Quantitative ethnobotanical study of medicinal plants used by local communities in Chamla Valley, Buner District, Pakistan

Nazim Ullah, Barkat Ullah, Muhammad Nauman Khan, Alevcan Kaplan, Hubert Olivier Dossou-Yovo, Sana Wahab, Majid Iqbal

Correspondence
Nazim Ullah[1], Barkat Ullah[1], Muhammad Nauman Khan[1,2*], Alevcan Kaplan[3*], Hubert Olivier Dossou-Yovo[4], Sana Wahab[5] and Majid Iqbal[6,7]

[1]Department of Botany, Islamia College Peshawar, Peshawar 25120, Pakistan
[2]Biology Laboratory, University Public School, University of Peshawar, Peshawar 25120, Pakistan
[3]Department of Crop and Animal Production, Sason Vocational School, Batman University, Batman 72060, Turkey
[4]Laboratory of Applied Ecology, Faculty of Agronomic Sciences, University of Abomey-Calavi Benin, Godomey P.O. Box 1974, Benin
[5]Department of Plant Sciences, Quaid-i-Azam University, Islamabad, Pakistan
[6]Key Laboratory of Ecosystem Network Observation and Modeling, Institute of Geographic Sciences and Natural Resources Research, Chinese Academy of Sciences, 11A, Datun Road, Chaoyang District, Beijing, 100101, China
[7]University of Chinese Academy of Sciences, (UCAS), Beijing 100049, China

*Corresponding Author: nomiflora@uop.edu.pk (M.N.K); kaplanalevcan@gmail.com (A.K)

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Abstract

Background: An ethnobotanical survey was conducted in Chamla Valley, District Buner, Khyber Pakhtunkhwa (Pakistan) to document the traditional medicinal knowledge held by indigenous people on local plant species. The study area has a diversified flora with a remarkable potential for ethnobotanical uses. However, ethnomedicinal studies to state such indigenous information lack. The present research is a contribution to fill in this gap of knowledge.

Methods: Data were collected from different socio-ethnic groups including aged people, herbal practitioners, and well-known aged people in the study area. To state scientific knowledge, these data were quantitatively analyzed using various ethnobotanical indices such as the relative frequency of citation (RFC), the use value (UV), fidelity level (FL), informant consensus factor (ICF), data matrix ranking (DMR) and the informant consensus factor (ICF).

Results: A total of 153 plant species belonging to 134 genera and 67 families were recorded in this study, showing the relevance of ethnomedicine in the community. Among all these species, 85% (57 families) were dicots whereas 10.4% of them (7 families) were monocots. Only 4.47% (3 families) and 1.49% (1 family) were Pteridophytes and gymnosperms respectively. With regards to the types of the recorded plant species, herbs were predominant followed by shrubs, trees, and climbers. The most used parts were leaves followed by the entire plant, stem, root, and fruit. Twenty major ailment groups were recorded, of which gastrointestinal disease showed the highest value, meaning the most relative importance whereas cardiovascular disease exhibited the lowest value. Fifteen alien plant species were identified and analyzed by using the EICAT impact assessment.

Conclusion: This study is the first quantitative investigation that emphasized the traditional herbal medicines used for ethnopharmacological purpose in Buner District, Chamla Valley, with information such as the mode of application and the

treated diseases as well as the relative importance of the recorded species. Outputs of this study are of great importance to motivate advanced pharmacological and phytochemical screenings useful in the pharmaceutical sciences serving human health.

Keywords: Ethnobotany; Asteraceae, Indigenous communities; Human diseases, Herbal medicine

Background

Ethnobotany is the relationship between people and plants regarding their cultural values which are different from area to area due to their relative importance (Cunningham 1993; Khan *et al.* 2018; Khan and Badshah, 2019). Cultural values of plant exploration have a key role in the pharmaceutical and nutritional industrial sectors (Anteneh & Demissew 2011; Ullah *et al*. 2018). About 80% of the world's population still relies on traditional plant-based medicines for primary health care because of their effectiveness, some may have side effects, and easily accessible at affordable prices (Ullah *et al.* 2018). Different ethnic groups throughout the world have a very close affinity with plants both for their personal use and commercial purposes (Dossou-Yovo *et al.* 2021, Dossou-Yovo *et al*. 2022). Since immemorial time, it was reported that humans depends on the plants for different life activities and services (Harshberger 1896). The term medicinal plant refers to a variety of plants that have medicinal properties or are used for various medico-magic purposes. These plants are a rich source of compounds that can be used to develop synthetic drugs. The parts of medicinal plants that may be used are different types i.e., seeds, roots, leaves, fruit, flowers, or even the whole plant. It has been reported by various scientists that the active compounds in most parts of medicinal plants have direct or indirect therapeutic effects and are used as medicinal agents (Torres *et al.* 2012, Jamshidi-Kia *et al.* 2018; Ali *et al.* 2020; Naila *et al.* 2020). An estimated 25% of the drugs prescribed worldwide are derived from plants, and a decade ago, it was already stated that 121, so active compounds are currently in use (Sahoo *et al.* 2010). The documented traditional knowledge provides a comprehensive basis for the novel phytochemical, pharmacological, and clinical studies necessary to secure sustainable and rational use of these plants as therapeutic resources (Hussain *et al.* 2018). As a result, there is a need to gather various ethnomedicinal knowledge on plant species hold by a big range of communities all over the world.

At present, the clinical, pharmaceutical, and chemical studies of traditional medicine, which are predominantly extracted from plants, are the premise of much early medicines like acetylsalicylic acid (anti-inflammatory) from willow bark, digoxin from foxglove, morphine from the opium poppy, and quinine from cinchona bark. It has been assessed that more than half of the accessible medications are one way, or another, got from therapeutic plants (Jamshidi-Kia *et al*. 2018). Traditional medicine is a fundamental part of the culture, beliefs, and lifestyle of many indigenous people all over the world, like Pakistani people, and medicinal plants are worldwide harvested from various vegetation types like termitaria flora (Dossou-Yovo *et al.* 2014), mangrove ecosystems (Dossou-Yovo *et al.* 2017), from the home gardens or purchased in commercial gardens (Dossou-Yovo *et al.* 2021). Native healing awareness and practices area part of the Pakistani tradition, and it was reported one decade ago that remedies based on plants are culturally used by the mainstream of the most of the Pakistani population (Bahadur *et al.* 2013). Since immemorial time and as per the estimates in Pakistan, up to 84% of individuals rely on conventional medication for practically a wide range of medication needs (Ahmad *et al*. 2015). Later, Singh *et al.* (2009) highlighted that about 85% of customary medication includes the utilization of plant extracts. All these show that more research attention should be focused on plants exploited for medico magic purposes in Pakistan. Moreover, Leaman (2001) reported that various medicinal plants that existed many years ago are no longer found today. In addition to this assertion, Gaoue & Ticktin (2007) stated the lack of precautions by indigenous people while collecting plant organs for medicinal goals. These mean an increasing pressure on plants and the need to focus various studies on the exploitation and sustainable conservation of taxa used for medicinal purposes worldwide.

Quantitative ethnobotany concerns the work designed to quantify local indigenous knowledge by using well-known indices of relative or cultural importance (de Albuquerque 2009). In other words, quantitative ethnobotanical surveys use quantitative techniques to assess the medicinal uses of plants in specific areas. The use of the quantitative techniques for analyzing data on the utilization of existing plants is quantitative ethnobotany (Hoffman & Gallaher 2007). To explain variables quantitatively, these approaches are considered useful. Such studies are helpful in the conservation and development of resources by creating quality information (Klassen *et al*. 2012). As a result, the relevance of the present research is evident and it aims to state scientific knowledge on the medicinal exploitation of plant species by a community in Pakistan. It is also necessary to realize the significance of the environment for people. Increasing efforts are made by scientists worldwide in the field of ethnobotany to state the quantitative profiles of plants exploited for medicinal purposes (Hussain *et al.* 2018). For instance, and very recently, Dossou-Yovo *et al*. (2021, 2022) applied ethnobotanical indices to assess the traditional knowledge of nine different herbaceous species, previously overlooked by research in Benin (West

Africa). So, the present study was undertaken with the objectives to state the diversity of plants having an ethnobotanical importance in Chamla Valley, to document diseases treated using these plant species as well as the various modes of preparation hold by the indigenous people on them in the region. In fact, the main rationale supporting this investigation in this area is that although it is known for its remarkable biological diversity (Alam *et al*. 2022), the area has received less attention dealing with ethnobotanical utilizations of plant species with application of indices. More specifically, authors questioned (i) which types of plant species are exploited by the indigenous people in the study area? (ii) What parts of plant species are used and what they are used for? (iii) Which modes of preparation the plants and their parts are used? (iv) What is the relative importance of these plants according to respondents? Besides, this research is quite important since it helped gather traditional information and state scientific knowledge hold by indigenous people on plants they are using since immemorial time. Such data are needed to promote the conservation of medicinal plants based on their medico magic relevance. For instance, Dossou-Yovo *et al*. (2021, 2022) based on ethnobotanical research ouputs to recommend and define conservation approach of nine herbaceous medicinal plants in Benin. Furthermore, Makgobole *et al*. (2023), in their review article on medicinal plants used for dental care in West Africa, reported the conservation status of the concerned species and found 5 vulnerable ones, 3 nearly threatened, and one being endangered. Authors expect that the present study provides insight for further investigations on the conservation of medicinal plants in Chamla Valley region of Pakistan.

