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Ethnobotanical Studies and Socio-Cultural Status of High-Altitude Villages in Byans Valley, Uttarakhand, India

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Abstract
Ethnobotanical knowledge plays a vital role in understanding the traditional uses of plants for medicinal and religious purposes. This study investigates the ethnobotanical significance of plant species used by local communities in Byans Valley, India. Using structured interviews, field surveys, and participant observations, data were gathered from traditional healers, community elders, and practitioners of indigenous knowledge. The study documents a wide range of plant species used in treating ailments, spiritual practices, and religious rituals, reflecting the deep cultural and ecological connection between local people and their environment. The results indicate that several plant species have significant therapeutic potential, warranting further pharmacological investigation. Additionally, the sacred use of plants demonstrates the role of cultural beliefs in biodiversity conservation. However, modernization, habitat loss, and diminishing interest among younger generations threaten the survival of this knowledge system. The findings emphasize the need for conservation efforts, sustainable resource management, and the documentation of indigenous knowledge to ensure its preservation for future generations. This research contributes to the broader field of ethnomedicine, highlighting the importance of integrating traditional knowledge with modern conservation strategies and promoting the sustainable use of medicinal and sacred plant species.

Keywords: Ethnobotany, Medicinal Plants, Sacred Plants, Traditional Knowledge, Conservation

Introduction

The natural resources are essential for the survival of human being as they continue used for the benefits of human communities worldwide. Natural products constitute an important source of livelihood for millions of people from forest fringe communities across the world (Murphy *et al*. 2005; Mamo *et al*. 2007 [25]; Blay *et al*. 2007 [2]). In ancient civilisations, community culture and beliefs are the driving force behind sustainable natural resource management, and are strengthened by their close connection to the environment (Rist *et al*. 2003; Negi *et al*. 2018) [42, 33]. As a result of ecosystems and cultural identities, as well as the symbiotic relationship between the environment and cultures, biodiversity and cultural diversity are closely linked in mountainous regions (Khan *et al*. 2008 [19]; Negi 2010 [31]; Anthwal *et al*. 2010 [1]; Sharma and Devi 2014). Nature worship and management have greatly influenced human perceptions of sacred preservation and sustainable use of natural resources. The vegetation diversity that has historically been protected by local communities include forests, groves, and sacred landscapes. These areas are excellent examples of in-situ biodiversity conservation (Negi *et al*., 2018) [33]. The healthcare systems among rural human population rely on traditional knowledge on the use of natural resources, such as medicinal plants, which has been recognized as an essential piece of knowledge that local communities have passed down through generations (Maikhuri *et al*. 1998 [20]; Nautiyal *et al*. 2000; Simbo 2010 [48]; Uprety *et al*. 2012 [52]; Negi *et al*. 2018 [33]). India has a long tradition of wise conservation strategies that are useful to people and society, as well as in pharmaceuticals use. The use of medicinal herbs based on indigenous belief and traditional knowledge is part of the oldest traditional cultures in India, known as folk tradition (Samant. *et al*. 1998 [45]; Maikhuri *et al*. 1998 [20]; Nautiyal *et al*. 2000; Kala 2005; Malik *et al*. 2015). The Himalayan region supports a large variety of wild-growing plants used for food and other subsistence needs by the local communities (Sundriyal and Sundriyal 2003) [51]. In Uttarakhand, communities and forests have a strong relationship because the dependency of people on the forests is high for their daily needs of fuelwood, fodder, and medicinal plants. The non-timber forest products that have contributed significantly to improving human socioeconomic conditions for thousands of years, especially in rural and tribal areas (Maikhuri and Ramakrishnan 1992; Maikhuri *et al*. 2004 [22]; Dhayani *et al*. 2007; Negi *et al*. 2018 [33]). Central Himalayan region, is an important source of various medicinal plant species and grow abundantly across an altitudinal gradient, especially in context of Kumaun Himalaya. More than 8000 species of flowering plants grow in the Himalaya, with nearly 4000 species identified from the Garhwal Himalayan region along with great diversity (Kandari and Gusain 2001) [18].

High-altitude alpine meadows are vital socio-economic assets because they supply forage, water, and many other socio-cultural services to the mountain communities. In the Qinghai-Tibet Plateau, grasslands support pastoralism (yaks, Tibetan sheep, Bactrian camels) and act as headwaters for nine major rivers that sustain over a billion people, linking local livelihoods to national and trans-border water security (Feng *et al*. 2020) [12]. In the European Alps, alpages provide summer feed for dairy and meat production, sustaining small farm holder and generating cultural ecosystem services that benefit tourism and local identity (Deléglise *et al*. 2022) [4]. Farmers in five Alpine nations describe "good" meadows in terms of forage quality, productivity, and soil (Wezel *et al*. 2021) [53]. Alpine meadows across the Himalaya are a cornerstone of mountain livelihoods, supplying the bulk of forage for trans-humance pastoralists and underpinning local economies. In the Kashmir Himalaya, the rangelands sustain ≈ 4.66 million Sheep Units, providing a livelihood base for thousands of families while generating a surplus of ≈ 25 % of the carrying capacity that could be tapped for community development (Saleem *et al*. 2024) [44]. In Sikkim, the 1998 ban on grazing aimed to protect biodiversity but produced mixed socio-economic outcomes: reduced household incomes, loss of manure for organic farming, and a shift toward monocultures, but modest gains in carbon stocks were recorded (Ingty 2021) [15]. Similar pressures are evident in the Indian Himalaya where state-led "fortress" conservation coupled with eco-tourism has displaced pastoralists from protected areas, eroding traditional cultural practices and curtailing livestock-based income streams (Singh *et al*. 2021). Yak rearing in NE India's alpine pastures remains the primary occupation of Brokpa and Dokpa communities, yet indiscriminate pasture use and climate change threaten both animal productivity and food security-linked with livelihoods. In Ladakh, rapid tourism growth and public-distribution-system subsidies have transformed an once agrarian-pastoral economy into a service-oriented community. This change of primary-sector earnings from 84 % to 71 %, prompting a gradual abandonment of farming and herding (Joshi *et al* 2025) [17] in the region. Collectively, these patterns show that Himalayan alpine meadows are not only ecological assets but also vital socio-economic pillars and the whose degradation directly threatens food security, cultural heritage, and rural prosperity. The aims of the present study are analysing the ethnobotanical and silvicultural status of the people residing in the Byans valley of Central Himalaya.

