Medicinal plant diversity of Hindubag mountain, Lalku valley, District Swat

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Research

Abstract

Background: Continuous studies and surveys on medicinal plants used by local communities in different parts of the world are needed for the documentation of local knowledge and for the potential development of modern pharmaceuticals. This study aimed at the documentation of knowledge about medicinal plant diversity in northern Pakistan and was conducted during summer 2018. During the survey, it was found that medicinal plants still are of paramount importance for everyday life of the local population and are extensively used for medicinal purposes.

Methods: By using semi-structured interviews, medicinal information was collected from 150 respondents in the area. The respondents involved in the interview were mostly older people, but young people and children were also included in the interviews. During the interviews the information about plants used by the local population for medicinal purposes was collected.

Results: The current study found 53 medicinal plants of 38 genera, belonging to 25 families. The medicinally dominant family were Ranunculaceae with 9 species, followed by Rosaceae 7 species, and Primulaceae with 5 species. Hakims in the area had higher knowledge about medicinal plants than other members of the population. Similarly, elders had more knowledge than younger people, and children and women showed less knowledge than men in the community.

Conclusion: The present study revealed that traditional knowledge of medicinal plants is still very common in the study area. The majority of the species used were still known to most people, but overexploitation and overgrazing are detrimental for the maintenance of plant life biodiversity. The current study suggests that there is a need to create awareness and understanding of plant management the area in order to ensure proper collection and to control overgrazing. These measures would help to ensure protection of the available medicinal herb diversity.

Keywords: Medicinal plants, Pakistan, Swat, Sustainability, Conservation

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Background

The use of medicinal plants is as old as the history of mankind (Meaza *et al*., 2015; Odhiambo *et al*., 2011). Communities inhabiting different areas of the world have developed their own knowledge of plant resources, uses, natural resource management and conservation (Cotton, 1996). Countries around the world need access to biodiversity resources to ensure fair and equitable sharing of benefits (Latif & Shinwari, 2005). Local inhabitants are facing many challenges in integration of local (e.g. for medicine and food) and market demands (generating income) for Medicinal and Aromatic Plants (MAPs) (Sher *et al.*, 2017). It has been shown that a large number of important medicinal plants are highly affected by climate change and human activities (Chi *et al*., 2017). This greatly affects the conservation of

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species, as well as their distribution and their use in the traditional medicinal industry. Inhabitants of distinct geographic localities in Pakistan still harbor distinct knowledge and practices using local plants. This indigenous knowledge of plants has been transferred from generation to generation through oral communication and personal experience (Shinwari, 2010). More than 70 % of the rural population relies on local medical plants mainly due to easy access, low prices (Ekor, 2013) and no availability of modern health facilities (Omwenga *et al*., 2009; Tene *et al*., 2007). Plant resources are providing food, clothing, shelter, nutritional, and health requirements of the population (Hanchinal *et al*., 2018). Traditional knowledge provides baseline information for effective in-situ conservation, which requires accurate and up to date data on medicinal plant populations, the extent and nature of plants used by local communities and the capacity of the resources base to support different financial activities. Traditional knowledge can be used for creating awareness about the importance of medicinal plants. Knowledge of influences of anthropogenic activities is important for setting priorities and directing efforts towards conservation and sustainable use (Anas, 2016). Thus, continuous studies and surveys on medicinal plants of the local communities in different parts of the world are needed for the documentation of local knowledge for the development of modern pharmaceutical. The present study was initiated with the aim to gather the available information concerning the uses of medicinal plants and to document it for further use in studies related conservation and sustainable utilization of medicinal plants. In our approach we hypothesized that: 1. That plant use especially for medicinal purposes was still highly important in this remote area, 2. that local knowledge, although part of a common cultural sphere, would differ from neighboring areas, and 3. that pressure on the resources was increasing.

Materials and Methods

Study area

Hindobaig Mountain of Lalku valley is located towards the North West part of District Swat at about 90 km from the Mingora city. The average altitude of the area ranges from 1500 - 3100 m. It is bordered by Shagho Sar, Daral mountains and Gabinjabba in the North, in the South by Julbasar and Bakroosar, and in the West by Sulatanr. The study area is located in the Hindukush mountain region of Swat, harboring moist temperate forests. These forests are composed by mixed conifer species i.e. *Pinus wallichiana, Abies pindrow* and *Picea smithiana* etc., and are contain a rich herbal flora and fauna, including valuable medicinal plants. The herbaceous flora found at lower and middle altitudes is used mostly for medicinal purposes. High altitude areas remain covered with snow in the months from November to May. The people from the nearby areas rely on plants resources found in the Hindubaig Mountain. The soil is sandy clay at the base while somewhat stony towards the top. In the study area there is no meteorological station. However, some information exists for the main city Mingora. The maximum rainfall occurs in the months from February-April, with the highest rainfall exceeding 200mm in March. Monsoon is active during the months of July and August, with rainfall of more than 150mm in July. The snowfall in the area occurs generally in the months of December to March. The weather is very pleasant in summer while very cold in winter. There is no developed system of irrigation in the area. Rainfall and snowfall are the main sources for water supply. Permanent springs are present in the area and are used for drinking and other domestic purposes and for irrigation, together with some local streams.

Most people of Hindubaig Mountain are poor. The majority of the people are farmers and more than 90% community depends on traditional agriculture and farming practices. Most of them are dependent on cattle and goats for milk production and bullocks for ploughing. The people living in the area belong to the Gujjar, Mian, Moulas and Pukhtoon tribes and the majority is illiterate. Crops found in that area are mainly maize, wheat, pea and some vegetables. The cultivation of these crops is for own consumption and are cultivated at the lower areas. Overgrazing and uncontrolled collection of plants are the main destructive forces causing loss of medicinal diversity (Fig. 1).

Taxonomic and ethnomedicinal Diversity

Our study was conducted on Hindubaig Mountain in 2018. Based on altitudinal variation the study area was divided into different sites. Field trips were arranged to these sites during the summer months of June-September. Ethnomedicinal information was obtained using semi structured interviews with a standard questionnaire. Some 150 respondents were interviewed after obtaining their prior informed consent. The participants mostly included older people (70%), some young people (20%) and children (10%). Details of the participants are given in Table 1. Plants were collected from different sites during the interviews and the fully dried specimens were mounted on herbarium sheets. The plants were identified with the help of available literature (Nasir and Ali, 1970-95, Stewart, 1967). The nomenclature was confirmed in the National Herbarium, NARC, Islamabad, and a set of voucher specimens was deposited at the Botany Department G.P. G. Jahanzeb College, Saidu Sharif Swat.

