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AN ETHNOMEDICINAL SURVEY OF INDIGENOUS KNOWLEDGE ON MEDICINAL PLANTS AND THEIR CURRENT MARKETING IN THE KAKAR REGION OF BALOCHISTAN PAKISTAN

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Abstract

This study aimed to document indigenous knowledge about the utilization of medicinal plants for various illnesses in the North-Eastern part of the Kakar region of Balochistan province. The ethnomedicinal documentation contains quantitative and qualitative information on medicinal plant diversity with aimed to develop current marketing for medicinal plants being traded in the province of indigenous and imported plants. The data was collected by semi-structured interviews, rapid appraisal approach and open ended questionnaire. The results were analyzed using quantitative indices including Information Consensus Factor (ICF), Fidelity level (FL), use value (UV), Frequency Citation (FC) and Relative Frequency Citation (RFC). A total of 60 plant species belonging to 20 families were observed being used as ethnomedicinal remedies by local inhabitants. The medicinal use of Asteraceaea plants and Lamiaceae plants families were reported to be dominant with 10 species each. Whole plant was used most frequently (30%) by indigenous inhabitants. Medicinal species uses against treatment of almost 15 categories of very common disorders. The most common plants were identified of genus *Artemisia* (six species). Besides this, the genus *Pulicaria* was used by most informants for typhoid and malarial diseases. Lamiaceae was also an important family in this region with *Seriphidum quettense* was highly medicinal species commonly used by a majority in the native community. The reported medicinal species were mostly herbs (80%) followed by shrubs and trees (10% each). Gastrointestinal problems were most commonly treated with the highest number of different species (19). The number of medicinal plants documented in this study represents evidence of high diversity that will continue to play an important role in healthcare system. The inhabitants of Kakar range use plants with medicinal properties for curing of various diseases due to shortage of medical facilities and unaffordable prices of pharmaceutical drugs.

Key words: Balochistan, Ethnomedicine, Floral inventory, Herbal trade, Quantitative indices.

Introduction

Pakistan is one of the most important richest country due to possessing a unique plant biodiversity, geographical location, variety of climatic and ecological conditions along with highly important medicinal plants diversity. Pakistan has nine hotspot biodiversity of medicinal plants. The identified flowering species of 6000 higher plants in which 500 to 700 plants are identified and used as ethnomedicinal remedies and have been used by indigenous inhabitants for various kind of illness since centuries. Besides this, 203 endemic species of about 4% of the flora was reported (Ali, 1978). More than 80% of flowering plants are found in western and northern parts and high mountainous of Pakistan and Kashmir region (Ali, 2008).

Balochistan comes 3 red in regard to medicinal plants biodiversity having very important hotspots. The indigenous people of Balochistan has great concern with the use of medicinal plants since centuries. Even today a great economical, as well as well financial trade not only on national level but also on international level of medicinal plants is in progress in the province. The sustenance of indigenous people of Balochistan is thoroughly dependent on natural resources. Among these natural resources, herbal medicines are widely used by indigenous inhabitants as cheapest, approachable remedies for their various kinds of health issues and problems (Jamal *et al.*, 2012). Since from the very beginning the herbal preparation plants in various forms such as plants parts, roots, seeds, powder and extracts and even whole plants were used. The indigenous people believed that the herbal medicines usage was more harmless than the synthetic medicines which had more side effects.

Indeed researchers have recorded the data of indigenous use of medicinal plants through the world (Ratnam & Raju 2008; Jamila & Mostafa, 2014; Bolson *et al.*, 2015; Ngarivhume *et al.*, 2015) and in Pakistan (Qureshi, 2012; Abbasi *et al.*, 2013; Ahmad *et al.*, 2014; Bibi *et al.*, 2014; Kayani *et al.*, 2014; Rehman *et al.*, 2015). However, the trade in medicinal plants has not been focused on since to date, therefore the present study would be considered a pioneer research project in order to explore both the aspects i.e., the usage of medicinal plants by local community and their herbal trade. The occurrence of these natural herbal flora is widely distributed in most parts of North-eastern and western highland climax mountains and plains. Due to narrow geographical distribution, there is a great threat to these medicinal plants towards extinction if do not properly conserved (Callmander, 2005).

In Pakistan, Ethnobotany is now well recognized discipline and explored various important medicinal plant species for herbal drug development and their sustainable utilization but still many regions such as Balochistan are unexplored. Far remote areas of Pakistan, knowledge of traditional herbal medicine helps the researchers to explore the new medicinal plants with precious pharmacological properties. Still many rural areas of Pakistan, local communities are practicing the old traditional system of medicines (Mahmood *et al.,* 2011). Many ethnobotanical studies on medicinal plants has been conducted in various regions of Northern Pakistan (KPK and GB), Azad and Jammu Kashmir, Plains of Punjab, and Sindh but majority of the studies are conducted in Northern mountainous regions of Pakistan while, southern plain regions of Pakistan are relatively unexplored. Ultimately, when precious medicinal plants are vanished the traditional knowledge regarding the use of these herbal plants would also get vanished.

In the literature, only a few studies have been reported from different regions of Balochistan. In certain villages of Zarghoon, ecological region, 26 medicinal species were documented from 13 plant families and 20 genera. Locals used these plants on a daily basis for a variety of reasons, with leaves, flowers, seeds, and roots being the most often used plant parts (Bazai *et al.,* 2013). Bibi *et al.,* (2014) explored medicinal plants in Mastung District, reporting 100 species from 47 groups, including 11 species belonging to the Asteraceae family. Decoction was the most popular herbal preparation. Indigenous ethnomedicinal surveys in Kalat and Khuzdar aimed at passing on herbalist expertise to the local population (Tareen *et al.,* 2010). Women have historically utilized 61 species of MPs from 56 genera and 34 families as remedies. Qasim *et al.,* (2010) reported 48 wild coastal plant species belonging to 26 families from Hub, Lasbela Poaceae (29%) was most frequently used plant family and the use of leaves was the highest (44%). Jan *et al.,* (2021) found 35 wild and cultivated plants belonging to 20 families in an ethnobotanical study of floral variety from the district Killa Abdullah. With five species, the Rosaceae family had the most species. The most utilized plant parts were the whole plant (51%) and seeds (23%) respectively. Plant species can be used to alleviate the research area's economic constraints.

The goal of this study is to deepen the knowledge of sustainable ethnomedicinal uses of medicinal plants along with herbal recipes as practiced in the North-Eastern range of Balochistan. An annotated list of plants traditionally used as medicinal products has been compiled along with a quantitative data analysis of specific herbal medicines used in the study area, recorded through field surveys.

