Ethnobotanical study of Makra Hills district Muzaffarabad, Azad Jammu and Kashmir, Pakistan

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Research

Abstract

Background: It is the first ethno-botanical study to preserve the ethno-flora of Makkra hills along with their different uses to document the indigenous knowledge. This study enumerated and highlighted the ethno-botanical significance of plants for different used categories by local people in unexplored and biodiversity rich region of Makkra hills AJ&K, Pakistan.

Methods: A questionnaire method was adopted to conduct an ethno-medicinal study. A Questionnaire were filled by researcher during interviewing the local people in their native languages and data was analyzed by quantitative ethno-botanical indices such as Relative Frequency of Citation (RFC), Use Value (UV), and Relative Importance (RI).

Results: Our findings revealed 68 plant species belonging to 64 genera of 36 families were used by the inhabitants of Makkra hills for various purposes. Angiosperms were leading in number with the contribution of 62 species of ethnoflora of study area. Herbaceous flora contributed 75% of ethnoflora of study area. Leading plant families were Poacceae, Compositae and Polygonaceae. Classification of ethnoflora based on use categories revealed the most used category was medicinal with 57 plant species followed by food 26 species and 19 species with miscellaneous uses. Among plant parts usage leaves were most used parts with the representation of 26 plant species.

Three quantitative matrices were used to calculate the important ethnobotanical species of study area with their versatility in uses. Based on Use Value index and Relative Frequency Citation, *Juglans regia* showed higher values of 2.62 and 0.84 respectively. *Berberis lycium* was the most versatile species of Makkra hills having a Relative Importance value of 1.80.

Conclusions: We conclude that the people of Makkra hills are still harbouring a good knowledge due to their dependences on local flora. Conservation practices along with providence of basic facilities to the local inhabitants will be helpful to retain and recover the vegetation of Makkra hills in its original position.

Keywords: RFC=Relative Frequency Citation, UV=Used value, Mis= Miscellaneous, Traditonal knowledge, Ethnobotanical indices

Background

Throughout history, humans have harnessed the potential of wild plants for sustenance, medicinal applications, fuel, and an array of other practical uses (Shackleton *et al.,* 2011; Haq *et al.,* 2023). The gathering and utilization of these wild botanical resources hold a significant role in the livelihoods of individuals residing in less developed regions (Waheed *et al.,* 2023). The utilization patterns of plants are greatly shaped by geographical and cultural factors, molding human interactions with flora into a blend of behavior and wisdom (Morell-Hart *et al.,* 2019). Nevertheless, the invaluable treasure trove of traditional knowledge faces a perilous decline due to the erosion of ancestral cultures and the transformation of forested landscapes into alternative land uses (Haq *et al.,* 2022). This impending loss carries the risk of forever vanishing in the wake of future progress (Arshad *et al.,* 2023). Hence, it emerges as a matter of utmost importance to meticulously document and safeguard the age-old botanical insights intertwined with these plants (Haq *et al.,* 2023a).

Over the past few decades, a multitude of ethnobotanical investigations have taken place, aimed at comprehensively capturing the age-old wisdom surrounding both wild and cultivated medicinal plants (Guo *et al.,* 2022). These studies delve into the intricate tapestry of cultural, social, and economic dimensions (Kumar *et al.,* 2021). Ethnobotany's far-reaching implications span numerous domains, including its examination of the intricate interplay between humans and plants, its contribution to biodiversity preservation (with a particular focus on the preservation and propagation of indigenous and local botanical insights), and its role in meticulously cataloging data concerning regionally abundant species (Gras *et al.,* 2019). Such species hold the potential to serve as novel sources of natural remedies, offering alternatives to their synthetic counterparts.

Presently, the preservation of this vital traditional indigenous knowledge is primarily allied with the old generation (Haq *et al.,* 2021). In recent years, however, there has been a noticeable revival of interest in these traditional medicines (Bonokwane *et al.,* 2022). The realm of traditional medicine continues to flourish across various domains, encompassing both cultivated and uncultivated terrains, extending its influence across both developed and developing nations (Waheed *et al.,* 2022). Furthermore, the historical legacy of wild plants persists and seamlessly integrates with modern practices across a diverse spectrum, encompassing vital roles in animal sustenance, veterinary care, agricultural applications, cosmetic formulations, household utilities, and even spiritual and ceremonial contexts (Haq *et al.,* 2023b).

In both remote and traditional societies, individuals possess extensive knowledge about approximately 50 different plants and their therapeutic properties. This knowledge extends to around 400-600 plants used for ethnomedicinal purposes in Pakistan (Shinwari and Qaiser 2011; Arshad *et al.,* 2020; Waheed *et al.,* 2023). This valuable ethnobotanical knowledge is primarily transmitted orally across generations, gradually evolving into a distinct discipline that signifies the intricate relationship between people and plants (Haq and Singh 2020). Indigenous communities carry a wealth of information regarding the medicinal applications of various plants and their components (Arshad *et al.,* 2022; Waheed *et al.,* 2022a). The elevated ecosystems of the Himalayas are widely recognized as a focal point for researchers who are dedicated to exploring and documenting ethnobotanical treasures (Haq *et al.,* 2022a; Haq *et al.,* 2023c; Haq *et al.,* 2023d). These treasures not only provide direct financial benefits to local communities but also serve as a crucial source of medicinal resources (Haq *et al.,* 2023b). The majority of documented medicinal plants in Pakistan are believed to be concentrated in mountainous regions (Ahmad *et al.,* 2014; Ibrar *et al.,* 2015; Rashid *et al.,* 2015). As mentioned earlier, ensuring the preservation of the traditional comprehension of the ethnomedicinal importance of plants throughout different regions of the country is vital for the welfare of generations to come. Furthermore, this knowledge holds the potential to contribute to the advancement of novel medicinal solutions. Notably, there is a lack of research investigating the ethnomedicinal capabilities of indigenous plants within the current study area. Hence, the aim of this research was to systematically gather and document the traditional ethnobotanical insights regarding diverse plants across Makkra Hills Muzaffarabad, Azad Jammu and Kashmir.

Materials and Methods

Study Area

Current research study was conducted in Makkra hills of District Muzaffarabad Azad Jammu and Kashmir. The study area lies between 2500-3800m above sea level with latitude of 34°33'43.59" N and longitude of 73°35'47.56" E. District Muzaffarabad is comprised of an area of 1642 km^2 (Figure 1). At higher altitudes study area is mostly covered by snow during the year. The estimated population of the Muzaffarabad is 0.726 million with the annual growth rate of 2.80%. the average household capacity is 5.8 and population density is 442 persons per km^2 during 2015.

