Indigenous utilization of medicinal plants in Kalasha tribes, District Chitral, Hindukush Range, Pakistan

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Databases and Inventories

Abstract

Background: Indigenous people residing in the remote localities have practicing knowledge about the utilization of herbal resources to cure different ailments. Current study was conducted in Kalash valley District Chitral (Lower), Pakistan to investigate the indigenous medicinal plants, their local names, uses, etc. The valley inhabits peoples with unique culture and costumes and considered as the descendants of Alexander the great having their own way of plant utilization for medication.

Methods: Data was collected by interviewing through questionnaires. During the fieldwork, 133 respondents (99 men and 34 women) of different age groups were selected and personal observations were also recorded. Data was analyzed by using parameters like Use Report (UR), Use Values (UV), Frequency of Citations (FC), Informant Consensus Factor (ICF) and Relative Frequency of Citations (RFC). The plants were provided with voucher numbers after collection and identification.

Results: 90 medicinal plant species from 44 families and 75 genera used to treat 23 illnesses. Rosaceae was leading family with 13 species (14.45%) followed by Asteraceae with 07 species (7.80%) and Lamiaceae 06 (6.70%) species. The most frequently used plant component was fruit (34.44%) followed by leaves (26.66 %) and powder was found to be the primary method of preparations and are often either ingested or used topically. The maximum used value was reported for *Allium cepa* (0.92) and minimum (0.06) for *Carum carvi*. The digestive system disorders showed highest Informant Census Factor (ICF) values (0.71) followed by the Anti-microbial diseases having ICF value of 0.68, while the evil-eyes repellent plants showed least ICF (0.40) values. The highest RFC was recorded for *Cannabis sativa* (0.40) while *Cedrus deodara* has the lowest (0.10).

Conclusion: The present findings revealed that the Kalash valley has diverse plant resources used for various human aliments. The current work will provide useful information for future studies on various aspects of botanical sciences from the area.

Keywords: Medicinal uses, plant resources, Kalash Valley, Hindukush Range, Pakistan

Background

Indigenous people in remote mountainous areas depend on traditional medicines due to lack of basic health facilities, cost effectiveness, fewer side effects, lower toxicity than current allopathic medications (Rehman *et al.* 2023; Khattak *et al.* 2015; Hu *et al.* 2020; Hussain *et al.* 2024). The ethnomedicinal surveys of indigenous plants play an important role in the discoveries of new herbal drugs, about 25% of herbal drugs in modern medicines are obtained from plants (Ahmad *et al.* 2018; Tufail *et al.* 2020).

Around the globe almost 3, 50,000 to 400,000 species of plants have been identified so far, about 40% of them are used for treatment of various human and animal diseases (Bussmann *et al.* 2008; Abbasi *et al.* 2010; Newman & Cragg 2012; Ahmad *et al.* 2014; Sher *et al.* 2016; Iqbal *et al.* 2021; Munir *et al.* 2022; Jan *et al.* 2023). In both rural and urban areas of the world most of the people are still using medicinal plants for treatment of various diseases. According to the reports of World Health Organization (WHO) approximately 78% of world's population is still depending on the herbal medicines for their health issues especially in the remote and backward villages (Kayani *et al.* 2015). Pakistan has diverse flora with about 6000 identified species, mostly distributed in the northern mountainous parts of the country. The work on medicinal plants, their indigenous therapeutic usage and pharmacognostic and pharmacological approaches have been increased in the last few decades in the country (Ali & Qaiser 1986; Ali, 2008). In Chitral Valley, research on medicinal plants is scarce, particularly in the higher altitude areas (Shah & Hussain 2021).

Furthermore, indigenous ethnomedicinal knowledge is declining rapidly due to modernization and increasing gap of younger generation with their traditions and culture (Rafique *et al.* 2021; Awan *et al.* 2023). If we move forward with the same pace and direction this traditional ethnomedicinal knowledge may vanish if not properly recorded (Khan & Ahmad 2015; Aziz *et al.* 2018; Rehman *et al.* 2022a; Awan *et al.* 2023; Kayani *et al.* 2024). The present study is the 1st ever attempt regarding the medicinal plants and was carried out with the aims to (i) Explore and prepare complete checklist of the medicinal flora in sub-localities of Kalash Valley (ii) Documenting the traditional knowledge about plants part(s) used, drugs formulation and mode of administration (iii) Undertook various quantitative indices to evaluate the community reliance, consistency and authenticity of traditional ethnomedicinal knowledge.

Materials and Methods

Study area

Chitral valley is the extreme north-west part (located in the Hindu-Kush mountains) of Pakistan lies between the latitudes of 35^0 15´ 06" to 36^0 55´32" N and longitudes of 71^0 11´ 32" to 73^0 51´ 34" E. Arundo (near Pak-Afghan border) is lowest (1396 m) elevation point of the valley towards the extreme south and Trichmir is the highest (7685m) elevation towards the extreme north. Strategically and geographically Chitral valley has an important location on the globe having boarders with district Ghizer (Gilgit-Baltistan) on the east, Swat and Dir on the south, Nooristan (Afghanistan) towards the west and Wakhan Corridor (Afghanistan) to the north-west (Figures 1 & 2).

The Kalash valley can be traced to the south-west of Chitral District (Lower) that is bordered with other parts of Chitral towards the north, south and east and with Nooristan valley (Afghanistan) on the west. The Kalash valley inhabits non-Muslims minority community that are practicing an indigenous and old religion (Kalasha) with majority Muslim community. The Kalasha community remained the ruler (almost five centuries viz: 332-712 AD) in the Chitral valley, however, they are now restricted to only three sub-valleys (Birir, Bumborait and Romboor) of the Kalash valley/Kafiristan having population of around 2800 individuals. The health facilities are not satisfactory in the valley and therefore, the local community rely on medicinal plants for their health related issues.

