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Quantitative ethnobotanical appraisal of medicinal plants used by inhabitants of lower Kurram, Kurram agency, Pakistan

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Abstract

Objective: Medicinal plants are used for treatment of ailments throughout rural and urban areas of the world. Such use of plants varies from one region to another and is measured using quantitative techniques. The current research which was conducted from March to October 2015, is the first explorative study of medicinal plants used by inhabitants of lower Kurram, Kurram agency, Pakistan.

Materials and Methods: Field trips were done to 20 location of lower Kurram and information regarding medicinal use of plants was collected from the locals through semi-structured interviews.

Results: A total of 52 plant species that were reported by the people from the region, to have medicinal value, fall within 48 genera and 35 families. The family Asteraceae comprised most of these herbs (6 species) followed by the family Lamiaceae (4 species) and Solanaceae (3 species). Leaves (24.3%) and fruits (21.6%) were the frequently used parts in preparation of remedies. The reported plants were used for treatment of 50 ailments with most of these plants (35 species; 30.97%) being used for treatment of digestive problems. *Seriphidium kurramensis* had the highest relative frequency of citation (66.18) and use value (1.10). Fidelity level of *Caralluma tuberculata* and *Artemisia scoparia* for diabetes was (61.22) and (55.56), respectively. The highest fidelity level for malaria was reported for *Artemisia absinthium* (43.66) and *S. kurramensis* (40.00).

Conclusion: The inhabitants of lower Kurram still practice medicinal plants and few of the plants were used for treatment of fatal diseases like malaria, hepatitis and blood cancer. Haphazard cutting of plants and overgrazing are major threats that can affect plants biodiversity.

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Introduction

One important aspect of quantitative ethnobotany survey is the use of quantitative techniques to assess the medicinal use of plants in a specific area. Quantitative ethnobotany survey involves the use of quantitative techniques for direct analysis of the data on utilization of the

existing plants(Phillips et al., 1994). This is a relatively new idea and the term was coined by Prance and coworkers in 1987 (Pepin., 1999). These approaches are useful in explaining the variables quantitatively (Hoffman and Gallagher 2007). Quantitative studies create quality information, which in turn leads to conservation and development of resources(Phillips and Oliver., 1996).So, considering methodological issues not only strengthens the discipline of ethnobotany but also improves the image of ethnobotany among other scientists (Phillips et al., 1994). This is also helpful to realize the importance of the environment for people(Atran & Medin, 2008). Such efforts are now made by ethnobotanists to present quantitative profiles of indigenous use of plants for medicinal purpose.

Medicinal plants are used for treatment of ailments all over the world and are regarded as natural treasures of each region. Usually, these sources are abundantly available and can be used in safe, stable, standardized, and effective galenical products to be utilized in primary health care (Farnsworth et al., 1985). An estimated 50,000 medicinal plant species provide primary health benefits to 80% of world population (Gewali and Awale, 2008; Wangchuk et al., 2011). They are integral part of healthcare in less-developed countries where 3.3 billion people utilize medicinal plants on a regular basis (Davidson-Hunt, 2000). Medicinal use of plants has become more popular due to dynamic nature of traditional knowledge as it is passed to the following generations through oral or discipleship practices in communities (Rastogi & Dhawan, 1982). Documentation of historically tested traditional knowledge from people is necessary before loss because much of the information remains intact with tribal people. A part of modern medicine research is based on ethnobotanical studies and traditional knowledge and many drugs have been derived from plants and several plants are currently undergoing investigation to ascertain their therapeutic efficacies (Torres et al., 2012). An estimated 25% of the drugs prescribed worldwide are derived from plants, and 121 such 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 (Srithi et al., 2009). It is also helpful in preservation of cultural and ecological value of plants.

Medicinal plants are still an important component of healthcare in Pakistan. This is largely due to poverty, inadequacy of health services, and availability of indigenous remedies and shortage of health-care provider. Medicinal plants have been traditionally used in various parts of Pakistan (Bano et al., 2014; Barkatullah & Ibrar, 2013; Bibi et al., 2014; Hussain et al., 2013; Jan et al., 2016; Marwat, 2008; Sarangzai et al., 2013; Shinwari & Khan, 2000; Tareen et al., 2010; M. Ullah et al., 2013; R. Ullah et al., 2010).However, limited quantitative assessment of the ethnomedicinal properties of these plants, has been done. Such information has been documented from upper Kurram agency (Ajaib et al., 2014; Gilani et al., 2003; Hussain et al., 2012) without quantitative appraisal as no systematic approach has been made to investigate the quantitative aspect of the indigenous uses of medicinal plants.

Lower Kurram is a rich diversified area extending from Thall in Hangu district to Sadda of Kurram agency. Due to inadequate medical facilities and lack of modern medicines, the inhabitants use available medicinal plants. Along these, instability and terroristic activities have limited developmental strategies for promotion of health, education, and infrastructure facilities. Most villages of the area are located on sides of rivers Kurram where plenty of medicinal plants are available. In the present research work, we

collected ethnomedicinally important plants information from inhabitants of lower Kurram, an ethnobotanically unexplored area. The study also focuses on indigenous knowledge and performs a quantitative analysis of the medicinal plants used by the inhabitant of lower Kurram.

Materials and Methods

Study area description

Kurram Agency is a remote tribal territory of Pakistan, (https://en.wikipedia.org/wiki/Kurram_Agency), which lies on Pakistan- Afghanistan border with geographic co-ordinates 33°45'0" N and 70°19'60" E. The agency is bounded on the north and west by Afghanistan provinces Ningarhar and Pukthia, respectively, on the east by Orakzai and Khyber Agencies, on the southeast by Hangu district and on the south by North Waziristan Agency. The agency takes its name from the river Kurram which passes through it. Major tribes living in the agency are Bangash, Turi, Orakzai, Zazai, Mangal, Ghilzai and Para Chamkani. The total length of agency is 115 kilometers and the total surface is3.380 Km^2. The total forest area cover of the agency both artificial and natural, make 22% of the total forest area of the Federally Administered Tribal Areas (FATA) of Pakistan (https://www.fata.gov.pk). The agency is further divided into three administrative units namely, upper, central and lower Kurram.

