Medicinal Plants
Vol. 13 (2), June 2021, 251-265

doi : 10.5958/0975-6892.2021.00028.9

IndianJournals.com
A product of Diva Enterprises Pvt. Ltd.

Research Article

An ethnobotanical study of wild medicinal plants among the mountain community of Western Himalayas: A case study of Govind wildlife sanctuary and national park

Rommila Chandra* and V.P. Uniyal

Forest Ecology and Environment, Wildlife Institute of India, Post Box #18, Chandrabani, Dehradun-248001, Uttarakhand

Received: November 20, 2020; Accepted: May 19, 2021

ABSTRACT

The biodiversity of Indian Himalayan Region has always provided the local mountain community with various goods and services, shaping their traditional food and healthcare system. For years, this forest-based resource subsistence has accumulated a great deal of traditional knowledge and practices, but is declining through younger generations. The present study aims to document the indigenous knowledge of the mountain community, regarding medicinal and aromatic plants, wild fruits and vegetables, in the villages around Govind Wildlife Sanctuary and National Park in the Western Himalayas. For the study, participatory rural appraisal tools (household survey, key informant interview, focus group discussion, field visit) were used to collect primary information from the local people. A total of 55 species were documented along with the uses for traditionally curing the diseases. The dependency of the community on medicinal plants was analyzed through Relative Frequency Citation (RFC), Relative Importance Index (RI), Cultural Importance Index (CI), Cultural Value Index (CV) and Fidelity Level (FL). The homogeneity of ethnomedicinal knowledge among the people was tested through Informant Consensus Factor (Fic). The respondents were divided into three age groups, old (> 50 years), adult (25-50 years) and young (<25 years) for the calculation of Knowledge Richness Index (KRI) across different generations. The study revealed that the traditional ethnomedicinal knowledge is declining among youth and it is important to identify, collect, organize and document it in some way, in order to maintain, use, disseminate and/or protect, so that the true holders of such knowledge can reap the future benefits of their culture. The study highlighted that the dependency of inaccessible and remote villages on traditional remedies was higher than the villages near roadhead. The study recommends agricultural diversification through medicinal and aromatic plant cultivation, to sustain the traditional healthcare system with a sustainable livelihood opportunity for the rural mountain community. The study suggests further research on biophysical and climatic conditions for medicinal plant cultivation, along with the demand-supply chain analysis of the same.

Keywords: Indian Himalayan region, medicinal plants, sustainable livelihood, traditional healthcare remedies, traditional knowledge

INTRODUCTION

Over the years, local and indigenous communities around the world have constantly struggled to maintain their livelihood, rights, culture and traditional knowledge. Yet, they have managed to survive, adapting their way through globalization and changing climatic conditions. Their diverse form of knowledge, deeply rooted in their

*Corresponding author e-mail: rommilac27@gmail.com

relationships with the environment as well as in cultural cohesion, have allowed many of these communities to maintain a sustainable use and management of natural resources (Magni, 2016). The United Nations Development Agenda also acknowledges their importance, stating "traditional and indigenous knowledge, adaptation and coping strategies can be major assets for local response strategies" (UN, 2012). According to the World Health Organization (WHO), 65-80% of the world's population, particularly in developing countries, depend on plants for healing, and this is well accepted in traditional culture (Cunningham, 1988), often due to poverty, and lack of access to modern medicine (Awoyemi *et al.,* 2012). The transgenerational nature is the unique characteristic of traditional knowledge, which has never been preserved in a written form and rather has verbally/orally passed over generations. It is the information that local people possess, based on their experience and adaptation to a local culture, environment and living system which is developed over time. These traditional resources are an economic asset which can be innovatively used, traded or licensed for income generation and livelihood development. The current market of herbal drugs is estimated at 40 billion and is expected to increase by 16% in the next 3-4 years (Kumar *et al.,* 2021).

The premise of the research framework is that diverse mountain communities across the Himalayas have been using traditional knowledge and practices for years in order to cope with their geographic isolation and vulnerability. The importance of medicinal plants is increasingly being recognized from ecological, social and economic perspective (Arnold and Perez, 2001; Negi *et al.,* 2011). The knowledge of medicinal plants conservation and its use has developed a link between promoting environmental conservation and indigenous knowledge (Cameron, 2008). On one hand, there has been a decline in the practice of herbal medicine due to the change in people's attitude towards growing usage of allopathic medicine. And on the other, traditional uses and practices are often being exploited by the modern herbal, pharmaceutical, food and cosmetic industries. But recently, decreasing populations of medicinal plants in the wild due to illegal exploitation have led to discussions among conservationists, ecologists and scientists (Singh, 2002). Several medicinal plants have been listed as endangered, vulnerable and threatened due to over exploitation, reckless harvesting from the forest and alpine meadows (Uniyal *et al.,* 2006). The local people rarely receive a fair and equitable share of associated benefits arising from their traditional knowledge which they have kept alive through generations. Thus, traditional knowledge and practices across local and indigenous communities should be identified, collected, organized, registered and/or recorded in some way, in order to maintain, use, disseminate and/or protect, so that the true holders of such knowledge can reap the benefits of their culture.

MATERIALS AND METHODS

Study area

The study was conducted in a remote mountainous region of Govind Wildlife Sanctuary and National Park, as it had sporadic access to basic medical facilities due to geographical isolation and poor connectivity. It is located in the Uttarkashi district of Uttarakhand, which lies in the middle and greater Himalayas of India. The area harbors a rich array of habitats, vegetation types and floral and faunal diversity. Chir, oak, deodar, spruce, silver fir, birch, alder, juniper, and rhododendron are some of the important forest trees found in the area. The alpine meadows, locally known as bugyals, are rich in herbs and medicinal plants. The prominent fauna in the tract includes, snow leopard, mountain weasel, brown bear, asiatic black bear, wild pig, musk deer, Himalayan thar, goral, bharal, among others. The landscape is an important catchment for the Tons river (a major tributary of the Yamuna river). Supin and Rupin, are the two tributaries of Tons which merges at the Naitwar village. The protected area is fragmented by 42 villages located in three valleys along the Supin, Tons and Rupin rivers.

Sampling technique

The study employed a combination of sampling techniques to select the target villages and local respondents for the collection of primary data. Through stratified random sampling four villages were selected, namely, Gainchwan Gaon, Deora, Dhatmeer and Osla. Initially, participatory resource surveys with the help of local people were organized for establishing a trust connection with the local

community. Then the snowball sampling technique was used for the selection of respondents for key informant interviews (KII), which was based on their sound knowledge of medicinal plants used in the study area. Later, intensive field visits and participatory rural appraisal tools like semi-structured questionnaire survey and focus group discussions (FGDs) were conducted to collect the primary information on medicinal plants and their traditional use. Secondary data sources based on government records and research publications were also analyzed, so as to prepare a detailed set of check-list and a suitable questionnaire. With the help of KII, a baseline information was collected on the traditional use of ethnomedicinal plants. Later, through household surveys and FGDs, consensus of information on the use of each plant and age group-based richness comparison was done. Depending upon the availability and willingness of the local community, from a total of 490 households and 1000 respondents from the selected 4 villages were interviewed.