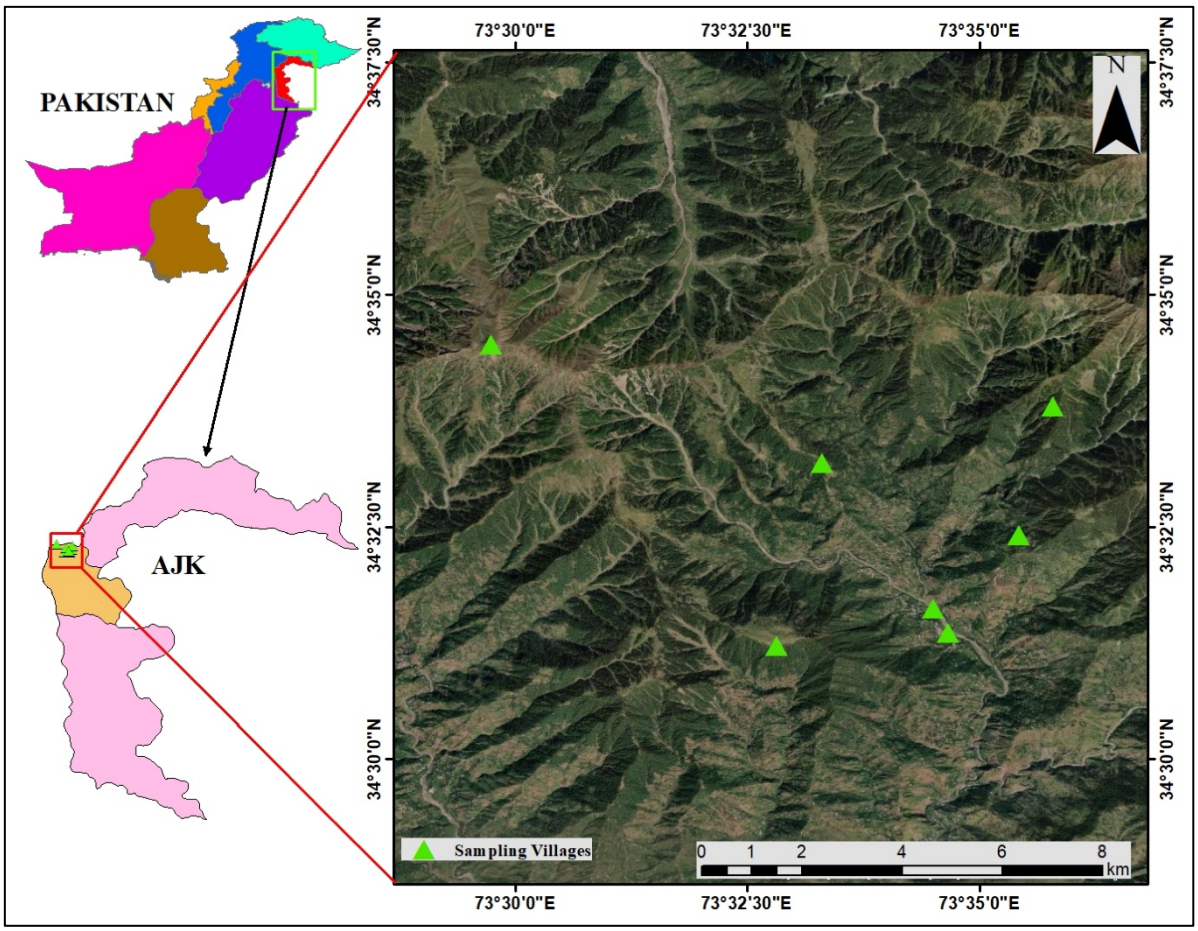

Figure 1. Map of the study area showing the locations of sampling villages.

Data Collection

Data was collected from 5 villages of Makkra hills including Rajpian, Rajkot, Gahna, Ghumoot and Makkri. 50 informants including old men (20) and women (20) as well as local Hakeems (10) were selected for ethnobotanical data collection following the Code of Ethics (The ISE Code of Ethics, 2006). A questionnaire was designed and filled by the researcher during the interview.

Plant Collection and Identification

Several visits were arranged to different villages/sites to collect data for the folk uses of the plants growing in the research area. Plants were collected with the help of locals and tagged with local names. Specimens were pressed, dried, and mounted on herbarium sheets. Specimens were identified with the help of flora of Pakistan (Stewart, 1972; Nasir and Ali, 1970-1992; Ali and Qaiser, 1993-2001) and other online available literature. Plant names were validated and authenticated by browsing each plant name in The Plant List (2013); IPNI (2012).

Quantitative data analysis

Use value (UV)

UV index is an important metric used to know the relative importance of a species (Ong and Kim,2014). It can be used by using following formula (Phillips *et al.,* 1993: Albuquerque *et al.,* 2006).

$$UV = \sum Ui/N$$

Where Ui is the total use of a species described by one informants and N is the Total number of individual interviewed.

Relative importance

RI calculate the usage of a species (Albuquerque *et al.,* 2006). It is calculated by the following formula:

$$RI = NUC + NT$$

Where NUC is the number of used categories and NT is the number of used attributes.
NUC can be calculated by the following formula:

$$NUC = NUCS / NUCVS.$$

Where NUCS is the number of used categories of a specific species and NUCVS is the number of use categories of most versatile plant species.

NT can be calculated by the following formula:

$$NT = NTS / NT.MIT$$

Where NTS is the number of use attributes of a specific species and NT,MIT is the number of uses of all categories attributes to the most versatile taxon (Phillips *et al.,* 1993).

For example, *Amaranthus viridis* is used in food and medicines it is two used categories (NUCS = 2) and in medicines, it is used for back pain, stomachache, and joint pain it has three used attributes. In the category food it is used for vegetable it is one attribute, so the total number of attributes become four. (NTS =). *Berberis lyceum* is the versatile species of the research with five use categories (NUCVS = 5) and nine attributes (NTS = 9). Now we can find the RI value for *Amaranthus virdis* by putting the above values.

Relative frequency of citation (RFC)

The ethnobotanical importance of plants can be efficiently assessed by using the RFC index. It can be calculated by the total uses of a species mentioned by the interviewees divided by the total number of informants interviewed (Kayani *et al.,* 2014). Its ranges between 0 and 1. Where 0 indicates the plant is not described by any informants and 1 represented the plant is described by all informants (Sadeghi & Mahmood., 2014). It Can be calculated by the formula:

$$RFC = FC/N$$

FC indicated frequency citation and N was the total number of informants interviewed.

Pearson Product- Moment Correlation coefficient

It is used to measure the correlation between two variables, which is the co-variance of the respective variables when divided by the product of their Standard deviation (Mukaka 2012). Greater values of variables indicate a high degree of positive correlation. It can be calculated by using RFC, UV, and RI values of plant species in past software.

