Inventorization of Phyto-remedial formulations prevalent among the natives of Deiya range, Nerwa, Himachal Pradesh, India

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Ethnobotany Research and Applications 29:14 (2024) - http://dx.doi.org/10.32859/era.29.14.1-21
Manuscript received: 07/02/2024 – Revised manuscript received: 05/x06/2024 - Published: 06/06/2024

Research

Abstract

Background: Indians has long been using plants and their parts as medical remedies to treat various diseases. They have been utilized as medications to treat various illnesses since ancient times. The majority of tribal people still rely on regional traditional healing methods to cure their illnesses. Therefore, documenting the use of traditional medicinal plants by the natives will provide valuable information on the distribution and utilization of medicinal plants in the region.

Methods: The present study commenced to explore the traditional knowledge of ethno-medicinal plants used by indigenous people of Deiya range, tehsil Nerwa of district Shimla, Himachal Pradesh, India. Snowball sampling was used to gather data from 110 people living in 11 distinct villages within the study area. Present work contains a compilation of information obtained through field surveys, semi-structured interviews, and questionnaires conducted with the natives of studied area.

Results: In this investigation, total 52 ethnomedicinal plants belonging to 34 distinct families were recorded from the natives as potential remedies for various illnesses. The indigenous inhabitants primarily utilized the 26 species of herbs for medical purposes. Rosaceae and Amaranthaceae families were the two most frequently employed in medicine. The most species (26) were used to cure skin ailments followed by 12 plant species for curing Gastro-intestinal Disease (GID), 11 plant species for General Health (GH) and 10 species for Muscle/Bone Problem (MBP).

Conclusion: This study offers comprehensive details about the Deiya range's significant medicinal plants. In this study we concluded that mostly old age people possess most of the information of medicinal plants, whereas the generation below forty has a little or no knowledge. Herbs and leaves (as a part) are majorly used as medicinal preparation and skin problems are most treatable disease in the study area. *Angelica glauca, Gentiana kurroo* and *Taxus wallichiana* need to be carefully monitored for conservation due to their great therapeutic value in the research region.

Keywords: Ethnobotanical Uses; Indigenous; Medicinal Plants; Phytotherapeutical; Traditional Knowledge

Background

Indians has long been using plants and their parts as medical remedies to treat various diseases (Bhatt *et al.* 2023, Khare 2008, Seth & Sharma 2004). Historically, the Chinese (5000–4000 BC), Syrians, Babylonians, Hebrews, and Egyptians (1600 BC) used plants for medicinal purposes (Lulekal *et al*. 2008). India has three traditional systems of medicine, namely Ayurveda, Siddha, and Unani. Ancient Hindu texts 'Rig-Veda' (4500-1600 BCE), 'Chakra Samhita' (1000-800 BCE), 'Sushrut Samhita' (800-700 BCE) have large, recorded data about medicinal plants (Manilal 1989; Singh, 2021; Rana *et al*. 2021). As one of the world's 12 megadiverse nations, India contributes 8% of the world's total biodiversity (Bapat *et al*. 2008, Myers *et al*. 2000). It also occupies four hot spots of the world (Himalaya, Indo-Burma, Sunderland and Western Ghats) (Chitale *et al*. 2014, Jaishankar *et al.* 2018). This is known as the "Medicinal Garden of the World" because of the abundance of medicinal plants; approximately 7500 plant species have been used by the local population for both traditional medicine and contemporary health care (Ahmadullah & Nayar 1999, Sharma & Pandey 2013, Vedavathy 2010). World Health Organization (WHO) estimates that at least 80% of the world's population relies on traditional medicine for primary health care (Ansari *et al*. 2023). Despite scientific progress and globalization, conventional medical treatments and practices remain a vital component of basic health care (Karunamoorthi *et al*. 2013). At present, approximately, 65% of the Indian population relies on traditional systems of medicine to maintain their health (Alok 1991, Mazid *et al.* 2016). The Indian subcontinent is inhabited by over 53.8 million tribal people and they were residing in approximately 5000 forest-dominated villages, covering 15% of the country's total area (Nath & Khatri 2010). Even today, most of the tribal communities still rely on local traditional healing methods to cure their ailments (Singh & Lal 2008). Conventionally, many kinds of medicinal plants are used to treat skin conditions caused by bacteria, fungus, and viruses (Prashantkumar & Vidyasagar 2008). Pharmacologists, chemists and academics have done extensive research on Ayurvedic medicinal plants (Patwardhan 2000, Patwardhan *et al*. 2004). Medicinal plants harbor a vast array of chemicals that are utilized in the synthesis of pharmaceuticals (Mukherjee 2003b).

There are a number of plants such as *Berberis aristata, Cannabis sativa, Curcuma longa, Cynodon dactylon, Prinsepia utilis,* and *Rhododendron arboreum* that have been conserved by native people based on superstitions and religious beliefs (Ahirwar 2015, Sahu *et al*. 2013, Rawat & Kumar 2024, Sharma *et al*. 2010, Sharma *et al*. 2014), as they are highly medicinal and are of great value to society at large. Hence, a comprehensive ethnobotanical study is necessary to document and analyze traditional knowledge and practices of the local people, with a focus on medicinal plants for treating human ailments, contributing to the conservation and utilization of biodiversity (Alemu *et al*. 2024).

Several researchers have carried out studies on the ethno botanical plants of Himachal Pradesh (Bhardwaj & Seth 2017, Bhatt *et al*. 2023, Chauhan 1999, 2011, Collett 1902, Jain & Puri 1994, Kharwal & Rawat 2009, Pratap & Kapoor 1985, Sharma & Lal 2005, Singh & Kumar 2000, Singh & Thakur 2014, Singh *et al*. 2020, Sood *et al.* 2001, 2009, Srivastava *et al.* 1992, Uniyal 1973). However, ethno-medical information in the current field of study is still underutilized and undocumented. Therefore, documenting the use of traditional medicinal plants by the natives of Deiya range of Tehsil Nerwa, Shimla will provide valuable information on the distribution and utilization of medicinal plants in the region. This knowledge can be used to preserve traditional healing practices and provide a foundation for future research in the field of ethnobotany. It can also lead to the discovery of new medicinal plants and their potential uses. Considering this, the present study aims to (i) collect, identify and record medicinal plants and related indigenous knowledge that is used to treat various diseases for humans in the study area. (ii) To prioritize the importance of ethno-medicinal plants based on their Use Value Index (UV), Informant consensus factor (ICF) and fidelity level (FL)**.**

Materials and Methods

Study area

The present study area (Figure 1) lies in subtropical to temperate zone comprising latitude 30.85°N and longitude 77.64°E with altitude ranging from 1,801- 2,550m. The area comes under demarcated protected forest (D.P.F) covering total forest area of 250 hectares. It is situated within 20 km distance from sub district headquarter Nerwa and 146 km from district headquarter Shimla. Nearest statutory town is Chopal in 46 km distance. Deiya is surrounded by Kupvi from south, Nerwa from north, Chopal from west and Uttarakhand from east. The study area has cool and moderate climate. It gets heavy snow during winter and temperature hover below freezing point. During summer, the climate gets warmer with temperature around 15-25°C. In 2023, the area received an average rainfall of 141.5 cm (imd.gov.in). The Gujjars are the primary ethnic group in the area; they migrate to the foothills in the winter and return to the higher mountains in the summer to find food and fodder for their livestock. There are 266 houses in all, and the population of the area is approximately 2,200 (censusindia.gov.in).