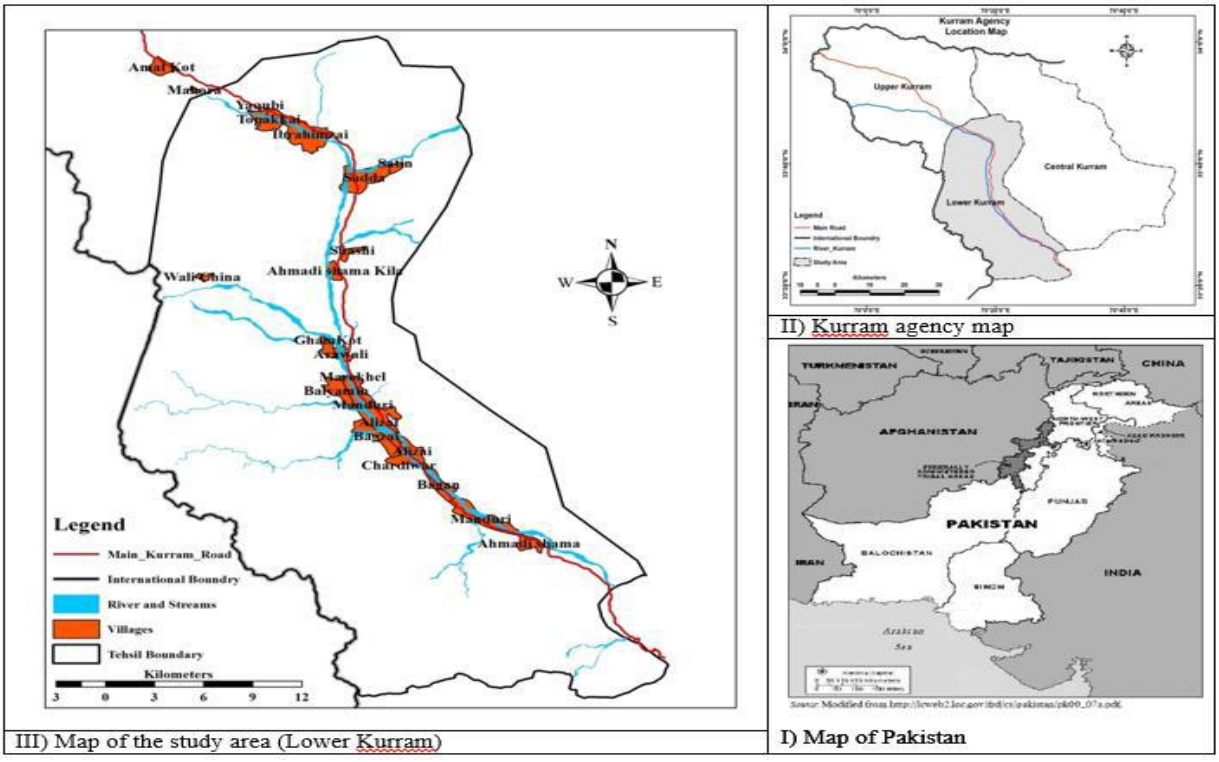

Figure 1. Map of (I) Pakistan (II) Kurram agency (III) Study area (Lower Kurram).

Sampling technique and data collection method

Field trips were done to 20 locations including Ahmadi shama, Manduri (Upper), Bagann , Alizai Chardiwar, Alizai Bagizai, Manduri (Lower), Bilyamin, Marokhel, Arawali, GhamKot, Wali China, Ahmadishama kila, Shasi, Sadda, Satin, Ibrahimzai, Toppaki, Yaqubi, Mahora and Amalkot of lower Kurram agency from March to October 2015 (Figure 1 III). Informants were selected according to purposive sampling technique, a technique which is now actively employed in ethnobotany (Tongco, 2007) with a number of data gathering methods (Godambe,

1982). The criteria for selection of informants were being an inhabitant of over 40 years old and having cultivated garden plants, or sold or collected wild plants. Totally, 68 informants were selected including farmers, pastorals, traditional healers, shopkeepers, drivers and gardeners. Ethnomedicinal plants data was collected through semi-structured interviews. Among the 68 informants interviewed, 59 were males and 9 were females. Traditional knowledge of medicinal plants mainly transferred through oral means to younger generations.

Collection, identification and preservation of medicinal plants

During field trips, samples of the plant and the part(s) of the plant used were collected with the help of the informants who were asked to share their information about indigenous medicinal plants. They were dried, preserved by using (1% $CuSO_4$) as 1g $CuSO_4$ dissolved in 99 ml distilled water and mounted on herbarium sheets. A voucher number was given to each plant sample. The plant specimens were identified by taxonomists at Botany Department University of Peshawar and compared with Flora of Pakistan (Ali & Qaiser, 1995) and were deposited in the Herbarium of Botany Department University of Peshawar for future references.

Quantitative analysis of data

Relative frequency citation (RFC)

Relative frequency citation was calculated by using the following formula:

RFC=FC/N

Where FC=is the number of informants reporting the use of species divided by the total number of informants participating in the survey (N), without consideration of the use categories.

Use Value (UV)

The relative importance of each species was calculated according to formula $UVs = \sum UVi / Ni$, proposed by (Phillips & Gentry, 1993). Where '*UVi'* represents use value for a given species among the informants participated and '*Ni'* represents the total number of informants.

Fidelity level (FL)

Fidelity level of plant was determined to find which plant is preferably used against specific ailments (Friedman, Yaniv, Dafni, & Palewitch, 1986). The following formula was used: FL = Ip/Iu×100

Where FL = Fidelity level, Ip = number of informants who cited the plant for a specific ailment, Iu = total number of informants who used the plant for treatment of any illness. Plants having higher FL value are considered biologically dynamic compared to those having less FL value (Canales et al., 2005).

Results

Medicinal plants diversity, life forms, uses and threats

During the present explorative survey, informants mentioned 52 plants and their use for medicinal purposes (Table 1). These plants falling within 48 genera and35) families included herbs (36 species), shrubs (8 species) and trees (8 species). These included six species belonging to family Asteraceae, as an exceedingly large and widespread family of angiosperms (Kadereit and Jeffrey, 2007) four species were from the family Lamiaceae and three species from the family Solanaceae. The results show an agreement with highest number of medicinal plants of family Asteraceae reported by (Ajaib, Anjum, Malik, & Sidiqui, 2015) and both family Asteraceae and Lamiaceae were reported as major families by(Andrade-Cetto, 2009; Bano et al., 2014; Castro., 2011). From each of the following seven families namely, Arecaceae, Asclepiadaceae, Liliaceae, Moraceae, Plantaginaceae, Polygonaceae, and Rosaceae, two species were found. The other species belonged to 25 families including Aizoaceae (1), Berberidaceae (1) Brassicaceae (1) Cannabaceae (1)

Chenopodiaceae (1) Ephedraceae (1) Equisetaceae (1) Fabaceae (1) Fagaceae (1) Fumariaceae (1) Malvaceae (1) Meliaceae (1) Oleaceae (1) Oxalidaceae (1) Papaveraceae (1) Poaceae (1) Polypodiaceae (1) Punicaceae (1) Ranunculaceae (1) Scrophulariaceae (1) Thymelaeaceae (1) Ulmaceae (1), Umbelliferae (1), Violaceae (1) and Zygophyllaceae (1).

The inhabitants that were professionally agropastorlists, collected medicinal plants from the wild and sold them in local market (e. g. *Withania coagulans*, *Caralluma tuberculata*, etc.). Overgrazing has affected the flora; however, deforestation is the major cause of loss of biodiversity in this area. Most people excessively cut plants such as *Dodonaea viscosa*,*Prosopis*speciesand *Nannorrhops ritchiana* for fuel, construction and making ropethat can raise concerns regarding loss of biodiversity in this area.