Materials and Methods

Study Area

The Study area is situated between 30°10´ and 30°20´ N latitude and 80° 20´and 80°50´ E longitude at an elevation 2400-3800m asl in the Byans valley of Pithoragarh district in Kumaun Himalaya, India. The valley is inhabited by transhumance, mainly the Bhotiya communities which migrates towards the valley during summer (snow free months) and again shifted back to low elevation villages during winter months (heavy snow cover present during this period). The occupation of the people during their stay period (May to September) are mainly marginal agriculture, livestock rearing, and use of natural resources present in the region, mainly the biodiversity of medicinal plants. These communities have a wealth of ethnobotanical knowledge and to have established a favourable relationship between biodiversity and cultural identity. The study area is comprised of alpine meadows with scattered trees, the major vegetation type consists of *Danthonia cachemyriana, Potentilla argyrophylla, Primula macrophylla,* etc, in the herb layer and *Cotoneaster microphyllus*, *Juniperus communis, Berberis spp* etc, in shrub layer, with sparsely growing *Betula utilis, Cedrus deodara, Picea smithiana, Pinus wallichiana* in the tree layer.

Table 1: Description of selected villages in Byans valley

Variable	Bundi	Garbyang	Napalachchu	Gunji	Navi	Raungkong	Kuti
Elevation (m)	2785	3149	3213	3251	3323	3295	3852
No. of Households	215	192	25	194	32	35	115
Sampled household	10	10	10	10	10	10	10
Total human population	665	426	74	335	78	118	363
Male population	370	277	43	229	45	60	198
Female population	295	149	31	106	33	58	165
Land area (ha)	239.4	581	141.2	188.9	434.7	322	249.3
Gender Ratio (per 1000)	1079	1364	721	727	733	1000	929
SC population	44	24	0	11	0	0	31
ST population	536	299	74	195	77	118	291
Total No. of livestock	2461	2040	797	1589	977	1561	1774
Education							
Literacy Rate (%)	89.3%	93%	97.2%	87.6%	85.5%	79.3%	87.2%
No schooling	20%	10%	10%	20%	10%	10%	10%
Primary	50%	30%	40%	20%	30%	30%	30%
Secondary	10%	40%	20%	40%	30%	10%	50%
Graduation	20%	20%	30%	20%	30%	50%	10%
Source of income							
Agriculture+Animal husbandry	20%	10%	10%	20%	10%	40%	30%
Business	50%	50%	50%	20%	60%	20%	30%

Agriculture+ Business	10%	30%	20%	30%	20%	30%	10%
Government job	20%	10%	20%	30%	10%	10%	30%

Source: Population Census, 2011

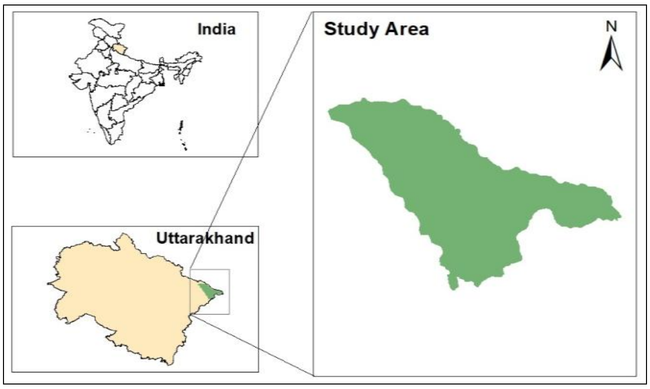

Fig 1: Location map of the Study area

Methods

The extensive survey of the village was conducted during the summer months (snow free months) in 2023 to 2024 in Byans valley. A total of seven migratory villages were selected for the detailed study (Table.1). A questionnaire was developed on various ethnobotanical and sociocultural status of the villages. The data consists ethnobotanical use of the biodiversity, name, age, gender, education, source of income and income of the respondent. For questionnaire survey, 70 informants of different age groups (25–50, 51–60, 61–70, >70 years) were selected randomly and interviewed as per the questionnaire (Fig 2). People less than 25 year of age generally were not residing in the villages. The house hold size also divided into three categories based on members in the family small (1-5 members), medium (6-8 members), and large (>9 members). The house hold earned from different sources income category also into two category low-income category ₹0-30,000 and high-income category above ₹30,000. The income sources were classified into four categories agriculture and animal husbandry, business, government sector, and a combination of agriculture and business. The sources of household energy used were classified into two categories: (1) LPG with kerosene stove, fuelwood, and solar energy, and (2) no LPG but fuelwood, kerosene stove, and solar energy. Apart from the above information the information in biodiversity like local name of plant species, ethnomedicinal uses, plant parts used, and the method of preparation and application plant extract were also recorded.

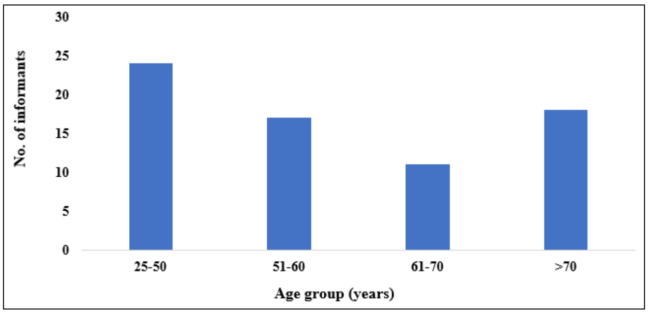

Fig 2: Relation between number of informants and age group (years)