Materials and Methods

Geo- ethnographical overview: Balochistan is considered as the smallest Province of Pakistan by population and the largest by land area 44% of total country land with 34.7 million hectares. Balochistan has vast land feature and broad planes physically of terrain rough consists on into Ranges of Basin notable high lands and arduous feature. In broad terms geographically the plateau has been separated in four different zones such as lower high lands, the upper high lands and deserts plains (Fig. 1). The Upper highland called Khorasan located at the height of 3800 meters having vales of planes which are above 1600 meters from the sea level. The highland includes Muakran, Kharran and Chagghi ranges. In the western part, Koh-e-Sulaimman, Pab, Kirether in the eastern side. The highland at upper side lies in the Districts Quetta, Pishin Killa Abdullah, Chuman, Killa Saifullah, Loralai, Zhob, Ziarat and Kalat. The western part of Balochistan has many notable ranges which are important and is rich in species diversity. Some of them are Chiltan, Zarghoon, Murdar, Takatu, Toba Kakari, Khawaja e Emran or Kozak and Sulaiman ranges. The altitude in lower high land ranges from 600 to 1200 meters.

Balochistan has long coastal-line of 760 km with Peninsula steppes. The steppes hilly ranges go up suddenly besides the thin glide plain. The well-known seaports in the area are Gawadar, Pasni, and Sonmiani. In recent years the Federal Government paid much attention to Gawadar and given the status as international port for trade and commerce, has lunched the most fascinating project and raised the status as China Pakistan Economic Corridor (CPEC).

The climatic conditions of Balochistan is arid to semiarid and the annual rain fall also varies. The variability in this total fall as moistures weather due to heavy snow in Qilla Saifullah and rain in winter or heavy rain fall in hot summer season. The annually recorded precipitations in Balochistan ranges from varying from 50 mm in the west to over 400 mm in the east. Evaporating rate of water is high than the rainfall and mostly different per annum (Anon., 2012).

In the study area we found most informants speaking Pashto, during field work, both as Herbalists and herbal shopkeepers and also general public purchasing medicinal plants for curing various kind of illness. In Quetta there is mixed population of Pashto, Barhvi, Punjabi, Urdu and Persian etc. Most of the ethnic group of people inhibiting in Balochistan commonly speak Urdu for general understanding and communication (Anon., 2011).

Hot spots: Balochistan being rich in biodiversity and have large, extensive land forms and high mountainous ranges has some important hotspots such as Ziarat *Juniper* forest, Kalat Herboi, Loralai forest, Suliman range, Musa Khail, Khawaja Emran or Koh e Qand, Zhob Sherani forest, and Chiltan National Park and Hingol National Park are important hotspot regarding biodiversity of medicinal plants.

Among these hot spots Zhob Sherani and Suliman ranges have *Pinus gardenia* forest produce (chilgoza) precious medicinal plant and *Pistacia khunjek* (shennay) also an important dry fruit and medicinal plant, while the wood of juniper forest of Ziarat and Koh e Qand are used for timber and construction and seeds are used as indigenous medicines.

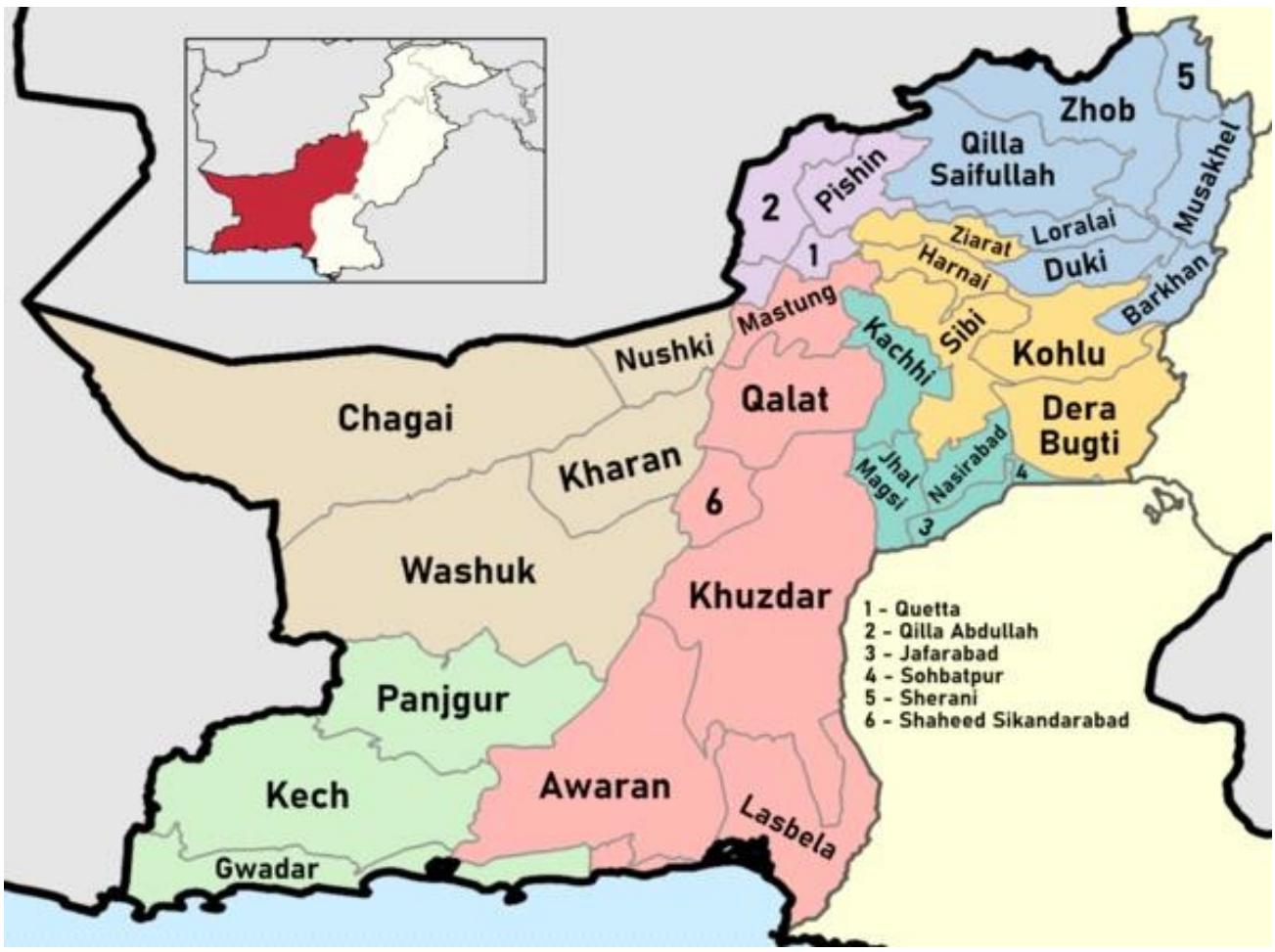

Fig. 1. Map of the study area: North Eastern Balochistan.

Socio-economic conditions of the area: Along with all sort of natural resources Balochistan has been gifted with important medicinal plants biodiversity. The indigenous inhabitants widely use these ethnomedicinal species as the local remedies for various kind of illnesses. Indeed the majority of population are residing in rural areas where their economic conditions are poor and quiet miserable, they do not have approach to proper health care so these herbal medicines are the cheapest easily accessible to the local communities.

