Lichens of Tehri Garhwal: Exploring Diversity, Distribution, and Ethnobotanical Significance in the Western-Himalayan Region

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Research

Abstract

Background: Lichens are used traditionally in the North-Western Himalayas due to their uses as food, medicine, perfumes, spiritual values, etc. The present study is an attempt to measure the diversity of ethnobotanically significant lichens in the Tehri Garhwal region of Uttarakhand state. The paper explains the use of lichens as food, medicine, and for other purposes by local communities. The study was done on the Tehri Garhwal district of Uttarakhand in the Northwestern Himalayas.

Methods: Data collection was done by various field visits and questionnaires. Food value (FV), ritual and spiritual value (RSV), ethnoveterinary value (EVV), medicinal value (MV), and dye-producing value (DV) value were noted along with demographic data of the respondents.

Results: In our study, we found that lichens were used significantly by local people of the area and the lichen genus *Hypotrachyna cirrhata* was the most used lichen. Family Parmeliaceae was the most well-used family in the study area.

Conclusions: Quantification and documentation of this data will help in the conservation of lichens in the future, as well as preserve lichens as a key species in ethnobotanical studies.

Keywbords: Lichen, Ethnobotanical, Ethnomedicinal value, Food value

Background

Lichens have been used in traditional foods and medicines for millennia and are crucial for ecosystem function and human well-being (Devkota *et al.* 2017). Lichens are a symbiotic association between a filamentous fungus, known as the 'mycobiont,' and at least one photosynthetic organism called the 'photobiont,' which can be a microalga, a cyanobacterium, or both. Despite their symbiotic nature being discovered in 1867, lichens have often been studied and perceived as single organisms due to the integrated development of the lichen thallus. They are frequently used as the best illustration of mutualism. A 'lichen species' is named after the fungus partner's species. The majority of fungi that create lichens (around 98%) are members of the Ascomycota phylum, which is the biggest fungal phylum. The remainder species are members of the Basidiomycota phylum, which is comprised of common mushrooms. The cyanobacterium *Nostoc* and the green algae

*Trebouxia a*nd *Trentepohlia* are the most prevalent lichen photobionts (Lutzoni & Miadlikowska 2009). Lichens can survive in various harsh conditions, such as tundra and arid deserts, because of their special relationship (Boruah *et al.* 2024) and thus need to be studied. Lichens are highly sensitive to environmental changes, which can significantly impact species numbers and community composition (Pinho *et al.* 2011). Lichen diversity has recently been used as a way to track how air pollution affects urban areas (Llop *et al.* 2012). Lichen are biological indicators for pollution and provide ecosystem services such as nutrient cycling, and soil formation, and as primary colonizers in harsh environments. Lichens contribute significantly to overall biodiversity. Studying their diversity aids in the conservation of unique species, preventing the loss of valuable components of ecosystems. There are about 20,000 lichen species reported globally. India, with its rich plant diversity spread over 303.9 million hectares, is home to more than 2,305 lichen species, which accounts for 12% of the world's known lichen species (Singh & Sinha 2010). Lichens thrive in moist and humid areas, with macrolichens favouring temperatures between 20-25°C. In India, the greatest richness and diversity of lichens are found in the Himalayan region. Lichens have traditionally been a frequent household item in India. The Himachal Pradesh and Uttarakhand hills are the primary locations for lichen gathering in the nation. Lichens harvested from the temperate sections of the Himalayas are used both domestically and internationally (Upreti *et al.* 2005).

The current research paper focuses on lichens having ethnobotanical values especially focusing on ethnobotanical use of these lichens. The study area has never been explored for the diversity of lichen species and their ethnobotanical relevance (Lutzoni & Miadlikowska 2009).

Materials and Methods

Study area

The Indian state of Uttarakhand, which has a rich cultural heritage, is situated between 77°34'27'' E and 81°02'22'' E longitude and between 28°53'24'' N and 31°27'50'' N latitude. At 53,566 km², it makes up 17.3% of India's total land area, with 92.57% of that area being mountainous and 7.43% being plain.

