Traditional knowledge and diversity of medicinal plants in Hindukush range, Tehsil Mastuj, Chitral, Pakistan: An ethnobotany survey

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Databases and Inventories

Abstract

Background: The aim of the current study was to elaborate the indigenous knowledge about the use of medicinal plants in the Hindukush range, Tehsil Mastuj, Chitral, Pakistan. The study's goal was to use quantitative ethnobotanical indices to chronicle indigenous knowledge about the treatment of various disorders, as well as to locate and describe traditional applications of medicinal plants in the area to highlight key medicinal plant species by comparing the results to previously published ethnobotanical and pharmacological data. The medicinal flora is on the verge of extinction due to overgrazing and injudicious use.

Methods: We conducted interviews with residents of Mastuj. Semi-structured protocols with a free list of plants were used to collect information, as well as botanical collection and identification of mentioned plants. Use Value (UV) and Informant Agreement Ratio (IAR) were used to analyze ethnobotanical data.

Results: 44 plants belonging to 25 families were identified. Of them 1 family was gymnosperm, and 24 families were angiosperms. There were 36 wild plants, 4 wild and cultivated, 3 cultivated plants. The information collected from the study area revealed that 38 plants were used for the treatment of various ailments and diseases i.e., for cough, backache, skin diseases, dysentery, eczema, diarrhea, purgative, typhoid, rheumatism, narcosis, dyspepsia, malaria, tuberculosis, bronchitis, leprosy, jaundice, vomiting, wheals, lumbago, oedema, and as vermifuge and anthelmintic.

Conclusion: Local communities have kept their traditional ways of life, relying on wild and cultivated plants for food, fuel, fodder, building materials, and crude drugs. Elders and health practitioners in the study area are knowledgeable about indigenous *et al.* medicinal plants, whereas young people are less interested in herbal treatments. As a result, traditional knowledge ethnomedicine is on the verge of extinction. *In situ* and *ex situ* conservation measures should be implemented to ensure the preservation and long-term use of such medicinal plant species, particularly those with economic and pharmaceutical importance. Residents should be properly trained and guided in the collection, drying, storage, and preservation of medicinal plants.

Keywords: Ethnobotanical indices, Extinction, Hindukush range, Indigenous knowledge, Medicinal plants.

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Background

Chitral (Hindukush range) is of the large district in Khyber Pakhtunkhwa Province, having an area of 14850 km^2 and located at 35°15 - 36°55 N, 71°11 - 73°51 E in northern Pakistan. It's a heaven for floristic, cultural, and geophysical diversity (Birjees *et al.* 2022). The dry mountains of Chitral valley are rich in medicinally important plant species. Locals pick these plants for therapeutic purposes and trade them in the local market to meet their daily requirements (Birjees 2021).

Ethnobotanical studies investigate the complex relationship that exists between local people and local plants, as well as the activities and cultural beliefs associated with various forms of use. These studies are critical in emphasizing the significance of native plant species in a variety of fields, including drug discovery (Ahlaq *et al.* 2018). Medicinal plants are essential to the survival of underdeveloped communities worldwide. Globally, 35000-70000 plant species are used in folk medicine. Plant-based medicines are still used by 60-80% of the population in impoverished countries because they provide a low-cost and safe alternative to allopathic medicine, which is often unavailable (Qaseem *et al.* 2019). This may also help with the preservation of indigenous culture and natural resource management. Pakistan has an abundance of medicinal and aromatic plants due to its diverse habitat, climate, and soil types, with over 6000 wild plant species (Naz *et al.* 2022). Around 70-80% of the world's population relies on medicinal plants to treat their illnesses, and allopathic medication is associated with high costs in countries such as Germany (40-45%), the United States (42%), Australia (48%), and France (49 percent). In Pakistan, a total of 5521 flowering plant species have been identified (Kifayatullah *et al.* 2017).

Zaman *et al.* (1972), Khan (1998), Hussain *et al.* (2004), Hussain *et al.* (2007), Shah & Hussain (2012), Shah & Hussain (2021) made a quantitative survey of medicinal plants of Chitral forest, northern Himalayan and Mastuj, District Chitral. Some of these useful species are under serious threats due to unsustainable activities. This study's findings are comparable to those of Hussain *et al.* (2015) who identified nanophylls as the dominating leaf size in Mastuj valley, district Chitral, Hindukush range, Pakistan. The association between tiny leaves and hot desert settings has been discovered and is an adaptive trait in soil moisture retention.

Today, ethnobotanical research can serve as a preferred and dependable route to drug discovery, as well as play an important role in biodiversity conservation (Shah & Hussain 2021). It demonstrates the urgent need for an extensive ethnobotanical survey to understand the judicious utilization of raw materials while also preparing an inventory for it, given that indigenous peoples of a given geographical area are associated with nature and rely on plants as a primary source of remedy for various physical ailments (Idm'hand *et al.* 2020).

To fill the research gape, the current study was designed to document the traditional knowledge related to medicinal plants and their uses. Furthermore, the research was initiated to aid in the preservation of the centuries-old oral tradition.

Materials and Methods

Study Area

Mastuj valley, District Chitral, lies in between 72°-0 ′ and 37°-58 ′ east latitude and 36°-2 ′ and 36°-57 ′ north latitude. It stretches about 110 km starting from Reshun up to Ghazin with many other villages. It is the northeastern part of the district, which is bounded on the north by Boroghol Pass, on the south by Shandur Pass, on the east by Chumarkhan Pass and on lower altitude, cool at high elevations and ultimately alpine type above 3000 m (Figure 1). The rural communities of Mastuj valley are still dependent upon wild plants for their primary health care and treatment of ailments (Shah & Hussain 2012). The climate varies from Arandu (3500 ft) in the South which is as hot as any other part of the sub-mountainous region of the West Pakistan to Boroghol (3804 m) in the North, where the climate is arid and cold like that of the Pamir in Central Asia (Zaman *et al.* 1972).