A thorough field visits to forests and meadow were also conducted to gather comprehensive data on plant biodiversity. Approximately 90% of the plant species were collected and identified with the help of herbal healers and local communities, while the remaining species were identified through consultation of regional floras (Duthie 1903 [7], 1906 [8]; Collett 1921 [3]; Osmaston 1927 [36]; Polunin and Stainton 1984 [39]; Murthy 2011 [27]; Naithani 2012; https://www.kew.org/) and local taxonomist. The conservation status of the plant species was also identified as per the IUCN Red List (https://www.iucnredlist.org 2025) they are Extinct (EX), Extinct in the Wild (EW), Critically Endangered (CR), Endangered (EN), Vulnerable (VU), Near Threatened (NT), Least Concern (LC), Data Deficient (DD), and Not Evaluated (NE). Traditional knowledge of medicinal plants was recorded based on their application in treating different diseases. The data collected was quantitatively analysed for Use Value (UV) as, given by Phillips *et al*. (1994) [38]:

$$UV = \sum U/n$$

Where 'U' is the number of use-reports cited by each respondent for a given species and 'n' refers to the total number of respondents. Use values are high when there are many use reports for a plant, implying that the plant is important and low use value indicates the minimum use of the species. The collected data, both on quantitative and qualitative, was analysed using Excel 2019, and SPSS version 16.0.

Results

A total number of 65 plant species (7 trees, 9 shrubs and 49 herbs) including 3 species of traditional crops/land races (*Triticum vulgare, Fagopyrum esculentum, Fagopyrum tataricum*) belonging to 32 families, used traditionally for ethnomedicinal purpose (Table 2). Out of the total 32 families recorded, Rosaceae was the dominant family with 8 species followed by Asteraceae, Polygonaceae and Liliaceae, 6 species each. The IUCN red list category indicated that 45% species were least concern followed by 19% Near Threatened and 12% not evaluated (Fig 3). The plant parts used for the treatment of different diseases include leaves (27%), fruits/seeds (26%), Roots (20%), stem (17%), whole plant (7%) and bark (3%) (Fig 4). Most of the plant species were used for treating various health issues such as digestive problems, stomach ache, colds and coughs, fever/ headache, cuts and wounds, hair and skin diseases, rheumatism, Kidney and liver diseases, jaundice, etc. The frequency of plant species used to treat diseases was also estimated, with a maximum of 21 plants used for stomach-ache and digestive problems, 17 for fever and headache, 13 for hair and skin diseases, and 1 for cold and cough (Fig 5).

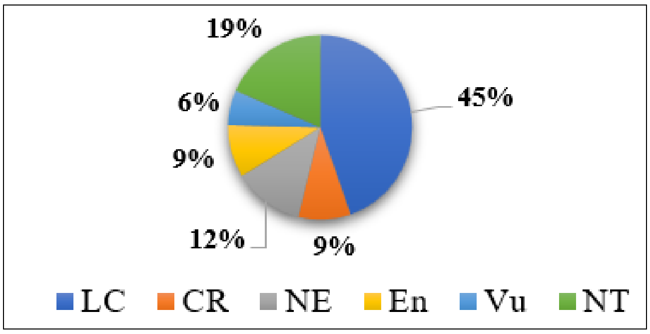

Fig 3: Conservation status of various plant species in study area (IUCN)

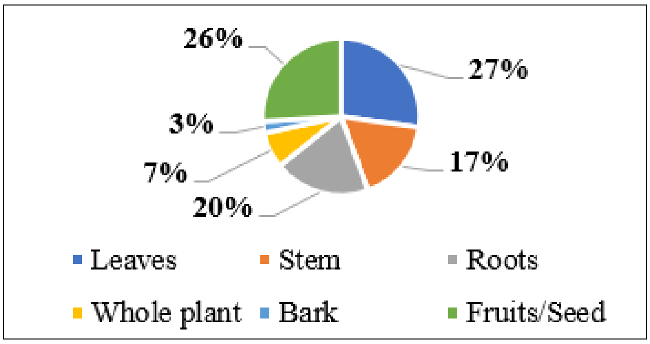

Fig 4: Parts of different plant species Used as medicine

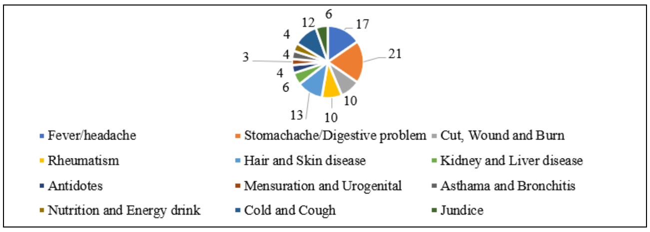

Fig 5: Plant species used to cure different diseases

The species with high use value (UV) are *Aconitum heterophyllum* (1.5), *Angelica glauca* (1.6), *Fagopyrum esculentum* (1.2), *Hippophae salicifolia* (1.5), *Fagopyrum tataricum* (1.2), *Ophiocordyceps sinensis* (1.3) which indicate that these are mostly used species for various purposes (Table 2). The formulation and application of medicinal plants often involved some sort of spiritual or ritual procedures. They used the plants/parts after obtaining prior permission of the local deity or old people residing in the area. The rural communities have also developed several indigenous and traditional methods for farming of most of the plants to conserve the agro-diversity with religious and cultural traditions. Besides providing staple food, these plants are also used in religious purposes and traditional healthcare (Table 2).