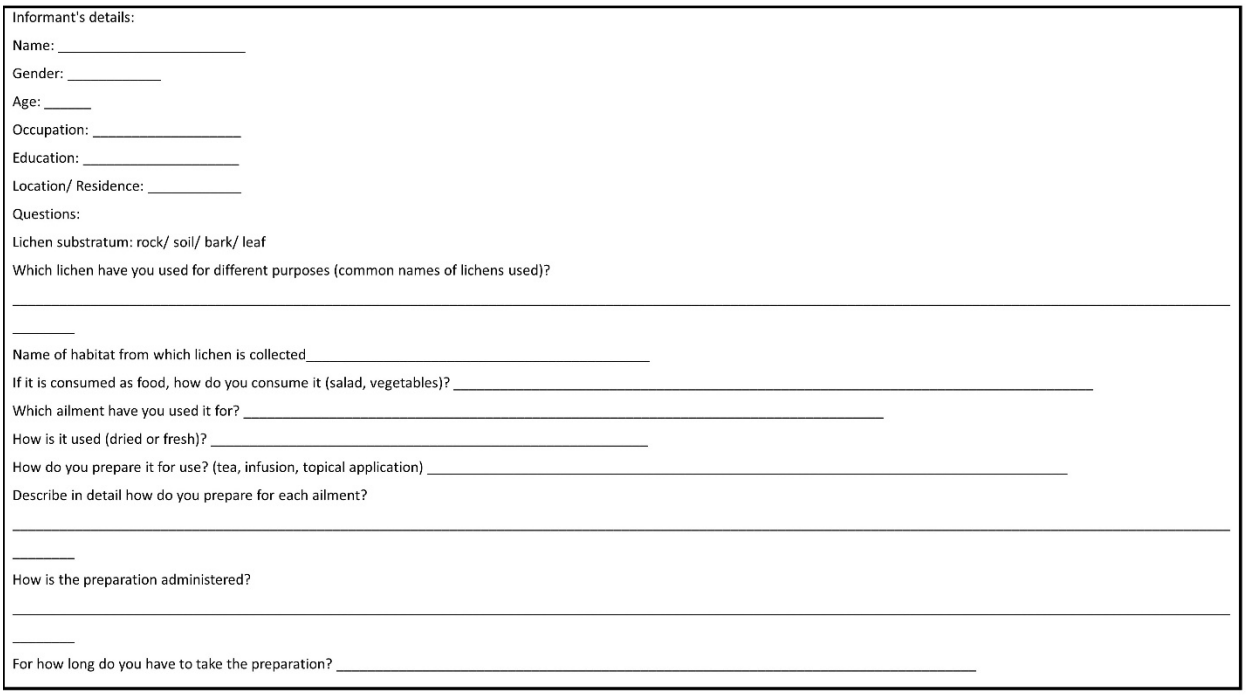
Tehri Garhwal, a district within Uttarakhand, lies between 30.17'' N to 36.45'' N latitude and 78°31'' E longitude, with coordinates of 30.293461 N and 78.524094 E. It is a part of the Western Himalayas and is bordered to the east by Rudraprayag District, to the west by Dehradun District, to the north by Uttarkashi District, and to the south by Pauri Garhwal District. At 19.96°C (67.93°F), the district experiences an average annual temperature that is 6.01% lower than the national average. Tehri Garhwal typically receives about 155.42 millimetres (6.12 inches) of precipitation annually, with around 120.62 rainy days (33.05% of the year).

Data Collection

Samples were collected from bark, rock and soil from various sites in the study area. Ethnobotanical data related to lichen species was obtained through interaction with local people, herbalists etc. Participants were not compelled to provide their actual identities, respond to all the questions from a predetermined set, or adhere to a specific order of questioning. Verbal prior consensus agreement (Rosenthal, 2006) was obtained from key informants, before recording their traditional knowledge regarding the several uses of lichens. The information was collected from local people by following the questionnaire (Fig 1) from various sites in the study area.

