

Ethno-medicinal plants used by JadhBhotiya Community of District Uttarakashi, Uttarakhand, India

Usha Devi^{1,2}, Ajendra Singh Bagri^{2,*}, Atal Bihari Bajpai¹

¹Department of Botany, DBS (P.G.) College Dehradun-248001, Uttarakhand, India

²Department of Botany & Microbiology, HNBGU Srinagar Garhwal- 246174, Uttarakhand, India

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

Received: 8 November 2023 / Accepted: 4 December 2023

Abstract. In the present study, our aim was to document the traditional knowledge regarding ethno-medicinal plants used by the Jadh-Bhotiya community in the Uttarakashi district (Uttarakhand, India). A total of 54 taxa, belonging to 49 genera and 31 families, were recorded with medicinal properties. Lamiaceae, Liliaceae and Orchidaceae were the dominant families (in terms of number of species), while the top genera included *Berberis*, *Habenaria*, *Malaxis* and *Polygonatum*. Herbs constituted the dominant life form (82%), followed by shrubs and trees (9% each). Roots (20%) and the whole plant (13%) showed a higher proportion of use for medication. Powder (33%) and paste (20%) were the most frequently used drug preparation methods. Regional conservation assessment analysis revealed that 76% of the species were recorded under the 'Least Concern' (LC) category, followed by 'Vulnerable' (VU) with 13% of the species, and 11% of the species were recorded under the 'Near Threatened' (NT) category. *Aconitum heterophyllum*, *Arnebia benthamii*, *Nardostachys jatamansi*, *Rheum australe*, *Saussurea obvallata* and *Taxus wallichiana* were recorded under the 'Near Threatened' (NT) category. *Angelica glauca*, *Carduus edelbergii*, *Dactylorhiza hatagirea*, *Ephedra Gerardiana*, *Lilium polyphyllum*, *Malaxis acuminata*, and *Malaxis muscifera* were recorded under the 'Vulnerable' (VU) category, while the remaining species were recorded under the 'Least Concern' (LC) category. The knowledge about therapeutic information concerning plants in the study area and elsewhere is diminishing day by day. Regional-level conservation status of plant species can be helpful in the global conservation status assessment. It is recommended that conservation measures be applied for the betterment of those species falling under various conservation categories, especially the threatened ones. Additionally, more ethno-medicinal studies are recommended in such remote regions to further enhance our understanding of traditional medicinal practices and contribute to the conservation of indigenous plant knowledge.

Keywords: Uttarakashi; Jadh-Bhotiya; ethno-medicine; traditional knowledge; conservation status.

1. Introduction

The Indian Himalayan region is renowned for its diverse plant wealth and is considered one of the biodiversity hotspots, encompassing the trans-Himalaya, eastern Himalaya and western Himalaya. Historically, the human population in these areas primarily resided in villages. However, in recent years, larger villages have been transformed into small towns, and residents now embrace modern products and facilities. Despite this modernization, the local communities still heavily rely on natural resources for their daily needs, such as fuel, fodder, medicine, and more. In India, there are approximately 68 million people belonging to 227 ethnic groups, constituting 573 tribal communities (Bhatt et al., 2009). Among these, four tribes

(*Tharus, Buxas, Rajis, and Bhotias*) inhabit the Uttarakhand region (northern part of India). The *Bhotia* tribe resides in remote regions near forests, relying on nature for their fundamental life requirements. The Uttarakhand state is home to eight major Bhotia groups: *Johari, Juthora, Darmi, Chudans, Byansi, Marccha, Tolcha, and Jad* (Bhatt et al., 2009). The tribal population of the *Bhotia* community accounts for 8.13% and occupies approximately 18.70% of the country's area (Bhatt et al., 2009). It is believed that the '*Bhotias*' are a transhumant community of semi-Mongoloid people of Tibetan origin (Fuchs, 1982). These communities maintain close interactions with the forest, drawing their economic livelihood and often shaping their cultural and spiritual identity from it. In the broader context, about 70% of the Indian population resides in rural areas, with many living in proximity to forests and utilizing various plant parts for food, medicines, and various other purposes essential to their daily livelihood. Indian people have been utilizing medicinal plants since the prehistoric period (Singh & Lahiri, 2010). Traditional medicine holds significant importance and constitutes approximately 40% of all health care delivered (WHO, 2002-2005). It is noteworthy that about 85% of traditional medicines are derived from plants (Farnsworth, 1988).

Almost every section of the Indian population uses plants as medicine, with approximately 7500 plant species being employed by various ethnic communities. Tribal communities, in particular, collect and preserve locally available wild and cultivated plant species, practicing herbal medicine to treat a variety of diseases and disorders. Villagers from these tribes or communities are migratory shepherds, necessitating their residence in forests during migrations from one place to another. Migration, defined as the movement of people either seasonally, temporarily, or permanently, poses dangers along the migratory routes from both tracking and climatic perspectives. Injuries and other health issues may arise during these journeys. It is believed that the fore-bearers of these people used plants for medicinal purposes, and over time, they refined their practices, incorporating these plant resources into their daily lives for survival. Through successive generations, selected plants became ingrained in their memories, evolving into traditions passed down from older generations. However, with the advent of modern civilization, this traditional knowledge of plant use is on the verge of extinction. Modern medication, with its quick effects and rapid healing properties, has led individuals to gravitate towards contemporary medical practices, contributing to the decline of traditional plant-based remedies. In developing countries, there is a growing effort to integrate traditional medicines, particularly herbal preparations, into local healthcare systems. Many modern researchers are currently engaged in exploring the vast potential of ethno-botanical knowledge for treating various diseases (Kala, 2005; Dutta & Dutta, 2005; Jeyprakash et al.,

2011; Jain et al., 2010). However, the ethno-medicinal plants face threats due to deforestation, overgrazing, and their reckless utilization, highlighting the urgent need for conservation. The conservation of biological resources, coupled with their sustainable use, plays a crucial role in preserving traditional knowledge (UNU-IAS, 2013). Despite a flurry of research on the use and status of medicinal plants in various parts of the state and nation, there has been no scientific documentation in the Jadh-Bhotiya community of the Uttarakashi region to date. Consequently, we designed this study to survey the use of medicinal plants among the tribal people of the Jadh-Bhotiya community in the district of Uttarakashi. The aim is also to assess the current status of medicinal plants in this area through an intensive survey.

2. Material and method

2.1. Study area

The Uttarakashi district is situated in the upper Himalayas, encompasses diverse geographic environments, ranging from snow-free valleys and outer hills to high peaks adorned with perpetual snow and glaciers. The terrain is characterized by a series of ridges and valleys, each ridge leading to another in seemingly endless chains. Uttarakashi is an ancient place with a rich cultural heritage, often revered as the ‘Kashi of the Uttara (north)’, holding a status almost as high as the ‘Kashi of the Varanasi’. Notably, both the ‘Kashi of the plains (Varanasi)’ and the ‘Kashi of the north’ are located on the banks of the river Ganga (Bhagirathi). The sacred region known as ‘Uttarakashi’ is situated between the rivers Syalam Gad, also known as the ‘Varuna’, and Kaligad, also known as the ‘Asi’. Remarkably, ‘Varuna’ and ‘Asi’ are also the names of the rivers between which the ‘Kashi of the plains’ is located. One of the holiest Ghats in Uttarakashi is ‘Manikarnika’, sharing the same name as the one in ‘Varanasi’, and both have temples dedicated to ‘Vishwanath’. Uttarakashi is the birthplace of two great and revered rivers in India: the Bhagirathi, known as the Ganga in the plains, and the Yamuna. The Ganga originates in the glaciers of ‘Gaumukh’, traversing 128 kilometers in Uttarakashi district before flowing downstream. Another significant river in this district is the ‘Ton’s, along with a multitude of tributaries that drain these areas.