Figure 1. Map of Himachal Pradesh, Shimla and Study area

Methods

The study was conducted in 11 different villages of study area from May, 2022 to May, 2023. The factor for choosing these particular villages were, the presence of traditional healers or an area that of lack of prior exploration. Group talks, field observations, guided field walks, and a semi-structured questionnaire (Jain & Mudgal 1999) were employed as data collection methods. In accordance with Jain & Rao (1977), plant specimens have been photographed, gathered, pressed, dried, and mounted on herbarium sheets. An initial, identification of the plant species was made in fields, and the results were confirmed at the Herbarium of Himachal Pradesh University, Shimla. We looked at several regional books, including Flora Simlensis (Collett 1902), Flora of Himachal Pradesh (Chowdhery & Wadhwa 1984), Flowers of the Himalaya (Polunin & Stainton 1984), Medicinal and Aromatic Plants of Himachal Pradesh (Chauhan, 1999) and Flora of Kullu District Himachal Pradesh (Dhaliwal & Sharma 1999) as part of the verification process for the species name and its family. We also visited the websites http://www.worldfloraonline.org/, http://www.ipni.org/ and https://powo.science.kew.org/ for this purpose.

Sampling method

During the survey, a total of 110 respondents were interviewed that included 91 males and 19 females from different age groups. They were initially chosen at random. Of the respondents, 25 were key informants (traditional healers, knowledgeable elders, and shepherds); specifically selected by using the Snowball method (Bailey 2008). The described medicinal plants were cross checked many times (3-4) with different informants and only that information is regarded as valid that has been mentioned by at least 3 informants.

As per their educational qualification it was observed that 20% of the respondents were illiterate, 12% studied up to fifth standard, 32% studied up to tenth standard, 25% of them studied up to twelfth class and only 11% were graduates in the respondent category (Table 1).

Table 1. Demographic data on informants and source of knowledge

Demographic feature	**Percentage (%)**
Gender	
Women	17%
Men	83%
Age group	
<20 years of age	7%
20-40 years of age	16%
40-60 years of age	23%
60-80 years of age	47%
>80 years of age	5%

Educational level	
University	11%
Secondary	25%
Intermediate	32%
Primary	12%
No schooling	20%
Source of knowledge	
Ancestral	80%
Self taught	20%

We obtained the verbal consent of each respondent in accordance with the ethical code of the International Society of Ethnobiology, Code of Ethics (with 2008 additions) http://ethnobiology.net/code-of-ethics/.

Quantitative analysis:

To analyses the data, the following quantitative analysis was performed.

Frequency of citation

Frequency of citation is used in finding the cumulative number of citations/usage reports for a specific species. The usage report refers to the informant's quotation of a single plant (Laldingliani *et al*. 2022)

Use value (UV)

The proportional Significance of medicinal plants is quantified by its use value (UV). The amount of uses specified for each species makes up its use value. It is frequently utilized to measure the relative significance of beneficial plants. It is computed using the formula below (Rana *et al.* 2021)

$$UV = \Sigma u/n$$

UV stands for use value; ΣU represents the total count of use reports referred by each informant for a specific species, while 'n' denotes the total number of informants involved. Use values are considered high when there is a significant number of use reports identified for a specific plant, whereas they are deemed to be low when only a few use reports are available.

Informant consensus factor

ICF or F_{ic} represents the consistency of the information provided by informants, indicating whether plants are being used for treating similar ailments among users in the study area. In order to calculate it, the following equation was used (Laldingliani *et al*. 2022)

$$FIC = Nur - Nt/Nur - 1$$

'Nur' represents the number of reports from users in each illness category, while '*Nt*' represents the number of plant species used by all informants for that particular illness category. Furthermore, a F_{ic} value of 1 or close to 1 indicates that a high number of informants agree that a few plants are sufficient to cure an illness category, whereas a low F_{ic} value indicates that there is disagreement regarding the use of medicinal plants to treat illness in the category.

Fidelity Level

A specific species of plant can be identified among a wide range of plant species that may cure a specific health problem through this method (Muhakr *et al.* 2024).

$$FL\% = \frac{Np}{N} \times 100$$

Using the following equation, Np represents the number of reports citing a particular species for a specific ailment and N represents the total number of reports for any given species. Plants with high FLs (near 100%) are used almost exclusively in one way, whereas plants with low FLs are used in numerous ways.

Observations

It has been noted that the inhabitants of the Deiya range rely on a variety of plants and their products for medical needs. The region primarily has temperate to sub-temperate vegetation. In the local vegetation, woody trees like *Pinus roxburghii, Pinus wallichiana, Picea smithiana, Abies pindrow*, and *Cedrus deodara* are the most common. Table (2) contains comprehensive ethnomedicinal data on the gathered plants, including their scientific and colloquial names, families, habits, and modes of intake in addition to their varied applications and use value (UV).

Table 2. List of medicinal plants with their use value utilized by locals of Deiya range, tehsil Nerwa, Himachal Pradesh

Botanical name	Family	Local name/s	Habit	Part/s used	Ethnomedicinal preparations	Frequency of citation (Fc)	Use Value (UV)	IUCN status
Achyranthes aspera L.	Amaranthaceae	**Puthkanda, Uang**	Herb	Leaves	Paste of fresh leaves is applied to heal the minor cuts and wounds.	15	0 .13	-
Acorus calamus L.	Acoraceae	**Shilbow**	Herb	Rhizome	Rhizome paste is utilized to treat sprain, wounds, and also to provide relief from joint pain.	33	0.3	LC
Ajuga parviflora Benth.	Lamiaceae	**Neelkanthi**	Herb	Aerial parts, roots	Paste of aerial part is applied to treat sores and wounds. Juice of leaves and roots is used to avert heatstroke.	45	0.40	-
Amaranthus blitum L.	Amaranthaceae	**Shaagchalayi**	Herb	Leaves, roots	Boiled fresh leaves are consumed for diarrhoea and dysentery. Root powder mixed with water is taken for kidney stone.	16	0.14	-
Angelica glauca Edgew.	Apiaceae	**Choro**	Herb	Roots	The root powder is given to infants along with milk to treat fever, vomiting and stomachaches.	40	0.36	EN
Artemisia vulgaris L.	Asteraceae	**Chhambor**	Herb	Aerial parts	Paste of aerial part is used to halt bleeding from cuts and to heal wounds.	45	0.40	LC
Asparagus adscendens Roxb.	Asparagaceae	**Shatbaar**	Shrub	Roots	The root powder is taken orally, preferably with milk for tonicity and viability.	13	0.11	-
Berberis aristata DC.	Berberidaceae	**Kashmal**	Shrub	Roots, Stem	Root and stem decoction is taken to treat stomach infections, fever and jaundice.	33	0.3	LC
Berberis lycium Royle	Berberidaceae	**Kashmal**	Shrub	Roots	Half a teaspoon of root powder is taken orally, accompanied by a spoon of honey for jaundice.	33	0.3	LC
Bergenia ciliata (Haw.) Sternb.	Saxifragaceae	**Daklambu, Pashanved**	Herb	Roots	The root powder is mixed with a glass of lukewarm water and taken to treat kidney stones. Root paste is eaten with honey for piles.	27	0.24	LC