Table 2: Ethnobotanical uses and conservation status of plant species

Plant species with common name	Family	Altitudinal Range (m)	IUCN category	Uses	Parts used	Use value
			Trees			
Abies pindrow Royle (Wuman shin)	Pinaceae	2,500–3,600	LC	Cough and cold, Fresh leaves are mixed with honey in equal quantities and made into paste for treatment of cough and cold	Leaf	0.77
Betula utilis D. Don (Bhojpatra)	Betulaceae	3,000–4,000	LC	Fracture, wounds and cuts, Bark is used for plaster during fracture and used to cover wounds	Bark	0.91
Cedrus deodara (Roxb. ex D.Don) (Deodar)	Pinaceae	1,500-3,200	LC	Fever, inflammation, pain, the wood acts as an expectorant and is useful in curing piles, epilepsy, stones in the kidney and bladder, useful in fevers and many other disorders	Stem	0.61
Prunus armeniaca L. (Chuli)	Rosaceae	1,800–3,800	NE	Muscular pain, asthma Oil from seed is applied on joints	Seed	0.60
Pinus wallichiana A. B.	Pinaceae	2,200–3,600	LC	Wounds and cuts, rheumatic pain, resin is applied	Resin	0.69

Jackson (Galchuri)				on heel cracks, wounds, and rheumatic pain		
Rhododendron campanulatum D. Don (Burans)	Ericaceae	3,000-4,000	En	Cold, cough, headache, fever, rheumatism, sciatica, skin diseases roots are treating boils, leaves in alleviating cough, rheumatism, skin diseases, and syphilis	Root, Stem	0.64
Malus baccata (L.) Borkh. (Mohl)	Rosaceae	2,800–3,500	LC	Fever/headache, paste of fruit is applied on head	Fruit	0.44
Shrubs						
Berberis pseudumbellata Parker (Rasaut)	Berberidaceae	2,000–4,200	LC	Liver disorders root powder is used for liver disorders	Root	0.74
Cotoneaster microphyllus Wall. ex Lindl. (Bugarchilla)	Rosaceae	2,200-5,200	LC	Scabies, whole plant is having astringent property fruits are edible, leaves are used in treating scabies	Whole plant	0.60
Hippophae salicifolia D.Don (Chooku)	Elaeagnaceae	2,800–3,400	NE	Stomach ache, cold and cough, the juice of fruits is used to cure stomach ache	Fruit	1.5
Juniperus communis L. (Dhup/ Pamakshin)	Cupressaceae	2,800–4,400	LC	Skin ailments, leaf paste applied on skin disease and used as incense	Leaf	0.49
Jurinea dolomiaea Boiss (Lakkad dhup)	Asteraceae	2,800–4,400	LC	Fever, roots are stimulant and used to cure fever	Root	0.76
Prinsepia utilis Royle (Dunthali)	Rosaceae	1,200–2,700	LC	Rheumatism, muscular pain, seed oil applied to the affected area	Seeds	0.67
Rosa macrophylla Lindl. (Jangaligulab)	Rosaceae	2,000–2,700	NT	Herbal tea, petals of flowers are used to prepare herbal tea and sometimes squash	Leaf	0.53
Rosa sericea Lindl. (Shyaple)	Rosaceae	2,400–4,000	LC	Used as energy drink, flower juice is consumed in bowel complaints and salted tea prepared from root	Root	0.46
Rhododendron anthopogon D.Don (Burans)	Ericaceae	3,000-4,300	NT	Cold, cough, bronchitis The leaves and stem are used in treatment of bronchitis, cold and cough, digestive disorder, general weakness, inflammations, and skin diseases	Leaf, Stem	0.43
Herbs						
Aconitum heterophyllum Wall. ex-Royle (Atis)	Ranunculaceae	2,300-4,400	En	Antidote, food poisoning, fever, stomach ache Dried tuber is used as an antidote and for food poisoning. Powder is taken with hot water to cure fever, stomach ache	Tuber	1.50
Aconitum violaceum Jacq. ex-Stapf. (Vsastanabh)	Ranunculaceae	3,700–4,500	Vu	Rheumatism, the dried roots are boiled in water and used in very small doses	Root	0.89
Allium stracheyi Baker (Jambu)	Liliaceae	2,700-3,900	En	Cough, cold, stomach ache, jaundice, decoction of green leaves is used to cure cold, cough, and jaundice. Dry plant is frequently used as spice and condiments useful in stomach disorder	Leaf, Whole plant	0.74
Allium humile Kunth. (Ladum faran)	Liliaceae	2,800–4,200	NE	Stomach ache, cold and cough, jaundice, whole plant is frequently used as spice and condiments, and useful in stomach disorder, cold and cough	Whole plant	0.64
Allium wallichi Kunth. (Doona)	Liliaceae	2,800-4,300	NE	Altitude sickness, cholera, cough, and dysentery, bulb is used in the treatment of altitude sickness, cholera, cough, and dysentery	Bulb	0.74
Angelica glauca Edgew. (Chibbi)	Apiaceae	2,500–4,000	NT	Stomach ache, gastric problem, fresh or dried root is chewed to cure acidity and gastric ailments. The powder of root is taken with milk to cure dysentery	Root, Stem	1.64
Artemisia nilagirica (Clarke) Pamp. (Pankhima)	Asteraceae	2,400–3,500	LC	Skin disease, the juice of leaves and aerial parts is applied to treat skin disease	Leaf, Stem	0.50
Arnebia benthamii (Wall. ex G. Don) Johnst. (laljadi)	Boraginaceae	3,000–4,300	LC	Hair tonic, dry powder of root is mixed with hair oil	Root	0.57
Artemisia japonica Thunb. (Pati)	Asteraceae	2,500–3,500	NT	Blood clotting, leaves are ground and paste is used	Leaf	0.53
Bergenia stracheyi (Haworth) Sternberg (Bhepat/Pashanbhed)	Saxifragaceae	2,200–3,600	NE	Fever, kidney, and gall stones, dry rhizomes and root soaked in water overnight and the water taken to cure kidney and gall stone	Rhizome, Root	0.86
Bistorta affinis (D.don) Greene (Kukdi)	Polygonaceae	2,800–4,400	NE	Fever, root paste applied on forehead to control fever	Root	0.49
Carum carvi L. (Thoya)	Apiaceae	2,500-3,500	LC	Digestive problem, stomach ache, fever, roasted seeds are eaten with salt for gastric and digestive problem	Seeds	0.93
Cassiope fastigiata (Wall.) D.Don (Chung)	Ericaceae	3,000-4,500	NT	Itching, incense Whole plant is used to treat itching, and used as	Whole plant	0.59