Lichen identification

The identification was done with the help of lichen identification keys. By examining the specimens' morphology, anatomy, and chemistry, the specimens were identified. A stereo binocular microscope was utilized to examine the morphology of the various taxa. The thallus anatomy and fruiting bodies were thoroughly inspected under a compound microscope. Colour tests were conducted on the cortex and medulla using standard chemical reagents, such as aqueous potassium hydroxide (K), Steiner's stable paraphenylenediamine (PD), and aqueous calcium hypochlorite (C). Thin layer chromatography was utilized to detect the lichen components in solvent system A (Toluene 180: 1-4 Dioxane 60: Acetic acid 8) using the techniques Walker and James (1980) described. While lichen samples were identified at the Lichenology Lab, Voucher specimens were housed in the LWG Herbarium of the CSIR-NBRI in Lucknow.


Informant's details:

Name: _____

Gender: _____

Age: _____

Occupation: _____

Education: _____

Location/ Residence: _____

Questions:

Lichen substratum: rock/ soil/ bark/ leaf

Which lichen have you used for different purposes (common names of lichens used)?

_____

_____

Name of habitat from which lichen is collected_____

If it is consumed as food, how do you consume it (salad, vegetables)? _____

Which ailment have you used it for? _____

How is it used (dried or fresh)? _____

How do you prepare it for use? (tea, infusion, topical application) _____

Describe in detail how do you prepare for each ailment?

_____

_____

How is the preparation administered?

_____

_____

For how long do you have to take the preparation? _____

Figure 1. Format of the questionnaire used for data collection

Results

Demographic characteristics of the informants:

A total of 132 informants (89 female and 41 male) representing six age groups (1-15, 16-30, 31-45, 46-60, 61-75, 76-90) were consulted for the study. In Table 1. Respondents from the study area, gender, number and proportion are shown.

Table 1. Respondents from the study area, gender, number and proportion.

Characteristics		**Number**	**Proportion**
Gender	Male	43	32%
	Female	89	67.42
Age group	1≥15	1	0.75
	16≥30	7	5.30
	31≥45	70	53.03
	46≥60	47	35.6
	61≥75	6	4.54
	76≥90	1	0.75
Education	Illiterate	24	18.18
	Basic	74	56.06
	Matriculate	23	17.42
	Graduate	11	8.33
Occupation	People from protected areas	15	11.36
	Farmer	72	54.54
	Unemployed	25	18.93
	Civil employee	20	15.15

Eight altitudinal levels were approached: ≤1000 m, 1000–1400 m, 1400–1800 m, 1800–2200 m, 2200–2600 m, 2600–3000 m, and 3000–3400 m. Of the 132 informants, 73.48 % (N = 97) are aware of at least one usage for lichens or have heard of them. The semi-structured questionnaires were used to conduct in-depth interviews with these 97 respondents.

Uses of Lichens:

Five lichen uses reported in the research region were found by our investigation. These values consist of food value (FV), ritual and spiritual value (RSV), ethnoveterinary value (EVV), medicinal value (MV), and dye-producing value (DV). Medicinal values (MV) had the highest usage rate (62%) among the 132 respondents, whereas ethno-veterinary values had the lowest use percentage (3.5%). Food values (FV) and ritual and spiritual values (RSV) accounted for 41% and 10% of the total, respectively. Values for dye yields were about 36.66%. Fig. 2 shows the use percentage of all the lichens.