Plant collection and identification

Mature specimens were collected, numbered and were identified and deposited in the Herbarium of Botany Department, University of Peshawar. The plants were identified with the help of available literature (Nasir & Ali 1971-1995, Ali & Qaisar 1995- 2011).

Field trips and interviews

In Tehsil Mastuj, deeper surveys were done from March to April 2019 (Figure 1). This includes many people being interviewed in groups. The interviews were recorded and then transcribed. The snowball method was used to collect

data from informal interviews (Fan *et al.* 2022, He *et al.* 2022). In Excel, the scientific name of the species, the plant family, and the known therapeutic uses were collated.

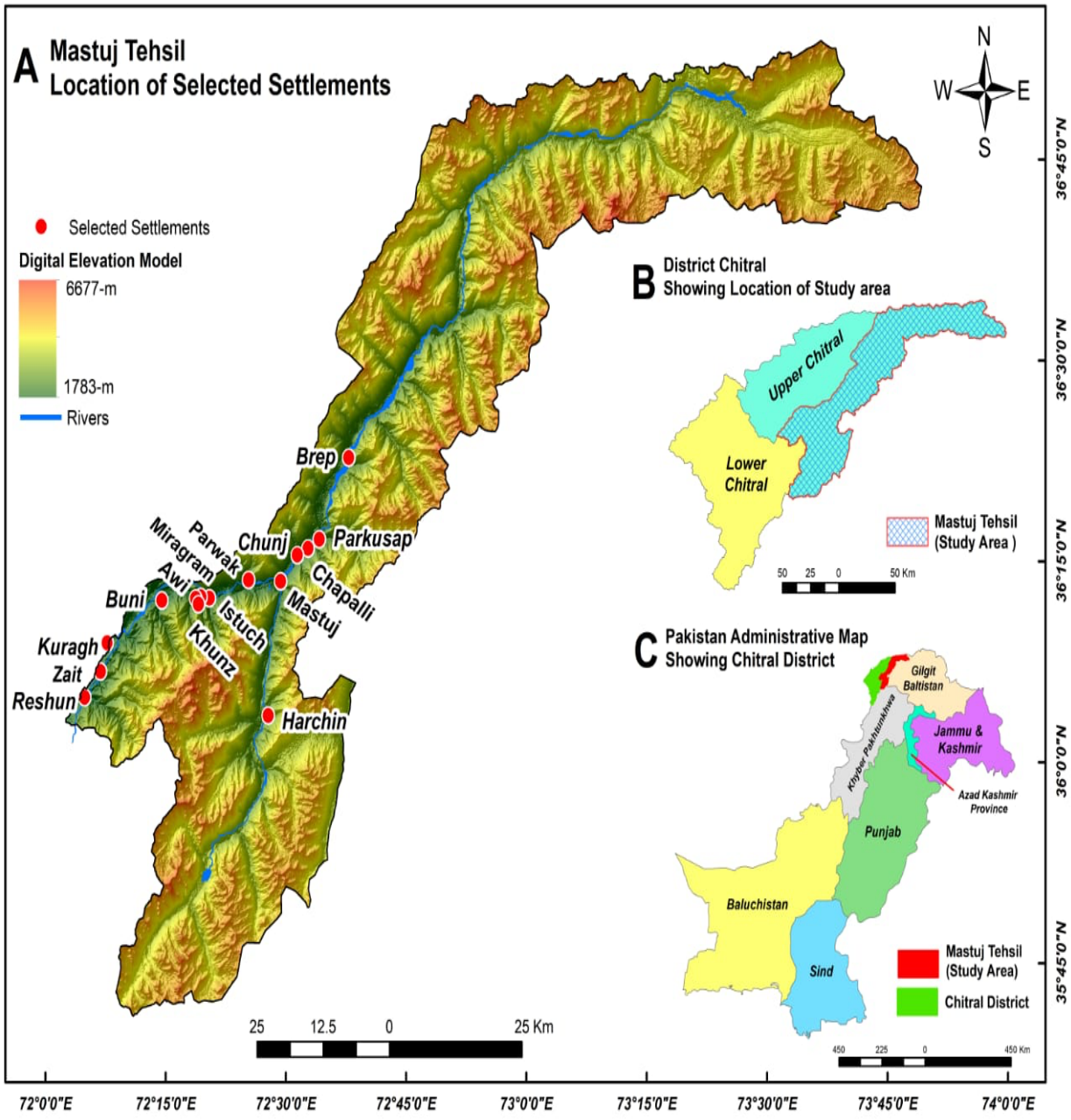

Figure 1. Map of Tehsil Mastuj, Chitral, Pakistan.

Data analysis

A content analysis was also performed on qualitative data. It is the systematic and rigorous examination of textual or visual documents (Usman *et al.* 2022).

Quantitative ethnobotany

Use value

The use value assesses each ethnomedicinal plant species' relative importance based on its relative use among respondents (Tardio *et al.* 2008). The use value (UV) was calculated through the following formula:

$$UV = (\sum Ui) / N$$

Where Ui represents the number of used reports mentioned by each participant and Nis represents the total number of respondents interviewed for a given plant species.

Informant Agreement Ratio (IAR)

The quantitative index, informant agreement ratio (IAR), was used to estimate the variability of ethnobotanical plant use. IAR is widely used to analyze ethnobotanical data. IAR has a value ranging from 0 to 1. Values close to 1 are considered high (close to 1) and indicate that a large proportion of respondents use relatively few plants. A low value (close to 0) indicates that respondents disagree on the use of a taxa within a category (Heinrich *et al.* 1998). It is sometimes referred to as the informant consensus factor (Heinrich *et al.* 2009) and is calculated as follows:

$$IAR = (Nur - Nt)/(Nur - 1)$$

Where Nur denotes the number of use-reports in each category and Nt denotes the number of taxa used in each category

Results and Discussion

The study documented 44 species of 25 families. Asteraceae (7 sp.), Apiaceae (4 sp.), Lamiaceae and Fabaceae (3 sp.), Ephedraceae, Elaeagnaceae, Plantaginaceae, Malvaceae, Rosaceae and Solanaceae (2 sp.) were the leading families in terms of number of species. The remaining families had one species each (Table 1).