The people of Kalash valley are mostly dependent on cattle rearing (goats and sheep), cultivated agricultural crops like beans, potato, wheat, maize, various vegetables and forest products as source of income generation. Over grazing, medicinal plants extraction on commercial level, soil erosion, land sliding and glaciers melting during the last few years has drastically changed the climatic conditions of the area, particularly raise in annual temperature and heavy floods that damaged the public properties, infrastructures, service roads, irrigation channels and cultivated fields

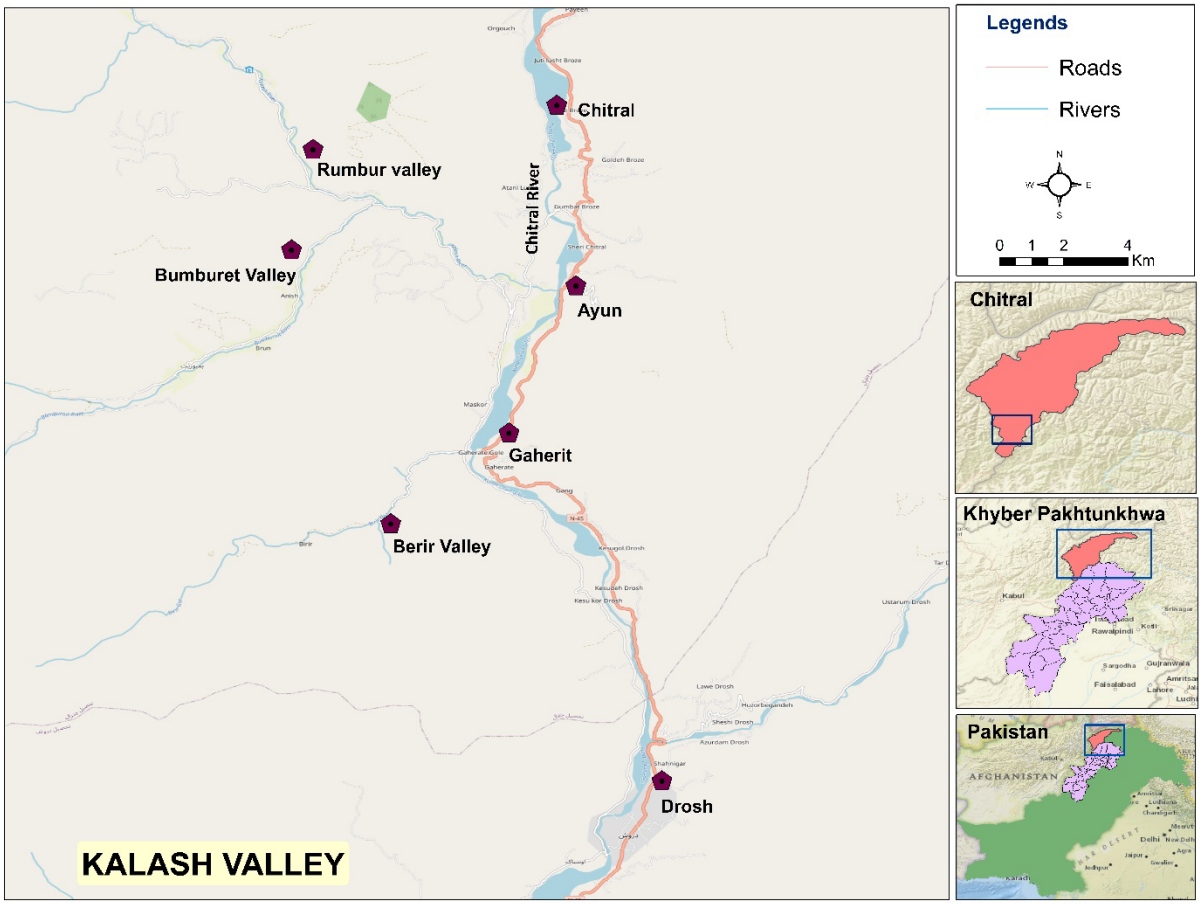

Figure 1. Map of the study area

Data Collection

Field survey were conducted in the sub-localities (Birir, Bomburait, and Romboor) of Kalash Valley following Heinrich and co-worker (Vijayakumar *et al.* 2015). A total of 133 individual including 99 men and 34women were randomly selected for interview using semi structured questionnaire. Informants were included both from ethnic Kalash minority and Muslims divided into four age groups viz. 31-40, 41-50, 51-60 and above 60 years of age for getting information regarding vernacular names, parts used, botanical names, family and medicinal uses of the plants present in the area. The Code of Ethics of the International Society of Ethnobiology (ISE) were followed during the data collection from the local community.

Plant collection and identification:

The Plant species collected from different areas of the valley were pressed, preserved and identified with the help of Flora of Pakistan (Ali and Nasir, 1990-1991, 1993-2019). The identified specimens were labelled, given voucher numbers and were deposited in the Department of Botany Herbarium (PUP), University of Peshawar, Pakistan.

Quantification of ethnobotanical data

The data collected were analyzed by using various quantitative ethnobotanical indices like Informant Consensus Factor (ICF), Use Value (UV), Frequency of Citation (FC) and Relative Frequency of Citation (RFC).

Informant Consensus Factor (ICF):

The following formula was used for calculation of Informant Consensus Factor (Martin 1995; Heinrich & Bremner 2006). This parameter is used to find out the homogeneity among the ethnomedicinal information documented from the traditional informants.

$$IFC = Nur–Nt/Nur-1$$

(Nur) is the total number of use reports for a particular plant-usage category and (Nt) shows total number of species used for that plant-usage category for all the informants.

Use Values (UV):

The below mentioned formula was used UV.

$$UV = \sum U / N$$

(U) shows number of uses mentioned by informants for a particular species. (N) shows the total number of respondents.

Frequency of Citation (FC):

The below mentioned formula was used to calculate FC:

FC = shows the No. a species mentioned by all respondents/No. that all species were listed by respondents X 100

Relative Frequency of Citations (RFC):

The below mentioned formula calculates the RFC index (Mao *et al.* 2009).

RFC = FC/N

FC indicates the informant's number whom mentioned the species, and N is the total number of informants participated in the survey.