The district is bounded on the north by Kinnaur and Shimla districts of Himachal Pradesh, on the northeast by Tibet, on the east by Chamoli district and the southeast by Rudraprayag district on the south by Tehri Garhwal district and on the west by Dehradun district. The district is situated between the coordinates 30°43' 59" N- 30°43' 99" N to 78°26'23" E -78°26'39" E. The area receives heavy (64.5–124.4 mm) to very heavy rainfall intensity

(124.5–244.5 mm) during the monsoon period with average annual rainfall of the district ranging from 921 mm to 1817 mm. The temperature in the district remains pleasant during the summer season, but in winter the temperature falls down to zero degrees in some regions. June is the warmest month of the year with the temperature (average 30.2° C). The lowest temperature (average -0.3° C) in the year occurs in January.

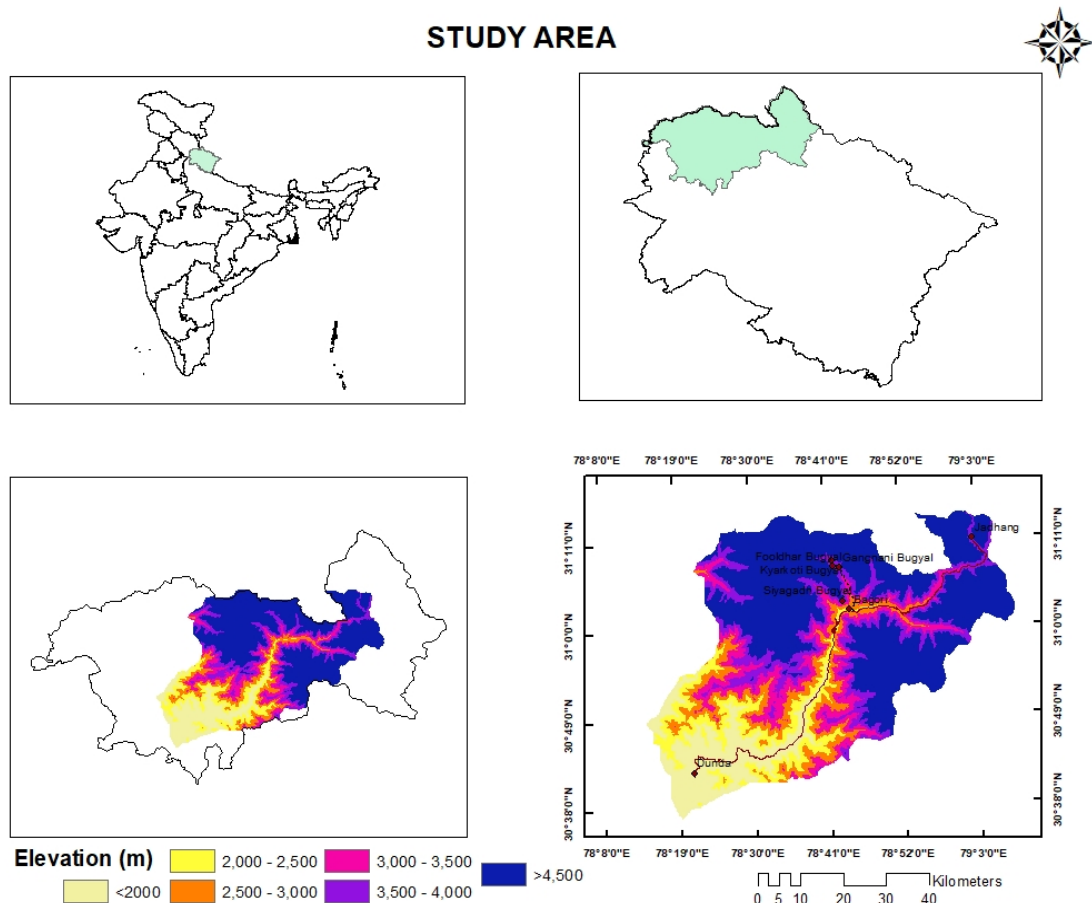


Figure1. Map of the study area

2.2. Plants collection, identification and assessment of conservation status

Field surveys were conducted to gather traditional knowledge about the utility of ethno-medicinal plants in the study area. A random sampling method was employed, and data were collected from various indigenous groups in the region. Personal talks and interviews were organized with individuals from different age groups, prominent traditional healers (referred to locally as Dayi), and plant experts. Written questionnaires were prepared, and verbal explanations in the local dialect (Garhwali) were provided for effective communication with informants. Prior consent was obtained from all informants. Sampling was carried out during the peak growing season, spanning from May to September. This period was chosen because, during these months, local and tribal people typically move towards higher regions with their

livestock. This made it convenient to accompany people into natural areas, enabling the identification and documentation of ethno-medicinal plants. Both in-situ and ex-situ approaches to interviewing were utilized, each having its own advantages and limitations. Combining these two methods logically provides the most comprehensive and accurate information (Thomas et al., 2007). During the field visits, plant specimens were photographed and collected. They were then pressed and dried following the standard herbarium techniques. Following the collection of plant specimens, the identification process was conducted using standard taxonomic literature, including references such as Naithani (1984-85), Gaur (1999), Pusalkar and Singh (2012), and Pusalkar et al. (2018). The collected plant species' specimens were submitted to the Garhwal University Herbarium (GUH), and voucher numbers were assigned for reference. To ensure accuracy, the accepted names of the collected specimens were cross-checked with databases such as 'The Plant List,' Tropicos, and Plants of the World, accessible at <https://theplantlist.org>, <https://www.tropicos.org>, and <http://www.plantsoftheworldonline.org>.

The regional conservation status (CS) of plant species was analyzed using the approach outlined by Shah et al. (2019).

$$\text{Conservation status (CS)} = K (\text{OC} + \text{AV} + \text{CE}) / \text{TF} \times \text{RP}$$

where, OC = Occurrence, AV = Availability, CE = Conservation efforts by locals, TF = Threatening factors, RP = Regeneration potential of species in a particular habitat. The constant K was assigned a value of 1. The degree of occurrence (OC) was assessed by assigning values of 3 for abundant, 2 for moderate, and 1 for rare occurrences. Availability (AV) values for the last ten years were assessed as 3 for increasing, 2 for persistent, and 1 for decreasing. The four most cited conservation efforts by locals were considered in the equation, with each conservation effort assigned a value of 1, resulting in a sum of 4. These conservation efforts include protection from grazing, cutting, fire, and cultivation of a plant species. For threatening factors (TF), values were assigned based on local perception. Each threatening factor received a value of 3 for extensive, 2 for moderate, 1 for low, and 0 for the absence of a threatening factor. The threatening factors considered in this formula were over-exploitation, fire, and overgrazing/over-browsing. Similarly, values assigned to regeneration potential (RP) were 3 for high, 2 for moderate, and 1 for low.

A total of 54 culturally significant plant species in the study area were assessed using the Conservation Status (CS) equation to quantify local wisdom. To interpret the CS index values, a scale was devised for assessing conservation categories for the flora under investigation. Based on the CS index values, plant species were categorized into 'Critically

Endangered' (CR), 'Endangered' (EN), 'Vulnerable' (VU), 'Near-Threatened (Rare)' (NT) and 'Least Concerned' (LC) (Shah et al., 2019, Table 1).

Table 1. Scale for the regional conservation status categories (Shah et al., 2019).

Name of Category	CS index values
Critically endangered	0.1 to 1
Endangered	1.1 to 1.5
Vulnerable	1.6 to 2.0
Near threatened	2.1 to 2.5
Least concern	2.6 and above

4. Results

4.1. Ethno-medicinal plants

A total of 54 plant species belonging to 49 genera and 31 families were recorded having medicinal properties (Table 2).