Balochistan has large amount of coal deposits and natural gas is the biggest field in Balochistan first discovered in the late 1952. Agriculture is also the back bone of our economy and almost 70% of people of Balochistan get their earning from agriculture. But in recent decades degrading water table and drought the agriculture practices such as cultivation of crops and arched have been very badly disturbed even dried and reduced very badly, which directly and adversely affected economy and life of people. Besides this, sustainable harvesting of medicinal plants, cultivations and proper marketing can boost up the economy of the local masses, if such trade on medicinal plants is regularized and some taxes are imposed on such trade that would bring hand some revenue to the government.

Field interview: The field survey of study area was conducted various seasons of 2021. During field surveys, dwellers are interviewed which are familiar with the use of plants as medicine and for other uses in daily life and traditional health practitioners (THPs) were interviewed through semi structured interviews, group discussion, the questionnaire, and random selection of informants, as well as specific interviews from THPs. Group discussion were conducted at specific locations where informants met for social gatherings from the same community. Traditional practitioners went together to the site during a field walk, where the medicinal plant had grown, given its local name, and clarified the ethnomedicinal knowledge of plant species. The main focus was given in the questionnaire on use of ethnomedicine by the local community used for various diseases and the current marketable of traded herbal plants.

During interviews, different languages were used to ask informants such as Pashto, Brahvi, and Urdu. Mr. Khalil Ur Rehman was well aware of these three languages and has full command over them so could easily communicate tactfully with all informants and herbalists.

The trade in medicinal plants and their ethnomedicinal data was collected from overall 300 informants among which 200 was traditional healers and 100 was an herbal trader of various aged groups (Table 1). Data was recorded with respect to vernacular name, medicinal herbal parts usage, and administrations mode, pharmacological agents of medicinal plants were presented in Table 2.

Table 1. Demographic Data of the participants in North-Eastern part of Balochistan, Pakistan.

Variable	Demographic categories	No. of informants	Percentage
Gender	Male	140	70
	Female	60	30
Experience	Local healers	100	33.3
	Local people	200	66.6
Age groups	60-70	150	50
	45-55	90	30
	30-40	60	20
Education	Illiterate	80	30
	Primary	70	20
	Secondary	60	20
	Graduate	60	20
Residence	Rural	200	75
	Urban	100	25

Identification, collection, medicinal plants deposition: Plant specimens have been collected, their localities have been recorded and field notes have been noted down. Using a digital camera (Model-Nikon S-444/China), digital photography of collected plant species was carried out. The plant specimen collected was dried, preserved and mounted on the sheets of Herbarium (Jain, 1977). The collected plant species are identified on the basis of morphological characteristics by renowned plant taxonomists. For the conformation of correct identification of plants, specimens are matched with already present specimens in Herbarium of Pakistan, Quaid-i-Azam University, Islamabad (ISL). All specimens are properly tagged with voucher for futures references and submitted to Balochistan University Herbarium. Online database of various reputed flora is utilized for correct botanical naming and proper identification. Correction of Scientific names of plants and their families were verified from various online databases, including Royal Botanic Garden Kew's Plants of the World Online (POWO) database and medicinal plant naming service (Kew Botanical Garden) (http://mpns.kew.org) and The Plant List (www.tpl.org).

Information of demographics: Demographically, we observed informants physiognomy and gathered documentation by face to face direct conversation and discussions. Entire male informers and herbalists were interviewed in field, herbal markets, and bazars and at their homes, while the female informants were consulted at homes of their own with help of female co-workers to collect the traditional knowledge. Hundred herbalists were also approached to obtain information in order to explore ethnomedicinal species with respect to herbal remedial potential.

Quantitative data analysis: For quantitative ethnobotanical analysis the collected data was analyzed and arranged in for quantitative indices such as "Use value (UV), Use reports (UR), Family importance value (FIV) and informant consensus factor (IFC)".

Medicinal used values (MUV) and used reports: In order to obtain MUV of the data, the MUV achieved through the following suggested formula by (Tardío & Pardo-de-Santayana, 2008; Savikin *et al.,* 2013).

Revising of MUV is indeed the Use Value (UV). The medicinal use value was measured with the small revision. This is the best method to calculate the probable utilization of a plants species instead of the consideration of their RFC. That was measured through the use of given formulas:

$$MUV = \sum MUi|N.$$

Over here the (MU) stand for the Number of citation of medicinal usage by each informant for the given species while N stand for the total No of informants participated in the survey. In fact MUV is usually higher when (1) if in case the utilization is higher and close to (0) when the used reports of the taxon are comparatively low.

Importance value index (FIV) frequency of citation (FC), relative frequency of citation (RFC): The family importance value (FIV) and relative frequency citation (RFC) were calculated for the determination of the concurrency among the informants about usage of herbal species and were statistically measured by the given formula (Vitalini *et al.,* 2013).

$$"RFC = FC/N\ (0 < RFC < 1)"$$

RFC stands for relative frequency citation and FC stands for citation of frequency, and indicates the number of participants that discussed a taxa whereas N stand for the overall informants. The values of RFC of a taxa and certain family of ethnopharmacological relevance are dependent percentage of informants.

The Family important value (FIV) provides the indigenous value of uncultivated medicinal species for specific family. The calculation was made by obtaining the percentage of informants (Vitalini *et al.,* 2013).

$$"FIV = FC\ (Family)\ /N \times 100"$$

Here Frequency Citation (FC) indicates number of informants mentioned about families where N signify the overall participants.

Table 2. Qualitative and quantitative floral inventory of medicinal plants of North-Eastern Balochistan.