Results and Discussion

Demographic features of informants

It is first-ever attempt for the documentation of indigenous knowledge of the locals regarding usage of medicinal plants in Kalash valley, Chitral, Pakistan (Figure 2). A total of 133 informants were interviewed including 99 men and 34 women belong to four age groups from 20 – above 60 Years (Table 1). Local informants were randomly selected for data collection from all the three sub-valleys (Birir, Bomburait and Romboor) of Kalash valley. Being the largest area the Bomburait had maximum (47) informants as compared to Barir and Romboor having 43 informants each (Table 1). The age groups showed that the indigenous knowledge about plants is transferring verbally mostly and the young generation has less knowledge and interest about the plant usage. The smaller number of female respondents is because of cultural/ethical constrains in the area to give interview/exchange of views with any outsider. Indigenous knowledge about the utilization of medicinal plants that has been passed down from generation to generation is currently in danger, as transmission between older and younger generations is not always maintained (Lahsissene *et al.* 2009; Yaseen *et al.* 2015; Bauzid *et al.* 2017; Hussain *et al.* 2023 and 2024).

Table 1. Demographic information of the informants participated in interview.

Age limits (in years)	Total male respondents			Total female respondents			% men	% women	Total Participants
	Br	B	R	Br	B	R			
31-40	4	6	5	0	0	0	11.28	0.00	15
41-50	7	8	7	2	1	1	16.54	3.00	26
51-60	11	13	9	3	4	4	24.81	8.27	44
Above 60	10	8	11	6	7	6	21.80	14.29	48
Total	32	35	32	11	12	11	74.43	25.56	133

Legend: Br= Birir, B=Bomburait, R= Romboo

Figure.2. (A) Data collection from nomads (B) High pasture in study area

Diversity of medicinal flora

A total of 90 medicinal plants species belonging to 75 genera and 44 families were recorded which were commonly used to cure 34 ailments (categorized into nine-major groups) by the local community in study area. Rosaceae was the dominant family in the area with 13 species (14.45%) followed by Asteraceae with 07 species (7.80%) and Lamiaceae with 06 species (6.70%) respectively (Figure 3).

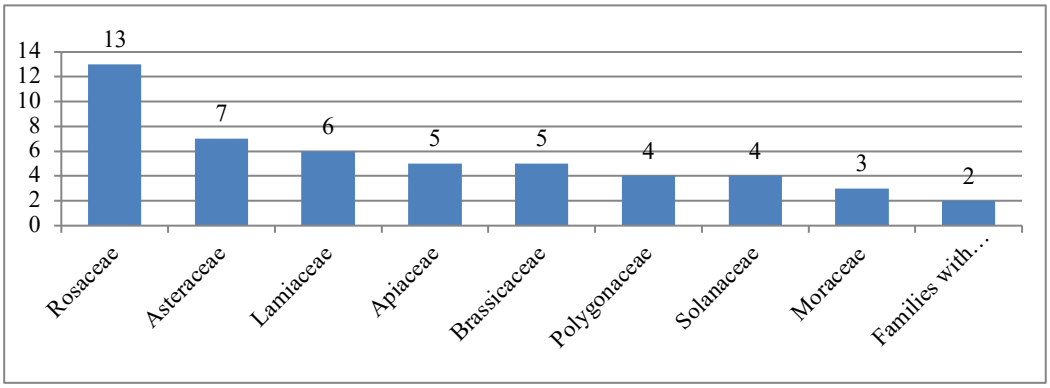

Figure 3. Dominant plants families

Similar reports presented earlier showed that Lamiaceae, Rosaceae, Asteraceae, Papilionaceae, Ranunculaceae, Brassicaceae, Chenopodiaceae and Amaranthaceae were documented as dominant ethnomedicinal plant families from different areas of Pakistan (Amjad *et al.* 2017; Rahim *et al.* 2023; Kayani *et al.* 2024; Hussain *et al.* 2024). The dominance of these families is attributed to the fact that they are abundant in the area and easily available to the local people.

Asteraceae was the leading family with maximum number of medicinal plants species to cure diseases. Medicinal significance of family Asteraceae is also well established through previous studies (Shinwari *et al.* 2000; Achika *et al*. 2014; Vijayakumar *et al.* 2015; Saini *et al.* 2020).

The fruits of 31 species (34.44%) were used for the treatment of various ailments in the area, leaves of 24 species (26.66%), stem of 13 species (14.44%), roots/rhizomes of 10 species (11.11%), seeds of 09 species (10%), flowers of 08 species (8.88%), bark and whole plants of 03 species (3.33%) each, bulb of 02 (2.22%) and tubers and gums of one species (1.11%) each were used for treatment various diseases (Table 4, Figure 4). As a result, when dealing with endangered or uncommon plant species, the usage of roots should be kept to a minimum. The utilization of roots or relying too heavily on fruits or seeds for therapeutic purposes might have a negative impact on plant growth and population. This has the potential to significantly reduce the populations of many therapeutic plants in their natural settings (Giday *et al.* 2003; Ghimire *et al.* 2008; Sher *et al.* 2023; Kayani *et al.* 2024).