Results

Flora of Makara Hills

Ethnobotanical study of Makra hills revealed a total of 68 plant species belonging to 64 genera of 36 families. Out of 68 species 3 plants belonging to 3 genera of 2 families were gymnosperms. There were three species belonging to 2 genera and 2 families of pteridophytes. Angiosperms were leading in number with the contribution of 62 species belonging to 59 genera of 31 families (Figure 2). Herbaceous flora was the most used habit of the study area with a contribution of 75% of the ethnobotanical flora of the study area. Trees contributed 13.23% followed by shrubs 7.35% and ferns 4.41%.

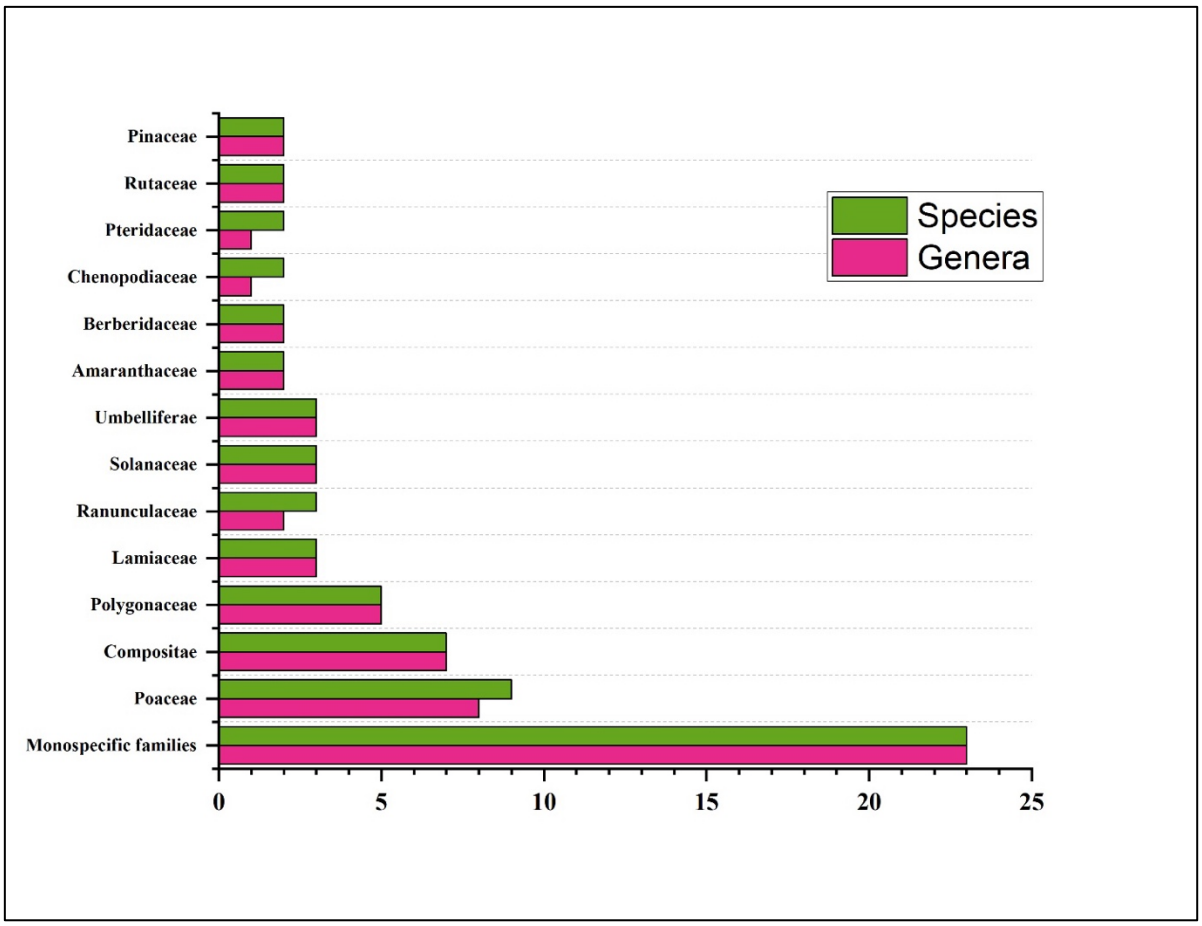

Figure 2. Distribution of species and genera in different families.

Use Categories

The Ethnoflora was classified into seven use categories (Medicinal, Fuel, Food, Timber, Furniture, Fodder and Miscellaneous). Based on use categories the most used category was medicinal with 57 plant species followed by food 26 species and 19 species with miscellaneous uses. 13 and 11 species were used as fodder and fuel respectively. 4 plants were used as timber and furniture in each category. Two plant species *Juglans regia* and *Pinus wallichiana* were most diverse in uses with the representation of 5 use categories. 8 plant species showed their usage in 4 use categories while 7 plant species with 3 use categories. 22 plants were used in two use categories and 30 plants with only in single-use category (Figure 3, Table 1).

Table 1. List of plant and ethnobotanical uses, mode of utilization, and ethnobotanical indices of recorded from Makra Hills.

Plant name	Family	Local name	Habit	Voucher No.		Part used	Mode of utilization	RFC	UV	RI
Abies pindrow Royle	Pinaceae	Rever	Tree	NSU-3744		B, Ar	Tree bark is used for cough, fever and stomach pain. Branches are used as fuel wood. Wood is used in construction of building and for furniture.	0.80	2.40	1.26
Acer caesium Wall. ex Brandis	Sapindaceae	Trakana	Tree	NSU-3745		Ar	Wood is useful in making agricultural tools and utensils. Also used as fuel, timber and making furniture.	0.70	1.40	1.11
Achillea millefolium L.	Asteraceae	Chiti booti	Herb	NSU-3746		L,Rh	Powder of dried leaves and rhizomes is used for Stomach-ache, urinary complaints, toothache, antiseptic.	0.60	0.60	0.51
Achyranthes aspera L.	Amaranthaceae	Puthkanda	Herb	NSU-3747		L, R	Leaves decoctions are given to cure diarrhea. 2 or 3 leaves are chewed for relief in toothache. A root decoction is applied to vagina to induce abortion.	0.16	0.16	0.43
Aconitum chasmanthum Stapf ex Holmes.	Ranunculaceae	Mohri	Herb	NSU-3748		Fl, Rh	Flower mixture in honey is given to asthma patient, Dried rhizomes paste used for foot and mouth diseases (Mukhar) of animals.	0.40	0.40	0.43
Aconitum heterophyllum Wall ex Royle	Ranunculaceae	Patris	Herb	NSU-3749		Rh	Paste made from Rhizome and applied on chest to cure pneumonia, fever, headache, diarrhea, cold and diabetes	0.66	0.66	0.66
Aconogonon alpinum (All.) Schur.	Polygonaceae	Chakroon	Herb	NSU-3750		Ar, R	Aerial parts are cooked as vegetables and roots are used by females in case of leucorrhea.	0.40	0.64	0.55
Actaea spicata L.	Ranunculaceae	Muniri	Herb	NSU-3751		R, F,	Decoction of dried roots and fruit used as anti-lice for humans and animals	0.20	0.20	0.28
Adiantum capillus-veneris L.	Pteridaceae	Kakwai	Fern	NSU-3752		L, Rh	Leaves infusion is used to expel phlegm and reduce Cough. Paste of dried rhizome is used externally on bites of snakes and insects.	0.34	0.34	0.51
Adiantum incisum Forssk.	Pteridaceae	Kakawa	Fern	NSU-3753		L	Leaves infusion is given to asthma patients. Crushed leaves paste is applied externally to cure skin diseases	0.26	0.26	0.35
Aesculus indica (Wall. ex Camb.) Hook.f.	Hippocastanaceae	Ban khor	Tree	NSU-3754		F	Fruit is given to overcome the weakness in humans and as a vermifuge for animals	0.54	0.54	0.35
Agrostis vernalis (M. Bieb.) Poir.	Poaceae	Ghaa	Herb	NSU-3755		Ar	Shoots are used as fodder both fresh and dried.	0.14	0.14	0.28
Ajuga bracteosa wall. Ex Beth.	Lamiaceae	Thandi jari	Herb	NSU-3756		Wp	Decoction is used to treat diabetes, skin diseases, blood purification, worm killing and stop burning of stomach.	0.70	0.70	0.58