Botanical names (Voucher No.)	Family	Traditional name	Distribution	Life form	Parts used	Therapeutic uses	Mode of preparation	Tropical or Oral	UR*	FC*	RFC*	MUV*	FC	FL*
Achillea santolina L. (TMP.1)	Asteraceae	Zahwal	Pishin	Annual herb	Entire plant	Typhoid fever	Decoction	Oral	8	9	0.06	0.84	4	53
Achillea wilhelmsii C. Koch. (TMP.2)	Asteraceae	Zawal	Ziarat, Pishin	Annual herb	Entire plant	Malaria fever	Powder	Oral	4	8	0.04	0.52	6	60
Seriphidum quettense (Podlech) L. (TMP.3)	Asteraceae	Shena terkha	Ziarat Pishin	Under shrub	Leaves	Stomach gases, Digestion	Extracts	Oral	9	12	0.3	0.61	7	100
Artemisia herba-alba Asso (TMP.4)	Asteraceae	Spena terkha	Pishin Ziarat	Herb	Stem, Leaves	Diabetes, Stomach ache	Crude leaves extracts	Oral	9	8	0.03	0.32	5	70
Centaurea cyanus L. (TMP.5)	Asteraceae	Kuragh	Pishin, Muslim Bagh	Herb	Leaves, Flower	Diabetes	Crude leaves	Oral	2	4	0.5	0.10	2	21
Pulicaria undulata L. (TMP .6)	Asteraceae	Zarrai terkha	Quetta, Pishin	Annual herb	Flowers	Typhoid fever	Extracts	Oral	8.7	3	0.10	0.32	4	100
Hertia intermedia Kuntze. (TMP.7)	Asteraceae	Gongan	Pishin, Ziarat	Under shrub	Leaves	Cough , Sore throat	Powder	Oral	2	2	0.6	0.12	2	20
Astragalus tribuloides Delile (TMP.8)	Papilionaceae	Sera makhii	Ziarat, Muslim Bagh	Shrub	Seeds, Leaves	Sore throat, Infection, Fever	Powder	Oral	3	3	0.5	0.23	3	24.3
Berberis balochistanica Beng. (TMP.9)	Berberidaceae	Zarlag	Ziarat, Muslim Bagh	Shrub	Leaves, Stem	Fracture, Wounds	Powder	Oral	9	5	0.4	0.22	4	81
Berberis lyceum Royle (TMP.10)	Berberidaceae	Zaralg	Pishin, Muslim Bagh	Shrub	Stem	Bronchitis, Throat fever	Powder	Oral	8.4	3	22.2	0.75	3	75
Eremurus stenophyllus (Boiss. & Buhse) Baker (TMP.11)	Xanthorroeaceae	Shazgee	Muslim Bagh, Pishin	Annual herb	Leaves, Stem	Arthritis, Joint pain	Crude extracts	Massage /rubbing	4	4	0.3	0.75	4	45.2
Ephedra ciliate Fisch & C.A.Mey (TMP.12)	Ephedraceae	Omman	Muslim Bagh, Pishin, Ziarat	Shrub	Leaves	Cough, Sore throat, Flue	Extract	Oral	5	6	0.8	0.22	6	65
Ephedra geradiana Wall. (TMP13)	Ephedraceae	Omman	Pishin, Ziarat	Shrub	Leaves	Asthma, Sore throat	Extracts	Oral	5	5	0.9	0.32	5	67.5
Eremostachys vicaryi Benth.ex Hook.F. (TMP.14)	Lamiaceae	Satagh	Muslim Bagh. Pishin	Annual herb	Stem	Asthma	Crude form	Oral /edible	3	3	0.8	0.25	4	32.2
Mentha arvensis L (TMP.15)	Lamiaceae	Shena podina	Quetta, Pishin	Annual herb	Leaves	Food poising, Diarrhoea	Extracts	Oral	3	2	0.5	0.22	4	38.4
Pervoskia abrotanoides Kar. (TMP.16)	Lamiaceae	Shenshobaii	Ziarat, Pishin	Under shrub	Leaves, Flower	Skin allergy, High blood pressure	Crude extracts	Washing of infected body part	4	3	0.4	0.32	6	34
Saliva bucharica Popov. (TMP.17)	Lamiaceae	Sera sursanda	Churmian, Muslim Bagh	Annual herb	Leaves, Flower	Typhoid, Malaria	Crude extract	Oral	5	4	0.6	0.42	5	43.3
Salvia cabulica Benth. (TMP.18)	Lamiaceae	Spena sursanda	Muslim Bagh, Churmian	Annual herb	Flower, Leaves	Dysentery, Fever	Crude extracts	Oral	4	5	0.6	0..42	6	42.4
Thymus linearis Benth. (TMP.19)	Lamiaceae	Tora morii	Ziarat, Churmian	Annual herb	Whole plant	Fever, Flue	Powder	Oral	8.7	3	0.5	0.40	5	53.5
Thymus vulgaris Linn. (TMP.20)	Lamiaceae	Spena morii	Pishin, Muslim Bagh	Annual herb	Whole plant	Pneumonia, Asthma	Extract	Oral	8.7	3	0.7	0.34	6	52.4

Table 2. (Cont'd.).

Botanical names (Voucher No.)	Family	Traditional name	Distribution	Life form	Parts used	Therapeutic uses	Mode of preparation	Tropical or Oral	UR*	FC*	RFC*	MUV*	FC	FL*
Ocimum basilicum L. (TMP.21)	Lamiaceae	Niazboo	Quetta, Pishin	Herb	Leaves, Flower	Head ache, Depression	Extract	Oral	3	3	0.3	0.32	3	24
Prunus eburnean Aitch. (TMP.22)	Rosaceae	Spena zera	Pishin, Ziarat	Annual herb	Seeds, Fruit	Digestion, Stomach gases	Powder	Oral	4	5	0.4	0.12	7	47
Rosa begeriania Schreenk ex Fisch & C.A.Meey. (TMP.23)	Rosaceae	Serrii/Nangan	Churmian, Muslim Bagh	Perennial shrub	Fruits, Seeds	Food poisoning	Fruit	Oral	5	3	0.4	0..33	5	32.4
Rosa indica L. (TMP.24)	Rosaceae	Gul gulab	Quetta, Pishin	Perennial shrub	Flowers	Eye problem, Skin disease	Extracts	Oral	6	7	0.5	0.13	7	52.5
Plantago ciliata Desf. (TMP.25)	Plantaginaceae	Speghole chelka	Ziarat, Pishin	Herb	Seeds, Fruits	Constipation, Maintenance of cloistral	Crude form	Oral	5	3	0.9	0.34	6	64.4
Plantago lanceolata Linn. (TMP.26)	Plantaginaceae	Kushni barthung	Churmian, Ziarat	Herb	Seeds	Throat, Chest infection	Crude form	Oral	5	3	0.8	0.42	5	62.3
Plantago major L. (TMP.27)	Plantaginaceae	Barthung	Pishin, Muslim Bagh	Herb	Fruits, Seeds	Cough, Chest infection	Crude form	Oral	4	5	0.7	0.84	4	73.5
Morus alba L. (TMP.28)	Moraceae	Speen tooth	Quetta, Pishin	Tree	Fruits	Constipation	Crude form	Oral	4	4	0.4	0.44	5	43.2
Morus nigra L. (TMP.29)	Moraceae	Tore tooth	Ziarat, Pishin	Tree	Fruits	Sore Throat, Allergy	Extract	Oral	6	3	0.3	0.14	6	37
Morus serrate Roxb. (TMP.30)	Moraceae	Shehtooth	Pishin, Ziarat	Tree	Fruits	Cough, Sore throat	Extract	Oral	5	4	0.3	0.52	4	34.5
Ficus carica L. (TMP.31)	Moraceae	Inzeher	Quetta, Pishin	Tree	Fruits	Constipation, Digestion	Crude fruit	Oral	4	3	0.4	0.24	3	53.4
Ficus palmata Forssk. (TMP.32)	Moraceae	Inzeher	Pishin, Quetta	Tree	Fruits	Constipation, digestion	Crude fruit	Oral	6	4	0.6	0.16	5	50.6
Ferula baluchistanica Kit (TMP.33)	Apiaceae	Steagh	Muslim Bagh, Churmian	Herb	Stem, Fruits	Bronchitis, Asthma	Crude form	Oral	5	6	0.4	0.32	4	24
Bunium cylindricum Boiss & Hoh. (TMP.34)	Apiaceae	Spena Zehera	Ziarat, Pishin	Annual herb	Fruits, Seeds	Cold Fever	Powder	Oral	4	7	0.3	0.13	5	43.2
Bunium persicum B.Fedtsch (TMP.35)	Apiaceae	Tora Zera	Hernai	Annual herb	Seeds, Fruits	Gastric problems	Powder	Oral	3	5	0.5	0.44	6	44.5
Sisymbrium irio Linn. (TMP.36)	Brassicaceaee	Khaksheer	Pishin, Ziarat	Annual herb	Seeds	Constipation, food poisoning	Crude form	Oral	8.5	5	0.4	0.32	5	56.4
Brassica rapa L. (TMP.37)	Brassicaceaee	Rai	Ziarat, Pishin	Herb	Seeds	Gastric problems	Powder	Oral	3	4	0.3	0.52	6	48.4
Brassica nigra L. (TMP.38)	Brassicaceaee	Tora Aurra	Muslim Bagh, Ziarat	Herb	Seeds	Gastric problems	Crude seeds	Oral	4	3	0.6	0.42	5	40
Solanaceae *Withania coagulans* Dunal (TMP.39)	Solanaceae	Khamazori	Harnai	Herb	Seeds, Fruits	Gastric problems, Constipation	Crude form	Oral	8.5	3	0.7	0.32	6	33.4
Solanum nigrum L. (TMP.40)	Solanaceae	Angoor tolla	Pishin, Quetta	Herb	Fruits	Cough, Sore throat	Powder	Oral	3	5	0.4	0.62	5	21

