

ETHNO-MEDICINAL PLANTS AND TRADITIONAL KNOWLEDGE LINKED TO PRIMARY HEALTH CARE AMONG THE INDIGENOUS COMMUNITIES LIVING IN WESTERN HILLY SLOPES OF DERA GHAZI KHAN, PAKISTAN

SHAFIQ AHMAD¹, MUHAMMAD ZAFAR¹, SHEHLA SHINWARI², MUSHTAQ AHMAD^{1*}, ZABTA KHAN SHINWARI³, SHAZIA SULTANA¹ AND MARYAM AKRAM BUTT¹

¹Department of Plant Sciences, Quaid-i-Azam University Islamabad-45320, Pakistan

²Department of Biological Sciences, Karakoram International University, Gilgit-Baltistan

³Department of Biotechnology, Quaid-i-Azam University Islamabad-45320, Pakistan

*Corresponding author's email: mushtaqflora@hotmail.com

Abstract

Medicinal plants are the rich source of bioactive compounds so that's why number of human ailments is treated by plant based medications. The main objective of this study is to document the local knowledge of medicinal plants used by indigenous communities living in western hilly Slopes of Dera Ghazi Khan, Pakistan with special emphasis on health issues facing by the local people of this area. Ethnobotanical data were recorded from 127 local informants. This data was collected through the use of questionnaires and personal interviews during field trips. Data collected in field was then analyzed by using different quantitative indices. Different quantitative indices were fidelity level (FL), use value (UV) and informant consensus factor (ICF). In this study 75 plants belonging to 78 families are reported for treating different human ailments with the highest number of species being used for Digestive disorders followed by respiratory diseases. Herbs (52 species) were found to be the most used plants. This study allows identifying many high value medicinal plant species of this region, indicating high potential for economic development through sustainable collection of these medicinal plants and these plants should be evaluated for further phytochemical screening and biological activities for future drug discovery and development.

Key words: Medicinal plants, Dera Ghazi Khan, Hilly areas, Herbal medicines.

Introduction

Medicinal plants have been used widely and their usage has been acknowledged for healing potential in several parts of the world (Ahmad *et al.*, 2014; Balunas & Kinghorn, 2005; Shinwari *et al.*, 2006; Nadembega *et al.*, 2011). Medicinal plants are vital for most ailment remedy, because a number of human ailments are cured by plant based medications (Hamayun, 2005; Rehecho *et al.*, 2011; Shinwari & Qaisar, 2011; Yaseen *et al.*, 2015). World Health Organization (WHO) reports that approximately 4 billion people in emerging countries not only rely on in the remedial properties of plant species but also exploit them consistently (Kadir *et al.*, 2012; Rai *et al.*, 2000). According to an assessment 35,000–70,000 plant species are used in traditional medicine worldwide (Bonet *et al.*, 1999; Kayani *et al.*, 2015; Rossato *et al.*, 1999). These plant species have been gathered from wild since primeval times (Balick & Cox, 1997; Mahmood *et al.*, 2011; Wondimu *et al.*, 2007) and used by ethnic groups in various parts of the world (Matu & Van Staden, 2003; Habiba *et al.*, 2016). Pakistan has rich diversity of Medicinal Plants (MPs), due to its peculiar climatic conditions (Bano *et al.*, 2014; Shinwari *et al.*, 2012).

Therapeutic plants occupy discrete status right from the primeval past to present at world level. In emerging nations they offer a tangible substitute for basic well-being of the locals, while in many under developed indigenous communities, traditional remedies are still acknowledged as the principle health care system (Kayani *et al.*, 2015; Manandhar, 1994; Saqib *et al.*, 2011; Tabuti *et al.*, 2003) due to their efficacy, lack of contemporary medicinal substitutes (Camejo-Rodrigues *et al.*, 2003). In recent years, usage of traditional

knowledge (TK) concerning medicinal plant practices and exploration has added significant contemplation among the scientific groups (Heinrich *et al.*, 2006; Kayani *et al.*, 2014). Several ethno-medicinal and pharmacological studies have been conducted on the usage and preference of wild medicinal plants as herbal remedies by various ethnic groups around the globe (Bibi *et al.*, 2014b; Jamila & Mostafa, 2014; Jeruto *et al.*, 2008; Kargioğlu *et al.*, 2010; Walter *et al.*, 2011). But these studies cover only a half percent of medicinal plants which have been studied thoroughly for their chemical composition and medicinal importance (Balick & Cox, 1996; Kargioğlu *et al.*, 2010). These inclinations leads to carry out ethno-medicinal appraisals and ethno-pharmacological investigations (Butt *et al.*, 2015; Heinrich, 2000; Leonti, 2011; Shaheen *et al.*, 2012) and are indispensable in management of various disorders (Mukherjee *et al.*, 2008; Khan & Shinwari, 2016).

Few studies have been carried out previously on Dera Ghazi Khan by (Gulshan *et al.*, 2012) on the medicinal plant usage by local people. (Ahmad *et al.*, 2013) conducted ethnobotanical studies on eastern plains of Takht e Suleiman range of DG Khan but no work has been done on quantitative approaches of medicinal plants in District Dera Ghazi Khan.

The present study aims to document the traditional uses of medicinal plants used by the indigenous communities living in hilly areas of District Dera Ghazi Khan, Pakistan. In specific, the main objective of this research is to analyze the collected data using quantitative ethno-botanical indices such as Use value (UV), Informant Consensus Factor (ICF), and Fidelity Level (FL). Also it provides the identification of most preferred medicinal plants of this region.

Material and Methods

Study site and informant selection: This study was carried out in almost all hilly areas of district DG Khan Punjab, Pakistan. It occupies total area of 11,922 km², lies between 29° 34' to 31-20° North latitudes and 69° 53' to 70-54° East longitudes. Altitudes vary approximately from 122-213 m as moving from plain to hilly areas. Most of the areas are flat alluvium of river Indus and extends over the hills on the western side. The soil of the area is plain terrain of alluvial soil consisting sand, silt and clay. The area is considered as the arid zone of Pakistan due to climatic conditions. Annual rainfall is very low approx. 102mm-270mm and the temperature is very high during summers (Gulshan *et al.*, 2012).

This research was conducted during the period of 10 months from February 2017 to November 2017. All the plants collected were not in their flowering condition due to climatic condition. In total we were able to collect plants from 11 localities (Mainly Fort Munro, Sakhi Sarwar, Shadun Lound, Bharthi, Gulki and Vehva) that were included in these hilly areas. A total of 127 informants (72 males and 55 females) were selected among villagers depending on their knowledge about traditional uses of medicinal plants. Informants were selected using random and purposive sampling methods of (Martin, 1995). 70 informants were sampled during random visits in the area while the remaining 57 informants were recommended by local people including religious leaders. All the informants selected in this study were based on the quality of knowledge given by the informant during interviewing.

Ethnobotanical data collection sources: The knowledge about medicinal plants was gathered through both primary and secondary sources. Primary source was semi-structured interviews during field visit and secondary source was comparing this data with previously published literature on this area. Some information was also collected about the study sites from different office persons of District DG Khan. This study followed recent ethno-pharmacological field studies standards of (Heinrich *et al.*, 2006; Martin, 2010; Weckerle *et al.*, 2018) and the international code of ethics applied in ethnobotanical studies (Teklehaymanot & Giday, 2007).

Semi-structured Interviews: Questionnaire was constructed and given to 73 informants as they were educated while the remaining 54 informants were interviewed orally in their homes, religious places and in field. Group discussions were also the part of this study. All the interviews were carried out in Saraiki and Balochi languages as these were the languages of local communities of study area.