				incense		
Dactylorhiza hatagirea D. DonSoo. (Hathajadi)	Orchidaceae	2,800–3,800	En	Wounds and cuts, fever Root paste is applied to treat wounds and cuts. The decoction of tuber used as tonic	Root, Tuber	0.97
Dioscorea deltoidea Wall. ex Kunth. (Ken jari)	Dioscoreaceae	1,200–2,500	NT	Constipation, urinogenital disorders, decoction of tuber with milk used to cure constipation. Boiled tubers taken in urinogenital disorders	Tuber	0.61
Ephedra intermedia Wall. ex-Stapf. (Somlata)	Ephedrraceae	3,200–4,000	LC	Rheumatism, juice extracted from shoots and used to cure joint pain	Stem	0.66
Fagopyrum esculentum Moench (Palti/Ogaal)	Polygonaceae	2,400–3,800	NT	Stomach ache, the grains are used to cure fever and all kinds of abdominal ailments. Juice of root is used for urinary disorder	Root, Seeds	1.3
Fagopyrum tataricum (L.) Gaertn. (Phaphar/Bhe)	Polygonaceae	2,400–3,800	NT	Headache, leaves are used in the treatment of fever and headache. Decoction of grains used to cure colic pain	Leaf	1.2
Fritillaria roylei Hook. (Kakoli)	Liliaceae	3,000–3,800	CR	Asthma, decoction of bulb used in treatment of asthma	Bulb	0.97
Fragaria nubicola (Lindl. ex-Hook.f.) Lacaita (Gand Kaphal)	Rosaceae	2,800-3,500	CR	Nutritive, mensuration, the juice of the plant is used to arrest excessive bleeding during mensuration	Whole plant	0.64
Geranium wallichianum D.Don ex Sweet. (Ratan jyot)	Geraniaceae	2,400–4,000	LC	Stomach ache, cold and cough, cuts, and wounds, decoction of leaves and leaf paste is used. Rootstock is used as tonic to reduce fatigue	Leaf, Root	0.46
Hordeum himalayens L. (Chama/Uwa)	Poaceae	2,400–3,800	LC	Digestive disorder, powder of grains is to improve digestion system	Seeds	0.77
Impatiens balsamina L. (Koel/Rose Balsam)	Balsaminaceae	1,000–2,800	NT	Rheumatism, leaves crushed and soaked in water to make paste and applied	Leaf	0.76
Iris kumaonesis D.Don ex Royle (Peupu)	Iridaceae	2,400–4,200	LC	Fever, constipation, liver complaints, the roots and the whole plant are used to cure scabies and various liver complaints	Whole plant	0.60
Lilium oxypetalum (D. Don) Baker (Sur)	Liliaceae	3,000–4,000	LC	Arthritis, muscular pain	Stem, Leaf	0.49
Nardostachys grandiflora DC. (Jatamasi)	Valerianaceae	3,000–4,200	CR	Jaundice, rheumatism, powder of rhizome is taken with warm water. Root paste with purified butter rubbed on the joints to cure rheumatism and used as incense	Rhizome, Root	0.96
Nepeta eriostachya Benth. (Balchari)	Lamiaceae	2,400–2,800	NE	Preventing hair loss, bark soaked in mustard oil used to cure hair loss	Bark	0.39
Oxyria digyna (L.) Hill (Chyakpalti)	Polygonaceae	2,400-5,500	LC	Nutritional and for appetizer, dysentery, whole plant is used as an appetizer and laxative, the leave is rich in vitamin-C, the cooked leaves stems and roots are eaten in case of dysentery	Leaf, Root	0.69
Ophiocordyceps sinensis (Nabu/keera ghas)	Ophiocordycipitaceae	Above 3,600	NT	Nutritional and energy, generally, it is market due to high cost however sometime used as tonic to reduce fatigue	Whole	1.3
Origanum vulgare L. (Ban Tulsi)	Lamiaceae	2,000–3,800	LC	Bronchitis, cold and cough, skin disease, tea is prepared using dry leaves. Leaf paste is applied for skin diseases	Leaf	0.50
Paris polyphylla Smith (Satwa)	Melanthiaceae	1,800–3,000	Vu	Antidotes, boils Paste of dried rhizomes used for treatment of boils and insect bites	Rhizome	0.54
Phytolacca acinosa Roxburgh. (Jurgyun)	Phytolaccaceae	1500-4300	NE	Antiasthmatic, antibacterial, locally the plant is used to get relief from body pain. Leaves and twigs are used as vegetable	Leaf	0.77
Picrorhiza kurrooa Royle ex Benth. (Kutki)	Scrophulariaceae	2,800–4,000	En	Fever, jaundice and stomach ache stem/root dipped in water for an hour and the water is used to cure stomach ache. Dried roots and rhizomes are used as blood purifier and liver tonic	Stem, Root	0.91
Plantago himalaica Pilg. (Isabgol)	Plantaginaceae	2,800–3,500	LC	Digestive disorder, dried leaves used with water or curd	Leaf	0.50
Podophyllum hexandrum Royle (Burkhalo/ Bankakri)	Podophyllaceae	3,200–3,500	En	Blood purifier, skin disease, cuts, and wounds, decoction of root used to cure fever, purify blood and fruits applied on wound and cuts	Root, Fruit	0.56
Polygonatum verticillatum (L.) Alloni (Mahamaida/ Khakan)	Liliaceae	2,600–3,800	Vu	Used as tonic, cold and cough, fever, root powder taken with water as a tonic and to cure skin disease	Root	0.57
Potentilla cuneata Wall. ex Lehm. (Bajardanti)	Rosaceae	2,500–3,000	LC	Tooth ache and pyorrhoea, paste of root used as an ointment around the infected teeth	Root	0.50
Parnassia nubicola Wall.	Parnassiaceae	3,000–3,700	LC	Wounds, cuts, insect/snake bites, root paste is	Root	0.64