Calotropis procera (Aiton) Dryand.	Apocynaceae	**Aonk**	Shrub	Latex, leaves	Latex is applied to teeth with a cotton swab for toothache and leave paste is applied for joint pain.	19	0.17	LC
Cannabis sativa L.	Cannabaceae	**Bhaang**	Herb	Leaves, seeds	Leaves burnt in mustard oil, then applied to minor burns and roasted seeds are consumed in a small amount to strengthen digestive system.	41	0.37	-
Cedrus deodara (Roxb.ex D.Don) G.Don	Pinaceae	**Kailtu, Deodar**	Tree	Leaves, wood oil	Leave paste and wood oil is often applied to cure skin infections.	27	0.24	LC
Chenopodium album L.	Amaranthaceae	**Bathu**	Herb	Leaves	Leave paste is applied on dog bite, bug bite and sunburn.	33	0.3	-
Cryptolepis buchanani Roem. & Schult.	Apocynaceae	**Nirbhishi**	Climber	Roots	Root paste is applied on snake bite and also applied on wounds to prevent infection.	39	0.35	-
Curcuma longa L.	Zingiberaceae	**Holij, haldi**	Herb	Rhizome	Rhizome paste is applied on cuts & wounds. Its powder is boiled along with milk and taken for internal infections.	45	0.40	DD
Cyathula capitata Moq.	Amaranthaceae	**Silra**	Shrub	Roots	Root paste is applied to skin infections and boils.	21	0.19	-
Cynodon dactylon (L.) Pers.	Poaceae	**Joob**	Herb	Roots	Root paste is applied on the eyelid to treat a stye. Leave extract taken for nasal & heavy menstrual bleeding.	16	0.14	-
Diplazium esculentum (Retz.) Sw.	Athyriaceae	**Lingar**	Fern	Aerial parts	Boiled aerial parts are eaten as a vegetable for diarrhoea and also believed to be good for diabetic patients.	32	0.29	LC
Erigeron bellidioides (Buch.-Ham. ex D.Don) Benth. ex C.B.Clarke	Asteraceae	**Katia**	Herb	Leaves	Plant extract is taken orally to treat Urinary tract infection (UTI) and leave paste is applied to treat wounds.	27	0.24	-
Ficus palmata Forssk.	Moraceae	**Fedu, fegra**	Tree	Leaves, latex	Leave paste is applied for shoulder pain and latex is applied to treat splinter infection.	17	0.15	LC
Gentiana kurroo Royle	Gentianaceae	**Kadwi**	Herb	Roots	Roots powder is taken for asthma, cold & cough, jaundice and stomachache.	40	0.36	CR
Geranium wallichianum D.Don	Geraniaceae	**Kugti**	Herb	Roots	Root paste is applied for treating dog bites, while its powder is mixed with	12	0.10	LC

					lukewarm water and taken for intestinal disorders.			
Girardiana diversifolia (Link) Friss.	Urticaceae	**Bhaabar**	Shrub	Leaves, roots	Boiled leaves are consumed to treat the gastric infection. Root paste is administered to cure boils.	26	0.23	-
Hedera helix L.	Araliaceae	**Kanauri**	Climber	Leaves	Leaves are immersed overnight in water and then crushed leaves juice is taken to treat jaundice.	27	0.24	LC
Hedychium spicatum Buch.-Ham. ex Sm.	Zingiberaceae	**Kachoor**	Herb	Rhizome	A small part of the rhizome is ingested for cold & cough, sore throat, bronchitis, headache and stomachache.	49	0.44	-
Lactuca macrorhiza Hook.f.	Asteraceae	**Dudhiyamoru**	Herb	Roots	Root paste is applied to cure cuts and wounds.	32	0.29	-
Macrotyloma uniflorum (Lam.) Verdc.	Fabaceae	**Kulath**	Herb	Seeds	Seeds are soaked in water overnight and then its water is consumed to get rid of kidney stones.	22	0.2	LC
Mentha × piperita L.	Lamiaceae	**Pudina**	Herb	Leaves	Leave infusion is taken to relieve gastric problems and constipation.	33	0.3	-
Morchella esculenta Fr.	Morchellaceae	**Chiyaun**	Fungus	Fruiting body	Entire fruiting body is eaten as a vegetable for body tonicity.	21	0.19	-
Murraya koenigii (L.) Spreng.	Rutaceae	**Kadi patta**	Shrub	Leaves	Leaves are used as flavoring agent in making curry and decoction of dried leaves is taken for morning sickness.	33	0.3	LC
Nicotiana tabacum L.	Solanaceae	**Tambakhoo**	Herb	Leaves	Leave paste is applied to cure boils and pimples, also kept ondental caries for relieve from pain.	36	0.32	-
Origanum vulgare L.	Lamiaceae	**Katia, Van-tulsi**	Herb	Leaves, roots	Leaves paste is applied on pimples or boils. Root fume is used to treat nausea and fever in children.	24	0.21	LC
Parthenocissus semicordata (Wall.) Planch.	Vitaceae	**Laau**	Climber	Leaves	Leaves are immersed overnight and the extract is taken for urologic diseases.	23	0.20	-
Persicaria capitata (Buch.-Ham. ex D.Don) H.Gross	Polygonaceae	**Ninai**	Herb	Leaves	Leave paste is applied to boils and fungal infections.	28	0.25	-
Phegopteris connectilis (Michx.) Watt	Thelypteridaceae	**Brahmsutri ki jadi**	Fern	Leaves, Roots	Leaves and root paste is applied for herpes zoster on the affected area.	9	0.08	LC

