100-4060	H	Rt, Sd	Medicinal (on contusions, menorrhoea, rheumatism, purgative)
A. polyanthes D. Don	-	A, B, C, D	3000-4140	H	AP	Fodder
A. rivularis Buch. – Ham. ex DC.	Yak-far, Jangali kakri	A, C, D	3000-3740	H	WP	Medicinal (ear complaints, maggots in sores, fracture); fodder
A. rupicola Camb.	-	A, B, C, D	3100-4270	H	AP	Fodder
Caltha palustris L.	Shomalap	A, B, C, D	3300-4270	H	Rt, Lf	Medicinal (gonorrhoea)
Clematis barbellata Edgew.	Bhujvir, Kanguli	A, B	3600-3690	Sh	Rt, Lf	Medicinal (itching, skin disease)
Delphinium vestitum Wall. ex Royle	Nirbishi, Salyan	A	3200-4270	H	WP	Medicinal (antidote to snakebite, cuts, wounds, fever, diarrhoea)
Oxygraphis polypetala (Royle) Hk.f. & Th.	-	A, B	3360-4270	H	AP	Fodder
1	**2**	**3**	**4**	**5**	**6**	**7**
Ranunculus diffusus DC.	-	A	3200-3550	H	WP	Medicinal (boils)
R. hirtellus Royle	Seripertali	A, B, D	3100-4270	H	AP	Medicinal (anthelmintic, cooling, vermicidal); fodder
Thalictrum pauciflorum Royle	Chota mamira	A, B, C, D	3100-3680	H	Rt	Medicinal (diuretic, eye disease, tonic)
T. reniforme Wall.	Mamira	A, B, D	3140-4060	H	Rt	Medicinal (cataract)
Rosaceae						
Cotoneaster microphyllus Wall. ex Lindl.	-	A, B, C, D	3000-3850	Sh	Fr, Rh	Medicinal (astringent); edible
Fragaria daltoniana Gay	-	A, C, D	3270-3630	H	Fr	Edible; fodder
F. nubicola Lindl. ex Lacaita	Bhuila	A, B, C	3100-4075	H	Fr	Edible; fodder
Geum elatum Wall.	-	A, B, C	3300-4050	H	Rt	Medicinal (astringent, dysentery, diarrhoea); fodder
Potentilla argyrophylla Wall. ex Lehm.	-	A, B, C, D	3100-4060	H	AP	Fodder
P. atrosanguinea Lodd.	Role	A, B, C, D	3000-4160	H	Lf	Medicinal (wounds as analgesic); fodder
P. peduncularis D. Don	-	A, B, C, D	3100-4010	H	AP	Fodder
Rosa macrophylla Lindl.	Kucha, Sedum	A, B, C, D	3100-3800	Sh	Fl, Fr	Medicinal (stomachache); edible
R. sericea Lindl.	Sedum, Dhrukucha	C, D	3200-3770	Sh	Rt, Fr	Medicinal (uterine disease); edible

R. webbiana Wall. ex Royle	-	D	3520-3540	Sh	Fl, St, Fr	Medicinal (hepatitis, jaundice, stomachache); edible; fuel
Rubus foliolosus D. Don	Hisalu	A	3200-3600	Sh	Fr	Edible
R. niveus Thunb.	Hisalu	A	3200	Sh	Fr, Rt, Lf	Medicinal (stomachache); edible
Sibaldia cuneata Hornem. ex Kunge	-	A, B, C, D	3000-4270	H	AP	Fodder
Rubiaceae						
Galium acutum Edgew.	Kura	B, C, D	3200-3875	H	WP	Medicinal (antiscorbic, diuretic, skin disease)
G. elegans Wall. ex Roxb.	Jharjharia	A, B	3100-4015	H	AP	Medicinal (bronchitis, sorethroat, tonsil, wounds)
Salicaceae						
Salix lidleyana Wall. ex Ander.	-	A, B, C	3300-4270	Sh	AP	Fodder
Saxifragaceae						
Bergenia stracheyi (Hk.f. & Th.) Engl.	Silphari	B, C	3750-4075	H	Rt, Lf	Medicinal (antiscorbic, astringent, diuretic, fever, ophthalmia, tonic, cuts, wounds); edible
B. ligulata (Wall.) Engl.	Silphor	A	3100	H	Rt, Rh, Lf	Medicinal (asthma, boils, cuts, wounds, burns, fever, liver complaints, ophthalmia, piles, thirst, kidney stones, urine complaints, diarrhoea of cattle); edible
Scrophulariaceae						
Euphrasia himalayica Wettst.	Siruli	A, B, C, D	3200-3980	H	Lf	Medicinal (eye disease)
Pedicularis longiflora Rudolph	-	D	3540-3780	H	AP	Fodder
P. pectinata Wall.	Lugro-Marpo	A, B, C, D	3000-4015	H	WP	Medicinal (bodyache, sedative)
P. pyramidata Royle ex Benth.	-	A	3200-3550	H	WP	Medicinal (headache)
1	**2**	**3**	**4**	**5**	**6**	**7**
Picrorhiza kurrooa Royle ex Benth.	Kutki	A, B, C, D	3600-4140	H	Rt, Rh	Medicinal (abdominal pain, anaemia, antispasmodic, cold dyspepsia, diarrhoea, influenza, jaundice, promotes bile secretion, purgative, dysentery, fever)
Verbascum thapsus L.	Van Tambaku	B, C, D	3200-3640	H	Lf, Infl	Medicinal (asthama, cough, skin disease); religeous
Solanaceae						
Hyoscyamus niger L.	Bzer-bangh	C	3300	H	WP	Medicinal (hysteria, muscle pain, whooping cough, astringent, toothache)
Physochlaina praealta (Decne.) Miers.	-	D	3550-4060	H	WP	Medicinal (epilepsy, liver complaints, boils, ulcers)
Tamarcaceae						
Myricaria elegans Royle	-	A	3570	Sh	Lf	Medicinal (bruises, swelling of joints)
Urticaceae						
Urtica hyperborea Jacq. ex Wedd.	Bichhu	A, C	3140-3550	H	Lf	Medicinal (rheumatism, stomachache); edible
Valerianaceae						
Nardostachys grandiflora DC.	Jattamansi	A, B, C, D	3600-4140	H	Rt	Medicinal (blood purifier, cooling, cough, diuretic, tonic ulcers, snakebite); miscellaneous (incense stick & dhoop preparation); religious
Valeriana hardwickii Wall.	-	A, B	3100-4015	H	WP	Medicinal (antidote to poisonous stings of insects, scorpion, epilepsy, hysteria,

						neurosis, skin disease); miscellaneous (incense)
Violaceae						
Viola biflora L.	Banafsha	A, B, C, D	3100-4270	H	Lf, Fl, Rt, Sd	Medicinal (antiseptic, antispasmodic, cold, cough, diaphoretic, emetic, fever, laxative, leucoderma, psoriasis, skin disease)

Abbreviations used: *A= Pindari; B= Latakharak; C= Malari; D= Milam; H= Herb; Sh= Shrub; Pt= Pteridophyte; LF= Life form; AP= Aerial part; Bb= Bulb; Br= Bark; Fl= Flower; Fr= Fruit; Frd= Frond; Infl= Inflorescence; Lf= Leaf; Pet= Petiole; Rh= Rhizome; Rt= Root; Sd= Seed; St= Stem; Tu= Tuber; Tw= Twig; WP= Whole plant*