Materials and Methods

Research area location, description and climate

The research area (Buner) is a part of Malakand Division, located in the province of Khyber Pakhtunkhwa in Pakistan. It is separated in the north by Malakand Agency on the west, upper Swat on the north, Mardan District on the south, and Hazara Division on the east as given in Fig 1. It covers an area of 952 square kilometers and lies between 34°-9' and 34°-43' N latitudes and 72°-10' and 72°-47' E longitudes (Zaman et al. 2018; Jan et al. 2020). District Buner is enriched with unique phyto-diversity due to its climate, geographical and geological conditions, and highly varied altitudes range from 600 to 3000m (Ali et al. 2015). Moreover, based on the existing data reported by these authors on the district, the climate is moderate. They emphasized that during the summer season, it is hot in the lower Buner with a temperature seldom rising above 40° C but pleasant in the upper parts, Gadezai & Gokand. The summer season is short and mild. The winter season is very cool and extends from November to February, with rains and snow occurring during this season. The average annual rainfall is approximately 30 inches (Hamayun 2003).

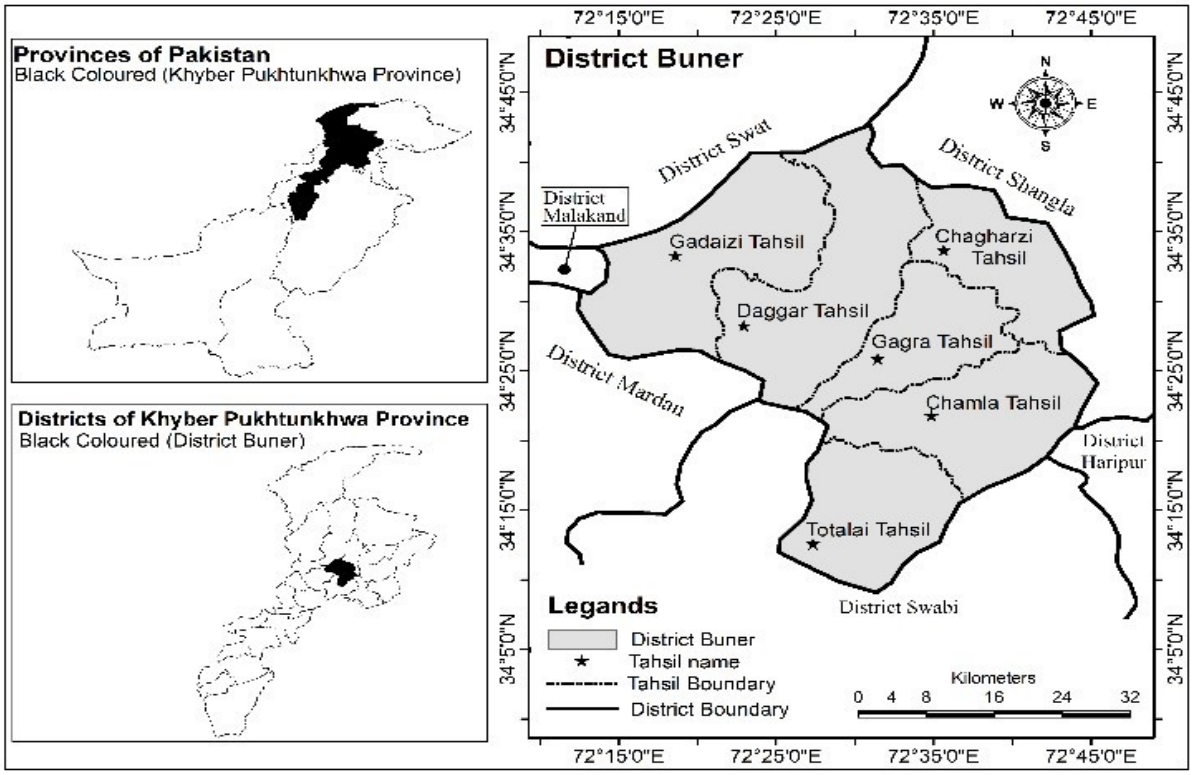

Figure 1. Map of Bengkulu province, Indonesia, showing the study area

Socio demographic characteristics of Malakand District in Pakistan

At the 2017 Pakistan Census, the district had 90,291 households and a population of 717,806 inhabitants all Muslims. The rural population was predominant with 650,120 people representing 90.57% of the whole population. Malakand had a sex ratio of 991 females per 1000 males and a literacy rate of 61.83%, 74.45% for males and 49.45% for females. 67,686 (9.43%) lived in urban areas. 30.81% of the population were under 10 years of age. 471 (0.07%) people in the district were recorded from religious minorities (https://en.wikipedia.org/wiki/Malakand_District). Pashto is the predominant language, spoken by 98.38% of the population. Utmankhel is the largest Pashtun tribe living in Malakand. A part of Malakand is occupied by the Yusufzai clan of Pashtuns Known As Ranizai, while towards the south, at the bottom of Malakand Pass, live the Ranizais known as Sam Ranizai (https://en.wikipedia.org/wiki/Malakand_District). With its surface of 952 Sq.Kms, the district has a population density estimated in 2017 at 750/km2 (2,000/sq mi) (https://en.Wikipedia.org/wiki/ Malakand_District)

Selection of study sites, of categories of informants and consent

The study area was divided into seven spots before visiting, by following the guidance of local herbal experts, agricultural officers, wood sellers, and farmers. Frequent visits were undertaken in the selected spots in 2019-2020 to gather information about traditional utilization of plants by residents. A minimum 10 (ten) and maximum of 18 (Average 14) informants were interviewed in each spot. Preference was given to the old and wise people of the study area especially those who are known to hold valuable knowledge about plant uses. Those people comprised Hakeems, farmers, wood sellers, and traditional healers, all Muslims, speaking mostly Pashto and belonging to Utmankhel ethnic group known as the predominant ethnicity. Most of these informants were above 30 years old. In addition to them and to gather the diversity of traditional knowledge from a wide range of people, some young's aged from 18 to 20 years were also randomly selected and included. The main objective of the research dealing with gathering ethno medicinal exploitation of plants for publication was explained to the respondents who provided their verbal consent to participate in the study. It was also told to each Informant that the proposal supporting this investigation received the ethical approval of the Department of Botany, Islamia College Peshawar, Pakistan as well as the authorization by the Head of the district to conduct such a research in line with the local population development. A total of 93 people participated in and data were collected by using a semi-structured questionnaire. Informants were mainly freely interviewed to list the local names of plant species used as medicines, the diseases and any social conditions treated by using the species as well as organs involved in each treatment. The preparation modes were also documented.

Field surveys including collection, preservation, and identification of plants

Frequent field visits were conducted in the spring and summer seasons of 2019-2020 for the collection of botanical samples of the recorded plant species. In addition, useful photographs of plants and their organs were taken for accurate and easy identification and certification at the herbarium of the Islamia College University Peshawar, Pakistan and the voucher specimens were submitted to the herbarium of the Department of Botany, Islamia College University Peshawar having accession number as ICUP (NU-01 to 153). Three parts were collected which may include vegetative parts, floral parts, or the entire plant for some herbs, to reduce chances of fungal attack or other means of sample loss. Specimen were then tagged with a number and its local name and wrapped in newspaper, properly pressed, and dried in the shade to avoid photochemical degradation. The newspapers were changed from time to time and placed in well-ventilated places to reduce fungal attacks by dehydrating plant specimens. Each dried specimen was pasted on herbarium sheets, following the method of Hassan et al. 2017, Ullah et al. 2018. The collected and processed specimens were identified from different databases including the plant list (http://www.theplantlist.org/), Tropicos (https://www.tropicos.org/home), international plant names index (https://www.ipni.org/) and Flora of Pakistan. After the identification of specimens, voucher numbers were deposited at the herbarium of the Department of Botany, Islamia College Peshawar, Khyber-Pakhtunkhwa, Pakistan as a record.