Taxonomic validation and preservation: Medicinal plants collected from the area were dried pressed, poisoned and mounted on herbarium sheets. Botanical names, families of these plants were validated using The Plant List (TPL). Accession numbers were given to herbarium specimens and then submitted to The Herbarium of Pakistan (ISL) at Quaid-I-Azam University Islamabad, Pakistan.

Ethnobotanical data analysis: All the ethnobotanical data collected were further analyzed by using different ethnobotanical indices. For better interpretation of the results of our ethnobotanical investigation, we use these following specific quantitative techniques.

Fidelity level: Fidelity level shows the preference of one species over the others for treating particular disease disorder (Ahmad *et al.*, 2009). By using FL we easily determine the most ideal species used for the treatment of particular disease. FL is calculated by using formula given by (Ugulu, 2012; Yaseen *et al.*, 2019).

$$FL = I_p / I_u \times 100$$

Here I_p stands for the number of informants that uses a plant species for a particular ailment and I_u stands for the total number of informants who reported the same plant for any disease.

Use value (UV): The comparative significance of the plant species reported by the informants was calculated by using the formula given by (Ahmad *et al.*, 2014; Phillips & Gentry, 1993).

$$UV = U/n$$

where 'U' represents the number of reports by the informants for a particular plant and 'n' is the total number of individuals interviewed for a given plant.

Informants consensus factor (ICF): This statistical index is used to find out the homogeneity of the information. All references were placed into disease classes that each plant was claimed to affect. Informant consensus factor is calculated by the formula (Giday *et al.*, 2007; Logan, 1986).

$$ICF = NUR - N_t / NUR - 1$$

where NUR is the number of use citations in each category and N_t is the number of species taken as medicine.

Results and Discussion

Demographics of participants: Demographic data of informants are mentioned in (Table 1). 127 informants were interviewed during this study that included both males and females. Male members were dominant with 72 while females were 52. During field visits it was common observation that some people did not share their knowledge because they believed that sharing the traditional knowledge about medicinal plants would lose their potency. Also some people kept their knowledge secret because they share this precious knowledge on payment outside their family circle. In the present study it was observed that most of the informants were males because in tribal areas there were some restrictions on females to interact with strangers so that's why the number of female informants was limited. According to their educational experiences mostly informants having traditional knowledge were illiterate (54 reports) which showed that most of the people of hilly areas rely on medicinal plants for the health care management.

Table 1. Demographic data of participants.

Category	Total
Gender	
Male	72
Female	55
Age group	
20-35	83
35-90	44
Education	
Illiterate	54
Primary	38
Middle	22
Secondary	13

Herbal remedies and diversity of plants: After identification of collected plant species we documented 74 wild medicinally important species using 170 herbal remedies for curing 84 illnesses for 15 categories of diseases. In this study total 39 families of plants was reported among which family Fabaceae was the most dominant family with 9 species (Fig. 1). Along with Fabaceae the Asteraceae and Brassicaceae represented with 7 and 5 species each. Members of family Fabaceae were also utilized by the people all over Pakistan (Bibi *et al.*, 2014a; Abbas *et al.*, 2019). Families with highest number of species contain diversity of chemical properties from which different potential remedies can be derived (Waterman & Mole, 1994). Families along with their species used for herbal preparations are mentioned in Table 2.

In terms of life form, the most dominant life form reported in this study were herbs (52 reports) followed by shrubs (15 reports) and trees (11 reports) (Fig. 2). Results of this study resembles with previously published literature on different areas of Pakistan Sindh (Yaseen *et al.*, 2018), Kurram Agency (Hussain *et al.*, 2018), Sangina (Hassan *et al.*, 2017), Hafizabad (Umair *et al.*, 2017), Alpine and sub alpine areas (Kayani *et al.*, 2015). Dominancy of herbs in making herbal remedies is due to its ubiquitous growth and easy collections of herbs as compared to trees and shrubs. Besides this, herbs can be manipulated with easiness in herbal preparation methods and extraction of bioactive compounds (Shrestha *et al.*, 2016). Similar findings have been reported in neighboring countries Nepal (Shrestha *et al.*, 2014), India (Rathore *et al.*, 2015).

In present study the most used part of plant are leaves (26 reports), followed by seeds, whole plant (16 reports) and roots (12 reports) (Fig. 3). Leaves are dominantly used in making herbal preparations due to the presence of active phytochemical constituents. Leaves are preferably used by the local people because leaves are easily removed as compared to whole plant and roots that also damage the growth of plants which leads to the decline in population of medicinal plants (Giday, 2018; Pyakurel *et al.*, 2017).

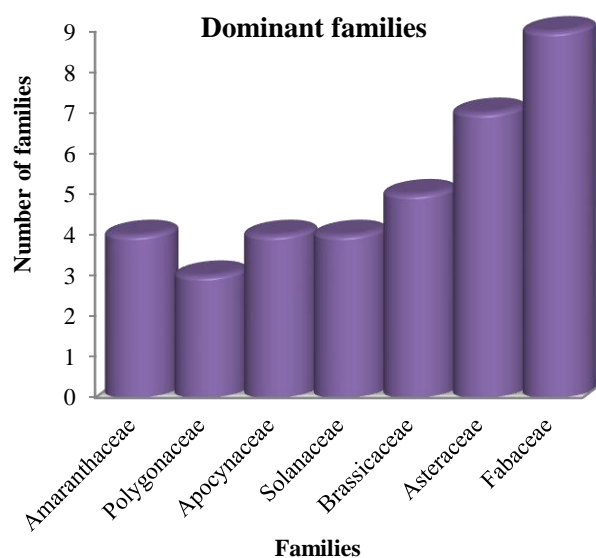


Fig. 1. Dominant families of the study area.

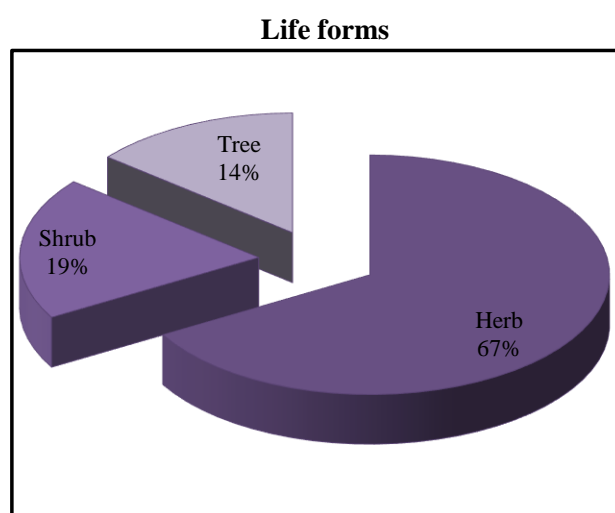


Fig. 2. Life forms of medicinal plants in study area.

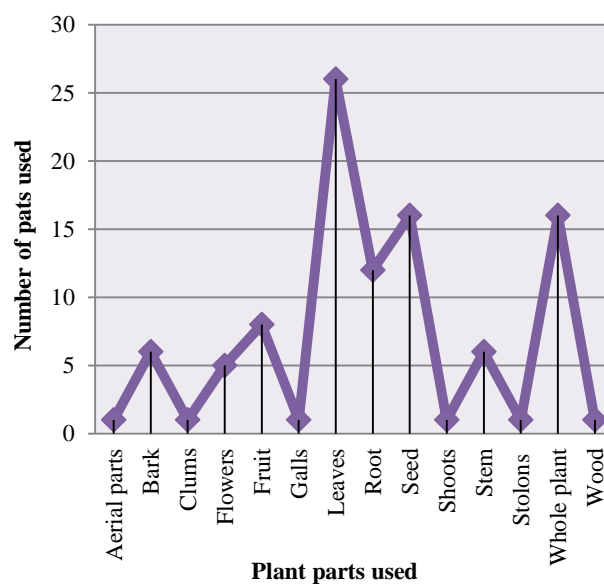


Fig. 3. Plant part used in treatment of various diseases in study area.