Medicinal plants and their uses

Anacardiaceae

Pistacia integerrima Stew ex Brandies. Locality: Dry plain areas of Rashun (2000 m) to Kuragh (2100 m) and to Parwak (2300 m).

Apiaceae

Anethum graveolens L. Locality: Rashun (1950 m), Zait (2000 m), Booni (2200 m), Parwak (2340 m), Parkusap (2450 m), Chapali (2500 m) Brep (2700 m) and Istuch (2750 m). The seeds are collected by women in September and stored for use.

Ferula jaeschkeana Vatke. Locality: Parwak (2340 m), Parkusap (2450 m), Chapali (2500 m) and Brep (2700 m). The stem is cut down near the ground in June to July and after a week, the gum, which is black in color and bitter in taste, is collected by knife. This dried gum is stored in plastic bags. 10 g gum is collected from a single plant.

Foeniculum vulgare Mill. Locality: Rashun (1930 m); Kuragh (2030 m); Booni (2200 m) and Mastuj (2450 m); 100 g or 1 kg seeds are collected in September and are stored in cloth bags.

Prangos pabularia Lindle. Locality: On the mountains and slopes of Rashun (1950 m), Zait (2000 m), Kuragh (2050 m) and Booni (2200 m); Kuragh (Pawasun) (3200 m). The young leaves are collected in August by locals and dried in shade for two days and ground to powder.

Asteraceae

Artemisia maritima L. Locality: Abundant in Rashun (1950 m), Kuragh (2100 m), Booni (2200 m), Mastuj (2200 m) to Bung (2800 m). The fresh young plants are collected from May to September. 250 g of fresh leaves are boiled in 1 liter of water, cooled, and filtered to get an extract.

Artemisia scoparia Waldst and Kit. Locality: Rashun (1950 m), Kuragh (2100 m) and Booni (2200 m).

Calendula officinalis L. Locality: Rashun (1950 m), to Parkusap (2450 m); The fresh leaves and flowers are collected in August and are ground and a thick and blue colored paste is obtained.

Carthamus tinctorius L. Locality: Kuragh (2100 m), Booni (2200 m). Flower heads are collected by women and are dried in shade for three days.

Chrysanthemum cinerariefolium (Trev) Vis. Locality: Rashun (1950 m), to Mastuj (2400 m); Sarghuz (2400 m). Flowers are collected from July to September and are boiled in water for five minutes and then filtered to get the infusion.

Cichorium intybus L. Locality: Plain areas along with grasses in Rashun (1950 m), Parkusap (2450 m), and Brep (2700 m). The roots are dug out from the soil from June to October, cleaned and cut into small pieces. These pieces are boiled in water for five minutes and filtered and decoction is cooled.

Taraxacum officinale Wig. F. B. I. Locality: Abundant in Rashun (1950 m), Mastuj (2400 m), Harchin (2850 m) and Pawer (3050 m); Parkusap (2450 m). Young leaves are collected by women when the plants first appear in April. They are cleaned and cooked as vegetable.

Table 1. Ethnobotany of Tehsil Mastuj with particular reference to medicinal plants.

Botanical Name	Voucher No	Local Name	Habit	Altitude (m)	Locality	Part Used	Uses	Administration, dosage and duration	IAR	UV
Althea rosea (L.) Cav. (Malvaceae)	126	Lain	P(H)	2450	Parkusap	Fl	To draw out the pus from boils	Paste	0.3	0.02
Anethum graveolens L. (Apiaceae)	127	Shorum	P(H)	2750	Istach	Sds	Backache	Orally	0.5	0.01
Arnebia euchroma Royle ex Benth. (Boraginaceae)	128	Pusuk	P(H)	2500	Chapali	Rt	Dandruff, hair dye	Extract, Ext (1x2)	0.1	0.02
Artemisia maritima L. (Asteraceae)	129	Draon	P(H)	2700	Diezk	W. P	Typhoid, anthelmintic, stomachache	Extract: Int (1x1)	0.6	0.6
Artemisia scoparia Waldst. & Kitam. (Asteraceae)	130	Jhaa	P(H)	2100	Koragh	Rt	To relieve sore, irritated eyes.	Paste: Ext (2x2)	0.05	0.41
Bergenia ciliata (Haw.) Sternb. (Saxifragaceae)	131	Bisaboor	P(H)	3700	Parkusap	Rz	Skin disease, leprosy and eczema	Paste: Ext (1x1)	0.5	0.07
Betula utilis D Don (Betulaceae)	132	Bhuli	T	2450	Chuinj	---	Unknown	-------	0	0.08
Calendula officinalis L. (Asteraceae)	133	Bodoki	H	1950	Rashun	Lys and Fl	Severe stabbing pain and lumbago	Paste: Ext (2x2).	0.03	0.05
Cannabis sativa L. (Cannabinaceae)	134	Bong	H	2980	Bung	Lv & Fl tops	Induce sleep, narcotic,, stomachache and toothache	Thick paste	0.7	0.02
Capparis spinosa L. (Capparidaceae)	135	Kaweer	SH	2500	Parkusap	Fl buds	Typhoid, malaria, eczema and, abdominal pain	Vegetable; Paste of fruit, Int (1x1)	0.8	0.04
Carthamus tinctorius L. (Asteraceae)	136	Paom	H	2280	Awi	Fl	Wheals and food dye	Powder	0.6	0.06
Chenopodium botrys L. (Chenopodiaceae)	137	Khodor	H	2950	Miragram	W. P	Diarrhea and dysentery	"Powder, Int (2x2)	0.5	0.3
Cichorium intybus L. (Asteraceae)	138	Kasti	P (H)	2480	Parkusap	Fl	Typhoid, malaria, headache and rheumatism	Decoction: Int (1x2)	0.5	0.6