Table 1: Demographic profile villages

Name of the village	Area of the village (ha)	Total no. of households (N)	Sample no. of households (n)
Gainchwan Gaon	137.76	192	129
Deora	44.18	99	79
Dhatmeer	269.16	192	129
Osla	378.16	151	109

Among the total respondents interviewed, 52% were female and 48% were male. The percent distribution of interviewees in young generation (< 25 years) was 27.80%, adult generation (25-50 years) 43.50% and old generation (> 50 years) 28.70%. Primarily, exploratory approach was used for the documentation of traditional medicinal practices in the study area in order to yield a more comprehensive and holistic view of traditional knowledge. It established a dynamic relationship between the respondent and the interviewer by establishing an understanding of underlying sentiments, opinions and motivation of the local people. It provided an insight about the lives, livelihood and problems of the mountain community, which further helped in developing a potential quantitative research. For a more detailed classification and analysis, the uses cited by the respondents were grouped into 15 health ailment categories (Table 2).

Data analysis

All the ethnobotanical indices are founded on the basic structure of the ethnobotanical information: "informant *i* mentions the use of the species *s* in the use-category *u.*" (Tardío and Pardo-de-Santayana, 2008). Thus, the survey yields *NS* number of species, with *NC* number of use-categories and *N* number of informants. For studying the cultural importance of the cited medicinal plants, the use-reports (UR) for each species were calculated based on the 15 health ailment categories. UR is expressed as (Tardío and Pardo-de-Santayana, 2008);

$$UR_s = \sum_{u=u_1}^{u_{NC}} \sum_{i=i_1}^{i_N} UR_{ui}$$

First, the UR of all the informants (i_1 to i_N) within each ailment category for that particular species was summed, followed by all the UR for each ailment category (u_1 to u_{NC}).

The comparison of importance of each cited species was attempted, using the following indices;

i. Relative Frequency Citation (RFC): This index was obtained by dividing the number of respondents who mention the use of the species i.e., frequency citation (*FCs*), by the total number of respondents participating in the survey (*N*). The value of RFC varies from 0 (when nobody refers to a plant as a useful one), to 1 (when all the respondents mentioning it as useful) (Tardíoand Pardo-de Santayana, 2008). It doesn't require the use-category and was calculated as:

   $RFC = FC_s / N$

ii. Relative Importance Index (RI): It was calculated for all the cited species using the formula given by Pardo-de-Santayana (2003). The RI index varies from 0 (when nobody mentions it) to 1 (frequently mentioned as useful).

   $RI_s = RFC_{(max)} + RNU_{(max)} / 2$

   Where, $RFC_{(max)}$ is the FC_s for a species over the maximum value of *FC* in all the species of the survey, given by:

   $RFC(max) = FC_s / FC_{(max)}$

Table 2: Number of use-reports and their percentage in health ailment category

Health ailment category	No. of species	Specific health issues	No. of use-reports	Percentage
Skeleton & Muscle	16	Rheumatic pain, muscular pain, back pain, throat pain, joint pain, swelling, bone fracture, leprosy, epilepsy, arthritis	4690	11.42
Gastro-intestinal	21	Stomach ache, dysentery, vomiting, diarrhea, intestinal spasm, stomach disorder, intestinal worms, ringworm, constipation, gastric issue, indigestion, dyspepsia, piles	8590	20.91
General	17	Head ache, cough, cold, fever, sore throat, antimalarial, typhoid fever	5843	14.22
Antidote	2	Snakebite	678	1.65
Dermatological	21	Skin rash, wounds, boils, cuts, itching, allergy, skin ulcer, burns, skin infection, scabies, fungal infection	8602	20.94
Respiratory	4	Nasal infection, asthma, lung infection, bronchitis, whooping cough	880	2.14
Circulatory	4	Diabetes, blood pressure, heart disease, heart tonic	1054	2.57
Hepatic	6	Jaundice	1666	4.06
Nervous	2	Brain functioning and power, psychological problems	704	1.71
Dental	5	Tooth ache, mouth wash	2059	5.01
Gynecological	5	Menstruation, smooth delivery, massaging oil for pregnant women and infants, post-natal care	2470	6.01
Genetic	1	Cancer	516	1.26
Hair	2	Hair growth, hair fall	1240	3.02
Ophthalmic	1	Eye infection	233	0.57
Body Heat	4	Keeping body warm, internal heat, cooling agent, bleeding nose	1849	4.50

Where, $RNU_{(max)}$ is the relative number of use reports for different ailment categories for the same species over the maximum value of usereports amongst all the species in all the categories, given by:

$RNU_{(max)} = NU_s D\ NU_{(max)}$

iii. Cultural Importance Index (CI): It is calculated by the summation of UR in every ailment category mentioned for a species divided by the total number of respondents (*N*). This index elaborates upon the extent of the use for a species as well as diversity of its use. A greater value of CI for a species signifies that the particular species is widely used for that health problem. It also gives the measure of relative importance of each plant use (Tardioand Pardo-de Santayana, 2008). The UR is the total number of respondents who mention a use for a species in the different ailment categories.

$$CI_s = \sum_{u=u_1}^{u_{NC}} \sum_{i=i_1}^{i_N} UR_{ui} / N$$

iv. Cultural Value Index (CV): It was given by Reyes-García *et al.* (2006) and is calculated using the flowing formula;

$CV_s = RNU_s \times RFC_s \times CI_s$

Theoretically, the maximum value of CV will be reached when all the contributing factors reach their maximum values (which is unlikely that all the respondents mention the use of all the species). The value of the index varies from 0 to the total number of use-category (in this case ailment categories) in the study.

v. Informant's Consensus Factor (Fic): In order to check the homogeneity in the use of medicinal plants (as mentioned by the respondents) in the different ailment categories informant's consensus factor was calculated using the following formula (based on Heinrich *et al.,* 1998).

$ICF = N_{ur} - N_t / N_{ur} - 1$

Where, N_{ur} is the number of use reports for a particular ailment category and N_t is the number of species used for a particular health ailment by all the respondents.