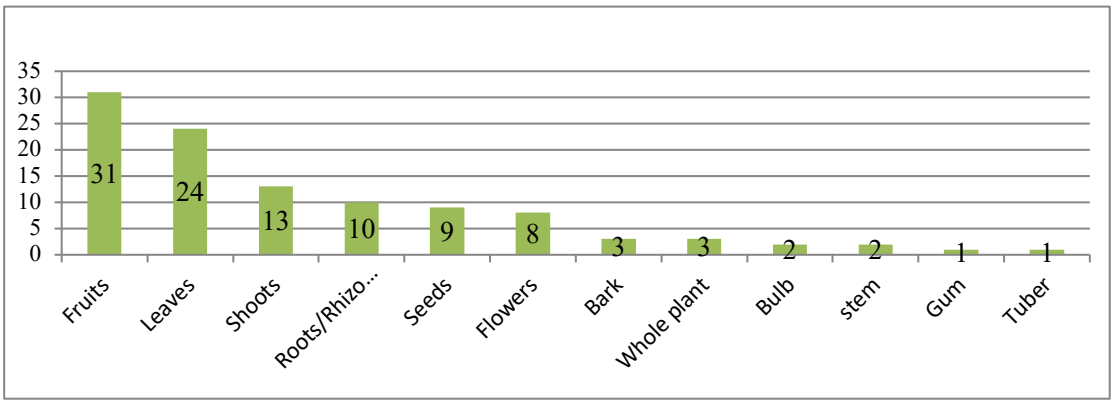

Figure 4. Number of species with a particular Plant parts are used as medicines

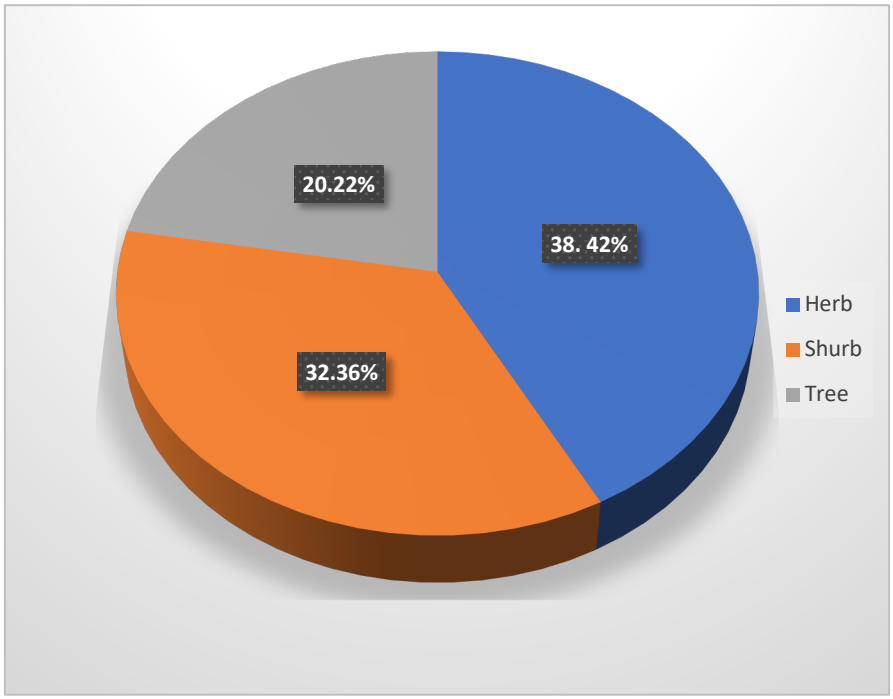

Figure 5. Growth form used for the treatment of different illness

Plant growth form

The herbs were maximum (38 species, 42.22%) followed by shrubs (32 species, 35.55%) and trees (20 species, 22.22%) in the area (Fig. 5). Our findings are in line with those of (Poonam & Singh 2009; Uysal *et al.* 2012; Hadi *et al.* 2014; Islam *et al.* 2014; Güzel *et al.* 2015; Kayani *et al.* 2015; Sadat-Hosseini *et al.* 2017; Khadim *et al.* 2023; Hussain *et al.* 2024) who found the similar results from their study areas and stated maximum use of fruits and leaves and most of the plants were herbs in their areas.

Use Value (UV)

The use values (UV) ranged from 0.06 to 0.92 (Table 2). *Carum copticum* and *Allium cepa* having highest use value (0.92) followed by *Cedrusdeodara, Lycopersicum esculentun* and *Mentha longifolia* with use value (0.89), were the five commonly used medicinal plants and *Salvia nubicola* (0.06 UV) was least medicinally used species in the area. Due to their widespread distribution and local herbalists' awareness of them, the reported plants have high use values, making them the first choice and most suitable for treatment. It is crucial to evaluate and demonstrate the pharmacological activity of ethnomedicinal species with high UVs and RFCs values (Yaseen, 2019). Although plants with low UVs are important (Amjad *et al.* 2017), their low values suggest that the locals are unaware of their benefits, which prevents the dissemination of information to recipient. Gastro-intestinal, respiratory tract disorders, skin diseases, fever etc. are among the common disorders in the study area that are treated by different medicinal plant species. The findings indicated thirty-four (37.77%) plant species were used for treatment of abdominal disorders, nine (10%) for pulmonary system problems, seven (7.77 %) for reduce fever, six (6.66%) each as analgesic and tonic, five (5.55%) for dermal disorders, four (4.44%) antiseptic, three (3.33%) each as cure wounds, Refrigerants, control blood pressure, blood enricher, mouth disease and tooth-pain. Rests of the disorders were treated by two or fewer plant species (Table 3). Our findings are similar with those of Korkmaz & Karakuş 2015; Saranya *et al.* 2015; Kassa *et al.* 2020; Manzoor *et al.*2023; Ghimire *et al.* 2023) having similar results about the uses of plants with maximum usage in Gastro-intestinal, respiratory tract disorders, skin diseases and fever.