Table 2. Medicinal uses of plants used by indigenous communities living in western hilly Slopes of Dera Ghazi Khan, Pakistan.

Families	Botanical name	Flowering Period	Local names	Life form	Parts used	Mode of administration	Recipes	UR*	UV*	FL*
Amaranthaceae	<i>Aerva javanica</i> (Burm.f) Juss. ex Schult.	January-October	Bui	Multi-stemmed herb	Whole plant	Powder	The flower is consumed against stomach problems and stem is applied for ear pain	2	0.06	56.25
	<i>Atriplex stocksii</i> Boiss.	August-September	Lanra	Herb	Leaves, Stem	Decoction	Fresh leaves are boiled in water and the extracted juice is used as blood purifier and in bites. It is also used in fever, jaundice and liver diseases	5	0.45	63.64
	<i>Salsola imbricata</i> Forssk.	July-September	Lanra	Herb	Whole plant	Powder	Dry plants are used in making "Khar" which is used in washing clothes. The "Khar" is also helpful in discharge of fetus	1	0.13	87.50
	<i>Leptadenia pyrotechnica</i> (Forsk.) Decne.	January, November, December	Khip	Shrub	Whole plant	Infusion	The plant is macerated in water and the macerate is taken as a diuretic to treat urine-retention	1	0.07	85.71
Apocynaceae	<i>Nerium oleander</i> L.	June-August	Kaner	Shrub	Leaves	Decoction	A decoction of the leaves has been applied externally in the treatment of scabies , and to reduce swellings	2	0.09	52.17
	<i>Rhazya stricta</i> Decne	December-March	Sinwar	Herb	Leaves	Extract	Extract of leaves is used for the treatment of diabetes, sore throat, helminthiasis, inflammatory conditions and rheumatism	5	0.11	46.67
Arecaceae	<i>Caralluma tuberculata</i> N.E.Br.	August-September	Chiunga, Jungli karaila	A succulent herb	Whole plant	Raw	Chunks of this plant are used to decrease hunger and help to reduce obesity. It is also cooked as vegetable in diabetic patients and to reduce joint pain	3	0.14	66.67
	<i>Nannorrhops ritchieana</i> (Griff.) Aitch.		Peesh, Mazari palm	Shrub like	Leaves	Infusion	Leaves infusion is used in the treatment of diarrhea and dysentery	2	0.07	66.67
	<i>Carthamus oxyacantha</i> M.Bieb.	February-April	Kundairi	Herb	Flowers, Seeds	Decoction, Oil	Decoction of flowers is given to children for anthelmintic . Seed oil is also helpful for ulcer patients.	2	0.11	57.89
	<i>Echinops echinatus</i> Roxb.	February-April	Uthkunda	Herb	Root	Powder	Powder of root is used as antilice	1	0.05	77.27
	<i>Erigeron canadensis</i> L.	May- August	Paleet	Herb	Flowers	Powder	The crushed flowers are inserted into the nostrils to cause sneezing, relieving rhinitis	2	0.12	70.59
Asteraceae	<i>Pulicaria glutinosa</i> (Boiss.) Jaub. & Spach	February-April		Herb	Root	Powder	Root powder is taken with water to cure infertility issues in males	1	0.10	70.00
	<i>Synphyotrichum graminifolium</i> (Spreng.) G.L. Nesom	March- July		Herb	Leaves	Decoction	Reduce fevers and will aid digestion when it is taken internally	2	0.08	70.83
	<i>Taraxacum officinale</i> sp. agr. F. H. Wigg. G.E.	February-April	Kheeri booti	Herb	Aerial parts	Decoction	Decoction of aerial parts of the plant is used for curing asthma	1	0.09	90.91
Berberidaceae	<i>Tricholepis glaberrima</i> DC.	February-April	Burmdundi	Herb	Roots	Decoction	Roots are boiled to make decoction and this decoction is taken 3 times a day to treat aphrodisiac problem	1	0.17	83.33
	<i>Berberis calliobotrys</i> Bien. ex Koehne	February-May		Shrub	Fruit, bark	Paste, powder	Fruits of this plant are boiled and are given to patient suffering from fever. Bark powder is mixed with black pepper and Desi ghee a paste is prepared which is applied for Backache	2	0.09	73.91

Table 2. (Cont'd.).

Families	Botanical name	Flowering Period	Local names	Life form	Parts used	Mode of administration	Recipes	UR*	UV*	FL*
Bignoniaceae	<i>Tecomella undulata</i> (Sm.) Seem	February-March	Desert teak	Small tree	Stem, Leaves, Flowers	Paste	The paste of fresh leaves is applied on head in relieving headache . The decoction of bark is used in constipation and gastric pain. Fresh flowers are used in tea which is used by sterile woman	4	0.10	56.41
Boraginaceae	<i>Heliotropium crispum</i> Desf.		Gundi booti	Herb	Leaves	Poultice	Laxative, diuretic, and as a treatment for snake bites and stings of nettles	4	0.19	47.62
	<i>Heliotropium europaeum</i> L.	July-October	Gundi booti	Herb	Leaves, Stem	Juice	The juice of fresh leaves is laxative and diuretic . It is also used for the treatment of sore eyes, boils, sores, wounds, ulcer and snakebite	8	0.15	20.75
	<i>Goldbachia laevigata</i> (M.Bieb) DC.	March- May		Herb	Leaves	Powder, Decoction	Powder of leaves is used in chest infection and cough	2	0.07	70.37
Brassicaceae	<i>Lepidium didymum</i> L.	July-September	Gajar booti	Herb	Whole plant	Decoction	A decoction of the whole plant is drunk to treat headache and fevers	2	0.11	68.42
	<i>Malcolmia africana</i> (L.) R.Br.	June- August	Junglee surme	Herb	Whole plant	Infusion, Oral	Infusion of whole plant is used in hypertension , cardiac pains	2	0.09	68.18
	<i>Sisymbrium irio</i> L.			Herb	Leaves	Infusion	Infusion of the leaves is used for throat and chest infections	2	0.06	59.38
Cactaceae	<i>Opuntia dillenii</i> (Ker Gawl) Haw.		Cactus	Herb	Leaves	Juice	Juice extracted from leaves is used for mental strength	1	0.08	75.00
Capparaceae	<i>Capparis decidua</i> (Forssk.) Edgew.	March- April	Dailha, Kareenh	A dense bushy shrub or Small tree	Fruits, Bark, Leaves, Wood	Raw	Fruits are sweet in taste and eaten by local people. Bark has laxative and anthelmintic properties	2	0.08	73.08
Cleomaceae	<i>Cleome brachycarpa</i> (Forssk.) Vahl ex DC.		Sirji like	Herb	Leaves, Flowers	Paste	Young shoots with leaves are grinded and mixed with mustard oil and the paste is applied on arms and legs in relieving fever . Vegetative parts are aromatic and insect repellent	1	0.05	85.71
	<i>Cleome viscosa</i> L.		Wild mustard	Herb	Seeds	Raw	Seeds of this plant are given to cure diarrhea and fever. Juices extracted from the leaves are used in healing wound	3	0.06	46.81
Convolvulaceae	<i>Convolvulus prostratus</i> Forssk.	January-April	Khauri booti	Herb	Roots, Stem	Decoction	Roots of this plant are used in chronic fever . Stem decoction is used in jaundice	2	0.07	57.14
Cucurbitaceae	<i>Citrullus colocynthis</i> (L.) Schrad.	May-August	Burambba	A vine like herb	Fruits, Seeds, Roots	Juice, Raw	Fruit pulp and juice is traditionally used in treating yellow fever and jaundice . Fruits are highly purgative and used in cattle for gastrointestinal disorders. The dried fruit powder is also mixed with honey and used against constipation. Careless use of fruits and seeds may also be fatal	4	0.07	38.89

Table 2. (Cont'd.).