ICF ranges from 0 to 1, where a high value of ICF means high rate of consensus amongst the respondents.

vi. Fidelity Level (FL): It helped in determining the most preferred species used in the treatment of a particular ailment. Following formula based on Friedman *et al.* (1986) was used to calculate the FL;

$FL\ (\%) = N_p\ D\ N \times 100$

Where, N_p is the number of use-reports for a given species for a particular ailment and N is the total number of uses reported for species for any major ailment.

vii. Knowledge Richness Index (KRI): It was calculated separately for the pre-determined age group classes. Following formula was used (based on Araujo *et al.,* 2012 and Alencar *et al.,* 2014);

$KRI = 1\ D\ \Sigma Ji^2$

$J_i = R_i / R_{ui}$

Where, *Ri* is the number of plant species mentioned by the respondent, R_{ui} is the total number of species mentioned by the unit (N=1000). The value of KRI ranges from 0 to infinity, where the lower value of KRI indicates a higher knowledge of medicinal plants by the respondents and vice versa.

RESULTS AND DISCUSSION

The complete detail of different medicinal and aromatic plants and their traditional uses in the study are recorded in Table 3. A total of 55 medicinal and aromatic plants were recorded, which were grouped into 15 different health ailment categories. According to the recorded data, the maximum number of plant species (Figure 1) were used for gastro-intestinal and dermatological ailments (21 each), followed by general health problems (17), skeleton and muscle issues (16), hepatic disorder (6), dental and gynecological issues (5 each), respiratory, circulatory and body heat problems (4 each), antidote, nervous system and hair (2 each) and optical and genetic problems (1 each).

Different plant parts were used across the community (Figure 2) for traditionally curing different diseases, like, leaves contributed the most (23.64%), followed by roots and whole plant (21.82% each), bark (12.73%), fruits (9.09%), tuber, seeds and flower (5.45% each), resin (3.64%) and rhizome (1.82%). During the survey, it was evident that almost all the people interviewed were aware of few of the

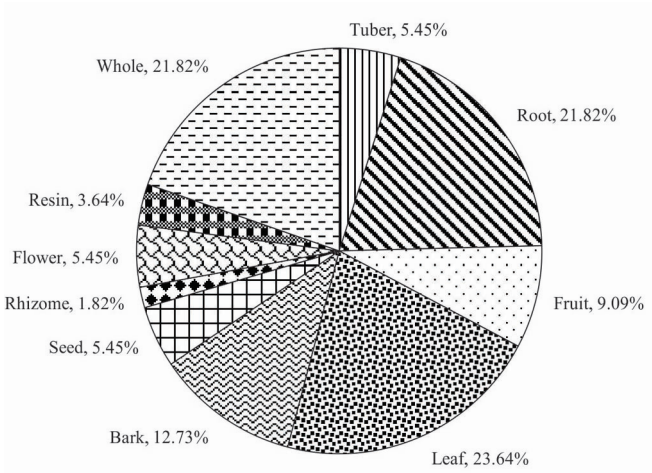

Figure 2: Proportion of plants parts used for curing health ailments

Figure 1: Number of plant species used to treat different health ailment categories

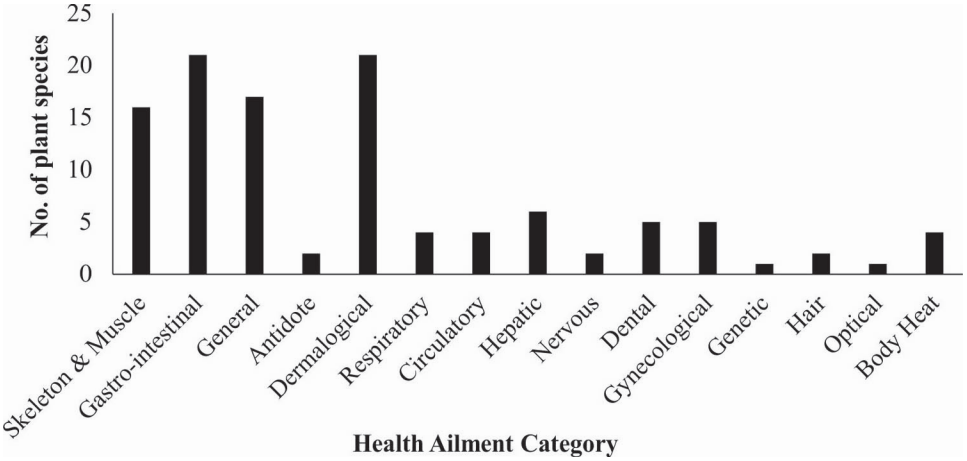

Table 3: Ethnobotanical knowledge of the wild plant species used in the traditional health care system

Scientific Name	Family	Vernacular Name	Part Used	No. of diseases treated	Folk Medicinal Use	Aromatic & Condiment
Aconitum balfourii (Bruhl) Muk.	Ranunculaceae	Meetha	Tuber	1	Snakebite	
Aconitum heterophyllum Wall. Ex Royle	Ranunculaceae	Atis	Root	3	Headache, fever and stomach ache	
Aesulus indica Colebr.	Hippocastanaceae	Pangar	Fruit	3	Sore throat and rheumatic pain	
Allium stracheyi Baker	Alliceae	Faran/Jambo	Whole	4	Cough, cold, nasal and lung infection	Condiment
Angelica glauca Edgew.	Apiaceae	Choru/Gandhra-yan	Root	5	Headache, fever, skin rashes, wounds, toothache	Condiment
Arnebia benthamii	Boraginaceae	Balchari/ Laljari	Root	1	Hair growth and hair fall	
Artemisia maritima	Asteraceae	Purchu	Root	2	Stomach disorder and epilepsy	
Artemisia nilagirica (Clarke) Pamp.	Asteraceae	Kunj/Panti	Leaf	6	Boils, cuts, wounds, intestinal worms, skin infection, asthma	
Asparagus racemosus L.	Liliaceae	Satavari	Root	1	Epilepsy	
Berberis aristate DC.	Berberidaceae	Kingore/ Kilmora	Bark, Root	3	Stomach ache, eye problems, fever	
Betula utilis D. Don	Betulaceae	Bhojpatra	Bark	6	Cough, cold, cuts, wounds, jaundice, and psychological problems	
Cannabis sativa L.	Cannabaceae	Bhaang	Leaf	5	Piles, cuts, skin ulcers, burns, muscular pain	Condiment
Carum carvi	Umbelliferae	Kala jeera	Seed	1	Dyspepsia	Condiment
Cedrus deodara Loud.	Pinaceae	Devdar	Bark	4	Rheumatism, back pain, wounds and cuts	
Centella asiatica	Apiaceae	Bramhi	Whole	1	Brain functioning and power	
Chenopodium album	Chenopodiaceae	Bathuwa	Leaf	1	Constipation	Wild Vegetable
Cinnamomum tamala Nees	Lauraceae	Dalchini/ Tejpaat	Bark, Leaf	3	Throat pain, headache, diabetes	Aromatic and Condiment
Cynodon dactylon L.	Poaceae	Doob	Whole	2	Dysentery and vomiting	
Dactylorrhiza hatagirea (D. Don) Soo	Orchidaceae	Hatazari	Tuber	5	Wounds, cuts, fever, dysentery, hair growth	
Datura stramonium	Solanaceae	Dhatura	Whole	2	Skin disease and joint pain	
Dioscorea deltoidei	Dioscoreacea	Genthi	Tuber	1	Wounds	
Diplazium esculentum Sw.	Polypodiceae	Lingra	Whole	3	Anti-malarial, jaundice and constipation	Wild Vegetable
Galium aparine L.	Rubiaceae	Kuri	Leaf	1	Cooling agent	
Geranium wallichianum D. Don ex Sweet	Geraniaceae	Ratijari	Root	2	Headache and rheumatic pain	
Grewia oppositifolia Drummond ex Burret	Tiliaceae	Bhimal	Bark	1	Pregnant women for smooth delivery	
Hippophae salicifolia	Elaeagnaceae	Amees	Fruit	6	Cold, cough and gastric issues	
Hypericum elodeoides Choisy	Hypericaceae	Vasanti	Leaf, root	1	Controls vomiting	
Juglans regia L.	Juglandaceae	Jangli Akhrot	Fruit	2	Treatment for ringworm, oil used for massaging the legs of pregnant women	
Lyonia ovalifolia (Wall.) Drud.	Ericaceae	Anyaar	Leaf	2	Itching and allergy, fungal infection	