Table 2. Description of the Medicinal flora of Kalasha Valley, Chitral, Pakistan

Botanical name/ Family Name	Local names	Voucher Number	Parts used	Disease treated	Prescription	UR	UV	FC	RFC
FUNGI									
Halveliaceae									
Morchella esculenta Fr.	Qussi	F.Hadii-321	full plant	Tonic	The cooked plant is eaten as pot herb	71	0.53	46	0.34
PTERIDOPHYTES									
Adiantaceae									
Adiantum capillus-veneris L.	Sumbaal	F.Hadii-322	Frond	Sore throat, Demulcent, expectorant	Take half teaspoon of the powdered frond with one glass of water before breakfast	20	0.15	41	0.31
Adiantum venustum D. Don.	Sumbaal	F.Hadii-323	Frond & spore	Diuretic, cardiac problems	Frond extract of frond is taken as heart tonic. The spores are poured on wounds healer	15	0.11	32	0.24
GYMNOSPERMS									
Cupressaceae									
Juniperus excels M. Bieb.	Sorouz	F.Hadii-324	Leaves	Anthelmintic	Leaf extract taken with water for warms removal	53	0.40	31	0.23
Ephedraceae									
Ephedra gerardiana Wall ex. Stapf.	Somane	F.Hadii-325	Stem	Asthma, cough	One teaspoon stem extract taken with water daily	94	0.71	26	0.20
Pinaceae									
Cedrus deodara (Roxb.) G. Don	Roogh	F.Hadii-326	Stem	Anti-bacterial and Anti-fungal, diaphoretic	The oil (roogh-xholo) is obtained from the freshly cut stem is applied on wounds and skin diseases for healing	101	0.89	13	0.10
Pinus gerardiana Wall. ex Lamb.	Chalghoza	F.Hadii-327	Seeds	Tonic	Seeds are tonic and nutritive used in winters as dry fruits	113	0.85	32	0.24
MONOCOTYLEDONS									
Alliaceae									
Allium cepa L.	Thereshto	F.Hadii-328	Full plant		Skin diseases, cure wounds	122	0.92	27	0.20
Allium sativum L.	Warezhno	F.Hadii-329	Full plant	Blood pressure, skin diseases, expectorant	The bulbs and leaves are used to reduce blood pressure. The bulbs are warmed and kept on wounds to discharge the puss	116	0.87	34	0.26
Iridaceae									
Iris germanica L.	Sosoon	F.Hadii-330	Rhizome	Fever and urinary problems	The rhizome as such is kept over skin swellings as remedy. The extract of rhizome is taken with water to reduce fever and urinary infections	44	0.33	25	0.19

Poaceae									
Hordeum vulgare L.	Siri	F.Hadii-331	Grains	Refrigerants, tonic, fever	The powder grains are eaten as bread to reduce heartburn and gastric problems	63	0.47	43	0.32
Zea mays L.	Jowari	F.Hadii-332	Fresh carpals	kidney stones/ reduce pain	Fresh carpals are boiled, and the extract obtained is drunk one spoon trice a day to relieve kidney pain and remove stones	91	0.68	28	0.21
DICOTYLEDONS									
Apiaceae									
Bomium persicum (Boiss.) B. Fedtsch.	Hojooj	F.Hadii-333	Fruits	Gastric problems	Abdominal pain and gastric problems will be reduced by taking a cup of its herbal tea	98	0.74	29	0.22
Carum copticum L.	Shoonj-mik	F.Hadii-334	Fruits	Gastric problems, fever	Abdominal pain and gastric problems will be reduced by taking a cup of its herbal tea	123	0.92	19	0.14
Carum carvi L.	Hojooj	F.Hadii-335	Fruits	Throat infection, condiment, gastric issues	Herbal tea for throat infection and gastric problems	81	0.61	21	0.16
Coriandrum sativum L.	Dano	F.Hadii-336	Stem, leaves	Carminative, digestive	Stem and leaves are eaten as raw or cooked with pottage as carminatives	83	0.62	31	0.23
Foeniculum vulgare Miller	Bodi-oong	F.Hadii-337	Fruits, leaves	Abdominal pain, laxative, expectorant	For abdominal pain, as expectorant and laxative, one teaspoon of seeds eaten or leaves are chewed as such for the same	91	0.68	44	0.33
Asteraceae									
Artemisia brevifolia Wall. ex DC.	Dron	F.Hadii-338	Stem	Stomachic	The herbal tea used as gastro0intestinal infections	81	0.61	51	0.39
Artemisia marítima L.	Pespok	F.Hadii-339	Stem	Antiseptic, anti-inflammatory, cooling agent	The decoction of stem is used as antiseptic and anti-inflammatory. Leaf extract is taken as the cooling agent	76	0.57	41	0.31
Artemisia parviflora Roxb.	Khar-khalich	F.Hadii-340	Seeds	Anthelmintic and stomachic	For expulsion intestinal worms and relieve pain, one teaspoon of seeds is taken with worm water	88	0.66	37	0.28
Artemisia scoparia Waldst. & Kit.	Dron	F.Hadii-341	Stem	Anthelmintic, diabetic and blood pressure	The stem extract is taken to reduce blood pressure, diabetes, and expel worms	78	0.59	33	0.25
Calendula arvensis L.	Bodaeki	F.Hadii-342	Leaves, flowers	Relieve Joints pain	Crushed leaves and flowers are mixed in cooking oil and applied on joints to relieve pain	41	0.31	39	0.29
Cichorium intybus L.	Kaasti	F.Hadii-343	Roots	Relieve typhoid fever	Root or its extract relieve typhoid and fever	88	0.66	49	0.37
Matricaria chamomilla L.	Sherisht	F.Hadii-344	Flowers	Gastric pain	For abdominal pain the herbal tea is taken	45	0.33	26	0.20

Berberidaceae									
Berberis lycium Royle	Cho-vainch	F.Hadii-345	Roots, fruits	Wound healing, local wine	Wounds are healed by applying powdered roots and local wine is prepared from fruits	93	0.70	22	0.16
Brassicaceae									
Brassica rapa L.	Tepoor	F.Hadii-346	Leaves and roots	Tonic and stomachic	The roots as tonic and leaves as stomachic are cooked as vegetables and taken	33	0.25	51	0.38
Lepidium sativum L.	Tro-aokkaardachi	F.Hadii-347	Leaves	Stomachic	Leaves are cooked or eaten as such to relieve stomach pain	21	0.16	31	0.23
Nasturtium officinale R. Br.	Sheako-shakh	F.Hadii-348	Leaves	Gastric trouble	Leaves are cooked or eaten as such to relieve stomach pain	29	0.22	25	0.19
Raphanus sativus L.	Troop	F.Hadii-349	Roots and leaves	Vomiting, and Refrigerants	The roots and leaves are used against vomiting and used as refrigerants	81	0.61	45	0.33
Sisymbrium irio L.	Khelekhele	F.Hadii-350	Seeds	Stabbing pain, sunburn	Powdered seeds are applied externally for stabbing pain and to cure sunburn	50	0.37	26	0.19
Boraginaceae									
Onosma hispida Wall. ex G. Don	Phosuk	F.Hadii-351	Roots	Anti-dandruff, wound healing	Roots paste dissolved in mustard oil is applied to control dandruff and to heal wounds	19	0.14	44	0.33
Cannabinaceae									
Cannabis sativa L.	Boong	F.Hadii-352	Leaves and seeds	Narcotic and stimulant	Narcotic drug “chars” is prepared from crushed leaves, while raw leaves and seeds are eaten as stimulant	66	0.50	53	0.40
Capparidaceae									
Capparis spinosa L.	Kaweer	F.Hadii-353	Floral buds, Fruits	Reduction of blood pressure Refrigerants	Floral buds and meat are cooked together and taken as pottage for BP and fever	61	0.46	29	0.22
Caryophyllaceae									
Silene conoidea L.	Apupar	F.Hadii-354	Leaves	Laxative, purgative	Leaves are cooked as vegetable and used as pottage herb	11	0.08	25	0.19
Chenopodiaceae									
Chenopodium murale L.	Dar konak	F.Hadii-355	Leaves	Blood purifier, jaundice, anthelmintic	Leaves are cooked as vegetable and used as pottage herb	13	0.10	29	0.22