Table 1. Medicinal plants diversity, voucher number, part used, FC, RFC and UV

Plant species	Voucher number	Family	Local name	Habit	Part used	FC	RFC	UV
***Adiantum capillus-veneris* L.**	Bot.Huss.01 (PUP)	Polypodiaceae	Lailazulfi	Herb	Leaves	17	25.00	0.25
***Allium sativum* L.**	Bot.Huss.02 (PUP)	Liliaceae	Wooga	Herb	Bulb	41	60.29	0.74
***Artemisia absinthium* Waldst&Kitam**	Bot.Huss.03 (PUP)	Asteraceae	Mastyra	Herb	Whole plant	39	57.35	1.04
***Artemisia scoparia* L.**	Bot.Huss.04 (PUP)	Asteraceae	Derang	Herb	Root	20	29.41	0.53
***Asparagus officinalis* Royle**	Bot.Huss.05 (PUP)	Liliaceae	Speragais	Herb	Leaves, branches	17	25.00	0.40
***Avena sativa* L.**	Bot.Huss.06 (PUP)	Poaceae	Karyanra	Herb	Fruit	26	38.24	0.46
***Berberis lycium* Royle**	Bot.Huss.07 (PUP)	Berberidaceae	Sarasghay	Shrub	Fruit, bark	41	60.29	0.88
***Calotropis procera* (wild) R.Br**	Bot.Huss.08 (PUP)	Asclepiadaceae	Sperboti	Shrub	Stem, leaves	33	48.53	0.76
***Cannabis sativa* L.**	Bot.Huss.09 (PUP)	Cannabaceae	Bang	Herb	Leaves, branches	44	64.71	0.90
***Caralluma tuberculata* N. E. Brown**	Bot.Huss.10 (PUP)	Apocynaceae	Pawanay	Herb	Stem	30	44.12	0.72
***Celtis australis* L.**	Bot.Huss.11 (PUP)	Ulmaceae	Togh	Tree	Fruit	14	20.59	0.21
***Chenopodium album* L.**	Bot.Huss.12 (PUP)	Chenopodiacea e	Sarmay	Herb	Aerial parts	12	17.65	0.66
***Cichorium intybus* L.**	Bot.Huss.13 (PUP)	Asteraceae	Sheenguli	Herb	Leaves, branches, root	24	35.29	0.59
***Cotoneaster horizontalis* Dcne**	Bot.Huss.14 (PUP)	Rosaceae	Kherawa	Shrub	Fruit	17	25.00	0.25
***Daphne mucronata* Royle**	Bot.Huss.15 (PUP)	Thymelaeaceae	Laghony	Shrub	Leaves, flower	16	23.53	0.24
***Datura stramonium* L.**	Bot.Huss.16 (PUP)	Solanaceae	Tura	Herb	Leaves, seeds	32	47.06	0.57
***Ephedra intermedia* Wall.ex.stapf**	Bot.Huss.17 (PUP)	Ephedraceae	Mawa	Shrub	Branches	21	30.88	0.31
***Equisetum arvensis* L.**	Bot.Huss.18 (PUP)	Equisetaceae	Bandoky	Herb	Stem, branches	17	25.00	0.25
***Foeniculum vulgare* Mill**	Bot.Huss.19 (PUP)	Apiaceae	Hogelanay	Herb	Aerial parts	37	54.41	1.01
***Fumaria indica* (Haussk) pugsl**	Bot.Huss.20 (PUP)	Fumariaceae	Shatara	Herb	Whole plant	20	29.41	0.40
***Lepidium sativum* L.**	Bot.Huss.21 (PUP)	Brassicaceae	Sugarbooti	Herb	Leaves, branches	15	22.06	0.22
***Malva parviflora* L.**	Bot.Huss.22 (PUP)	Malvaceae	Takalay	Herb	Aerial parts	25	36.76	0.66
***Melia azedarach* L.**	Bot.Huss.23 (PUP)	Meliaceae	Daraka	Tree	Leaves, flower	11	16.18	0.24
***Mentha piperita* (L.) Huds**	Bot. Huss. 24 (PUP)	Lamiaceae	Walay	Herb	Leaves, branches	37	54.41	0.54
***Mentha viridis* L.**	Bot.Huss.25 (PUP)	Lamiaceae	Podina	Herb	Fruit	21	30.88	0.82
***Morus alba* L.**	Bot.Huss.26 (PUP)	Moraceae	Speentoot	Tree	Fruit	22	32.35	0.32
***Morus nigra* L.**	Bot.Huss.27 (PUP)	Moraceae	Toortoot	Tree	Fruit	18	26.47	0.40
***Nannorrhops ritchiana* H. Wendl.**	Bot.Huss.28 (PUP)	Arecaceae	Mazaray	Tree	Fruit	22	32.35	0.56
***Olea ferruginea* (Wall. Ex G. Don) Cif.**	Bot.Huss.29 (PUP)	Oleaceae	Hawney	Tree	Aerial parts	41	60.29	0.75

***Oxalis corniculata* L.**	Bot.Huss.30 (PUP)	Oxalidaceae	Bibishatala	Herb	Fruit	13	19.12	0.21
***Papaver somniferum* L.**	Bot.Huss.31 (PUP)	Papaveraceae	Doda	Herb	Seeds	25	36.76	0.57
***Peganum harmala* L.**	Bot.Huss.32 (PUP)	Zygophyllaceae	Speenali	Herb	Leaves, fruit	10	14.71	0.15
***Plantago lanceolata* L.**	Bot.Huss.33 (PUP)	Plantaginaceae	Palespara	Herb	Aerial parts	18	26.47	0.51
***Plantago major* L.**	Bot.Huss.34 (PUP)	Plantaginaceae	Ghoayzaba	Herb	Aerial parts	26	38.24	0.47
***Polygonum plebejum* L.**	Bot.Huss.35 (PUP)	Polygonaceae	Bandokay	Herb	Leaves, branches, seeds	10	14.71	0.16
***Portulaca oleracea* L.**	Bot.Huss.36 (PUP)	Aizoacea	Warhuray	Herb	Fruit	24	35.29	0.43
***Prosopis juliflora* (Sw) DC**	Bot.Huss.37 (PUP)	Fabaceae	Asgenkikar	Shrub	Fruit	15	22.06	0.22
***Punica granatum* L.**	Bot.Huss.38 (PUP)	Punicaceae	Wangar	Tree	Fruit, seeds	28	41.18	0.49
***Quercus baloot* Roxb**	Bot.Huss.39 (PUP)	Fagaceae	Seray	Tree	Flower, seeds	16	23.53	0.24
***Ranunculus muricatus* L.**	Bot.Huss.40 (PUP)	Ranunculaceae	Zergolak	Herb	Whole plant	11	16.18	0.16
***Rosa moschata* L.**	Bot.Huss.41 (PUP)	Rosaceae	Gulab	Shrub	Leaves, fruit	24	35.29	0.51
***Rumex dentatus* L.**	Bot.Huss.42 (PUP)	Polygonaceae	Zamda	Herb	Whole plant	15	22.06	0.28
***Seriphidium kurramensis* Qazilb.**	Bot.Huss.43 (PUP)	Asteraceae	Tarkha	Herb	Aerial parts	45	66.18	1.10
***Solanum nigrum* L.**	Bot.Huss.44 (PUP)	Solanaceae	Kharsoby	Herb	Leaves, root, seeds	12	17.65	0.31
***Taraxacum officinale* L.**	Bot.Huss.45 (PUP)	Asteraceae	Chupaska	Herb	Whole plant	12	17.65	0.18
***Teucrium stocksianum* Boiss**	Bot.Huss.46 (PUP)	Lamiaceae	Gulbahar	Herb	Leaves, flower	15	22.06	0.43
***Thymus linearis* Benth**	Bot.Huss.47 (PUP)	Lamiaceae	Panay	Herb	Rhizome	18	26.47	0.47
***Tulipa stellata* L.**	Bot.Huss.48 (PUP)	Arecaceae	Spergha	Herb	Leaves	7	10.29	0.10
***Verbascum thapsus* L.**	Bot.Huss.49 (PUP)	Scrophulariace	Kharghogay	Herb	Leaves	14	20.59	0.25
***Viola canescens* Wall**	Bot.Huss.50 (PUP)	Violaceae	Benafsha	Herb	Leaves, flower	9	13.24	0.13
***Withania coagulans* (Stocks) Dunal in DC.**	Bot.Huss.51 (PUP)	Solanaceae	Khapanga	Shrub	Fruit	35	51.47	0.57
***Xanthium strumarium* L.**	Bot. Huss. 52(PUP)	Asteraceae	Kandola	Herb	Fruit	9	13.24	0.13