Table 2. Ethno-medicinal plants with part used, mode of drug, preparation method and their regional conservation status.

Botanical name/ Family	VN	LF	Part used	Disease cured	Mode of drug	Mode of preparation	CSI Value s	CC
<i>Aconitum heterophyllum</i> Wall. ex Royle/ Ranunculaceae	Atees	H	Tuber	Fever, stomach ach	Powder	1 teaspoon powder of dried tuber is taken orally with lukewarm water thrice a day for treatment of fever and stomach ache.	2.33	NT
<i>Aesculus indica</i> Wall. Ex Cambess.)Hook./ Hippocasteneaceae	Pangar	T	Seeds	Rheumatism	Paste	1 teaspoon powder of dried seed is given with lukewarm water twice a day against rheumatism.	4	LC
<i>Ajuga bracteosa</i> Wall. ex Benth./ Lamiaceae	-	H	Whole plant	Diabetes	Powder	Powder of whole plant is prepared and 1 teaspoon powder is taken with warm water to cure diabetes.	4	LC
<i>Allium sativum</i> L./ Liliaceae	Lasan	H	Bulb	Cardiac disorders, diabetes	Raw	1-2 pieces of bulb eaten raw early morning to control cholesterol and diabetes.	8.33	LC
<i>Angelica glauca</i> Edgew./ Apiaceae	Chura	H	Root	Stomach disorder	Powder	½ teaspoon powder of dried root is taken with a glass of water twice a day for 4-5 days against stomach disorders	2	VU
<i>Ariseama tortusum</i> (Wall.) Schott./ Araceae	Nag- chhatri	H	Leaves	Disinfectant	Decoction	Decoction of leaves is prepared and used as a disinfectant with a mop.	2.67	LC
<i>Arnebia benthamii</i> (Wall.ex G.Don) I.M. Johnst./ Boraginaceae	Bal-jari	H	Root	Cut and wounds	Paste	Paste of fresh or dried roots is applied on cuts and wounds and used as antiseptic.	2.33	NT
<i>Artemisia gmelinii</i> Weber ex Stechm./ Asteraceae	Ganga-tulsi	H	Whole plant	Skin diseases and ulcer	Powder and paste	Paste of whole plant is prepared and applied against the skin diseases. Powder of whole plant is taken with like warm water to cure ulcer.	11	LC

<i>Berberis aristata</i> DC./ Berberidaceae	Chuchid	S	Bark, Root	Snake bite	Decoction	1 glass root and bark decoction is taken orally once a day for 3-5 days against snake bite. Cats also used its root against the snake bite.	4	LC
<i>Berberis chitria</i> Ahrendt/ Berberidaceae	Kilmore	S	Root	Eye problems	Decoction	Root decoction is prepared and 1-2 drops are used against eye problems.	4	LC
<i>Berberis lyceum</i> Royle/ Berberidaceae	Kingore	S	Root	Jaundice and hepatitis	Decoction	1 glass root decoction is taken orally once a day for 3-5 days against jaundice and hepatitis.	9	LC
<i>Bergenia ciliata</i> (Haw.) Sternb./ Saxifragaceae	Patharchatt a	H	Roots	Kidney stone, abdominal disorders	Powder	½-1 teaspoon powder of dried root taken twice with a glass of lukewarm water is used to cure kidney stone and abdominal disorders.	6	LC
<i>Cannabis sativa</i> L./ Cannabaceae	Bhangla	H	Bark, Leaves	Bone dislocation, asthma, rheumatism	Decoction	1 glass leaves and barks decoction is taken orally against bone dislocation, asthma and rheumatism.	6	LC
<i>Capsicum annum</i> L./ Solanaceae	Mirch	H	Fruit	Rabies, snake bite	Paste, powder	Paste applied against snake bite and 1 teaspoon powder taken with lukewarm water against rabies.	9	LC
<i>Carduus edelbergii</i> Rech.f./ Asteraceae	-	H	Flower	Increase Hemoglobin	Raw	Ray florets of flower are eaten raw to increase haemoglobin level in blood.	2	VU
<i>Cedrus deodara</i> (Roxb. ex D.Don) G.Don/ Pinaceae	Deodar	T	Bark	Skin diseases	Oil	Bark oil is prepared and used against itching.	6.5	LC
<i>Curcuma longa</i> L./ Zingiberaceae	Haldu	H	Rhizo me	Internal injury, cuts and wounds	Powder and paste	Rhizome powder taken with milk to cure internal injury and paste of rhizome is prepared for cuts and wounds.	8	LC
<i>Dactylorhiza hatagirea</i> (D.Don) Soo/ Orchidaceae	-	H	Leaves ,Tuber	Cuts and wound	Powder and paste	Paste of tuber is applied on cut and wounds to check bleeding. ½ teaspoon powder of leaves taken orally with 1 glass water as coolant.	2	VU

<i>Delphinium denudatum</i> Wall.ex Hook.f. Thomson./ Ranunculaceae	-	H	Root	Snake bite and scorpion sting	Paste	Root paste applied on snake bite and scorpion sting.	5.5	LC
<i>Ephedra gerardiana</i> Wall. ex Klotzsch & Garcke/ Ephedraceae	Somlata	H	Aerial part	Asthma, Fever	Decoction	Decoction of aerial part prepared and used against the asthma and fever.	2	VU
<i>Fritillaria roylei</i> Hook./ Liliaceae	Kakoli	H	Bulb	Energy booster	Powder	Powder of bulb is prepared and used as energy booster. It is an important plant of asthberg.	2	LC
<i>Habenaria edgeworthi</i> Hook. f. ex Collett/ Orchidaceae	Ridhhi	H	Tuber	Energy booster	Powder	Powder of tuber is prepared and used as energy booster. It is an important plant of asthberg.	2	LC
<i>Habenaria intermedia</i> D.Don/ Orchidaceae	Sidhhi	H	Tuber	Energy booster	Powder	Powder of tuber is prepared and used as energy booster. It is an important plant of asthberg.	h2	LC
<i>Hippophae rhamnoides</i> L./ Elaeagnaceae	-	S	Fruits	Cancer	Juice	Fruit juice is prepared to cure cancer.	4	LC
<i>Juglans regia</i> L./ Juglandaceae	Akhor	T	Fruit coat, Leaves	Hair fall and teeth problems	Paste	Fruit coat paste prepared and used against hair loss and leaves paste is used to treat teeth problems.	5.5	LC
<i>Lespedeza juncea</i> (L.f.) Pres.	Bal-kari	H	Arial part	Infection	Paste	Paste of areal part is prepared and applied in infected organ to cure infection.	5	LC
<i>Lilium polyphyllum</i> D.Don/ Liliaceae	Ksirakakoli	H	Bulb	Energy booster	Powder	Powder of bulb is prepared and used as energy booster. It is an important plant of asthberg.	2	VU
<i>Malaxis acuminata</i> D.Don/ Orchidaceae	Jeevak	H	Bulb	Energy booster	Powder	Powder of bulb is prepared and used as energy booster. It is an important plant of asthberg.	2	VU
<i>Malaxis musifera</i> (Lindl.) Kuntze/ Orchidaceae	Rishvak	H	Bulb	Energy booster	Powder	Powder of bulb is prepared and used as energy booster. It is an important plant of asthberg.	2	VU