Quantitative ethnobotanical analysis

The documented and organized data were analyzed by using quantitative approaches such as ethnobotanical indices. Thus, indigenous traditional knowledge was assessed by using quantitative ethnobotanical indices (Dossou-Yovo et al. 2021) such as Use value (UV), Relative frequency citation (RFC), Data matrix ranking (DMR), Informant consensus factor (FIC), and Fidelity level (FL) to determine the consent between the informants on the use of wild medicinal plants in the study area. Such indices give a scientific idea of the local importance of a species or a botanical family (Amjad et al. 2020, Bahadur et al. 2020).

Relative frequency of citation (RFC)

RFC was determined to highlight the relative importance of the recorded plant species based on its citations as medicine by the participants. It is calculated using the number of the surveyed participants reporting a species or a disease by the total number of informants involved in the study. It is calculated by using the following formula:

$$\mathrm{RFC} = \frac{\mathrm{FC}}{\mathrm{N}}$$

FC stands for the frequency of citation which represents the number of informants who mentioned the use of a plant species while "N" stands for the total count of informants who contributed to the whole study (Vitalini et al. 2013).

Fidelity level (FL)

FL is used to demonstrate the importance of plant species in the treatment of a specific disease. It points out the most suitable species for curing specific disease. It was calculated by using the following formula described by Ahmad et al. (2017).

$$\mathrm{FL} = \frac{\mathrm{Ip}}{\mathrm{Iu}} \mathrm{x}\ 100$$

Where, "Ip" represents the number of informants who reported the species for some specific disease category, and "Iu" is the number of informants who mentioned the same species for any disease category. If the maximum number of informants agreed for selected plant species to treat a specific disease category, the FL value will be highest (100 or near 100%).

Use value (UV)

It is a relevant ethnobotanical index that elaborates on the relative importance of various locally used plant species (Barkatullah et al. 2015). The UV highlights the most important species of the specific area and consequently interacted with issues of preservation, ultimately supporting the idea that the most important species face great harvesting threats (de Albuquerque & Hanazaki 2009). High UV values mean the concerned plant has more useful information and the plant is essential while low use value (near 0) means there is little use information. It was calculated by using the following formula described by Ahmad et al. (2017).

$$\mathrm{UV} = \frac{\sum \mathrm{Ui}}{\mathrm{N}}$$

where Ui is the number of use reports cited by each informant for a given species and N is the total number of informants.

Data matrix ranking (DMR)

Data matrix ranking (DMR) analysis was used to assess the multiple uses of given plants reported by informants following protocol as described by Ahmad et al. (2017). DMR analysis describes various usages capability of one plant for various purposes (Ishtiaq et al. 2013).

Informant consensus factor (ICF)

Informant Consensus Factor (ICF) was calculated by using the following formula (Tsioutsiou et al. 2019).

$$\mathrm{ICF} = \frac{\mathrm{Nur}}{\mathrm{Nt}}$$

where Nur indicates the number of use reports for a specific disease category and Nt mentions the number of taxa used for the disease category.

Regarding the differences between indices, the UV reports the relative importance of each species compared to the group of plants known as used by a community of people while surveying a community exploiting plants for various purposes. Elsewhere, the RFC and FL give a right idea on the significance of each plant or its specific organs in the treatment of specific diseases or social conditions. They also provide great ideas on the species or parts used in specific modes of preparation as well as the most predominant modes of preparation used against various diseases. Such indices serve to find out level of threats on medicinal plants according to the most used parts. For instance, Dossou-Yovo et al. (2022) reported by using the RFC and FL that herbs entirely used as medicines are more subject to threats compared to those of which leaves are collected for medicinal goals. Similarly, when the use of the RFC and FL on woody medicinal species reveals bark as the most used part for certain species compared to others exploited for their leaves, it serves to predict the level of threats on each species.

The data matrix ranking Informs on the diversity of uses a species is applied in. The more a species is used for various purposes, the more important it is for the concerned community. It also helps predict likely threats dealing with the range of uses.

The Informant Consensus Factor provides a right idea on how people belonging to a community or different have the same level of knowledge, meaning consensus on the use of specific plant species against categories of diseases.

The reason why indices have not been presented based on various sites in the present article is that Dossou-Yovo et al. (2021, 2022) combined data collected in various districts of southern Benin, meaning from different sites, to state relevant ethnobotanical knowledge on nine herbaceous species. It helps state information on these species in the whole region. Moreover and as reported above, most of the informants are Muslims, speaking mostly Pashto and belonging to Utmankhel ethnic group.

Results

Diversity of plant species, botanical families, uses and used parts

Informants used a diversity of plant species for medicinal purposes. We recorded a total of 153 plant species belonging to 134 genera and 67 families of which 85% were dicots (57 families), 10.4% of monocots (7 families), 4.47% of pteridophytes (3 families), and 1.49% of gymnosperm (1 family), as shown in Fig. 2. Dicot group was dominated by Asteraceae having 11 species, followed by Lamiaceae with 10 species, Amaranthaceae (7), Rosaceae and Euphorbiaceae (5) each, Mimosaceae, Moraceae, Polygonaceae, Papilionaceae and Solanaceae showed (4) species each. Elsewhere, Acanthaceae, Brassicaceae, Compositeae, Sapindaceae, Saliaceae and Umbillifera was each represented by (3) species and the rest of all was composed of only one species. Monocot families are 07 and dominated by Poaceae, with 14 species, followed by Cyperaceae having 03 species, and Araceae, Asparagaceae, Amaryllidaceae, and Commelinaceae have only one species. Pteridophytes of the area were represented by three (03) families via Dryopteridaceae (1 species), Equisetaceae (1 species), and Pteridaceae (2 species). Gymnosperm was represented by only one family Pinaceae with one species. Details on the botanical names, local names, families, habits, and medicinal uses are shown in Table 1. The vegetation composition of the recorded species revealed that the study area is dominated by herbs 61% (93 species), followed by shrubs 20.9% (32 species), trees 12.4% (19 species) and climbers 6% (9 species) Fig. 3. Based on the relative frequency citation, the most used parts of all recorded plants were leaves (29.5%) followed by the whole herbaceous plants (21.5%), stem (14%), root (12%), fruit (10%), seed (5.6%), bark (4.6%), flowers (3.3%), latex (2.6%), gum (2%), rhizome (2%), bulb (1.3%), fronds (1.3%) as given in Fig. 4. Surveys revealed that most of the informants frequently use folk medicine to treat diseases since a very long time.

Elsewhere, among the 153 valuable plants recorded in the present study, 135 (87.6 %) were reported as medicines, 73 (47.4 %) were mentioned as fodder, followed by 52 plant species (33.7 %) recorded as fuel. Moreover, there were 31 edible plants representing 20.1% of all species. In addition to all these, 23 plant species (14.9%) were reported as used for fencing, 13 plants (8.4%) mentioned as timber, 11 species exploited for ornamental purposes, and 26 plant species (16.8%) were used for other purposes.

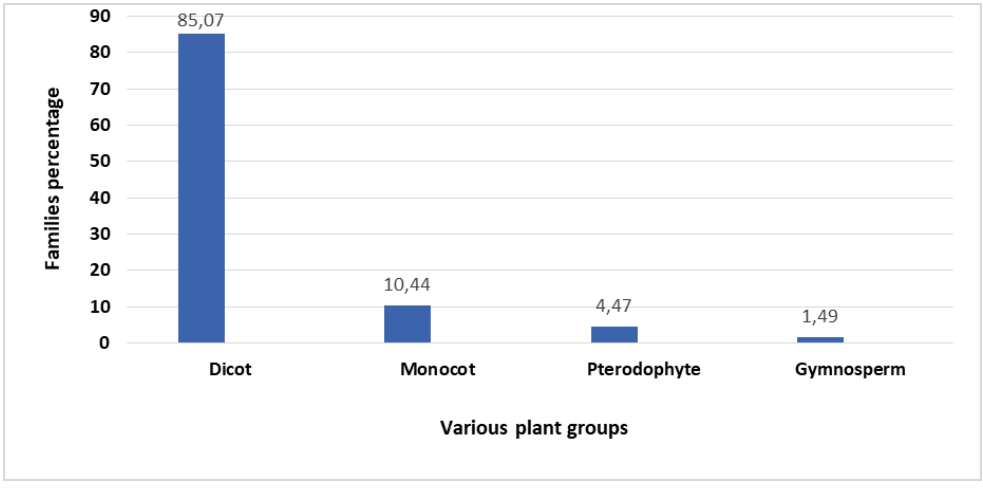

Figure 2. Percent contribution of various plant groups. It shows dicot medicinal plant species as the most abundant

Table 1. Shows Fic values of medicinal plants for treating certain human ailments of Chamla Valley

