

# Quantitative ethnomedicinal study of indigenous medicinal plants used for digestive disorders of Laspur Valley, Chitral, Northern Pakistan

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# Research

# Abstract

*Background:* The present study was the first one of its own kind conducted in the study area. Throughout the world digestive system diseases and their related symptoms are widely prevalent. People of Chitral still heavily rely upon therapeutic plants to cure digestive disorders.

*Aim of the study:* The present study was conducted in order to document the traditional uses of medicinal plants for the cure of digestive disorders in Laspur Valley of Chitral.

*Methods:* Ethnomedicinal data was obtained from 200 inhabitants of the area through face to face interviews and semi-structured questionnaires. To analyze data quantitatively, Use-Value (UV), Familiarity-Index (FI), Family Importance Value (FIV), Consensus-Index (CI), and Informant Consensus Factor indices (ICF) were applied.

*Results:* A total of 44 medicinal plants were documented. The recurring life forms were herbs (75%), shrubs (15.91%) and trees (6.82%). The most frequently utilized part was the leaves (43.18%). To prepare medicine leaves were used unprocessed in fresh/dried form, as powder, and decoction, and were usually taken orally. The FI value was led by *Coriandrum sativum* (0.285). The family Apiaceae had the maximum FIV value (46.5). The value of "CI" was highest for *Coriandrum sativum*. ICF values for Dysentery, Vomiting and Intestinal Disorders (1.0) presented the maximum consensus factor.

*Conclusion:* The practice of using therapeutic plants to cure digestive disorders by medicinal plants is still prevalent in the study area.

*Key words:* Quantitative ethnomedicinal; indigenous medicinal plants; digestive disorders; Laspur valley; Northern Pakistan

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#### لنډيز

پس منظر: اوسنی مطالعه د خپل ډول لومړۍ برخه ده چې د مطالعې په ساحه کې ترسره کیږي. په ټوله نړی کې د هاضمي سیستم سیسټمونه او د هغې اړوند نښی په پراخه کچه شتون لري. د چترال خلک لا اوس هم د معالجوي نباتاتو پرضد تکیه کوي تر څو د هاضمي نارو غیو درملنه وکړي. د مطالعي مقصد: اوسنۍ مطالعه د دې لپاره ترسره شوه چې د چترال د لاسپر ویلو په سیمه کې د هضم د اختالطونو درملني لپاره د درملو دودیز کارول مستند کړي.

ميتودونه: د ماين پاکی ډاټا د سيمې د خلکو څخه د مخامخ مرکو او نيم ساختماني پوښتنليکونو له الرې تر السه شوې. د محاسبې د معلوماتو تحليل لپاره، د ارزښت ارزښت، د پيژندنې لست، د کورنۍ اهميت ارزښت، د موافقت ليست، او د معلوماتو غير رسمي مرکوونکي شاخصونه تطبيق شوې.

پايلي: په ټوليزه توګه 44 درمل شوي نباتات ثبت شوي. د ژوند بيا ځلي بڼه د بوټو (75٪)، بوټو (15.91٪) او ونې (6.82٪) وې. تر ټولو ډير استعمال شوي برخه پاڼي (43.18٪) وې. د درملو چمتو کولو لپاره د نويو وچو وچو شويو فارمونو لکه پاؤډر، او کڅوړي په شان غير پروسس شوي کارول شوي، او عموما په شفاهي توګه اخيستل شوي. د پېژندګلوي ليست ارزښت د کورينډرم سايټيم (0.285) لخوا مشري شوی. د کورنۍ Apiaceae تر ټولو لوړه FIV ارزښت درلود (46.5). د "Cl" ارزښت د کوينډرموم سايټيم لپاره خورا لوړ و. د ډيسريري، کنډک او معدني ناروغيو لپاره د ICF ارزښتونه (1.0 1.0) د ډيری موافقت عنصر وړاندې کوي.

# Background

For basic healthcare, almost 80% of the human population depends upon therapeutic plants (WHO, 2002; Sarma *et al.* 2012). Plant based remedies are also popular in the West, because they are assumed to have negligible or no negative effects if directed appropriately (Jordan *et al.* 2010). Other than therapeutic use, plants are progressively utilized as a part of beauty care products and nutraceuticals (Rokaya *et al.* 2014).

Natural remedies were found to be often a viable option to treat an extensive variety of illnesses (Rokaya et al. 2014), including digestive ailments (Heinrich et al. 1992; Manandhar, 2002; Rokaya et al. 2014; Street and Prinsloo, 2013). Individuals living in the mountainous regions of Pakistan utilize plants for numerous reasons, for example, as medicines, protection, timber, firewood, kindling, sustenance and feed, housing, etc. (Hussain et al. 1996). Throughout the world Digestive diseases and their related symptoms are very widespread. Nearly 8-10% of the population is affected even in the developed world. The primary reasons are poverty, changes in dietary patterns, and water pollution, among others (Mc Michael 2006; Molares and Ladio, 2009).