<i>Malva neglecta</i> Wallr./ Malvaceae	Kwachuli	H	Whole plant	Cuts and Wound	Paste	Paste of whole plant is prepared and applied in cuts and wounds.	6	LC
<i>Mentha longifolia</i> L./ Lamiaceae		H	Aerial part	Antiseptic, indigestion and vomiting	Decoction	Decoction of aerial part is prepared and 1-2 drops was taken with lukewarm water against indigestion and vomiting as well decoction applied as an antiseptic.	6	LC
<i>Nardostachys jatamansi</i> (D.Don) DC./ Caprifoliaceae	Jatamasii	H	Root	Rheumatism	Paste	Root paste mixed with cow ghee and rubbed on the joints to treat rheumatism.	2.33	NT
<i>Origanum vulgare</i> L./ Lamiaceae		H	Whole plant	Diarrhea, influenza	Decoction	Decoction of whole plant is prepared and 1-2 teaspoon is taken with lukewarm water against diarrhoea and influenza.	7	LC
<i>Paeonia emodi</i> Royle/ Paeoniaceae	-	H	Leaves	Dysentery	Juice	Leaves juice is prepared and taken orally 1-2 times a day to treat dysentery.	5	LC
<i>Picrorhiza kurroa</i> Royle ex Benth./ Plantaginaceae	-	H	Roots	Fever, Jaundice, diabetes	Powder	1-2 teaspoon root powder along with sugar and drunk with water to cure fever, jaundice and diabetes.	3	LC
<i>Pinus roxburghii</i> Sarg./ Pinaceae	Chir-pine	T	Resin	Cracked heals	Raw	Raw resin heated and applied on cracked heals.	6	LC
<i>Plantago depressa</i> Willd./ Plantaginaceae		H	Seeds	Dysentery	Powder	Powder of seeds is prepared and taken with lukewarm water against dysentery.	5	LC
<i>Podophyllum hexandrum</i> Royle/ Podophyllaceae	-	H	Root	Diabetes and stomach disorders	Powder	1 teaspoon powder taken orally with lukewarm water to cure diabetes and stomach disorders.	2	LC
<i>Polygonatum cirrhifolium</i> (Wall.) Royle/ Liliaceae	Meda	H	Leaves , Tuber	Energy booster	Powder	Powder of tuber and leaves is prepared and used as energy booster. It is an important plant of asthberg.	6	LC
<i>Polygonatum verticillatum</i> (L.) All./ Liliaceae	Salam- misri	H	Root	leucorrhoea	Powder	1-2 teaspoon root powder along with lukewarm water to cure leucorrhoea.	5	LC

<i>Potentilla fulgens</i> Wall. ex Sims/ Rosaceae	Bjrdanti	H	Leaves , Root	Toothache, cleaning teeth	Raw	Root and leaves pieces chewed raw to clean teeth and cure toothache.	7	LC
<i>Rheum austral</i> D. Don/ Polygonaceae	Archu	H	Root	Internal and external injury	Paste and powder	1 teaspoon with haldi powder and lukewarm water is taken orally to cure internal injury. Paste is applied on external injuries.	2.33	NT
<i>Rhododendron arboreum</i> Sm./ Ericaceae	Burans	H	Flower	Cardiac disorders and anemia	Juice	Flowers juice is prepared and taken orally to cure cardiac disorders and anaemia.	6.33	LC
<i>Salvia nubicola</i> Wall.ex Sweet/ Lamiaceae	-	H	Aerial part	Itching	Decoction	Decoction of aerial part is prepared and few drops of it is mixed with warm water and bath is taken.	6	LC
<i>Saussurea obvallata</i> (DC.) Sch. Bip./ Asteraceae	Brahm- kamal	H	Leaves , Seeds	Cuts and wounds and mental problems	Paste	Leaves paste is prepared and applied on cuts and wounds. 2 teaspoon of seeds powder is taken with normal water to cure mental problems.	2.33	NT
<i>Silene vulgaris</i> (Moench) Garcke/ Caryophyllaceae		H	Whole plant	Bronchitis	Powder	Powered of whole plant is prepared and taken with warm water or milk against bronchitis.	7	LC
<i>Solanum nigrum</i> L./ Solanaceae	-	H	Leaves	Toothache, cleaning teeth	Paste	Paste of leaves used as toothpaste to cleaning teeth as well to cure toothache.	6	LC
<i>Sorbaria tomentosa</i> (Wenz.) Rahn/ Rosaceae	Hamchyat	S	Fruits	Internal injury	Paste	Paste of ripen fruit prepared to cure internal injury (Gumchoat).	5.67	LC
<i>Swertia cordata</i> (G.Don) Wall.ex C.B. Clarke/ Gentianaceae	Chiratu	H	Whole plant	Fever	Powder	1 teaspoon powder is taken with lukewarm water 3 times a day to cure fever.	6	LC
<i>Taxus wallichiana</i> Zucc./ Taxaceae	Thuner	T	Bark	Blood pressure, bone fracture, cancer	Paste, decoction	Bark paste is applied to cure fractured bones. Bark is boiled with water and salty tea is prepared and used to maintain blood pressure and cure cancer.	2.33	NT

<i>Thymus linearis</i> Benth./ Lamiaceae		H	Leaves	Cuts and wounds	Paste	Leaves paste is prepared and applied on cuts and wounds.	7	LC
<i>Verbascum thapsus</i> L./ Scrophulariaceae	-	H	Seeds	Antiseptic	Powder	Powder of seeds mixed with the oil of <i>Prunus armaniaca</i> and used as a antiseptic.	7	LC
<i>Vicia bakeri</i> Ali/ Fabaceae	-	H	Whole plant	Increase blood	Decoction	Decoction of whole plant is prepared to maintain blood level.	6	LC
<i>Zingiber officinale</i> Roscoe/ Zingiberaceae	Aadu	H	Rhizome	Cut, wounds, cough, cold,	Paste, decoction	½-1 glass decoction of rhizome is taken orally twice a day for treatment of cough and cold. Paste of rhizome is also used for curing burns and boils.	5	LC

Note: H= herbs; CC= Conservation categories; CS values= Conservation index values; LF= Life form; NT= Near threatened; S= Shrubs; T=Trees; VN=Vernacular names; VU= Vulnerable; LC= Least concern.

Twelve of the 54 analyzed plant species are presented in Plate 1.



Plate 1. (A) *Aconitum heterophyllum*; (B) *Carduus edelbergi*; (C) *Podophyllum hexandrum* ; (D) *Picrorhiza kurroa*; (E) *Malva neglecta*; (F) *Silene vulgaris*; (G) *Thymus linearis*; (H) *Ephedra gerardiana*; (I) *Vicia bakeri*; (J) *Swertia cordata*; (K) *Salvia nubicola*; (L) *Lespedeza juncea*.

Plants family and life form:

Lamiaceae, Liliaceae, Orchidaceae were the dominant family (with 5 species), followed by Asteraceae and Berberidaceae (3 species each), Fabaceae, Pinaceae, Plantaginaceae, Ranunculaceae, Rosaceae, Solanaceae and Zingiberaceae (2 species each) while remaining families are represented by only single species (Fig. 2). Top genera were represented by *Berberis* (3 species) followed by followed by *Habenaria*, *Malaxis* and *Polygonatum* (2 species each) and remaining genera were represented by single species.