Convolvulaceae									
Convolvulus arvensis L.	Bakar bale/ Meshk	F.Hadii-356	Leaves	Stomachic	Leaves are cooked as vegetable and used as pottage herb	9	0.07	47	0.35
Cucurbitaceae									
Cucumis sativa L.	Badraang	F.Hadii-357	Fruit	Refrigerants	The fruit is eaten as salad and refrigerants	116	0.87	51	0.38
Cucurbita maxima Duchesne	Aalok	F.Hadii-358	Fruit and seeds	Laxative, Refrigerants, cough	The fruit is cooked as pottage herb and is laxative &refrigerants. The seeds are boiled and the extract is taken to relieve cough	93	0.70	31	0.23
Ebenaceae									
Diospyrus lotus L.	Kokkibana	F.Hadii-359	Fruits	Tonic	Fruits are eaten as tonic	67	0.50	39	0.29
Elaeagnaceae									
Elaeagnus angustifolia L.	Shenjoor	F.Hadii-360	Bark and fruits	Throat infection, jaundice, Gastro	Fruits are directly eaten as expectorant. The extract of fruit and bark is drunk to relieve jaundice, gastric-disorders and as blood purifier	88	0.66	44	0.33
Fabaceae									
Astragalus grahamianus Royle	Gaarmenzu	F.Hadii-361	Roots	Toothache	Toothbrushes are made from the root and used to relieve toothache	19	0.14	35	0.26
Fumariaceae									
Fumaria indica (Hausskn.) Pugsley	Shahtara	F.Hadii-362	Stem	stomachic, blood cleaner, antipyretic	Herbal tea of shade dried stem is used as stomachic, in fever, and as purifier of blood	31	0.23	21	0.16
Geraniaceae									
Geranium wallichianum D.Don ex Sweet	Ratan-joth	F.Hadii-363	Rhizome	Relieve back pain, hypertensive	The sweet-dish containing its powdered rhizome is used for back-pain especially in post-delivery cases and to reduce high blood pressure	11	0.08	28	0.21
Juglandaceae									
Juglans regia L.	Beermough	F.Hadii-364	Bark, leaves, seeds	Antimicrobial, tooth cleaner, tonic	“Dandasa” (the peeled bark) and leaves are antimicrobial and are teeth cleaner. The seeds are tonic and keep body warm	92	0.70	47	0.35
Lamiaceae									
Mentha arvensis L.	Podena	F.Hadii-365	Leaves	refrigerants, carminative, stomachic	Powdered leaves mixed in yogurt and used in gastro-intestinal problems	111	0.83	22	0.16

Mentha longifolia (L.) Huds	Bayen	F.Hadii-366	Leaves	Stomachic, vomiting, gas trouble	Leaves are eaten to reduce gastric issues, stomach pain, vomiting. Herbal tea of plant controls fever	118	0.89	25	0.19
Marrubium vulgare L.	Istorzokho	F.Hadii-367	Leaves	Cough, vomiting	To relieve vomiting and cough, the decoction of young leaves is used	41	0.31	51	0.39
Ocimum basilicum L.	Kashmala	F.Hadii-368	Stem, leaves	Carminative, Stomach-problem	The leaves and stem are eaten for reducing stomach pain	51	0.38	45	0.33
Salvia nubicola Wall. ex Sweet	Jangalikashmala	F.Hadii-369	Stem	Carminative, Stomachic, flavoring agent	The stem is taken as carminative and flavoring agent	8	0.06	32	0.24
Thymus serphyllum L.	Woor-josho	F.Hadii-370	Stem	antipyretic, cough stimulant	Herbal tea is used to relieve fever, cough and as stimulant	22	0.16	38	0.28
Malvaceae									
Malva neglecta Wallr.	Sawachaal	F.Hadii-371	Stem	Antispasmodic	Cooked stem and leaves are antispasmodic	41	0.31	21	0.16
Moraceae									
Ficus carica L.	Koyeth	F.Hadii-372	Fruit	Laxative, Carminative, tonic	The fruits are carminative, tonic, laxative and removes kidney urinary bladder stones	101	0.76	39	0.29
Morus alba L.	Marach	F.Hadii-373	Fruit	Laxative, Purgative, tonic	Fruits are eaten as laxative, tonic, purgative and keep the body warm during the winters	91	0.68	44	0.33
Morus nigra L.	Sha-marach	F.Hadii-374	Fruits	Laxative, cough, throat infections	The fruits are eaten to relieve cough and throat infections. Also used as a laxative	74	0.56	41	0.31
Oleaceae									
Fraxinus xanthoxyloides (Wall. ex G. Don) DC.	Tor	F.Hadii-375	Bark	Help in deliveries	For smooth delivery and reduce labor pain, one teaspoon powdered bark mixed in a cup of water is given to pregnant women	19	0.14	29	0.22
Paeoniaceae									
Paeonia emodi Wall ex G. Don	Mamaikhi	F.Hadii-376	Fruits	Backache	Crushed fruit and wheat flour are fried to relieve back-pain	28	0.21	31	0.23
Plantaginaceae									
Plantago lanceolata L.	Brono-Achar	F.Hadii-377	Leaves	oral diseases, Laxative	Pottage herb and cooked for oral infections	31	0.23	47	0.35