Allium humile wall	Amaryllidaceae	Mali da payas	Herb	NSU-3757		Wp	Whole plant used as Condiment in cooking and for stomach-ache.	0.40	0.84	0.55
Alopecurus himalaicus Hook.f.	Poaceae	Ghaa	Herb	NSU-3758		Ar	Used as fodder.	0.40	0.40	0.28
Amaranthus viridis L.	Amaranthaceae	Ganyar	Herb	NSU-3759		Ar,Se	Aerial parts are used as vegetable and seeds with other medicinal plants are used for back pain, stomach-ache ad joint pain	0.50	0.72	0.71
Angelica glauca Edgew.	Umbelliferae	Chora	Herb	NSU-3760		R,L	Leaves and roots are used to cure cough, cold, influenza, constipation. Also used as condiment	0.48	0.68	0.78
Aristida abnormis Chiov.	Poaceae	Baroo	Herb	NSU-3761		Ar	Shoots are dried and used to make Brooms.	0.34	0.34	0.28
Arnebia benthamii L.	Boraginaceae	Gow zuban	Herb	NSU-3762		Rh	The dried rhizome is used for Joint pain, stomach-ache, fever, ulcer and Scurvy.	0.20	0.20	0.66
Artemisia scoparia Waldst. & Kit.	Asteraceae	Lussjaree	Herb	NSU-3763		Ar	Aerial parts infusion is given to treat patients of Jaundice and fever. Crushed shoots are also used to cure ringworm.	0.40	0.40	0.43
Arundo donax L.	Poaceae	Nari	Herb	NSU-3764		Ar	Mature stem is used to make walls also used for making utensils.	0.24	0.24	0.35
Atropa acuminata Royle ex Miers	Solanaceae	Challah lubbur	Herb	NSU-3765		L, R	Leaves and roots are given to cure cough, fever and pyrexia of animals.	0.22	0.22	0.43
Berberis lycium Royle.	Berberidaceae	Sumbal	Shrub	NSU-3766		R,B,F	Fruits are eaten. Paste of bark and roots is used to Cure joint pains, skin diseases, jaundice, piles, bleeding, stomach ulcer, backache, malaria, fractures and pain in vertebral Colum. Fruit is laxative. Shoots are used as fuelwood. Branches are used to make fences of cultivated fields for the prevention of grazers to graze crops.	0.66	1.70	1.80
Bistorta affinis (D. Don) Green. Masloon	Polygonaceae	Masloon	Herb	NSU-3767		Rh,F	Roots are used for the treatment of diarrhea, dysentery and Hoptysis as well as for the general weakness of animals. Flower and dried roots are used to make tea which is considered good for stomach problems.	0.66	0.90	0.86
Chenopodium album L.	Chenopodiaceae	Bathwa	Herb	NSU-3768		L	Fresh leaves are cooked as a vegetable, dried leaves are used in pain. Also used as fodder.	0.50	0.76	0.83
Chenopodium ambrosioides L.	Chenopodiaceae	Drubra	Herb	NSU-3769		Wp	Dried leaves are used in stomach pain. Decoction of shoots is given to children for the removal of intestinal parasites. Whole plant parts are mixed in soil to kill larva of pests.	0.34	0.48	0.63
Coriandrum sativum L. D	Umbelliferae	haniya	Herb	NSU-3770		L, F, Se	In case of indigestion, nausea, vomiting and diarrhea seeds powder along with water given for the treatment. Fresh leaves are used as flavor in many dishes. Fruits are used as condiment.	0.54	1.14	0.86

Datura stramonium L. Solanaceae	Solanaceae	Datoora	Herb	NSU-3771		L, Se	Powder of dried leaves with water taken to relieve body pain. Decoction of seeds is used for cough and asthma. Excessive use of seeds is poisonous and may cause death. Fresh leaves infusion is used for washing hairs to get rid of dandruff.	0.14	0.20	0.71
Diospyros lotus L.	Ebenaceae	Amlook	Tree	NSU-3772		F, S	Fruits are dried and eaten in winter season. Wood is used as fuel wood.	0.56	1.00	0.55
Equisetum arvense L.	Equisetaceae	Ban kaiya	Fern	NSU-3773		Ar	Shoots are dried and a concentrated decoction is made which is externally applied to wounds for the regeneration of damaged tissues, stopping bleeding and speedy healing. Shoots is also used to clean the tools used in kitchen.	0.30	0.50	0.71
Festuca kashmiriana Stapf	Poaceae	Ghaa	Herb	NSU-3774		Ar	Used as fodder.	0.34	0.34	0.28
Ficus palmata Forssk.	Moraceae	Phagwara	Tree	NSU-3775		Wp	Latex of bark is used to remove warts, spines and prickles from skin. Fruits are edible, eaten as a tonic and expectorant. Stem is used as fuel wood.	0.52	1.06	1.14
Foeniculum vulgare Mill.	Umbelliferae	Sounf	Herb	NSU-3776		L, Se	Leaves are eaten raw as mouth freshener and carminative. Fresh leaves infusion is used as gargle in sore throat. Seeds are chewed in case of bad smell and dryness of mouth.	0.32	0.40	0.78
Gentiana kurroo Royle	Gentianaceae	Bhangri	Herb	NSU-3777		Wp	Whole plant is dried and used as blood purifier	0.20	0.20	0.28
Geranium wallichianum D. Don ex Sweete	Geraniacea	Ratan jog	Herb	NSU-3778		Rh	Decoction of rhizome is used for cough and fever. Paste of crushed rhizome is applied externally for wound healing. Fresh rhizome is chewed for toothache and mouth sore.	0.14	0.14	0.51
Hypericum perfotatum L.	Hypericaceae	Dudh Jari	Herb	NSU-3779		L	Decoction of leaves is taken in case of anxiety and depression as well to boost up the mood. Green tea is made by using dried leaves.	0.40	0.60	0.71
Indigofera heterantha Brandis	Leguminosae	Kainthi	Shrub	NSU-3780		Ar, S	Bark is crushed and extract is used as vermifuge. Leaves are used as fodder; shoots are used for making ropes and used as fuel.	0.68	2.04	1.11
Inula racemosa J.D. Hook.	Asteraceae	Poshkara	Herb	NSU-3781		R	Roots oil is mixed with and used to lower the blood pressure as well as stimulation of peristaltic movements of the intestine.	0.28	0.28	0.35
Jasminum humile L.	Oleaceae	Jangli chumbali	Shrub	NSU-3782		L, Fl	Decoction of dried flowers is used as heart tonic. Leaves are used as fodder. Also cultivated in garden as ornamental.	0.34	0.70	0.83