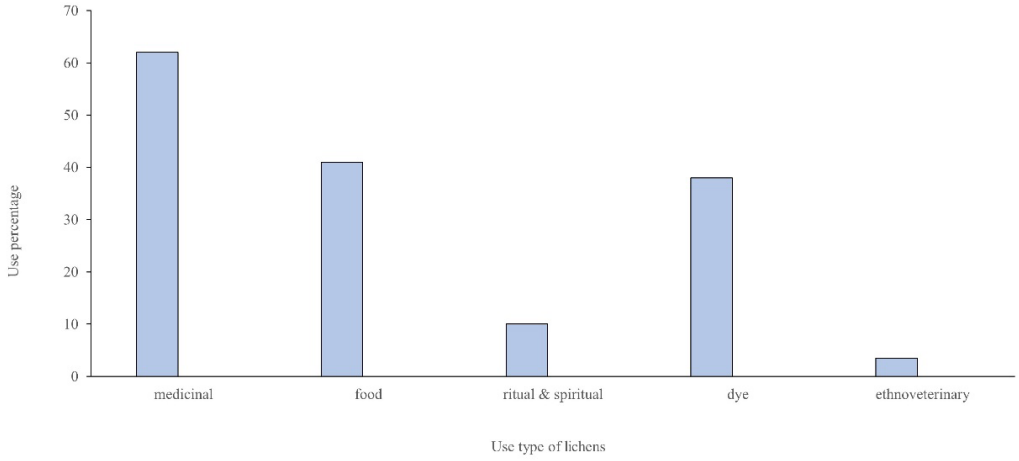


Fig 2. Use percentage of lichens in various use categories

Among the respondents, seven lichen species are particularly significant for a variety of purposes. Among these, use percentage was highest for *Hypotrachyna cirrhata* (20%). Use percentage of *Flavoparmelia caperata*, *Parmotrema nilgherrense* was 15%. *Heterodermia diademata, Ramalina conduplicans, Ramalina sinensis, Parmotrema reticulatum* and *Usnea sinensis* had use percentage 20%. Fig. 3 represents percentage of use of most used lichens.

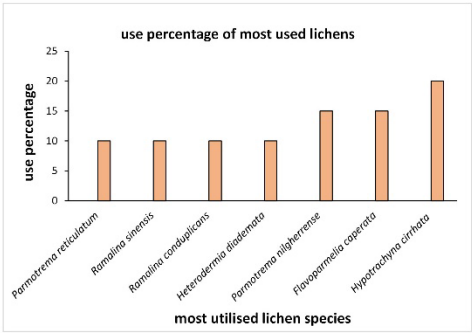


Fig 3. Percentage of use of most used lichens

Data analysis

A thorough examination of the data was conducted, employing various quantitative ethnobiological parameters such as diversity indices, informant consensus factor, use value, and relative frequency citation.

Informant consensus factor (ICF) was utilized to assess the understanding among the respondents regarding the utilization of floras in different ailment categories. ICF was measured by (Fongnzossie *et al.* 2017; Heinrich *et al.* 1998):

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

Where N_{ur} = Number of use citations for each disorder group, N_t = Number of taxa used for that disorder group. The value of this factor falls within the range of 0 to 1. A high ICF value (near to 1) signifies that a smaller number of taxa are utilized by a large portion of the respondents. Conversely, a small value suggests conflict among the respondents regarding the utilisation of taxa in various categories shown in Table 2 (Xavier et al., 2014).

Use value (UV) - The importance of the plant species was committed by calculating:

$$UV = \Sigma U_i / N$$

Where ΣU_i = Total number of uses cited by every respondent for a given taxon, N= Total number of respondents who participated in the survey are shown in table 4. High use values indicate that a plant has many use reports, highlighting its importance. Conversely, use values approach zero when there are few use reports for taxa, indicating its limited significance (Fongnzossie *et al.* 2017; Mhlongo & Van Wyk 2019).

Relative frequency citation (RFC) - In this current study, RFC values ranged from 0.248 to 0.854. It was computed by dividing the number of participants who tell the uses of taxa (FC) by the total number of participants surveyed (RFC = FC/N) shown in table 4 (Chinsembu *et al.* 2019; Tardío & Pardo-de-Santayana 2008).

ICF was used to assess the culturally significant medicinal plants that were used by different informants for the same use or disease category. The current investigation included 57 disorders within 10 distinct disease categories (Table 2). The Respiratory disorders category (heart disease and hypertension) and Ear, Nose and Throat problems had the highest ICF score (0.96), and *Hypotrachyna cirrhata* was the most used lichen.

Table 2. Informant consensus factor for lichens belonging to different disease groups from different study sites

Category or Disease group	Ailments	Use citation (Nur)	Species (Nt)	ICF
Dermatological disorders	Wound Healing, Inflammation, Skin Rashes, Boils, Warts, Dandruff, Hair Growth, Leucoderma, Eczema, Burning, Psoriasis	99	10	0.90
Gastrointestinal disorders	Stomachache, Ulcers, Ringworms, Diarrhea, Dysentery, Constipation, Gastroenteritis, Flatulence, Pyloric Disease, Dyspepsia, Vomiting, Digestion, Haemorrhoids	49	3	0.95
Ear, Nose and Throat problems	Earaches, Nose Bleeding, Tonsillitis, Running Nose	31	2	0.96
Infectious diseases	Headache, Jaundice, Migraine, Cold, Fever	62	6	0.91
Metabolic disorders	Diabetes, Cholesterol, Blood purification	7	2	0.83
Muscular and Joint disorders	Arthritis, Fractured bones, Sprain, Epilepsy, Rheumatism	30	1	1