ex-Royle (Nirbisi)				applied on wounds and cuts		
Rheum webbianum Royle. (Dolu)	Polygonaceae	3,000–4,000	Vu	Wound and cuts, leaf powder is mixed with mustard oil and applied externally to treat boils, cuts, and wounds	Leaf	0.54
Rumex nepalensis Spreng. (Thonkalya)	Polygonaceae	2,500–4,600	NT	Diarrhea, dysentery, skin disease, decoction of leaves is used to cure skin disease	Leaf	0.47
Saussurea costus (Decne.) Sch.-Bip. (Kuth)	Asteraceae	2,500–3,600	CR	Cold and cough, asthma, bronchitis, dysentery, fever, rheumatism, rhizome is used along with *Picrorhiza kurroa* to cure various diseases	Rhizome	0.51
Satyrium nepalense D.Don (Salam-mishri)	Orchidaceae	1,500-4,000	LC	Aphrodisiac, Diarrhea, rhizome is widley used as an aphrodisiac, it has antidiarrheal property	Rhizome	0.67
Saussurea costus (Falc.) Lipsch. (Kuth)	Asteraceae	2,000-3,800	CR	Cramps, headache, mental diseases, snake poisoning, in Ayurveda roots are used in treat cramps, headache, metal diseases, snake poisoning and used for swelling, stomach-ache, irregular mensuration, breathing troubles, rheumatism, skin disorder, ulcers, and toothache	Root	0.50
Silene vulgaris (Moench) Garcke (Khushu)	Caryophyllaceae	2,700–4,000	LC	Washing agent, hair problems, roots are crushed into powder form for washing hair	Root	0.54
Swertia chirata Buch.-Ham. ex-Wall. (Chiretta)	Gentianaceae	3,000-4,200	CR	Fever, constipation, upset stomach, loss of appetite, intestinal worms, skin diseases, whole plant is frequently used as medicinal purpose.	Whole plant	0.97
Taraxacum officinale Weber ex Wiggers (Beera Phool)	Asteraceae	2,200–3,800	LC	Liver ailments, jaundice, fever, juice of leaves is taken as blood purifier. Root infusion used to treat jaundice and fever.	Leaf, Root	0.79
Thalictrum minus L. (Mamira)	Ranunculaceae	2,000–4,000	LC	Liver disorder, fever, constipation, roots are sundried and powder used to cure liver disorders and constipation	Root	0.67
Thymus linearis Benth. (Balama)	Lamiaceae	2,000–3,000	LC	Eye complaints, cuts, and wounds, whole plant is used to prepare local beverage and to cure skin disease	Whole plant	0.60
Triticum vulgare L. (Nappal)	Poaceae	2,800–3,800	NT	Burns and boils, paste of grain applied on burn	Seeds	0.54

En; Endangered species, Vu; Vulnerable, NE; Not Evaluated, NE; Near threatened, LC; Least concern, CR; Critically endangered

In low-income category, the highest proportion of per house hold was recorded in Gunji village (24%), followed by Napalchu and Kuti villages (20% each), while the lowest proportion was observed in Garbyang and Roungkong villages (12% each). In high-income category, the highest proportion of per house hold was recorded in Roungkong and Garbyang villages (88% each), followed by Nabi and Budi villages (84% each), while the lowest proportion was observed in Gunji (76%) (Table. 3). The highest proportion of households engaged in agriculture and animal husbandry was observed in Napalchu and Kuti villages (20% each), followed by Gunji and Nabi villages (16% each), while the lowest was recorded in Budi village (8%). The highest proportion of households engaged in business was observed in Garbyang (72%), followed by Nabi (44%), while the lowest was recorded in Gunji (4%). The highest proportion of households engaged in government sector was observed in Kuti (28%), followed by Budi and Gunji villages (20%), while the lowest was recorded in Garbyang (10%). The highest proportion of households engaged in both agriculture and business was observed in Gunji (60%), followed by Budi and Roungkong villages (40% each), while the lowest was recorded in Garbyang (6%) (Table. 4.26). The highest proportion of housholds using the first combination LPG, kerosene stove, fuelwood, and solar was observed in Budi (24% each), followed by Garbyang (23%), while the lowest was recorded in Gunji village (8%). The highest proportion of housholds using the second combination fuelwood, kerosene stove, and solar energy was observed in Gunji (92%), followed by Napalchu and Roungkong villages (84% each), while the lowest was recorded in Budi village (76%) (Table. 3).

Table 3: Income, source of income and energy

Income %	Budi	Garbyang	Napalchu	Gunji	Nabi	Roungkong	Kuti
0-30,000 (low income)	16	12	20	24	16	12	20
Above 30,000 (High income)	84	88	80	76	84	88	80
Source of Income %							
Agriculture + animal Husbandry	8	12	20	16	16	12	20
Business	32	72	28	4	44	32	28
Government sector	20	10	16	20	12	16	28
Both Agriculture and Business	40	6	36	60	28	40	24
Energy %							
L.P.G + Kerosene Stove + Fuelwood + Solar	24	23	16	8	20	16	20
Fuelwood + Kerosene Stove + Solar	76	77	84	92	80	84	80

The highest fuelwood consumption/kg/HH/Migratory cycle was recorded in Budi (5675 ± 157) followed by Garbyang (5178 ± 124.23) while lowest was recorded in Kuti (4710 ± 156.4). The highest medicinal plant collection/kg/HH/Migratory cycle was recorded in Nabi (7.23 ± 0.50) followed by Garbyang (6.7 ± 0.42) while lowest in Budi (5.5 ± 0.33) (Table. 5). In the medium family category, the highest fuelwood consumption/kg/HH/Day/Migratory cycle was recorded in Kuti (7.6 ± 0.33) followed by Napalchu (7.44 ± 0.29) while the lowest was observed in Budi (6.6 ± 0.26). The highest fuelwood consumption/capita was recorded in Napalchu (4.93 ± 0.15) followed by Budi (4.81 ± 0.13) while lowest recorded in Roungkong (4.51 ± 0.13). The highest fuelwood consumption/kg/HH/Migratory cycle was recorded in Budi (6009 ± 62.94) followed by Nabi (5800 ± 93.8) while lowest was recorded in Roungkong (5580 ± 131). The highest medicinal plant collection/kg/HH/Migratory cycle was recorded in Nabi (7.3 ± 0.57) followed by Napalchu (6.88 ± 0.75) while lowest in Roungkong (5 ± 0.61) (Table. 4.4.6). In the large family category, the highest fuelwood consumption/kg/HH/Day/Migratory cycle was recorded in Napalchu (8 ± 1) followed by Kuti (8 ± 0.57) while the lowest was observed in Garbyang (6 ± 0.31). The highest fuelwood consumption/capita was recorded in Kuti (3.67 ± 0.1) followed by Napalchu (3.65 ± 0.3) while lowest recorded in Roungkong (3.38 ± 0.4). The highest fuelwood consumption/kg/HH/Migratory cycle was recorded in Napalchu (6219 ± 81) followed by Budi (6218 ± 37.2) while lowest was recorded in Garbyang (5760 ± 360). The highest medicinal plant collection/kg/HH/Migratory cycle was recorded in Roungkong (7.3 ± 0.88) followed by Budi (6.5 ± 0.9) while lowest in Garbyang (4.5 ± 0.5) (Table. 4).