Juglans regia L.	Juglandaceae	Akhrote	Tree	NSU-3783		L, Se, Ar	Decoction of leaves is used for blood purification and anti-asthmatic. Cotyledons of seeds are eaten with honey to boost memory and for cardiac problems. Bark of the stem is used to clean teeth. Epicarp is used as dye by using its paste after boiling in water. Wood is used for making furniture.	0.84	2.62	1.69
Medicago sativa L.	Papilionaceae	Sinjee	Herb	NSU-3784		Ar	Shoots are cooked as vegetable. Leaves used as fodder. Infusion of shots used to prevent constipation.	0.18	0.30	0.83
Mentha longifolia (L.) L.	Lamiaceae	Jungli podina	Herb	NSU-3785		L	Tea of dried leaves is used for coughs, colds, asthma, indigestion, headache and fever. Fresh leaves are used as condiment.	0.58	0.78	0.94
Oxalis corniculata L.	Oxalidaceae	Khatli booti	Herb	NSU-3786		Ar, L	Infusion of aerial parts is given to children for the removal of hook worms. Fresh leaves are eaten raw for sore taste and stimulation of saliva. Leaves are crushed with onion to obtain a juice, which is used to weather the skin warts.	0.26	0.34	0.71
Panicum miliaceum L.	Poaceae	Ghaa	Herb	NSU-3787		Ar	Used as fodder.	0.40	0.40	0.28
Persicaria alpina (All.) H.Gross	Polygonaceae	Chukaroo	Herb	NSU-3788		Wp	Dried roots powder is used for stomach-ache. Fresh aerial parts are cooked as vegetable. Dried shoots are used as vegetable in winter season.	0.42	0.60	0.63
Pinus wallichiana A.B. Jackson.	Pinaceae	Kail	Tree	NSU-3789		Ar	Skin and respiratory diseases are cured by using resins. Before using resin it is boiled in milk until milk gets dried and only resin left behind. After this resin is mixed with water and taken. Wood is valuable and used as timber. Cones and branches are used as fuel and resinous wood is used for lighting as well as fire boosting.	0.82	2.54	1.46
Plantago major L.	Plantaginaceae	Chamchi patar	Herb	NSU-3790		L, R	Paste of root is applied to skin as antidote for snake bite. Fresh leaves used as vegetable. Also leaves crushed and applied on feet for healing the heel.	0.66	0.88	0.63
Poa alpina L.	Poaceae	Ghaa	Herb	NSU-3791		Ar	Used as forage and fodder for cattle.	0.46	0.46	0.35
Poa annua L.	Poaceae	Ghaa	Herb	NSU-3792		Ar	Aerial parts fresh and dry used as fodder.	0.36	0.36	0.35
Rheum australe D. Don.	Polygonaceae	Chotyal	Herb	NSU-3793		R	Dried roots powder is mixed with mustard oil and applied on joints to get relief. Root is also used for stomach problems, headaches and wound healing.	0.32	0.32	0.51

Rumex nepalensis Spreng.	Polygonaceae	Hola	Herb	NSU-3794		L, R	Decoction of leaves and roots is used for wound healing and stops bleeding in cuts. Fresh and dried leaves are cooked as vegetable	0.56	0.74	0.63
Sambucus wightiana Wall. ex Wight & Arn.	Adoxaceae	Ghanola	Herb	NSU-3795		R	Paste made from root is applied to the injured parts of animals for wound healing.	0.30	0.30	0.28
Sauromatum venosum (Dryand. ex Aiton) Kunth	Araceae	Sur Ganda	Herb	NSU-3796		R	Root is used against cough, intestinal ailments and also given to animals to overcome weakness.	0.36	0.36	0.43
Saussurea costus (Falc.) Lipsch.	Compositae	Kuth	Herb	NSU-3797		R	Dried roots along with sugar are used for backache. Decoction of roots is given for asthma and cardiac problems.	0.60	0.60	0.43
Senecio chrysanthemoides DC.	Compositae	Baggo	Herb	NSU-3798		L, Fl	Fresh leaves and flowers are crushed. Extract is used to cure stomach and liver problems.	0.24	0.24	0.35
Sinopodophyllum hexandrum (Royle) T.S.Ying	Berberidaceae	Bankhakri	Herb	NSU-3799		L, R	Leaves and roots are crushed and applied for skin problems. Fruits are eaten raw.	0.52	0.80	0.55
Skimmia laureola (DC.) Sieb, & Zucc, ex Walp.	Rutaceae	Neira	shrub	NSU-3800		L	Decoction of leaves is given to reduce obesity. Decoction of dried leaves given to animals as insect repellent. Paste of leaves with is taken to cure cough. Leaves are also used to make fragrances in different dishes.	0.38	0.56	0.71
Solanum americanum Mill.	Solanaceae	Kach Mach	Herb	NSU-3801		F	Fruits are eaten raw and considered as blood purifiers also given to the patients suffering jaundice.	0.44	0.60	0.63
Sonchus asper (L.) Hill.	Asteraceae	Gazban	Herb	NSU-3802		Wp, L	Whole plant is given to livestock to get proper amount of milk especially when their calf is dead. Leaves are cooked as vegetable and are also considered good for abdominal pain.	0.38	0.64	0.83
Taraxacum tibetanum Hand.-Mazz.	Compositae	Hand	Herb	NSU-3803		L	Leaves are cooked as vegetable. Vegetable is considered good for diabetes patient.	0.54	0.54	0.35
Taxus baccata L.	Taxaceae	Barmi	Tree	NSU-3804		Wp	Leaves powder is used for bronchitis and asthma. Seeds are used as antiseptic while bark is used to make tea. Leaves are used as fodder in the absence of grass. Wood is used as timber and fuel.	0.38	1.04	1.26
Thymus linearis Benth.	Lamiaceae	Cheekan	Herb	NSU-3805		L, Ar	Decoction of leaves is used for stomach problems, urine suppression, shivering, constipation and dysentery. Tea of dried leaves is carminative. Dried shoots cooked with eggs and given to breast feeding mothers.	0.60	0.86	0.94

