Ethnomedicinal plants used in Khatling valley of Western Himalaya, India

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Research

Abstract

Background: Khatling valley is an unexplored and remote region located in the Uttarakhand state of Indian Himalaya, the area possesses rich medicinal flora, and local inhabitants using these plants since generations. The majority of primary health care depends upon traditional medicine due to the unavailability of a modern medicinal facility, however, the identity of medicinal plants is limited to traditional healers or elder people in the region thus the documentation of such important medicinal knowledge is a dire need for sustainable use.

Methods: An ethnomedicinal survey was carried out in this region from 2018 to 2020. Ethnomedicinal data were collected from 82 informants through semi-structured questionnaires and group conversations. To check the popular and frequently used species URs and Informant consensus factor (ICF) were calculated for the collected data.

Results: The present study recorded 68 plants from 63 genera and 35 families utilized for treating various disorders. The dominant families were Asteraceae (7) and Rosaceae (6) followed by Apiaceae, Lamiaceae, Ranunculaceae, Polygonaceae, Zingiberiaceae (4 species each). The majority of the useful plants were herbaceous (78%) followed by trees (12%), shrubs (9%), and climbers were the least in number (1%). Most of the plant parts used were leaves and roots 25% each, followed by rhizome, aerial part and tuber (9% each), seeds, fruits, and whole plant (5% each), bark (4%) while, stem, flower, resin, and the bulb has less proportion (1% each). Five drug formulations were used by the local inhabitants of which paste was the most common (32%) followed by powder (31%), decoction (19%), raw (12%), and juice (6%). Some important medicinal plants based on use reports (URs) were *Valeriana jatamansi* Jones (300 URs and 5 uses), *Aconitum lethale* Griff. (275 URs and 5 uses), *Nardostachys jatamansi* (D. Don) DC (250 URs and 4 uses), *Solanum nigrum* (L.) (234 URs and 5 uses), *Paeonia emodi* Royle (230 URs and 4 uses). ICF values ranged between 0.96 and 1. The highest ICF value (1) was recorded for mental disorders (ICD code F) and epilepsy (ICD code G) while a minimum of 0.96 was recorded for blood problems (ICD code I).

Conclusion: Ethnomedicinal plants having high URs and ICF can be a good source for novel phytoconstituents and novel drug discoveries, apart from this documentation of traditional knowledge will be helpful for the new generation, researchers, and policymakers for sustainable use of the species.

Keywords: Ethnomedicine; Indigenous knowledge; Medicinal plants**;** Remote region

Background

Globally, medicinal plants have been the main source of primary healthcare systems since ancient times. Traditional herbal medicine such as Ayurveda of India, Traditional Chinese Medicine (TCM) of China, and Muti of Africa has been widely practiced in ancient civilizations for more than 500 years (Prasthkumar *et al.,* 2021). Several medicinal plants mentioned in ancient Indian literature (Rig-Veda, Atherveda, and Charka Sanhita) are effective in treating various ailments and at present various potent plant-derived modern medicines are available (Sharma et al., 2011). Recently the use of herbal medicine is rapidly increasing due to its safe and cost-effective properties in comparison to modern allopathic medicine and pharmacological activity is being investigated for several medicinal plants (Tamang et al 2019, Kunwar et al 2009). The traditional medicine market is expected to reach $115 billion by the end of 2023 at a growth of Compound annual growth rate (CAGR) of ~ 7.2 % during 2017-2023 (Carvalho 2020).

Ethno-medicine is an integral part of native or local people and plays a vital role in daily lifestyle. Due to low cost, effective outcomes, and easy availability of medicinal plants in near surroundings, these therapeutic techniques have been passed down from generation to generation and are currently practiced in many communities (Singh *et al.* 2017). Younger generations are out-migrating for education and job thus, indigenous knowledge is disappearing day by day, thus necessitating the recording of traditional medical knowledge (Tamang *et al.* 2021). These significant therapeutic plants contain a variety of bioactive chemicals with several pharmacological uses. Ethnic or tribal people rely upon the surrounding plants to acquire monetary qualities and essential medical services (Singh *et al.* 2017, Tamang *et al.* 2021). Remote regions still possess good knowledge about medicinal plants especially elder people and specialists (Vaidya and Daai) possess high medicinal knowledge (Singh *et al.* 2017).

Documentation of ethnomedicinal plants not only serves the local remedies about uses but also helps to identify the extraction pressure on wild genetic resources. Quantification of local medicinal knowledge could be helpful for further pharmacological investigation and novel drug discoveries. There is a great scope for ethnobotanical study in remote regions where people mainly rely on ethnomedicinal plant wealth for therapeutic care due to the lack of modern healthcare facilities and transportation. The residents of Khatling valley still have immense intact traditional knowledge of medicinal plants and ethnobotanical study of tree species has been carried out in this region so far (Singh *et al.* 2022). Therefore present study was carried out in Khatling valley and aims to:

1. Identify the traditional medicinal plants in a remote region of western Himalaya.
2. Documentation of use pattern, parts used, and mode of administration of medicinal plants in the region.
3. Identify the frequently used plant species for the recommendation of future research and pharmacological activity as well as conservation and sustainable use.

Material and Methods

Study area

Khatling valley is located in Tehri district of Uttarakhand, India, and lies between 30◦31"19.13' to 30◦41"24.65'N and 78◦44"40.01' to 78◦50"28.80'E (Fig. 1). The Khatling valley covers a broad range of geographical and climatic conditions which support a rich diversity of plant habitats i.e. Alpine to subalpine and temperate environment. Khatling valley consisted of about 260 villages and the total population is about 109756 (49466 males and 60290 females) (Census of India 2011). Inhabitants of the valley speak the Garhwali dialect. The valley is dominated by different plant communities and forest types, lower altitudes are dominated by *Pinus roxburghii, Quercus oblongata,* and so forth and higher altitudes are dominated by *Betula utilis* forests, scrubs, and alpine pastures. Rabi, Kharif, and Zaid are the three most common types of crops. Wheat and mustard are the principal Rabi crops in the region, whereas Rice, Maize, Finger millet, and Amaranthus are the key Kharif crops. Beans, cucumbers, and pumpkin are among the Zaid crops. Generally, the people of the lower valley are dependent on a mixed cropping system, however, mono-cropping is prevailing in higher altitudes , and it is an important part of their diet as well as a source of livelihood., these crops are Amaranthus, Potato, Beans, and Pulses. Apple, Peach, Cherry, and Walnut are among the fruits available in the region, few of the villagers also cultivate some important medicinal and aromatic plants i.e. *Aconitum heterophyllum, Saussurea costus, Valeriana jatamansi* etc. The annual rainfall ranges from 1400 to 2600 mm, with summer temperature varying from 15° C to 35°C and winter from -4°C to 15°C.