Scientific name	Local name	Habit	Part use	Voucher's Number	Method of preparation	Mode of administration	Medicinal uses	RFC
Amaranthus spinosus L.	Senglay	H	whole plant	NBuner.a.02082020/ICP	Decoction	Orally	Expectorant, diuretic, laxative, rheumatism, snake bite,	0.5
Arisaema flavum (Forssk.) Schott	Shnai	H	whole plant	NBuner.b.02082020/ICP	Extract	Orally	Antipyretic, vermifuge for cattles	0.4
Achyranthes aspera L.	Jeshky	H	Leaves, Whole plant	NBuner.d.02082020/ICP	Decoction , powder	Orally	Stomachache , arthritis, diuretic, analgesic, diarrhea, asthma, expectorant, laxative	0.7
Ailanthus altissimus Mill. Swingle	Bukyanra	T	Stem, Leaves Bark	NBuner.f.02082020/ICP	Juice	Orally	Abdominal pain, skin irritation, pimples, opthalmia, dysentery, gastric intestinal	1
Aerva sanguinolenta (L.) Blume	Maloch boty	H	Leaves, Stem Fruit	NBuner.b.05082020/ICP	Infusion	Dermal , orally	Anti-inflammatory, anti-oxidant, diuretic	0.1
Alternanthera philoxeroides (Mart.) Griseb.	Speengualy perpolak	H	Whole plant	NBuner.c.05082020/ICP	Dilute juicy extract	Orally	Urinary tract infection Tuberculosis	0.1
Artemisia vulgaris L.	Tarkha	S	Root, leaves Inflorescence	NBuner.d.05082020/ICP	Oily extract	Dermally and orally	Skin disease, intestinal worms, applies on tumors	0.4
Amaranthus viridis L.	Gunharo sag	H	Whole plant, Leaves	NBuner.b.07082020/ICP	Decoction, paste	Orally, top	Urinary disease, hair tonic, boils	0.9
Allium cepa L.	Pyaz	H	Bulb	NBuner.c.07082020/ICP	Decoction	Orally, top	Menstrual pain, condiment, bacteriostatic, stimulant, piles, expectorant, carminative, diuretic, aphrodisiac	0.8
Allium sativum L.	Ooga	H	Bulb, Leaves	NBuner.d.07082020/ICP	Paste	Orally	Carminative, stimulant, aromatic, cough, whooping, asthma	0.8
Acacia modesta Wall.	Palosa	T	Gum, Stem, leaves	NBuner.f.07082020/ICP	Stem and bark ash, direct, Leaves Decoction	Orally	Relaxant, stimulant, pain killer, hepatitis, tonic after delivery, body weakness, colic pain in horses	0.8
Acacia nilotica (L.) Delile	Nare kekar	T	Leaves Stem Seed	NBuner.g.07082020/ICP	Decoction	Orally	Dysentery, stomach, expectorant	0.9

Asparagus officinalis L.	Sheenlakhty	S	Roots powder, young shoot	NBuner.a.09082020/ICP	Juice, powder	Orally	Anti-diarrheal, fever, flatulence, kidney stones	1
Berberis lycium Royle	Karosky	S	Whole plant	NBuner.b.09082020/ICP	Grinded root bark with milk, Boiled peeled root	Orally Paste externally on wound	Jaundice, tonic, internal wound healing, sore throat, blood purifier, diabetic, bone fracture, diarrhea, cognitive, ulcer, carminative	1
Boerhavia diffusa L.	Zaham boty	H	Root powder	NBuner.c.09082020/ICP	Poultice, powder	Orally	Skin inflammation, ulcer, bleeding after delivery	0.5
Broussonetia papyrifera (L) L,Herit.Ex Vent	Gul thooth	T	Leaf, Fruit	NBuner.a.11082020/ICP	Powder	Orally	Astringent, diuretic, tonic	0.4
Cynodon dactylon (L.) Pers.	Kabal	H	Whole plant	NBuner.b.11082020/ICP	Extract	Orally	Wound healing, astringent, diuretic, leprosy	0.9
Cyperus rotundus L.	Della	H	Shoot, Rhizome	NBuner.c.11082020/ICP	Decoction	Orally	Tonic for cattle's, chest infection, cold, cough, menses	1
Crotalaria sagittalis L.	Zangali matar	H	Whole plant	NBuner.d.11082020/ICP	Powder Decoction	Orally and top	Scabies, lower blood pressure, toxic	0.2
Cleome viscosa L.	Zangali sharsham	H	Whole plant	NBuner.f.11082020/ICP	Juice	Dermal Orally	Rheumatic, arthritis, hypertension	0.5
Cardiospermum halicacabum L.	Khubara	H	Root, Shoot	NBuner.i.11082020/ICP	Root powder, Decoction	Top and orally	Emmenagogue (promot menstruation), demulcent, anthelmintic, stimulant, diuretic, tonic fever	0.2
Conyza canadensis (L.) Cronq.	Pesholakay	H	Stem, Root, Leaves	NBuner.j.11082020/ICP	Infusion	Orally	Diuretic, astringent, diarrhea, dysentery	0.4
Clematis grata Wall.	Zelay	H	Leaves	NBuner.e.15082020/ICP	Paste	Top	Jaundice, ulcer, insect killer, cough, febrifuge	0.3
Calotropis procera (Ait.) Ait. f.	Spalmay	S	Leaves, Latex	NBuner.g.15082020/ICP	Stem smoke, paste Powder, decoction	Smoke smelled, paste externally on skin Orally	Digestion, cough, flatulence, cold, leucorrhea, asthma, dandruff remover, expectorant, dysentery, dye, toothpaste	0.85
Cannabis sativa L.	Bhang	H	Whole plant	NBuner.a.18082020/ICP	Juice Smoke smelling	Orally	Anti-lice, narcotic, ulcer, painkiller, sedative, antidandruff, dysentery, anthrax, boil malaria, anodyne	0.7

Cuscuta reflexa Roxb.	Xyara jaly	H	Whole plant	NBuner.c.180820 20/ICP	Juice , decoction	Orally	Arthritis, blood purifier, sterility, skin disease	0.4
Cirsium arvense (L.) Scop.	Kapar azghe	H	Whole plant	NBuner.d.180820 20/ICP	Decoction	Orally	Indigestion, worms in children, toothache	0.2
Capsella bursa-pastoris (L.) Medik.	Pepansa	H	Whole plant	NBuner.e.180820 20/ICP	Decoction, infusion	Orally	Abnormal stoppage of menses, diuretic, astringent, tension, anxiety	0.8
Carissa opaca Stapf ex Haines.	Soor azghe/ garanda	S	Stem, Leaves, Fruit	NBuner.f.180820 20/ICP	Decoction Poultice	Top Orally	Epilepsy, inflammation, arthritis	0.5
Dodonaea viscosa (L.) Jacq.	Ghwarasky /jorky	S	Whole plant	NBuner.j.180820 20/ICP	Poultice, decoction	Top	Fungal infection, wound healing, bone fracture, exes menstrual flow, urinary disorders	1
Datura stramonium L.	Batura	H	Leaves	NBuner.k.180820 20/ICP	Poultice, powder	Top, orally	Anti-inflammatory, boil softening, anti-spasmodic	0.6
Dicliptera bupleuroides Nees.	Tanky wakha	H	Whole plant	NBuner.m.18082 020/ICP	Juice Decoction	Orally Top	Wound healing, cough, skin disease	0.6
Desmodium elegans DC.	Matar botay	S	Leaf, Fruit	NBuner.n.180820 20/ICP	Decoction	Orally	Carminative, diuretic, tonic	0.4
Duchesnea indica (Andrews) Focke.	Shahtooth	H	Fruit, Shoot	NBuner.b.250820 20/ICP	Poultice decoction	Orally	Astringent, refrigerant, menstrual disorder, sore throat, laxative	0.3
Euphorbia hirta L.	Skha boty	H	Latex, Whole plant	NBuner.d.250820 20/ICP	Poultice Juice	Orally Top	Wound healing expectorant, kidney stone, bronchitis, constipation, cough, nausea, vomiting, diuretic, pulmonary disorder,	0.5
Eucalyptus occidentalis Endl.	Lalchi	T	Leaves, Stem, Gum	NBuner.f.250820 20/ICP	Gum direct,	Dermal	astringent in pharyngitis and laryngitis , antiseptic	0.7
Euphorbia cyathophora Murr.	Peryandolay	H	Leaves, Fruit, Latex	NBuner.b.290820 20/ICP	Powder	Dermal	Constipation, asthma, bronchitis, wound healing	0.2
Equisetum arvense L.	Bandaky	H	Whole plant	NBuner.c.290820 20/ICP	Juice, powder	Orally	Constipation, pneumonia, scorpion bite, gonorrhea, tonic, diuretic, anti-lice	0.8
Euphorbia helioscopia L.	Peryandolay	H	Latex, Shoot, Root	NBuner.d.290820 20/ICP	Powder	Orally	Anthelminthic, laxative, cholera, kidney stone, constipation, purgative,	0.8