Plants parts used in formulation of remedies

Parts of the plants that were reported to have therapeutic effect were leaves (24.3%) and fruits (21.6%) being the most frequently used followed by branches (10.8%), aerial parts (9.5%) and seeds (8.1%) (Table 2). The more frequent use of leaves and fruits in treatment of ailments is attributed to the fact that they are easily collected and could be directly used (Dolatkhahi et al., 2014). The use of a single or few parts of the same species is also clear and that were easily collected due to availability. The locals used various parts of the same species in treatment of a variety of ailments e. g. leaves, branches and root of *Cichorium intybus* were all cited by informants as blood purifier, antipyretic and anti-malarial agents. Aerial parts of *Seriphidium kurramensis* were used as anthelmintic, anti-malarial and antipyretic medicines. The other plants with two parts used or aerial parts used in formulation of remedies are shown in Table 1.

Table 2. Medicinal plants parts used by inhabitants of lower Kurram agency.

Plant part	Absolute value	Frequency (%)
Leaves	18	24.3%
Fruits	16	21.6%
Branches	8	10.8%
Aerial parts	7	9.5%
Seeds	6	8.1%
Flowers	5	6.8%
Whole plant	5	6.8%
Root	3	4.1%
Stem	3	4.1%
Bark	1	1.4%
Bulbs	1	1.4%
Rhizome	1	1.4%
Total	74	100

Medicinal applications of the plants

In the current report, 50 medicinal applications were documented for 52 medicinal plants (Table 3 and Figure 2). The highest number of species (35species) that represented (30.97%) of total species were used for treatment of disorders of digestive system. The use of medicinal

plants in treatment of digestive disorders is also an important application of the min other rural areas of Iran and Pakistan (Dolatkhahi et al., 2014; Rahman et al., 2016; M. Ullah et al., 2013). Moreover, 16 plants (14.15%) were used for problems of circulatory system and the same number of plants (16) (14.15%) were used against pain and fever. Eight species (7.07%) were used for problems of Integumentary system and another eight species (7.07%) were used against respiratory conditions. Five species (4.42%) were used for wound healing and as antidotes,5 species (4.42%) against urologic problems 3 species (2.65%) for hepatitis/jaundice, 3 species (2.65%) for reproductive system disorders 3 species (2.65%) as narcotic/sedatives, 3 species (2.65%) had antiseptic/antibacterial properties and 1 species (0.88%) for ophthalmological problem.

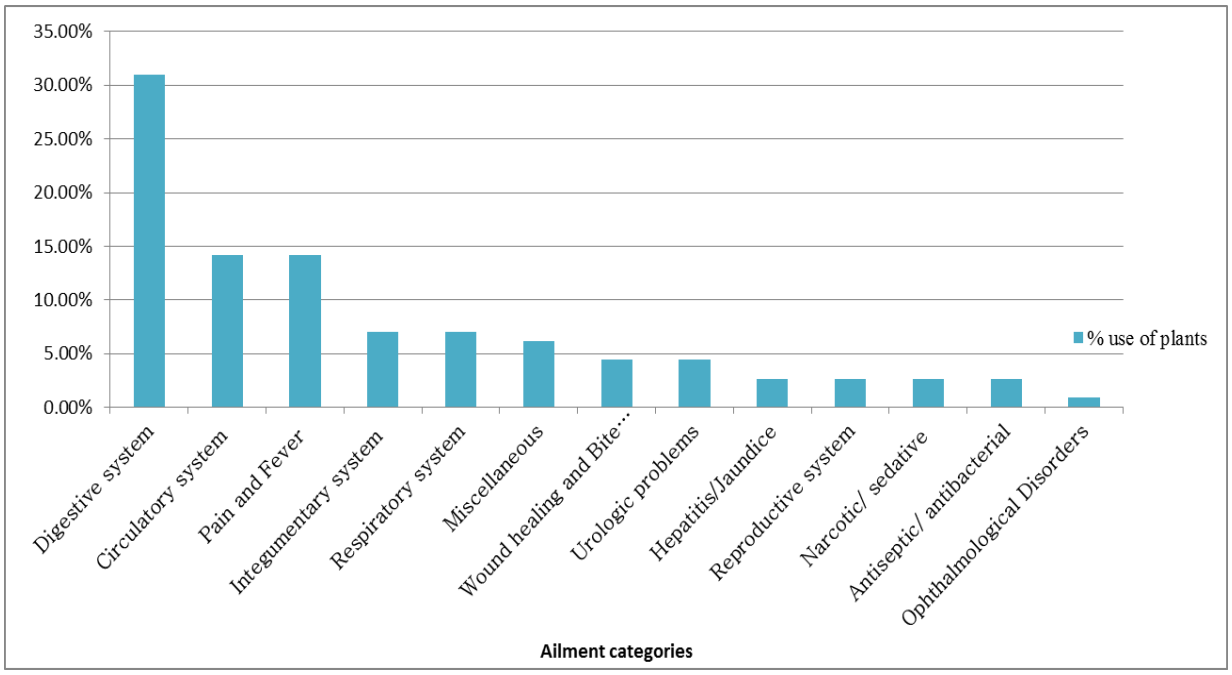

Figure 2. Relative value or percentage (%) use of medicinal plants.

Table3. Medicinal applications, number of plants used and relative value (%).