Urtica dioica L. U	Urticaceae	Kayari	Herb	NSU-3806		L	Leaves are used as diuretic and anti-allergic. Roots are crushed and applied on cuts and wounds. Paralyzed parts of the body are treated by putting plant on affected parts.	0.20	0.20	0.58
Verbascum thapsus L.	Scrophulariaceae	Gadhi kan	Herb	NSU-3807		L, Fl	Dried leaves are smoked for mental relaxation. Paste of leaves id used for wound healing. Tea of leaves is given to cure cold and dysentery. Also used as fodder. Flowers are crushed in water and used as hair dye.	0.26	0.48	1.06
Viburnum grandiflorum Wall. ex DC.	Caprifoliaceae	Guchh	Shrub	NSU-3808		Wp, F	Fruits are edible and eaten raw. Whole plant is used as fuel wood. Juice of fruit is taken as blood purifier. Shoots are used as ropes. Shoots are used as fuel wood.	0.70	1.96	1.18
Viola biflora L.	Violaceae	Banafsha	Herb	NSU-3809		L, Fl	Decoction of whole plant is given to Malaria patient or fever of any other reason. Crushed leaves and flower given as vegetable to cure liver problems.	0.30	0.48	0.71
Zanthoxylum armatum DC.	Rutaceae	Timber	Tree	NSU-3810		Wp, F	Dry powder of fruit mixed with water and salt is used for stomach-ache. This recipe is also considered as general body stimulant. Also used as condiment to make chutney. Young branches as used to make toothbrush (Miswak) to clean teeth and also for relief in toothache. Whole plant is used as fuel wood as well as making fence.	0.58	1.10	1.34
Zea mays L.	Poaceae	Mak	Herb	NSU-3811		Ar, Se	Cultivated in the fields to gain grains and fodder for livestock. Corn flour is used for making breads and other local recipes. Stem is chewed by children as a substitute of sugar cane. Different herbal remedies are administered to livestock by mixing them with corn flour.	0.78	1.90	1.26

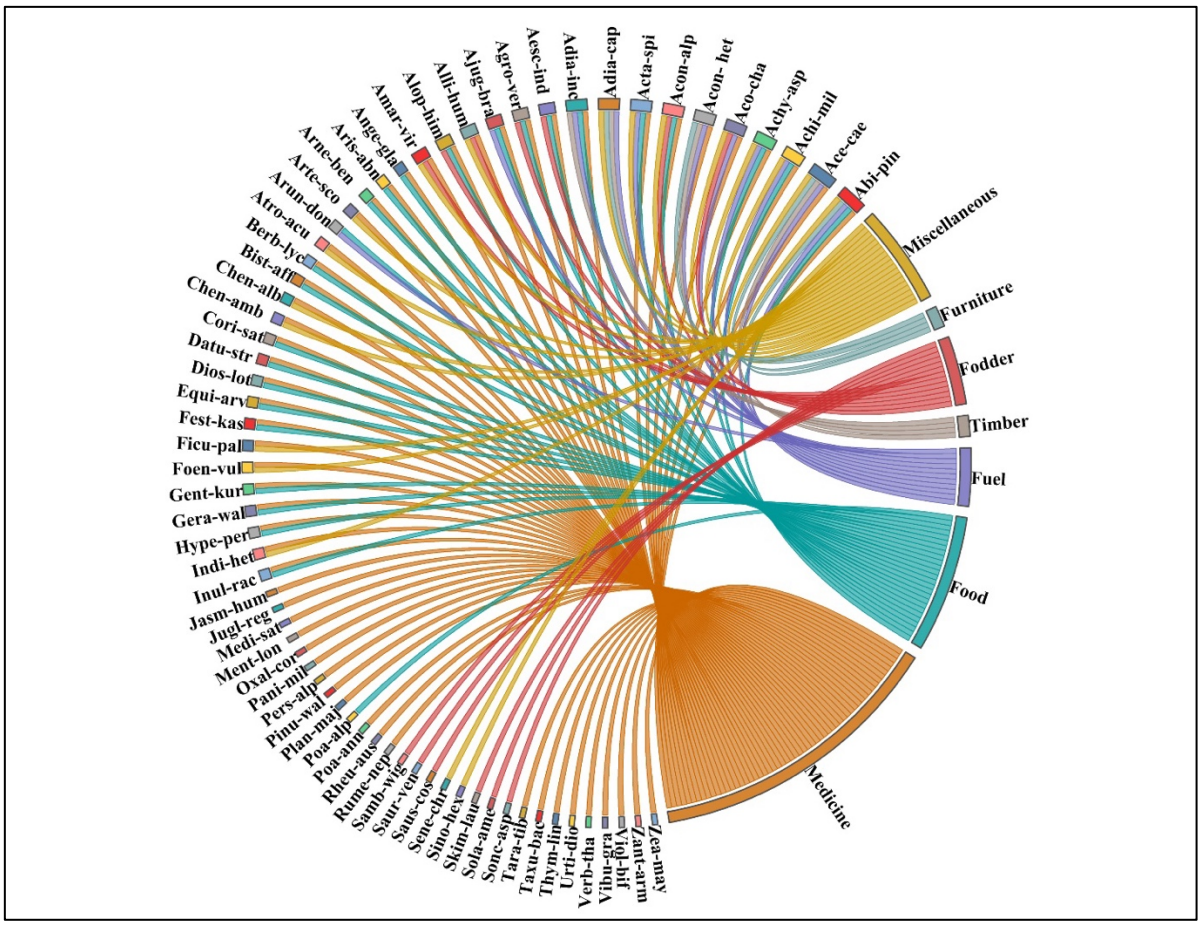

Figure 3. Chord diagram plant use categories with a respective species recorded from Makra Hill Azad Jammu and Kashmir.

Uses of plant parts

Plant parts usage varies in accordance with different use categories. Among plant parts usage leaves were the most used parts with the representation of 26 plant species. 21 species of aerial parts were used by the locals of Makra Hills. From underground parts roots of 11 species and Rhizomes of 10 species were used. Among reproductive parts, the fruit of 9 species, a seed of 6, and a flower of 5 species were used by local inhabitants. More than one part of many plant species was used for different purposes (Figure 4).

Use value (UV) of plant specimens

UV is a very important index for measuring the uses of plant species and the information level of inhabitants about plant species. *Juglans regia* (2.62) was the species with a high UV value in the study area. Other high UV values-bearing species were Pinus wallichiana (2.54), *Abies pindrow* (2.40), *Indigofera heterantha* (2.04), *Viburnum grandiflorum* (1.96), *Zea mays* (1.9) and *Berberis lycium* (1.7). Species with lower UV values were *Agrostis vernalis* (0.14), *Geranium wallichianum* (0.14), *Achyranthes aspera* (0.16), *Datura stramonium* (0.2), *Urtica dioica* (0.2) and *Actaea spicata* (0.2).