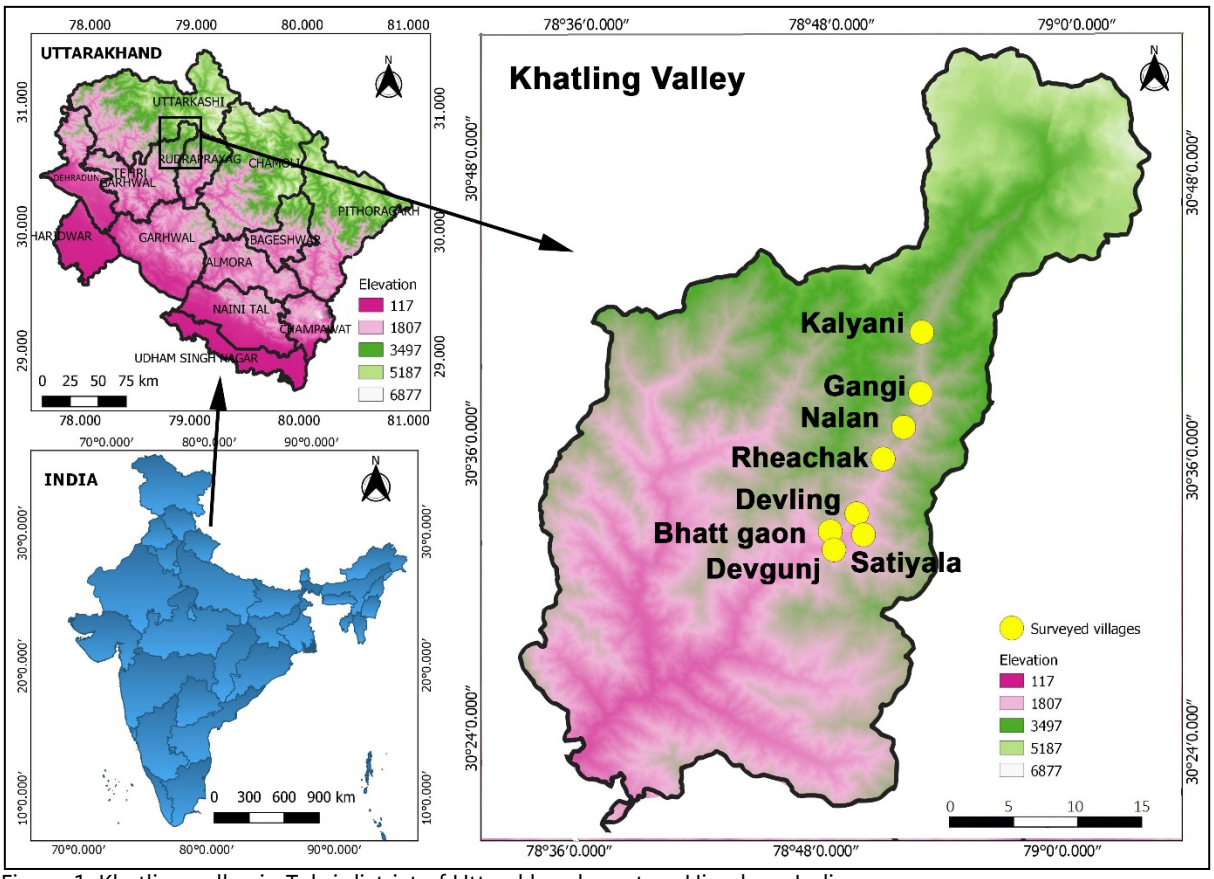

Figure 1. Khatling valley in Tehri district of Uttarakhand, western Himalaya, India

Data collection

Ethnomedicinal survey was conducted from 2018 to 2020 in the Khatling valley of Western Himalaya India, information was collected using semi-structured questionnaires following Singh *et al.* 2019, interviews, and group discussions with local inhabitants and local healers. With the aid of local healers and key informants, useful medicinal plants were gathered. After getting their prior informed consent, a total of 82 informants were questioned. Collected specimens were processed as per the standard herbarium techniques and mounted on herbarium sheets (Singh *et al.* 2017, Tamang *et al.* 2021) collection number were allotted and further identified by consulting local and regional floras (Gaur, 1999, Naithani, 1984-85, Pusalkar, 2018), Kew herbarium catalog (http://apps.kew.org/herbcat/navigator.do), and herbaria of Botanical Survey of India Northern circle, Dehradun (BSD) and Garhwal University Herbarium (GUH). Recently accepted names of species were updated by following the Plant List, Tropicos, and Plants of the world (https://theplantlist.org, https://www.tropicos.org, http://www.plantsoftheworldonline.org).

Demographic profile of the informants

During the study, 82 people were interviewed in the Khatling valley in Western Himalaya India. (Table 1). Among the 82 informants, 45 (54.88%) were men and 37 (45.12%) were women. A majority of Informants were in the age group of 40-59 (58.53%) and the minimum (3) in the age group of 30-39 (3.65%). Among the informants, primary education was predominant (59.75%), while the rest were illiterate (28.04), and matric (12.19%). Among the 82 informants, 26 were traditional practitioners (17 men and 9 women). The majority of the participants learned their ethnomedicinal knowledge from their elders (67.07%) however, 32.93% obtained it via self-experiment.

Data analysis

Collected data were analyzed using Microsoft Excel 2013 and R version 3.6.2. Further Ethnomedicinal data were quantitatively analyzed by the following indices-

Use Reports (URs)

Use report or citation for a species is an important tool for assessing ethnobotanical data set, if a species has single use and high URs means the species is popular among the inhabitant and also has high use efficiency and can be

further investigated for pharmacological testing and drug discoveries. URs represents the absolute number of participants citing any uses of species and can be effective for further research.(Trotter and Logan, 1986, Caroline et al 2018).

Table 1. Demographic feature of informants.

Demographic feature	Categories	No of person	Percentage
Informants	Local inhabitant male	45	54.88
	Local inhabitant female	37	45.12
Total		82	
	Local healer male	17	20.73
	Local healer female	9	10.97
Age group	30-39	3	3.65
	40-49	28	34.14
	50-59	20	24.39
	60-69	16	19.51
	>70	15	18.29
Education	Illiterate	23	28.04
	Primary	49	59.75
	Matric	10	12.19
Source of knowledge	Self-experiment	27	32.93
	Parents	55	67.07

Informant consensus factor (ICF)

The ICF was determined using formula given by Phillips & Gentry, 1993.

$$ICF = Nur\text{-}N\ species\ /(Nur-1).$$

Where Nur indicates use-reports number for a certain category of ailment while N taxa denote the total number of taxa utilized for that ailment category by all informants. The ICF scale runs between 0 to 1 and a high value suggests that a small fraction of informants utilize a small number of taxa (Tamang *et al.* 2021).

Ethnomedicinal uses and ailments were categorized following the International Classification of Diseases 11th 141 (ICD 11, Access date 15 March 2022) and thirteen ailments categories were assigned.