Table 4: Fuelwood and medicinal plant collection and consumption by different village

Small Family	Budi	Garbyang	Napalchu	Gunji	Nabi	Rounkong	Kuti
Fuelwood consumption/kg/HH/Day/ Migratory cycle	5.5 ± 0.4	6.6 ± 0.34	7.07 ± 0.30	6.5 ± 0.43	6.9 ± 0.41	7.2 ± 0.41	6.8 ± 0.24
Fuelwood consumption/capita	6.54±0.16	6.26 ± 0.14	6.51± 0.20	6.7 ± 0.25	6 ± 0.20	6.3 ± 0.34	6 ± 0.17
Fuelwood consumption/kg/HH/Migratory cycle	5675 ± 157	5178 ± 124.23	4839.4 ± 181	4794.5 ± 161.5	4604.7 ± 209	5022 ± 132.6	4710 ± 156.4
Medicinal plant collection/kg/HH/Migratory cycle	5.5 ± 0.33	6.7 ± 0.42	6.07 ± 0.41	6.09 ± 0.47	7.23 ± 0.50	5.7 ± 0.3	6.7 ± 0.39
Medium Family							
Fuelwood consumption/kg/HH/Day/ Migratory cycle	6.6 ± 0.26	6.9 ± 0.45	7.44 ± 0.29	6.8 ± 0.35	6.7 ± 0.27	7.16 ± 0.44	7.6 ± 0.33
Fuelwood consumption/capita	4.81 ± 0.13	4.64 ± 0.20	4.93 ± 0.15	4.68 ± 0.12	4.7 ± 0.14	4.51 ± 0.13	4.8 ± 0.12
Fuelwood consumption/kg/HH/migratory cycle	6009 ± 62.94	5796 ± 139	5780 ± 105.8	5616 ± 177.5	5800 ± 93.8	5580 ± 131	5616 ± 116
Medicinal plant collection/kg/HH/Migratory cycle	5.9 ± 0.53	6.2 ± 0.71	6.88 ± 0.75	6.1± 0.48	7.3 ± 0.57	5 ± 0.61	6.1± 0.60
Large Family							
Fuelwood consumption/kg/HH/Day/ Migratory cycle	7.33 ± 0.33	6 ± 0.31	8 ± 1	7.25 ± 0.75	6.7 ± 0.33	7.6 ± 0.33	8 ± 0.57
Fuelwood consumption/capita	3.5 ± 0.2	3.55 ± 0.3	3.65 ± 0.3	3.39 ± 0.1	3.57 ± 0.1	3.38 ± 0.4	3.67 ± 0.1
Fuelwood consumption/kg/HH/migratory cycle	6218 ± 37.2	5760 ± 360	6219 ± 81	6194.7 ± 147.5	6000 ± 158.7	6180 ± 120	5940 ± 41
Medicinal plant collection/kg/HH/Migratory cycle	6.5 ± 0.9	4.5 ± 0.5	5 ± 1	5.25 ± 0.47	5 ± 0.57	7.3 ± 0.88	6.3 ± 0.88

The income from medicinal plants was highest in Budi (₹4000 ± 150), followed by Grabyang (₹3310 ± 220) and Kuti (₹3300 ± 140). The lowest income was recorded in Gunji (₹2563 ± 123). Nabi (₹3412 ± 108) reported the highest agricultural income. The lowest was observed in Gunji (₹1800 ± 234). Moderate agricultural returns were seen in Grabyang (₹2644 ± 145) and Nappalchu (₹2563 ± 57). The highest income from livestock rearing was recorded in Grabyang (₹3900 ± 343), followed by Gunji (₹3560 ± 56) and Kuti (₹3315 ± 145). The lowest income was found in Rounkong (₹2600 ± 124). Grabyang (₹5512 ± 135) generated the highest horticultural income, followed by Budi (₹4200 ± 209) and Nabi (₹3612 ± 107). Kuti (₹1200 ± 123) recorded the lowest income (Table. 5).

Table 5: Annual economic value of ecosystem services in Indian rupees

Villages	Medicinal plants	Agriculture	Animal husbandry	Hoticulture
Budi/HH/Migratory cycle	4000±150	2300±250	1312±212	4200±209
Grabyang/HH/Migratory cycle	3310±220	2644±145	3900±343	5512±135
Nappalchu/HH/Migratory cycle	3215±230	2563±57	3000±124	2900±52
Gunji/HH/Migratory cycle	2563±123	1800±234	3560±56	4033±123
Nabi/HH/Migratory cycle	3012±127	3412±108	3104±112	3612±107
Rounkong/HH/Migratory cycle	2903±85	1907±117	2600±124	2301±114
Kuti/HH/Migratory cycle	3300±140	2300±121	3315±145	2145±102