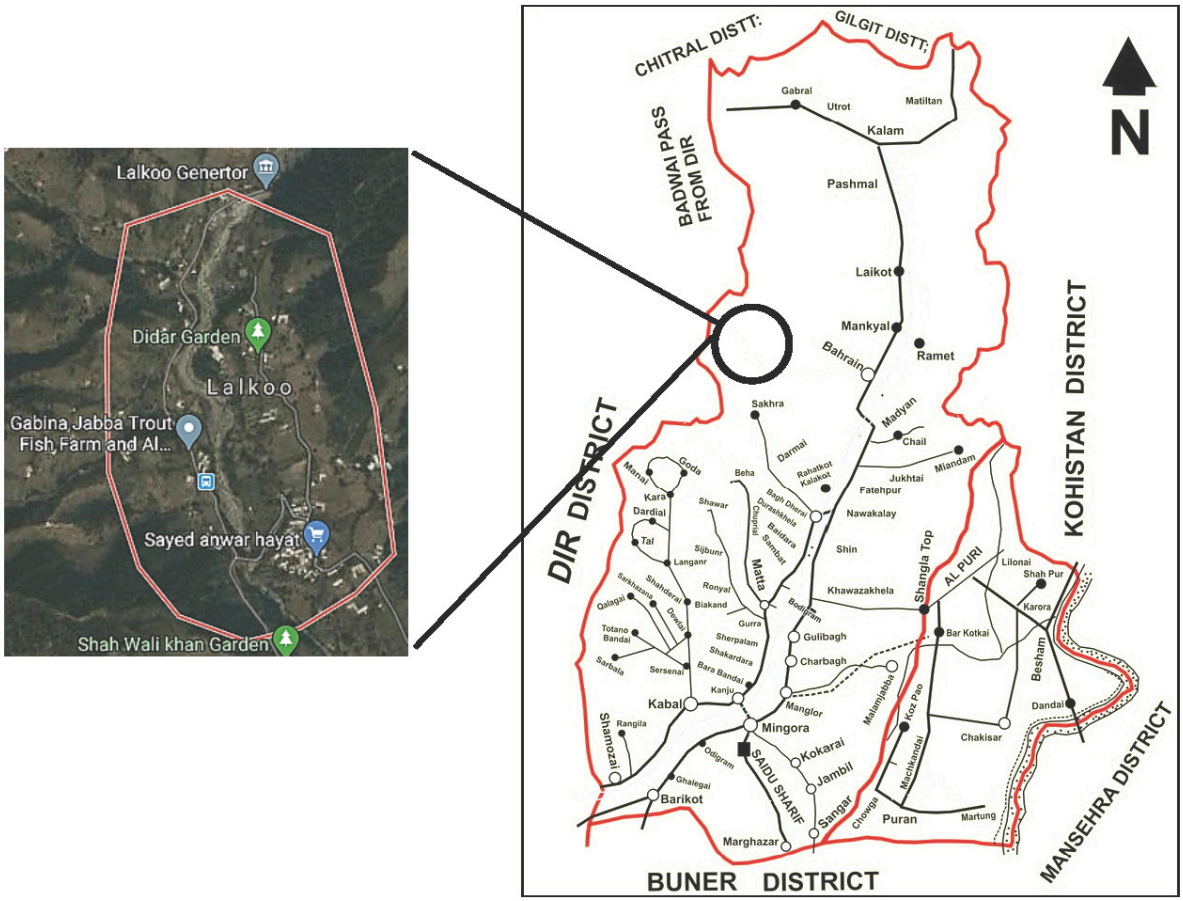

Figure 1. Map of District Swat and study area.

Table.1. Age and Gender wise detail of the respondents in the research area

Age	Male	Female	Total	Percentage
≥ 40 Years	60	45	105	**70**
21-40 Years	20	10	30	**20**
05-20Years	8	7	15	**10**
Total	**88**	**62**	**150**	**100**

Ethnomedicinal Indices

Data obtained from questionnaires was evaluated through different statistical indices commonly used in ethnobotanical studies:

Informant consensus factor (ICF).

ICF value evaluates views of different peoples about the purpose and mode of utilization for different ailments. For obtaining ICF values, we arranged ailments into 13 categories (Heinrich *et al,* 1998).

$$\mathrm{ICF} = \frac{N_{ur} - N_t}{N_{ur} - 1}$$

Nur = Total number of use reports for each disease category.

Nt =Number of species used in said category.

Use value (UV)

It measures the relative importance of a plant species among informants of an area. It is calculated following Savikin *et al*. (2013) using the following formula:

$$\mathrm{UVi} = \frac{\sum U_I}{\mathrm{N}}$$

UV =Use value of a species. U = Number of uses recoded for a species.

N =total number of informants who reported that species

Relative frequency of citation (RFC)

RFC identify the mostly used plant species by the local respondents. It is calculated following Tardi and Pardo-de-Santayana, (2008).

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

where (0 < RFC < 1)
FC = Number of informants citing a useful species.
N= Total number of informants in the survey.

Fidelity level (FL)

Fidelity level shows us the informants number claiming a particular plant use for a particular disease. It is calculated according to Alexiades and Sheldon (1996):

$$\text{FL \%} = \frac{N_p}{\text{N}} X100$$

Np = Number of informants that claiming use of a species for a particular disease.
N = Total number of informants reporting the species for any disease.

Relative popularity level (RPL)

RPL is the ratio between number of diseases treated by a particular plant species and the total number of informants for any disease. The relative popularity level (RPL) of the plant species is calculated and the species are divided into popular or unpopular (Ali-Shtayeh *et al.,* 2000).

Rank order priority (ROP)

ROP is a correction factor, used for proper ranking of the plant species with different FL and RPL values. The ROP is calculated by multiplying RPL and FL values (Ali-Shtayeh *et al.,* 2000).

$$ROP = FL\ X\ RPL$$

Results and Discussion

Botanical investigation of medicinal flora of study area

In the present study we found 53 medicinal plants species of 38 genera in 25 families (Table 2). Most of the medicinal plants belonged to the family Ranunculaceae with 9 species followed by Asteraceae with 7, species. Most of the species were herbs (47 species, 89%), followed by shrubs (4, 7%) and trees (2, 3.7%). The whole plant (28%) was most frequently used to prepare remedies, followed by roots (22%) and shoot (22%). The usage of other parts like leaves (11%), flower (6%), fruits (6%) seeds (4%) and wax (2%) was more limited (Fig. 2). Overall, the use of above ground parts was much more frequent (78%), than the use of below ground parts (22%). Shoots were used frequently because its collection is quite effortless, independent of flowering season and the active compound contents is relatively high (Giday *et al*, 2010; González *et al*, 2010).