Table 3 contd....

Scientific Name	Family	Vernacular Name	Part Used	No. of diseases treated	Folk Medicinal Use	Aromatic & Condiment
Mentha longifolia (L.) Hudson	Lamiaceae	Pudina	Leaf, flower	1	Indigestion	Aromatic
Morchella esculenta L. Peres	Helvellaceae	Guchhi	Whole	2	Cough and cold	Wild edible
Nardostachys grandiflora DC.	Valerianaceae	Jatamasi	Rhizome	5	Blood pressure, jaundice, leprosy, heart disease	
Origanum vulgare L.	Lamiaceae	Ban Tulsi	Whole	4	Fever, cough, bronchitis and epilepsy	
Paeonia emodi Wall ex Royle	Paeoniaceae	Chandra	Whole	5	Whooping cough, diarrhea, intestinal spasm, cuts	
Perilla frutescens (L.) Britton	Lamiaceae	Bhang jeera	Seed, leaf	3	Cold, abdominal pain and massaging infants	
Picrorhiza kurrooa Royle ex Benth	Scrophulaceae	Kutki	Root	3	Stomach ache, typhoid and jaundice	
Pinus roxburghii Sarg.	Pinaceae	Chir	Resin	2	Cut and wounds	Aromatic
Pinus wallichiana Jacks.	Pinaceae	Kail	Resin	1	Arthritis	
Pleurospermum angelicoides	Apiaceae	Chippi	Whole	3	Dysentery, stomach problems and typhoid fever	
Podophyllum hexandrum Royle	Podophyllaceae	Bankakri	Fruit, root	2	Cuts and wounds	
Prinsepia utilis Royle	Rosaceae	Bhaikal	Seed	2	Muscular pain and wounds	
Reinwardita indica Dumortier	Linaceae	Pauyoli	Flower	1	Mouth wash	
Rheum emodi (D. Don)	Polygonaceae	Dolu	Root	3	Boils, wounds and cuts	
Rhododendron arboretum Smith	Ericaceae	Burans	Flower	7	Bleeding nose, arthritis, boils, wounds, jaundice, blood pressure and heart tonic	Wild Edible
Rubus ellipticus Smith	Rosaceae	Hinsalu	Fruit	2	Stomach pain and dysentery	Wild Edible
Rumex hastatus (D. Don)	Polygonaceae	Janglipalak	Leaf	3	Wounds, bleeding and generation of internal heat	
Saussurea costus (Falc) Lipsch.	Asteraceae	Kut	Root	4	Toothache, jaundice, snakebite and skin problems	
Saussurea obvallata	Asteraceae	Bharamkamal	Whole	2	Cuts and wounds	
Skimmia anquetilia Taylore & Airy Shaw	Rutaceae	Kedarpatti	Leaf	3	Rheumatism, swelling and wounds	
Skimmia laureola (DC.) Zucc.	Rutaceae	Kasturapatti/ Neerpatti	Leaf	1	Scabies	Aromatic–Incense sticks
Swertia chirayita Roxb. Ex Flem	Gnetianaceae	Chirayata	Whole	2	Fever and diabetes	
Taxus baccata L.	Taxaceae	Thuner	Bark	3	Cancer, bone fracture and keeping body warm	
Thymus linearis Benth.	Lamiaceae	Van Ajwain	Whole	2	Tooth ache and stomach ache	Aromatic
Utrica dioica L.	Urticaceae	Kandali	Leaf	4	Stomach disorders, menstruation, arthritis and boils	Wild Vegetable
Zanthoxylum armatum DC.	Rutaceae	Timru	Bark, fruit	1	Toothache	

(based on Kumar and Singhal, 2019; Manikandan and Srivastava, 2015; Kala, 2015; Negi *et al.,* 2010)

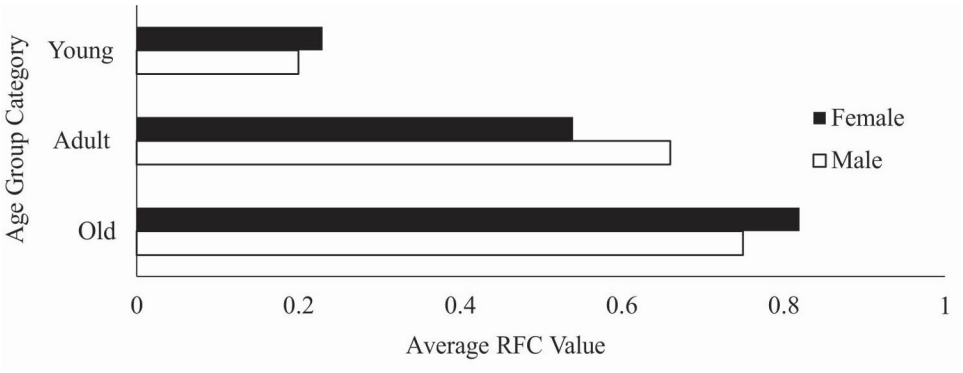

Figure 3: Average RFC of 55 species across different age groups

most common plant species, which were specially being utilized in their daily eating habits.