Families	Botanical name	Flowering Period	Local names	Life form	Parts used	Mode of administration	Recipes	UR*	UV*	FL*
Euphorbiaceae	<i>Chrozophora tinctoria</i> (L.) A. Juss.	February-April	Neel booti	Herb	Leaves	Extract	The extract of leaves is used to heal wounds	1	0.08	91.67
	<i>Euphorbia hirta</i> L.	July-October	Dudhi	Herb	Stem, Leaves	Sap, Poultice	The stem sap is used in the treatment of eyelid styes and a leaf poultice is used on swelling and boils	3	0.06	44.90
	<i>Acacia nilotica</i> (L.) Delile	Feb-May	Kiker	Tree	Roots	Powder	The roots powder of this plant is used against cancers and tumors . Roots may also help in curing Tuberculosis	3	0.08	52.50
	<i>Argyrolobium roseum</i> (Cambess.) Jaub. & Spach	February-April	Pahaari Loosin	A small prostrate herb	Whole plant	Juice	Fresh plants are powdered then add one glass of water in this powder and filter this solution. Take 1 glass daily to treat liver disorders	1	0.06	88.24
Fabaceae	<i>Astragalus rhizanthus</i> Benth.	February-May	Peeli Jundi	A small shrub	Roots	Decoction	Decoction of roots is used to treat common cold . Infusion is used to treat kidney disorders.	2	0.09	59.09
	<i>Astragalus stocksii</i> Bunge	February-May	Jundi	A small shrub	Leaves	Powder	Leaves powder is mixed with <i>Ligustrum lucidum</i> and used to treat liver and breast cancer	2	0.11	57.89
	<i>Medicago monantha</i> (L.) Mill	February-May	Jungli loosin	Herb	Whole plant	Juice	Juice extracted from whole plant is used as aphrodisiac	1	0.08	83.33
	<i>Rhynchosia minima</i> (L.) DC.	July-September	Jumby bean	Herb	Seeds	Raw	Seeds are eaten raw to treat hemorrhoids	1	0.11	77.78
	<i>Senna occidentalis</i> (L.) Link	Throughout the year	Pan war	Herb	Seeds	Tea	Seeds are roast, brew and serve as tea to treat Diuretic, hemorrhoids, gout, laxative, rheumatism , diabetes	6	0.14	47.73
	<i>Sophora mollis</i> (Royle) Bakr	February-April		Shrub	Seeds	Powder	Powder obtained from the seeds are used in destroying vermin	1	0.17	83.33
	<i>Acacia jacquemontii</i> Benth	July-September	Kunda	Tree	Bark	Paste	The dried bark is converted in form of paste with water. The paste is applied on cut by snake bite . Young stems are also used as Miswaak (Teeth cleaner)	2	0.13	56.25
	<i>Isodon rugosus</i> (Wall. ex Benth.) Codd		Mujosar	Shrub	Leaves	Juice	Juice of Leaves are used for blood pressure, body temperature, rheumatism and toothache	4	0.19	57.14
	<i>Abutilon indicum</i> (L.) Sweet	March- June	Geedar war	A small shrub	Whole plant	Decoction	Taken as oral soup. It is also used to treat fever due to common cold, bronchitis	3	0.14	71.43
	<i>Corchorus depressus</i> (L.) Stocks	February-April	Baiphall booti	Prostrate herb	Whole plant	Juice	Whole plant is crushed in water along with poppy seeds, rose water and almond used as cooling agents during summer	1	0.10	90.00
Malvaceae	<i>Malva parviflora</i> L.	April- November	Malook booti	Herb	Whole plant	Poultice	The whole plant is emollient and pectoral. It can be used as a poultice on swellings , running sores and boils. The seeds are demulcent	6	0.12	60.78
	<i>Prosopis cineraria</i> (L.) Druce	Jan-May	Kunda	Tree	Bark	Decoction	The bark of the tree is dry, acrid and bitter with a sharp taste; cooling anthelmintic tonic also cures leprosy, dysentery, bronchitis, asthma, leukoderma, hemorrhoids and muscle tremors	8	0.16	53.06

Table 2. (Cont'd.).

Families	Botanical name	Flowering Period	Local names	Life form	Parts used	Mode of administration	Recipes	UR*	UV*	FL*
Moraceae	<i>Prosopis juliflora</i> (Sw.) DC.	March-May	Muskeet	Tree	Seeds	Powder	Syrup made from powder of pods is used to increase lactation	1	0.09	81.82
	<i>Ficus palmata</i> Forssk.	February-August	Hanjeer, Phagwara	Tree	Fruit	Raw	Fruit is used in diseases of lungs and urinary bladder disorders	2	0.06	69.70
	<i>Morus macroura</i> Miq.	February-April	Shatoot	Small tree	Root	Juice	Juice of the bark is used in healing of cuts and wounds	2	0.09	68.18
Nitriaceae	<i>Peganum harmala</i> L.	April-September	Hurmul	Herb	Seeds	Powder	Seeds of the plant is used in treating skin cancer	1	0.02	88.64
Oleaceae	<i>Olea europaea</i> subsp. <i>Cuspidate</i> (Wall. & G.Don) Cif.		Kaoo	Tree	Leaves	Decoction	Fresh leaves is boiled strained and given to patients suffering from oral disorders	1	0.04	76.00
Oxalidaceae	<i>Oxalis corniculata</i> L.	Throughout the year	Khatkal	Herb	Whole plant	Juice	Fresh leaves are chewed to relieve toothache. Juice of fresh leaves is used to treat eye ailments such as cataract . Leaves are also chewed as mouth freshener	3	0.12	53.85
Plantaginaceae	<i>Plantago amplexicaulis</i> Cav.	February-May	Isobgol	Herb	Seeds	Raw	Dried seeds are used in the treatment of intestinal complaints and as a demulcent in cases of dysentery	2	0.07	44.44
	<i>Plantago ciliata</i> Desf.	February-April	Isobgol	Herb	Seeds	Husk	Seeds husk swells up in the gut, acting as a bulk laxative and soothing irritated membranes	2	0.04	58.33
	<i>Plantago lanceolata</i> L.	February-May	Isobgol	Herb	Leaves	Juice	Juice of leaves is taken to cure stomach complaints	1	0.07	80.00
Poaceae	<i>Cymbopogon jawarancusa</i> (Jones) Schult			Herb	Whole plant	Paste	Whole plant paste is applied on skin to cure skin disorders	1	0.20	80.00
	<i>Panicum turgidum</i> Forssk.	February-August	Cheena	Herb	Clums	Powder	Old culms, dried and powdered, are used as a wound-dressing	1	0.06	94.12
	<i>Emex spinosa</i> (L.) Campd.	January-March	Chulai khardar	Herb	Leaves	Decoction	Purgative and diuretic. The boiled leaves are used by locals for the cure of dyspepsia and biliousness, and to stimulate appetite	5	0.11	39.13
Polygonaceae	<i>Polygonum plebeium</i> R.Br.	February-March	Common knotweed	Prostrate herb	Seeds	Powder	The crushed seeds are cooked and eaten as a remedy for bowel complaints	1	0.06	82.35
Resedaceae	<i>Rumex vesicarius</i> L.	February-May	Khatti booti	Herb	Root	Paste	The root is used as an astringent in the treatment of cutaneous disorders	1	0.08	83.33
	<i>Oligomeris linifolia</i> (Vahl ex Hornem.) J.F.Macbar.	February-April	Choti Mazardum	Herb	Seeds		Seeds are soaked in water and put some sugar in it. It is used to cure back pain, abnormal menstrual cycle	2	0.10	61.90
	<i>Ziziphus nummularia</i> (Burm.f.) Wight.&Am	July-September	Jhar ber	Shrub	Leaves, Bark	Decoction	The leaves are antipyretic and reduce obesity, Bark is used as remedy in diarrhea and cures boils	4	0.10	70.73
Rosaceae	<i>Cotoneaster microphyllous</i> Wall. Ex lindle	April-August		Shrub	Stolons	Raw	Stolons are used as astringent	1	0.13	87.50

Table 2. (Cont'd.).