Sexual disorders	Menstrual cramps, Hematuria, Urinary tract infection, Leucorrhoea	20	3	0.89
Respiratory disorders	Cough, Asthma, Tuberculosis, Bronchitis	62	3	0.96
Teeth disorders	Toothache, Gum bleeding, Gingivitis	15	1	1
Excretory disorders	Kidney stone, Kidney infection, Diuretic	20	3	0.89

ICF value was the highest from lichens with Ethnoveterinary value (1). The ICF value for food value, ritual & spiritual value, ethnoveterinary value and dyeing agent was 0.56, 0.71, 1, 0.56 (Table 3).

Table 3. Represents Informant Consensus Factor (ICF) of lichens with food value, ritual & spiritual value and ethnoveterinary value from different study sites.

Category or use group	**Use type**	**Use citation (Nur)**	**Species (Nt)**	**ICF**
Food value	Spice, vegetable, soup, wine	26	12	0.56
Ritual & spiritual value	Sacrificial matter	8	3	0.71
Ethnoveterinary value	Wounds, cuts, boils, warts on animal skin	5	1	1
Dyeing agent	Dye and litmus agent	42	19	0.56

Lichens in ethno-medicine:

The study discussed 16 lichen species, their ethno-medicinal values, and mode of administration. These lichens were used for different health problems like dysuria, cardiac and renal conditions, bone and muscle problems, etc (Table 4).

Table 4. Lichen with their ethno-medicinal uses, mode of administration, family.

Lichen sp.	**Family**	**Mode of administration**
Cladonia fruticulosa Kremp.	Cladoniaceae	Topical application of the extract of this lichen is employed to treat bacterial infections affecting the skin.
Dermatocarpon miniatum (L.) W. Mann	Verrucariaceae	It is used for hypertension, as a potent diuretic, for eliminating parasites, treating children's malnutrition, diarrhoea, enhancing digestion, and relieving abdominal distention. Consume the decoction or consume it as a soup.
Flavoparmelia caperata (L.) Hale	Parmeliaceae	The lichen is desiccated, pulverised, and sprinkled on skin abrasions. A decoction is ingested to alleviate high body temperature.
Flavoparmelia flaventior (Stirt.) Hale	Parmeliaceae	It is used as an Antibiotic precursor.
Heterodermia diademata (Taylor) D.D. Awasthi	Physciaceae	It is utilised for lacerations and wounds. The leaves of *Ageratina adenophora* are utilised to create a paste, which is applied to cuts and subsequently covered with a paste prepared from lichen thalli. This protective measure safeguards the wound from water and potential infections.
Hypotrachyna cirrhata (Fr.) Divakar, A. Crespo, Sipman, Elix & Lumbsch	Parmeliaceae	The combustion of this substance produces smoke that alleviates headaches, while the powdered form can be used as an effective nasal snuff for treating cephalic conditions and also, prescribed for the treatment of colds and fever. Application of the entire thallus is used to treat cuts and wounds.