Results

Ethomedicinal plants of Khatling valley

A total of 68 taxa belonging to 63 genera and 35 families which were utilized for curing several diseases were recorded. (Table 2). The higher number of plants reported in the region showed that the people are still using local remedies and depend on medicinal plants for curing various intense and chronic diseases due to the unavailability of modern medicines, hospitals, transportation, and poor financial status of the inhabitants (Singh *et al.* 2017).

Plants family and life form

Asteraceae was the dominant family (with 7 species), followed by Rosaceae (6 species), Apiaceae, Lamiaceae, Ranunculaceae, Polygonaceae, Zingiberiaceae, (4 species each). Herbs were frequently used plant part (78%), followed by trees (12%), shrubs (9%), and climbers (1%). (Fig. 2).

Plant part used

Present study reported thirteen plant parts used to cure different ailments in Khatling valley of Western Himalaya, India. Leaves and roots were showed higher use proportion (25%), followed by rhizome, aerial part, and tuber (9%), seeds, fruits and whole plant (5 %), bark (4%), stem, flower, resin, and bulb (1%) (Fig. 3).

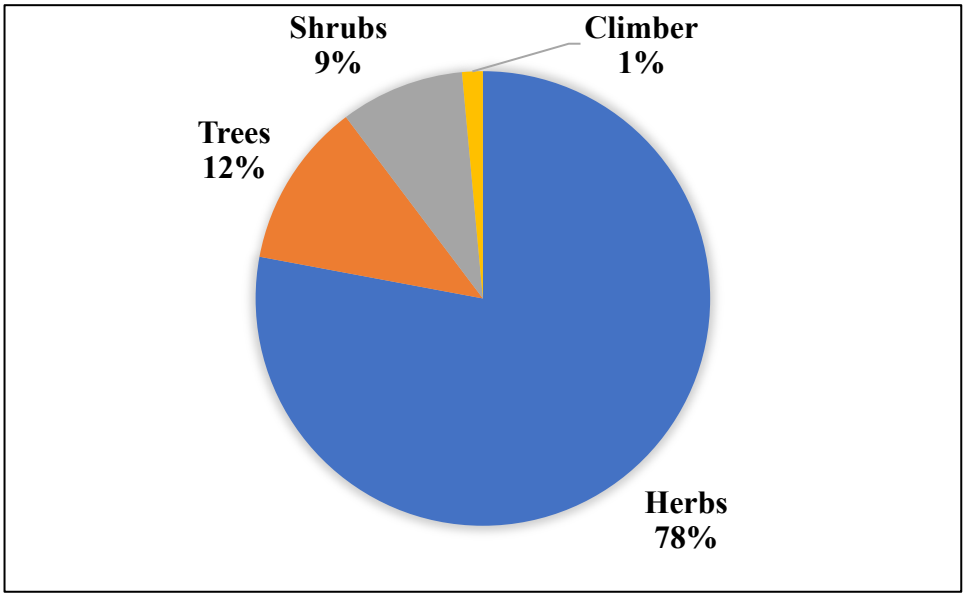

Figure 2. Proportion of life froms of ethnomedicinal plants

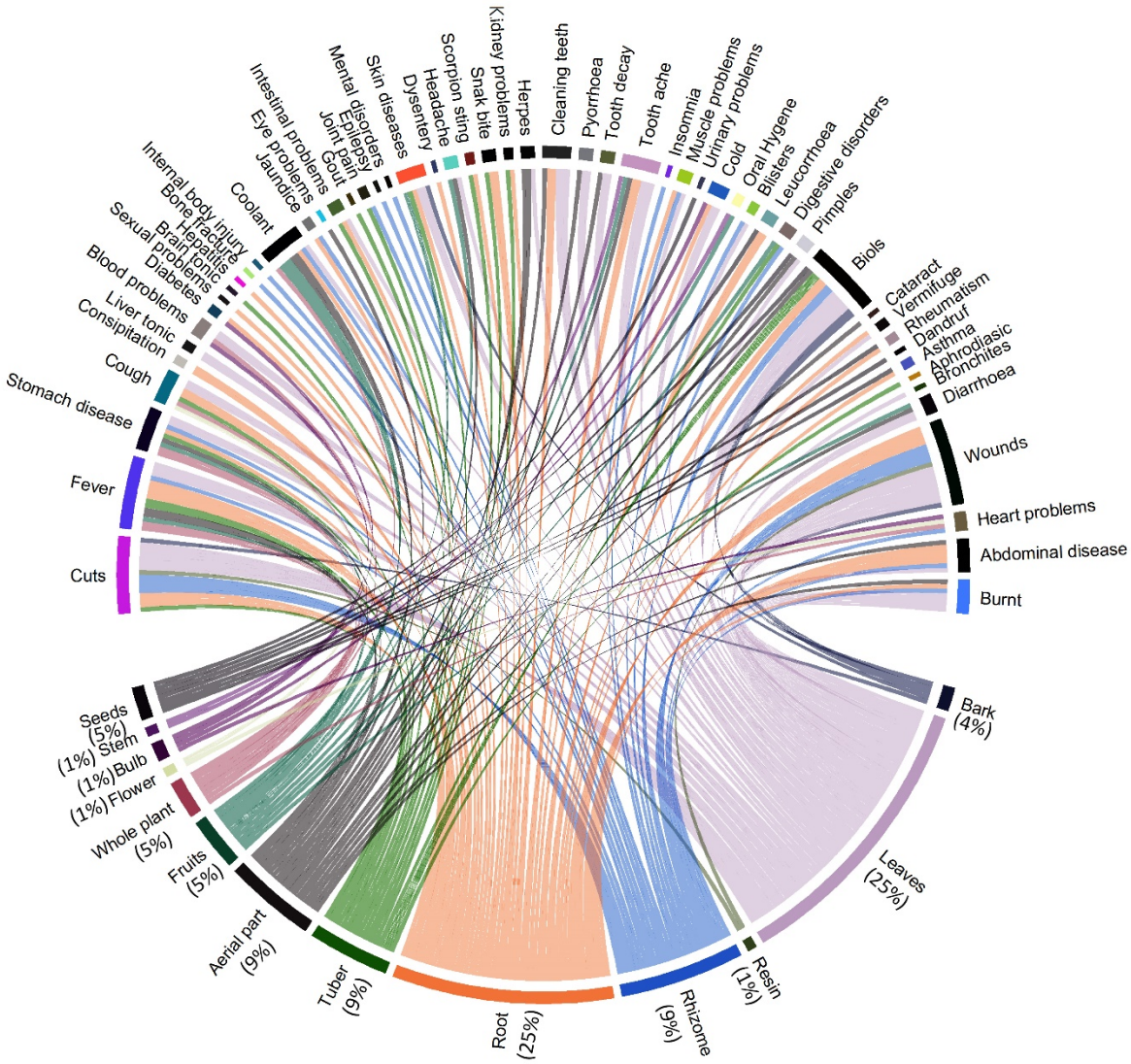

Figure 3. Plant parts used in the treatment of different ailments, lower half of chord diagram showing plant parts used and upper half showing ailments treated.