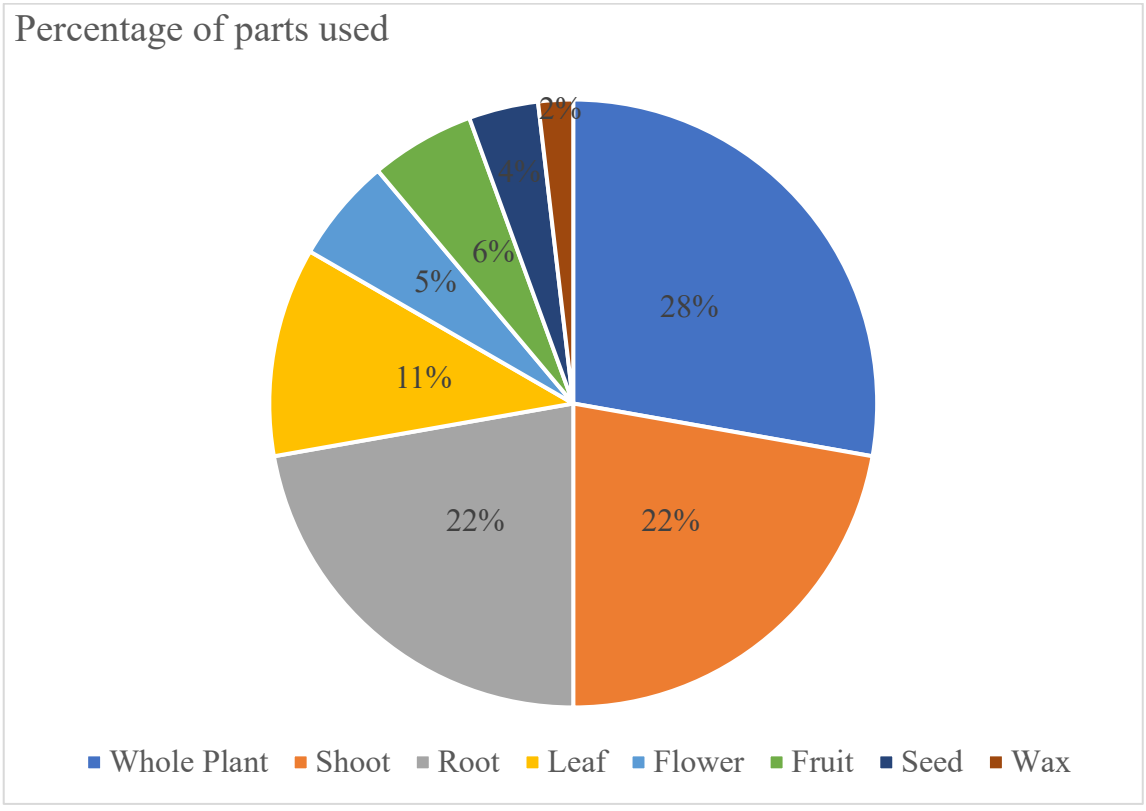

Figure 2. Classification of medical plants based on part used.

Table 2. List of medicinal plants, its uses and ethnomedicinal indices.

Voucher No.	**Family name**	**Scientific name**	**Local name**	**Habit**	**Part used**	**Medicinal uses**	UV	RFC	FL	RPL	ROP
GPGJ-H2311	Adoxaceae	*Sambucus wightiana* Wall. ex Wight & Arn	Chaijgen	Shrub	Sh	Sight of eyes, and the removal of kidney stones.	0.57	0.23	80	0.8	64
2312	Alliaceae	*Allium humile* Kunth	Zangali pyaz	Herb	W.P	Respiratory problem.	0.74	0.15	97	1.0	97
2313	Araceae	*Arisaema flavum* (Forssk.) Schott	Marjarai	Herb	R	Stomach disorder, cough and skin diseases.	0.64	010	82	0.8	65
2314	Araceae	*Arisaema utile* Hook. f. ex. Schott	Tura marjarai	Herb	R	Asthma	0.52	0.13	78	0.9	70
2315	Asteraceae	*Artemisia dubia* L. ex B.D. Jacks	Tarkha	Herb	Sh	Vermifuge, also regulate liver and sexual problem.	0.43	0.08	94	1.0	94
2316	Asteraceae	*Taraxacum officinale* L.	Buda budai		R	As anti-inflammatory & anti-carcinogenic	0.21	0.04	98	0.9	88
2317	Asteraceae	*Achilllea millefolium* L.	Jarrai / Aqarqara	Herb	W.P	Cure all kind of piles	0.42	0.05	70	0.9	63
2318	Asparagaceae	*Polygonatum geminiflorum* Decne.	Peramol	Herb	Sh	cleaning of eye and eye disorder	0.54	0.03	87	0.7	61
2319	Caryophyllaceae	*Gypsophila cerastioides* D. Don.		Herb	R	Give Strength to bone.	0.52	0.03	75	0.6	45
2320	Campannulaceae	*Campanula tenuissima* Dunn.	Gul pek	Herb	W.P	Eye purifier, liver disorder, heart problem.	0.56	0.10	80	0.7	56
2321	Caprifoliaceae	*Viburnum grandiflorum* Wall. ex DC.	Ghazmeva	Shrub	L/Fr	Stomach disorder and leaves for cleaning of intestine.	0.51	0.06	83	0.8	66
23222	Cupressaceae	*Juniperus communis* L.	Gogar	Tree	Sh	Used for all skin problem, high fever and cold.	0.53	0.05	87	0.6	52
2323	Crassulaceae	*Rhodiola wallichiana* Hook.	Ghra / Warkharai	Herb	Sh	Cooling agent to treat hepatitis.	0.33	0.04	80	0.5	40
2324	Crassulaceae	*Rhodiola quadifida* Pall	Soor / Warkharai	Herb	Sh	Brain, stomach and liver problem.	0.19	0.02	85	0.5	42
2325	Ericaceae	*Gaultheria trichophylla* Royle		Herb	R	Used as a pain killer.	0.25	0.05	72	0.4	29
2326	Euphorbiaceae	*Euphorbia wallichiana* Hook. f.	Argamala	Herb	L	Constipation.	0.13	0.03	83	0.6	49
2327	Fumeriaceae	*Corydalis govaniana* Wall.	Mameera	Herb	W.P	Help in eye problem,	0.87	0.26	97	0.8	77
2328	Fumeriaceae	*Corydalis diphylla* Wall.	Shamdana	Herb	Sd	Used for weight loss.	0.32	0.07	85	0.5	42