Medicinal use applications	A. V for group of symptom or ailment	Relative value (%)	Symptom or ailment	A. V or symptom or ailment	Name of plants used
Integumentary system	8	7.07%	Skin allergy	7	*Adiantum capillusveneris, Artemisia absinthium, Daphne mucronata, Fumaria indica, Melia azedarach, Rumex dentatus, Mentha piperita*
			Strengthen hairs	1	*Melia azedarach*
Circulatory system	16	14.15%	Blood pressure	2	*Allium sativum, Olea ferruginea*
			Blood cancer	1	*Artemisia scoparia*
			Blood purifier	6	*Artemisia absinthium, Artemisia scoparia, Cichorium intybus, Foeniculum vulgare, Fumaria indica, Teucrium stocksianum*
			Bleeding control	1	*Verbascum thapsus*
			Diabetic	5	*Artemisia absinthium, Caralluma tuberculata, Lepidium sativum, Quercusbaloot, Solanum nigrum*
			Cardio-tonic	1	*Celtis australis*
Digestive system	35	30.97%	Intestinal tonic	1	*Asparagus officinalis*
			Dysentery	1	*Plantago major*
			Laxative	5	*Asparagus officinalis, Chenopodium album Nannorrhops ritchiana. Morus alba. Morus nigra*
			Stomachic	6	*Avena sativa, Cotoneaster horizontalis, Mentha viridis, Portulaca oleracea. Thymus linearis, Withania coagulans.*
			Intestinal flatulence	2	*Caralluma tuberculata, Foeniculum vulgare*
			stomach pain	5	*Caralluma tuberculata, Foeniculum vulgare, Oxalis corniculata, Plantago lanceolata, Solanum nigrum.*
			stomach acidity	1	*Plantago lanceolata*
			Carminative	1	*Mentha piperita*
			Colic	2	*Mentha viridis, Thymus linearis*
			Constipation	3	*Malva parviflora, Rumex dentatus, Withania coagulans*
			Intestinal pain	1	*Malva parviflora*
			Purgative	2	*Nannorrhops ritchiana, Rosa moschata*
			Diarrhea	3	*Equisetum arvensis, Plantago lanceolata, Punica granatum*
			Anthelmintic	2	*Seriphidium kurramensis, Tulipa stellata*
Respiratory system	8	7.07%	cough	6	*Calotropis procera Cannabis sativa Mentha viridis, Morus nigra, Papaversomniferum, Thymus linearis*
			Asthma	1	*Calotropis procera*
			Flu	1	*Thymus linearis*
Wound healing and Bite (Antidote)	5		Wound healing	3	*Calotropis procera, Plantago major Rumex dentatus*
		4.42%	Snake Bite	1	*Datura stramonium*
			Honey bees biting	1	*Allium sativum*
Urologic problems	5	4.42%	Renal pain	3	*Berberis lyceum, Polygonum plebejum Xanthium strumarium*
			Kidney stone	1	*Oxalis corniculata*
			Strengthen urinary tract wall	1	*Chenopodium album*
Pain and Fever	16	14.15%	Analgesic	4	*Calotropis procera, Datura stramonium, Papaver somniferum, Ranunculus muricatus*
			Chest pain	3	*Berberis lyceum, Mentha viridis, Rosa moschata*
			Rheumatism	1	*Caralluma tuberculata*
			Antipyretic	4	*Cichorium intybus, Fumaria indica, Seriphidium kurramensis, Teucrium stocksianum*
			Malaria	4	*Artemisia absinthium, Cichorium intybus, Seriphidium kurramensis, Teucrium stocksianum*
Hepatitis/ Jaundice	3	2.65%	Hepatitis	1	*Taraxicum officinale*
			Jaundice	2	*Chenopodium album, Solanum nigrum*
Reproductive system	3	2.65%	Aphrodisiac	3	*Chenopodium album, Foeniculum vulgare, Cannabis sativa*
Ophthalmological Disorders	1	0.88%	Eye sight	1	*Foeniculum vulgare*
Narcotic	3	2.65%	Narcotic	2	*Cannabis sativa, Datura stramonium*
Sedative			Sedative	1	*Datura stramonium*

Antiseptic Anti-bacterial	3	2.65%	Antiseptic Anti-bacterial	2 1	*Berberis lycium, Ephedra intermedia* *Verbascum thapsus*
Miscellaneous	7	6.19%	Weight loss/Obesity	2	*Peganum harmala, Teucrium stocksianum*
			Tonic	2	*Plantago lanceolata, Polygonum plebejum*
			Lactation	1	*Prosopis juliflora*
			Nutritive	1	*Papaver somniferum*
			Stimulant	1	*Malva parviflora*

Abbreviation: A.V = Absolute Value

Medicinal plants applications, as well as their formulation and route of administration

The applications of medicinal plants as well as their formulation and route of administration are given in Table 4. In traditional medicine, the methods of preparation of herbal remedies vary and are based upon the plant utilized and symptom being treated. The plant parts used in preparation of remedies were either fresh, dried or a combination of both forms. The main method of preparation of remedies was extract (22 species) followed by powder (14 species), intact (7 species), as a vegetable (4 species), decoction (3 species) and infusion (3 species) (Table 4). Extract was also reported as the main method of preparation in ethnobotanical studies conducted by researchers (Asase et al., 2005; M. Khan et al., 2012). The locals also kept dried parts of plants that were either boiled to prepare an extract or grounded into powder before application. Some plants recipes were used for treatment of fatal diseases like malaria, hepatitis and blood cancer. Most diseases were usually treated with a single plant remedy; however, the inhabitants also prepared herbal mixtures of two plants. A concoction of whole plant of *E. arvensis* and leaves of *M. viridis* was used for the treatment of diarrhea. The leaves of *S.kurramensis* and *T. linearis* were boiled in water to prepare a concoction for treatment of cough and malaria. The concoction of *C. intybus* root and leaves of *A. absinthium* was used against malaria and fever as well as a blood purifier. A concoction of the bark of *P. granatum* and aerial parts of *T. linearis* are boiled in water for treatment of cough. A concoction of *D. mucronata* and *A. capillus-veneris* are applied on skin for treatment of skin allergy. The inhabitants practiced the remedies both orally and topically. Forty plants were used orally, eight plants were used both orally and topically and the other four plants were applied topically (Figure 3).

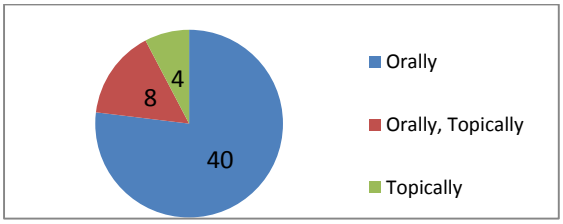

Figure 3. Route of administration of remedies.

Table 4.Medicinal plants application as well as their formulation and route of administration.