Mode of drug preparation

A total of five drug preparation methods i.e. paste, powder, decoction, raw and juice were reported in present study, among these paste was frequently used drug preparation method (32%), followed by powder (31%), decoction (19%), raw (12%), juice (6%) (Fig.4). Paste was most utilized drug form and generally used to treat various skin diseases like cuts, wound and boils (15, 16, 12 taxa each) (Fig. 4)

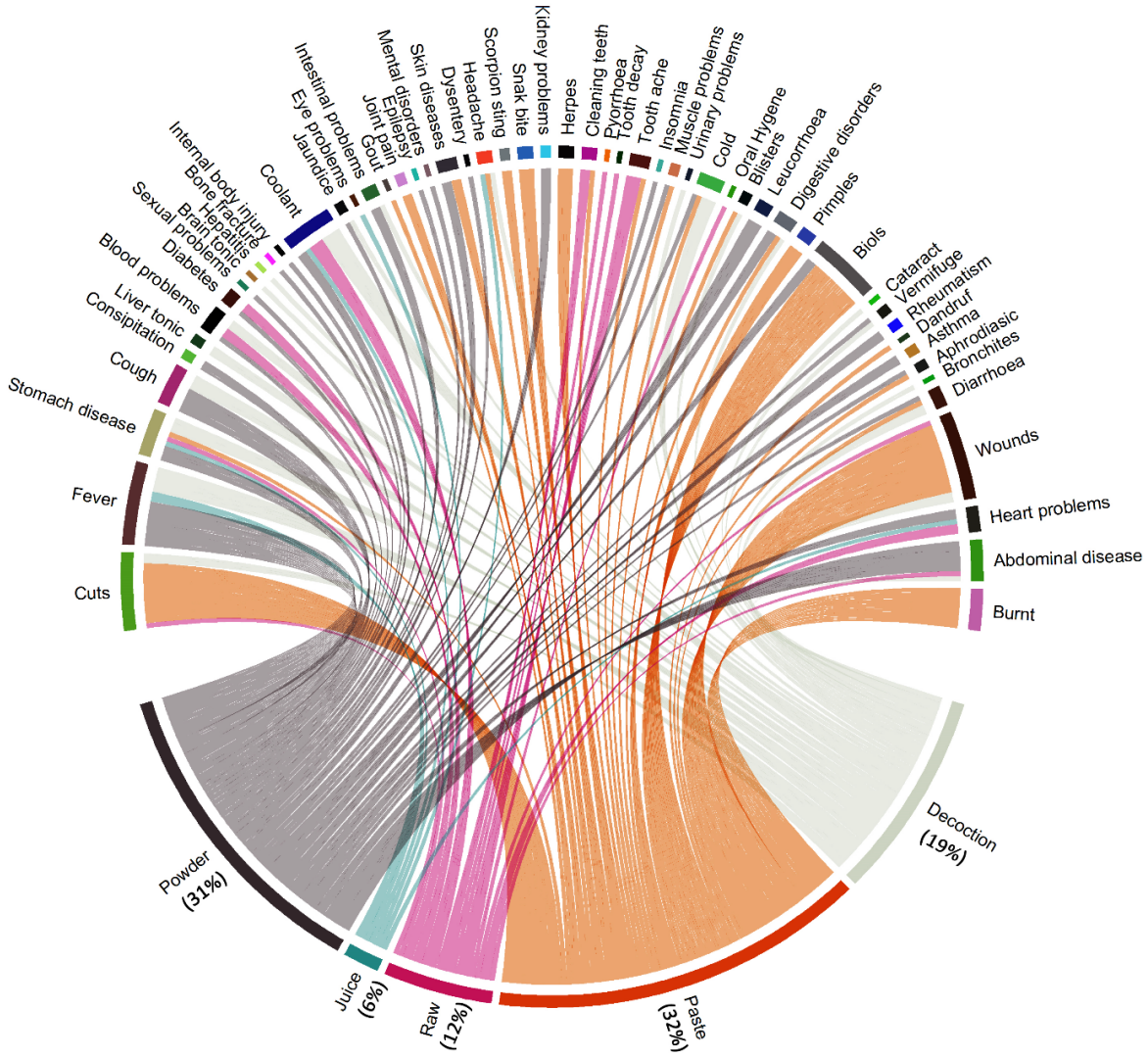

Figure 4. Method of drug preparation in different ailments, lower half of chord diagram showing drug preparation methods and upper half showing disease cured by respective drug formulation.

Medicinal uses and Use reports

In the present study, some frequently cited plant species are *Valeriana jatamansi* 300 URs and used to cure fever, abdominal pain, digestive problems, cuts, wounds and blisters, *Aconitum lethale* 275 URs used to cure snake bite and scorpion sting, boils, gout, joint pain, *Nardostachys jatamansi* 250 URs and used to cure epilepsy, mental disorder, insomnia and heart diseases, *Solanum nigrum* 234 URs and used to cure fever, indigestion, coolant, headache, cut and wounds., *Paeonia emodi* 230 URs and used to cure stomachache, intestinal spasm, diarrhea, and to remove intestinal worms, *Rumex nepalensis* 216 URs and used to cure burns, boils, cut and wounds, *Polygonum capitatum* 204 URs and used to cure burns, boils, pimples and herpes, *Hedychium spicatum* 186 URs and used to cure joint pain, burns, boils, cuts and wounds, *Ocimum basilicum* 200 URs and used to cure fever, cough and cold, urinary troubles, *Origanum vulgare* 200 URs and used to cure diarrhea, bronchitis, cough and cold, *Picrorhiza kurrooa,* 188 URs and used to cure fever, abdominal pain, coolant and to expel intestinal worms, *Plantago depressa* 188 URs and used to cure burns, boils, pimples and herpes, *Geranium wallichianum* 184 URs and used to cure fever, cough, cold and dysentery, *Juglans regia* 184 URs and used to cure tooth decay, pyorrhea and for shining teeth, however, *Cyathula tomentosa* and *Rhododendron arboreum* was least cited species; *Cyathula tomentosa* 19 URs and used to cure snake bite, *Rhododendron arboreum* 12 URs and used as a heart tonic. (Table 2).