Parmotrema abessinicum (Nyl. ex Kremp.) Hale	Parmeliaceae	It is eaten in raw form for some unknown medicinal benefits.
Parmotrema nilghirrense (Nyl.) Hale	Parmeliaceae	Many diseases are treated using thallus paste. This medication is used to treat rheumatism, fevers, headaches, sore throats, broken bones, musculoskeletal pain, constipation, loss of hunger, flatulence, diarrhoea, stomach issues, stones in the kidneys, painful urine production, haemorrhoids, unintentional semen emission, lack of menstruation, painful menstruation, bronchitis, congestion, shortness of breath, salivation that is excessive, fevers, headaches, painful throats, fractured bones, musculoskeletal pain, rheumatism, scabies, scabies, constipation, and prenatal and postnatal care. changed into therapeutic oils, applied as a head ointment to alleviate migraines, and applied as a poultice to the lower back and kidney areas to stimulate the generation of urine.
Parmotrema reticulatum (Taylor) M. Choisy	Parmeliaceae	This lichen is recommended for the treatment of coughs and throat ailments by local people, as well as unidentified respiratory conditions. Thallus is made into a paste, mixed with honey and taken for colds and coughs.
Parmotrema sancti-angeli (Lynge) Hale	Parmeliaceae	It is utilised in the treatment of dermatological conditions by incinerating 30-50 grammes of jhavila and combining the resulting ash with mustard oil.
Parmotrema subtinctorium (Zahlbr.) Hale	Parmeliaceae	This lichen is utilised for the treatment of haemorrhage from external trauma, localised oedema, and discomfort. It is also taken in the form of juices in water.
Punctelia borreri (Sm.) Krog	Parmeliaceae	The medication from this lichen is employed for the treatment of visual impairment, uterine bleeding, external injury bleeding, skin ulcers and inflammation, and chronic dermatitis.
Ramalina conduplicans Vain.	Ramalinaceae	Thallus powder is used to treat colds and coughs.
Ramalina sinensis Jatta	Ramalinaceae	Thallus powder is taken with warm water in case of cold and coughs.
Usnea aciculifera Vain.	Parmeliaceae	Dried lichen powder is taken with warm water and used for the treatment of cystitis, dysuria, urine retention, as well as oedema in cardiac and renal conditions.
Usnea orientalis Motyka	Parmeliaceae	The entire lichen is pulverised and then used topically on cuts and wounds.

Lichen with ritual/spiritual values:

In our study, we found that 3 lichens (*Hypotrachyna cirrhata , Parmotrema nilgherrense* and *Ramalina conduplicans*) were of ritual/ spiritual lichens value(Table 5).

Table 5. Lichen with ritual/spiritual values

Lichen sp.	**Family**	**Use**
Hypotrachyna cirrhata (Fr.) Divakar, A. Crespo, Sipman, Elix & Lumbsch	Parmeliaceae	It is used in Hindu rituals where it is used as a sacrificial material for fire or 'hawan'
Parmotrema nilgherrense (Nyl.) Hale	Parmeliaceae	It is used by Hindus as sacrificial material in 'hawan'.
Ramalina conduplicans Vain.	Ramalinaceae	It is said that couples who eat this cold dish at marriage feasts would love each other more and never part. The lichen is served with salt, chilli powder, and other flavours after being boiled in water with soda for ten to twenty minutes and then soaked in fresh water for one to two days to make the dish.

Lichens used in cuisine

Lichens have a history of use in various cuisines around the world, often valued for their unique flavours and textures. Lichens as food have become increasingly popular among humans because of their many benefits, including low cost, high nutritional value, and widespread accessibility.

Lichen species have been discovered as a more potent means of averting starvation. In our study we mention the use of 12 lichen species (Table 6) used for flavoring meat, vegetables, curries. *Hypotrachyna cirrhata, Canomaculina subtinctora, Parmotrema reticulatum* were commonly used as spices.

Table 6. Lichen in cuisine

Lichen species	Family	Use
Bulbothrix meizospora (Nyl.) Hale	Parmeliaceae	People use it to flavour food in local ceremonies.
Canomaculina subtinctoria (Zahlbr.) Elix	Parmeliaceae	This lichen is used as a spice for flavouring food including meat, vegetables and curries.
Canoparmelia texana (Tuck.) Elix & Hale	Parmeliaceae	It is commonly utilised as a spice for flavouring vegetables.
Flavoparmelia flaventior (Stirt.) Hale	Parmeliaceae	Lichen is used to make a mixture that is used in preparation of meat dishes.
Heterodermia diademata (Taylor) D.D. Awasthi	Physciaceae	Lichen is used to flavour food in local ceremonies.
Hypotrachyna cirrhata (Fr.) Divakar, A. Crespo, Sipman, Elix & Lumbsch	Parmeliaceae	This lichen is used by people of higher altitudes to make a soup, and is also used as a spice.
Myelochroa aurulenta (Tuck.) Elix & Hale	Parmeliaceae	This lichen is used as a spice for flavouring food including meat, vegetables and curries.
Parmotrema nilgherrense (Nyl.) Hale	Parmeliaceae	This lichen is used as a spice for flavouring food including meat, vegetables and curries.
Parmotrema reticulatum (Taylor) M. Choisy	Parmeliaceae	This lichen is used as a spice for flavouring food like curries.
Parmotrema tinctorum (Despr. ex Nyl.) Hale	Parmeliaceae	It is commonly used by people to flavour their foods as it is important part of spice mixture.
Ramalina sinensis Jatta	Ramalinaceae	It is used as a spice for flavouring food including meat, vegetables and curries.
Usnea orientalis Motyka	Parmeliaceae	It is used as a spice by people of higher altitudes for flavouring food.