Medicinal plant	Method of formulation of remedies	ROA	Medicinal use
Adiantum capillus veneris	Ext	T	Extract of leaves is topically applied on skin for treatment of skin allergy.
Allium sativum	Dir, veg, ext	O, T	Bulb is either directly eaten or cooked as vegetable for lowering blood pressure. Extract of bulb topically applied on skin as antidote for honey bees biting.
Artemisia absinthium	Pow, ext	O, T	Whole plant is grinded into powder and boiled in water to prepare an extract for malaria, skin allergy, diabetic and also used as blood purifier.
Artemisia scoparia	Dec	O	Decoction of root is used for blood cancer and as blood purifier.
Asparagus officinalis	Pow	O	Powder of leaves and branches is used as intestinal tonic and laxative.
Avena sativa	Ext	O	Fruit extract is considered CNS tonic and stomachic
Berberis lycium	Pow, dec, Dir	O	Bark is grinded into powder or boiled in water to get decoction. These powder and decoction are orally taken for chest pain and renal pain. Fruit is directly consumed as antiseptic.
Calotropis procera	Lat, smo.	O, T	Latex of stem and leaves is applied as wound healing agent. Smoke of these part is useful for cough asthma analgesic
Cannabis sativa	Ext	O	Extract of leaves and branches is narcotic, analgesic, sedative and aphrodisiac.
Caralluma tuberculata	Dir, veg	O	Stem is directly used or cooked as vegetable for diabetic, stomach pain, rheumatism and as intestinal flatulence
Celtis australis	Dir	O	Fruit is directly consumed as cardio-tonic
Chenopodium album	Veg, Pow	O	Leaves are cooked as vegetable for jaundice and as aphrodisiac and laxative. Powder of seeds used to strengthen wall of urinary tract.
Cichorium intybus	Veg	O	Leaves and branches are cooked and consumed as blood purifier, antipyretic and anti-malaria.
Cotoneaster horizontalis	Dir	O	Fruit is consumed as stomachic.
Daphne mucronata	Ext	T	Leaves and flower extract used as skin allergy
Daturastramonium	Ext	O, T	Leaves and seeds extract is sedative, analgesic and also applied topically as antidote on snake bite part.
Ephedra intermedia	Ext	O	Extract of leaves is used as antiseptic.
Equisetum arvensis	Pow	O	Powder of stem and branches is useful in diarrhea.
Foeniculum vulgare	Dir, Pow	O	Fruit is directly eaten or grinded into powder for its medicinal properties like stomach pain, flatulence, aphrodisiac, improving eye sight and as blood purifier.
Fumaria indica	Pow, Dir	O, T	Powder of the aerial parts is used as blood purifier and antipyretic. Fresh plant is used in skin allergy.
Lepidium sativum	Pow	O	Powder of leaves and branches is used as antidiabetic agent.
Malva parviflora	Ext	O	Extract of aerial parts is useful in constipation, Intestinal pain and as stimulant.
Melia azedarach	Ext	T	Leaves and flower extract is useful in skin allergy and hair strength.
Mentha piperita	Veg, ext	O, T	Leaves are cooked as vegetable for its carminative affect. Fresh leaves extract topically used in skin infections.
Mentha viridis	Dir, ext	O	Leaves and branches are consumed as stomachic and colic while its extract is considered useful in cough and chest pain.
Morus alba	Dir	O	Fruit is directly consumed as laxative.
Morus nigra	Dir	O	Fruit is useful as laxative and against cough.
Nannorrhops ritchiana	Dir	O	Fruit is directly consumed for its laxative and purgative properties.
Olea ferruginea	Dir	O	Fruit is considered useful in high blood pressure and as blood purifier.
Oxalis corniculata	Ext	O	Extract of aerial parts is useful in stomach pain and kidney stone.
Papaver somniferum	Ext, Dir	O	Fruit extract is useful in cough and as analgesic. Seeds are nutritive.
Peganum harmala	Pow	O	Seeds powder is useful in weight loss.
Plantago lanceolata	Ext, Pow	O	Leaves extract and fruit powder is useful in stomach pain, diarrhea stomach acidity and as tonic.
Plantago major	Ext	O, T	Extract of aerial parts is useful in healing of wounds and dysentery.
Polygonum plebejum	Ext	O	Extract of aerial part is useful in renal pain and as tonic.
Portulaca oleracea.	Veg	O	Leaves, branches and seeds are cooked as vegetable that possess flatulent and stomachic properties.
Prosopis juliflora	Pow	O	Powder of fruit is used for increasing milk production.
Punica granatum	Pow	O	Powder of fruit peel is used in diarrhea and chronic cough treatment.
Quercus baloot	Pow	O	Powder of fruit and seed is antidiabetic.
Ranunculus muricatus	Ext	O	Leaves extract is analgesic.
Rosa moschata	Dir, ext	O	Dry leaves purgative and extract is useful in chest pain and cough.
Rumex dentatus	Ext	O, T	Leaves, roots and seeds extract were used in healing of wounds, skin allergy and constipation.
Seriphidium kurramensis	Ext	O	Whole plant extract is mixed with sugar and is used as anthelmintic, anti-malarial and antipyretic agent.

Solanum nigrum	Veg	O	Leaves and fruit are cooked for Jaundice, stomach pain and diabetes.
Taraxicum officinale	Ext	O	Extract of plant is used against hepatitis.
Teucrium stocksianum	Inf	O	Infusion of leaves is used as blood purifier, anti-diabetic, antipyretic and for control of obesity
Thymus linearis	Inf	O	Infusion of aerial parts is considered useful for cough, flu and as stomachic and colic.
Tulipa stellata	Dec	O	Decoction of rhizome is used as anthelmintic.
Verbascum thapsus	Ext	T	Leaves extract is topically applied on skin to control bleeding and as anti-bacterial agent.
Viola canescens	Inf	O	Infusion of leaves is drink for cough.
Withania coagulans	Pow	O	Fruit is grinded powder and taken orally for constipation and as stomachic.
Xanthium strumarium	Ext	O	Extract of fruit is useful in renal pain.

Abbreviations; 'ROA' 'Route Of Administration' 'Dec' Decoction, 'Dir' Directly, 'Ext' Extract, 'Inf' Infusion, 'Pow' Powder, 'Veg' Vegetable, 'Lat' Latex, 'Smo' Smoke, 'O' Orally, 'T' Topically.

Relative frequency and use value of medicinal plants

The relative frequency index shows that the highest relative frequency of citation was for *S. kurramensis* (66.18) followed by *Cannabis sativa* (64.71), *Berberis lycium* (60.29), *Olea ferruginea* (60.29), *Allium sativum* (60.29), *Artemisia absinthium* (57.35), *Foeniculum vulgare* (54.41), *Mentha piperita* (54.41) and *Withania coagulans* (51.47). The lowest relative frequency of citation was calculated for *Tulipa stellata*(10.29). Use value of plant was calculated according to the method of Phillips and Gentry (Phillips & Gentry, 1993) formula in order to assess the importance of plant in the studied area. A highest use value was recorded for *S. kurramensis* (1.10) followed by *A. absinthium* (1.04), *F. vulgare* (1.01), *Cannabis sativa* (0.90) *Berberis lycium* (0.88) and *M. viridis* (0.82). *T. Stellata* attained the lowest use value of 0.10 (Table 1).