Chrysanthemum abolinii (Kovalevsk.) H. Ohashi & Yonek. (Asteraceae)	139	Serisht	P(H)	2350	Sarghuz	Fl	Abdominal pain	Decoction: Int (2x1)	0.05	0.2
Convolvulus arvensis L. (Convolvulaceae)	140	Mishk	H	2600	Kargin	Lvs	To relieve constipation	Vegetable Int (1x1)	0.9	0.2
Corydalis govaniana Wall., (Fumariaceae)	141	Marjunic	P(H)	2650	Parkusap	Lvs	Backache	Powder. Int (1x7)	0.2	0.6
Crataegus songarica K. Koch (Rosaceae)	142	Gooni	T	3000	Pawer	Ber	Asthmatic, cough, headache and tonic	Extract: Int (1x1)	0.5	0.04
Cuscuta reflexa Roxb. (Convolvulaceae)	143	Ambool	H	2320	Snowghur	--	Unknown	---	0	0.07
Datura stramonium L. Solanaceae)	144	Porol	H	2500	Chapali	--	Unknown	--	0	0.03
Daucus carota L (Apiaceae)	145	Kari	P(H)	2650	Khuz	--	Unknown	---	0	0.5
Echinops echinatus Roxb. (Asteraceae)	146	Zhukh	H	2450	Mastuj	--	Unknown	---	0	0.42
Elaeagnus angustifolia L (Elaeagnaceae)	147	Shonjoor	T	2400	Mastuj	Fr and Gm	Cough, dyspepsia and substitute of shampoo	Decoction of fruits, Int (1x7)	0	0.01
Ephedra gerardiana Wall. ex Stapf (Ephedraceae)	148	Somani	SH	2600	Parkusap	Fr. Bran	Backache, oedema, anthelmintic and for snuff preparation	Decoction and orally eaten ext (1x7)	0.7	0.09
Ferula jaeschkeana Vatke (Apiaceae)	149	Rawo	P(H)	2700	Parkusap	Gm and Rt	Tonic, stomachache and toothache	Orally, int (2x2)	0.02	0.53
Foeniculum vulgare Mill., Apiaceae)	150	Bodiong	P(H)	2200	Booni	Fr and Lvs	Carminative, stomachache and bronchitis	Orally, int (2x2)	0.7	0.06
Galium aparine L. (Rubiaceae)	151	Karacha	H	2500	Kargin	----	Unknown	----	0	0.61
Glycyrrhiza glabra L (Fabaceae)	152	Mo-Yo	P(H)	2450	Parkusap	Rt	Purgative, cough	Decoction	0.5	0.5

Hippophae rhamnoides L. (Elaeagnaceae)	153	Mirghinz	SH	2450	Parkusap	Ber	Anthelmintic, to relieve split heels	Paste of fruits: Ext{1x 7)	0.8	0.3
Hyoscyamus niger L. (Solanaceae)	154	Bung-e-diwana Birmogh	H	2480	Chuin	Sds	Skin diseases	Ointment: Ext; (2x4)	0.03	0.3
Juglans regia L. (Juglandaceae)	155	Birmogh	T	3050	Pawer Purgative	Ker & Bar	Purgative, tonic and miswak.	Paste, oil from fruit orally. Int (1x2)	0.07	0.07
Juniperus polycarpos K. Koch (Cupressaceae)	156	Saruz	T	3200	Parkusap	Con. lvs & Bar	Anthelmintic, stomachache bleeding and snuff preparation	Decoction, Int (1x1)	0.6	0.01
Medicago sativa L (Fabaceae)	157	Mushij	P(H)	2350	Snowghur	--	Analgesic	Vegetable	0.9	0.7
Malva neglecta Wallr. (Malvaceae)	158	Yourpag Huzu	P(H)	2710	Diwangol	lvs	Headache, sunstroke.	Paste, Ext (1x5)	0.01	0.06
Melia azedarach L. (Meliaceae)	159	Bakaeeni	T	2200	Kuragh	-----	Unknown	------	0	0.2
Mentha longifolia (L.) L. (Lamiaceae)	160	Bain	P(H)	2200	Booni	Rt & lvs	Anthelmintic and stomachache	Extract leaves, Ext (1x2) Decoction (roots)	0.05	0.7
Morus alba L. (Lamiaceae)	161	Marach	T	2700	Brep	Lvs. Fr, Bar	Anthelmintic, jaundice, tonic, cough and stomachache	Paste, Ext (1x5)	0.9	0.7
Papaver somniferum L. (Papaveraceae)	162	Afyun	H	2200	Booni	Gm and Cp	Narcotic, stomachache, cough, dysentery	Air dried gum orally and smoking through hukka Int (1x1)	0.6	0.5
Pistacia integerrima J.L. Stewart ex Brandis (Anacardiaceae)	163	Thuk	T	2300	Parwak	Gm	Split heels	Directly: Ext (1x3)	0.02	0.01
Plantago lanceolata L. (Plantaginaceae)	164	Bioykioligini	P(H)	2700	Brep	Sds	Diarrhea	Syrup. Int (2x2)	0.9	0.6
Plantago major L. (Plantaginaceae)	165	Bronoachar	P(H)	2150	Jinalikoch	Sds	Diarrhea	Syrup: lnt (2x2)	0.9	0.63