2329	Fumeriaceae	*Corydalis stewartii* Fedde	Mameera	Herb	W.P	Cleanness of eyes and also prevent the tear.	0.43	0.05	88	0.5	44
2330	Iridaceae	*Iris hookeriana* Foster	Turai	Herb	L	Anthelmintic for sheep, goat	0.37	0.14	85	0.5	42
2331	Lamiaceae	*Thymus linearis* Benth.	Ghrasperkai	Herb	Sh	Help in childbirth, high fever, all abdominal pain	0.65	0.24	95	0.7	66
2332	Peaoniaceae	*Paeonia emodi* Royle	Ward / Mamekh	Herb	R	Help in backbone pain, rickets problem.	0.58	0.05	99	0.9	89
2333	Pinaceae	*Picea smithiana* Wall	Manghazay	Tree	Wx	Skin problem also helps in the removal of kidney stone.	0.35	0.12	60	0.5	30
2334	Plantaginaceae	*Plantago himalica* Pilg.	Speeghul	Herb	Sh	Stomach problem, diarrhea	0.28	0.04	75	0.3	22
2335	Primulaceae	*Primula rosea* Royle	Sramameera	Herb	W.P	Wound healing, eye problem, high fever, cough in child	0.34	0.06	80	0.4	32
2336	Primulaceae	*Androsace foliosa* Duby	Gul pensa	Herb	W.P	Expel of kidney stone, used in fever, blood purifier,	0.44	0.08	65	0.3	19
2337	Primulaceae	*Cortusa brotherii* Pax ex Lipsky		Herb	W.P	Blood purifier.	0.22	0.03	80	0.4	32
2338	Primulaceae	*Primula elliptica* Royle		Herb	W.P	To kill the parasites like ticks, lice etc.	0.17	0.05	70	0.5	35
2339	Primulaceae	*Primula denticulata* Sm.	Mameera	Herb	W.P	Control of eye diseases	0.46	0.03	80	0.7	56
2340	Polygonaceae	*Bistorta amplexicaulis* D. Don.	Torapanra	Herb	R	Used as antibiotics	0.38	0.06	90	0.8	72
2341	Polygonaceae	*Rumex dentatus* L.	Shalkhay	Herb	L	Cure external wound and to reduce inflammation of skin.	0.63	0.05	85	0.8	68
2342	Ranunculaceae	*Aconitum violaceum* Jacquem. ex Stapf.	Da Ghra Zahar	Herb	R	General body tonic	0.76	0.10	90	0.7	63
2343	Ranunculaceae	*Anemone obtusiloba* Anth.	Chat Pooolai	Herb	Sd	Help in vomiting, stomach disorder, diarrhea	0.61	0.08	55	0.3	16
2344	Ranunculaceae	*Anemone falconeri* Thomson	Chat poolai	Herb	R	Anti-cancer, anti-tumor	0.35	0.06	75	0.3	22
2345	Ranunculaceae	*Anemone tetrasepala* Royle.	Kadoo	Herb	W.P	stomach pains, cough, asthma and throat diseases	0.38	0.08	82	0.4	32
2346	Ranunculaceae	*Anemone rupicola* Cambess.	Chat poolai	Herb	W.P	Stomach problem and sexual health	0.43	0.10	88	0.3	26
2347	Ranunculaceae	*Aquilegia nivalis* Baker	DeseeZahar	Herb	W.P	Help in muscle problem, fever, mixed with milk to take dose.	0.56	0.08	82	0.3	25
2348	Ranunculaceae	*Aquilegia pubiflora* Wall.	Bajar Dantee / Quandibutee	Herb	W.P	Gynecological disorders like, menstrual cycle and fertility.	0.66	0.13	93	0.6	55
2349	Ranunculaceae	*Aquilegia fragrans* Benth.	Bajar Dantee	Herb	Sh	To regulate menses	0.74	0.16	87	0.5	43

2350	Ranunculaceae	*Caltha alba* Cambess	Makar pat	Herb	L	Leg, ,back and abdominal pain	0.73	0.15	93	0.7	65
2351	Rosaceae	*Fragaria nubicola* (Lindl. ex Hook.f.) Lacaita	Tut	Herb	Fr	Help in heart diseases.	0.54	0.18	86	0.5	43
2352	Rosaceae	*Fragaria vesca* L.	Strawberry	Herb	Fr	Heart problem.	0.79	0.24	88	0.5	44
2353	Rosaceae	*Geumalatum* Wall. ex Hook. f.	Spensar bootee	Herb	Sh	Diabetes, blood purifier, help to reduce inflammation.	0.68	0.19	85	0.8	68
2354	Rosaceae	*Potentilla monanthes* Lindl.		Herb	Sh	Swelling of throat and mouth, body tonic.	0.88	0.23	83	0.4	33
2355	Rosaceae	*Potentilla atrosanguinea* G. Lodd. ex D. Don.		Herb	R	Used to control Diarrhea, Mildly painful menstruation	0.42	0.13	88	0.6	53
2356	Rosaceae	*Cotoneaster microphylla*Wall. ex Lindl.	Kharawa	Shrub	Sh	Used as blood purifier also better for weight loss.	0.32	0.21	83	0.4	33
2357	Rosaceae	*Potentilla reptans* L.		Herb	W.P	Used against to kill microorganism	0.36	0.07	87	0.8	69
2358	Ruteaceae	*Skimmialaureola* Franch	Nameer /sadab	Shrub	L	Digestive problems	0.59	0.05	88	1.0	88
2359	Saxifragaceae	*Bergenia cilata* (Haw.) Sternb	Gat panra	Herb	R	Digestive problems of human and also for animals	0.10	0.03	88	0.9	79
2360	Saxifragaceae	*Bergenia stracheyi* (Hook. f. & Thomson) Engl.	Gat panra	Herb	R	Used for abdominal pain.	0.37	0.09	87	0.9	78
2361	Violaceae	*Viola betonicifoclia* Sm.	Banafsha	Herb	Fl	As laxative in human	0.40	0.10	80	1.0	80
2362	Violaceae	*Viola canescens* Wall.	Banafsha	Herb	Fl	Against typhoid	0.23	0.04	92	1.0	92
2363	Violaceae	*Viola biflora* L.	Ziarabanafsha	Herb	Fl	Used as pain relief after hard work	0.25	0.03	90	0.8	72

Legend: Sh= Shoot, Fl= flower, R=Root, Sd= Seed, Fr= Fruit,L=Leaves, Wx= Wax, W. P= Whole plant

People involved in collection

The information about the demography of the collectors can be found in Table 3. We found during our survey that medicinal plants were mostly collected by men (60%). Especially older people (70%) were involved in the collection, followed by younger people (20%) and children (10%). The study also indicated that the participants were mostly illiterate (60%) with only 30% having passed elementary school and 10% finishing school education. Based on socioeconomic status, collectors included 50% farmers, 30% laborers, 10 shopkeepers, 5% hakims and 5% shepherds. (Fig. 3).