Relative Frequency of Citation (RFC)

The highest value of RFC was shown by *Juglans regia* (0.84), which indicates most of the informants were aware of its uses. The lowest values species were *Datura stramonium* (0.14), *Agrostis vernalis* (0.14), *Geranium wallichianum* (0.14), *Achyranthes aspera* (0.16) and *Medicago sativa* (0.18). *Pinus wallichiana* (0.82), *Abies pindrow* (0.80), *Zea mays* (0.78), *Viburnum grandiflorum* (0.70), *Ajuga bracteosa* (0.70) and *Acer caesium* (0.70) were other important species with high-frequency citation.

Relative Importance

It shows how much a species is useful for different purposes. Results showed it range from 1.80 for *Berberis lycium* to (0.28) for *Agrostis vernalis* and 7 other species. The RI value of *Berberis lyceum* showed its diverse uses, as medicinal, fuel, food and miscellaneous. Among medicinal it was used to cure joint pains, skin diseases, piles, pain in vertebral column, bleeding, stomach ulcer, backache, malaria, and fractures. Other high RI value species were *Juglans regia* (1.69), *Pinus wallichiana* (1.46), *Zanthoxylum armatum* (1.34), *Abies pindrow* (1.26), *Zea mays* (1.26), *Taxus baccata* (1.26) and *Viburnum grandiflorum* (1.18). High values of RI are indicators of versatility in the usage of these plant species.

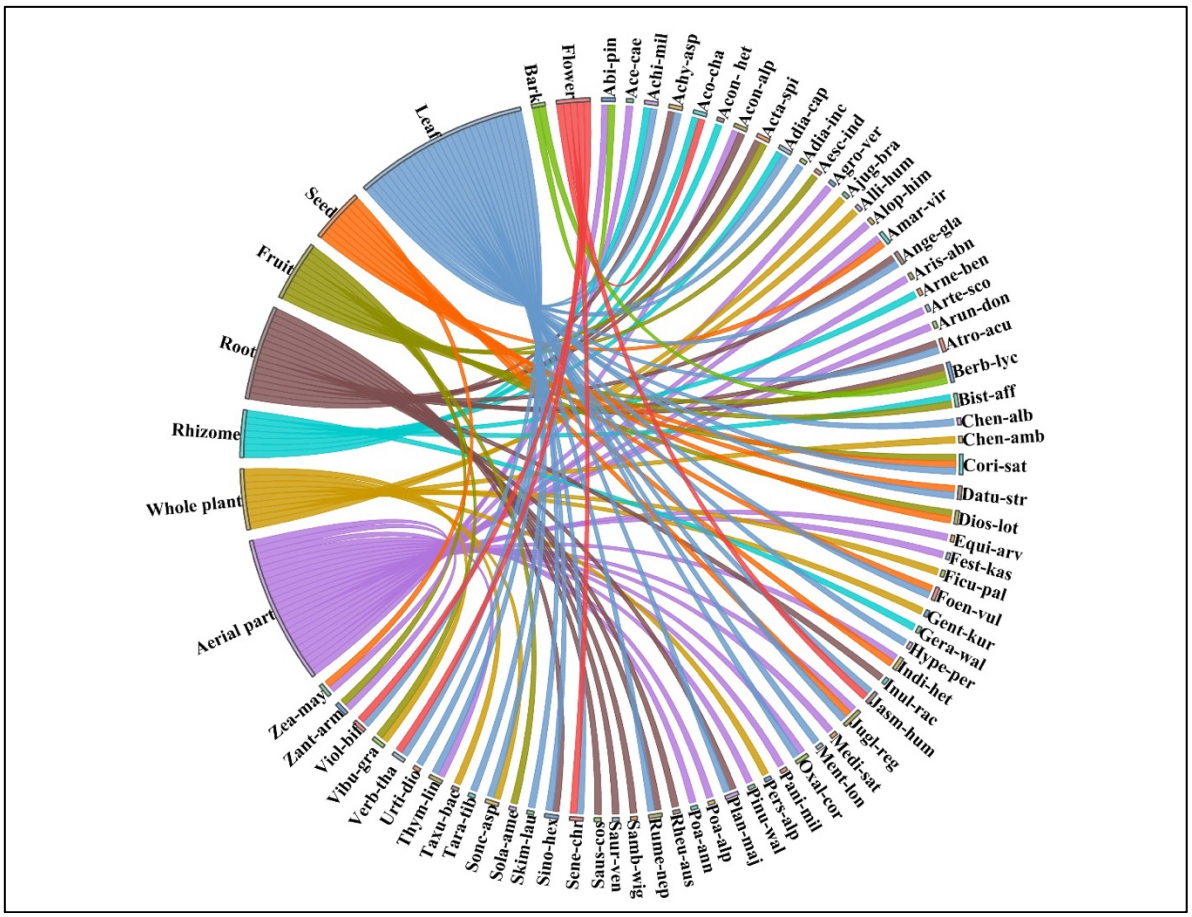

Figure 4. Chord diagram depicting the part used and species name recorded from the study area.

Discussion

Ethnobotanical exploration showed a total of 68 plant species belonging to 64 genera of 36 families were used by people of Makra hills for different purposes. Among them, angiosperms were the leading component with the representation of 68 taxa followed by gymnosperms and angiosperms 3 species each. Similar results were obtained by Dar et al. (2012) with the plants uses in different categories from the neighboring study area of Makra Hills. This similarity shows peoples of the same area and culture share similar uses of plants. Our results are in line with other studies conducted in the same vegetation zones of AJ&K and Pakistan with more or a smaller number of species (Mahmood *et al.,* 2011; Singh *et al.,* 2023: Shaheen *et al.,* 2017; Mahmood *et al.,* 2012; Awan *et al.,* 2011).

Three quantitative data matrices were used for the estimation of the importance of ethnoflora of Makra Hills. Use value index (Phillips *et al.,* 1994) is an important quantitative ethnobotanical technique that compares the importance of plant species within ethnic communities with respect to their uses and species identified to prioritize for conservation practices (Albuquerque *et al.,* 2006). In Makra hills, Muzaffarabad species with the highest use values were *Juglans regia* (2.62), Pinus wallichiana (2.54), *Abies pindrow* (2.40), *Indigofera heterantha* (2.04), *Viburnum grandiflorum* (1.96), *Zea mays* (1.9) and *Berberis lycium* (1.7). These plants were used by locals for multipurpose and are under immense exploitation pressure. *Juglans regia* is also reported with highest use values from other Himalayan valleys (Khan *et al.,* 2013a; Ilyas, 2015). Such plant resources can be effectively conserved by using scientific approach with the involvement of indigenous peoples (Heywood 2011; Hill *et al.,* 2020).