Table 2. (Cont'd.).

Botanical names (Voucher No.)	Family	Traditional name	Distribution	Life form	Parts used	Therapeutic uses	Mode of preparation	Tropical or Oral	UR*	FC*	RFC*	MUV*	FC	FL*
Datura strimonium L. (TMP.41)	Solanaceae	Bojen botii	Pishin, Ziarat	Herb	Seeds	Throat infection	Powder	Oral	5	5	0.5	0.12	5	23
Tulipa biebersteiniana L. (TMP.42)	Liliaceae	Zerr khatol	Pishin, Ziarat	Herb	Flowers, Seeds	Stomach problems	Powder	Oral	4	6	0.3	0.53	6	34.2
Tulipa lehmanniana Merckl.ex Bunge (TMP.43)	Liliaceae	Sor khatol	Ziarat, Pishin	Herb	Flowers, Seeds	Gastric gases	Powder	Oral	5	3	0.5	0.44	5	30
Tulipa stellate Hook (TMP.44)	Liliaceae	Spen khatol	Pishin	Herb	Flowers	Digestion	Powder	Oral	6	4	0.4	0.36	6	31.5
Gegea conjungenus Wendelbo (TMP.45)	Liliaceae	Arghuch	Pishin	Herb	Blubs, Flowers	Ulcer	Powder	Oral	3	5	0.2	0.22	5	28
Fraxinus xanthpxyloides DC. (TMP.46)	Oleaceae	Shungan	Pishin	Tree	Seeds	Arthritis, Joints pain	Crude form	Oral	5	4	0.4	0.33	4	26
Olea ferruginea Royl, (TMP.47)	Oleaceae	Zaitoon	Ziarat	Tree	Seeds	Back ache, Joints pain	Oil extracts	Oral	4	5	0.6	0.54	5	47
Cassia senna Linn. (TMP.48)	Caesalpiniaceae	Sanna gettii	Ziarat	Perennial herb	Leaves	Constipation, Gastric problems	Decoction	Oral	4	6	0.3	0.55	6	52
Peucedanum aucheri. Boiss (TMP.49)	Apiaceae	Raghboli	Pishin, Ziarat	Herb	Whole plant	Bronchitis, Asthma	Crude form	Oral	5	5	0.5	0.34	7	33.2
Artemisia turanica Krasch. (TMP.50)	Asteraceae	Tora terkha	Churmian	Herb	Whole plant	Skin allergy	Powder	Decoction	4	4	0.5	0.33	5	23.4
Taraxacum glaucanthum (Ledeb.) DC. (TMP.51)	Asteraceae	Shendarazi	Churmian	Herb	Whole plant	Digestion, Stomach aches	Crude form	Oral	3	3	0.3	0.21	4	21.3
Solanum tuberosum L. (TMP.52)	Solanaceae	Patata	Pishin	Herb	Fruits	Skin burning	Crude form	Paste	3	4	0.6	0.16	3	24
Teucrium stocksianum Boiss. (TMP.53)	Lamiaceae	Karpola	Churmian	Herb	Seeds	Ulcer, Constipation	Decoction	Oral	4	6	0.4	0.25	5	23.4
Punica granatum L. (TMP.54)	Punicaceae	Anar	Quetta, Pishin	Tree	Seeds, Straw	Diarrhoea, Motion	Decoction	Oral	6	4	0.5	0.24	6	32.2
Ixiolirion tatarium Pall. (TMP.55)	Amaryllidaceae	Chenaskey	Churmian, Khanozai	Herb	Whole plant	Eye problems	Crude form	Oral	3	3	0.3	0.32	4	23
Fumaria indica Pugsley (TMP.56)	Papaveraceae	Shatta	Roadh Mulazai, Ziarat	Herb	Seeds	Pregnancy	Decoction	Oral	5	4	0.4	0.51	6	50
Salix acmophylla Boiss (TMP.57)	Salicaceae	Tora walla	Pishin, Khanozai	Tree	Leaves	Skin allergy	Boil in water and use for ablution	Dermal	3	4	0.5	0.10	4	22.3
Conyza bonariensis (L.) Cronqust. (TMP.58)	Asteraceae	Booch	Ziarat, Quetta	Herb	Whole plant	Vomiting, Diarrhoea	Powder	Oral	3	3	0.6	0.30	5	23
Zizyphus jujuba (TMP.59)	Rhamnaceae	Malangan	Churmian, Ziarat	Herb	Whole plant	Stomach problem	Powder	Oral	4	3	0.3	0.13	4	32.4
Juniperus excelsa M. Bieb. (TMP.60)	Cupressaceae	Obeshtta	Ziarat, Pishin	Tree	Seeds	Joint pain, Fever	Powder	Oral	4	5	0.4	0.31	6	45

Table 3. Informant consensus factor for disease categories.

Categories of Diseases	Number of use reports	% Of use reports	Number of taxa	% Of taxa used	Factor of informant consensus (ICF)
Gastrointestinal disease, Gastric gases, constipation, vomiting	28	32	19	11.4	2
Infectious disease, Sore throat, Flu, Cough, Cold	24	28	8	4.8	1.64
Dermatological problems (Antiseptic, leprosy, skin allergy Dermal diseases	22	26.3	17	9.8	0.44
Respiratory infections/pulmonary disorder, Bronchitis, Pneumonia	20	23.4	15	10.3	0.43
Ophthalmological disorders (Eye disease)	3	6.5	2	4.31	0
Arthritis/joint pain, Muscular and body aches	18	21	3	5.12	0.25
Typhoid fever	7	12.3	4	6.32	0.13
Depression/Anxiety, Head ache	6	9.4	8	7.65	0.10
Endocrine disorder Diabetes, Hepatitis, liver Cancer	10	13.5	9	7.31	0.24
Orthopaedic disorder (Injuries and bone fractures)	5	8.34	4	6.23	0.23
Gynaecological disorder (pregnancy complications)	4	7.83	1	4.76	0.31
Cardiovascular disease (Cardiac diseases), Hypertension	12	16.4	3	4.26	0.11
Ulcer & Piles Problem	4	7.32	5	7.34	0.10
Hypertension (high blood pressure), high Cholesterol	7	9.30	2	4.21	0.21
Malaria &seasonal fever	6	9.75	3	5.43	0.22

Here, N is the overall Number of informants participated in the study

Level of fidelity (FL.): In order to visualize the highly therapeutic species for curing the specific disorder, level of fidelity (FL) index was applied. Sometime the inhabitants may use more than single species to cure the similar group of diseases.