The utilization of therapeutic plants for disorders of digestive system is common. Strikingly, a characteristic of these plants is their specific odor or flavor: they are typically bitter, fragrant, and also astringent. These organoleptic qualities originate from secondary metabolites, for example, terpenoids and their derivates (Molares and Ladio, 2009), and tannins or other chemical components (Heinrich *et al.* 1992).

These qualities can be precious memory aids with regards to the cultural transference of this ethnomedicinal data (Molares and Ladio, 2009). Information on plant use is normally transmitted orally, including in Pakistan (Haq, 1983; Khan and Zaidi, 1991; Haq and Hussain, 1993; Hussain *et al.* 1996; Shinwari and Khan, 2000; Gilani *et al.* 2001; Ahmad *et al.* 2009; Qureshi *et al.* 2009; Abbasi *et al.* 2013; Rahman *et al.* 2016). People of Chitral still heavily rely upon therapeutic plants for majority of their illnesses, thus a loss of these plant assets would hamper the current healthcare system in the area. Actions for the protection especially of therapeutic plants of Chitral valley are critically required (Ali and Qaiser, 2009). Because verbally conveyed information is held especially by the older generation, a large portion of it can vanish easily with their passing (Kim et al. 2006; Kim and Song, 2008). The present research aimed at recording the ethnomedicinal practices of therapeutic plants to cure Digestive Disorders (DD) in Laspur Valley, and to assess the use of plant species in light of the literature review. In particular, we tried to answer the following questions: (i) which plant species are used for DDs in Laspur Valley (ii) what DDs are cured with the maximum amount of therapeutic species? (iii) are certain families of plants more or less utilized than anticipated in DDs? and (iv) what types of illnesses are ordinarily cured with the help of which parts of plant, plant species, families and administration modes?

### Materials and Methods

#### Introduction to the study area

Laspur valley is one of the most beautiful valleys of Chitral. It is located to the north-east of Chitral town, at a distance of 125 km. The total length of the valley is around 104 km, 57 km of which are above the village of Laspur, representing an uncultivated tract. According to the census 2017 the population is approximately 9500 people distributed in 1450 houses and the literacy rate is more than 65%. Laspur valley lies in between latitude 36°1'56.3" N, 72°32'26.8" E (Fig. 1). The elevation of Laspur valley is around 2400m. Temperature hardly exceeds the limit of 30°C and the Minimum temperature is -8°C. Laspur borders with Gilgit in the north, Mastuj in the south, and high snowy mountains separate it from Swat in the west. Laspur valley harbors six main villages namely Balim, Sor-Laspur, Harchin, Broke, Raman and Gasht. The most beautiful and attractive village among them is Balim. Shandur, the highest polo ground of the world, is only 6 km away, in the meadow area of Laspur, a flat piece of land situated 3725m above sea level. There are 5 colleges, 18 private and 16 government middle and high schools in Laspur valley (www.chitraltoday.net).

#### Literature review

Different online data bases (ISI Web of Science, MEDLINE, Science Direct, Scopus, and Google Scholar) were searched using the terms "therapeutic plants", "medicinal plants", "gastrointestinal", "digestive disorders", "diarrhea", "dysentery", "stomach" and "Chitral, Pakistan" before beginning the field work. The term "Chitral, Pakistan" was employed to constrain the topographical extent of the search. The exactness of species names given in this work depend upon that from the original bases. But, we confirmed presently recognized name(s) in online classification sources (<u>http://www.theplantlist.org</u>) and (<u>http://www.tropicos.org/project/Pakistan</u>). Available vernacular names were also recorded. Habitat and origin (wild/developed) of each plant species was documented (Baral and Kurmi, 2006; Rokaya *et al.* 2014).

To get phytochemical or pharmacological data about respective therapeutic plants species we also used the above stated databases.



Fig. 1. Map of the study area (www.mapcarta.com)

#### Collection of ethnomedicinal data

The ethnomedicinal field survey was completed in 2014-2015 to record the data about therapeutic plants utilized by the local population. Data was gathered through semi-structured interviews (Akerreta et al. 2007). All interviews were conducted after receiving prior informed consent from the participants. Two hundred and eight (200) participants 136 men including 8 herbalists (68%) and 64 (32%) women were interviewed. This random sample was 2.105% of the population of the studied community. They were asked about information on plants utilized against Digestive Disorders (DDs), folk names, plant parts utilized and the preparation mode. All the informants and expert herbalists were chosen randomly, and no appointments were scheduled before the visits.

#### Plant sampling and identification

Specimens of plants were collected and identified through standard taxonomic techniques and scientific names were confirmed online through (http://www.tropicos.org/extend/Pakistan and "The Plant List" (<u>http://www.theplantlist.org/</u>). The specimens were submitted to the Herbarium of Department of Botany, Islamia College Peshawar, Pakistan.