Relative frequency citation is an indication of how many interviewes have mentioned a plant species being used in any use categories. Its value ranges from 0-1. Species with high RFC values were *Juglans regia* (0.84), *Pinus wallichiana* (0.82), *Abies pindrow* (0.80), *Zea mays* (0.78), *Viburnum grandiflorum* (0.70), *Ajuga bracteosa* (0.70) and *Acer caesium* (0.70). Greater RFC values indicates the majority of the population relies on these taxa and needs to be conserved for the sake of future perspectives. These species were also reported by many ethnobotanical explorers of western Himalayas (Dar *et al.,* 2012; Bano *et al.,* 2013; Shaheen *et al.,* 2011).

Relative Importance is also another quantitative index of ethnobotany which shows the effectiveness of species for various purposes (Galeano 2000, Torre-Cuadros and Islebe, 2003). *Berberis lycium* was the diverse in uses in the study area with an RI value of 1.80. Other species with higher values were*Juglans regia* (1.69), *Pinus wallichiana* (1.46), *Zanthoxylum armatum*

(1.34), *Abies pindrow* (1.26), *Zea mays* (1.26), *Taxus baccata* (1.26) and *Viburnum grandiflorum* (1.18). Higher values of RI are indicators of versatility in usage of these plant species.

Juglans regia is the most common tree in the world. It inhabits the region stretching from the Balkans eastward to the western Himalayan (Fernandez-Lopez *et al.,* 2000). World production of whole walnut was around 1.5 x 106 t in 2008 (FAO, 2008). China is the top world producer. Followed by USA, Iran, Turkey, Ukraine, Romania, France and india (Martinez *et al.,* 2010). This species showed highest RFC and UV values along with second most versatile species in uses (RI) of the Makra hills. This was used in 5 major categories including food, fuel, furniture, medicinal and miscellaneous uses. Leaves of *Juglans regia* are widely used for medicinal uses as antimicrobial, astringent, anti-diarrheal, hypoglycaemic, depurative, tonic, craminative and for the treatment of cold and stomach-ache (Girzu *et al.,* 1998; Mouhajir et al 2001; Viadyaratnam, 2005). In Turkey fresh leaves are applied on naked body to reduce fever and joint pain (Fujita *et al.,* 1995; Yesilada, 2002). In México it is used as healer to reduce liver damages (Torres-gonzalea *et al.,* 2011). It is used to treat vascular disturbance, diabetes and asthma in Palestine (Jaradat, 2005; Spaccarotella *et al.,* 2008; Kaileh *et al.,* 2007). Miswaks (teeth cleaning brushes) are made by using bark of this tree (Ibrar *et al.,* 2007). Paste of bark is considered as useful to cure arthritis, toothache, skin diseases and hair growth in Nepal (Kunwar and Adhikari, 2005). The wood is used to make furniture due to its high quality (Taha & Al-wadaan, 2011). Dye is used to color hairs and as a tonic (Brwon, 1995).

Berberis lycium was the most versatile species with many uses in the study area. In the medicinal category it was used to cure joint pains, skin diseases, jaundice, piles, bleeding, stomach ulcer, backache, malaria, fractures and pain in vertebral Colum. Fruits are laxative and eaten raw. Shoots are used as fuel and making fence. This species was also reported as promising species from Shangla Pakistan (Ibrar *et al.,* 2007), with almost similar uses as our study. Kapoor *et al.* (2013) review about medicinal importance of *Berberis lycium* revealed it as a useful traditional and pharmacological plant and a potential shrub for commercial preparation of drugs.

Current findings could be summarized as the people of the study area are well aware of knowledge about plants and still using them in their life necessities. Angiosperms were the most used plants in the study area. Herbs contributed largely in local uses of plants. Poaceae was the dominant family with most representation of the taxa among all other families. Most of the plants were used for medicinal purposes in the local communities. Many species were used with more than one use categories. Leaf was the prominent used part and consumed in different use categories for many purposes. Underground parts were also used in high number which is a threat to the local flora. Quantitative metrics showed *Juglans regia* as a most important species of the study area with its usage in most use categories and high value of frequency citation. *Berberis lycium* was the species with high number of uses among all. Other important species were *Pinus wallichiana*, *Abies pindrow*, *Zea mays*, *Viburnum grandiflorum*, *Ajuga bracteosa* and *Acer caesium*. High values of many species shows the dependency of local people on regional flora which needs to be conserved for future uses.

Conclusions

Current study contributes in the great understanding of plant based on knowledge of local peoples of Makkra hills. There was no previous study existed in literature about the study area so current study bridged this gap of knowledge. Ethnobotanical flora of Makkra hills was comprised of 68 plant species belonging to 64 genera of 36 famlies. Poaceae is the prominent family in the study area along with the dominance of herbaceous flora in traditional uses. Most of the plants were used for drugs preparation and recorded in medicinal use category followed by food use category. Leaves were the leading plant part used by the inhabitants of Makkra hills. *Juglans regia* and *Berbeis lycium* were important species based on RFC, UV, and RI Indices values. Other important species were *Pinus wallichiana*, *Abies pindrow*, *Zea mays*, *Viburnum grandiflorum*, *Ajuga bracteosa*, *Acer caesium*, *Taxus baccata,* and *Indigofera heterantha*. Due to lack of resources and income people of the study area were using plants with extensive exploitation. The people of the study area are still harbouring a good knowledge due to their dependences on local flora. Conservation practices along with providence of basic facilities to the local inhabitants will be helpful to retain and recover the vegetation of Makkra hills in its original position.

Declarations

Ethics approval and consent to participate: The ethical guidelines for the survey of rural and indigenous communities provided by International Society of Ethnobiology (available online: www.ethnobiology.net/whatwe-do/coreprograms/ise-ethics-program/code-of-ethics) were carefully followed. Prior to interviews, formal verbal consent (regarding data collection and publication) of each participant was taken. The PRA (Participatory rural appraisal) approach mentioned in the Kyoto Protocol (2017) was applied with the consent of the informant. In addition, formal consent from the University of Okara Ethical Review Committee was also taken (consent number UOERCC#124).

Consent for publication: "Not applicable" in this section.

Availability of data and materials: All data generated or analyzed during this study are included in this published article.

Competing interests: The authors have no relevant financial or non-financial interests to disclose.

Funding: No funding has been received for the study. Authors utilized their own resources for the completion of the study.

Authors' contributions: **Z.M,** and **S.K.** designed and supervised the entire study, **M.M, S.W.G.** and **C.M.B.** conducted field surveys and collected data. **M.W., M.A.J. Z.M.** and **S.K.** contributed in data arrangement, presentation and analysis. **M.W** played role in statistical interpretation of data and also wrote the first draft of the manuscript along with **M.A.J.** and **M.M**.

Later **M.W. R.W.B. and Z.M** revision of the draft manuscript and incorporation of the scientific input and improved the manuscript in all rounds of peer review.

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