Table 2. Ethnomedicinal plants used by local inhabitants of Khatling valley in Tehri district of Uttarakhand, western Himalaya, India

Name/ Family/ Voucher no	Vernacular name	Life form	Part used	Mode of drug	Prepartion, Doses, Application	URs
Achyranthes bidentata Blume Amaranthaceae GUH JH 4099	Chicheree	H	Whole plant	Powder	½-1 teaspoon powder of whole plant with a glass of water is taken orally twice for 5-7 days against malarial fever and whooping cough	38
Aconitum heterophyllum Wall. ex Royle Ranunculaceae GUH JH 4017	Atees	H	Tuber	Powder	½-1 teaspoon powder of dried tuber is taken orally with lukewarm water thrice a day for treatment of fever, stomachache, and against intestinal worms.	165
Aconitum lethale Griff. Ranunculaceae GUH JH 4001	Methabish	H	Tuber	Paste	Tuber paste with ghee (clarified butter) applied for treatment of snake bite and scorpion sting, boils, gout, joint pain.	275
Acorus calamus L. Acoraceae GUH JH 4030	Bauj / Baj	H	Rhizome	Powder	½ teaspoon powder of dried rhizome is taken with a glass of cold water twice a day for a week against stomachache, jaundice, refrigerant.	66
Aesculus indica (Wall. ex Cambess.) Hook. Sapindaceae GUH JH 4096	Panger	T	Seeds	Powder, paste	½ teaspoon powder of dried seed is given with lukewarm water twice (morning-evening) a day for 15-20 days against Leucorrhea and rheumatism. Hairs washed with paste of fresh seeds to cure dandruff.	117
Ageratina adenophora (Spreng.) R.M. King & H. Rob. Asteraceae GUH JH 4040	Basya	S	Leaves,	Paste	Paste of fresh leaves is applied on cut and wounds (antiseptic) and burns.	111
Ageratum conyzoides (L.) L. Asteraceae GUH JH 4031	Kalabasya / Gundrya	H	Aerial parts	Paste	Paste of aerial part is applied on cuts and wounds (antiseptic) and burns.	123
Ajuga parviflora Benth. Lamiaceae GUH JH 4022	Neelkanthi/	H	Aerial part	Decoction	½-1 teaspoon decoction of aerial part with a glass of water is taken orally thrice a day for treatment of stomachache, abdominal problems, and also act as coolant.	138
Allium sativum L. Amaryllidaceae GUH JH 4011	Thom	H	Bulb	Paste, raw	1-2 pieces of bulb eaten raw early morning to control cholesterol, high blood pressure and diabetes. Bulb paste mixed with mustard oil heated is applied on nose to treat cold.	88

Angelica glauca Edgew Apiaceae GUH JH 4042	Chooru	H	Root	Powder	½ teaspoon powder of dried root is taken with a glass of water twice a day for 4-5 days against constipation and stomach disorders	44
Arisaema jacquemontii Blume Araceae GUH JH 4051	Meen	H	Tuber	Powder	½ teaspoon powder of dried tuber with a glass of water once a day for cough and kidney complaints and powder mixed with oil is applied externally for skin diseases.	90
Arnebia benthamii (Wall. ex G. Don) I. M. Johnst. Boraginaceae GUH JH 4018	Lal jadi	H	Root	Paste	Paste of fresh or dried roots is applied on cut and wounds.	44
Asparagus adscendens Roxb Asparagaceae GUH JH 4045	Jhirni	S	Root	Powder	½ teaspoon powder of dried root is taken orally with a glass of lukewarm milk twice a day (morning-evening) for 15-20 days against seminal weakness, Leucorrhea, Spermatorrhoa,	60
Barleria cristata L Acanthaceae GUH JH 4096	Kularkatya / Kuladya/	H	Leaves, Root	Paste	Leaf and root paste applied in cuts and wounds.	38
Berberis lycium Royle Berberidaceae GUH JH 4077	Kingod	S	Root,	Decoction	1 glass root decoction is taken orally once a day for 3-5 days against jaundice and hepatitis.	100
Bergenia ciliata (Haw.) Sternb Saxifragaceae GUH JH 4079	Silpara	H	Root	Powder	½-1 teaspoon powder of dried root taken twice with a glass of lukewarm water is used to cure kidney stones, leucorrhea, and abdominal sanitation.	117
Betula utilis D. Don Betulaceae GUH JH 4055	Bhoj / Bhojpatra/	T	Leaves, Bark	Decoction	Leaf and bark decoction used for treatment of cut and wounds and boils.	150
Centella asiatica (L.) Apiaceae GUH JH 402	Brahmi	H	Aerial part	Decoction, juice	1-2 teaspoon decoction of the aerial part is taken with a glass of cold water for 3-4 days against diarrhea. Juice of fresh aerial part of the plant taken daily is used to cure eyesight.	54
Curcuma longa L. Zingiberiaceae GUH JH 4110	Haldu	H	Rhizome	Powder, paste	Paste of dried rhizome is applied on cuts and wounds. ½ teaspoon powder of dried rhizome mixed with a glass of lukewarm milk is taken once during bedtime against internal body injury and bone fracture.	124

Cyathula tomentosa (Roth.) Moq Amaranthaceae GUH JH 4088	Kuroo	H	Root	Paste	Root paste applied against snake bite	19
Dactylorhiza hatagirea (D. Don) Soo Orchidaceae GUH JH 4049	Hathajadi	H	Tuber, Leaves	Powder, 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. ½-1 teaspoon powder of dried tuber is taken with lukewarm milk or water to act as aphrodisiac.	150
Delphinium denudatum Wall. ex Hook. f. & Thomson Ranunculaceae GUH JH 4031	Nirbishi	H	Root	Paste	Paste of fresh or dried root mixed with ghee (clarified butter) is used against snake bite and scorpion sting.	110
Dioscorea bulbifera L Dioscoriaceae GUH JH 4048	Genthi	CL	Tuber	Powder, paste	½ teaspoon powder of tuber is taken orally thrice a day for curing fever. Tuber paste applied for treatment of boils.	100
Drymaria cordata (L.) Willd. ex Schult. Caryophyllaceae GUH JH 4044	Daidya	H	Aerial part	Paste, juice	Leaves juice is used for treatment of fever and headache. Paste of aerial part is used to cure herpes.	153
Duchesnea indica (Jacks.) Focke Rosaceae GUH JH 4073	Bhuikafa	H	Fruit	Raw	Fruit eaten directly and acts as coolant.	48
Geranium wallichianum D. Don ex Sweet Geraniaceae GUH JH 4012	Ratnjot/ kafalya	H	Root	Powder	½-1 teaspoon powder of dried root with a glass of water twice a day against fever, cough, cold and dysentery.	184
Habenaria intermedia D. Don Orchidaceae GUH JH 4082	Ridhibridhi	H	Tuber	Decoction	1 teaspoon decoction of tuber is taken with a glass of water once a day as brain tonic.	50
Hedychium spicatum Sm. Zingiberiaceae GUH JH 4004	Syodu	H	Rhizome	Paste	Paste of fresh rhizome is applied for treatment of joint pain, burns, boils, cuts and wounds.	186
Juglans regia L. Juglandaceae GUH JH 4009	Akhor	T	Leaves, Bark	Raw	Leaves, bark or branches, are directly chewed against tooth decay, pyorrhea and for shining teeth.	184
Jurinea macrocephala DC Asteraceae GUH JH 4047	Bishkandaroo	H	Root	Powder	½ teaspoon powder of dried root is taken with lukewarm water for 3-5 days to treat fever. Roots also has religious importance.	41
Lyonia ovalifolia (Wall.) Drude Ericaceae GUH JH 4101	Anyar	T	Leaves, Bark	Paste	Paste of Leaves and bark is applied to cure boils, skin diseases (antiallergic).	92