Fidelity level

Fidelity level was calculated to highlight the importance of each plant for each ailment. For this purpose we analyzed the data whiles species with a single application were not considered. For treatment of diabetes with respect to fidelity level, the most important species were *Caralluma tuberculata* (FL=61.22) and *Artemisia scoparia* (FL=55.56). Species with high fidelity level for malaria were *A. absinthium* (FL=43.66) and *S. kurramensis* (FL=40.00). The fidelity level for cough treatment had the highest value for *P. somniferum* (56.41) followed by *Thymus linearis* (56.25), *Morus nigra* (37.04), *Calotropis procera* (25.00), *Rosa moschata* (20.00), *Punica granatum* (18.18) and *M. viridis*(10.71) (Table 5).

Table 5. Fidelity level of plants.

Medicinal application	Plant species	FL	Ailment	Plant species	FL
Analgesic	*Ranunculus muricatus* L	100.00	Eye sight	*Foeniculum vulgare* Mill	11.59
	Papaver somniferum L	33.33	Flu	*Thymus linearis* Benth	31.25
	Cannabis sativa L	32.79	Hepatitis	*Taraxacum officinale* L.	100.00
	Calotropis procera (wild) R.Br	7.69	Honey bees biting	*Allium sativum* L.	20.00
	Datura stramonium L.	5.13	Intestinal flatulence	*Portulaca oleracea* L.	55.17
Anthelmintic	*Tulipa stellata* L.	100.00		*Foeniculum vulgare* Mill	21.74
	Seriphidium kurramensis Qazilb.	41.33		*Caralluma tuberculata* N. E. Brown	4.08
Antibacterial	*Verbascum thapsus* L.	29.41	Intestinal pain	*Malva parviflora* L.	28.89
Antidiabetic	*Quercus baloot* Roxb	100.00	Intestinal tonic	*Asparagus officinalis* Royle	55.56
	Lepidium sativum L.	100.00	Jaundice	*Solanum nigrum* L.	47.62
	Caralluma tuberculata N. E. Brown	61.22		*Chenopodium album* L.	24.44
	Artemisia scoparia L.	55.56	Kidney stone	*Oxalis corniculata* L.	50.00

	Solanum nigrum L.	19.05	Lactation	*Prosopis juliflora* (Sw)DC	100.00
	Teucrium stocksianum Boiss	17.24	Constipation	*Morus alba* L.	100.00
	Artemisia absinthium Waldst & Kitam	17.00		*Morus nigra* L.	62.96
Antimalarial	*Artemisia absinthium* Waldst & Kitam	43.66		*Nannorrhops ritchiana* H. Wendl.	52.63
	Seriphidium kurramensis Qazilb.	40.00		*Asparagus officinalis* Royle	44.44
	Cichorium intybus L.	12.50		*Chenopodium album* L.	24.44
Antipyretic	*Cichorium intybus* L.	30.00	Narcotic	*Cannabis sativa* L.	29.51
	Teucrium stocksianum Boiss	24.14	Nutritive	*Papaver somniferum* L.	10.26
	Fumaria indica (Haussk) pugsl	22.22	Obesity	*Teucrium stocksianum* Boiss	6.90
	Seriphidium kurramensis Qazilb.	18.67	Purgative	*Rosa moschata* L.	60.00
Antiseptic	*Ephedra intermedia* Wall.ex.stapf	100.00		*Nannorrhops ritchiana* H. Wendl.	47.37
	Berberis lycium Royle	26.67	Renal pain	*Xanthium strumarium* L.	100.00
Aphrodisiac	*Chenopodium album* L.	35.56		*Polygonum plebejum* L.	63.64
	Cannabis sativa L.	14.75		*Berberis lycium* Royle	5.00
	Foeniculum vulgare Mill	7.25	Rheumatism	*Caralluma tuberculata* N. E. Brown	14.29
Asthma	*Calotropis procera* (wild) R.Br	9.62	Sedative	*Datura stramonium* L.	35.90
Bleeding control	*Verbascum thapsus* L.	70.59		*Cannabis sativa* L.	22.95
Blood cancer	*Artemisia scoparia* L.	44.44	Skin allergy	*Adiantum capillus veneris*	100.00
Blood pressure	*Allium sativum* L.	80.00		*Daphne mucronata* Royle	100.00
	Olea ferruginea (Wall. Ex G. Don) Cif.	35.29		*Melia azedarach* L.	68.75
Blood purifier	*Olea ferruginea* (Wall. Ex G. Don) Cif.	64.71		*Rumex dentatus* L.	26.32
	Fumaria indica (Haussk) pugsl	62.96		*Fumaria indica* (Haussk) pugsl	14.81
	Cichorium intybus L.	57.50		*Artemisia absinthium* Waldst & Kitam	12.68
	Teucrium stocksianum Boiss	51.72		*Mentha piperita* (L) Huds	10.81
	Artemisia absinthium Waldst&Kitam	26.76	Snake bite	*Datura stramonium* L.	58.97
	Foeniculum vulgare Mill	15.94	Stimulant	*Malva parviflora* L.	20.00
Cardio-tonic	*Celtis australis* L.	100.00	Stomach acidity	*Plantago lanceolata* L.	17.14
Carminative	*Mentha piperita* (L.) Huds	89.19	Stomach pain	*Oxalis corniculata* L.	50.00
Chest pain	*Berberis lycium* Royle	68.33		*Foeniculum vulgare* Mill	43.48
	Mentha viridis L.	37.50		*Solanum nigrum* L.	33.33
	Rosa moschata L.	20.00		*Plantago lanceolata* L.	25.71
Colic	*Mentha viridis* L.	16.07		*Caralluma tuberculata* N. E. Brown	20.41
	Thymus linearis Benth	6.25	Stomachic	*Cotoneaster horizontalis* Dcne	100.00
Constipation	*Withania coagulans* (Stocks) Dunal in DC.	89.74		*Avena sativa* L.	61.29
	Malva parviflora L.	51.11		*Portulaca oleracea* L.	44.83
	Rumex dentatus L.	10.53		*Mentha viridis* L.	35.71
Cough	*Viola canescens* Wall	100.00		*Withania coagulans* (Stocks) Dunal in DC.	10.26
	Papaver somniferum L.	56.41		*Thymus linearis* Benth	6.25
	Thymus linearis Benth	56.25	Strengthen hairs	*Melia azedarach* L.	31.25
	Morus nigra L.	37.04	Strengthen urinary wall	*Chenopodium album* L.	15.56
	Calotropis procera (wild) R.Br	25.00	Tonic	*Avena sativa* L.	38.71
	Rosa moschata L.	20.00		*Polygonum plebejum* L.	36.36
	Punica granatum L.	18.18		*Plantago lanceolata* L.	11.43
	Mentha viridis L.	10.71	Weight loss	*Peganum harmala* L.	100.00
Diarrhea	*Equisetum arvensis* L.	100.00	Wound healing	*Plantago major* L.	81.25
	Punica granatum L.	81.82		*Rumex dentatus* L.	63.16
	Plantago lanceolata L.	45.71		*Calotropis procera* (wild) R.Br	57.69
Dysentery	*Plantago major* L.	18.75			