Ethnomedicinal exploration of the study area

The present study found that plant species play an important role in the livelihood of the population in the investigated area. The local population has great indigenous knowledge about local plant species which is transferred orally from generation to generation. Although most of the plant species and their uses were known to the local population, the overall count only yielded 53 medicinal species. It was found during investigation that the Hakims in the area had higher knowledge about medicinal plants. Similarly, elders, especially women, had more knowledge than the younger people, while children had least knowledge in the community, indicating that knowledge transfer is a slow process during the participants lifetime.

Table 3. Demographic information of the medicinal plant collectors.

Variables	Demographic categories	Percentage (%)
Gender	Male	60
	Female	40
Age group	≥ 40 Years	70
	21-40 Years	20
	05-20Years	10
Education	Illiterate	60
	Elementary education	30
	Graduate	10
Socioeconomic status	Farmer	50
	Laborer	30
	Shopkeeper	10
	Hakim	5
	Shepherd	5

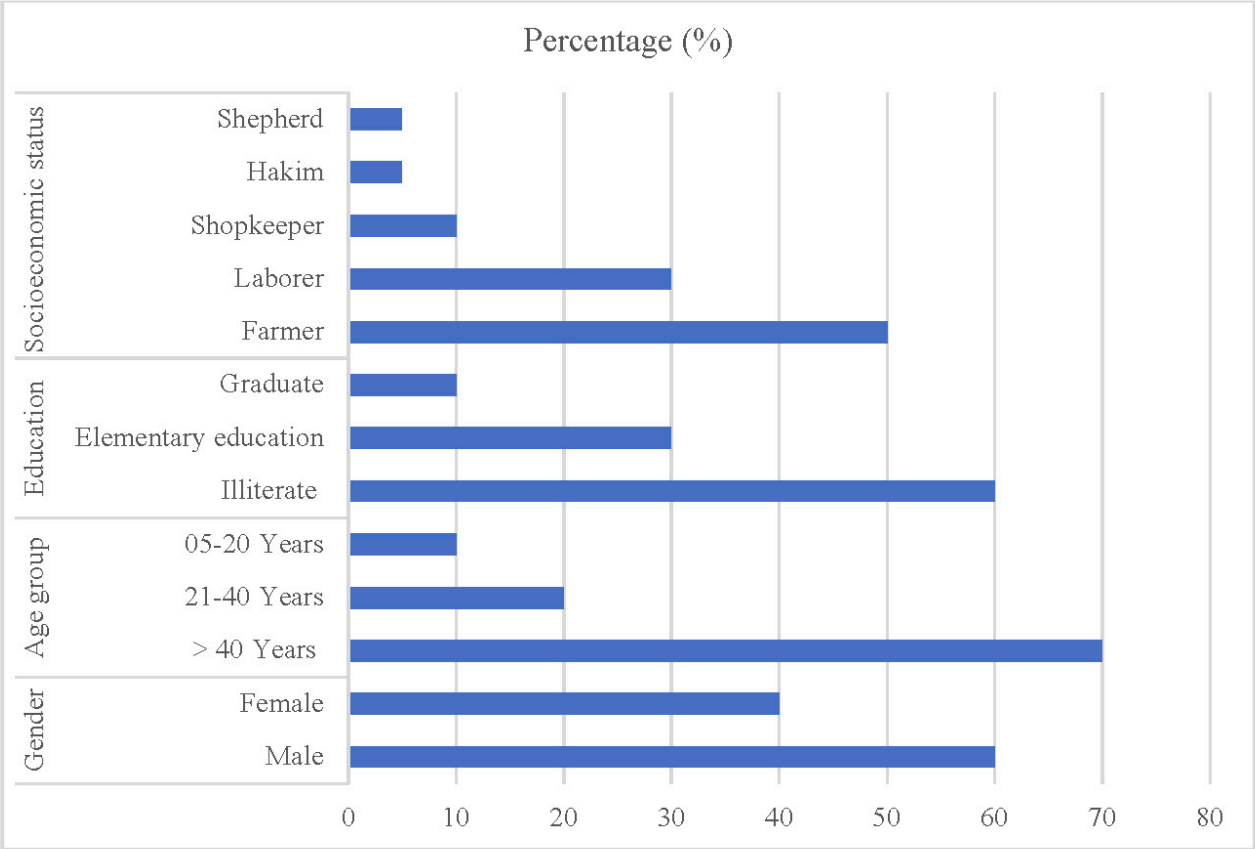

Figure 3. Percent representation of different demographic physiognomies in study area.

The surveyed medicinal plants were grouped into 13 use-categories on the basis of their medicinal uses (ailment categories, Table 4). Most of the species (21) were used for digestive disorders followed by cardiovascular diseases (11). Use as analgesic and antipyretic was the third ailment group with most plant species used. Ten plant species were used for urinogenital complaints while nine species were used for different body care purposes (Table 4, Fig. 4).

Table 4. Medicinal plants used against various ailments.

Used categories	No. of species	Plant species used
Digestive diseases	20	*Viola betonicifolia*, *Skimmia laureola*, *Bergenia cilata*, *Bergenia stracheyi*, *Caltha alba*, *Anemone obtusiloba*, *Plantago himaalica*, *Thymus linearis, Euphorbia wallichiana*, *Rhodiola quadifida*, *Viburnum grandiflorum*, *Achilllea millefolium*, *Arisaema flavum, Viburnum grandiflorum, Anemone tetrasepala, Anemone rupicola, Potentilla atrosanguinea, Viola betonicifoclia, Viola canescens*
Cardiovascular system	11	*Androsa*ce foliosa, *Cortus abrotherii*, *Cotoneaster microphylla*, *Achilllea millefolium, Campanula tenuissima, Androsace foliosa, Cortus abrotherii, Fragaria nubicola, Fragaria vesca, Geum alatum, Cotoneaster microphylla*
Pain and fever	11	*Bergenia stracheyi*, *Potentilla atrosanguinea, Paeonia emodi, Gaultheria trichophylla, Juniperus communis*, *Thymus linearis, Primula rosea, Androsa cefoliosa, Aquilegia nivalis*, *Viola biflora*
Urinogenital system	10	*Sambucus wightiana, Picea smithiana*, *Thymus linearis, Androsace foliosa, Anemone rupicola, Aquilegia pubiflora, Aquilegia fragrans, Potentilla atrosanguinea Sambucus wightiana,*
Body Care	9	*Gypsophila cerastioides, Paeonia emodi*, *Aconitum violaceum*, *Potentilla monanthes, Rhodiola quadifida, Corydalis diphylla*, *Aconitum violaceum, Cotoneaster microphylla*
Eye disease	8	*Polygonatum geminiflorum*, *Campanula tenuissima*, *Corydalis govaniana*, *Corydalis stewartii*, *Primula rosea*, *Primula denticulata*, *Sambucus wightiana*
Respiratory system	6	*Allium humile*, *Anemone tetrasepala, Arisaema flavum, Primula rosea, Anemone tetrasepala, Potentilla monanthes*
Antibiotics	6	*Taraxacum officinale, Primula rosea, Bistorta amplexicaulis*, *Geum alatum*, *Potentilla reptans*, *Viola canescens*
Muscles and skeleton	5	*Aquilegia fragrans, Paeonia emodi, Gypsophila cerastioides, Aquilegia nivalis, Caltha alba*
Liver and glands	5	*Rhodiola wallichiana, Artemisia dubia, Campanula tenuissima, Rhodiola quadifida*, *Geum alatum*
Insecticide/ Vermifuge	4	*Arisaema utile, Artemisia dubia, Iris hookeriana, Primula elliptica*
Skin diseases	3	*Juniperus communis, Picea smithiana, Rumex dentatus*
Neoplastic	2	*Anemone falconeria*, *Taraxacum officinale,*