Nardostachys jatamansi (D. Don) DC Caprifoliaceae GUH JH 4098	Maasi	H	Rhizome	Powder	½ teaspoon powder of dried rhizome with lukewarm water is given orally twice a day morning and evening against epilepsy, mental disorder, insomnia and heart diseases	250
Ocimum basilicum L. Lamiaceae GUH JH 4018	Tulsi	H	Leaves, seeds	Decoction	½ glass decoction of leaves is taken twice a day for 3-5 days against fever, cough and cold. Seed immersed in a glass of water and is taken twice a day for urinary troubles.	200
Origanum vulgare L. Lamiaceae GUH JH 4026	Bantulsi	H	Leaves	Decoction	½ glass decoction of leaves is taken twice a day for 3-5 days against diarrhea, bronchitis, cough and cold.	200
Oxalis corniculata L. Oxalidaceae GUH JH 4086	Bhilmod	H	Aerial part	Decoction	1-2 teaspoon decoction of aerial part with half glass of water is used against fever it also acts as coolant. Aerial parts decoction is used to cure cataract.	150
Paeonia emodi Royle Paeoniaceae GUH JH 4083	Dhandroo / Gandhya	H	Leaves	Decoction	1 teaspoon decoction of leaves is given twice a day for treatment of stomachache, intestinal spasm, diarrhea, and to remove intestinal worms.	230
Paris polyphylla Sm. Melanthiaceae GUH JH 4071	Sankhjadi / Satwa	H	Leaves, Rhizome	Paste	Rhizome and leaves paste applied in treatment of cut and wounds.	100
Picrorhiza kurrooa Royle ex Benth Plantaginaceae GUH JH 4093	Kadway	H	Root	Powder	½ teaspoon powder of dried root is taken with 2-3 sips of lukewarm water for 3-5 days against fever, abdominal pain, coolant and intestinal worms	188
Pinus roxburghii Sarg. Pinaceae GUH JH 4084	Cheed / Kulain	T	Resin	Raw	Resin is applied against cracked heels, cut and wounds.	92
Plantago depressa Willd. Plantaginaceae GUH JH 4035	Luhurya	H	Leaves	Paste	Paste of fresh leaves is applied on burns, boils, pimples and herpes.	188

Pleurospermum brunonis Benth. ex C.B. Clarke Apiaceae GUH JH 4020	Lessar	H	Root	Powder	½ teaspoon powder of dried root with 2-3 sip of water against abdominal pain. Plant also have religious importance.	27
Podophyllum hexandrum Royle T.S. Ying Berberidaceae GUH JH 4033	Bankakhri	H	Root	Powder	½ teaspoon powder of dried root is given with lukewarm water morning and evening for a week as vermifuge, and against diabetes and constipation	150
Polygonum capitatum Buch.-Ham. ex D. Don Polygonaceae GUH JH 4002	Lohchadi	H	Aerial part	Paste	Paste of aerial part is applied on burns, boils, pimples and herpes.	204
Potentilla fulgens Wall. ex Sims Rosaceae GUH JH 4057	Bajradant	H	Root, leaves	Raw	Roots and leaves are directly chewed to cleaning teeth and against toothache.	88
Potentilla polyphylla Lindl. ex Lehm. Rosaceae GUH JH 4107	Bajradanti	H	Root, leaves	Raw	Roots and leaves are directly chewed to cleaning teeth and toothache. Paste of leaves applied on wounds	132
Prinsepia utilis Royle Rosaceae GUH JH 4052	Bhainkal	S	Fruits	Raw	Fresh fruits are eaten raw against diarrhoea and stomachache.	88
Prunus persica (L.) Batsch Rosaceae GUH JH 4108	Aaru	T	Seeds	Paste	Seeds with pericarp are burnt and prepared paste mixed with oil is applied on boils and pimples.	88
Rheum australe D. Don Polygonaceae GUH JH 4007	Archu	H	Root,	Powder, paste	½-1 teaspoon powder of dried root is taken with water for treatment of internal body injury. Paste of dried root is applied externally on muscle breakage.	102
Rhododendron arboreum Sm. Ericaceae GUH JH 4091	Burans	T	Flower	Juice	1 glass juice of flower is taken once a day as heart tonic	12
Roscoea purpurea Sm. Zingiberiaceae *GUH JH 4006*	Kakoli/nagdoon	H	Tuber	Powder	1 teaspoon powder of dried tuber is taken with 2-3 sips of water twice a day for 3-5 days against indigestion.	27
Rubus ellipticus Sm Rosaceae GUH JH 4077	Hinsar	S	Root	Paste, raw	Root and leaves paste applied for treatment of skin diseases, and boils. Fruit eaten as coolant.	132

Rumex hastatus D. Don Polygonaceae GUH JH 4004	Amedu/	H	Whole plant	Decoction	1 teaspoon decoction of whole plant is taken with a glass of water orally once a day for treatment of stomachache.	55
Rumex nepalensis Spreng. Polygonaceae GUH JH 4103	Khuldya	H	Root, Leaves	Paste	Leaf and root paste applied in burns, boils, cut and wounds.	216
Saussurea costu s(Falc.) Lipsch. Asteraceae GUH JH 4072	Kuth	H	Roots	Powder	½ teaspoon powder of dried root is taken with lukewarm water twice a day for 2-3 days against fever and abdominal pain and 10-15 days against rheumatism	60
Saussurea obvallata (DC) Edgew Asteraceae GUH JH 4041	Brahmkamal	H	Seeds	Powder	½ teaspoon powder of dried seeds is taken with a glass of water once a day for 10-15 days against asthma.	15
Selinum wallichianum (DC.) Raizada & H.O. Saxena Apiaceae GUH JH 4023	Bhutkeshi	H	Root	Powder	½ teaspoon powder of dried root is given with lukewarm water twice a day for 10-12 days against asthma and cough	54
Senecio nudicaulis Buch-Ham ex D. Don. Asteraceae GUH JH 4066	Neelbadi	H	Whole plant	Juice	1 teaspoon whole plant juice with 2-3 sips of cold water is used for treatment of stomach problems and as a coolant.	82
Solanum nigrum L. Solanaceae GUH JH 4100	Kiwaini / Kyawen	H	Leaves, fruit	Juice, paste,decoction	2-3 teaspoon ripe fruit juice mixed with a glass of water is taken orally twice a day to cure fever, indigestion, and acts as a coolant. Fruit paste applied on forehead for treatment of headache. Leaf decoction is applied on cut and wounds.	234
Swertia chirayita (Roxb.) Buch.-Ham. ex C.B. Clarke Gentianaceae GUH JH 4102	Chirayta	H	Leaves	Decoction	½ glass decoction of leaves is taken twice a day for 3-5 days, as liver tonic, blood purifier and against fever.	36
Swertia ciliata (D. Don ex G. Don) B.L. Burtt Gentianaceae GUH JH 4043	Chirayta	H	Leaves	Decoction	½ glass decoction of leaves is taken twice a day for 3-5 days, as liver tonic, blood purifier and against fever.	36
Taraxacum officinale (L.) Asteraceae GUH JH 4070	Kadatu	H	Whole plant	Powder	1-2 spoonful powder of whole plant is taken with lukewarm water for 10-15 days as heart tonic, blood purifier, and to treat fever.	123