Prangos pabularia Lindl. (Apiaceae)	166	Mushain	P(H)	3200	Koragh	Lvs.	Tuberculosis	Ointment Int (1x7)	0.4	0.07
Rheum emodi Wall. (Polygonaceae)	167	Ishpar	PH)	2450	Mastuj	Lvs	Cough, flu	Suspension (Powder+ water: int (1x1)	0.05	0.043
Rubus fruticosus auct. L. (Rosaceae)	168	Achoo	SH	2500	Parkusap	Fr	Asthmatic tonic	Fresh juice Extract, Int (1x2)	0.6	0.51
Solanum nigrum L. (Solanaceae)	169	Pirmilic	H	2750	Balim	Ber.	To relieve sore eyes, protection from sun-burn	Fresh juice; Ext (1x1)	0.07	0.09
Sophora mollis (Royle) Baker (Fabaceae)	170	Baisho	SH	2450	Parkusap	Fl & Bran	Eczema	Oil; Ext (1x2)	0.03	0.01
Taraxacum officinale (L.) Weber ex F.H. Wigg. (Asteraceae)	171	Poho	(PH)	2500	Parkusap	---	Unknown	----	0	0.06
Thymus serphyllum L. (Lamiaceae)	172	Sio	(PH)	3700	Parkusap	Lvs & Fl	Backache	Ointment: Ext(1x7)	0.04	0.42
Trifolium pratense L. Fabaceae)	173	Shaftal	(PH)	2100	Kuragh	--	Unknown	--	0	0.6
Trifolium repens L. (Fabaceae)	174	Shablonqui	(PH)	2600	Chapali	--	Unknown	--	0	0.61
Tribulus terrestris L. (Zygophyllaceae)	175	Zhokh	(PH)	2650	Khuz	Fr	Toothache	Powder, Ext (1x2)	0.05	0.09
Verbascum thapsus L. (Schrophulariaceae)	176	Gordoghkaro	(PH)	2450	Chuinj	Lvs	To relive swelling	Directly, Ext (1x2)	0.8	0.6
Ziziphora clinopodioides Lam (Lamiaceae)	177	---	(PH)	3700	Parkusap	Lvs & Fl	Backache	Ointment; Ext (1x2)	0.8	0.2

Vo. No= Voucher specimen number

Ber= Berries; Bar = Bark; Branch= Branches; Con = Cones; Cp= Capsules; GM=Gums; Fl= Flower; Fr=Fruit; H= Herb; Ker= Kernel; Lvs= Leaves; Rt= Root; Rz= Rhizome; Sds=Seed; SH= Shrub; T = Tree; WP= Whole plant; PH =Perennial herb

(1x1) = One application for one day; (2x2) =Two applications for two days; (1x7) = One application for seven days; (2x4) = Two applications for four days; (1X3) = One application for three days;

Int = Internal; Ext = External; (1x2) = Daily one application for two days; (2x1) = Two applications for one day; (2x3) = Daily two applications for three days; (1x5) = Daily one application for five days

Boraginaceae

Arnebia euchroma (Royle ex Benth). Locality: Dry areas and slopes of Rashun (1950 m), Mastuj (2400 m), and Chapali (2450 m). 2 kg roots are collected in May to September are dried in rooms or in shade for two days. The roots are tasteless, and odorless. The dried roots are cut into small pieces and mixed with the mustard oil and slightly heated for five minutes.

Cannabinaceae

Cannabis sativa L. Locality: Cultivated in Brep (2750 m), Diezk (2900 m), Bung (2980 m) and Pratangas (2980 m). 20-40 kg of seeds are collected to get oil. The ground seeds are slightly heated, with few drops of water and along with 10g of salt and shaken for sometimes and oil is obtained.

Capparidaceae

Capparis spinosa L. Locality: Kuragh (2100 m), Parwak (2300 m), Parkusap (2450 m), Khuz (2650 m) and Brep (2700 m); 20 kg flowering buds are collected from Kuragh and Parwak (lower areas) in July, and from Parwak to Diwangol (upper areas) in August as collection season varied here. Females mostly do the collection. 8 kg floral buds are put into earthen vassal with water and kept in sun for a week, the floral buds are separated from the water and dried in sun for three days and stored in cloth bags.

Chenopodiaceae

Chenopodium botrys L. Locality: Waste places of Rashun (1950 m), Booni (2200 m), to Brep (2700 m); Miragram (2950 m). 1 kg plants are collected from dry places in June to October and dried in sun for two days and ground to powder.

Convolvulaceae

Convolvolus arvensis L. Locality: A weed in cultivated fields of wheat, maize and barley in Rashun (1950 m), Booni (2200 m), Mastuj (2400 m), Kargin (2600 m) and Brep (2700 m). The fresh leaves are collected by women in April to May and used as vegetable, locally called "Shakh".

Cupressaceae

Juniperus policarpos C. Koch. Locality: Hilly areas of Awi (2280 m), Parwak (2340 m) and Parkusap (2450 m).

Elaeagnaceae

Elaeagnus angustifolia L. Locality: Rashun, (1950 m), Zait (1980 m), Booni (2200 m), Awi (2500 m) and Chinar (2400 m); Mastuj (2400 m).

Hippophae rhamnoides L. ssp. *turkestanica* Rousi. Locality: Plain areas of Rashun (1950 m); Booni (2200 m); Mastuj (2450 m); Brep (2700 m), Pawer (3050 m); Parkusap (2450 m). The ripe berries (100-500g) are collected by women and men in October to December and ground to form a paste which is golden brown in color with sour taste.

Ephedraceae

Ephedra gerardiana Wall. Distribution: Booni (2200 m), Parwak (2340 m), Parkusap (2450 m), Chapali (2500 m) and Kargin (2500 m). Men mostly collect branches of this plant.

Fabaceae

Glycyrrhiza glabra L. var. *glandulifera*. Waldst and Kit. Locality: Zait (1980 m), Booni (2200 m), Parkusap (2450 m), Chapali (2600 m). Five kg roots are collected by men in September to November and cut into small pieces and about 1 kg roots are boiled in 2 L water to obtain yellowish white decoction which is sweet in taste.