Informant consensus factor (ICF)

Gastrointestinal disorders were dominant with 48 use reports, followed by eye disorders and Pain and fever with 23 and 24 use reports respectively. Most of the reported plants were used for gastric complaints (21), cardiovascular problems (11) and pain/fever (11) (Table. 5). Cardiovascular complaints along with pain and fever were the second most prevalent ailments which were treated with medicinal plants. Some other studies also reported similar findings (Kadir *et al*, 2012; Singh *et al*, 2012). The ICF values ranged from 0 (Anticancer) to 0.57 (Digestive disorders, Body tonic). The average of all values was 0.45, which was somewhat higher than in similar studies (Bibi *et al*, 2014; Abbasi *et al*, 2013).

Use Value (UV)

The UV shows the relative importance of species (Vendruscolo and Mentz, 2006). High UV is reached due to a high number of use reports for a species. *Potentilla monanthes* (0.88), *Corydalis govaniana* (0.87), *Allium humile* (0.74) and *Aquilegia fragrans* (0.74) scored especially high UV (Table 2). This shows their popularity in herbal recipes. This value also indicates that some plants are quite effective among a large variety of patients and supposedly without serious side effects, thus people suggesting their use to others for treatments.

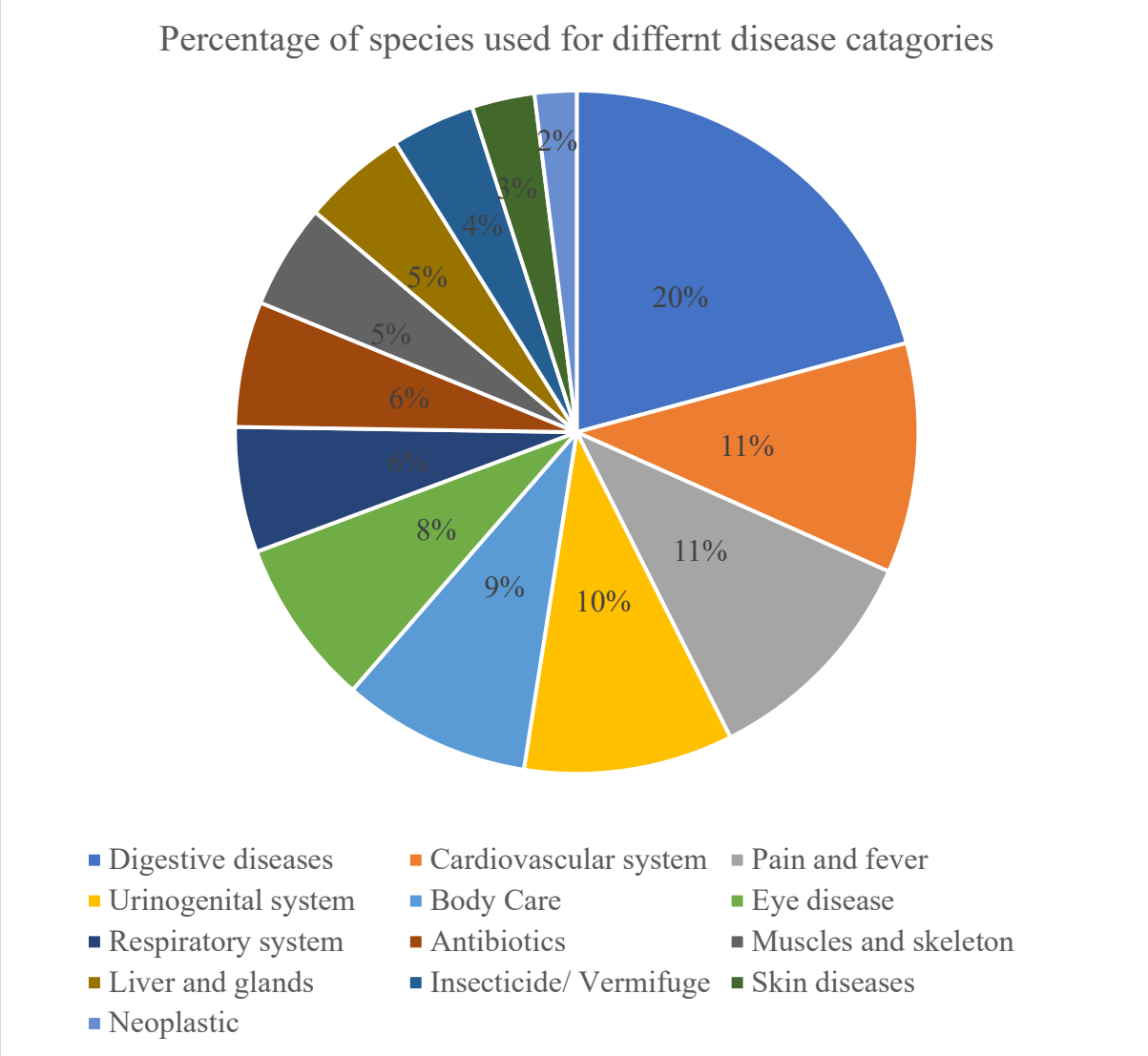

Figure 4. Percentage of plants used for different indications.

Table 5. Informant consensus factor (ICF) values for 13 different diseases categories.