#### Data analysis

#### Quantitative analysis of data

The ethnomedicinal data gathered was analyzed statistically. The species were assembled into classes of diseases in view of emic data gathered from informants. The aim was to document all the data as it was given by the informants to us. A quantitative investigation was completed with the specific goal to assess the significance of those species in the culture of the elderly individuals of the area. This sort of investigation, the first of its kind in this area, has been made using the accompanying indices:

#### Use Value (UV)

In order to calculate the relative importance of native medicinally important plant species for DDs Use Value (UV) (Phillips *et al.* 1994) a quantitative method was applied. UV is calculated as:

$$UV = \Sigma Ui/n$$

Ui = Total number of used records/species n = Sum of respondents questioned for a particular medicinal plant.

#### Familiarity Index (FI)

To find out the popularity of therapeutic plant among the folk communities a relative indicator Familiarity Index (FI) was used (Tabuti *et al.* 2004; Kidane *et al.* 2014a):

FI = FC/N

FC = Particular species' frequency stated as remedy N = Sum of informants take part in survey

#### Family Importance Value (FIV)

To know the importance and familiarity of a botanical family, the importance value (FIV) was applied (Kayani *et al.* 2014), using the following formula:

$$FIV = FC(family)/N \times 100$$

FC = Informants number citing the family N = Sum of respondents take part in this survey

#### Informant Consensus Factor (ICF)

In order to elucidate the agreement between use of plants for different disease groups and informants of the study area the Informant Consensus Factor (FIC) was calculated following (Trotter and Logan, 1986; Heinrich *et al.* 1998; Kayani *et al.* 2015; Butt *et al.* 2015):

$$ICF = Nur - Nt/Nur - 1$$

Nur = Total number of reports of the use category in inquiry

Nt = Total number of species used in this category

#### Consensus index (CI)

To find out the percentage of informants in the area with folk medicinal knowledge of medicinal plant species the Consensus index (CI) was (Rahman *et al.* 2016).

$$CI = n/N \times 100$$

Where

n = Number of respondents citing DDs species N = Total number of informants

# **Results and discussion**

#### Socio-demographic evidence

A total of 200 participants were interviewed and the participants' age ranged from 20-80 years. A total of 136 were men (68%) and 64 women (32%) (Table 1). The prevalence of men was related to gender issues, i.e. that women cannot talk with male strangers (the interviewer). This certainly had some influence on the outcomes of our work in the form of a barrier in the transfer of knowledge documentation due to which we did not document some precious knowledge of medicinal plants known to women. The vast majority of the participants were farmers or shepherds, still active or retired, with a small number of workers, shopkeepers, Government servants, housewives and some folk herbalists participating. A large portion of the respondents had not finished secondary school (Fig. 2).



Fig. 2. Percentage of participants on the basis of education

The most noteworthy cite frequency of remedial species utilized for DDs were documented from individuals with age range 50-80 years, while little data was acquired from younger as well as older respondents (Table 1, Fig. 3). In the 1<sup>st</sup> group (younger respondents), this may be because of progressed and dynamic lack of engagement in the ethics of "folk culture" and "rural advancement". In the 2<sup>nd</sup> case (older respondents), the lack of information was based on a certain reluctance / objective difficulties in contributing in interviews. Most reports were gotten from the rural groups when contrasted with urban groups, similar to other studies (Giday *et al.* 2009).

Table 1. Demographic description of the participants

Total participants		Percentage%
Male	136	68
Female	64	32
Age Group	_	
20-40	43	21.5
41-60	84	42
61-80	62	31
81-above	11	5.5
Education Level		
Illiterate	75	37.5
Grade 1-5	52	26
Grade 6-10	34	17
Grade 11-14	28	14
14 and above	11	5.5



Fig. 3. Age distribution of participants

#### Diversity of medicinal plants used for DDs

In study area 44 species used to treat DDs were documented and the therapeutic plant species belonged to 21 families (Table 2). The documented therapeutic plants used for DDs were categorized into twelve different DDs classes (Table 3 and Fig. 4). Stomachic was the ailment cured through the maximum number of medicinal plant species (18), tailed by constipation (6) and laxative (5). In table 3 some important local recipes are listed. These were more commonly used recipes of the area.

Medicinal plants used for DDs presented a diversity of growth forms (Fig. 5). Herbs were most common (75%), followed by shrubs (15.91%), and trees (6.82%), similar to other studies (Giday *et al.* 2003; Ayyanar and Ignacimuthub, 2005; Uniyal *et al.* 2006; Mesfin *et al.* 2012). Participants indicated that they preferred mostly herbs because of their potency and fast regeneration, as compared to other life forms. The high percentage of herbs was also reported in some other studies (Upadhyay *et al.* 2007; Upadhyay *et al.* 2010; Megersa *et al.* 2013).

Among the plant families used, the most noteworthy in terms of number of species reported were Apiaceae (7 sp.), Asteraceae (6 sp.), Poaceae and Rosaceae (5 sp. each), and Lamiaceae (3 sp.) (Table 4 and Fig. 6), which was similar to the work of (Bibi *et al.* 2014; Tareen *et al.* 2016). The pharmacological significance of therapeutic plant families FIV is given in Fig. 7. Family Apiaceae had the peak (FIV) value (46.5), tailed by Asteraceae (37.5), Rosaceae (31), Lamiaceae (30.5) and Poaceae (29) (Table 4). Medicinal plant species of family Apiaceae, Asteraceae and Rosaceae are cited as important in many pharmacological works (e.g. Martin and Briones, 1999; Shad *et al.* 2013; Kayani *et al.* 2014; Tareen *et al.* 2016).