Medicago sativa L. Locality: Rashun (1950 m), Charun (2050 m); Snowghur (2350 m); Mastuj (2400 m), Brep (2700 m) Balim (2800 m) and Pawer (2950 m). The young plants are collected by women in April and boiled in water and crushed and cooked as vegetable locally known as “Shakh”.

Sophora griffithii Stocks in Hook. Locality: On hills and slopes of ashun (1950 m), Zait (2000 m), Booni (2200 m), Parwak (2340 m), Parkusap (2450 m) and Khuz (2600 m). The thick portion of the branches is cut in December to February and are kept in sun for 1-2 days and slightly warmed and after 20 min, a colorless and odorless oil appears on branches.

Fumariaceae

Corydalis govaniana Wall. Locality: On exposed areas of some villages such as Parkusap (2450 m), Chumerkan-Gol (2580 m) and Ghoro-Gol (2600 m); Parkusap-Gol (2650 m). 5 kg of leaves are collected in August to October, dried in shade for one week to make powder.

Juglandaceae

Juglans regia L. Locality: Abundant in Rashun (1950 m); Booni (2200 m); Mastuj (2450 m); Brep (2700 m); Bung (2850 m) and Pawer (3050 m). The fruits are collected in November and dried in sun. By hand pressing, oil is obtained. ½ kg of seeds yield ½ glass of oil. The oil is light yellow in color, tasteless, and odorless. ½ kg seeds are crushed and ground with 1kg fruits of *Morus alba* locally called "Birmoogh" for 20 min. A thick paste is formed, locally known as "Shakarposteck" which is sweet in taste**.**

Lamiaceae

Mentha longifolia L. Locality: Abundant in Rashun (1950 m), Booni (2299 m), Snowghur (2350 m), Mastuj (2400 m), Parkusap (2450 m) and Brep (2700 m); Booni (2200 m). 2 kg leaves are collected in May to August and crushed in water and on filtration green an extract is obtained, having aromatic smell. The roots are dug out in September, cleaned, and boiled in 1L of water for 15 minutes. It is cooled and filtered to get decoction which is light brown in colour with bitter taste.

Thymus serphyllum L. Locality: Rarely occur on mountains and at high altitudes such as Parkusap mountain (3700 m), Chuinj mountain (3600 m). Flowers and leaves are collected above 3500 m by men, dried in shade for two days and ground. 20 g ground flowers and leaves are mixed with 10-20 ml of butter oil to prepare a thick brownish colored ointment.

Ziziphora clinopodioides Lam. Locality: Rarely found at high mountains of Parkusap (3700 m), Khuz (3550 m), and Parwak (3550 m); Parkusap (3550 m). The leaves and flowers are collected in August by men, dried in shade for two days and ground to powder, which is reddish brown in color and having minty odor.

Malvaceae

Althea rosea (L.) Cav. Locality: Cultivated as an ornamental plant in gardens, and at the edges of wheat fields, at Rashun (1950 m); Kuragh (2050 m); Booni (2200 m); Parkusap (2450 m). The flowers are collected in July and August. They are dried in shade for three days and ground to powder. There are two varieties of this plant, the red and white flowered. The red flowered variety is preferred medicinally in all the areas.

Malva neglecta Wall. Locality: Parkusap (2450 m); Mastuj (2400 m); Booni (2200 m); Snowghur (2300 m); Diwangol (2710 m). The leaves are collected in July and August and dried in shade for two days and ground to powder. 20 g of ground leaves are mixed with few drops of water, to form a bluish, tasteless and odorless paste.

Moraceae

Morus alba L. Locality: Rashun (1950 m), to Brep (2700 m). The ripe fruits are collected in June to August. The fruits are collected by spreading a cloth sheet under the trees and then shaking the branches of the trees. These fruits are dried in sun for a week. The dried fruits locally called "Kitoree" are cleaned and ground with *Juglans regia,* to form a thick paste, locally called "Shakarposteck" having sweet taste and brown in color. 5-10 kg fresh fruits are boiled in 10 L of water for 2-3 hours, the extract is filtered through a muslin cloth and again the extract is boiled for 1-2 hours, and a thick reddish-brown paste is formed, which has sweet taste, locally called "Sherni".

Papaveraceae

Papaver somniferum L. Locality: Rashun (1950 m), Booni (2200 m), Awi (2250 m) and Mastuj (2400 m). Flowering starts in May (Rashun and Booni), and June (Parwak to Brep). Capsules mature in August and September and oblique or vertical incisions are made in the capsules by a sharp knife by women. The white latex comes out quickly and hardens on the outer surface of the capsule in brownish masses. It is collected next day for domestic uses.

Plantaginaceae

Plantago lanceolata L. Locality: Abundant along with grasses, mostly in Rashun (1950 m), Zait (2000 m), Booni (2200 m), Parwak (2340 m), Parkusap (2450 m), Chapali (2500 m), Brep (2700 m) and Pawer (3050 m). 100 g seeds are collected in September and then stored in cloth bags by women for domestic use.

Plantago major L. Locality: Found along with grasses, mostly in Rashun (1950 m), Zait (2000 m), Jinali-koch (2150 m), Booni (2200 m), Parwak (2340 m), Parkusap (2450 m) and Chapali (2500 m); Jinalikoch (2150 m). 50 g seeds are collected and soaked in a glass of water and 50 g of sugar is added and shaken for one min.

Polygonaceae
Rheum emodi Wall. Locality: Hilly areas of Booni (2200 m), Parwak (2340 m), Mastuj (2400 m) and Parkusap (2450 m). Leaves are collected by men in June in Rashun to Parwak and July-August in Mastuj to Brep. They are dried in sun on roofs by placing them one above the other locally called Prashal for winters fodder.