If the fidelity level value is high it shows highest number of the species utilization for the treatment of specific illness.

Fidelity level is calculated via below given formula (Friedman *et al.*, 1986).

$$FL\,(\%) = IP/IU \times 100$$

whereas, IP represent frequency of informants that freely pointed out the species usage with similar major disorders and IU is the overall informant frequency that discussed species with highly diagnosed aliments.

Informant consensus factor (ICF): The informant consensus factor was calculated based on categorizing species into 15 groups to treat various aliments (Table 3). The ICF calculations were made by the help of formula given (Heinrich *et al.*, 1998).

$$\text{“}ICF = Nur - Nt/Nur - 1\text{”}$$

Here Nur stand for the frequency specific disorder group, and N is the number of species to treat specific aliment group. The ICF gives a measures ranging from 0 to 1. High value ICF indicates the limited category of species utilized to treat a specific disease group. While lowest ICF values (closed to zero) shows that species is rarely ethnomedicinally used.

Results and Discussion

Socio-demographic brief of participants: The demographic information including local people, THPs, gender, education, experience, and the mother language of the study all participants is given in Table 1. Variations in occupation, status, gender, age, ethnicity and education play an essential role in the diversity of folk knowledge that exists among indigenous peoples (Asowata-Ayodele *et al.*, 2016). Ethnomedicinal uses reported species were documented from 300 study participants, including 200 indigenous peoples and 100 traditional health practitioners. Traditional healers play a major role in primary health care systems in an area where modern health facilities are limited (Albejo, 2018). Majority of informants were males (70%) while females were 30%. Umair *et al.*, (2017) also documented in their survey that prevalence of male participants was higher than female is due to the fact that females of the study area were hesitate in conversation with male interviewers. Regarding inequality of participation of gender, a smaller number of participation of females was due to cultural rules. In educational perspective, most of the informants had either primary educated (50%), 8 years secondary educated (30%) or 20% was graduated. This socioeconomic aspect of the participants in the research was found to be consistent with the study carried out elsewhere (Paksoy *et al.*, 2016). Regarding experience, majority of the THPs ranged from 2 to 5 years while least number of THPs were found having experience of less than 2 years in herbal recipes as global communities transmission of ethnobotanical knowledge of medicinal is accelerated.

It is pertinent to mention that some reported species were widely used as herbal medicines in herbal markets could not be found and collected in fields due to severe drought and over grazing. Some of them are *Heliotropium remotiflorum, Dionysia lacei*. The morphological similar identified species of a genera might be considered such as species of *Allium* called (Anjawori) the wild (Peyaz), similarly *Artemisia* or *Seripidium* genus like *Seripidium alba-herba*, *Seripidum vulgaris* was both named as (Terkha in Pashto), though their morphology are also different. Both species reported are used by indigenous people for gastric gases adults, children being produced during feeding of new born babies (Bibi *et al.*, 2014).

Medicinal plants diversity and their ethno-medicinal usage: A total of 60 ethnomedicinal plant species belongs to 20 families, along with their ethnomedicinal uses, part used, methods of utilization and herbal recipes, have been recorded from different communities in the North-Eastern Balochistan (Fig. 2). The detailed information including taxonomic name, local names, part used, mode of preparations, ethnomedicinal uses and quantitative indices count were presented in Table 2.

In life forms, the maximum of the reported plant species were herbs (55%), followed by under shrubs (20%), shrubs (15%) while tress (10%) was least collected plant species as summarized in Figure 3. The dominant use of herbaceous form might be the easy availability and collection of these plant species. Herbs are primarily reported in ethnomedicine due to easy reachable, and bioactive compounds which are effective for the health of humans and animals to treat diseases and disorders (Voeks & Leony, 2004). The earlier findings of (Baydoun *et al.*, 2015) stated that due to their medicinal properties, herbs were used dominantly in herbal preparation and also played a great role in the preparation of various human ailments and served as the basis for therapeutic indications. According to Panickar (2013), herbs have rich history in traditional medicine because they were used to cure a number of chronic diseases.

Fig. 2. Field pictorial photographs of selected medicinal plants (A) *Salvia buchrica* (B) *Tulipa bieberstenina* (C) *Pulicaria undulata* (D) *Tulipa lehmanniiana* (E) *Plantago ciliata* (F) *Sisymbrium irio* (G) *Saliva cabulica* (H) *Achillea santolina* (I) *Cyanus segetum.*

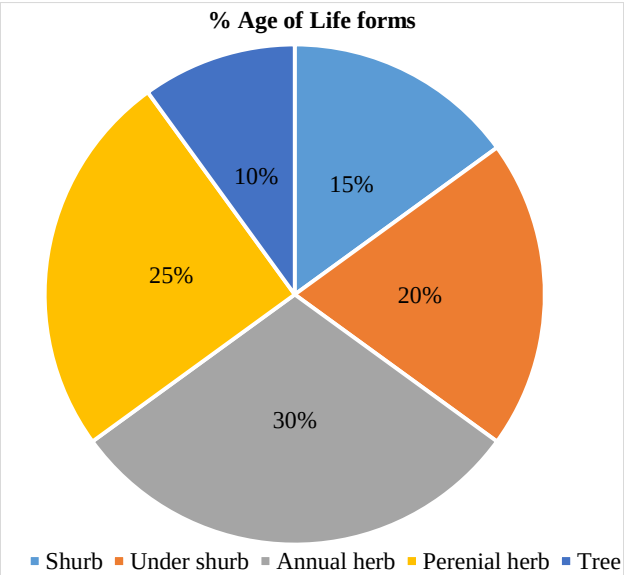

Fig. 3. Life form classification of reported ethnomedicinal species.