Pistacia integerrima J.L.Stewart	Anacardiaceae	**Kakadsinghi**	Tree	Leaf galls	Gall is dried, grinded and taken for cough, fever, vomiting etc.	33	0.3	-
Polygonatum verticillatum (L.) All.	Asparagaceae	**Salam-misri**	Herb	Roots	Roots powder taken orally for stomachache and also useful to treat burning sensations during the toilet.	16	0.14	-
Prinsepia utilis Royle	Rosaceae	**Bekhal**	Shrub	Seeds	Seed oil is used to treat boils, sprain and body massage.	28	0.25	-
Prunus armeniaca L.	Rosaceae	**Chulli**	Tree	Seeds	Seed oil is utilized for the treatment of sprains and joint pain, as well as for the purpose of massaging children's bodies to enhance bone strength.	13	0.11	DD
Pyrus pashia Buch.-Ham. ex D.Don	Rosaceae	**Kointh, kainth**	Tree	Fruits	Fruits are eaten for diabetes and its paste is applied to piles.	29	0.26	LC
Quercus semecarpifolia Sm	Fagaceae	**Khareu**	Tree	Bark	Decoction of bark is taken to cure kidney stones.	21	0.19	LC
Rhododendron arboreum Sm.	Ericaceae	**Buransh, burass**	Tree	Bark, flowers	The infusion of dried flowers and bark is utilized to treat fever.	19	0.17	LC
Rubus ellipticus Sm.	Rosaceae	**Hisar**	Shrub	Fruits	Fruit dried and its paste is applied to the wound.	18	0.16	LC
Rumex nepalensis Spreng.	Polygonaceae	**Khransh**	Herb	Leaves, roots	Root paste is applied on boils and leaves paste is used to treat burns.	26	0.23	-
Soymida febrifuga (Roxb.) A.Juss.	Meliacea	**Rasaynai**	Tree	Bark	Paste of bark powder is used to treat sprain and fractured bone.	32	0.29	-
Taxus wallichiana Zucc.	Taxaceae	**Thune**	Tree	Bark, leaves	A paste of bark is applied to cure boils. Tea is prepared from the leaves and taken for cancer.	19	0.17	EN
Thalictrum foliolosum DC.	Ranunculaceae	**Pili zari**	Herb	Roots	Root paste is applied to cure boils and snakebite.	25	0.22	-
Thuja occidentalis L.	Cupressaceae	**Saru**	Tree	Seeds	The seed paste is applied to burns.	15	0.13	LC
Urtica dioica L.	Urticaceae	**Kunkuva**	Herb	Leaves, roots	Root paste is applied to treat sprain and boils.	26	0.23	LC
Viola canescens Wall.	Violaceae	**Vanaksha**	Herb	Entire plant	Powder of entire plant taken orally with lukewarm water for dysentery; flower decoction is utilized for cold and cough;	38	0.34	-

					paste of leaves is applied to treat skin infections.			
Zanthoxylum armatum DC.	Rutaceae	**Timbur, tirmir**	Shrub	Leaves	Leaves are used for toothache and also as decoction for cold and cough.	17	0.15	LC

Abbreviations: CR- Critically endangered, DD- Data deficient, EN- Endangered, LC- Least common

Results

A total of 52 plants were found in study area as medicinal plants belonging to 4 major taxonomic groups: Angiosperms (88%) with 28 families, 45 genera and 46 species followed by Gymnosperms(6%) with 3 families, 3 genera and 3 species; Pteridophytes (4%) with 2 families, 2 genera, 2 species and Fungi (2%) with 1 family, 1 genus, and 1 species (Table 3).The region has the highest proportion of herbs (50%) in terms of habit. Subsequently, the presence of shrubs (19%), trees (19%), climbers (6%), ferns (4%), and fungus (2 %) was reported (figure 2). A total of 34 families were utilized for therapeutic purposes. Rosaceae (4 spp) and Amaranthaceae (4 spp) families exhibit their dominance. Other families are Asteraceae (3), Lamiaceae (3), Apocynaceae, Asparagaceae, Berberidaceae, Polygonaceae, Rutaceae, Urticaceae and Zingiberaceae (2 spp), the remaining families each include one species (figure 3). Leaves (38%) were the frequently employed plant parts for medicinal formulations followed by roots (36%), seeds (9%), bark (7%), rhizome (5%), aerial parts (5%) latex (2%), flower (2%) and rest (1%).

Table 3. A taxonomic description of medicinal plants diversity of Deiya range, tehsil Nerwa of Shimla, Himachal Pradesh

Taxonomic Group	Family	Genera	Species	Tree	Shrub	Herb	Climber	Fern	Fungus
Angiosperms	28	45	46	7	10	26	3	-	-
Gymnosperms	3	3	3	3	-	-	-	-	-
Pteridophytes	2	2	2	-	-	-	-	2	-
Fungus	1	1	1	-	-	-	-	-	1
Total	34	51	52	10	10	26	3	2	1