The RFC shows that *Allium stracheyi* Baker (Faran), *Cannabis sativa* L. (Bhaang), *Chenopodium album* (Bathuwa), *Cinnamomum tamala* Nees (Dalchini), *Diplazium esculentum* Sw. (Lingra), *Mentha longifolia* (L.) Hudson (Pudina), *Rhododendron arboretum* Smith (Burans), *Rubus ellipticus* Smith (Hinsalu) and *Utrica dioica* L. (Kandali) are the most cited and widely known plant species across the three age groups, with the RFC index score of 1. These species were well recognized by the younger generation as they are used in daily household cooking in the form of vegetable, condiment/spice and wild edibles. The other highly cited species across all the age groups were, *Arnebia benthamii* (Balchari), *Grewia oppositifolia* Drummond ex Burret (Bhimal) and *Cedrus deodara* Loud. (Devdar) with RFC index score of nearly 0.96, 0.95 and 0.94, respectively. Some of the least cited species were, *Swertia chirayita* Roxb. Ex Flem (Chiryata), *Paeonia emodi* Wall ex Royle (Chandra) and *Geranium wallichianum* D. Don ex Sweet (Ratajari) all having the RFC index score of nearly 0.22.

On comparing the species ranking based on each of the index (RI, CI and CV), not much difference was seen (Table 4). Culturally, the most important species are, *Utrica dioica* L. (Kandali), *Rhododendron arboretum* Smith (Burans) and *Allium stracheyi* Baker (Faran) with a CI index of 1.766,

Table 4: Evaluation of the Quantitative Indices (RFC, RI, CI and CV)

Species	Basic Values			Indices Values			
	FC	UR	NU	RFC	RI	CI	CV
Aconitum balfourii (Bruhl) Muk.	356	356	1	0.356	0.211	0.356	0.008
Aconitum heterophyllum Wall. Ex Royle	413	641	2	0.413	0.273	0.641	0.035
Aesulus indica Colebr.	305	412	2	0.305	0.219	0.412	0.002
Allium stracheyi Baker	1000	1488	3	1	0.600	1.488	0.298
Angelica glauca Edgew.	797	1088	3	0.797	0.498	1.088	0.173
Arnebia benthamii	960	960	1	0.960	0.513	0.96	0.061
Artemisia maritima	316	347	2	0.316	0.225	0.347	0.015
Artemisia nilagirica (Clarke) Pamp.	474	633	3	0.474	0.337	0.633	0.060
Asparagus racemosus L.	204	204	1	0.204	0.135	0.204	0.003
Berberis aristate DC.	526	751	3	0.526	0.363	0.751	0.079
Betula utilis D. Don	790	1389	4	0.790	0.528	1.389	0.293
Cannabis sativa L.	1000	1309	3	1	0.600	1.309	0.262
Carum carvi	611	611	1	0.611	0.338	0.611	0.025
Cedrus deodara Loud.	948	1185	2	0.948	0.541	1.185	0.150
Centella asiatica	620	620	1	0.620	0.343	0.620	0.026
Chenopodium album	1000	1000	1	1	0.533	1	0.067

Table 4 contd....

Species	Basic Values			Indices Values			
	FC	UR	NU	RFC	RI	CI	CV
Cinnamomum tamala Nees	1000	1126	2	1	0.566	1.126	0.150
Cynodon dactylon L.	286	286	1	0.286	0.176	0.286	0.005
Dactylorrhiza hatagirea (D. Don) Soo	606	815	4	0.606	0.436	0.815	0.132
Datura stramonium	675	888	2	0.675	0.404	0.888	0.079
Dioscorea deltoidei	664	664	1	0.664	0.365	0.664	0.029
Diplazium esculentum Sw.	1000	1329	3	1	0.600	1.329	0.266
Galium aparine L.	422	422	1	0.422	0.244	0.422	0.012
Geranium wallichianum D. Don ex Sweet	224	246	2	0.224	0.179	0.246	0.007
Grewia oppositifolia Drummond ex Burret	948	948	1	0.948	0.507	0.948	0.059
Hippophae salicifolia	505	655	2	0.505	0.319	0.655	0.044
Hypericum elodeoides Choisy	332	332	1	0.332	0.199	0.332	0.007
Juglans regia L.	637	807	2	0.637	0.385	0.807	0.068
Lyonia ovalifolia (Wall.) Drud.	344	344	1	0.344	0.205	0.344	0.007
Mentha longifolia (L.) Hudson	1000	1000	1	1	0.533	1	0.067
Morchella esculenta L. Peres	789	789	1	0.789	0.428	0.789	0.0415
Nardostachys grandiflora DC.	525	889	3	0.525	0.362	0.889	0.093
Origanum vulgare L.	488	621	3	0.488	0.344	0.621	0.061
Paeonia emodi Wall ex Royle	220	361	4	0.220	0.243	0.361	0.021
Perilla frutescens (L.)Britton	352	438	3	0.352	0.276	0.438	0.031
Picrorhiza kurrooa Royle ex Benth	612	837	3	0.612	0.406	0.837	0.102
Pinus roxburghii Sarg.	782	782	1	0.782	0.424	0.782	0.041
Pinus wallichiana Jacks.	537	537	1	0.537	0.302	0.537	0.019
Pleurospermum angelicoides	498	612	2	0.498	0.316	0.612	0.041
Podophyllum hexandrum Royle	411	411	1	0.411	0.239	0.411	0.011
Prinsepia utilis Royle	298	418	2	0.298	0.216	0.418	0.017
Reinwardita indica Dumortier	263	263	1	0.263	0.165	0.263	0.005
Rheum emodi (D. Don)	235	235	1	0.235	0.151	0.235	0.004
Rhododendron arboretum Smith	1000	1527	5	1	0.667	1.527	0.509
Rubus ellipticus Smith	1000	1000	1	1	0.533	1	0.067
Rumex hastatus (D. Don)	768	1104	2	0.768	0.451	1.104	0.113
Saussurea costus (Falc) Lipsch.	683	1050	4	0.683	0.475	1.050	0.191
Saussurea obvallata	627	627	1	0.627	0.347	0.627	0.026
Skimmia anquetilia Taylore & Airy Shaw	583	703	2	0.583	0.358	0.703	0.055
Skimmia laureola (DC.**)** Zucc.	383	383	1	0.383	0.225	0.383	0.009
Swertia chirayita Roxb. Ex Flem	216	244	2	0.216	0.175	0.244	0.007
Taxus baccata L.	699	991	3	0.699	0.449	0.991	0.138
Thymus linearis Benth.	566	834	2	0.566	0.349	0.834	0.006
Utrica dioica L.	1000	1766	4	1	0.633	1.766	0.471
Zanthoxylum armatum DC.	796	796	1	0.796	0.431	0.796	0.042

FC = frequency of citation, UR = number of use reports in different ailment categories, NU = Number of uses, RFC = relative frequency of citation, RI = relative importance, CI = cultural importance, CV = cultural value