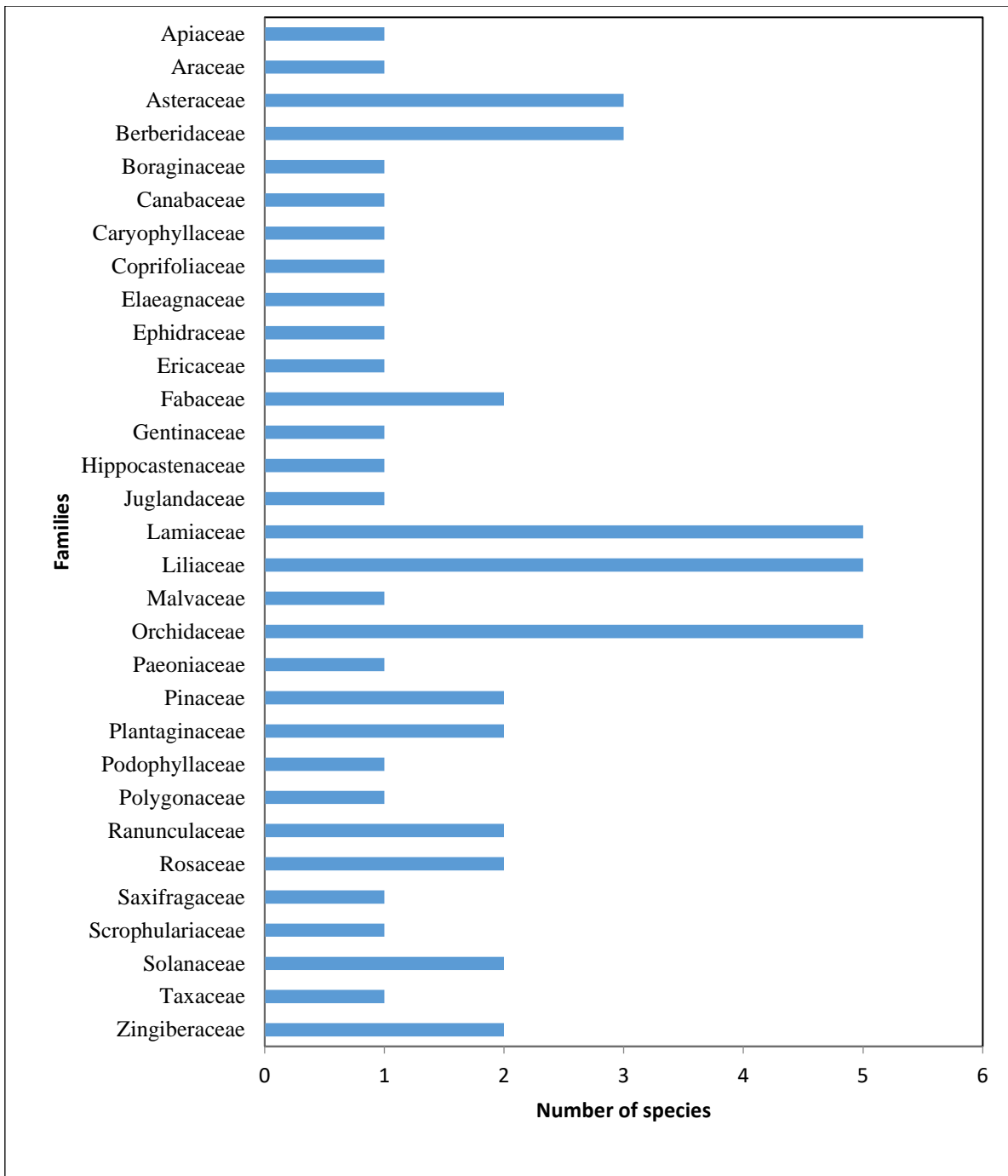


Figure 2. Dominant families representing number of ethno-medicinal plants.

Herbs were the dominant life form (82%), followed by shrubs and trees (9% each) (Fig. 3).

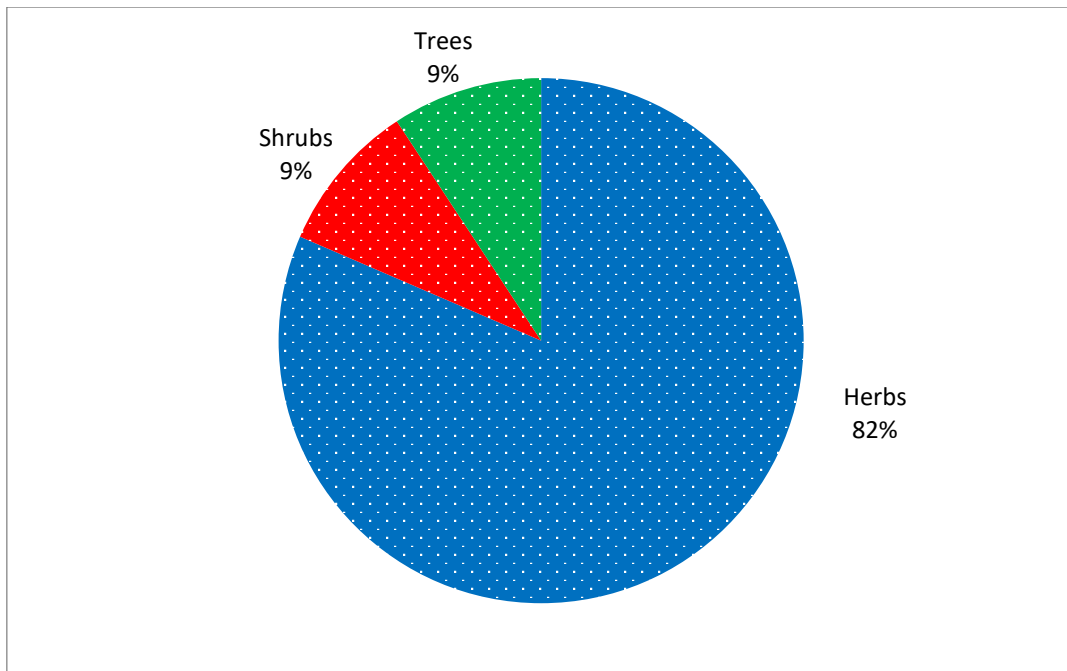


Figure 3. Percentage of herb shrub and tree used for medical propose

Plant part used:

Present study reported eighteen plant part categories used to cure different ailments in Jadh-Bhotiya community of Uttarakashi, Uttarakhand, India. Roots showed higher use proportion (20%), followed by whole plant (13%), bulb (9%), aerial part, fruits, leaves, tuber, seeds (6% each), bark, tuber and leaves, flower, rhizome (4 % each) fruits coat and leaves, leaves and seeds, leaves and bark, resin, root and bark, root and leaves (2% each) (Fig. 4).