Taxus wallichiana Zucc. Taxaceae GUH JH 4111	Thuner	T	Leaves	Decoction	Decoction of fresh leaves is applied on forehead to cure headache, cut and wounds.	117
Thalictrum foliolosum DC Ranunculaceae GUH JH 4039	Mamiri / Peelijad	H	Leaves	Paste	Paste of fresh leaf is applied on burns, cuts and wounds.	144
Thymus linearis Benth. Lamiaceae GUH JH 4063	Banajwain	H	Leaves	Raw	Fresh leaves are chewed against abdominal pain and stomachache.	100
Valeriana jatamansi Jones Caprifoliaceae GUH JH 4029	Sumaya	H	Rhizome	Powder, paste	½ teaspoon powder of dried rhizome with 2-3 sips of water is taken orally twice a day for treatment of fever, abdominal pain, digestive problems. Paste of fresh rhizome is applied on cut wounds and blisters.	300
Viola canescens Wall. Violaceae	Bansai/ Banasa	H	Aerial part	Powder	1-teaspoon powder of shade dried flowers is taken orally twice a day with lukewarm water to cure cough.	31
Zanthoxylum armatum DC. Rutaceae GUH JH 4074	Timru	S	Fruit and stem	Raw	Fruit eaten directly against fever. and stem directly chewed against oral hygiene and tooth problems.	78
Zingiber officinale Roscoe Zingiberiaceae GUH JH 4106	Aadu	H	Rhizome	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.	108

Informant consensus factor (ICF)

The highest ICF value (1) was recorded for mental disorders (ICD code F) and epilepsy (ICD code G) while a minimum 0.96 was recorded for blood problems (ICD code I). (Table 3). The highest number of species (50) was utilized for ICD code S-T. Among these cuts and wounds were treated with 31 taxa alone (Table 3).

Table 3. Informant consensus factor for various ailment categories

ICD	ICD code	Disease	nUR	N Taxa	Sum UR	Sum Taxa	ICF
I	A-B	Fever	583	15	1209	30	0.97
		Dysentery	46	1			
		Diarrhea	167	4			
		Jaundice	72	2			
		Hepatitis	50	1			
		Cold	195	5			
		Vermifuge	96	2			
IV	E	Diabetes	72	2	72	2	0.98
V	F	Mental disorders	50	1	100	1	1
		Brain tonic	50	1			
VI	G	Epilepsy	50	1	50	1	1
VII	H	Eye problems	27	1	127	3	0.98
		Insomnia	50	1			
		Cataract	50	1			
IX	I	Blood problems	87	4	87	4	0.96
X	J	Asthma	42	2	217	7	0.97
		Bronchitis	50	1			
		Cardiac problem	125	4			
XI	K	Teeth ache	173	4	1845	45	0.97
		Tooth decay	46	1			
		Cleaning teeth	134	3			
		Pyorroea	46	1			
		Oral Hygiene	39	1			
		Digestive disorders	116	3			
		Intestinal problems	148	3			
		Abdominal disease s	279	7			
		Coolant	387	9			
		Stomach disease	381	9			
		Liver tonic	24	2			
		Constipation	72	2			
XII	L	Pimples	142	3	850	19	0.97
		Boils	549	12			
		Hair problems	39	1			
		Skin diseases	120	3			
XIII	M	Muscle problems	82	2	313	8	0.97
		Bone fracture	31	1			
		Joint pain	86	2			
		Gout	55	1			
		Rheumatism	59	2			

XIV	N	Sexual problems	30	1	307	8	0.97
		Leucorrhea	108	3			
		Aphrodisiac	50	1			
		Urinary problems	50	1			
		Kidney problems	69	2			
XVIII	R	Cough	280	8	409	11	0.97
		Headache	129	3			
XIX	S-T	Cuts	607	15	2110	50	0.97
		Scorpion sting	110	2			
		Snake bite	129	3			
		Wounds	652	16			
		Burnt	336	8			
		Blisters	96	2			
		Herpes	149	3			
		Internal body injury	31	1			

Discussion

Previous studies carried out in near surroundings (adjoining districts/Tehsil/Block) showed a higher similarity to the ethnomedicinal uses of some frequently used plants while regions far from the study area showed less similarity. *Aconitum lethale* was used to treat, snake bite, scorpion sting, boils, gout and rheumatism, similar to Singh *et al.* 2019, while Bisht & Badoni, (2009) reported it for joint pain. *Nardostachys jatamansi* was used to treat epilepsy, mental disorders, insomnia, and heart diseases similar to (Kunwar *et al.* 2009, Singh *et al.* 2017, Tamang *et al.* 2021, Monika *et al.* 2020) however, Kunwar *et al.* (2009) reported that the oil of *Nardostachys jatamansi* is used for headaches. *Solanum nigrum* was used for the treatment of fever, indigestion, coolant, headache, cuts and wounds similar to (Singh *et al.* 2017, Kumari *et al.* 2021, Gaur and Sharma 2011). *Paeonia emodi* was used for the treatment of stomachache, intestinal spasms, vermifuge, and diarrhea similar to Singh *et al.* 2017. *Rumex nepalensis* used for healing cuts, wounds, burns and boils, similar to (Singh *et al.* 2017, Singh *et al.* 2019, Khajuria *et al.* 2021). *Polygonum capitatum* was used for curing burns, boils, pimples and herpes similar to (Singh *et al.* 2017, Gaur and Sharma, 2011). *Picrorhiza kurrooa* is used against fever, abdominal pain, coolant and intestinal worms. Singh *et al.* (2019), Malik *et al.* (2015), Singh & Rawat (2011),Kunwar *et al.* (2009) reported it for fever and stomachache,Masood *et al.* (2015) reported to cure stomachache and high fever, while Monika *et al.* (2020) reported it for biliousness, urinary discharge, blood troubles, burning sensations, leukoderma, and jaundice, while Rana *et al.* (2019) reported it for fever and jaundice, Ahmad *et al.* (2014) digestive complaints, heart disease. *Saussurea obvallata* is used for the treatment of asthma however, Kirtikar & Basu 1984 ,Monika *et al.* (2020) reported to cure cardiac diseases, cuts and wounds. Malik *et al.* (2015), reported it for fever; and religious importance, Singh & Rawat (2011) reported it for cough and Singh *et al.* (2019) reported it for boosting the immunity, Tsarong (1986) reported to cure paralysis of limbs and cerebral ischemia, Sharma 2016 reported to cure leucoderma . *Dactylorhiza hatagirea* was used to treat cut and wounds, as coolant and aphrodisiac similar to Jamloki *et al.* (2022), while Thakur *et al.* (2019), reported it for energetic, health tonic, and nervine tonic headache, cuts and wounds,Wani *et al.* (2020) reported for colic pain and fever, besides for speckling over cuts, burns, and wounds to stop bleeding however, Kunwar *et al.* 2006, Giri & Tamata 2010, reported to cure dysentery, diarrhea, gastritis. Rana *et al.* (2019), reported it for removal of weakness and Dutt *et al.* (2015), reported it for rheumatism and insecticidal.