# Plant-parts used, preparation method and administration mode of therapeutic plants used for DDs

In order to prepare various folk medicines, different parts of the plants were used, such as bark, flower, fruit, leaves, root, seed, and stem. The most frequently used plant parts were leaves (43.18%) tailed by seeds (29.54%), fruit (22.72%) and flower (15.9%) (Fig. 8). The common use of leaves has been also reported by Saikia et al, (2006), Dogan et al. (2013), Tareen et al. (2016), and Shah and Rahim (2017) likewise fruit and seeds were commonly used as reported by Rokaya et al. (2010) and Tareen et al. (2016) for the cure of DDs. Leaves are well-known for the synthesis of numerous active ingredients and pharmacologically more active than some other part (Rokaya et al. 2014; Ahmad et al. 2016; Shah and Rahim 2017). Furthermore, the utilization of leaves is less deleterious to the survival of a plant species as compared to the use of other parts (e.g. roots, stem, bark), or the use of entire plants (Abebe and Ayehu 1993; Giday et al, 2003; Zheng and Xing 2009). Moreover, leaves are collected more easily than other parts of plants (Giday et al. 2009).

Different plant parts were used direct/unprocessed, decoction, juice, powdered or any other form along with dietary items. Unprocessed leaves in fresh/dried form (34.09%) were most commonly used for many DDs, tailed by powder (27.27%), decoction (18.18%) and cooked (15.91%) (Fig. 9).

Table. 2. Qualitative and quantitative ethno-medicinal data of therapeutic plants utilized for digestive disorders by the people of Laspur Valley.

Family/Botanical Name (Voucher No.)	Part/s	Diseases cured	Administration	Participants	UV	FI	CI	Nr	Na	IAR	CAI
	used										
AMARANTHACEAE											
Amaranthus cruentus L. (LS-235)	Leaves	Laxative	Cooked	13	0.076	0.065	+	13	1	1	6.5
APIACEAE											
Carum carvi L. (LS-240)	Seeds	Stomachic	Herbal tea	22	0.045	0.11	++	22	1	1	11
Carum copticum L. (LS-241)	Leaves,	Diarrhea	Decoction	18	0.055	0.09	+	18	1	1	9
	Flower &										
	Seeds										
Coriandrum sativum L. (LS-245)	Seeds &	Carminative	Powder	57	0.017	0.285	+++	57	1	1	28.5
	Leaves										
Cuminum cyminum L. (LS-247)	Seeds &	Appetizer	Cooked	19	0.052	0.095	+	19	1	1	9.5
	Leaves										
Daucus carota L. (LS-248)	Seeds	Stomachic	Herbal tea	33	0.030	0.165	++	33	1	1	16.5
Ferula narthex L. (LS-250)	Stem	Stomachic	Direct	14	0.071	0.07	+	14	1	1	7
Foiniculum vulgare Mill. (LS-251)	Seeds &	Stomachic	Direct	24	0.041	0.12	++	24	1	1	12
	Leaves										
ASTERACEAE											
Artemisia absinthium L. (LS-236)	Seeds	Stomachic	Powder	17	0.058	0.085	+	17	1	1	8.5
Artemisia bigelovii A. Gray (LS-237)	Leaves &	Gastric problem &	Powder	23	0.086	0.115	++	23	2	0.95	10.925
	Flowers	Stomachic									
Cichorium intybus L. (LS-243)	Roots	Vomiting	Decoction	29	0.034	0.145	++	29	1	1	14.5
Lactuca sativa L. (LS-254)	Leaves	Appetizer	Direct	43	0.023	0.215	++	43	1	1	21.5
Matricaria chamomilla L. (LS-258)	Flowers	Stomachic &	Decoction	22	0.091	0.11	++	22	2	0.95	10.45
		indigestion									
Taraxacum officinale F.H. Wigg (LS-274)	Leaves	Constipation	Cooked	29	0.034	0.145	++	29	1	1	14.5
BERBERIDACEAE											
Berberis vulgaris L. (LS-238)	Leaves &	Dyspepsia	Decoction	54	0.018	0.27	+++	54	1	1	27
	Fruit										
BRASSICACEAE											
Lepidium ruderale L. (LS-255)	Leaves	Dyspepsia	Direct	11	0.090	0.055	+	11	1	1	5.5
Nasturtium officinale W.T. Aiton (LS-263)	Leaves	Dyspepsia	Cooked	15	0.066	0.075	+	15	1	1	7.5