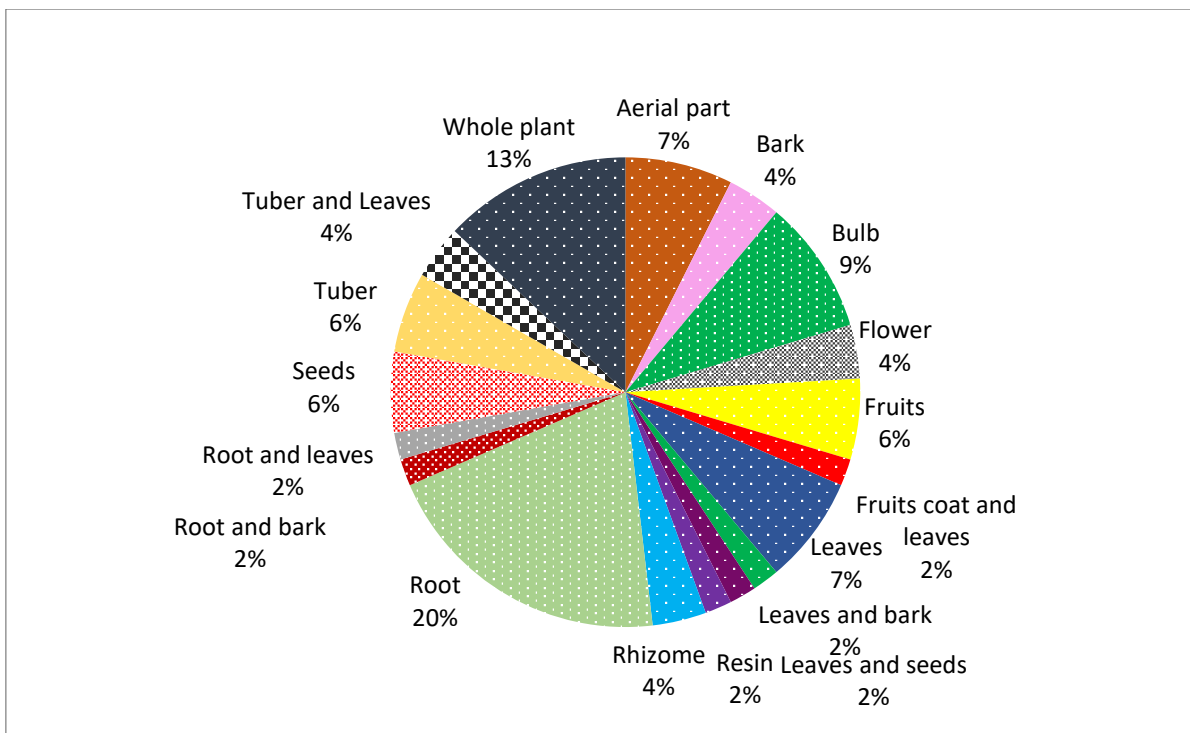


Figure 4. Percentage plant parts used for various ailments

Disease cured:

A total of 32 type of disorders are cured by locals using plants which were abdominal disorders, asthma, bone fracture or dislocation, bronchitis, cancer, cardiac disorders, cracked heals, cuts and wounds, cough and cold, diabetes, diarrhoea, dysentery, disinfectant, eye problems, energy booster, external injury, fever, hair fall, hepatitis, influenza, internal injury, Itching, jaundice, leucorrhoea, mental disorders, stomach disorders, rabies, rheumatism, scorpion bite, skin problems, snakebite, teeth problems and ulcer (Table.2).

Mode of drug preparation:

A total of nine drug preparation methods i.e. paste, powder, decoction, raw, juice, paste and powder, paste and decoction, and oil were reported in present study, among these powder was frequently used drug preparation method (33%), followed by paste (20%), decoction (19%), paste and powder (9%), raw (7%), juice (6%), paste and decoction (4%) and oil (2%) (Fig. 5).

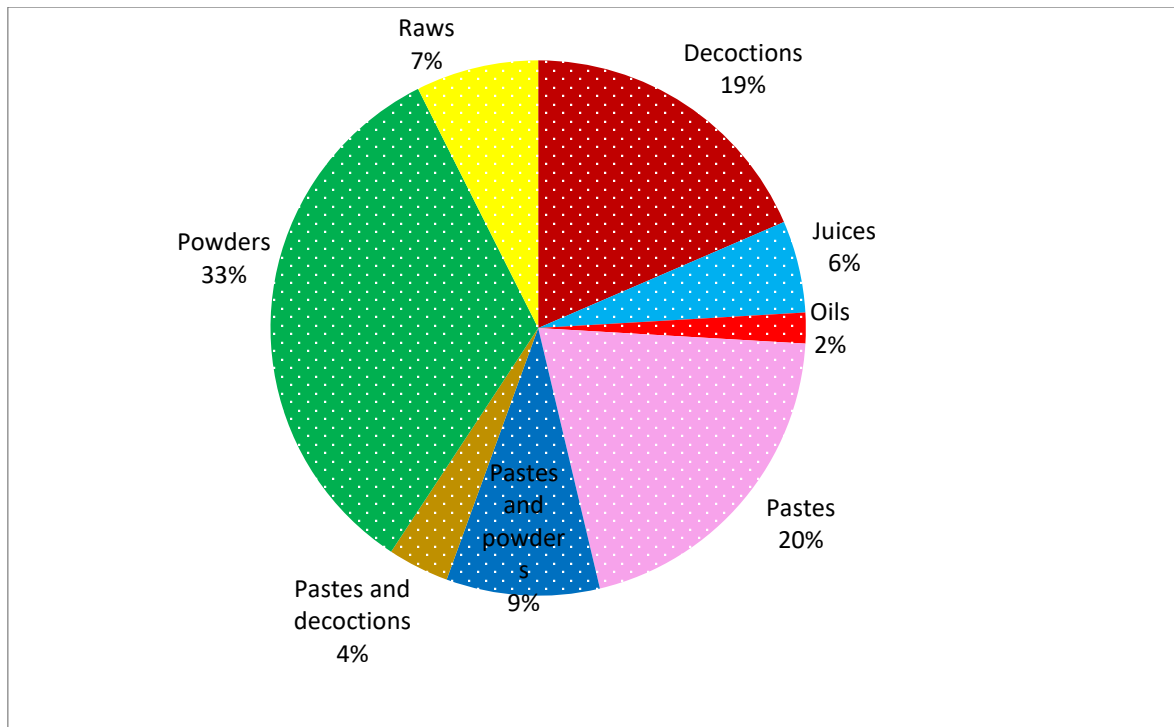


Figure 5.Percentage of plants with their mode of drug preparation

Conservation status:

Out of the 54 species 76% species was recorded under the least concern (LC) category, following by vulnerable (VU) (13% species) and least 11% species was recorded under the near threatened (NT) (Fig. 6).

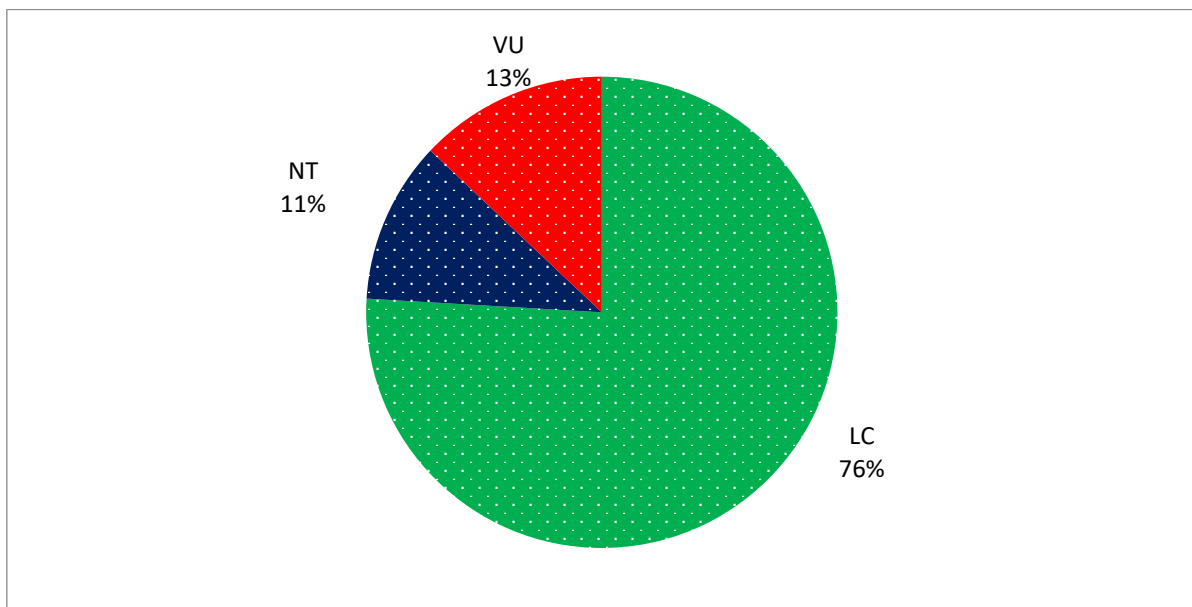


Figure 6. Percentage of species showing various IUCN categories

Aconitum heterophyllum, *Arnebia benthamii*, *Nardostachys jatamansi*, *Rhume australe*, *Saussurea obvallata* and *Taxus wallichiana* were recorded under near threatened (NT) category. *Angelica glauca*, *Carduus edelbergii*, *Dactylorhiza hatagirea*, *Ephedra gerardiana*, *Lilium polyphyllum*, *Malaxis acuminata* and *Malaxis muscifera* were recorded under vulnerable (VU) category. Whereas remaining species were recorded under least concern (LC) category (Table 2).