Among the used species *Valeriana jatamansi* was frequently used species and also having high number of uses (5). Charmakar *et al.* (2021) also reported that *Valeriana jatamansi* having high uses and traded species in Nepal. *Valeriana jatamansi* is used to cure fever, abdominal pain, digestive problems cut wounds and blisters similar to Charmakar *et al.* (2021). *Aconitum lethale* and *Valeriana jatamansi* showed high number of uses (5 each) and URs (300 and 275); higher uses and URs may be due to easy availability, high use efficiency and possess rich active constituents and can be further investigated for pharmacological testing and isolation of novel therapeutically important chemical compounds.

Asteraceae was the dominant plant family similar to the other findings (Singh *et al.* 2019, Monika et al 2020, Khajuria *et al.* 2021) at the regional and global level, the dominance of these families in traditional herbal medicine could be due to their spontaneous availability (Maulidiani *et al.* 2015), and higher content of phenols and flavonoids (Maulidiani *et al.* 2015, Miara *et al.* 2018).

Among the life forms, herbs showed a higher proportion (78%), trailed by trees (12%), shrubs (9%) and climbers (1%) (Fig. 2) similar to earlier studies (Singh *et al.* 2017, Singh *et al.* 2019, Gaur, 1999, Monika *et al.* 2020, Khajuria *et al.* 2021, Rawat *et al.* 2026).

Leaves and roots were the most utilized plant parts, Singh *et al.* (2017) and Khajuria *et al.* (2021) also documented leaves and roots as the most commonly utilized plant part. Ethno-medicinal studies in other regions of the world, from Nepal (Shrestha *et al.* 2016, Shrestha *et al.* 2014)**,** Pakistan (Khan *et al.* 2015, Amjad *et al.* 2017), China (Li *et al.* 2020)**,** and Bangladesh (Faruque *et al.* 2018)**,** have also reported leaves and roots as the most utilized plant parts.

The use of leaves may be high due to easy availability, storage, and portability and leaves contain phytochemicals that are easily extracted beside this root contain rich storage material along with higher secondary metabolites leading to higher uses among the local people. Singh *et al.* (2017) and Dutt *et al.* (2015), also reported that the use of leaves is safe and sustainable**.** Ghimire & Bastakoti (2009) reported that the use of roots for local medicine preparation leads to destructive effects on the growth of plants and can cause a serious threat to the population in the wild**.**

The paste was used predominantly in local remedies because of the easy and less time-consuming process related to other methods (generally, plant parts were rubbed/crushed on stone and applied externally on affected parts), as well as people are more prone to external injuries due to their lifestyle, narrow trails and intensive thorny shrubs or hard work in the field or forests with sharp tools and implements (Singh *et al.* 2017). Powder also had a higher proportion among drug preparations may be due to a longer storage period in comparison to other drug preparation and can be consumed whenever required. Khajuria *et al.* (2021) reported that paste was used for the treatment of external problems i.e. wounds, and powder is used for internal ailments. The proportion of juice was minimum due to less storage period and a time-consuming process. The powder is made by crushing the shade-dried plant parts, while the 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 was the primary solvent in most preparations, particularly decoctions because most plant metabolites are soluble in it (Bhattarai *et al.* 2010, Gumisiriza *et al.* 2019). Other solvents may be added to increase the solubility of active ingredients that are insoluble in water (Bhattarai *et al.* 2010), or honey, jaggery, or sucrose may be used to mitigate the bitterness of the recipe Bhatia *et al.* (2014).

ICF value was recorded highest for mental disorders and epilepsy (1) it may be high due to fewer incidents of such diseases occurs in the region thus few species are used to cure particular ailments, or the species used is effective for particular disease and used by larger proportion of the community (Umair *et al.* 2017) Chaachouay *et al.* also found high ICF for epilepsy (0.99). Cut and wounds found predominated in the region thus the maximum plants utilized in the region similar to Usman *et al.* 2021 .

Conclusion

The present study documented 68 ethnomedicinal plants utilized by the indigenous people of Khatling valley in Western Himalaya India. *Valeriana jatamansi, Aconitum heterophyllum, Nardostachys jatamansi* and *Peonia emodi* are important plants in this region. Lack of modern medicine and inaccessibility with road and transportation people are still depending on medicinal plants near surroundings. Elders and traditional healers still have high knowledge about the identity of medicinal plants and their uses. Medicinal plants having higher number of uses and URs can be further investigated for novel phytomedicine apart from this documentation of such usefull knowledge is also helpful for researchers, health practitioners, pharmaceutical industries and policymakers in near future.

Future implementations

Indigenous people possess rich traditional medicinal knowledge, especially those harboring in the remote region due to the unavailability of modern medicine and transportation although, people living in such conditions have good immunity and health due to hard work and wild/organic food. Outmigration of the younger generation due to increasing population leads to gradually disappearing the heritage of ethno-medicinal knowledge among the inhabitants. Thus, documentation of such knowledge is an urgent need for the sustainable use and development

of novel drugs and phyto-constituents in near future. There is an extraction pressure on natural population of highly useful and important medicinal plants thus *in-situ* and *ex-situ* measure of conservation is a mere need for sustainable use of the species, awareness, and cultivation of such useful medicinal plants can be a good source of earning in near future.

Declarations

Ethics Approval: Verbal prior informed consent was obtained from each informant during the survey.
Data Availability: supporting data available in article and if generated data required available upon request.
Competing Interests: The authors declare that they have no competing interests.
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Author contributions: JH, ASB and HS carried out the field survey and collected specimens, prepared the manuscript. AS analyzed the data and drafted the final manuscript. JPM, MCN, RWB revised the manuscript. All the authors read and approved the final manuscript.

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