Rosaceae
Crataegus songarica Koch. Locality: Abundant in Booni (2200 m), Parwak (2340 m), Mastuj (2400 m), Parkusap (2450 m), Brep (2700 m), Bung (2900 m), Balim (2750 m) and Harchin (2850 m). One kg reddish brown fruits are collected in November to December. They are crushed and added to 1L water and shaken for 10 min. The red water is used medicinally.
Rubus fruticosus L. Locality: Snowghur (2350 m) Parwak (2340 m), Parkusap (2450 m) and Chapali (2500 m). Fruits are collected in September in Snowghur and Parkusap and used due to their sweet taste. ½ kg fruits are crushed and mixed with 1 L of water and this is strained to get the red-colored extract.

Rubiaceae
Galium aparine L. Locality: In wheat fields at Rashun (1950 m), Zait (2000 m), Booni (2200 m), Parwak (2340 m), Parkusap (2450 m), Chapali (2500 m) and Kargin (2500 m).

Saxifragaceae
Bergenia ciliata (Haw) Sternb. Locality: Abundant on high pasture above 11000 ft; on the mountain of Snowghur, Parkusap (3700 m), Brep and Bung. 2 kg leaves are collected in summer by men and boiled in 2 L water for two hours and a thick brown paste is formed locally called "Ghulja". Rhizomes are collected in summer by men and cut into small pieces and boiled in 4 L of water and a thick red colored, odorless and bitter paste is formed, locally called "Kroy-ghulja".

Scrophulariaceae
Verbascum thapsus L. Locality: Rashun (1950 m), to Mastuj (2400 m), and Chuij (2500 m). Leaves are collected in July.

Solanaceae
Hyoscyamus niger L. Locality: Rashun (1950 m), Zait (2000 m), Booni (2200 m), Chuinj (2480 m), Chapali (2500 m), Brep (2700 m). 20 g seeds are collected from September to October. 10g ground seeds are mixed with 20 ml of butter oil to form a black colored ointment locally called "Mathi".
Solanum nigrum L. var. *villosum* L. Locality: The plain areas like Booni (2200 m), Parwak (2340 m), Parkusap (2450 m), Chapali (2500 m), Brep (2700 m), Balim 2750 m), Harchin (2800 m) and Pawer (3150 m). Ripe berries are collected in August and September by women and are pressed by fingers and a yellow juice which is bitter in taste comes out.

Zygophyllaceae
Tribulus terrestris L. Locality: Dry areas in Rashun (1950 m), Zait (2000 m), Booni (2200 m), Parwak (2340 m), Parkusap (2450 m), Chapali (2500 m) and Kargin (2500 m). Khuz (2650 m). Children up to 8-12 years old collect the fruits in August. They are dried in sun for two days and ground in mortar.

The dominance of Asteraceae and Lamiaceae in this study coincides with the work reported by Boudjelal *et al.* (2013) who confirmed the dominance of the Asteraceae family followed by the Lamiaceae (Nawash *et al.* 2013, Benarba *et al.* 2015, Miara *et al.* 2019, Hassan *et al.* 2020) have documented in their studies that Lamiaceae and Asteraceae are the most predominant families. This predominance has also been documented in the Mediterranean region (Gonz'alez-Tejero *et al.* 2008). Furthermore, the dominance of Lamiaceae and Asteraceae families in the desert have been also reported (Idm'hand *et al.* 2020).

Medicinal plant growth forms
The form of vegetation is determined by their genetic pool and tolerance to climatic variation. Growth form reflects the environmental and biotic influences that exist in a specific location. The flora was divided into four groups based on growth forms i.e., annual herbs, perennial herbs, shrubs, and trees. Perennial herbs (52%) were the dominant growth forms followed by annual herbs (23 %), trees (15 %) and shrubs (10 %) (Figure 2). The high percentage of herbs could be attributed to their diversity, ease of access, and frequent growth in the study area. Herbs may also be used as a source of bioactive compounds (Lulekal *et al.* 2013). Our current results are in parallel

to the survey conducted by (Salim *et al.* 2019) in Gilgit Baltistan.

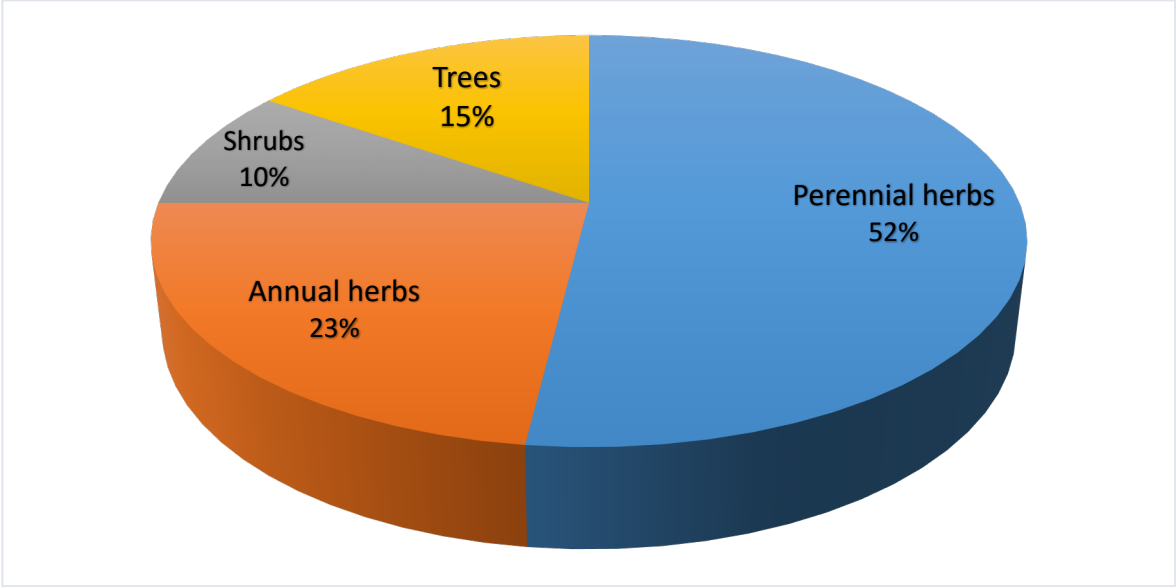

Figure 2. Growth form of the selected plants.