Families	Botanical name	Flowering Period	Local names	Life form	Parts used	Mode of administration	Recipes	UR*	UV*	FL*
Salvadoraceae	<i>Salvadora oleoides</i> Decne.	March-April	Jaal, Pitu	Evergreen tree or shrub	Whole plant	Raw	Fruits are edible and have a digestive role. They are also used in removing kidney and gall bladder stones . The leaves after heating, bound in the form of poultice on areas affected by rheumatism. The root bark is highly effective in toothache and gum inflammation. Short cuttings of roots and young shoots are used as a Miswaak	7	0.15	65.96
Scrophulariaceae	<i>Verbascum thapsus</i> L.	May-August	Giddar Tamakhoon	Perennial herb	Leaves	Poultice	The leaves are warmed, tightly tied on the joints to relieve pain and also used for softening boils	2	0.08	57.69
Simaroubaceae	<i>Ailanthus altissima</i> (Mill.) Swingle	February-April	Tree of heaven	A deciduous tree	Root, Stem bark	Decoction	Decoction made from root and stem bark are take on daily basis to treat kidney stones	1	0.03	82.76
	<i>Datura innoxia</i> Mill.	July-September	Dhatura	An annual shrub	Leaves, Flowers, Fruits	Extract, Raw	Extract of whole leaves and fresh fruits is antiseptic, narcotic, sedative and is useful in asthma . Leaves are dried and then smoked in a pipe or handmade cigarette to treat asthma	4	0.14	41.38
Solanaceae	<i>Solanum virginianum</i> ?	July-August	Kandairee	Herb	Fruits	Raw	Used against indigestion, diarrhea, stomachache	3	0.07	68.29
	<i>Withania coagulans</i> (Stocks) Dunal	July-September	Paneer	Herb	Whole plant	Decoction	Decoction of dried fruits is used in digestive and liver complaints. Leaves and root extract is also used as blood purifier	3	0.11	88.89
	<i>Withania somnifera</i> (L.) Dunal	June-September	Asgand	Herb	Roots	Powder	Roots are ground and mixed with honey to prepare a tonic for hair growth	1	0.08	48.65
Tamaricaceae	<i>Tamarix aphylla</i> (L.) H.Karst.	July-September	Toola	Tree	Galls	Powder	The galls are astringent; it is used for treating eczema and other skin diseases	3	0.06	66.67
Thymelaeaceae	<i>Daphne mucronata</i> Royle	February-May		Shrub	Roots, leaves, fruit	Powder, Poultice	Root and leaves powder is taken along with water to cure cutaneous infections . Poultice of fruit is used for rheumatism	2	0.11	61.11
Violaceae	<i>Viola stocksii</i> Boiss.	February-April	Makham booti	Herb	Seeds	Decoction	Seeds of this plant is boiled in water to make decoction and taken twice a day to cure respiratory disorders	1	0.08	84.62
Zygophyllaceae	<i>Fagonia indica</i> Burm.f.	April-June	Damanhan	Herb	Whole plant	Decoction, Paste	The plant is acrid and bitter and has cooling properties. Decoction of leaves is used in asthma , fever, thirst, vomiting and in dysentery. Paste of leaves is applied on tumors and swellings of neck. The plant is also used as fodder for camels and goats	7	0.14	41.18
	<i>Tribulus terrestris</i> L.	July-September	Bakhra	Herb	Leaves, Fruits, Seeds	Decoction, Powder	Decoction of mature seeds is locally used to remove kidney obstruction and to ease urination. Powdered form of fruits is used to enhance the sexual desire in males . The plant is also used as fodder	3	0.18	64.71

UR = Use reports, UV* = Use value, FL* = Fidelity level

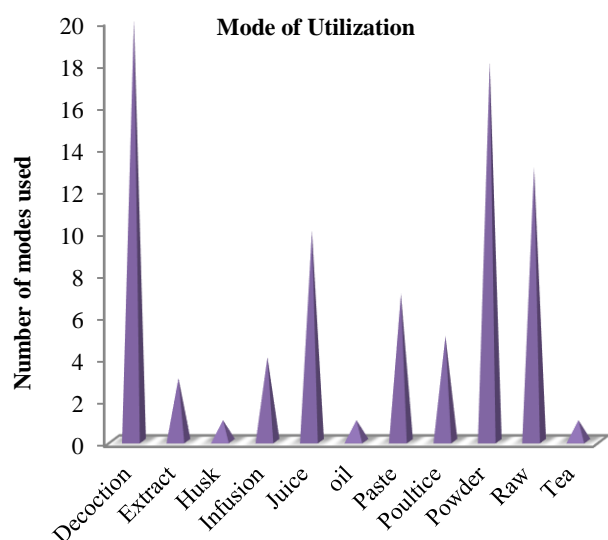


Fig. 4. Mode of utilization of medicinal plants.

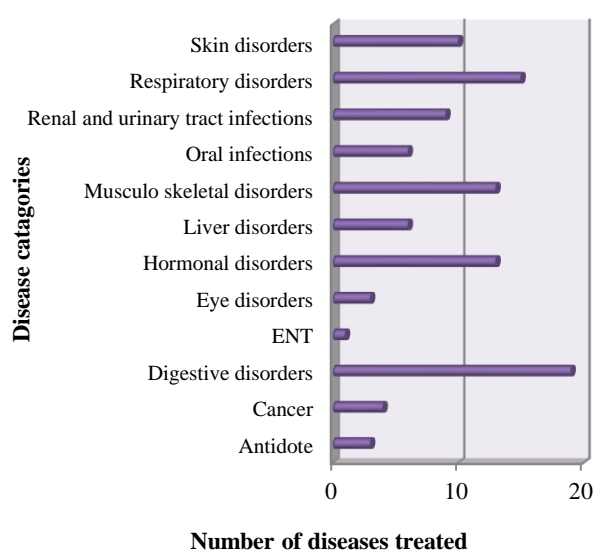


Fig. 5. Disease categories in the study area.

In this study a total of 83 mode of utilization were reported out of which decoction was the most common with (20 reports), followed by powder (18 reports), raw plant (13 reports) and juice (10 reports) (Fig. 4). The use of decoction was common because of its quick effectiveness against illness. Also boiling of any part of plant biological reactions are accelerated resulting in the extraction of many useful compounds (Huai & Zhang, 2006; Pei *et al.*, 2009). In some areas people also prefer utilization of plants in powder form due to deficiency of water and extreme climate (Albuquerque *et al.*, 2005; Qureshi & Bhatti, 2008).