Discussion

Uttarakhand is that state mainly dominated by the mountain region. The mountain people traditionally use the plant biodiversity for various purpose including the livelihood of the people. The mountain part is rich of biodiversity and exploited by local inhabitants from time-to-time agriculture is the nucleus, all the human activities in lower valley while animal husbandry and rainfed agriculture at higher elevation most of the human population concentrated up to 2000 m elevation beyond this few people are residing. The occupation of high elevation people is marginal agriculture with animal-based economy. These people depend on plant biodiversity for their daily needs. The Presence of least medical facility made these people dependent on herbal healers for the cure of various diseases. Preparation of plant extract generally made by boiling of plant parts in water, or by crushing the plant pieces with a mortar and pestle (Kala 2005; Negi *et al*. 2010; Malik *et al*. 2015; Negi *et al*., 2018 [33]). Some plant pastes can also be applied topically to relieve muscle soreness or to set shattered or dislocated bones. For example, a crack covered with *B. utilis* bark is plastered with *Pinus wallichaina* resin. For optimal effects, it is advised to use certain herbs on an empty stomach. The knowledge of many important medicinal plants remained confined to Amchi, who hold knowledge on the correct timing of collection, the parts to be used, storage techniques, and methods of preparation. With high use value, these species even remain in high demand at local level, not only in the Byans valley but throughout the Indian Himalayan Region (IHR). This implies that the wild populations of such species are under severe threat of indiscriminate harvesting. Consequently, their number and abundance in nature have declined and several such species have entered various degrees of threat (Uniyal and Shiva 2005). The traditions of these civilisations have shown that biological variety and traditional knowledge are closely related, and that the loss of one lead to the loss of the other have highlighted the conservation values of these sacred sites/groves. Biodiversity and the naturalness of sacred landscapes in the Byans valley namely, Hya-Roshe bugyal (alpine) near village Napalchu (3400 m asl), sacred forest near Rongkong (3400), Putuk-tu bugyal (alpine) and Pandav kutti near the village of Kuti (4000 m asl), is thus protected through deep rooted socio-cultural belief systems, as also reported in earlier studies (Negi 2010 [31]; 2015 [32]; 2018). Numerous endangered plant species, including uncommon medicinal plants, can be found in these sacred forests and pastures that are abundant in biological diversity. Offering certain locations to deities has long been shown to be beneficial for preserving biodiversity, and it may serve as a model for creating plans for the sustainable use, preservation, and management of finite bioresources. This would necessitate a thorough comprehension of the beliefs and attitudes that communities hold when placing locations under this kind of protection (Negi *et al*. 2018) [33]. A significant positive correlation with age and number of known uses suggests a decline in interest by younger generations (<50 age group) on these important resources in (Fig 6).

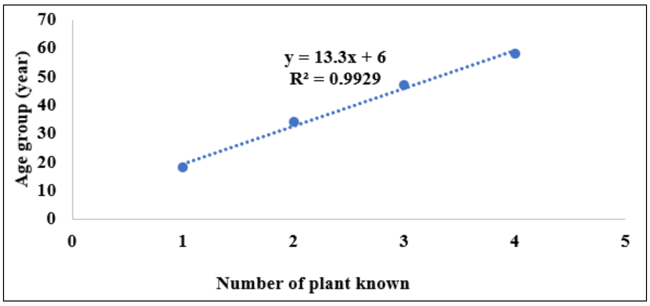

Fig 6: Relationship between age group and number of species known to the informants

This also indicates the changing priorities of youth. Accumulation of greater knowledge with older people (>70 years) is serious concern, which is likely to remain with this generation if not transferred adequately to the younger generation. This loss of knowledge may have serious implications by way of tapering the resource base for developing various pharmaceutical formulations (Negi *et al*., 2018) [33]. Declining traditional knowledge of underutilized medicinal plants and the process of making herbal formulations among the young generation agrees with earlier studies (Raut, Adhikari, and Rawat 2012 [41]; Nijar 2013 [35]; Ezuruike and Prieto 2014 [10]; Malik *et al*. 2015; Ngarivhume *et al*. 2015 [34]; Negi *et al*. 2018 [33]). Considering the serious threat of complete loss of such a rich heritage of information restricted to only higher age groups, there is an urgent need for attention and progressive exposure at government level. The values of the factor informant consensus were on the higher side suggesting that the informants particularly >50 age group do share ethnobotanical knowledge. This is a good sign for possible protection of this precious knowledge base with minimal effort. However, to document, conserve and maintain this knowledge and conserve the unique biodiversity, collective efforts are required from non-governmental organizations, government authorities, ethnobotanists, and the pharmaceutical industries. In addition to sacred groves, temples dedicated to local deities are surrounded by several tiny sections of pasture or forest, and harvesting is strictly prohibited there. Local people firmly believe that if they cut or the condition plants from sites of worship, the deity may punish them in some way. The decision to worship the local deity to gain permission to use these resources is made by consensus when there is an urgent need or clear justification for harvesting from such sacred groves. Additionally, the community does not chop shrubs or seedlings of tree species bound with red and white robes. This is an additional form of defence that most likely would have developed with sociocultural customs. As a result, the community has preserved several plant and tree species at various valley places. It is a religious practice to erect miniature temples and places of devotion beneath ancient *A. pindrow* trees because the surrounding vegetation is not chopped down for any reason. In Kumaun Himalaya, it is commonly known that the natural riches found within a temple's boundaries are attributed to the relevant deity (Sharma, Rikhari, and Palni 1999; Farooquee, Majila, and Kala 2004; Negi 2010; Singh *et al*. 2014; Negi 2015) [47, 11, 31, 49, 32].

Conclusion

The ethnobotanical practices of the Byans Valley in Kumaun Himalaya, India, play a crucial role in biodiversity conservation and sustainable resource management. Traditional knowledge, passed down through generations, has enabled local communities to utilize plant resources for medicinal, cultural, and subsistence purposes while maintaining ecological balance. The findings highlight the intricate relationship between indigenous practices and biodiversity preservation, emphasizing the need for documentation and integration of traditional wisdom with modern conservation strategies. However, challenges such as habitat degradation, climate change, and socio-economic transformations threaten these age-old practices. To ensure the sustainability of both biodiversity and ethnobotanical knowledge, collaborative efforts involving local communities, researchers, and policymakers are essential. Further research and policy interventions should focus on fostering community-led conservation approaches that uphold both ecological and cultural heritage in the region.

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