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CAPPARIDACEAE											
Capparis spinosa L. (LS-239)	Flowers	Stomachic	Decoction	16	0.062	0.08	+	16	1	1	8
CARYOPHYLLACEAE											
Lepyrodiclis holosteoides (C.A.Mey.) (LS-256)	Leaves	Laxative	Direct	15	0.066	0.075	+	15	1	1	7.5
CHENOPODIACEAE											
Chenopodium album L. (LS-242)	Leaves	Laxative	Cooked	36	0.027	0.18	++	36	1	1	18
CONVOLVULACEAE											
Convolvulus arvensis L. (LS-244)	Leaves	Constipation	Cooked	32	0.031	0.16	++	32	1	1	16
CUCURBITACEAE											
Cucumis sativus L. (LS-246)	Fruit	Constipation	Direct	25	0.040	0.125	++	25	1	1	12.5
EPHEDRACEAE											
Ephedra gerardiana Wallich ex C.A. Meyer (LS-249)	Whole	Gastric problem	Decoction	31	0.032	0.155	++	31	1	1	15.5
	plant										
LAMIACEAE			-				-		-		
Mentha arvensis L. (LS-259)	Leaves	Stomachic	Direct, Powder	38	0.026	0.19	++	38	1	1	19
Mentha longifolia (L.) Huds. (LS-260)	Leaves	Stomachic	Direct, Powder	43	0.023	0.215	++	43	1	1	21.5
Mentha spicata L. (LS-261)	Leaves &	Stomachic,	Direct, Cooked	53	0.056	0.265	+++	53	3	0.96	25.44
	flowers	appetizer &									
		dyspepsia									
MALVACEAE	•		•						-		
Abelmoschus esculentus L. (LS-234)	Fruit	Dysentery	Direct	21	0.047	0.105	+	21	1	1	10.5
Malva neglecta Wallr. (LS-257)	Leaves	Constipation	Decoction	19	0.052	0.095	+	19	1	1	9.5
MORACEAE							-				
Morus nigra L. (LS-262)	Fruit	Dyspepsia	Direct	23	0.043	0.115	++	23	1	1	11.5
PLANTAGINACEAE					_		-	-			
Plantago major L. (LS-266)	Seeds	Constipation &	Direct	37	0.054	0.185	++	37	2	0.97	17.945
		diarrhea									
POACAE											
Hordeum distichon L. (LS-252)	Seeds	Appetizer	Powder	17	0.058	0.085	+	17	1	1	8.5
Hordeum vulgare L. (LS-253)	Seeds	Stomachic &	Powder	38	0.052	0.19	++	38	2	0.97	18.43
		indigestion									
Panicum miliaceum L. (LS-264)	Seeds	Stomachic	Powder	16	0.062	0.08	+	16	1	1	8
Pennisetum typhoideum (Burm. f.) Stapf (LS-265)	Seeds	Stomachic	Powder	8	0.125	0.04	+	8	1	1	4
Zea mays L. (LS-277)	Seeds	Stomachic	Powder	47	0.021	0.235	++	47	1	1	23.5

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POLYGONACEAE											
Rumex longifolius DC. (LS-272)	Leaves	Laxative	Paste	11	0.090	0.055	+	11	1	1	5.5
ROSACEAE											
Prunus armeniaca L. (LS-267)	Fruit	Constipation	Syrup	34	0.029	0.17	++	34	1	1	17
Pyrus malus L. (LS-268)	Fruit	Stomachic	Direct	36	0.027	0.18	++	36	1	1	18
Rosa alba L. (LS-269)	Flower	Stomachic	Juice	22	0.045	0.11	++	22	1	1	11
Rosa webbiana Wall ex. Royle. (LS-270)	Flower	Stomachic	Herbal tea	24	0.041	0.12	++	24	1	1	12
Rubus fruticosus L. sens.str. (LS-271)	Fruit	Carminative, diarrhea & looseness of intestine	Direct, powder	27	0.111	0.135	++	27	3	0.92	12.42
SOLANACEAE											
Solanum nigrum L. (LS-273)	Fruit	Stomachic	Powder	37	0.027	0.185	++	37	1	1	18.5
VIOLACEAE											
Viola rupestris F.W. Schmidt. (LS-275)	Flowers	Purgative	Decoction	33	0.047	0.105	++	33	2	0.97	10.18
VITACEAE											
Vitis vinifera L. (LS-276)	Fruit	Gastric problem	Direct	13	0.076	0.065	+	13	1	1	6.5

Use Value=UV Familiarity Index=FI Consensus Index=CI Informant Agreement Ratio=IAR Cultural Agreement Index=CAI

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Table 3. Listing some important folk herbal recipes