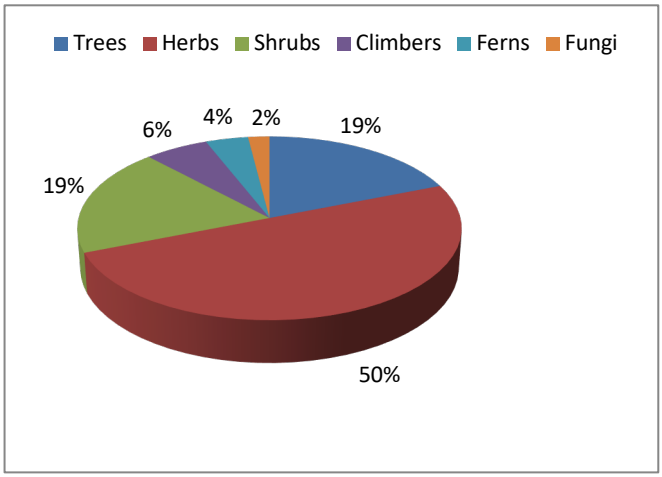

Figure 2. Habit-Wise Classification of Medicinal Plant Species

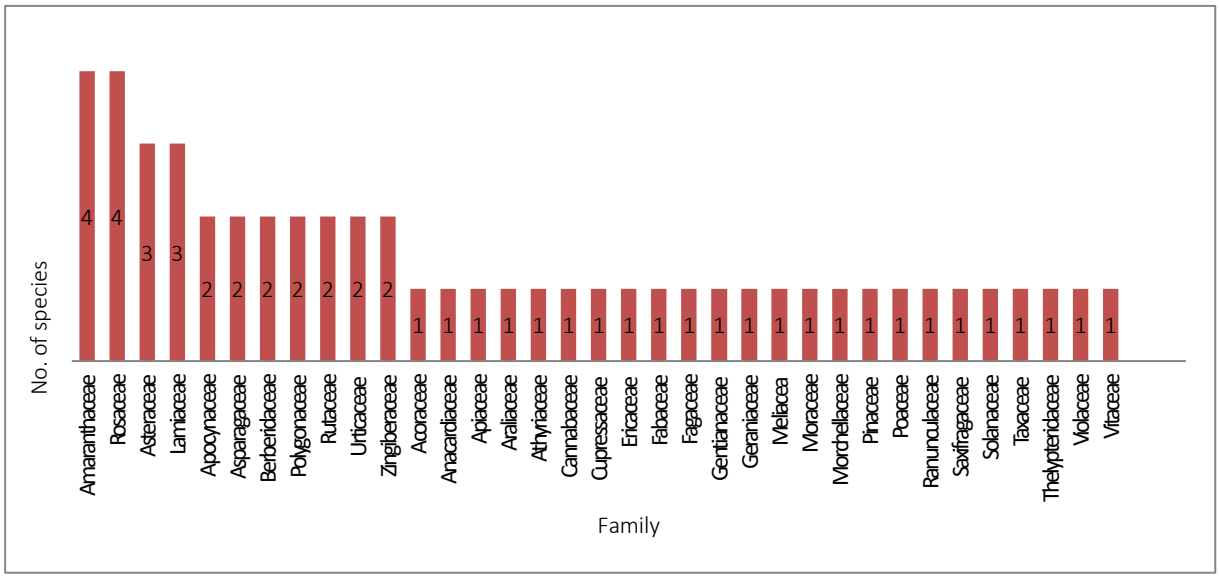

Figure 3. A Total Number of Medicinal Plant Species under Each Taxonomic Family

Oral, topical, or both methods may be used to treat different illnesses. Preparation methods include using pastes made from different plant parts, extracts and decoctions, or powdered plant parts combined with water, honey, or certain oils. Study revealed that most treated ailment is boils with 10 plant species. Other conditions that are cured include cuts and wounds (7spp), colds and coughs (6spp), fever, jaundice, kidney stones, sprains, stomachaches (4 spp), burns, skin infections, diarrhoea and dysentery(3spp), body massage, diabetes, dog bite, gastroesophageal reflux, piles, snakebite, urinary tract diseases and vomiting (2 spp), and rest ailments with one species each. Elderly individuals are more likely to use plants for medicinal purposes (figure 4) as compared to younger ones and the informants were mostly open to share their information, except for some who were reluctant to do so.

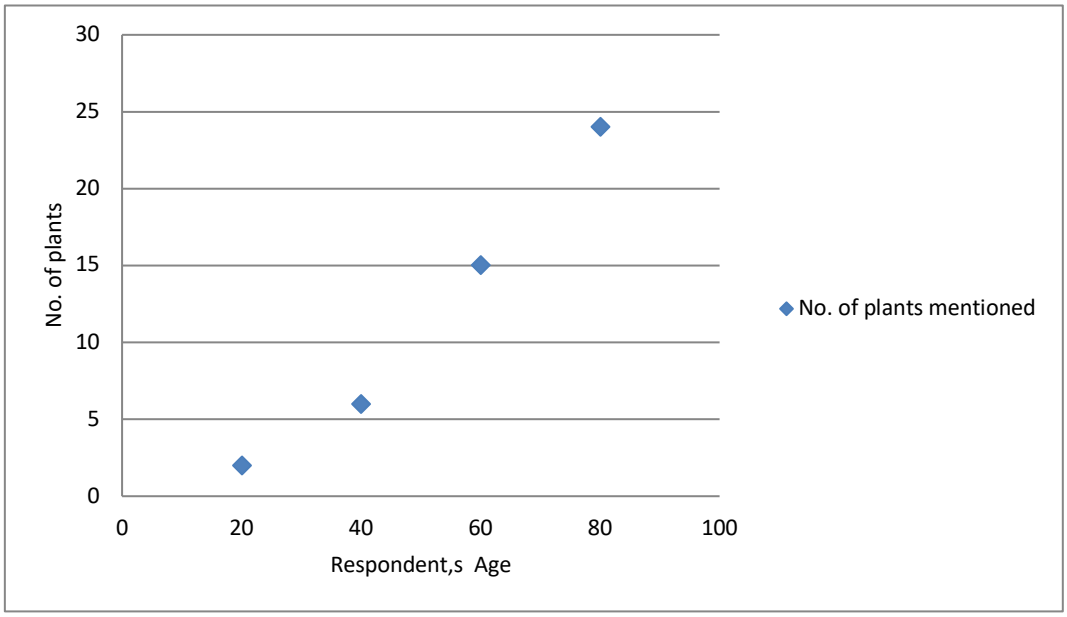

Figure 4. Plants reported by respondents with respect to their age

Hedychium spicatum (49) has the highest frequency of citation while other are with *Ajuga parviflora* (45), *Artemisia vulgaris* (45), *Curcuma longa* (45), *Cannabis sativa* (41), *Angelica glauca* (40), *Gentiana kurroo* (40), *Cryptolepis buchanani* (39), *Viola canescens* (38), *Berberis aristata* (33), *Berberis lycium* (33) and *Mentha × piperita* (33). Highly valuable medicinal plants on the basis of use value (UV) are *Hedychium spicatum* (0.44) followed by *Ajuga parviflora* (0.40), *Artemisia vulgaris* (0.40), *Curcuma longa* (0.40), *Cannabis sativa* (0.37), *Angelica glauca* (0.36), *Gentiana kurroo* (0.36), *Cryptolepis buchanani* (0.35), *Viola canescens* (0.34), *Berberis aristata* (0.3), *Berberis lycium* (0.3) and *Mentha × piperita* (0.3).

To calculate, Informant consensus factor (ICF or F_{ic}), we grouped the various similar related ailments into 12 major categories in accordance with their use reports (Table 4).In these categories, skin ailments were found to be cured by 26 species followed by gastrointestinal disorders (12 spp), general health (11), Muscle/Bone Problem (10), Eyes/Nose/ Ears/Mouth (6), Genital-urinary Disease, Kidney Disease, Liver Problem and Poisonous Bites with 4 species each, Dental Care (3), Respiratory System illness (2)and cancer diseases with 1 species. Informant consensus factor ICF or F_{ic} value ranged from 0.75 to 1. In our studies cancer illness category has highest factor informant consensus value (F_{ic}=1) followed by liver problems and ENT with F_{ic} 0.97 and 0.95 respectively. Lowest F_{ic} values (F_{ic}=0.75) were observed for respiratory System illness as it contain vast type of ailments therefore require different type of compounds from different plants.