Category of Diseases	Number of use reports	Number of taxa used	ICF
Digestive system	48	20	0.57
Eye disease	24	8	0.69
Pain and fever	23	11	0.54
Cardiovascular system	20	11	0.47
Body tonic	20	9	0.57
Urinogenital system	19	10	0.50
Antibiotics	11	6	0.50
Respiratory system	10	6	0.44
Muscular/skeletal system	09	5	0.50
Liver and glands	08	5	0.42
Insecticide/ Vermifuge	05	4	0.25
Skin diseases	05	3	0.50
Neoplastic	02	2	0.00

Relative frequency citation (RFC)
RFC index indicates that how users frequently cite a plant for different disease. The RFC value for species in study area were in ranged of 2 to 26% (Table 2). The highest RFC was reported for *Corydalis govaniana* (0.26), *Fragaria vesca* (0.24), and *Sambucus wightiana,* and *Potentilla monanthes* (0.23 each).

Relative popularity level (RPL)
Thirty-one species were frequently cited by the local population for various diseases. Species cited by more people were especially popular, while species cited by fewer people are declared as unpopular. *Allium humile, Artemisia dubia, Skimmia laureola, Viola betonicifolia,* and *Viola canescens* were considered popular having RPL value of 1.0. Similarly, *Arisaema utile, Taraxacum officinale*, *Achilllea millefolium*, *Paeonia emodi, Bergenia cilata* and *Bergenia stracheyi* were also considered popular with values of 0.9. Various other studies are similar to our findings (Ali-Shtayeh *et al*, 2000; Umair *et al*, 2017).

Fidelity level (FL)
The ethnomedicinal value of a species is related to FL value. The fidelity level (FL) values of the 53 species are presented in Table 2. High FL shows the occurrence of a specific disease in an area and the use of a species for its cure (Bibi *et al*. 2014; Srithi *et al*. 2009). Species with high FL values included *Paeonia emodi* (99) for back pain, *Taraxacum officinale* (98) against inflammation, *Allium humile* (97) for respiratory problems, and *Corydalis govaniana* (97) for eye diseases.

Rank order priority (ROP)
This index is used for arrangement of different species with different fidelity values. The Relative popularity level (RPL) values were multiplied with Fidelity values (FL) to obtain ROP values. These values are given in Table 2. Species showing high ROP values include *Allium humile* (97), *Artemisia dubia* (94), *Bergenia cilata* (79), *Bergenia stracheyi* (78), *Viola betonicifoclia* (80), *Viola canescens* (92). Most of the species showed low values, which might indicate a slow loss of knowledge of their use.

Novelty of the present study
Recently a lot of scientific investigations on the traditional knowledge of Swat have been published (Ali *et. al,* 2012; Akhtar *et. al*, 2013; Adnan *et. al,* 2014; Ahmad *et. al,* 2014; Khan *et al*, 2015; Sher *et al*, 2017; Ali *et al*, 2011). However, none of these studies included specifically our study site. Furthermore, most of the previous studies only documented medicinally important plants qualitatively, without statistical analysis. The present study is the first of its type for the study area and apart from documentation of traditional knowledge aimed to preserve the rapidly disappearing traditional knowledge regarding medicinal plants among the local community. The loss of traditional knowledge is due to loss of interest in the younger population, premature harvesting, over-exploitation, deforestation and grazing, illiteracy, absence of professionalism, lack of documentation, although the use of herbal medicines to cure various diseases was still prevalent among the people of Hindubaig mountain.

Conclusions

Our result show that the research area is very rich in herbaceous medicinal plants. The main purpose of the recent study was to document the medicinal flora of Hindubaig Mountain, exploration of traditional knowledge and its statistical presentation. The study found that there were several important plants with medicinal potential, e.g. *Gypsophila cerastioides, Paeonia emodi, Aconitum violaceum, Potentilla monanthes, Sambucus wightiana, Picea smithiana, Androsa cefoliosa*, *Cotoneaster microphylla*, *Rhodiola quadifida, Achilllea millefolium Arisaema flavum*, *Anemone tetrasepala* and *Anemone falconeria.*

We could confirm our hypothesis that plant use especially for medicinal purposes was still highly important in this remote area, and that pressure on the resources was increasing. However, we also found that the knowledge in the area was very similar to neighboring regions, thus refuting our hypothesis that local knowledge would differ from neighboring areas.

The uncontrolled collection of plants and overgrazing in the area is dangerous for future generations. Medicinal plants in the region are extensively used. The people in the region have no proper instruction about medicinal plants and also have no appropriate training about these resources and their market value. The present study revealed that while the area is a source for important medicinal herbs, there were no conservation strategies established, while the inhabitants of the area were highly dependent on medicinal herbs both for local use and sale. The study also showed that the population of the area have a maintained a high amount of indigenous knowledge. Programs to foster the awareness and understanding for plant management in the area, in order to ensure proper collection and to control overgrazing are urgently needed. These measures will ensure protection of the available diversity.

Declarations

Ethics approval: Before conducting interviews, individual prior informed consent was obtained from all participants. No further ethics approval was required. All work conducted was carried out under the stipulations of the Nagoya Protocol on Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising from their Utilization to the Convention on Biological Diversity and following the Code of ethics of the International Society of Ethnobiology. The right to use and authorship of any traditional knowledge of all participants is maintained, and any use of this information, other than for scientific publication, does require additional prior consent of the traditional owners, as well as a consensus on access to benefits resulting from subsequent use.

Conflict of interests: The authors declare that they have no competing interests.

Consent for publication: Not applicable – no personal data are included in this manuscript.

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Availability of data and materials: The raw data without names of participants are available from the authors.

Author's contributions: HS and IUR designed and supervised the study; HS, I, ZK and IUR conducted the fieldwork, and the main statistical analysis. HS, I, ZK, IUR and RB rewrote and revised the manuscript; all authors read, corrected and approved the manuscript.

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Literature cited

Abbasi AM, Khan MA, Shah MH, Shah MM, Pervez A, Ahmad M. 2013. Ethnobotanical appraisal and cultural values of medicinally important wild edible vegetables of Lesser Himalayas-Pakistan. Journal of Ethnobiology and Ethnomedicine 9:66. doi:10.1186/1746-4269-9-66 PMID: 2403413

Adnan M, Ullah I, Tariq A, Murad W, Azizullah A, Khan AL, Ali N. 2014. Ethnomedicine use in the war affected region of northwest Pakistan. Journal of Ethnobiology and Ethnomedicine. doi:10.1186/1746-4269-10-16.

Ahmad M, Sultana S, Fazl-i-Hadi S, Ben Hadda T, Rashid S, Zafar M, Khan MA, Khan MPZ, Yaseen G. 2014. An Ethnobotanical study of Medicinal Plants in high mountainous region of Chail valley (District Swat- Pakistan), Journal of Ethnobiology and Ethnomedicine. doi:10.1186/1746-4269-10-36.