Ethnomedicinal relevance

The medicinal importance of plants included in the present study has been documented from other parts of Pakistan or the world. In some research report a single species has been found with multiple medicinal uses indicating that some of the reported plants in the present article are

preferred for their medicinal value in other cultures around the globe. A decoction of the aerial parts of *A. capillus-veneris* is used for treatment of asthma and dyspnea. *Malva parviflora* root and flowers have been used for stomach ulcers. *Peganum harmala* fruit powder and decoction is used for toothache, gynecological infections and menstruation disorders (Mosaddegh et al., 2012). The dried leaves and inflorescence paste of *A. absinthium* is used to cure stomach pain and intestinal worms. Paste prepared from fresh fruit of *Berberis lycium* is used to heal wounds (Malik et al., 2011)and against diabetes (Jouad et al., 2001). Bulb of *A. satvium* is used against rheumatism while its seed vessel mixed with hot milk is useful for the prevention of tuberculosis and high blood pressure. Bark and fruit bark of *P. granatum* are used in a herbal mixture prepared for intestinal problems (Tumpa et al., 2014). *Avena sativa* decoction is used for skin diseases including eczema, wounds, irritation, inflammation, erythema, burns, itching and sunburn (Zari and Zari, 2015). *F. vulgare* and *Lepidium sativum* are used for treatment of diabetes and renal diseases (Jouad et al., 2001). *Viola canescens* flower is used as a purgative (Shinwari and Khan, 2000). *Verbascum thapsus* leaves and flower can be used to reduce mucous formation and stimulate the coughing up of phlegm. Externally, *V. thapsus*is used as a good emollient and wound healer. Leaves of *Thymus linearis* are effective against whooping cough, asthma and round worms as well as an antiseptic agent (M. Ullah et al., 2013). *Berberis lycium* decoction of wood with sugar is the best treatment for jaundice. *Chenopodium album* has anthelmintic, diuretic, and laxative properties and its roots decoction is effective against jaundice. *Fumaria indica* whole plant decoction is used for blood purification. *Oxalis corniculata* roots are anthelmintic and powder of *Chenopodium album* is used for headache and seminal weakness (Devi et al., 2013). *Cichorium intybus* boiled leaves are used as stomachic and laxative while boiled leaves of *Plantago major* is used against gastralgia (Dogan and Ugulu, 2013). The above ethnomedicinal information confirms the therapeutic importance of the reported plants.

Pharmacological relevance

The reported plant species have been investigated by researchers for their biological activities and were found to be beneficial or of therapeutic importance. The aqueous extract of *A. sativum* has been studied for its lipid-lowering ability and was found to be effective at 200 mg/kg body weight. It also has significant antioxidant effect and normalizes the activities of superoxide dismutase, catalase, glutathione peroxidase and glutathione reductase in the liver (Shrivastava et al., 2012). The extract of *A. absinthium* showed antinociception in mice and this effect was linked to its effects on cholinergic, serotonergic, dopaminergic, and opioidergic systems (Zeraati et al., 2014). The hepatoprotective activity of crude extract of aerial parts of *Artemisia scoparia* was investigated against carbon tetrachloride (CCl_4)-produced hepatic damage. The data showed that crude extract of *A. scoparia* has hepatoprotective activities (Zeraati et al., 2014). Ethanolic and aqueous extracts of Asparagus exhibited strong hypolipidemic and hepatoprotective actions when administered at a daily dose of 200 mg/kg for 8 weeks to hyperlipidemic mice (Zhu et al., 2010). The anti-tumor potential of the root extracts of *Calotropis procera* prepared in methanol, hexane, water and ethyl acetate, were found to inhibit proliferation of HEp2 cells (Zhu et al., 2010). Cannabidiol from *C. sativa* was found as an anxiolytic, antipsychotic and schizophrenic agent (Zuardi et al, 2006). The aqueous and methanol crude extract of *Celtis australis*, traditionally used in Indian medicine, was screened for its antibacterial activity against *S. aureus* and *P. aeruginosa*(Ahmad et al, 2012). The two new aromatic esters Horizontoate A and B

and a one new sphingolipid C were isolated from *Cotoneaster horizontalis*. Compounds Horizontoate A and Horizontoate B showed significant inhibitory effects on acetylcholinesterase (AChE) and butylcholinesterase (BChE) activities in a dose-dependent manner, while sphingolipid C was inactive. The IC_{50} values of compounds Horizontoate A and B were 1.54 and 3.41 mM, respectively against AChE and 5.97 and 6.84 mM, respectively against BChE(S. Khan et al., 2014). The alkaloids found in *D. stramonium* are organic esters clinically used as anticholinergic agents (Soni et al, 2012). The anti-inflammatory potential of *Malva sylvestris* was also tested in mice following administration of an oral dose of 100 mg/kg of the aqueous extract. The extract reduced inflammation by 60% in both the acute and chronic inflammation models (Gasparetto et al, 2012). The study evaluated antifungal activity of *Nannorrhops ritchiana* against fungal strains; *Aspergillus flavus*, *Trichophyton longifusis*, *Trichophyton mentagrophytes*, and *Microsporum canis* by agar tube dilution method and found these fungi susceptible to the extracts with inhibition percentage of 70-80%(Rashid et al, 2014). The inhibitory effects of *Olea ferruginea* crude leaves extract on bacterial and fungal pathogens has been investigated (Amin et al., 2013). The ethyl acetate extract of *Teucrium stocksianum* possesses hypoglycemic effect in alloxanized rabbits which confirms its traditional use against diabetes. The antifungal activity of *Viola canescens* acetone, ethanol, petroleum ether and water extract on the development of *Fusarium oxysporum* f. sp. *Lycopersici* which was carried out using paper disc diffusion assay. The highest antifungal activity (17.62 mm inhibition zone) was observed in case of 1000 mg/ml acetone extract of *Viola canescens*. The other solvents were moderately effective. The highest MIC (100 mg/ml)was found for ethanol and petroleum ether solvents (Rawal et al, 2015). Methanolic extract of *X. strumarium* leaf was evaluated for antibacterial activities against eight pathogenic bacteria. The extract of *X. strumarium* (50 and 100 mg/ml) showed inhibition of (Rajashekar et al, 2011).

In the current research work, for the first time, we documented the ethnopharmacological knowledge from lower Kurram, Kurram agency, Pakistan. The use of medicinal plants is observable in lower Kurram where the locals use plants for 50 medicinal purposes. A few of the plants reported from this area was not documented in ethnobotanical literature. The remedies preparation was mostly formulated using a single species instead of a mixture. The historical use of the reported plants can be confirmed by scientific evidence and their efficacy and efficiency can be evaluated by further pharmacological research. The documented traditional knowledge can provide evidence for development of novel, safer and more affordable drugs.

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Conflicts of interest

The authors declare that they have no conflict of interest.

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