Table 4. ICF with their use report for each of the ailment categories

Ailment/Illness categories	No. of use report (Nur)	No. of taxa (Nt)	Nur-Nt	Nur-1	F_{ic}
Cancer Disease (CD)	16	1	15	15	1.00
Dental Care (DC)	39	3	36	38	0.947
Eyes/Nose/ Ears/Mouth (ENT)	102	6	96	101	0.95
Gastro-intestinal Disease (GID)	167	12	155	166	0.933

Genital-urinary Disease (GUD)	45	4	41	44	0.931
Kidney Disease (KD)	55	4	51	54	0.944
Liver Problem (LP)	90	4	86	89	0.977
Muscle/Bone Problem (MBP)	132	10	122	131	0.931
Poisonous Bites	43	4	39	42	0.928
Respiratory System illness (RSI)	5	2	3	4	0.75
Skin ailments (SA)	457	26	431	456	0.945
General health (GH)	154	11	143	153	0.934

Fidelity levels (Fl) of the reported 52 plant species ranged from 4.11 to 100% (Table 5). A number of species showed 100% fidelity level, including *Achyranthes aspera* (cuts and wounds), *Artemisia vulgaris* (cuts and wounds), *Asparagus adscendens* (tonicity and viability), *Berberis lycium* (jaundice), *Cedrus deodara* (skin infections), *Lactuca macrorhiza* (cuts and wounds), *Macrotyloma uniflorum* (kidney stones) *Mentha × piperita* (gastric reflux) *Morchella esculenta* (tonicity), *Murraya koenigii* (morning sickness), *Parthenocissus semicordata* (urologic diseases), *Phegopteris connectilis* (herpes), *Quercus semecarpifolia* (kidney stones), *Rhododendron arboreum*(fever), *Rubus ellipticus* (wounds), *Thuja occidentalis* (burns). The plant with lowest Fl value (4.11 %) is *Hedychium spicatum* (Bronchitis).

Table 5. Fidelity level (Fl %) of plant species for various diseases

Plant Species	**Ailments/ Disorders**	**Citations**	**FL%**
Achyranthes aspera	Cuts and wounds	15	100
Acorus calamus	Cuts and wounds	19	57.57
	Joint pain	8	24.24
	Sprain	6	18.18
Ajuga parviflora	Sores and wounds Heatstroke	27	60
		18	40
Amaranthus blitum	Diarrhea and dysentery	9	56.25
	Kidney stone	7	63.75
Angelica glauca	Vomiting	21	52.5
	Stomachache	19	47.5
Artemisia vulgaris	Cuts and wounds	45	100
Asparagus adscendens	Tonicity and viability	13	100
Berberis aristata	Jaundice	21	63.63
	Fever	8	24.24
	Stomachache	4	12.12
Berberis lycium	Jaundice	33	100
Bergenia ciliata	Kidney stones	25	92.59
	Piles	2	7.41
Calotropis procera	Toothache	14	73.68
	Joint pain	5	26.31
Cannabis sativa	Burns	21	51.21
	Tonicity and viability	20	48.78
Cedrus deodara	Skin infections	27	100
Chenopodium album	Dog bite	22	66.66
	Bug bite	7	21.21
	Sunburn	4	12.12
Cryptolepis buchanani	Cuts and wounds	31	79.49
	Snakebite	8	20.51
Curcuma longa	Cuts and wounds	32	71.1
	Internal infections	13	28.9
Cyathula capitata	Boils	12	57.1
	Skin infections	9	42.9

Cynodon dactylon	Nasal bleeding	8	50
	Heavy menstrual bleeding	5	31.25
	Stye	3	18.75
Diplazium esculentum	Diarrhea	25	78.13
	Diabetes	7	21.87
Erigeron bellidioides	Wounds	15	55.56
	Urinary tract infection (UTI)	12	44.44
Ficus palmata	Shoulder pain	11	64.7
	Splinter infection	6	35.3
Gentiana kurroo	Cold & cough	21	52.5
	Jaundice	9	22.5
	Stomachache	7	17.5
	Asthma	3	7.5
Geranium wallichianum	Dog bites	9	75
	Intestinal disorders	3	25
Girardiana diversifolia	Boils	17	65.38
	Gastric reflux	9	34.62
Hedera helix	Jaundice	27	100
Hedychium spicatum	Cold & cough	22	44.89
	Sore throat	9	18.36
	Headache	8	16.32
	Stomachache	8	16.32
	Bronchitis	2	4.11
Lactuca macrorhiza	Cuts and wounds	32	100
Macrotyloma uniflorum	Kidney stones	22	100
Mentha × piperita	Gastric reflux	33	100
Morchella esculenta	Tonicity	21	100
Murraya koenigii	Morning sickness	33	100
Nicotiana tabacum	Boils	23	63.9
	Dental caries	8	22.2
	Pimples	5	13.9
Origanum vulgare	Boils	16	66.67
	Fever	6	25
	Nausea	2	8.33
Parthenocissus semicordata	Urologic diseases	23	100
Persicaria capitata	Boils	24	85.72
	Fungal infections	4	14.28
Phegopteris connectilis	Herpes	9	100
Pistacia integerrima	Cough	15	45.46
	Fever	9	27.27
	Vomiting	9	27.27
Polygonatum verticillatum	Stomachache	11	68.75
	Urologic diseases	5	31.25
Prinsepia utilis	Boils	12	42.86
	Body massage	9	32.14
	Sprain	7	25
Prunus armeniaca	Body massage	6	46.16
	Joint pain	5	38.46
	Sprain	2	15.38
Pyrus pashia	Diabetes	26	89.66
	Piles	3	10.34
Quercus semecarpifolia	Kidney stones	21	100
Rhododendron arboreum	Fever	19	100
Rubus ellipticus	Wounds	18	100

Rumex nepalensis	Boils	21	80.7
	Burns	5	19.3
Soymida febrifuga	Fractured bone	29	90.6
	Sprain	3	9.4
Taxus wallichiana	Cancer	16	84.2
	Boils	3	15.3
Thalictrum foliolosum	Boils	19	76
	Snakebite	6	24
Thuja occidentalis	Burns	15	100
Urtica dioica	Boils	21	77.78
	Sprain	5	18.52
Viola canescens	Cold & cough	22	57.89
	Dysentery	9	23.68
	Skin infections	7	18.42
Zanthoxylum armatum	Cold & cough	17	100

IUCN Status of the plant species

The IUCN red list was checked for the status of the documented plants. The data of 25 plant species was not found in the IUCN online database. As for others, 22 plant species were found least concern (LC), 2 species (*Curcuma longa* and *Prunus armeniaca)* was data deficient (DD), 2 species (*Taxus wallichiana, Angelica glauca*) was endangered and 1 species (*Gentiana kurroo*) was of critically endangered (CR) category (IUCN 2024).