Lichens used as dyeing agents:

Lichens have been used as natural dyes for centuries, prized for their ability to produce a range of colours. In India, lichens have a long history of being used as natural dyes. The country's diverse flora includes many lichen species that have been traditionally used for dyeing textiles, especially in rural and tribal areas. Table 7 mentions the lichen used as dyes in the study area.

Table 7. Lichen used as dyes:

Lichen sp.	Lichen family
Bulbothrix setschwanensis (Zahlbr.) Hale	Parmeliaceae
Dermatocarpon vellereum Zschacke	Verrucariaceae
Heterodermia hypochraea (Vain.) Swinscow & Krog	Physciaceae
Heterodermia pseudospeciosa (Kurok.) W.L. Culb.	Physciaceae
Leptogium delavayi Hue	Collemataceae
Leucodermia boryi (Fée) Kalb	Physciaceae

Parmelinella wallichiana (Taylor) Elix & Hale	Parmeliaceae
Punctelia rudecta (Ach.) Krog	Parmeliaceae

In the present study, the value of the relative frequency citation (RFC) ranged from 0.015-0.153. The results showed that RFC value of **Heterodermia diademata** for food value was highest (0.72) and RFC for food value was lowest for *Bulbothrix meizospora* (0.015) (Table 8).

Table 8. Lichen, their families, application, their use value and RFC

Lichen sp.	**Family**	**Traditional application**	**Use Value**	**RFC**
Bulbothrix meizospora (Nyl.) Hale	Parmeliaceae	FV	0.75	0.015
Bulbothrix setschwanensis (Zahlbr.) Hale	Parmeliaceae	DV	0.11	0.12
Canoparmelia texana (Tuck.) Elix & Hale	Parmeliaceae	FV	0.43	0.27
Cladonia fruticulosa Kremp.	Cladoniaceae	MV, DV	0.34, 0.21	0.22, 0.23
Dermatocarpon miniatum (L.) W. Mann	Verrucariaceae	MV	0.51	0.11
Dermatocarpon vellereum Zschacke	Verrucariaceae	DV	0.10	0.13
Flavoparmelia caperata (L.) Hale	Parmeliaceae	MV, RV, DV	0.22, 0.21, 0.43	0.31, 0.24, 0.41
Flavoparmelia flaventior (Stirt.) Hale	Parmeliaceae	MV, FV	0.4, 0.32	0.3, 0.35
Heterodermia diademata (Taylor) D.D. Awasthi	Physciaceae	MV, FV	0.31, 0.28	0.13, 0.72
Heterodermia hypochraea (Vain.) Swinscow & Krog	Physciaceae	DV	0.11	0.10
Heterodermia pseudospeciosa (Kurok.) W.L. Culb.	Physciaceae	DV	0.11	0.12
Hypotrachyna cirrhata (Fr.) Divakar, A. Crespo, Sipman, Elix & Lumbsch	Parmeliaceae	MV, FV, RV, DV	0.17, 0.31, 0.34, 0.41	0.204, 0.23, 0.41, 0.37
Leptogium delavayi Hue	Collemataceae	DV	0.13	0.11
Leucodermia boryi (Fée) Kalb	Physciaceae	DV	0.10	0.11
Myelochroa aurulenta (Tuck.) Elix & Hale	Parmeliaceae	FV	0.21	0.30
Parmotrema abessinicum (Nyl. ex Kremp.) Hale	Parmeliaceae	MV	0.21	0.18
Parotrema nilghirrense (Nyl.) Hale	Parmeliaceae	MV, FV, DV	0.35, 0.23, 0.33	0.23, 0.38, 0.43
Parmotrema reticulatum (Taylor) M. Choisy	Parmeliaceae	MV, FV	0.27, 0.34	0.17, 0.43
Parmotrema sancti-angeli (Lynge) Hale	Parmeliaceae	MV	0.37	0.30
Parmotrema subtinctorium (Zahlbr.) Hale	Parmeliaceae	MV	0.02	0.015
Parmotrema tinctorum (Despr. ex Nyl.) Hale	Parmeliaceae	FV	0.57	0.53
Parmelinella wallichiana (Taylor) Elix & Hale	Parmeliaceae	DV	0.42	0.39
Punctelia borreri (Sm.) Krog	Parmeliaceae	MV	0.25	0.15
Punctelia rudecta (Ach.) Krog	Parmeliaceae	DV	0.23	0.18
Ramalina conduplicans Vain.	Ramalinaceae	MV, RV	0.22, 0.4	0.37, 0.31
Ramalina sinensis Jatta	Ramalinaceae	MV, FV	0.22, 0.11	0.17, 0.21