Eryngium planum L.	Alikanda	H	Root	NBuner.e.290820 20/ICP	Juice Decoction	Orally	diuretic, aphrodisiac,	0.8
Fumaria indica (Hausskn.) Pugsley.	Papra	H	Whole plant, Seed, Young shoot	NBuner.h.290820 20/ICP	Decoction Juice Powder	Orally	Blood pressure, vomiting, fever, antispasmodic, dyspepsia, emesis, constipation, diuretic, blood purification,	1
Ficus carica L.	Enzar	T	Fruit, Latex, wood, leaves	NBuner.a.050920 20/ICP	Direct	Orally	removal of warts, stomach disorder, laxative, tonic, menorrhagia, constipation and piles, sexual debility,	1
Ipomoea pes-tigridis L.	Laspanri	H	Root, leaves	NBuner.f.050920 20/ICP	Poultice, juice	Orally and top	Dog bite, purgative, boil	0.1
Isodon coetsa (Buch.-Ham. ex D.Don) Kudô.	Pamanky	H	Leaves, Flower	NBuner.g.050920 20/ICP	Juice	Orally	Abdominal pain, gastric, toothache	0.2
Indigofera tinctoria L.	Nare kekar	S	Whole plant	NBuner.h.050920 20/ICP	Infusion	Orally	Demulcent, anti-cancer, diuretic, carminative, urinary disease	0.4
Isodon rugosus (Wall. ex Benth.) Codd.	Khangere	H	Flower, leaves	NBuner.i.050920 20/ICP	Extract	Orally, top	Gastric, abdominal pain	0.2
Ipomoea purpurea (L.) Roth.	Dewal botay	S	Leaves, flower	NBuner.j.050920 20/ICP	Decoction	Orally	Anthelmintic, diuretic, laxative	0.2
Justicia adhatoda L.	Baykarh	T	Root, Whole plant	NBuner.a.110920 20/ICP	Decoction Poultice	Orally Top	Blood purifier, antispasmodic, expectorant, respiratory disease, leucorrhea	0.3
Juglans regia L.	Ghuz	T	Wood, Bark, Leaves, Nuts	NBuner.b.110920 20/ICP	Direct	External, orally	Boost memory Cosmetics Anthelmintic	0.8
Lantana camara L.	Phanchpal	S	Whole plant	NBuner.c.110920 20/ICP	Infusion, Oil decoction	Dermal Orally	Diaphoretic, antiseptic, carminative	0.6
Mallotus philippensis (Lam.) Müll. Arg. (L.) L.	Kambella	S	Bark, Seeds, Root	NBuner.c.170820 20/ICP	Juice Direct	Orally	Gonorrhea Anthelmintic, stomachic, astringent, abdominal pain, purgative	1
Mentha longifolia (L.) L.	Velany	H	Whole plant powder	NBuner.d.170920 20/ICP	Powder , juice	Orally	Stimulant	0.8

Chenopodium ambrosioides L.	Skhaboty	H	Whole plant	NBuner.e.170920 20/ICP	Tea Infusion decoction	Orally	Stimulant, anthelmintic, antispasmodic, carminative	0.3
Mentha piperita L.	Podina	H	Leaves, Whole plant	NBuner.f.170920 20/ICP	Powder , juice	Orally	Easy delivery, abdominal pain, Indigestion, diarrhea, nausea, stimulant, febrifuge, antispasmodic, diuretic, aromatic, carminative	0.8
Mirabilis jalapa L.	Gule nazak	H	Leaves, Flower	NBuner.h.170920 20/ICP	Fry in ghee for two minutes	Top	Wound healing, ring worms	1
Melia azedarach L.	Rarhai	T	Leaves, Fruit, Stem	NBuner.a.240920 20/ICP	Decoction	Orally	Antiseptic, anti-diabetic, anemia, laxative, anthelmintic, scrofula, rheumatism	1
Morus nigra L.	Thor thoot	T	Fruit, Leaves, Stem	NBuner.b.240920 20/ICP	Direct	Orally	Coughing, expectorant, laxative, cooling agent, anti-throat infection	1
Morus alba L.	Speen thoot	T	Fruit	NBuner.c.240920 20/ICP	Direct	Orally	Constipation, increase digestion, laxative, purgative, anthelmintic, sore throat, dyspepsia, refrigerant	1
Nasturtium officinale R.Br.	Thalmera	H	Shoots	NBuner.e.240920 20/ICP	Juice Vegetable	Orally	Carminative, heart and kidney disorder, emetic, diuretic, purgative	0.9
Otostegia limbata (Benth.) Boiss.	Karosky/ kharh kwary	S	Leaves, Whole plant	NBuner.b.280920 20/ICP	Direct Powder	Orally. Top Fry	Healer, jaundice, toothache	0.6
Origanum vulgare L.	Shamaky	H	Shoot	NBuner.c.280920 20/ICP	nfusion	Orally Topically	Malaria Antiseptic Diuretic	0.2
Olea ferruginea Royle.	Khoona	T	Leaves, Stem, Fruit	NBuner.d.280920 20/ICP	Direct , decoction	Toothbrush Orally	Astringent, antiseptic, diuretic, sore throat, fever, debility, toothache	1
Oxalis corniculata L.	Tharoky	H	Leaves, Whole plant	NBuner.e.280920 20/ICP	Juice Poultice	Orally Top	Avoid vomiting during early pregnancy, stomach disorder of cattle, diarrhea, dysentery, scurvy, antiscorbutic, cooling agent.	1
Persicaria hydropiper (L.) Spach.	Perpolak	H	Whole plant	NBuner.f.280920 20/ICP	Poultice	Externally	Astringent, antiseptic, snake bite	0.4
Parthenium hysterophorus L.	Speen gually	H	Whole plant	NBuner.b.031020 20/ICP	Extract decoction, powder	Orally	Skin inflammation, anti-sugar, diarrhea, urinary tract infection, diabetic	0.6

Pinus roxburghii Sarg.	Nakhter	T	Seeds, Resin, Shoots	NBuner.d.031020 20/ICP	Direct use, Decoction	Orally, Top	Antipyretic, urinary disease, wound healing, delivery, diarrhea	1
Perilla frutescens (L.) Britton.	Skha boty	H	Whole plant	NBuner.e.031020 20/ICP	Juice Powder	Orally	Asthma, vomiting, cough, cold	0.2
Pluchea lanceolata (DC.) C. B. Clarke.	Ziar guli	S	Leaves, Flower	NBuner.f.031020 20/ICP	Decoction Oil	Orally Massage	Inflammation, cough, piles	0.2
Pistacia chinensis ssp. Integerrima (J. L. Stewart) Rech. f.	Shnai	T	Bark, Fruit, Gall, stem	NBuner.i.031020 20/ICP	Decoction	Orally	Hepatitis, loss of appetite, tonic, antiseptic, expectorant, cough, asthma	0.6
Plantago lanceolata L.	Speghol/ jabai	H	Seeds/ husk, Leaves	NBuner.j.031020 20/ICP	Extract, powder	Orally	Gonorrhea, antidiarrheal, antiseptic, tonic, dysentery	0.5
Pyrus pashia Buch.-Ham. ex D.Don	Tangai	T	Fruit, Wood	NBuner.k.031020 20/ICP	Juice (fruit) Powder (bark)	Orally	Coughing, weakness, refringent, laxative,	0.5
Rubus ellipticus Smith.	Gorag	S	Whole plant	NBuner.c.081020 20/ICP	Direct	Orally	Anti-diarrheal, cough, diuretic,	0.9
Rumex hastatus D. Don.	Ghar taruky	H	Leaves	NBuner.e.081020 20/ICP	Direct Juice Poultice	Orally, top	Skin disease, arthritis, purgative, jaundice, antiseptic, carminative, diuretic, astringent	0.6
Ricinus communis L.	Arhanda	S	Leaves, Seed oil	NBuner.f.081020 20/ICP	Powder , oil	Orally Dermal	Wound healer, laxative, analgesic, oil purgative, easy delivery	0.6
Rumex dentatus L.	Shalkhy	H	Roots, Leaves	NBuner.g.081020 20/ICP	Decoction Poultice Vegetable	Orally, top	Diuretic, demulcent, laxative for cattle, skin rash, wound healing, astringent, emollient	1
Sonchus oleraceus L.	Pai boty	H	Rhizome, shoot, Flower	NBuner.j.081020 20/ICP	Decoction	Orally	Tonic, diuretic, skin disease, snake bite	0.4
Solanum nigrum L.	Kachmachu	H	Leaves, Fruit	NBuner.k.081020 20/ICP	Juice, poultice	Orally, top	Menorrhagia, anti-diarrhea, wound healing, carminative, anti-piles, warts, , diuretic and laxative	0.7
Salix babylonica L.	Wala	T	Stem, Bark	NBuner.c.111020 20/ICP	Decoction , poultice	Orally	Astringent, tonic, anti-rheumatic	0.7
Salix tetrasperma Roxb.	Mala	T	Stem, Bark	NBuner.d.111020 20/ICP	Decoction Juice	Orally	Astringent, tonic, diarrhea, fever	0.7