Quantitative data analyses

Informants consensus factor (ICF): Medicinal plants that were used to treat different human ailments were analyzed quantitatively by developing 16 categories of diseases (Fig. 5). In present study ICF ranged from 0.1-0.8. The highest value of ICF was found in Digestive disorders (0.8) followed by respiratory disorders and musculoskeletal disorders with (0.75) (Table 3). The

result of ICF indicated the most prevalent disease in the study area was digestive disorders. This disease was common because the people of the area were malnourished, and they were not aware of balanced diet. Poor hygiene and contaminated water also causes digestive disorders (Bibi *et al.*, 2014b; Kayani *et al.*, 2015). Second highest number of disease in this area was respiratory disorders. This disease is common due to inhalation of dust particles and pollen. Also temperature changes affect the respiratory system of most of the people (Ahmad *et al.*, 2013; Gulshan *et al.*, 2012). The highest value of ICF indicates that the people rely on medicinal plants to treat their common health problems. The most used plant for curing digestive disorder was seeds of *Plantago ciliata* (48) which were mostly taken either in raw form or mixed with milk. For treating respiratory disorders *Fagonia indica* (51) was most used plant among the locals.

Fidelity level (FL) and use value (UV): Fidelity level of plant species treated different human ailments ranging from 20-94%. The highest percentage of fidelity level was shown by *Panicum turgidum* (94%). The highest fidelity level shows that this is an important plant and should be further evaluated through pharmaceutical, phytochemical and biological activities. Besides this, plants having low Fidelity percentage should not be ignored as dwindling to remark them to the future generation that it could increase the risk of gradual disappearance of the knowledge (Bhattarai *et al.*, 2006; Nawaz *et al.*, 2009).

Use value determines the importance of species having more use reports specified by local people. In this study UV ranges from 0.2 to 0.45 (Table 2). It has been observed that species having more uses reported by the people usually have high use value and plants with low use reports have low use value. Highest use value was found for *Atriplex stocksii* (0.45). Highest use value indicates that the plant species are more likely biologically active (Heinrich *et al.*, 1998). Thus having high Use value of plant species indicates the potential for healing for specific disease.

Conclusions

This study provides comprehensive documentation of medicinal plants used by the local communities of hilly areas of District DG Khan Punjab, Pakistan. Results of present study showed a variety of plant species used in making various herbal remedies which plays vital role in the primary healthcare of the local people in the hilly areas of District DG Khan Punjab, Pakistan. Total 75 plant species were used in making different medicinal recipes to cure 15 disease categories cited by 127 total numbers of informants. Highest cited plants include *Citrullus colocynthis*, *Fagonia indica*, *Plantago ciliata* and *Salvadora oleoides* indicating the common use of plants among locals and also the presence of active biological compounds in these species. The most common disease category was Digestive disorder, was most common life form herb and leaves were the most used plant part. The most frequent mode of preparation was decoction. Plants having noticeable Fidelity percentage and Use value are precious to these areas. So these plants should be evaluated for further phytochemical screening and biological activities for future drug discovery and development.

Table 3. Disease categories, symptoms and informant consensus factors of medicinal plants.

Categories	Symptoms	Nur	Nt	ICF	Important plant of this category	Number of citations of this plant
Respiratory disorders	Bronchitis, Sore throat, tuberculosis, common cold, cough, Asthma, Throat infections	9	15	0.75	<i>Fagonia indica</i>	51
Digestive disorders	Diarrhea, constipation, vomiting, dysentery, biliousness, dyspepsia, stomachache, heartburn, ulcer, intestinal disorders	11	19	0.80	<i>Plantago ciliata</i>	48
ENT	Ear pain, rhinitis, ear ache	8	9	0.14	<i>Erigeron canadensis</i>	17
Cancer	Tumors, breast cancer, skin cancer, liver cancer	4	6	0.67	<i>Astragalus stocksii</i>	19
Renal and Urinary tract infections	Kidney stone, kidney failure, urinary bladder stones	3	4	0.50	<i>Salvadora oleoides</i>	47
Liver disorders	Jaundice, yellow fever, gall bladder stones	7	8	0.17	<i>Citrullus colocynthis</i>	54
Musculoskeletal disorders	Backache, joint pain, rheumatism, gout	9	15	0.75	<i>Berberis calliobotrys</i>	23
Hormonal disorders	Diabetes, dysuria,	9	13	0.50	<i>Caralluma tuberculata</i>	21
Skin disorders	Cutaneous infections, boils, scabies, leprosy, leukoderma, hair loss, eczema, insect repellent, antilice	8	10	0.29	<i>Peganum harmala</i>	44
Eye disorders	Eyelid styes, eye sores, cataract	3	4	0.50	<i>Oxalis corniculata</i>	26
Oral infections	Toothache, oral thrush, gum inflammation	6	8	0.40	<i>Olea europaea ssp. cuspidata</i>	25
Antidote	Snake bite, scorpion bite	3	4	0.50	<i>Heliotropium crispum</i>	21
Male genital diseases	Loss of libido, impotence	5	7	0.50	<i>Tribulus terrestris</i>	17
Female genital diseases	Galactagogue, fertility enhancer, dysmenorrhea, fetal discharge,	4	5	0.33	<i>Oligomeris linifolia</i>	21
Cardiovascular disorders	Hypertension, blood purifier, cardiac pains, hemorrhoids	4	6	0.67	<i>Malcolmia africana</i>	22

Acknowledgements

The authors are extremely appreciative to indigenous communities of Dera Ghazi Khan, Pakistan for their ethno medicinal knowledge and their kind support and co-operation during the field surveys.

References

- Abbas, Z., J. Alam, S.M. Khan, M. Hussain and A.M. Abbasi. 2019. Diversity, ecological feature and conservation of a high montane flora of the Shigar valley (Karakorum range) Baltistan region, Northern Pakistan. *Pak. J. Bot.*, 51(3), 985-1000.
- Ahmad, K., M. Ahmad and C. Weckerle. 2013. Ethnobotanical studies of the eastern plains of Takht-e-Sulaiman hills. *Pak. J. Bot.*, 45(Special Issue): 197-205.
- Ahmad, M., R. Qureshi, M. Arshad, M.A. Khan and M. Zafar. 2009. Traditional herbal remedies used for the treatment of diabetes from district Attock (Pakistan). *Pak. J. Bot.*, 41(6): 2777-2782.
- Ahmad, M., S. Sultana, S. Fazl-i-Hadi, T. Ben Hadda, S. Rashid, M. Zafar, M.A. Khan, M.P.Z. Khan and G. Yaseen. 2014. An Ethnobotanical study of Medicinal Plants in high mountainous region of Chail valley (District Swat-Pakistan). *J. Ethnobiol. & Ethnomed.*, 10: 36.
- Albuquerque, U.P.d., L.D.H.C. Andrade and A.C.O.D. Silva. 2005. Use of plant resources in a seasonal dry forest (Northeastern Brazil). *Acta Botânica Brasileira*, 19(1): 27-38.
- Balick, M. and P.A. Cox. 1997. Ethnobotanical research and traditional health care in developing countries. *Med. Plants for Forest Conser. & Health Care*, 92: 12-23.
- Balick, M.J. and P.A. Cox. 1996. Plants, people, and culture: the science of ethnobotany. *Scientific American Library*, New York, USA pp.10-228.
- Balunas, M.J and A.D. Kinghorn. 2005. Drug discovery from medicinal plants. *Life Sci.*, 78(5): 431-441.
- Bano, A., M. Ahmad, T.B. Hadda, A. Saboor, S. Sultana, M. Zafar, M.P.Z. Khan, M. Arshad and M.A. Ashraf. 2014. Quantitative ethnomedicinal study of plants used in the skardu valley at high altitude of Karakoram-Himalayan range, Pakistan. *J. Ethnobiol. & Ethnomed.*, 10: 43.
- Bhattarai, S., R.P Chaudhary and R.S. Taylor. 2006. Ethnomedicinal plants used by the people of Manang district, central Nepal. *J. Ethnobiol. & Ethnomed.*, 2: 41.
- Bibi, S., J. Sultana, H. Sultana and R.N. Malik. 2014a. Ethnobotanical uses of medicinal plants in the highlands of Soan Valley, Salt Range, Pakistan. *J. Ethnopharmacol.*, 155(1): 352-361.
- Bibi, T., M. Ahmad, R.B. Tareen, N.M. Tareen, R. Jabeen, S.U. Rehman, S. Sultana, M. Zafar and G. Yaseen. 2014b. Ethnobotany of medicinal plants in district Mastung of Balochistan province-Pakistan. *J. Ethnopharmacol.*, 157(18): 79-89.
- Bonet, M.À., M. Parada, A. Selga, and J. Valles. 1999. Studies on pharmaceutical ethnobotany in the regions of L'Alt Emporda and Les Guilleries (Catalonia, Iberian Peninsula). *J. Ethnopharmacol.*, 68(1-3): 145-168.
- Butt, M.A., M. Ahmad, A. Fatima, S. Sultana, M. Zafar, G. Yaseen, M.A. Ashraf, Z.K. Shinwari and S. Kayani. 2015. Ethnomedicinal uses of plants for the treatment of snake and scorpion bite in Northern Pakistan. *J. Ethnopharmacol.*, 168: 164-181.