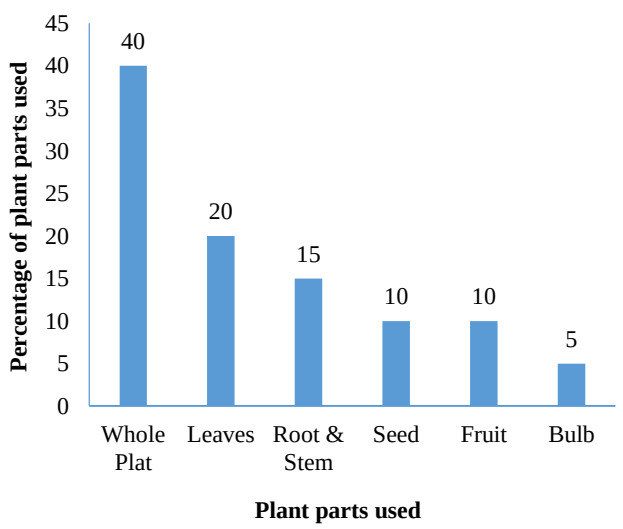

Fig. 4. Graphical representation of plant parts used in percentage.

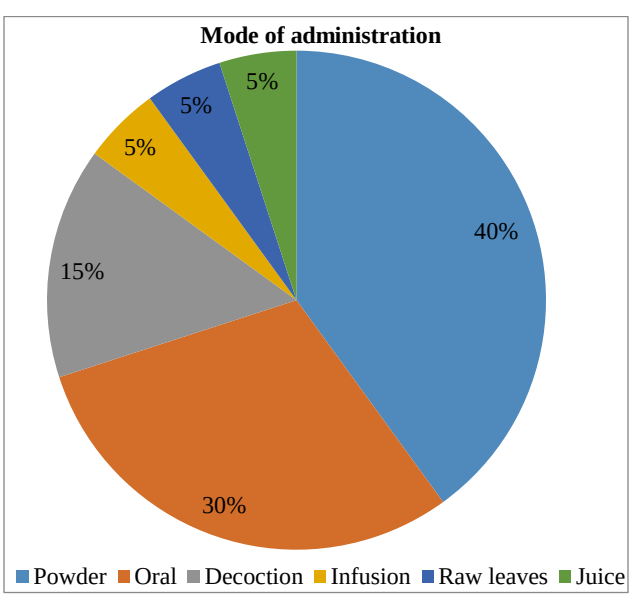

Fig. 5. Graphical illustration showing mode of utilization.

Among the highly reported families, based on the number of species were: Asteraceae and Lamiaceae (10 species each), Moraceae (5 species), Apiaceae, Liliaceae, Solanaceae (4 species each), and Rosaceae, Plantaginaceae, and Brassicaceae (3 species each) and Ephedraceae and Oleaceae (2 species each) as shown in (Fig. 6).

Most importantly, the Asteraceae and Lamiaceae were the dominant families having high frequency of medicinal taxa utilized by local inhabitants of Balochistan. The dominance of the species of these families is indicated by their frequent use in traditional ethnomedicine, which are easily available or preferred over other species of medicinal plants. The plant species belonging to above commonly cited families have also been reported in earlier studies for their medicinal importance indicating the reason behind frequent reports of species (Wodah & Asase, 2012). It was observed that certain readily available plant species were favoured by individuals from specific areas. This observation was also substaintiated by the findings of Stepp & Moerman (2001). Local people thought that legumes were an essential source of protein, dietary fiber, carbohydrates and dietary minerals.

Categories of use and use reports of area: The highest number of 19 species were observed to be utilized for curing children's gastric problems of both new born babies followed by infectious diseases, sore throat, cough for which 8 species were used, 17 species were used for dermal problem, skin allergy, followed by arthritis, muscular pain for (3 species), followed by dermatological disorders with 6 species, eight species for depression (Table 3).

Different types of gastrointestinal problems among children of all ages are quite prevalent and common among local communities around the world, and a variety of ethnomedicinal species were are being used as a treatment for illness (Ankli *et al.*, 1999; Bennett & Prance, 2000). Gastro disease was the first utilized category in many parts of the world, according to ethnopharmacological research (Miraldi *et al.*, 2001; Ghorbani, 2005; Ghorbani *et al.*, 2011; Mosaddegh *et al.*, 2012). Gastric problems have expanded throughout the study area and have also been reported from the majority of the world due to weak dietary conditions, especially in children who are not breastfed for at least six months and are given whiteners as dry milk (Nasabs & Khosravi, 2014). Meanwhile, Ullah *et al.*, (2013), and Sadeghi *et al.*, (2014) agreed with the findings of (Bibi *et al.*, 2014), who reported digestive issues in District Mastung Balochistan, Pakistan.

Plant parts used, administration route and method of preparations: The entire plant (40%) were the predominantly used for preparation of herbal recipes, followed by leaves (20%), root and stem (15%), seeds (10%), fruit (10%) while least reported parts used were bulbs (5%) (Fig. 4). These findings of our research are in line with Bibi *et al.*, (2014) who reported frequent use of the entire plants by local inhabitants. Traditional healers often use herbs and trees as medicine in literature because of their easy availability (Parthiban *et al.*, 2016). On the other hand, the result of this study was not in agreement with the findings of (Maneenoon *et al.*, 2015) which

reported that underground parts and whole plant were the most used parts. The predominance of leaves in herbal therapies may be attributed to their abundance, their richness in secondary metabolites and a collection of leaves would be much easier and sustainable than that of roots or flowers (Benarba, 2016). The use of leaves for the treatment of diseases focuses on the fact that leaves are the primary photosynthetic organ that are most readily available and usable throughout the year (Bhushan & Kumar, 2013). A number of informants reported in this study indicated leaves are the very important part and are widely used by local communities.

In present study, powder was predominantly reported (40% reports), followed by oral mode (30%), decoction (15%), infusion (5%), raw leaves (5%) and juice (5%) as depicted in Figure 5. Powder is made by crushing and grinding of dried plant parts while decoction can be prepared by putting plant part in boiling water until quantity of water is decreased to half or requisite. Most THPs prefer powder to be used as a common utilization mode. Powders have a longer shelf-life in herbal clinics than decoctions that spoil faster, explaining the wide use of powder form in our study (Komoreng *et al.,* 2017). Powder of the plant material was reported most dominant mode of utilization (Yaseen *et al.,* 2018). Traditional healers found medicines prepared with plant powders to be more effective as the powder form allows bioactive compounds to be extracted more efficiently (Dyubeni & Lisa, 2012). Decoctions are widely recorded for several reasons in most studies (Tchicaillat-Landou *et al.,* 2018). The major reason for study is that the boiling of medicinal plants releases various metabolites which work in healing. In some cases, more than one plants are used to prepare the decoction, this type of drug preparation leads to synergism (Kamatou *et al.,* 2008). In addition, ethnomedicinal plant pastes are used to apply to the injured or distressed area or section of the body, with the plant paste often dissolving in water (5%). In this research, the predominance of powder form suggests a cultural trend in the mode of utilization.

Data Quantitative analysis

Family importance value (FIV): Asteraceae and Lamiaceae were the most dominant families (10 FIV each), followed by Moraceae (5 FIV), Apicaceae, Solanceae, and Laliaceae (4 FIV each), Rosaceae, Plantaginaceae, Brassicaceae, Ephedraceae, Berberidaceae, and Oleaceae (each with 3 FIV) species are used traditionally as ethnomedicine by folk people (Fig. 6).