Plantago major L.	Ustambash	F.Hadii-378	Leaves, seeds	Heartburn, Diarrhea, jaundice	Cooked leaves are used for heartburn and jaundice. A teaspoon seeds soaked in a glass water are taken to treat diarrhea	23	0.17	22	0.16
Polygonaceae									
Bistorta amplexicaule (D.Don) Green	Koroyjosho	F.Hadii-379	Stem, leaves	Tonic, carminative, antiseptic	The paste of shoots is antiseptic, carminative and tonic	15	0.11	34	0.25
Polygonum nepalense Meissn.	Basarjosho	F.Hadii-380	Stem	Rheumatism	Small pieces of Peeled stem are warmed and placed on joints for the treatment of rheumatism	21	0.16	29	0.22
Rheum emodi Wall. exMeissn.	Ashpar/ Chotial	F.Hadii-381	Floral scape	Expectorant	The flowers are eaten directly as expectorant	34	0.25	43	0.32
Rumex hastatus L.	Serkhonzo	F.Hadii-382	Leaves	Astringent, constipation	Pottage herb and useful in constipation	41	0.31	31	0.23
Portulacaceae									
Portulaca oleracea L.	Pechile	F.Hadii-383	Stem	Improve digestion, laxative	Pottage herb that is helpful in digestion and is laxative	66	0.50	37	0.28
Punicaceae									
Punica granatum L.	Dalom	F.Hadii-384	Seeds, fruit rind	Refrigerants, cardiac, cure wound, swollen body parts	Seeds or their juice used as refrigerants, cardio-tonic. Dried powdered fruit rind effective for wound healing	92	0.70	35	0.26
Ranunculaceae									
Adonis aestivalis L.		F.Hadii-385	Leaves	Diuretics, Laxative	Decoction of leaf is diuretic and laxative	10	0.08	28	0.21
Clematis orientalis L.	Chontoruk	F.Hadii-386	Flowers, fruits	Dysentery, Diarrhea	A soup prepared of flowers, fruits and wheat flour is used to treat dysentery and diarrhea	24	0.18	39	0.29
Rosaceae									
Cotoneaster microphylla Wall. ex Lindl.	Badoor	F.Hadii-387	Fruits	Stomachic	The fresh fruits juice is helpful in digestion and relieves abdominal pain	23	0.17	40	0.30
Cotoneaster numularia Fisch. & Mey	Mekein	F.Hadii-388	Fruits	Blood-tonic	The fruits are blood-tonic	77	0.58	25	0.18
Crataegus songarica C. Koch.	Goony	F.Hadii-389	Fruits	Cardio-tonic	The fruits are cardio-tonic	33	0.25	23	0.17
Cydonia oblonga Mill.	Boup	F.Hadii-390	Fruits	blood purifier, diarrhea, cardio tonic	The fruits are blood purifier, cardio-tonic and useful in diarrhea	31	0.23	34	0.25

Prunus armeniaca L.	Zhole	F.Hadii-391	Fruits	Tonic, laxative	Both fresh and dry fruits are tonic, but heavy intake is laxative	81	0.61	25	0.19
Prunus domestica L.	Aloocha	F.Hadii-392	Fruits	Blood purifier, Laxative	The fruit are eaten as blood purifier and laxative	72	0.54	45	0.33
Prunus dulcis (Mill.) D. A. Webb.	Kaandu	F.Hadii-393	Flowers, gum	anti-dandruff	The gum and flower extracts are used as anti-dandruff	39	0.29	27	0.20
Prunus persica L.	Gergaloogh	F.Hadii-394	Fruits	Wound-healing Kidney stones	Fruits are considered as removal of kidney stones and helpful in healing of wounds	88	0.66	34	0.25
Pyrus communis L.	Toung	F.Hadii-395	Fruit	Tonic, blood purifier	The fruit is eaten as blood purifier, tonic	71	0.53	35	0.26
Pyrus pashia Ham. ex D. Don	Taango	F.Hadii-396	Fruits, leaves	Cooling agent, tonic	The fruit is tonic and leaves are used as a cooling agent	23	0.17	37	0.28
Pyrus malus L.	Palough	F.Hadii-397	Fruits	Blood-tonic	The fruits are famous nutritious and good tonic	17	0.88	28	0.21
Rosa webbiana Wall. ex Royle	ZokhGulab	F.Hadii-398	Petals	Abdominal pain	Herbal tea prepared from petals is used as stomachic and for abdominal problems	77	0.58	29	0.22
Rubus fruiticosus L.	Achchow	F.Hadii-399	Fruits	Enriches blood, tonic	The fruits enrich blood and are good tonics	89	0.67	38	0.28
Saxifragaceae									
Bergenia himalaica Boriss.	Besaabur	F.Hadii-400	Rhizome	Dermal diseases	The paste of powdered rhizome prepared in mustard oil is applied on infected skin	21	0.16	44	0.33
Scrophulariaceae									
Verbascum thapsus L.	Gordogh-Karoo	F.Hadii-401	Leaves	Wound-healer	Crushed fresh leaves are applied on wounds or inflammation as healer	21	0.16	32	0.24
Solanaceae									
Datura stramonium L.	Porool	F.Hadii-402	Leaves	Joint-pain	Dried leaves are placed over joints for relief	27	0.20	28	0.21
Lycopersicon esculentum Miller.	Pateengail	F.Hadii-403	Fruits	Energy source, blood-enricher	Fruits are used in pottage as condiment or eaten directly as blood enrich and energy source	109	0.89	21	0.16
Solanum tuberosum L.	Alou	F.Hadii-404	Stem tuber	Energy source, food item	The stem tubers are cooked alone or with variety of dishes as energy source	111	0.83	36	0.27
Solanum nigrum L.	Peermelic	F.Hadii-405	Fruits, leaves	Cough, Eye-disease, fever	Fruit juice is applied to cure sore eyes while leaves are cooked and eaten to relieve cough and fever	44	0.33	19	0.14
Tamaricaceae									
Tamarix dioica Roxb.ex Roth.	Henju	F.Hadii-406	Inflorescence	Healing of wounds	Paste prepared from inflorescence is helpful in wounds healing	38	0.28	41	0.31