Plant Name	Herbal Recipes
Amaranthus cruentus L.	Young leaves are plucked, washed and cooked; these cooked leaves are used as laxative.
Artemisia bigelovii A. Gray	Leaves and inflorescence are ground to make powder; this is used for gastric problems and stomachache.
Artemisia absinthium L.	One teaspoon full of powdered seeds is taken with a glass of water to cure abdominal pain.
Berberis vulgaris L.	Leaves and fruits are collected, juice is extracted and filtered, which can be taken orally for the treatment of dyspepsia.
Capparis spinosa L.	Floral buds are collected, dried, mashed with wheat flour and cooked to prepare aqueous extract called Kavirough, which is efficient for abdominal pain.
Carum carvi L.	Seeds are boiled in water to make a herbal tea, which is used for stomachache.
Carum copticum L.	The aromatic seeds, leaves and flowers are boiled in milk with a little salt and given to the patients of diarrhea
Cichorium intybus L.	The root of this plant is dug out, washed, chopped and boiled with water. This aqueous extract is useful for vomiting.
Chenopodium album L.	Young leaves are plucked washed and cooked; these cooked leaves are used as laxative and to cure constitution
Coriandrum sativum L.	The dried seeds and leaves are powdered and taken with water about half teaspoon as a carminative after meal.
Convolvulus arvensis L.	The fresh leaves are collected and boiled in water and chopped. The paste is mixed with tomato, onion, ginger, garlic, salt (as required) and then fried in oil. This gravy is used for curing constipation. The doze is usually 2-3 times a day.
Daucus carota L.	The dried 10-15 seeds are boiled in water to form herbal tea; this tea is used for the cure of abdominal pain.
<i>Ephedra gerardiana</i> Wallich ex C. A. Meyer	Boiled in water, crushed and aqueous extract is obtained, called Gholja in Khowar language, which is used to treat gastric problem.
Ferula narthex L.	Young stems are cut which result in oozing of milky exudates. This exudate solidifies after one day and is locally called Hing, which is used against toothache.
Foeniculum vulgare L.	Seeds and fresh leaves are chewed for abdominal pain.
Hordeum vulgare L.	The seeds are ground to make powder; this powder is used for bread making, which is recommended for stomachache and indigestion.
Matricaria camomilla L.	The flower heads of this plant are collected, dried, boiled in water and the decoction is given to the patients with abdominal pain and indigestion.
Mentha spicata L.	The leaves and flowers meshed with wheat flour are cooked to prepare Suspruough, which is eaten as appetizer and to cures dyspepsia, stomach pain.
Pennisetum typhoideum (Burm. f.) Stapf	The seeds are ground to form powder and then bread is made from it. This is used to treat stomachache.
Plantago major L.	About one teaspoon seeds are soaked in one cup water or milk, his is used 3-4 times a day to treat constipation and diarrhea.
Prunus armeniaca L.	The ripe fruits are dried, soaked in water and sweet syrup is obtained, this syrup is used for constipation.
Rosa webbiana Wall ex. Royle.	The petals of these plants are collected, petals are dried, crushed and powdered; this powder in one teaspoon is poured into tea, due to which herbal tea is made for stomachache.
Rumex longifolius DC.	The fresh leaves are collected, boiled, cut, and the past are mixed with tomato, onion, ginger, garlic, salt (as required) and then fried in oil, this gravy is used as laxative when eaten as vegetable.
Viola rupestris F.W. Schmidt.	Flowers are dried and powdered and boiled in water to make decoction this is used as astringent (Kabaz) and purgative (dast awar).



Fig. 4. Digestive disorders on the basis of Informant Consensus Factor (ICF)



Fig. 5. Percentage of life forms of medicinal plants



Fig. 6. Number of species in each family



Fig. 7. Family Importance Value (FIV) based on participant's answers



Fig. 8. Plant parts used for medicinal purposes



Fig. 9. Modes of preparation of medicinal plants

# Familiarity Index and Use value of medicinal plant species for DDs

All medicinal plant species used for DDs documented through interviews are listed in Table 2. Statistical tools were applied to quantitatively analyze the ethnomedicinal data about DDs.

#### Familiarity Index (FI)

The familiarity index (FI) was used to determine the general practicality of the cited medicinal plant in the viewpoint of DDs (Tabuti *et al.* 2004; Hoffman and Gallaher, 2007; Kidane *et al.* 2014). FI values were led by *Coriandrum sativum* (0.285, 57 citations and 1 use category), followed by *Berberis vulgaris* (0.27), *Mentha spicata* (0.265, with 53 citations and 3 use categories), *Zea mays* L. (0.235, 47 citations and 1

use category). Least values of FI were found for *Pennisetum typhoideum* (0.04, with 8 citations and single use report), *Rumex longifolius* and *Lepidium ruderale* (0.05, 11 use reports and one single use category) (Table 3 and Fig. 10).

#### Use Value (UV)

It was noted that the use values of therapeutic plants fluctuated from 0.017-0.125 (Table 2 and Fig. 11). The therapeutic plants with highest use values were *Pennisetum typhoideum* (0.125), *Rubus fruticosus* (0.111), and *Matricaria chamomilla* (0.091). On the other hand, therapeutic plants with least use values were *Coriandrum sativum* (0.017), *Berberis vulgaris* (0.018), and *Zea mays* (0.021).