Silene conoidea L.	Mangotay	H	Whole plant	NBuner.e.111020 20/ICP	Juice	Orally	Laxative, purgative, anthelmintic	0.2
Trichodesma indicum (L.) R. Br.		H	Root, Shoot	NBuner.f.111020 20/ICP	Poultice	Top	Anti-inflammatory, snakebite	0.4
Trichosanthes dioica Roxb.	Hindwanu kakora/ khataky	H	Leaves, Fruit	NBuner.i.111020 20/ICP	Juice	Orally	Diarrhea, tonic, febrifuge	0.3
Taraxacum officinale Weber.	Xiar guli	H	Roots, Leaves, petal	NBuner.j.111020 20/ICP	Decoction	Orally	Diabetic, jaundice, cough, eyes and urine, diuretic, constipation	0.6
Tribulus terrestris L.	Markonday	H	Leaves	NBuner.k.111020 20/ICP	Juice	Orally	Gonorrhea, tuberculosis, sore throat	0.6
Verbascum thapsus L.	Khardag	H	Leaves juice, ear drop	NBuner.L.111020 20/ICP	Juice	Eardrop , orally	Otitis media, cough, pulmonary disease	0.7
Vitex negundo L.	Marvanday	S	Shoot, Roots	NBuner.a.161020 20/ICP	Juice	Orally	Regulate menstrual cycle, cramps, rheumatism, antiseptic, pain reliever of chest, back and legs.	0.65
Withania somnifera L. Dunal.	Kotilal	S	Root, leaves	NBuner.d.161020 20/ICP	Powder , vegetable	Orally	Sexual weakness Pneumonia, diuretic	0.5
Woodfordia fruticosa (L.) S. Kurz.	Dadky	S	Flower,	NBuner.e.161020 20/ICP	Powder	Orally	Menorrhagia, nasal and rectum bleeding	0.6
Xanthium strumarium L.	Mangazay	H	Fruit, leaves, roots	NBuner.f.161020 20/ICP	Extract	Orally	Antimalarial, demulcent, anti-cancer, indigestion, diarrhea, small pox, sedative, emollient, astringent, mouth ulcer	0.8
Ziziphus nummularia (Burm.f.) Wight & Arn.	Karkanda	S	Leaves, Fruit, Root	NBuner.g.161020 20/ICP	Decoction , direct, paste	Orally, external	Ulcer, skin infection, induce abortion, laxative, cooling agent	0.7
Ziziphus oxyphylla Edgew.	Elanay	S	Roots, Fruit	NBuner.h.161020 20/ICP	Powder Decoction	Orally	Loss of appetite, constipation, diabetic	0.7
Zanthoxylum armatum DC.	Dambara	S	Shoots, Fruit	NBuner.I.161020 20/ICP	Direct Powder	Orally	Stomachache, carminative, toothache, stimulant, gum pain, cooling agent, abdominal pain, aromatic	0.9

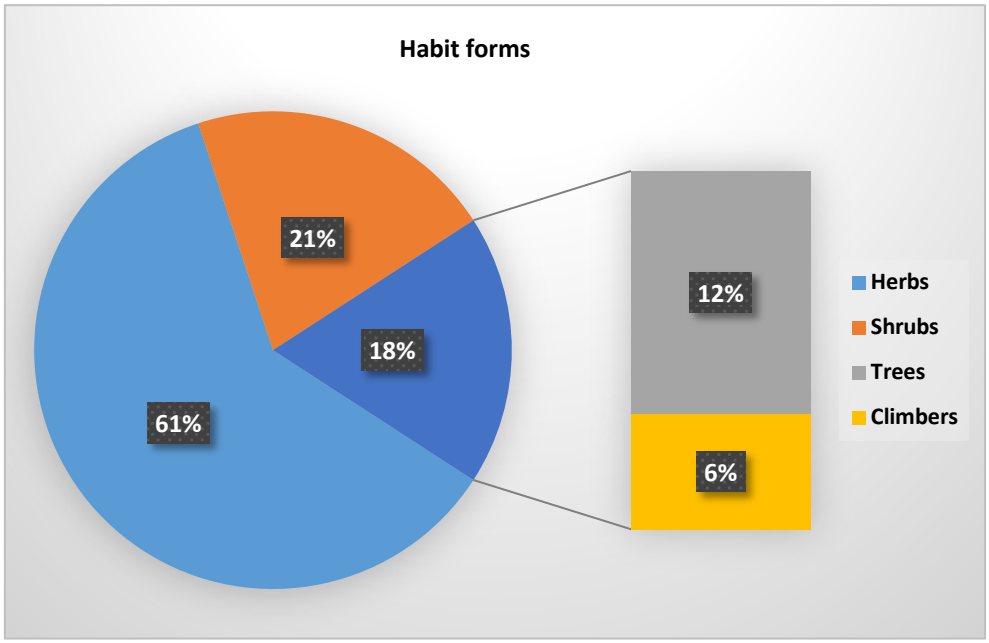

Figure 3. Summary of habit classes. It reveals herbs as the most used medicinal plants

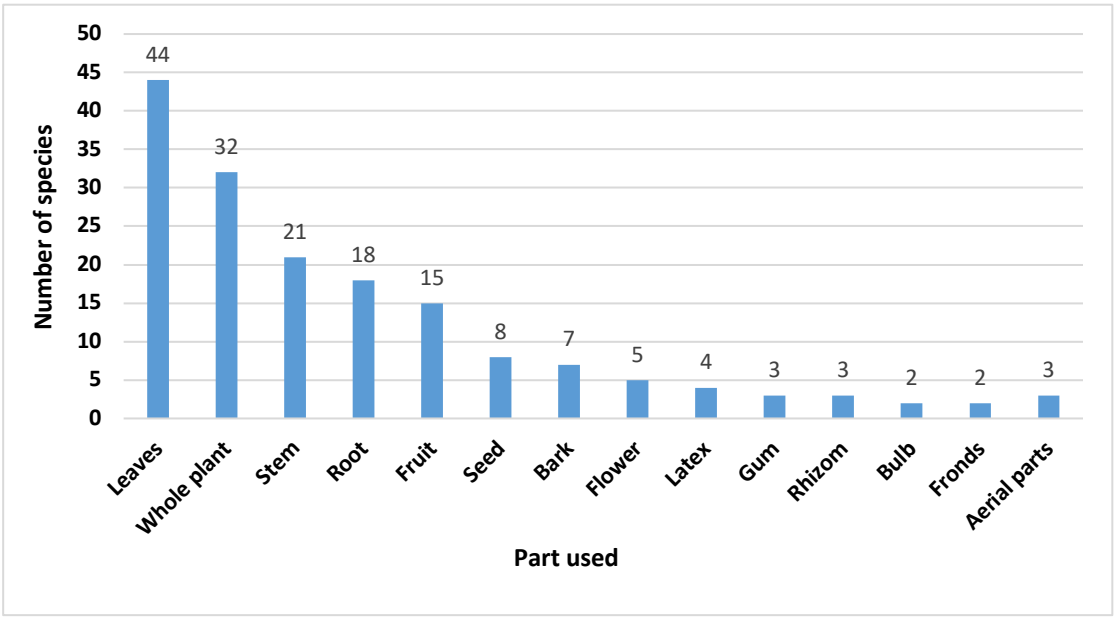

Figure 4. Parts used of local plants. It shows leaves as predominant part followed by the use of entire plants

Quantitative ethnobotanical knowledge based on indices

In terms of quantitative knowledge on the recorded species, we noticed the highest RFC (1) for the following species *Pinus roxburgii, Ailanthus altissimus, Asparagus officinalis, Berberis lycium, Dodonaea viscosa, Cyperus rotundus, Fumaria indica, Ficus carica, Mallotus philippensis, Olea ferruginea,* and *Melia azedarach.* Those species were followed by *Amaranthus viridis (*0.9), *Calotropis procera* (0.85*), Mentha longifolia* (0.8), *Achyranthus aspera* (0.7), *Euphorbia hirta* (0.5), *Pluchea lanceolata* (0.2) and *Ipomoea pes-tigridis* (0.1). A high RFC value shows that the plant was reported by the maximum number of informants. Data analysis on the relative importance of 92 medicinal plants revealed the highest use value 0.98 for *Pinus roxburgii* and *Mentha piperita* while the lowest (0.17), meaning the least important in this study was *Eryngium planum* (Table 2).