Urticaceae									
Urtica dioica L.	Drowzono	F.Hadii-407	Full plant	Anthelmintic	The decoction of plant is used as anthelmintic	55	0.41	27	0.20
Violaceae									
Viola canescens Wall. exRoxb.	Melkhon/Banafshah	F.Hadii-408	Leaves	fever, cough, headache	Leaves are grinded to fine powder taken with water to relieve fever, cough and headache	41	0.31	44	0.33
Vitaceae									
Vitis venifera L.	Drowch	F.Hadii-409	Fruits	Typhoid, wine	Juice of fruits is good in curing typhoid fever. Local community also makes wine from it	98	0.74	39	0.29
Zygophyllaceae									
Peganum harmala L.	Espandor	F.Hadii-410	Seeds	Evils repellent	Dry seeds are burn on hot surface resulting pleasant smoke that is taken to repel evil eyes	117	0.88	32	0.24

Key: UR: Used Reports; **UV**: Use Value; **FC**: Frequency of Citation; **RFC**: Relative Frequency of Citation

Table 3. Number of plant species used for treatment of a specific disease in the research area

General Categories	Diseases treated	No. of use reports	No. of total species used	ICF value
Gastro-intestinal diseases	Gastrointestinal diseases, Anthelmintic, Anti-spasmodic Purgative Refrigerants	130	38	0.71
Pulmonary tract disorders	Flu, Cough Fever	82	30	0.64
Pain reliever	Pain killers Toothache Backache Rheumatism/ joints pain Stabbing pain	62	22	0.65
General diseases	Tonic Vomiting Stimulant Diaphoretic Narcotic Jaundice Labor cases/Delivery	55	18	0.68
Anti-microbial	Antiseptic Mouth diseases Wounds	33	11	0.69
Blood and heart related	Blood pressure Blood tonic Diabetic Blood purifier Cardio-tonic	31	17	0.46
Renal related diseases	Kidney stones removal Kidney infections Diuretic	21	9	0.60
Dermatological infections	Sun burn Anti-dandruff Anti-inflammatory Skin diseases	15	7	0.57
Mythology	Evil eye repellents	5	3	0.38

Legend: IFC= Informant Consensus Factor

Informant Consensus Factor (ICF)

The digestive system disorders showed highest Informant Census Factor (ICF) values (0.71) followed by the Anti-microbial diseases having ICF value of 0.68, while the evil-eyes repellent plants showed least ICF (0.40) values (Table 3). Kayani *et al.* (2015); Sadat-Hosseini *et al.* (2017); Faruque *et al.* (2018) stated that digestive tract disorders were common infections to be treated mostly through the collected plants in their respective areas.

Relative Frequency of Citation (RFC)

RFC values were in the range of 0.10% to 0.40 % and *Cannabis sativa* displayed the highest RFC (0.40 %) value. RFC values depict the relative use-based popularity of several species in the research region. Asthma, skin diseases, diarrhoea, colds, fevers, diabetes, Jaundice, throat infections, blood pressure and fractures are just a few of the conditions that these species have been shown to be effective in treating, according to their significant values. *Cedrus deodara* had minimal RFC values of 0.10% (Table 2). The RFC demonstrates how knowledgeable the tribes were about the curative properties of specific plant species. Furthermore, it shows widespread application and efficacy with minimal adverse effects (Hussain *et al.* 2018). Previous findings also support the findings of present study (Hussain *et al.* 2018; Munir *et al.* 2022).

Conclusion

The present study area (Kalash valley) is rich in plant natural resources and the indigenous community mostly depends on plants resources for their medicinal and other daily life uses. A variety of plant species viz. *Berberis lycium, Bumium persicum*,

Carum capticum, *Ephedra gerardiana* and *Paeonia emodi* are over-exploited in the area for their medicinal properties that resulting quick and mass decline in the population of these plant species in the study area. This continuous unsustainable use and over-exploitation of these plants may cause extinction of these plants from the area in near future. Deforestation, browsing and overgrazing have resulted habitat-loss and soil-erosion in the area that are further putting heavy pressure on the local vegetation. Some of the medicinal plants (*Artemisia brevifolia*, *Artemisia maritima*, *Artemisia scoparia, Capparis spinosa*, *Cotoneaster nummularia, Elaeagnus angustifolia*, *Fraxinus xanthoxyloides*, *Juniperus excelsa, Prunus dulcis, Salvia nubicola, Tamarix dioica, Thymus serphyllum, Viola canescens* and *Peganum harmala*) are also utilized in the area as fodder for domestic cattle and as firewood that also declined the populations of these plants in the area.

The present study will provide baseline information and data regarding the medicinal plants and their utilization in the area and will also help in better management, sustainability, commercialization and improvement of livelihood security in the area. Modernization, urbanization and development in various sectors is a threat for indigenous community of the area that resulting change in their culture, norms and traditions among the young generation, needed to be preserved from the extinction.

Declarations

List of abbreviations: RFC= relative frequency of citation, UV= use value, ICF= Informant consensus Factor

Ethics approval and consent to participate: Prior to the survey, we obtained oral informed consent from each informant.

Consent for publication: All people shown in images agreed to have their images published

Availability of data and materials: All data generated or analyzed during this study are included in this published article.

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Contributions: FH and OK designed the study; FH and S conducted the fieldwork, FH, OK, AG and GMH conducted the main statistical analysis; FH, S, OK, AG wrote the manuscript; RWB provided guidance, improved writing, revised the manuscript, improved images, and data analysis, GMH improved the overall presentation of manuscript, AG, SN revised the data analysis and corrected manuscript; all authors read, corrected and approved the manuscript.

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