5. Discussion

Previous studies conducted in nearby areas, specifically in other mountainous regions of the state of Uttarakhand, demonstrated a higher similarity in the ethno-medicinal uses of some commonly used plants, whereas regions distant from the study area exhibited lower similarity. *Aconitum heterophyllum* was employed for treating fever and stomach ache, aligning with findings by Hussain et al. (2023). Phondani et al. (2010) previously reported its use for alleviating headache, dysphasia, and stomach ache in the Niti valley of the western Himalaya. Semwal et al. (2010) documented its application for addressing diarrhea and body ache in a block of the Garhwal Himalaya. *Angelica glauca* was utilized for addressing stomach disorders, corroborating the observations made by Hussain et al. (2023). However, Sarkar and Nahar (2004) reported its use in the treatment of dysentery, atrophy, and dyspepsia. Additionally, Phondani et al. (2010) documented its application against cough and cold. *Arnebia benthamii* was employed in the treatment of cuts and wounds, aligning with the observations of Semwal et al. (2010) and Hussain et al. (2023).

Berberis lycium was utilized for treating jaundice and hepatitis, consistent with the findings of Hussain et al. (2023). However, Kumar and Singhal (2019) reported its use in curing conjunctivitis and mouth blisters. *Cannabis sativa* was employed for the healing of bone dislocation, asthma, and rheumatism. Semwal et al. (2010) reported its use in the treatment of fever, bronchitis, indigestion, and asthma. *Delphinium denudatum* is utilized against snake bites and scorpion stings, in accordance with the findings of Hussain et al. (2023). *Ephedra gerardiana* is applied for the treatment of asthma and fever. *Mentha longifolia* was used as an antiseptic and for addressing indigestion and vomiting. Semwal et al. (2010) documented its use in the treatment of dehydration, vomiting, and liver disease, while Gaur and Sharma (2011) reported its use for treating indigestion. *Nardostachys jatamansi* was reported to be used against rheumatism. Hussain et al. (2023) reported its use in the treatment of epilepsy, mental disorders, insomnia, and cardiac disorders. *Paeonia emodi* was employed for inhaling to

address dysentery. Kumar and Singhal (2019) reported its use for whooping cough, diarrhea, eczema, and ulcers. Phondani et al. (2010) documented its application for the cure of dysentery.

Picrorhiza kurroa was utilized for curing fever, jaundice, and diabetes. Semwal et al. (2010) reported its use in the treatment of fever, stomach ache, jaundice, and dysentery. *Polygonatum verticillatum* was employed for the cure of leucorrhoea. Semwal et al. (2010) reported its use as a tonic, appetizer, and aphrodisiac. *Rheum australe* was utilized against internal and external injuries, consistent with the findings of Hussain et al. (2023). Phondani et al. (2010) reported its use in the treatment of goiter. *Saussurea obvallata* was employed for curing cuts, wounds, and mental problems, similar to the observations of Phondani et al. (2010), and Maikhuri et al. (2000) reported its use against cuts and wounds. *Verbascum thapsus* was applied as an antiseptic, with Gaur and Sharma (2011) noting its use for treating fever, as an antidote for snake bites, and for colic. *Carduus edelbergii*, *Silene vulgaris*, *Malva neglecta*, *Lespedeza juncea* and *Vicia bakeri* are among the unique species included in the study, and they are not widely recognized for their therapeutic uses. These species have been relatively less explored in terms of their therapeutic potential.

Lamiaceae, Liliaceae, and Orchidaceae revealed as the dominant plant families. Gaur and Sharma (2011) and Hussain et al. (2023) also noted the presence of Lamiaceae among the top ten dominant families. The widespread utilization of Lamiaceae members may be attributed to the ease of picking or identifying these plants due to their aromatic properties. Regarding life forms, herbs constituted the highest proportion (82%), followed by shrubs and trees (9% each). Herbaceous plants have been identified as the most therapeutic plants according to Gaur and Sharma (2011) and Hussain et al. (2023). Roots and the whole plant were the most frequently utilized plant parts. Singh et al. (2017) and Khajuria et al. (2021) also recorded leaves and roots as the most commonly used plant parts. Ghimire and Bastakoti (2009) highlighted that the use of roots for local medicine preparation can have destructive effects on plant growth, posing a serious threat to the wild population.

Powder was predominantly used in local remedies due to its easy and less time-consuming preparation process compared to other methods. Generally, plant parts were crushed or rubbed with mortar and pestle and consumed orally or with liquids such as milk and lukewarm water to address internal problems. Additionally, the prevalence of external injuries in people's lives, attributed to their lifestyle, narrow trails, and intensive or hard work in the fields or forests with sharp tools and implements, contributed to the preference for powder (Singh et al., 2017). Paste also had a higher proportion among drug preparations, possibly because of its low time-consuming period compared to other drug preparations, and it can be

made whenever required. Powder is typically produced by crushing shade-dried plant parts, whereas paste is generally prepared from fresh or dried plant parts by grinding with oil or water (Singh et al., 2017; Kayani et al., 2014). Water served as the primary solvent in most preparations, especially decoctions, as most plant metabolites are soluble in it (Bhattarai et al., 2010; Gumisiriza et al., 2019). Other solvents may be added to enhance the solubility of active ingredients that are insoluble in water (Bhattarai et al., 2010). Additionally, honey, jaggery, or sucrose may be used to mitigate the bitterness of the recipe, as suggested by Bhatia et al. (2014).

The regional conservation status analysis revealed that the majority of the species (76%) fall under the ‘Least Concern’ category. Some medicinally important species, such as *Aconitum heterophyllum*, *Arnebia benthamii*, *Nardostachys jatamansi*, *Rheum australe*, *Saussurea obvallata*, and *Taxus wallichiana*, were categorized under the ‘Near Threatened’ category. *Angelica glauca*, *Carduus edelbergii*, *Dactylorhiza hatagirea*, *Ephedra gerardiana*, *Lilium polyphyllum*, *Malaxis acuminata*, and *Malaxis muscifera* were classified under the ‘Vulnerable’ (VU) category. *Aconitum heterophyllum*, *Angelica glauca*, *Lilium polyphyllum*, *Nardostachys jatamansi*, and *Taxus wallichiana* are also reported by the IUCN Red List (<https://www.iucnredlist.org>) under the categories of ‘Critically Endangered’ (CR) and ‘Endangered’ (EN) respectively. These species, valued for their medicinal properties and historically used by locals, face the risk of decline in population due to over-exploitation. Conducting a regional-level assessment could provide more accurate information about the conservation status of these specific species. Rawat et al. (2022) also published a checklist of threatened plants of Uttarakhand by using various publications and official sources and emphasizes that this type of studies will restrict the unnecessary inflation of threatened plant list and will decrease the pressure on resources which are utilized for conservation.

6. Conclusion

The study aimed to evaluate the diversity, therapeutic uses, and conservation status of medicinal plants in the region. The findings revealed a rich abundance of medicinal plants, with locals continuing traditional uses. Some well-known species are familiar across generations, but traditional knowledge is diminishing due to improved medical facilities. Locally recognized plants are at risk of extinction from over-exploitation. The study also uncovered little-explored species, emphasizing the importance of documenting their uses before potential loss. Sustainable utilization and conservation efforts are crucial for highly utilized species. Overall, the study highlights the vast diversity of medicinal plants in the region

and the declining traditional knowledge amid the growing influence of modern medications, signaling a potential loss of this valuable knowledge in the near future.