Fig. 10. Familiarity index (FI) of therapeutically valuable plants



Table. 4. Family importance value of medicinallyimportant families

Family Name	No. of species	No. of informants	FIV
Apiaceae	7	93	46.5
Amaranthaceae	1	13	6.5
Asteraceae	6	75	37.5
Berberidaceae	1	54	27
Brassicaceae	2	19	9.5
Capparidaceae	1	16	8
Caryophyllaceae	1	15	7.5
Chenopodiaceae	1	36	18
Convolvulaceae	1	32	16
Cucurbitaceae	1	25	12.5
Ephedraceae	1	31	15.5
Lamiaceae	3	61	30.5
Malvaceae	2	23	11.5
Moracaeae	1	23	11.5
Plantaginaceae	1	37	18.5
Poaceae	5	58	29
Polygonaceae	1	11	5.5
Rosaceae	5	62	31
Solanaceae	1	37	18.5
Violaceae	1	33	16.5
Vitaceae	1	13	6.5

#### Comparison with previously publish work

In the present work Abelmoschus esculentus was reported to be used for dysentery and the same plant was reported by Akhtar et al. (2013) used as emollient, demulcent and diuretic. We reported Artemisia absinthium to be used as stomachic, while the plant was documented to treat tuberculosis and cough, Kayani et al. (2014), and for skin problems and itching, Bano et al. (2014). Berberis vulgaris was found to treat dyspepsia in our study, while reported as stomachic, Shah et al. (2016). Similarly, Capparis spinosa was documented, us as stomachic, while it was used against malaria in the study of Sher et al. (2016), and for joint pain, Bano et al. (2014). We found Carum carvi to be used for stomachache, while Bano et al. (2014) reported its uses for gastric problems, sore throat, and rheumatism and Sher et al. (2016) reported its use for stomachache and indigestion. In our study we reported Carum copticum for diarrhea (dysentery, Tariq et al. 2015), Chenopodium album as a laxative (appetite and abdominal pain, Ullah et al. 2013) Cichorium intybus for vomiting (gastrointestinal problems, Bano et al. 2014; aphrodisiac and cooling, Barkatullah et al. 2015) Convolvulus arvensis for treatment of constipation (purgative,, Sher et al. 2011; purgative, Adnan et al. 2014; constipation, Abbasi et al. 2010), Coriandrum sativum as a carminative (carminative, Adnan et al. 2014; carminative and for indigestion, Tariq et al. 2015), Cucumis sativus for constipation (cooling, diuretic, tonic, vermifuge, diuretic and purgative, Marwat et al. 2009), Cuminum cyminum as an appetizer (stomach problem, Huassain and Ghani, 2008), Daucus carota as a stomachic (regulate menstruation, Muhammad and Khan, 2008; carminative and for dysentery, Jan et al. 2008), Ephedra gerardiana for gastric problem (joint pain, Noor et al. 2014; rheumatism and respiratory disorders, Bano et al. 2014; asthma and tuberculosis, Shinwari and Gilani, 2003) Ferula narthex as a stomachic (cough, asthma, toothache, gastric problems and anti-constipation, Shinwari and Gilani, 2003), Foeniculum vulgare was used as stomachic (stomach-ache, Bano et al. 2014; bronchitis and abdominal pain, Sher et al. 2016; carminative, constipation, diarrhea, dyspepsia, stomachic, Shah et al. 2016), Hordeum vulgare as a stomachic and for indigestion (cathartic and purgative, Shah and Khan, 2006; jaundice, Khan et al. 2011), Lactuca sativa as an appetizer (blood purification, Adnan et al. 2014; skin diseases, syphilis and rheumatism, Shah and Khan, 2006), Malva neglecta to cure constipation (stomach pain, Tariq et al. 2015; boils, bitter mouth feel, constipation, expulsion of retained placenta, Shah et 2016), Matricaria chamomilla used al. as stomachache and indigestion (for wounds and rheumatic pain, Bano et al. 2014), Mentha arvensis stomachache (antiemetic, for carminative, stomachic, fat burner, hyperacidity, bitter mouth feel, cough suppressant, cooling, diarrhea, toothache, Shah et al. 2016; emollient, aperient, demulcent, Shah and Khan, 2006), Mentha longifolia for stomach ache (anti-stomachache and carminative, Barkatullah et al. 2015; cholera, diarrhea and vomiting, Abbasi et al. 2010), Mentha spicata as a stomachic, appetizer and for dyspepsia (stomachache and carminative, diarrhea and dysentery, Jan et al. 2008; dyspepsia and carminative Hazrat et al. 2011), Morus nigra for dyspepsia (analgesic, Adnan et al. 2014; antistomachache, Barkatullah et al. 2015), Nasturtium officinale used to cure dyspepsia (febrifuge and antistomachache, Barkatullah et al. 2015; purgative and emetic, Sher et al. 2011), Plantago major used for constipation and diarrhea (cool and wash the mouth, Adnan et al. 2014; wound healing and laxative, Barkatullah et al. 2015; laxative, dysentery and mouth diseases, Jan et al. 2008), Prunus armeniaca used as remedy for constipation (carminative, appetizer and help control stomach acidity, Khan and Ahmad, 2015; anticancer, Akhter et al. 2013), Pyrus