Discussion

Herbs (50%) are dominantly used form in the study area, other studies also reflect dominant use of herbs for medicinal purposes (Chauhan *et al*. 2017, 2020, Karki *et al*. 2023, Singh *et al*. 2017, 2020, Singh & Thakur 2014, Thakur *et al*. 2016, Tamang *et al*. 2023). It can be due to their high abundance, easy harvest and processing in pharmacology (Bekalo *et al*., 2009). Leaves (38%) were the mostly used plant parts for therapeutic purposes followed by roots (36%).High usage frequency of leaves is due to their ease of collection, storage, present densely, and pertain a variety of secondary metabolites (Bhattarai *et al*. 2009, Karaköse 2022).Both leaves and roots contain very potent active ingredients and are mostly used for medicinal preparations, as also revealed earlier by other studies (Balkrishna *et al*. 2023, Bhatt *et al*. 2023, Chauhan *et al*. 2020, Tamang *et al*. 2023, Thakur *et al*. 2016).The abundance and high frequency of usage of leaves point to a more environmentally friendly method of conservation. However, bark (stripping) and root harvesting (uprooting) is likely to cause plant death and pose a threat to the survival of rare and slow-reproducing medicinal plants (Rao *et al*., 2015).

During the field trips, more men (91 males) than women (19 females) were referred to have knowledge of medicinal plants through snowball sampling (Bailey 2008). In this context, other studies show that men are more knowledgeable than women about the usage of therapeutic plants (De Albuquerque *et al*. 2011, Sher *et al.* 2015). Besides this some other previous research has also shown that, when compared to men, women typically demonstrate higher levels of ethnobotanical knowledge when it comes to identifying plants and making common household medicines (Camou-Guerrero *et al*. 2008, Tugume *et al*. 2016, Karaköse 2022). This divergence in the study area may be due to the consequence of local cultural or societal norms that have traditionally restricted women's access to the home and emphasized men as healers and providers.

During the field surveys we found that, elderly individuals had most of the information and are more likely to use plants for medicinal purposes (Sharma *et al*. 2024, Singh *et al*. 2017, 2020, Rana *et al*. 2014). Without documentation, these ethno-medical traditions can often go away, leading to the loss of valuable cures and treatments that have been handed down over the years (Junsongduang *et al*. 2020, Shah & Bhat 2019). While most informants in the research region were willing to share their knowledge about the medical worth of plants, some were reluctant to do so because they believed that by sharing the information, the therapeutic effects of the plants would be lessened. Such reluctance behavior to share the information has also been documented by Rani *et al*. (2014). This could lead to a decrease in the effectiveness of healthcare options. Furthermore, the loss of traditional knowledge may also contribute to the erosion of cultural identity and heritage.

It is the first study that results in *Hedychium spicatum* (49 URs) being listed as the most frequently cited species which indicates that it is extensively used medicinally due to its numerous health benefits and effectiveness in treating various ailments (Rawat *et al*. 2018) whereas *Ajuga parviflora, Artemisia vulgaris, Curcuma longa* ranked second (45 URs), and

Cannabis sativa ranked third (41URs). The highest ICF value (F_{ic}=1) was calculated for cancer ailment category which means that all the informants (16) agreed to the use of one plant (*Taxus wallichiana*) is sufficient to cure or atleast prevent the growth of cancer diseases. Many active compounds are formed in *Taxus wallichiana* which is used to cure cancer (Sehgal *et al*. 2023) similar results were observed by Eminagao (2017) with oncological disorders having the highest ICF value.

In our study fidelity level (FL) ranged from 4.11 to 100%. There are 16 plant species including *Achyranthes aspera* (cuts and wounds), *Artemisia vulgaris* (cuts and wounds), *Asparagus adscendens* (tonicity and viability), *Berberis lycium* (jaundice), *Cedrus deodara* (skin infections), *Lactuca macrorhiza* (cuts and wounds), *Macrotyloma uniflorum* (kidney stones) *Mentha × piperita* (gastric reflux) *Morchella esculenta* (tonicity), *Murraya koenigii* (morning sickness), *Parthenocissus semicordata* (urologic diseases), *Phegopteris connectilis* (herpes), *Quercus semecarpifolia* (kidney stones), *Rhododendron arboreum* (fever), *Rubus ellipticus* (wounds), *Thuja occidentalis* (burns) with a FL value of 100%. Generally, high fidelity values signify a preference among people for using certain plant species to cure a specific ailment (Muhakr *et al.* 2024). Thus, these plants are almost exclusively used in treating those particular diseases mentioned with them. *Hedychium spicatum* (Bronchitis) had the lowest FL value (4.11 %) which means it is used in numerous ways for different diseases. So, it is imperative that further studies are conducted regarding the pharmacology and phytochemistry of these plant species in order to effectively use them against the health problems mentioned above (Chaachouay *et al.* 2019).

Ethnomedicinal studies are an important step in the expansion of natural source medicines. Numerous scientists have contributed to this topic in an effort to further human civilization. The traditional uses of some plants recorded in the current study shows similarity to some previous literature such as root powder of *Berberis lycium* is used to treat jaundice; leave paste and wood oil of *Cedrus deodara* is used to treat skin infections; rhizome paste of *Curcuma longa* is applied on wounds and cuts to prevent infections and similar uses were reported by Kapoor *et al.* (2013), Chauhan *et al.* (2017) & Singh *et al.* (2017) respectively. Some important ethno-medicinal uses of studied area are as: root powder of *Angelica glauca* is given to infants along with milk to treat fever, vomiting and stomachaches; leave paste of *Artemisia vulgaris* used to stop bleeding on cuts and also applied on wounds to cure it; root and stem decoction of *Berberis ariststa is* used to treat jaundice, fever and stomach infections; leaf paste of *Cannabis sativa* is used to cure burnt skin; root paste of *Cynodon dactylon* is applied on the eyelid to treat a stye; root powder of *Gentiana kurroo* is taken for jaundice and asthma; root paste of *Phegopteris connectilis* also called as brahmsutri ki jadi, is applied on affected area to treat herpes; bark paste of *Soymida febrifuga* is used to treat sprain and fractured bone; root paste of *Thalictrum foliolosum* is applied to boils and snakebite; root paste of *Urtica dioica* is applied to treat sprain; *Viola canescens* is used in several ailments such as dysentery, skin infection and cold & cough.