Acknowledgements

The authors express their sincere gratitude for the assistance provided by numerous local inhabitants during the field study. Special thanks are extended to the Head of the Department of Botany & Microbiology, HNB Garhwal University, for the provision of facilities.

References

- Bhatia H., Sharma Y.P., Manhas R.K. & Kumar K., 2014, Ethnomedicinal plants used by the villagers of district Udhampur, J&K, India. *Journal of Ethnopharmacology* 151(2): 1005-1018.
- Bhatt D., Joshi G.C. & Tiwari L.M., 2009, Culture, habitat and ethno-medicinal practices by bhotia tribe people of Dharchula region of Pithoragarh district in Kumaun Himalaya, Uttarakhand. *Ethnobotany Leaflet* 13: 975-983.
- Bhattra S., Chaudhary R.P., Quave C.L. & Taylor R.S., 2010, The use of medicinal plants in trans-himalayan arid zone of Mustang district, Nepal. *Journal of Ethnobiology and Ethnomedicine* 6(1): 1-11.
- Dutta B.K. & Dutta P.K., 2005, Potential of ethno-botanical studies in North East India: an overview. *Indian J. Tradit. Knowl.* 4: 7-14.
- Fransworth N.R., 1988, Screening plants for new medicines, [in:] Wilson E.O. (ed.) *Biodiversity*. Washington DC: National Academy Press: 83-97.
- Fuchs S., 1982, *The aboriginals tribes of India*, Macmillan India Ltd. New Delhi.
- Gaur R.D. & Sharma J., 2011, Indigenous Knowledge on the Utilization of Medicinal Plant Diversity in the Siwalik Region of Garhwal Himalaya, Uttarakhand. *Journal of Forest Science* 27(1): 23-31.
- Gaur R.D., 1999, *Flora of the district Garhwal North West Himalaya with ethno-botanical note*. Transmedia, Srinagar, Garhwal, India.
- Ghimire K. & Bastakoti R.R., 2009, Ethnomedicinal knowledge and healthcare practices among the Tharus of Nawalparasi district in central Nepal. *Forest Ecology Management* 257(10): 2066-2072.
- Gumisiriza H., Birungi G., Olet E.A. & Sesaazi C.D., 2019, Medicinal plant species used by local communities around Queen Elizabeth National Park, Maramagambo Central Forest Reserve and Ihimbo Central Forest Reserve, South western Uganda. *Journal of Ethnopharmacology* 239: 111-926.
- <http://www.iucnredlist.org>[Accessed 5 Oct 2023].
- Hussain J., Mehta J.P., Singh A., Bagri A.S., Singh H., Nautiyal M.C. & Bussmann R.W., 2023, Ethno-botanical plants used in Khatling valley of Western Himalaya, India. *Ethnobotany Research & Applications* 25(3): 1-19.
- Jain D.L., Baheti A.M., Jain S.R. & Khandelwal K.R., 2010, Use of medicinal plants among tribes in Satpuda region of Dhule and Jalgaon districts of Maharashtra-an ethnobotanical survey. *Indian J. Trad. Knowl.* 9: 152-157
- Jeyaprakash K., Ayyanar M., Geetha K.N. & Sekar T., 2011, Traditional uses of medicinal plants among the tribal people in Theni districts (Western Ghats), Southern India. *Asian Pac J Trop Biomed* 1(Suppl 1): S20-S25.
- Kala C.P., 2005, Current status of medicinal plants used by traditional vaidyas in Uttaranchal State of India. *Ethnobot Res Appl* 3: 267-278.
- Kayani S., Ahmad M., Zafar M., Sultana S., Khan M.P.Z., Javid H., Ashraf M.A. & Yaseen G., 2014, Ethno-botanical uses of medicinal plants for respiratory disorders among the inhabitants of Gallies-Abbottabad, Northern Pakistan. *Journal of Ethnopharmacology* 156: 47-60.

- Khajuria A.K., Manhas R.K., Kumar H., Bisht, N.S., 2021, Ethno-botanical study of traditional used medicinal plants of Pauri district of Uttarakhand, India. *Journal of Ethnopharmacology* 276, 114204.
- Kumar R. & Singhal V.K., 2019, Traditional knowledge and conservation status of some selected medicinal herbs from Uttarkashi district in Uttarakhand, Western Himalayas. *Taiwania* 64(1): 52-64.
- Maikhuri R.K., Nautiyal S., Rao K.S. & Semwal R.L., 2000, Indigenous knowledge of medicinal plants and wild edibles among three tribal sub communities of the central Himalayas, India. *Indigenous Knowledge and Development Monitor* 8(2): 7-13.
- Naithani B.D., 1984-85, *Flora of Chamoli*. 2 vols. Botanical Survey of India, Howrah.
- Panda S. & Mishra N., 2018, Factors affecting temporary labour migration for seasonal work: A Review. *Manager Research Review* 41(10): 1176-1200.
- Phondani P.C., Maikhuri R.K., Rawat L.S., Farooque Kala C.P., Vishvakarma K.S., Rao K.S. & Saxena K.G., 2010, Ethnobotanical uses of plants among the Bhotiya tribal communities of Niti Valley in Central Himalaya. *Ethnobotany Research & Applications* 8: 233-244.
- Pusalkar P.K. & Singh D.K., 2012, *Flora of Gangotri National Park, Western Himalaya, India*. Botanical Survey of India, Kolkata.
- Pusalkar P.K., Srivastava S.K. & Singh P., 2018, *Flora of Uttarakhand, Volume 1: Gymnosperms and angiosperms (Ranunculaceae to Morinaceae)*. Botanical Survey of India.
- Rawat D.S., Chandra S. & Chaturvedi P., 2022, Threatened flora of Uttarakhand: an update. *Journal of Threatened Taxa* 14(12): 22309-22328.
- Sarker S.D. & Nahar L., 2004, Natural medicine: the genus *Angelica*. *Current Medicinal Chemistry* 11(11): 1479-1500.
- Semwal D.P., Saradhi P.P., Kala C.P. & Sajwan B.S., 2010, Medicinal plants used by local Vaidyas in Ukhimath block, Uttarakhand. *Indian Journal of Traditional Knowledge*. 9(3): 480-485.
- Shah A.H., Mehmood A., Farooq M., Khan K.R., Nawab B., Shah A.H., Hussain M., Zohra L., Khan S.M. & Ahamd H., 2019, A new quantitative ethnoecological approach to assessing the conservation status of plants: A case study of district Tor Ghar, Pakistan. *Applied Ecology and Environmental Research* 17(5): 10399-10419.
- Singh A., Nautiyal M.C., Kunwar R.M. & Bussmann R.W., 2017, Ethnobotanical plants used by local inhabitants of Jakholi block, Rudraprayag district, weastern Himalaya, India. *Journal of Ethnobiology and Ethnomedicine* 13(1): 1-29.
- Singh U. & Lahiri N., 2010, *Ancient India: new research*. New Delhi: Oxford University Press.
- Thomas E., Vandebroek I. & Van Damme P., 2007, What works in the field? A comparison of different interviewing methods in ethnobotany with special references to the use of photographs. *Economic Botany* 61(4): 376-384.
- United Nations University, Institute of Advanced Studies (UNU-IAS), Payyappallimana U, Fadeeva Z. (eds), 2013, *Traditional knowledge and biodiversity*, p. 8-9. Yokohama, Japan: UNU-IAS.
- World Health Organization (WHO). *WHO Traditional Medicine Strategy 2002-2005*. Geneva: World Health Organization.
<http://www.who.int/medicines/publications/traditionalpolicy/en/index.htm> [Accessed on 27 October, 2023].