malus as stomac, to lower uric acid, blood pressure and rheumatism problems in the community (as tonic to invigorating the body and strengthen bones, Ishtiaq et al. 2012; to potent vigor, blood purifier, anticardiovascular diseases, Ishtiaq et al. 2015). Rosa alba was used as stomachic (lowering blood glucose, Ahmad et al. 2009), Rosa webbiana as stomachic, to cure piles (Barkatullah et al. 2015); as stomachic (Ullah et al. 2013) for fever, cough and sore throat (Khan and Khatoon, 2007), Rubus fruticosus as carminative, diarrhea and looseness of intestine, reported as aphrodisiac and carminative (Barkatullah et al. 2015); for diarrhea (Jan et al. 2008), Solanum nigrum as a stomachic (jaundice and blood purification, Mahmood et al. 2011b; skin inflammation and against fever, Akhtar et al. 2013), Taraxacum officinale for constipation (analgesic and astringent, Shah and Khan, 2006; jaundice, Abbasi et al. 2010), Viola rupestris used as astringent and purgative (chest infection, Ahmad et al. 2016), Vitis vinifera for gastric problems (common cold, relax body and brain, stomach diseases, Marwat et al. 2009; carminative, Adnan et al. 2014), and Zea mays used as stomachic (diabetes, Ahmad et al. 2004; Kidney stones, Akhtar and Begum, 2009; kidney stones and inflammation of urinary system, Mahmood et al. 2004).

#### The most versatile medicinal family

To find out the most versatile medicinal family, Family Importance Value (FIV) was used (Table 4). In the present work the most important family on the basis of medicinal value was Apiaceae with FIV value (46.5) followed by Asteraceae (37.5), Rosaceae (31) and Lamiaceae (30.5). Familiarity Index (FI) values demonstrated high proportion of recurrence of *Coriandrum sativum* referred by the native informants, though, Consensus Index CI showed agreement on the significance of *Coriandrum sativum* as a vital, well-known therapeutic plant utilized in the study area to cure DDs.

#### Medicinal importance of plants used to treat DDs

In the study we recorded 49 different DDs and those were grouped into 11 different aliments/conditions (Table 5, Fig. 4). Informant's consensus on the usage of medicinal plants for DDs was elucidated through the ICF. The range of ICF has been from 0-1 (Table 5). The ailment groups with maximum ICF are Dysentery, Vomiting and Intestinal Disorder (1.0 each), followed by Carminative (0.97), Gastric problems (0.95), Dyspepsia (0.94 each), Constipation and Diarrhea (0.93 each) Laxative (0.92), Appetizer (0.90) and Stomachache (0.79).

Table 5. Informant consensus factor (ICF) of medicinal plants for various digestive disorders classes

Disease Category	nt	n <sub>ur</sub>	ICF
Appetizer	4	31	0.90
Carminative	2	43	0.97
Constipation	6	76	0.93
Diarrhea	3	32	0.93
Dysentery	1	21	1.00
Dyspepsia	5	69	0.94
Gastric problem	3	44	0.95
Laxative	5	51	0.92
Stomachache	18	82	0.79
Vomiting	1	29	1.00
Intestinal Disorder	1	9	1.00

Nur = Total number of reports of the use category in inquiry

Nt = Total number of species used in this category

#### Conclusions

This work was conducted to document how local communities of Laspur Valley. Pakistan treat DDs with medicinal plant species. A total of 44 therapeutic plant species belonging to 21 families was found to be used to treat one or more DDs. After literature review, to the best of our knowledge, many medicinally important plants were documented for the first time from Pakistan: Amaranthus cruentus, Artemisia bigelovii, Hordeum distichon, Lepidium ruderale. Lepvrodiclis holosteoides. Panicum miliaceum, Pennisetum typhoideum, and Rumex longifolius. Similarly, in this work some plants were reported for the first time to cure DDs, such as, Abelmoschus esculentus which was reported to be used for dysentery, Artemisia absinthium used as stomachic, Berberis vulgaris to treat dyspepsia, and others, such as Capparis spinosa, Cucumis sativus, Ephedra gerardiana, Lactuca sativa, Matricaria chamomilla, Pyrus malus, Rosa alba, Solanum nigrum, Taraxacum officinale, and Zea mays. The population of the study area clearly holds different ethnomedicinal knowledge from other regions in Pakistan.

# Declarations

#### Abbreviations:

DD = Digestive disorder UV = Use Value FI = Familiarity Index FIV = Family Importance Value ICF = Informant Consensus Factor *Ethics approval and consent to participate:* Before conducting interviews, the individual prior informed consent was obtained from all participants. No further ethics approval was required. All work conducted was carried out under the stipulations of the Nagoya Protocol on Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising from their Utilization to the Convention on Biological Diversity. The right to use and authorship of any traditional knowledge of all participants is maintained, and any use of this information, other than for scientific publication, does require additional prior consent of the traditional owners, as well as a consensus on access to benefits resulting from subsequent use.

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

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#### Availability of data and materials

The raw data without names of participants are available from the authors.

#### Author's contributions

SW and HAJ designed the study; SW conducted the fieldwork, SW and HAJ conducted the main statistical analysis and wrote the manuscript, SW, HAJ and RWB revised the data analysis and the manuscript; all authors read, corrected and approved the manuscript.

*Competing financial interests:* The authors declare that they have no competing financial interest.

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