- Camejo-Rodrigues, J., L. Ascensao, M.À. Bonet and J. Valles. 2003. An ethnobotanical study of medicinal and aromatic plants in the Natural Park of "Serra de São Mamede"(Portugal). *J. Ethnopharmacol.*, 89(2-3): 199-209.
- Giday, M. 2018. Traditional knowledge of people on plants used as insect repellents and insecticides in Raya-Azebo district, Tigray region of Ethiopia. *Ind. J. Trad. Know.*, 17(2): 336-343.
- Giday, M., T. Teklehaymanot, A. Animut and Y. Mekonnen. 2007. Medicinal plants of the Shinasha, Agew-awi and Amhara peoples in northwest Ethiopia. *J. Ethnopharmacol.*, 110(3): 516-525.
- Gulshan, A.B., A.A. Dasti, S. Hussain, M.I. Atta and M. Amin-ud-Din. 2012. Indigenous uses of medicinal plants in rural areas of Dera Ghazi Khan, Punjab, Pakistan. *J. Agri. & Biol. Sci.*, 7(9): 750-762.
- Habiba, U., M. Ahmad, S. Shinwari, S. Sultana, Z.K. Shinwari and M. Zafar. 2016. Antibacterial and antifungal potential of Himalayan medicinal plants for wound infections. *Pak. J. Bot.*, 48(1): 371 375.
- Hamayun, M. 2005. Ethnobotany of Some Useful Trees of Hindu-Kush Mountain Region: A Case Study of Swat Kohistan, District Swat, Pakistan. *Ethnobot. Leaflets*, 2005(1).
- Hassan, N., D. Wang, M. Shuaib, Z. Zhong, M. Nisar, W. Ahmad, S. Ahmed and A. Khan. 2017. Identification and ethnobotanical survey of profitable medicinal plants used as remedy in Sangina Pakistan. *Int. J. Herbal Med.*, 5(4): 117-123.
- Heinrich, M. 2000. Ethnobotany and its role in drug development. *Phytotherapy Research: An. Int. J. Devoted to Pharmacol. & Toxicol. Eval. of Natural Prod. Derivat.*, 14(7): 479-488.
- Heinrich, M., A. Ankli, B. Frei, C. Weimann and O. Sticher. 1998. Medicinal plants in Mexico: Healers' consensus and cultural importance. *Soc. Sci. & Med.*, 47(11): 1859-1871.
- Heinrich, M., J. Kufer, M. Leonti and M. Pardo-de-Santayana. 2006. Ethnobotany and ethnopharmacology-Interdisciplinary links with the historical sciences. *J. Ethnopharmacol.*, 107(2): 157-160.
- Huai, H. and X. Zhang. 2006. Ethnobotany of exotic weeds in China. *Ethnobot.*, 18(1/2): 96-101.
- Hussain, W., M. Ullah, G. Dastagir and L. Badshah. 2018. Quantitative ethnobotanical appraisal of medicinal plants used by inhabitants of lower Kurram, Kurram agency, Pakistan. *Avicenna J. Phytomed.*, 1-11.
- Jamila, F. and E. Mostafa. 2014. Ethnobotanical survey of medicinal plants used by people in Oriental Morocco to manage various ailments. *J. Ethnopharmacol.*, 154(1): 76-87.
- Jeruto, P., C. Lukhoba, G. Ouma, D. Otieno and C. Mutai. 2008. An ethnobotanical study of medicinal plants used by the Nandi people in Kenya. *J. Ethnopharmacol.*, 116 (2): 370-376.
- Kadir, M.F., M.S.B. Sayeed, T. Shams and M.M.K. Mia. 2012. Ethnobotanical survey of medicinal plants used by Bangladeshi traditional health practitioners in the management of diabetes mellitus. *J. Ethnopharmacol.*, 144(3): 605-611.
- Kargioğlu, M., S. Cenkeci, A. Serteser, M. Konuk and G. Vural. 2010. Traditional uses of wild plants in the middle Aegean region of Turkey. *Human Ecol.*, 38(3): 429-450.
- Kayani, S., M. Ahmad, M. Zafar, S. Sultana, M.P.Z. Khan, M.A. Ashraf, J. Hussain and G. Yaseen. 2014. Ethnobotanical uses of medicinal plants for respiratory disorders among the inhabitants of Gallies-Abbottabad, Northern Pakistan. *J. Ethnopharmacol.*, 156: 47-60.
- Kayani, S., M. Ahmad, S. Sultana, Z.K. Shinwari, M. Zafar, G. Yaseen, M. Hussain and T. Bibi. 2015. Ethnobotany of medicinal plants among the communities of Alpine and Sub-alpine regions of Pakistan. *J. Ethnopharmacol.*, 164: 186-202.
- Khan, M.Q. and Z.K. Shinwari. 2016. The ethnomedicinal profile of family Rosaceae, a study on Pakistani plants. *Pak. J. Bot.*, 48(2): 613 620.
- Leonti, M. 2011. The future is written: Impact of scripts on the cognition, selection, knowledge and transmission of medicinal plant use and its implications for ethnobotany and ethnopharmacology. *J. Ethnopharmacol.*, 134(3): 542-555.
- Logan, M.H. 1986. Informant consensus: a new approach for identifying potentially effective medicinal plants. *Plants in Indigenous Medicine and Diet: Biobehavioral Approaches*, 91-112.
- Mahmood A., R. N. Malik, Z. K. Shinwari and A. Mahmood. 2011. Ethnobotanical Survey of Plants from Neelum, Azad Jammu & Kashmir, Pakistan. *Pak. J. Bot.*, 43 (Special Issue): 105-110
- Manandhar, N.P. 1994. An ethnobotanical survey of herbal drugs of Kaski district, Nepal. *Fitoterapia*, 65: 7-13.
- Martin, G. 1995. Ethnobotany: A methods manual. A people and plants conservation manual. WWF International. UNESCO and Royal Botanic Gardens, Kew. Chapman and Hall, London.
- Martin, G.J. 2010. Ethnobotany: a methods manual. Routledge. Earthscan, UK and USA
- Matu, E.N. and J. Van Staden. 2003. Antibacterial and anti-inflammatory activities of some plants used for medicinal purposes in Kenya. *J. Ethnopharmacol.*, 87(1): 35-41.
- Mukherjee, P.K., V. Kumar, N.S. Kumar and M. Heinrich. 2008. The Ayurvedic medicine *Clitoria ternatea*-from traditional use to scientific assessment. *J. Ethnopharmacol.*, 120(3): 291-301.
- Nadembega, P., J.I. Boussim, J.B. Nikiema, F. Poli and F. Antognoni. 2011. Medicinal plants in Baskoure, Kourittenga province, Burkina Faso: an ethnobotanical study. *J. Ethnopharmacol.*, 133(2): 378-395.
- Nawaz, A.M., M. Hossain, M. Karim, M. Khan, R. Jahan and M. Rahmatullah. 2009. An ethnobotanical survey of Rajshahi district in Rajshahi division, Bangladesh. *Amer. Eur. J. Sustain. Agri.*, 3: 143-150.
- Pei, S., G. Zhang and H. Huai. 2009. Application of traditional knowledge in forest management: Ethnobotanical indicators of sustainable forest use. *For. Ecol. & Manag.*, 257(10): 2017-2021.
- Phillips, O., A.H. Gentry. 1993. The useful plants of Tambopata, Peru: II. Additional hypothesis testing in quantitative ethnobotany. *Econ. Bot.*, 47(1): 33-43.
- Pyakurel, D., I.B. Sharma and S.K. Ghimire. 2017. Trade and conservation of medicinal and aromatic plants in western Nepal. *Botanica Orientalis: J. Plant Sci.*, 11: 27-37.
- Qureshi, R. and G.R. Bhatti. 2008. Ethnobotany of plants used by the Thari people of Nara Desert, Pakistan. *Fitoterapia*. 79(6): 468-473.
- Rai, L.K., P. Prasad and E. Sharma. 2000. Conservation threats to some important medicinal plants of the Sikkim Himalaya. *Biol. Conser.*, 93(1): 27-33.
- Rathore, S., J.K. Tiwari and Z.A. Malik. 2015. Ethnomedicinal survey of herbaceous flora traditionally used in health care practices by inhabitants of Dhundsir Gad watershed of Garhwal Himalaya, India. *Glo. J. Res. Medi. Plants & Indig. Med.*, 4(4): 65-78.
- Rehecho, S., I. Uriarte-Pueyo, J. Calvo, L.A. Vivas and M.I. Calvo. 2011. Ethnopharmacological survey of medicinal plants in Nor-Yauyos, a part of the Landscape Reserve Nor-Yauyos-Cochas, Peru. *J. Ethnopharmacol.*, 133(1): 75-85.
- Rossato, S.C., H.F. De Leitã O-Filho and A. Begossi. 1999. Ethnobotany of caícaras of the Atlantic Forest coast (Brazil). *Econ. Bot.*, 53(4): 387-395.