Usnea aciculifera Vain.	Parmeliaceae	MV	0.151	0.21
Usnea orientalis Motyka	Parmeliaceae	MV, FV	0.30, 0.35	0.32, 0.29

Discussion

Our study revealed the presence of lichens with different uses. We found considerable overlap between the medicinal and consumed lichens and 7 lichens were of numerous uses. These lichens include *Flavoparmelia caperata*, *Parmotrema nilgherrense*, *Heterodermia diademata, Ramalina conduplicans, Ramalina sinensis, Parmotrema reticulatum* and *Usnea sinensis* (Fig. 3). *Heterodermia diademata* was also found to be important lichen in study by (Saklani & Upreti, 1992). Yang et al (2021) mentioned use of three species of edible lichens (*Leptogium wilsonii*, *Leucodermia leucomelos* and *Lobaria isidiophora*), other species with edible uses also have medicinal functions. The RFC values ranged from 0.015-0.53. Lichens have been used since ancient times for their various benefits. Due to the presence of various phytochemicals lichens have been proven medicinal and edible (Murugesan 2020). Fig 4. show the number of lichen family with most members used for different purposes.

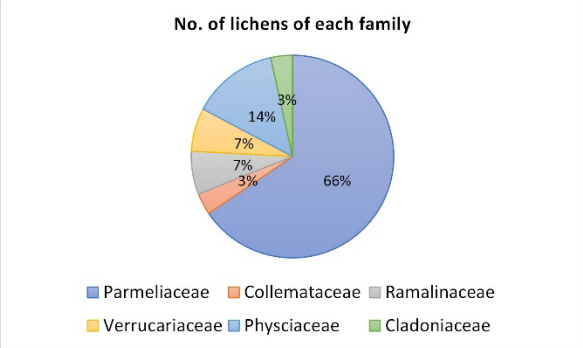


Figure 4. Lichen families represented by percentage of members of each family.

Family Parmeliaceae with nineteen members was the dominant family, followed by Physciaceae(four lichens), Ramalinaceae (two lichens), Verrucariaceae (two lichens), Collemataceae and Cladoniaceae both represented by one member each.

Conclusion

The use of lichens to treat different diseases has actively been emerging in the recent decade. Various researchers have found that ethnopharmacological relevance can be examined through comparison with previous studies. Our investigation has discovered more than 28 types of lichens in the study area. We have identified lichen species that are utilized for food, medicinal, and spiritual purposes. The North-Western Himalayas have an abundant supply of lichen resources. One significant advantage is that they are easily accessible in this region and predominantly thrive at high altitudes, unaffected by human activity and pollution. We would recommend bioprospection of the lichens of the study area. The use of these lichens is limited to personal uses by the people of the study area. Bioprospection of lichen so that people can generate their livelihood from these natural resources found in the wild would be a great method of livelihood generation. Local people may contact vendors in nearby towns and supply them the lichens for livelihood generation.

Declarations

Abbreviations: Relative frequency citation (RFC), Food value (FV), ritual and spiritual value (RSV), ethnoveterinary value (EVV), medicinal value (MV), and dye producing value (DV), Informant consensus factor (ICF).

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Consent for publication: Not applicable.
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