Regarding the ICF analysis, 20 major groups of ailments were recorded, among which gastrointestinal illness exhibited the highest ICF value (0.57), meaning that more than half of Informants agreed on the treatment of this disease using specific and known plant species in the study area. Cardiovascular troubles showed the lowest value (0.26), there is a low consensus

on this treatment using plants among the community. In addition to gastrointestinal troubles, diuretic, antidiarrheal, menstrual disorder and skin problems exhibited better consensus regarding their treatment since they showed a high ICF values (0.57, 0.54, 0.48, 0.46, and 0.45). Apart from cardiovascular diseases, respiratory troubles, anti-inflammatory problems also showed low IFC values (0.36, 0.33). This means that the medicinal exploitation of plants among the community for the treatment of such diseases is relatively varied from one informant to another.

Table 2. Shows Fic values of medicinal plants for treating certain human ailments of Chamla Valley

S. No	Disease categories	Nur	nt	Fic
1.	Anti-inflammatory	12	4	0.33
2.	Diuretic	31	17	0.54
3.	Antidiabetic	10	3	0.3
4.	Menstrual disorder	28	13	0.46
5.	Urinary tract infection	12	5	0.41
6.	Skin problems	20	9	0.45
7.	Gastrointestinal	49	28	0.57
8.	Snake bite	10	3	0.3
9.	Blood purifier	11	4	0.36
10.	Wound healing	24	9	0.37
11.	Cardiovascular	7	2	0.28
12.	Arthritis	8	3	0.37
13.	Laxative	22	9	0.40
14.	Painkiller, Tonic	29	13	0.44
15.	Cough	12	5	0.41
16.	Stimulant	14	6	0.42
17.	Anti-diarrheal	29	14	0.48
18.	Respiratory problems	11	4	0.36
19.	Aromatic	13	4	0.3
20.	Dental problems	16	7	0.43

The DMR value as medicinal uses was 41 followed by fuel purposes (35) and fodder uses (17), meaning that the medicinal exploitation of the recorded plants is predominant in the research area. The fidelity level (FL) varied from 33% to 100% (Table 3). Furthermore, the DMR value identified for the 10 most commonly used plants showed *Morus nigra* with the highest value (22) and *Mentha longifolia* had the lowest (5) (Table 4). The Fidelity level of taxa regarding the recorded treatments revealed *Mentha longifolia* as mostly used in the research sites to heal diarrhea, *Berberis lycium* against diabetes, *Mirablis jalapa* mostly used to heal wound. Moreover, *Juglans regia* was mostly mentioned in boosting human memory while *Plantago lanceolata* was mostly reported by informants as anti-diarrheal. Overall, *Pinus roxburgii*, *Berberis lycium*, and *Mentha piperita* got the highest UV (0.98), meaning the relative importance among all species and *Juglans regia* (0.26), *Isodon rugosus* (0.17) showed the lowest UV of all species, less important to the respondents.

Table 3. FL value of each medicinal plant against various ailments

Scientific name	Ailments	Np	N	FL value %
Amaranthus spinosus L.	Diuretic	10	21	47
Arisaema flavum (Forssk.) Schott.	Antipyretic	6	15	40
Achyranthes aspera L.	Stomachache	14	21	66
Ailanthus altissimus Mill. Swingle.	Skin irritation	12	19	63
Aerva sanguinolenta (L.) Blume.	Anti-inflammatory	3	7	42
Artemisia vulgaris L.	Intestinal worms	5	13	38
Amaranthus viridis L.	Urinary disease	4	7	57
Allium cepa L.	Carminative	7	10	70
Allium sativum L.	Aromatic	17	19	89
Acacia modesta Wall.	Pain killer	22	25	88
Acacia nilotica (L.) Delile.	Dysentery	12	17	70
Asparagus officinalis L.	Fever	6	11	54

Berberis lycium Royle.	Diabetics	20	22	90
Boerhavia diffusa L.	Ulcer	3	7	42
Cynodon dactylon (L.) Pers.	Diuretics	19	20	95
Cyperus rotundus L.	Tonics	11	16	68
Crotalaria sagittalis L.	Scabies	2	3	66
Cleome viscosa L.	Arthritis	2	5	40
Cardiospermum halicacabum L.	Stimulant	3	7	42
Conyza canadensis (L.) Cronq.	Diarrhea	5	9	55
Clematis grata Wall.	Jaundice	5	8	62
Calotropis procera (Ait.) Ait. f.	Antidiabetic	7	9	77
Cannabis sativa L.	Narcotics	26	29	89
Cuscuta reflexa Roxb.	Blood purifier	3	5	60
Cirsium arvense (L.) Scop.	Worms in children	6	11	54
Capsella bursa-pastoris (L.) Medik.	Menses	9	13	69
Carissa opaca Stapf ex Haines.	Inflammation	1	3	33
Dodonaea viscosa (L.) Jacq.	Bone fracture	11	16	68
Datura stramonium L.	Urinary disorder	4	6	66
Dicliptera bupleuroides Nees.	Wound healing	2	3	66
Desmodium elegans DC.	Carminative	1	2	50
Duchesnea indica (Andrews) Focke.	Astringent	3	7	42
Euphorbia hirta L.	Constipation	15	19	78
Eucalyptus occidentalis Endl.	Antiseptic	4	7	57
Euphorbia cyathophora Murr.	Asthma	9	13	69
Equisetum arvense L.	Pneumonia	2	5	40
Euphorbia helioscopia L.	Laxative	7	11	63
Eryngium planum L.	Diuretic	3	7	42
Fumaria indica (Hausskn.) Pugsley.	Anthelmintics	18	22	81
Ficus carica L.	Removal of warts	13	17	76
Ipomoea pes-tigridis L.	Purgative	1	3	33
Isodon coetsa (Buch.-Ham. ex D.Don) Kudô.	Abdominal pain	1	3	33
Indigofera tinctoria L.	Demulcent	3	7	42
Isodon rugosus (Wall. ex Benth.) Codd.	Gastric	1	2	50
Ipomoea purpurea (L.) Roth.	Diuretic	2	5	40
Justicia adhatoda L.	Respiratory disorder	16	21	76
Juglans regia L.	Boost memory	23	23	100
Lantana camara L.	Diaphoretic	7	13	53
Mallotus philippensis (Lam.) Müll. Arg. (L.) L.	Abdominal pains	19	20	95
Mentha longifolia (L.) L.	Diarrhea	20	20	100
Chenopodium ambrosioides L.	Stimulant	3	6	50
Mentha piperita L.	Antispasmodic	9	13	69
Mirabilis jalapa L.	Wound healings	9	9	100
Melia azedarach L.	Diabetics	21	25	84
Morus nigra L.	Coughing	13	14	92
Morus alba L.	Throat infection	10	13	76
Nasturtium officinale R.Br.	Carminative	7	9	77
Otostegia limbata (Benth.) Boiss.	Antijaundice	2	5	40
Origanum vulgare L.	Malaria	1	2	50
Olea ferruginea Royle.	Antiseptics	14	17	82
Oxalis corniculata L.	Vomiting	9	12	75
Persicaria hydropiper (L.) Spach.	Snake bite	2	3	66
Parthenium hysterophorus L.	Antisugar	3	4	75
Pinus roxburghii Sarg.	Wound healing	21	23	91
Perilla frutescens (L.) Britton.	Asthma	2	3	66

Pluchea lanceolata (DC.) C. B. Clarke.	Piles	1	3	33
Pistacia chinensis ssp. Integerrima (J. L. Stewart) Rech. f.	Hepatitis	3	5	60
Plantago lanceolata L.	Anti-diarrheal	9	9	100
Pyrus pashia Buch.-Ham. ex D.Don.	Coughing	2	3	66
Rubus ellipticus Smith.	Diuretic	3	7	42
Rumex hastatus D. Don.	Arthritis	1	3	33
Ricinus communis L.	Purgative	1	2	50
Rumex dentatus L.	Emollient	7	9	77
Sonchus oleraceus L.	Tonic	3	4	75
Solanum nigrum L.	Anti piles	6	9	66
Salix babylonica L.	Astringent	3	5	60
Salix tetrasperma Roxb.	Astringent	3	4	75
Silene conoidea L.	Anthelmintic	1	3	33
Trichodesma indicum (L.) R. Br.	Snake bite	3	4	75
Trichosanthes dioica Roxb.	Diarrhea	9	13	69
Taraxacum officinale Weber.	Diabetic	13	15	86
Tribulus terrestris L.	Sore throat	2	4	50
Verbascum thapsus L.	Cough	5	7	71
Vitex negundo L.	Pains killer	7	9	77
Withania somnifera L. Dunal.	Sexual weakness	3	4	75
Woodfordia fruticosa (L.) S. Kurz.	Leucorrhea	1	2	50
Xanthium strumarium L.	Antimalarial	9	13	69
Ziziphus nummularia (Burm.f.) Wight & Arn.	Skin infection	13	19	68
Ziziphus oxyphylla Edgew.	Loss of appetite	5	8	62
Zanthoxylum armatum DC.	Cooling agent	3	7	42