1.527 and 1.488, respectively. These species are used in the daily lives of the local community, for example, Kandali is cooked in the form of vegetable as it provides warmth to the body specially during cold season, Faran is used as a condiment in the daily cooking of pulses and Burans flowers are used to make squash and juice keeping the body cool and energized during the summer heat. *Asparagus racemosus* L. (Satavari), *Rheum emodi* (D. Don) (Dolu) and *Swertia chirayita* Roxb. ex Flem (Chiryata) are amongst the least culturally important species with a CI index of 0.204, 0.235 and 0.244 respectively, and were amongst the least cited medicinal plants as well. Similarly, the RI and CV indices also placed *Rhododendron arboretum* Smith (Burans) in the top position, because of the multiplicity in the plant use, having the highest NU of 5. It was also cited by all the respondents during the survey (FC = 1000). The least important species is *Asparagus racemosus* L. (Satavari) and it was cited by only 204 respondents, out of which 57% were old, 36% adult and 7% young. The species which were cited by all the respondents (FC = 1000), still differ in their cultural value and importance based on the multiplicity of use. For example, *Cannabis sativa* L. (Bhaang) has NU of 3 and *Chenopodium album* (Bathuwa) has NU of 1 (both have FC of 1000), have CV of 0.262 and 0.067 respectively across the community.

The result of Fic (Table 5) shows that the genetic and ophthalmic category had the greatest agreement with a Fic value of 1.00, the reason being that a single species was used to treat the associated health problem. For example, for genetic ailment there was only one species *Taxus baccata* L. (Thuner) that was used and similarly for ophthalmic related issues, just *Berberis aristate* DC. (Kingora) was used. The other categories had nearly the same Fic of 0.09. Gastro-intestinal and dermatological problems were being treated with the highest number of species (21 species each), followed by the category of general health (17 species) and skeleton and muscle (16 species). Based on FL%, the most preferred plant species for the medical treatment in the different ailment categories were, for skeleton and muscle related issues *Cedrus deodara* Loud. (Deodar), for gastro-intestinal problems *Chenopodium album* (Batuwa), *Mentha longifolia* (L.) Hudson (Pudina) and *Rubus ellipticus* Smith (Hinsalu), for general health care *Morchella esculenta* L. Peres (Guchhi), for antidote *Aconitum balfourii* (Bruhl) Muk. (Meetha), for dermatological conditions *Pinus roxburghii* Sarg. (Chir), for respiratory issues *Allium stracheyi* Baker (Faran), for circulatory issues *Cinnamomum tamala Nees* (Dalchini), for hepatic concerns *Picrorhiza kurrooa* Royle ex Benth (Kutki), for nervous system related problems *Centella asiatica* (Brahmi), for dental concerns *Zanthoxylum armatum* DC. (Timru), for gynecological needs *Grewia oppositifolia* Drummond ex Burret (Bhimal), for genetic issues *Taxus baccata* L. (Thuner), for hair concerns *Arnebia benthamii* (Balchari), for ophthalmic issues *Berberis aristate* DC. (Kingora) and for body heat problem *Rhododendron arboretum* Smith (Burans).

The weakening of traditional ethnobotanical knowledge was alarming in the study area. The KRI value was highest for the young generation (0.04), implying that they have the least knowledge about the uses of medicinal plants. The KRI value was recorded low for both adult (0.005) and old (0.004) generation group which means that they had a vast knowledge of the traditional medicinal practices. Out of the total 1000 respondents, 37 (6 adult males, 13 old males and 18 old females) of them were able to report all the 55 medicinal plants in the study area. Youngsters and students who were interviewed, knew the plant species but they possessed least knowledge about its medicinal use. It was obvious that due to education and exposure, they preferred the modern medicine over the old traditional practices.

Despite the development of modern healthcare services, rural communities, particularly in remote mountain regions of Indian Himalayan Region, still use a large number of medicinal plants for the treatment of various ailments (Malik *et al.,* 2015). The results revealed that, plant-based

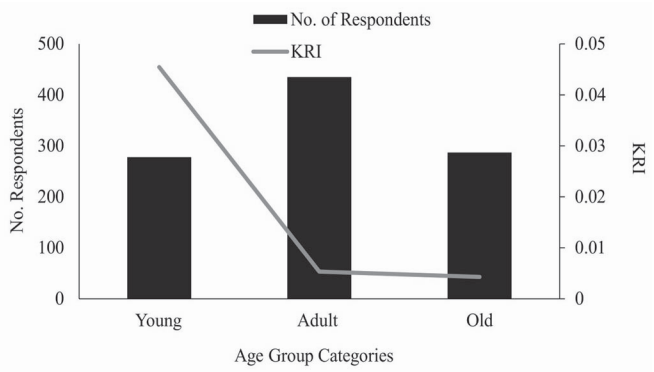

Figure 4: Knowledge richness index of respondents

Table 5: Evaluation of Informant consensus (Fic) and fidelity level (FL%)

Health Ailment Category	Informant Consensus Factor (Fic)	Name of the species used	Species Fidelity Value (FL%)
Skeleton and Muscle	0.997	*Aesulus indica* Colebr.	19.70
		Allium stracheyi Baker	49.20
		Artemisia maritima	12.30
		Asparagus racemosus L.	20.40
		Cannabis sativa L.	35.90
		Cedrus deodara Loud.	64.30
		Datura stramonium	42.50
		Geranium wallichianum D. Don ex Sweet	10.10
		Nardostachys grandiflora DC.	39.00
		Origanum vulgare L.	23.80
		Pinus wallichiana Jacks.	53.70
		Prinsepia utilis Royle	20.20
		Rhododendron arboretum Smith	16.60
		Skimmia laureola (DC.) Zucc.	28.20
		Taxus baccata L.	16.50
		Utrica dioica L.	16.60
Gastro-intestinal	0.998	*Aconitum heterophyllum* Wall. Ex Royle	30.40
		Artemisia maritima	22.40
		Artemisia nilagirica (Clarke) Pamp.	24.60
		Berberis aristate DC.	22.60
		Cannabis sativa L.	31.60
		Carum carvi	61.10
		Chenopodium album	100
		Cynodon dactylon L.	28.60
		Dactylorrhiza hatagirea (D. Don) Soo	15.30
		Diplazium esculentum Sw.	62.60
		Hippophae salicifolia	36.50
		Hypericum elodeoides Choisy	33.20
		Juglans regia L.	33.90
		Mentha longifolia (L.) Hudson	100
		Paeonia emodi Wall ex Royle	7.20
		Perilla frutescens (L.) Britton	8.40
		Picrorhiza kurrooa Royle ex Benth	22.50
		Pleurospermum angelicoides	31.20
		Rubus ellipticus Smith	100
		Thymus linearis Benth.	45.50
		Utrica dioica L.	41.40
General	0.996	*Aconitum heterophyllum* Wall. Ex Royle	33.70
		Aesulus indica Colebr.	21.50
		Allium stracheyi Baker	56.80

Table 5 contd...