The previous study shows that in Churah subdivision of district Chamba, root powder of *Asparagus adscendens* is used as carminative and demulcent and also used to control hair fall (Rana *et al.* 2021) whereas, in present study area it is found to be used for tonicity and viability. In previous literature of Himachal Pradesh, it is reported that leaves of *Girardiana diversifolia* is used to treat sprain (Sharma & Rana 2000) and according to informants of present study area, fresh leaves are boiled and ingested to treat gastric problems. In Pabbar valley of district Shimla, bark and needles of *Taxus wallichiana* are boiled with water and taken to purify blood (Chauhan *et al.* 2020) and in present study area tea is prepared from the leaves and taken for cancer**.** Plants parts are used to cure various oral related diseases (Rawat *et al*. 2024**)**; leaves of *Zanthoxylum armatum* are used for toothache and also as decoction for cold and cough and previously it is documented to be used for stomachache (Phuyal *et al.* 2019*)*. Even after comparing the results of previous studies from nearby areas to the findings of the present study, it was found that certain plants and its parts were used in different ways e.g. in Kanda region of Shimla district, seeds of *Cannabis sativa* were utilized to treat dysentery and roots powder of *Bergenia ciliata* taken early in the morning along with water and *is* used for weight loss purposes (Singh *et al*. 2017) whereas, in present study *Cannabis sativa* is used to treat minor burns and seeds are taken to strengthen digestive system and roots of *Bergenia ciliata* is taken orally to treat the kidney stone. This comparison makes clear that plants and their parts can be employed in a variety of ways to treat different medical issues in different regions of the world. *Hedychium spicatum, Ajuga parviflora, Angelica glauca, Curcuma longa and Gentiana kurroo* was found to be the most significant plants for its medicinal properties since it is used to cure several conditions such as cold and cough, fever, headaches, stomachaches and sore throat.

Conservation status and strategies of medicinal plants

Plants like *Angelica glauca, Gentiana kurroo* and *Taxus wallichiana* are endangered species (IUCN 2024, Gowthami *et al*. 2021, Mehta *et al*. 2023) and also reported in low frequency in the study area; as roots of *Gentiana kurroo* and *Angelica*

glauca issued for medicinal purposes which require uprooting of entire plant and bark of *Taxus wallichiana* is used for boils therefore, the plants requires immediate conservation attention and the locals should be provided with information on sustainable use of such plants. Although, some people in the study area are already aware of the decline of some species around them therefore, they are already employing various methods to gather these plants responsibly. They carefully select mature plants, leaving the young ones to continue growing and reproducing. They also practice sustainable harvesting techniques, ensuring that only a small portion of the plant is taken, allowing it to regenerate. Several wild plants are already being cultivated in the study area due to their high medicinal properties, such as *Angelica glauca, Curcuma longa, Hedychium spicatum* and *Macrotyloma uniflorum*.

We need to put forth plans for sustainable use of medicinal plants. These plans should include encouraging the cultivation of medicinal plants, harvesting guidelines and supporting community-led conservation initiatives to reduce pressure on wild populations.

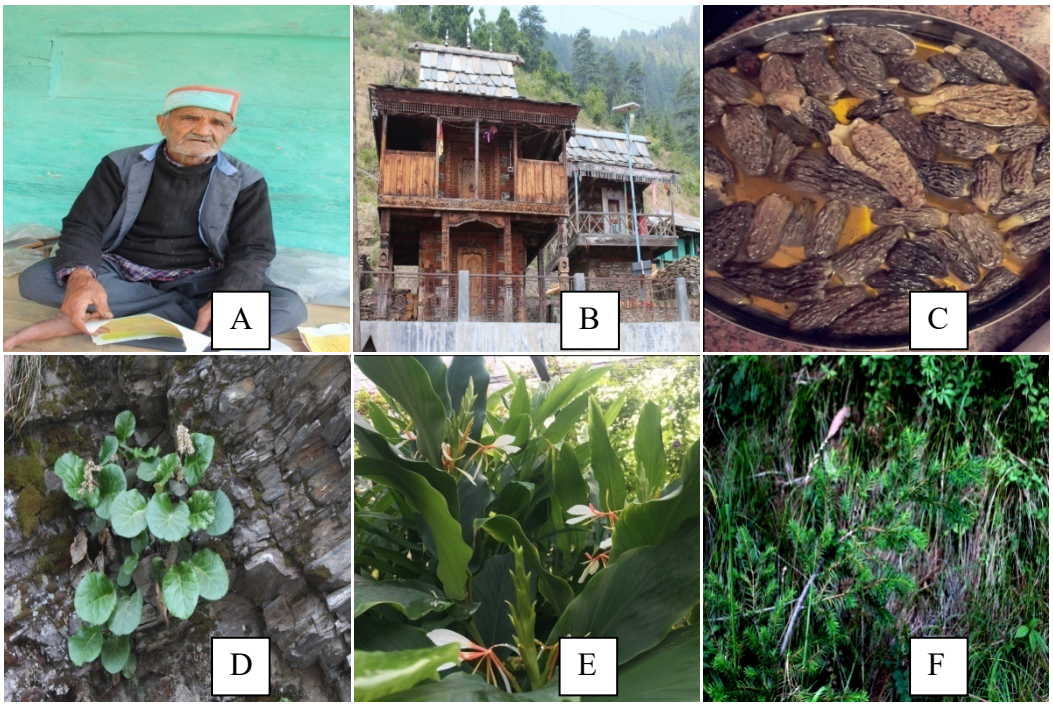

Figure 5: **A** Local Vaid (traditional practitioner)**; B** Local Deity temple; **C** Dried *Morchella esculanta;* **D** *Bergenia ciliata;* **E** *Hedychium spicatum;* **F** *Taxus wallichiana*

Conclusion

The results of the current study conclude that people of the Deiya range possesses some knowledge of medicinal plants. Mostly old age people hold most of the information of medicinal plants, whereas the generation below forty had little or no knowledge. Herbs and leaves (as a part) are majorly used as medicinal preparation and skin problems are mostly treatable disease in the study area. Due to great therapeutic value, *Angelica glauca, Gentiana kurroo* and *Taxus wallichiana* need to be carefully monitored for conservation in the research region. Information about traditional medicine is disappearing from the area, due to the fact that elderly individuals who possess majority of the information are not passing it on to the next generation, and younger generations are uninterested in traditional medicine. Therefore, acknowledging and documenting traditional healthcare practices can lead to a more holistic approach to healthcare, as these practices often focus on preventive and natural remedies. By encouraging native people to preserve the region's flora, we can protect the biodiversity and traditional knowledge that is essential for the development of semisynthetic derivatives and plant-based supplements, offering a sustainable solution for pharmaceutical companies.

Declaration

Ethics approval and consent to participate: In order to conduct the research on traditional knowledge, a number of ethical and legal guidelines were followed. Participants were required to sign the Free and Informed Consent Form, and those shown in images gave their prior consent for publication.
Availability of data and materials: The data used to support the findings of this study is included in the article.
Conflict of interest: The authors confirm no conflict of interest.
Funding: Not applicable
Author's contributions: Priya carried out field surveys and data recording and prepared the manuscript. Dr. Suman Rawat read, edited and approved the final manuscript.

Acknowledgement

The author is thankful to the Chairman, Department of Biosciences, Himachal Pradesh University- Shimla, for providing the lab facilities and to the local people of study area for cooperation extended during the study and for sharing their valuable information regarding the plants and its uses.

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