- Saqib Z., R. N. Malik, M. I. Shinwari and Z. K. Shinwari. 2011. Species Richness, Ethnobotanical Species Richness and Human Settlements along a Himalayan Altitudinal Gradient: Prioritizing Plant Conservation in Palas Valley, Pakistan. *Pak. J. Bot.*, 43 (Special Issue): 129-133
- Shaheen H., & Z. K. Shinwari. 2012. Phyto diversity and Endemic richness of Karambar Lake Vegetation from Chitral, Hindukush- Himalayas. *Pak. J. Bot.*, 44(1): 17-21
- Shinwari, Z. K., M. Rehman, T. Watanabe, and Y. Yoshikawa. 2006. Medicinal and Aromatic Plants of Pakistan (A Pictorial Guide). Pp. 492 Kohat University of Science and Technology, Kohat, Pakistan. ISBN: 969-8870-00
- Shinwari, Z.K. & M. Qaisar. 2011. Efforts on Conservation and Sustainable Use of Medicinal Plants of Pakistan. *Pak. J. Bot.*, 43 (Special Issue): 5-10
- Shinwari, ZK; S.A. Gilani and A.L. Khan. 2012. Biodiversity Loss, Emerging Infectious Diseases and Impact on Human and Crops. *Pak. J. Bot.*, 44 (SI): 137-142
- Shrestha, N., D. Prasai, K.K. Shrestha, S. Shrestha and X.C. Zhang. 2014. Ethnomedicinal practices in the highlands of central Nepal: A case study of Syaphru and Langtang village in Rasuwa district. *J. Ethnopharmacol.*, 155(2): 1204-1213.
- Shrestha, N., S. Shrestha, L. Koju, K.K. Shrestha and Z. Wang. 2016. Medicinal plant diversity and traditional healing practices in eastern Nepal. *J. Ethnopharmacol.*, 192: 292-301.
- Tabuti, J.R.S., S.S. Dhillion and K.A. Lye. 2003. Traditional medicine in Bulamogi county, hayma Uganda: its practitioners, users and viability. *J. Ethnopharmacol.*, 85(1): 119-129.
- Teklenot, T. and M. Giday. 2007. Ethnobotanical study of medicinal plants used by people in Zegie Peninsula, Northwestern Ethiopia. *J. Ethnobiol. & Ethnomed.*, 3(1): 12.
- Ugulu, I. 2012. Fidelity level and knowledge of medicinal plants used to make therapeutic Turkish baths. *Studies on Ethno-Med.*, 6(1): 1-9.
- Umair, M., M. Altaf and A.M. Abbasi. 2017. An ethnobotanical survey of indigenous medicinal plants in Hafizabad district, Punjab-Pakistan. *PLoS One.*, 12(6): 22.
- Walter C., Z. K. Shinwari, I. Afzal and R. N. Malik 2011. Antibacterial Activity in Herbal Products Used in Pakistan. *Pak. J. Bot.*, 43 (Special Issue): 155-162
- Waterman, P.G. and S. Mole. 1994. Analysis of phenolic plant metabolites. *Blackwell Scientific Publications*. London Edinburgh Boston
- Weckerle, C.S., H.J. de Boer, R.K. Puri, T. van Andel, R.W. Bussmann and M. Leonti. 2018. Recommended standards for conducting and reporting ethnopharmacological field studies. *J. Ethnopharmacol.*, 210: 125-132.
- Wondimu, T., Z. Asfaw and E. Kelbessa. 2007. Ethnobotanical study of medicinal plants around 'Dheeraa'town, Arsi Zone, Ethiopia. *J. Ethnopharmacol.*, 112(1): 152-161.
- Yaseen, G., M. Ahmad, D. Potter, M. Zafar, S. Sultana and S. Mir. 2018. Ethnobotany of Medicinal Plants for Livelihood and Community Health in Deserts of Sindh-Pakistan. *Plant & Human Health.*, 1: 767-792.
- Yaseen, G., M. Ahmad, S. Shinwari, D. Potter, M. Zafar, G. Zhang, Z.K. Shinwari and S. Sultana. 2019. Medicinal plant diversity used for livelihood of public health in deserts and arid regions of Sindh-Pakistan. *Pak. J. Bot.*, 51(2), pp.657-679.
- Yaseen, G., M. Ahmad, S. Sultana, A.S. Alharrasi, J. Hussain and M. Zafar. 2015. Ethnobotany of medicinal plants in the Thar Desert (Sindh) of Pakistan. *J. Ethnopharmacol.*, 163: 43-59.

(Received for publication 8 August 2018)