Health Ailment Category	Informant Consensus Factor (Fic)	Name of the species used	Species Fidelity Value (FL%)
		Angelica glauca Edgew.	39.80
		Berberis aristate DC.	29.20
		Betula utilis D. Don	47.30
		Cinnamomum tamala Nees	67.40
		Dactylorrhiza hatagirea (D. Don) Soo	21.70
		Diplazium esculentum Sw.	47.50
		Geranium wallichianum D. Don ex Sweet	14.50
		Hippophae salicifolia	29.00
		Morchella esculenta L. Peres	78.90
		Origanum vulgare L.	21.30
		Perilla frutescens (L.) Britton	9.20
		Picrorhiza kurrooa Royle ex Benth	21.80
		Pleurospermum angelicoides	30.00
		Swertia chirayita Roxb. Ex Flem	14.70
Antidote	0.998	*Aconitum balfourii* (Bruhl) Muk.	35.60
		Rumex hastatus (D. Don)	32.20
Dermatological	0.998	*Angelica glauca* Edgew.	34.20
		Artemisia nilagirica (Clarke) Pamp.	19.30
		Betula utilis D. Don	50.50
		Cannabis sativa L.	63.40
		Cedrus deodara Loud.	54.20
		Dactylorrhiza hatagirea (D. Don) Soo	16.50
		Datura stramonium	46.30
		Dioscorea deltoidea	66.40
		Lyonia ovalifolia (Wall.) Drud.	34.40
		Paeonia emodi Wall ex Royle	7.50
		Pinus roxburghii Sarg.	78.20
		Podophyllum hexandrum Royle	41.10
		Prinsepia utilis Royle	21.60
		Rheum emodi (D. Don)	23.50
		Rhododendron arboretum Smith	25.70
		Rumex hastatus (D. Don)	62.30
		Saussurea costus (Falc) Lipsch.	20.00
		Saussurea obvallata	62.70
		Skimmia anquetilia Taylore & Airy Shaw	42.10
		Skimmia laureola (DC.) Zucc.	38.30
		Utrica dioica L.	52.00
Respiratory	0.996	*Allium stracheyi* Baker	42.80
		Artemisia nilagirica (Clarke) Pamp.	19.40
		Origanum vulgare L.	17.00
		Paeonia emodi Wall ex Royle	8.80

able 5 contd...

Health Ailment Category	Informant Consensus Factor (Fic)	Name of the species used	Species Fidelity Value (FL%)
Circulatory	0.997	*Cinnamomum tamala* Nees	45.20
		Nardostachys grandiflora DC.	26.60
		Rhododendron arboretum Smith	23.90
		Swertia chirayita Roxb. Ex Flem	9.70
Hepatic	0.997	*Betula utilis* D. Don	32.70
		Diplazium esculentum Sw.	22.80
		Nardostachys grandiflora DC.	23.30
		Picrorhiza kurrooa Royle ex Benth	39.40
		Rhododendron arboretum Smith	22.90
		Saussurea costus (Falc) Lipsch.	25.50
Nervous	0.998	*Betula utilis* D. Don	8.40
		Centella asiatica	62.00
Dental	0.998	*Angelica glauca* Edgew.	34.80
		Reinwardita indica Dumortier	26.30
		Saussurea costus (Falc) Lipsch.	27.30
		Thymus linearis Benth.	37.90
		Zanthoxylum armatum DC.	79.60
Gynecological	0.998	*Grewia oppositifolia* Drummond ex Burret	94.80
		Juglans regia L.	46.80
		Paeonia emodi Wall ex Royle	12.60
		Perilla frutescens (L.) Britton	26.20
		Utrica dioica L.	66.60
Genetic	1.00	*Taxus baccata*L.	51.60
Hair	0.999	*Arnebia benthamii*	96.00
		Dactylorrhiza hatagirea (D. Don) Soo	28.00
Ophthalmic	1.00	*Berberis aristate* DC.	23.30
Body Heat	0.998	*Galium aparine* L.	42.20
		Rhododendron arboretum Smith	63.60
		Rumex hastatus (D. Don)	48.10
		Taxus baccata L.	31.00

traditional knowledge system formed the primary basis of healthcare in the study area. The geographic isolation of communities in the Tons Valley of Govind Wildlife Sanctuary and National Park, has strengthened the traditional knowledge base of medicinal plants. Local people show preferences for the use of traditional herbal remedies due to their belief in the effectiveness of folklore herbal remedies (Malik *et al.,* 2015). In this study, local people residing in the remote and inaccessible high-altitude areas Dhatmeer and Osla largely depended upon the traditional remedies for general health issues, like, cough, cold and fever.

The reason being lack of alternative options, inaccessibility to a medical facility and inconvenience of transport. Another reason was the proximity of the village settlements to the sub-alpine and alpine meadows (bugyals) which are the reservoirs of medicinal plants. In the study area, these 'bugyals' are frequently being visited by the

Table 6: General information about the selected villages

Name of the Village	Availability of motorable road	Walking Distance to reach the village (approx.)	Distance from the market (approx.)	Availability of chemist shop in the market	Primary Health Centre/ Government Hospital (approx. distance)	Ease in availability of transport
Gainchwan Gaon	Yes	0	5-6 km	Yes	17-18 km	Yes
Deora	Yes	0	8-9 km	Yes	20-21km	Yes
Dhatmeer	No	6-7 km	6-7 km	No	43-44 km	No
Osla	No	17 km	17 km	No	54-55 km	No

pastoralists for livestock grazing and by tourists for trekking and camping. Even for the villages located on a roadhead or near a market (Gainchwan Gaon and Deora), the community gave preference to traditional medicine. Even though there was a primary health centre at the village Gainchwan Gaon, there was no availability of doctor or basic medical facility. Amidst, the lack of proper medical guidance, the local community was skeptical to trust the nearby chemist shops and thus continued with their traditional remedies. In case, of medical emergencies, many people have suffered due to their physical isolation and lack of tele-connectivity in the area. It was also evident, that since the inhabitants of remote villages appreciated the use of medicinal plants, they were apparently much more aware and alert to conserve these species by sustainably utilizing them in their daily lives. The knowledge of least cited medicinal plants remained confined with the old people, who knew the time of collection, plant parts to be used and method of medicinal preparation. Accumulation of traditional knowledge with the older generation is also a matter of concern, as the losing interests of younger generation had hindered the transfer of this knowledge. Since, the local people showed high agreement on the usage of different medicinal plants (as the informant's consensus factor was high), indicating that the knowledge system is still strong.