Used value (UV), used report (UR) and relative frequency of citation (RFC): The largest used value data was measured for *Berberis baluchistanica*, *Seripidium quettense* and *Seripidium herba-alba*, (9 UR each), followed by *Thymus linearis, Pulicaria undulata, Sisymbrium irio* and *Withania coagulans* (8.7 UR each) and the least used report (2 UR) was measured for *Hertia intermedia and Cyanus segetum* (Table 2).

The use value was used to calculate the relative importance of the plant on the basis of the number of uses of the plant and the number of people it considers useful (Ong *et al.,* 2018). The use value is applied for determination of important species based upon reported uses. The use value ranged from 0.1 to 0.84. Highest value was reported for *Achillea santolina* (0.84) followed by *Berberis lyceum* and *Eremurus stenophyllus* (0.75 for each). The lowest value was accounted for *Salix acmophylla* and *Cyanus segetum* (0.1 each). *Berberis baluchistanica*, a commonly used plant species used to heal bone fractures, throat infections, ulcers, Diabetes, and other ailments, is a popular cure. Our ethnomedicinal documentation shows that in modern times, plants with higher UVs have been more commonly used for a variety of treatment of diseases. This is an interesting outcome and explain the importance of medicinal plants used repeatedly are biologically more active and it is not necessary for a low valued plant to become unessential or not biologically active as used value is constant in specific areas, but may vary depending on the differences in indigenous people's knowledge from area to area (Amjad *et al.,* 2020).

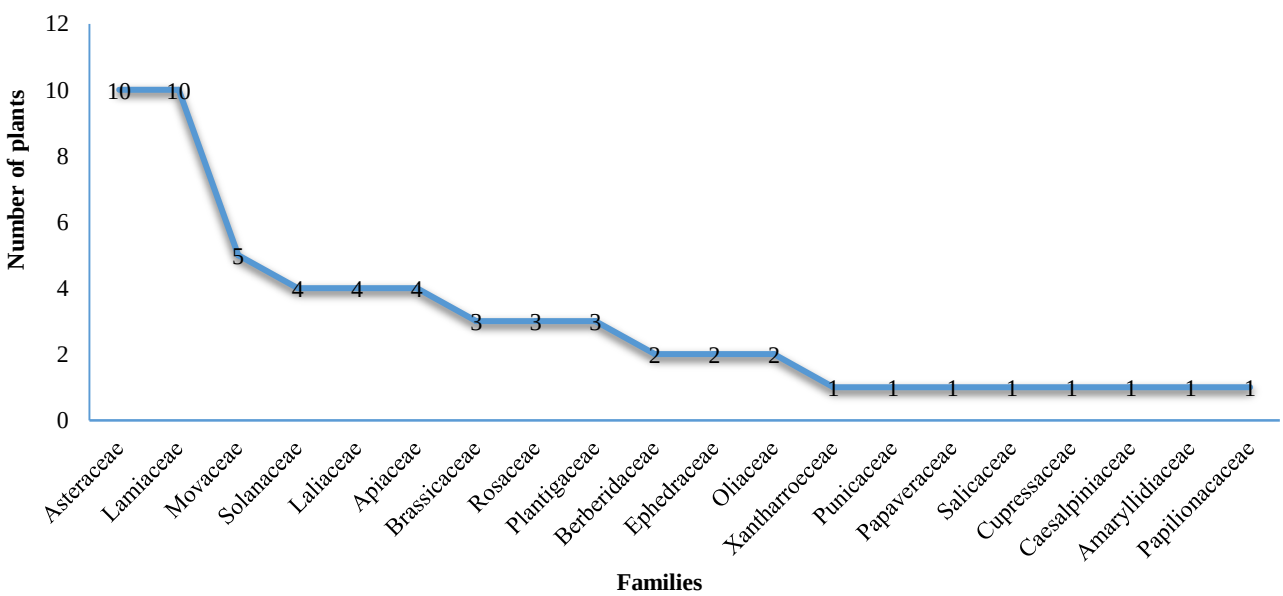

Fig. 6. Family importance value (FIV) index of medicinal plants families.

The plants species which are commonly utilized for the various diseases and disorders are assess by the relative citation frequency (RCF). RFC values were recorded highest for *Pulicaria undulata* (0.10) followed by *Plantago major* and *Ephedra balochistanica* (0.9 each) and lowest was for *Gegea conjungenus* (0.02) as mentioned in Table 2. Ethnomedicinal plant species with high RFC values have shown their abundant use and widespread awareness among local communities (Faruque *et al.,* 2018). The reasoning behind their highest RFC values may be that they are used in traditional herbal recipes. This indicates that traditional medicine practitioners are well known for their clinical virtues and their large distribution in the study area. Moreover, these species are native to the area and have long been known to local cultures. Thus, their specific properties for treating different disorders have been popularized and well known among indigenous peoples. However, Dudney *et al.,* (2015) reported that UV parameter was not capable of distinguishing between the numbers of informants citing the species or the consensus among those uses. Hence the analysis of the species significance, derived solely from the UV value, is very limited; other parameters, such as the RFC, are therefore recommended.

Level of fidelity (FL): Two species, *Seriphidum quettense* and *Pulicaria undulata*, were identified as the medicinal plants with a 100% fidelity level. Our findings showed that the greatest FL values reflected the prevalence of a particular ailment in the study area that had been treated by particular medicinal plants (Table 2). Although the local population has access to government hospitals for a modernized healthcare system, they still rely heavily on medicinal plants for their local, more accessible methods of treatment.

Informant consensus factor (ICF): The noticed range fell from 0 to 2 of informant consensus factor (ICF) as mentioned in Table 3. Gastrointestinal diseases category has maximum ICF value (02) for which highest number of species have been utilized. Bibi *et al.,* (2014) complied similar finding showing highest ICF value for the gastric disorders followed by sore throat infections on second (ICF = 1.64). The least ICF value (0) was calculated for plants utilized against ophthalmological disorder was in line with earlier findings of Jamila & Mostafa (2014).

Conclusions

This research is part of a pioneer project to measure ethnomedicinal data for the collection of commonly used native plants with highly medicinal properties and their trade in the North-Eastern of Balochistan to explore potentially useful remedies to cure the various human ailments and to assist in the preparation of ethnomedicinal databases. Based on interviews with local traditional healers, the research assessed the medicinal knowledge and remedial usage of 60 promising medicinal plants belonging to 20 plant families. Asteraceae and Lamiaceae dominate the flora. Medicinal plants with largest number of species belonged to families: Asteraceae, Lamiaceae, Moraceae, Apiaceae, Liliaceae and Solanaceae. Depending on the category of use, the families indicate various patterns of use. With regard to the medicinal plant usage, the study revealed that folk practioners still focus on the exploitation of locally available medicinal plants for the remedy of various disorders and diseases. This study documents the floristic and cultural aspects that play a vital role in defining the ethnobotanical awareness among communities of the Balochistan region and their trade to markets for herbal drug discovery development. Consequently medicinal plants cultivation and sustainable harvesting should be encouraged in this region and surely this would enhance the socio-economic condition and good health of the well beings.

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