Akhtar, N. Rashid, A. Murad, W. &Bergmeier, E. 2013. Diversity and use of ethno-medicinal plants in the region of Swat, North Pakistan, Journal of Ethnobiology and Ethnomedicines. doi:10.1186/1746-4269-9-25.

Alexiades MN, Sheldon JW. 1996. Selected guidelines for ethnobotanical research: A Field Manual. Boranx, NY: The New York Botanical Garden.

Ali H, Ahma H, Marwat KB, Yousaf M, Gul B, Khan I. 2012. Trade potential and conservation issues of medicinal plants in District Swat, Pakistan. Pakistan Journal of Botany 44(6):1905-1912.

Ali K, Khan N, Rahman IU, Khan W, Ali M, Uddin N, Nisar M. 2018. The ethnobotanical domain of the Swat Valley, Pakistan., Journal of Ethnobiology and Ethnomedicine doi:10.1186/s13002-018-0237-4.

Ali-Shtayeh MS. Yaniv Z, Mahajna J. 2000. Ethnobotanical survey in the Palestinian area: a classification of the healing potential of medicinal plants. Journal of Ethnopharmacology 73:221-232.

Anas A. 2016. Biodiversity, Conservation of Some Medicinal Plants of Katsina State Nigeria. International Journal of Health and Medicine 1(1):30.

Bibi T, Ahmad M, Tareen RB, Tareen NM, Jabeen R, Rehman S, Sultana S, Zafar M, Yaseen G. 2014. Ethnobotany of medicinal plants in district Mastung of Balochistan province-Pakistan. Journal of Ethnopharmacology 157:79-89. doi:10.1016/j.jep.2014.08.042

Chi X, Zhang Z, Xu X, Zhang X, Zhao Z, Liu Y, Guo L. 2017. Threatened medicinal plants in China: Distributions and conservation priorities. Biological Conservation 210:89-95.

Cotton CM. 1996. Ethnobotany: Principles and Applications. Chichester, England: John Wiley and Sons Ltd.

Ekor M. 2013. The growing use of herbal medicines: issues relating to adverse reactions and challenges in monitoring safety. Frontiers in Pharmacology 4:177. doi: 10.3389/fphar.2013.00177

Giday M, Asfaw Z, Woldu Z. 2010. Ethnomedicinal study of plants used by Sheko ethnic group of Ethiopia. Journal of Ethnopharmacology 132(1):75-85.

González JA, García-Barriuso M, Amich F. 2010. Ethnobotanical study of medicinal plants traditionally used in the Arribes del Duero, western Spain. Journal of Ethnopharmacology 131(2):343-355.

Hanchinal RR, Jaiswal J, & Kumar D. 2018. Biodiversity Conservation in Medicinal Plants and Protection of Plant Varieties and Farmers' Rights Act. New Age Herbals pp. 313-328. Springer, Singapore.

Heinrich M, Ankli A, Frei B, Weimann C, Sticher O. 1998. Medicinal plants in Mexico: Healers'

consensus and cultural importance. Social Science and Medicine 47:1859-1871. PMID: 9877354.

Kadir MF, Bin Sayeed MS, Mia M. 2012. Ethnopharmacological survey of medicinal plants used by indigenous and tribal people in Rangamati, Bangladesh. Journal of Ethnopharmacology 144:627- 637. doi: 10.1016/j.jep.2012.10.003 PMID: 23064284.

Khan MPZ, Ahmad M, Zafar M, Sultana S, Ali MI, Sun H. 2015. Ethnomedicinal uses of Edible Wild Fruits (EWFs) in Swat Valley, Northern Pakistan, Journal of Ethnopharmacology. doi:10.1016/j.jep.2015.07.029.

Latif A, Shinwari ZK. 2005. Global Forest Resource Assessment. Country report. Pakistan.

Meaza G, Tadesse B, Maria AS, Piero B, Giday, Y. 2015. Traditional medicinal plants used by Kunama ethnic group in Northern Ethiopia. Journal of Medicinal Plant Research, 9(15): 494-509.

Nasir E, Ali SI. 1970-1995. Flora of West Pakistan and Kashmir. Pakistan Agriculture Research Council, Islamabad.

Odhiambo JA, Lukhoba CW, Dossaji SF. 2011. Evaluation of Herbs as Potential Drugs/Medicines. African Journal Traditional Complement Alternative Medicines 8(5):144-151.

Omwenga, E., Okemo, P., Mbugua, P &Ogol, C. K. 2009. Ethnobotanical Survey and Antimicrobial Evaluation of Medicinal Plants used by the Samburu Community (Kenya) for treatment of Diarrhorea. - Pharmacognosy Magazine 5(18):165-172.

Savikin K, Zdunić G, Menković N, Živković J, Ćujić N, Tereščenko M, Bigović D., 2013. Ethnobotanical study on traditional use of medicinal plants in SouthWestern Serbia, Zlatibor district. Journal of Ethnopharmacology 146(3):803-10.

Sher H, Bussmann RW, Hart, R. 2017. Promoting Sustainable Use of Medicinal and Aromatic Plants for Livelihood Improvement and Biodiversity Conservation under Global Climate Change, through Capacity Building in the Himalaya Mountains, Swat District, Pakistan. Annals of the Missouri Botanical Garden 102(2):309-315.

Shinwari, Z.K. 2010. Medicinal plants Research in Pakistan. Journal of Medicinal Plants Research 4(3):161-176.

Singh AG, Kumar A, Tewari DD. 2012. An ethnobotanical survey of medicinal plants used in Terai forest of western Nepal. Journal of Ethnobiology and Ethnomedicine 8:19. doi:10.1186/ 1746-4269-8-19 PMID: 22591592

Srithi K, Balslev H, Wangpakapattanawong P, Srisanga P, Trisonthi C. 2009. Medicinal plant knowledge and its erosion among the Mien (Yao) in northern Thailand. Journal of Ethnopharmacology 123:335-342. doi:10.1016/j.jep.2009.02.035 PMID:19429381

Stewart, R., 1967. Checklist of the Swat State North West Pakistan. The Pakistan Journal of forestry. Vol-xvii, Pakistan. Symposium Karachi, pp: 229-234.

Tardio J, Pardo-de-Santayana M. 2008. Cultural importance indices: a comparative analysis based on the useful wild plants of Southern Cantabria (Northern Spain) 1. Economic Botany 62:24-39.

Tene V, Malagón O, Finzi PV, Vidari G, Armijos C, Zaragoza T. 2007. An ethnobotanical survey of medicinal plants used in Loja and Zamora-Chinchipe, Ecuador. Journal of Ethnopharmacology 111(1):63-81.