Discussion

Diversity of plant species, botanical families, uses and used parts

As reported above, the literature survey showed that the research area has not been investigated before for ethnobotanical purposes by using indices such as RFC, DMR, UV, FL and ICF. The diversity of plant species and botanical families recorded in this study proves that the concerned community holds relevant traditional knowledge on plant uses since immemorial times, which corroborates the assertions of Cunningham (1993) on the deepest relationships between humans and plants worldwide. In other words, various communities all over the world are highly connected to the medico-magic exploitation of plants of their environment (Dossou-Yovo *et al*., 2014, 2017). Such ethnobotanical studies are required to gather data on the cultural and medical importance of plant species. Outputs of these investigations are useful for sensitizing on their sustainable conservation. The big range of diseases treated using such plants, collected from the wild or purchased in markets, demonstrates that medicinal plants are valuable alternatives for healthcare in the daily life of Pakistani people. The diversity of use value recorded in this study shows that plants have various importances according to users. The predominant exploitation of leaves stressed in this study is synonym of less threat towards species whether precautions are observed during the collection to avoid cutting the reproductive organs (Gaoue & Ticktin 2007; Shippmann *et al*. 2006). However, the species which were recorded as entirely used as medicines are somehow facing threats (Dossou-Yovo *et al*. 2021).

Compared to other parts of Pakistan, the flora of Buner district is explored ethnobotanically by many workers. Chamla Valley is the only tehsil of district Buner which remain unexplored. Only one spot (Malka & Mahabanr) of the area was explored by Shaukat *et al*. (2015). Zaman *et al.* (2011) surveyed the Chagharzai Valley, district Buner and recorded 216 medicinal plant species. These plants were classified for their traditional medicinal and economic uses into 89 families of which 77 families were Dicots; 7 Monocots and 3 Pteridophytes. Later, Zaman *et al.* (2014) studied, for ethnobotanical purposes, the Ashezai and Salarzai Valleys, District Buner, and 163 plant species belonging to 73 families were reported for their traditional, medicinal and economic uses.

Table 4. Ten informants DMR score of ten important plants of all medicinal plants about medicinal as well as other vital uses

Use diversity	*Cannabis sativa* L.	*Salix babylonica* L.	*Pinus roxburghii* Sarg.	*Olea ferruginea* Royle.	*Morus nigra* L.	*Melia azedarach* L.	*Mentha longifolia* (L.) L.	*Mallotus philippensis* (Lam.) Müll. Arg. (L.) L.	*Ficus carica* L.	*Fumaria indica* (Hausskn.) Pugsley.	**Total**	**Rank**
Medicine	3	3	5	3	4	5	5	4	5	4	41	1
Fodder	0	0	0	5	5	4	0	0	2	5	20	3
Fuel	4	4	5	4	4	5	0	5	4	0	35	2
Timber	0	2	5	2	5	4	0	0	1	0	19	4
Agricultural tools	0	3	2	1	3	3	0	1	0	0	13	5
Total	7	12	17	15	22	21	5	10	12	9		
Rank	9	5	3	4	1	2	10	7	6	8		

Jan *et al*. (2020) documented 60 plant species belonging to 40 families for gynecological disorders, from the local community of the whole District Buner. Other parts of Buner and Chamla Valley were also studied, and scientists documented their plants for various purposes (Hamayun 2004, Zaman *et al*. 2018, Khan *et al*. 2019, Sulaiman *et al*. 2020).

The whole Chamla Valley (research area) was not explored ethnobotanically, that's why we believe that the current attempt is quite relevant since served to study the local uses of plants by the local people. Authors do hope that this investigation motivates many others towards this community, highly linked to plants and with a rich cultural knowledge. Once again, this study has shown the ethnobotanical indices for generating traditional knowledge held by various communities all over the world. In fact, Dossou-Yovo *et al.* (2021, 2022) based on such quantitative indices to gather data and state scientific knowledge on herbaceous species that seem neglected by science but highly used by local communities in Benin (West Africa), a country known for its high exploitation of plants for medicinal and religious purposes. In addition to the ethnobotanical investigation conducted in the present study, pharmacological studies are necessary to validate the folk knowledge of the recorded species.

Diversity of treated diseases and implications of this research for community development and well-being

Plants play a great role in the healthcare system in the study area. Among diseases recorded in this study, there is diabetes, one of the most lethal in the world (Dossou-Yovo *et al*. 2021) treated using herbal remedies. This adds value to the relevance of such a research in the field of modern and traditional medicine. In other words, pharmacological insights on the reported medicinal plants against diabetes will help progress in the scientific information regarding its treatment. Species that exhibited high use value in this research need better conservation and people should be sensitized on their importance and conservation. The consensus noticed regarding various diseases using plants confirms the fact that people belonging to the same geographical region and the same ethnicity share a lot of traditional knowledge together. Similar to this finding, Dossou-Yovo *et al*. (2014) reported a lot of medicinal knowledge common to indigenous people living in the Pendjari Biosphere Reserve in northern Benin despite the diversity of ethnic groups.

People have high knowledge about plants and their uses are mostly aged ones. In many parts of the world, there is evidence that less and fewer youngsters are less interested in using plants as medicine compared to older generations. Such thoughts compromise the heritage and transmission of valuable traditional knowledge (Dossou-Yovo *et al.* 2017). Although they still rely on folk medicine, it was reported by informants that more people were dependent on plants and used them as medicine decades ago for fuel, timber, fencing, agricultural tools, all generating income. But due to the modernization and development of every field of life, the use of allopathic medicine, the rapid population growth, deforestation, overgrazing, urbanization, and migration of people to the cities, the use of herbal medicine is potentially decreasing in the study area. Considering the significance of green resources and their association with indigenous knowledge, it is necessary to give more priority to the ethno-medicinal investigations towards the local population of Chamla Valley by assessing the conservation strategies, conservation status of medicinal plants. Such aspects are among the limitations of the present study. In addition the ecological assessment of areas where medicinal plants are found and harvested from is required as well as the role of home and commercial gardens in the conservation of medicinal plants in the study area. Based on Dossou-Yovo *et al*. (2021), market surveys towards herbal traders and wholesalers are also needed to generate scientific knowledge on the sources of medicinal plants purchased in used in this area.

The implications of this research in tourism are that Inputs are background that needs dissemination in order to serve for tourism activities. In other words, local guides will stress the medico magic exploitation that local inhabitants hold on plants since immemorial times. They will also report during their explanations to tourists that such knowledge have been documented and published. The reading of this article will motivate various tourists to visit the surveyed district as well as seeing medicinal preparations of plants by people in the study area, being of great importance to tourists. In fact, a recent study reported the positive effects of tourism in the surveyed district in addition to the overall relevance of tourism in Pakistan economy since it generates high income and contributes to poverty reduction (Alam *et al.* 2022). The medico magic knowledge and practices on medicinal plants should be better integrated into the tourism development programs and ethnobotanical information on the recorded species should be disseminated and used to argue the importance to conserve species in the region. This will be profitable to the communities forever. Findings of the present research are expected to motivate many other studies on medicinal exploitation and conservation of plant species in the research sites.

Conclusion

This study revealed a total of 153 plant species belonging to 134 genera and 67 families. The dominant dicot family was Asteraceae with 11 species and Lamiaceae with 10 species. Pteridophytes were also represented as well as Gymnosperm. The multiple uses of wild plants in the Chamla Valley proved that local plants have a significant role in the life the local populations particularly for the treatment of many infectious and chronic diseases. There is a need to work on the conservation of the medicinal plants of the study area through the training of indigenous communities on sustainable plant collection and planting. Outputs of the present research will serve in tourism and the medical system of the local community. Thus plant biodiversity and biocultural history will somehow be protected and documented for future references serving for drug discovery and drug development. It is also important to bring out awareness among local people, especially the young generation about the utilization of medicinal plants.

Declarations

List of abbreviations: Relative Frequency of Citation (RFC), Use Value (UV), Fidelity Level (FL), Informant Consensus Factor (ICF), Data Matrix Ranking (DMR).

Ethics approval and consent to participate: This study was authorized by the Department of Botany, Islamia College Peshawar, Pakistan. All participants provided verbal informed consent prior to data collection.

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Conflicts of Interest: The authors declare that there are no conflicts of interest in this article.

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Author's contribution: Nazim Ullah and Barkat Ullah collects the field data, Muhammad Nauman Khan, Alevcan Kaplan and Sana Wahab supervised this work, Muhammad Nauman Khan, Alevcan Kaplan, Hubert Olivier Dossou-Yovo, and Majid Iqbal participated in data analysis and the final revision of the manuscript. All the authors approved the final manuscript after revision under the supervision of Hubert Olivier Dossou-Yovo, having a great expertise in the field.

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