Uttarakhand's diverse geo-climatic conditions and rich availability of wild medicinal and aromatic plants highlights the great potential for the cultivation of the same. It can play an important role in the conservation of biodiversity as well as livelihood enhancement of the mountain people. In the study area, few of the households in the village Dhatmeer and Osla have initiated nurseries of medicinal plants. As the villagers lack scientific and technical know-how of cultivation practices involved in medicinal plants, they are still skeptical towards its successful establishment as a source of income generation. The current management practices in Uttarakhand are disorganized, as there is limited data available on the quantity and quality of medicinal and aromatic plants being supplied for trading from the region. For sustainable commercialization, it is important to map the potential cultivation areas and communities, providing local people with quality planting material, demonstration and training. Further, it requires the development of proper marketing channel, so as to synchronize the efforts of local people with the demand-supply of medicinal plants at the national level.

CONCLUSION

This study provides broad information about the traditional knowledge and practices of medicinal plants in the remote villages of Himalayas. It conceptualizes the local peoples' notions of development, for further exploring the relationship between traditional practices and sustainable use of natural resources. It clearly sheds light on the relation between medicinal plant use with the age of people, availability of medical facility and distance of households from the forest area. It provides a baseline data which can be further explored through a more scientific study of traditional medicinal formulations, which may lead to development of safe and affordable herbal medicines. This will not only make our healthcare system less dependent on the chemical drugs, but will also give an opportunity to the rural poor for growth and development. It is important to understand the regional conditions of the local mountain community, so as to assist the concerned authorities in developing policies and initiatives that could incorporate elements of traditional knowledge for income generation. With the rise in issues, like, illegal harvesting, smuggling,

climate change, bio-piracy and declining interest of younger generation, it becomes urgent to document the traditional knowledge and conserve the biodiversity. There is a need for regular reforms in traditional institutions, governance system, policies and rules, so as to link knowledge with action in order to sustainably benefit the local community in their own niche.

REFERENCES

Alencar NL, Junior WSF and Albuquerque UP (2014). Medicinal plant knowledge richness and sharing in north-eastern Brazil. *Econ. Bot.*, 68: 371–382.

Araujo TAS, Almeida ALS, Melo JG, Medeiros MFT and Ramos MA (2012). A new technique for testing distribution of knowledge and to estimate sampling sufficiency in ethnobiology studies. *J. Ethnobiol. Ethnomed.*, 8(1): 11.

Arnold JEM and Perez MR (2001). Can non-timber forest products match tropical forest conservation and development objectives. *Ecol. Econ.*, 39: 437–447.

Awoyemi OK, Ewa EE, Abdulkarim IA and Aduloju AR (2012). Ethnobotanical assessment of herbal plants in south-western Nigeria. *Acad. Res. Int.*, 2: 50–57.

Cameron MM (2008). Modern desires, knowledge control, and physician resistance: Regulating ayurvedic medicine in Nepal. *Asian Med.*, 4: 86–112.

Cunningham AB (1988). An investigation of the herbal medicine trade in Natal/Kwazulu. Investigational report number 29. Institute of Natural Resources, University of Natal, Pietermaritzburg, South Africa.

Friedman J, Yaniv Z, Dafni A and Palewitch D (1986). A preliminary classification of the healing potential of medicinal plants, based on a rational analysis of an ethnopharmacological field survey among bedouins in the Negev desert, Israel. *J. Ethnopharmacol.*, 16: 275–287.

Heinrich M, Ankli A, Frei B, Weimann C and Sticher (1998). Medicinal plants in Mexico: Healers' consensus and cultural importance. *Soc. Sci. Med.,* 47: 1863–1875.

Kala CP (2015). Medicinal and aromatic plants of Tons watershed in Uttarakhand Himalayas. *Appl. Ecol. Environ. Sci.*, Vol. 3, 1: 16-21.

Kumar M, Rawat S, Nagar B, Kumar A, Pala AN, Bhat JA, Bussmann WR, Cabral-Pinto M and Kunwar R (2021). Implementation of the use of ethnomedicinal plants for curing diseases in the Indian Himalayas and its role in sustainability of livelihoods and socioeconomic development. *Int. J. Env. Res. Pub. He.*, 18: 1509.

Kumar R and Singhal VK (2019). Traditional knowledge and conservation status of some selected medicinal herbs from Uttarkashi district in Uttarakhand, western Himalayas. *Taiwania*, 64(1): 52-64.

Magni G (2016). Indigenous knowledge and implications for the sustainable development agenda. Background paper prepared for the 2016 GEM Report – Education for people and planet: Creating sustainable futures for all, UNESCO.

Malik ZA, Bhat JA, Ballabha R, Bussmann RW and Bhatt AB (2015). Ethnomedicinal plants traditionally used in health care practices by inhabitants of western Himalaya. *J. Ethnopharmacol.*, 172: 133–144.

Manikandan R and Srivastava SK (2015). Diversity, medicinal and threatened plants in Govind pashu vihar wildlife sanctuary, western Himalayas. *Indian For.*, 141(9): 966-973.

Negi VS, Maikhuri RK, Phondani PC and Rawat LS (2010). An inventory of indigenous knowledge and cultivation practices of medicinal plants in Govind pashu vihar wildlife sanctuary, central Himalaya, India. *Int. J. Biodivers. Sci. Ecosys. Serv. Manag.*, 6(3-4): 96-105.

Negi VS, Maikhuri RK and Rawat LS (2011). Non-timber forest products (NTFPs): A viable option for biodiversity conservation and livelihood enhancement in central Himalaya. *Biodivers. Conserv.*, 20: 545–559.

Pardo-de-Santayana M (2003). Las plantasen la culturatradicional de la Antigua Merindad de Campoo. Ph.D. dissertation, Departamento de Biología, Facultad de Ciencias, *Universidad Autónoma de Madrid*, Spain.

Reyes-García V, Huanca T, Vadez V, Leonard W and Wilkie D (2006). Cultural, practical, and economic value of wild plants: A quantitative study in the Bolivian Amazon. *Econ. Bot.*, 60(1): 62–74.

Singh JS (2002). The biodiversity crisis: A multifaceted review. *Curr. Sci.*, 82: 638–647.

Tardío J and Pardo-de Santayana M (2008). Cultural importance indices: A comparative analysis based on the useful wild plants of Southern Cantabria (Northern Spain). *Econ. Bot.*, 62(1): 24–39.

UN (2012). United Nations system task team on the Post 2015 UN Development Agenda - Realizing the future we want for all. Report to the Secretary-General, New York.

Uniyal SK, Singh KN, Jamwal P and Lal B (2006). Traditional use of medicinal plants among the tribal communities of Chhota Bhangal, western Himalaya. *J. Ethnobiol. Ethnomed.*, 2: 1–14.