Mode of use

As shown in (Figure 3), different preparations were available and were being used by the local communities as the present study revealed that paste (29%) was used mainly by the local population. Decoction (17%), extract (14%), and ointment (11%) were also common. The remaining mode of preparation: chewing (9%), powder form (8%), syrup (6%), suspension and fresh juice (3%) were used less. The locals administer 47 % of the plants externally while 53 % internally (Figure 3).

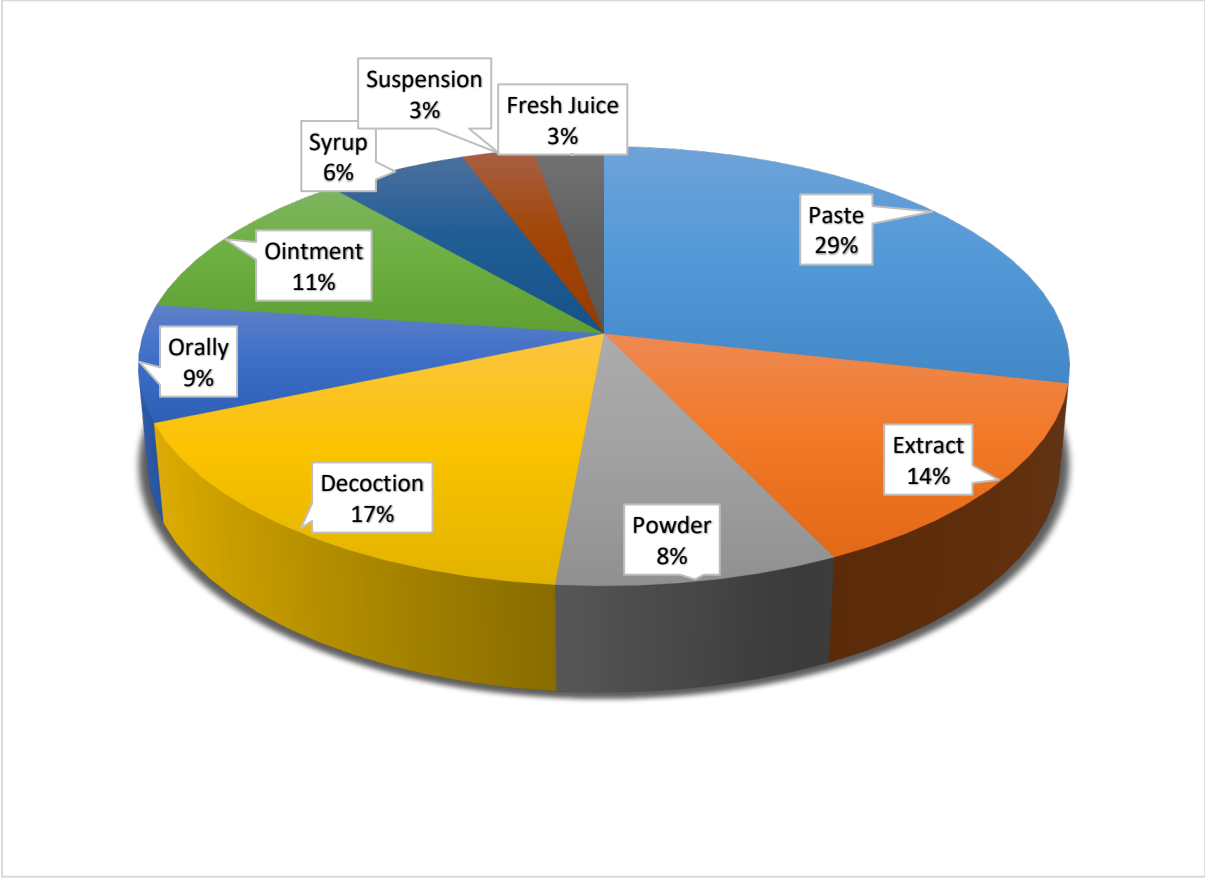

Figure 3. Percentage of mode of administration.

Güler *et al.* (2015) have also recorded the predominate of infusion. It should be noted that it is difficult to separate between infusion and decoction in several cases (Bonet *et al.* 1999). However, the local population of Hindu Kush range 'discriminates correctly between the two methods. *H. niger* and *T. serphyllum* were used in the form of an ointment for skin and backache problem. *C. cineraraefolium* (flowers), *C. intybus* (roots), *G. glabra* (roots) and *M. longifolia* (roots) were used in the form of a decoction. *A. rosea* (flowers), *A. scoparia* (roots), *C. officinalis* (flowers & leaves), *H. rhamnoides* (berries), *J. regia*, *M. neglacta* (leaves), *C. spinosa* (fruits), *M. alba* (fruits) and *B. ciliata* (rhizomes) were used in the form of a paste. *A. maritima* (aerial parts), *M. longifolia* (leaves), *C. songarica* (berries) and *R. fruticosus* (fruits), *J. policarpos* and *M. alba* (fruits) were used in the form of an extract. *C. sativa*, *D. stramonium* were used in the form of juice while, *F. vulgare*, *P. somniferum*, *T. terrestris* and *T. serphyllum* were used in the form of infusion. *C. spinosa*, *C. arvensis*, *M. sativa* and *T. pratense* were used as vegetable. Oil is extracted from *J. regia*, *C. spinosa*, *C. sativa* and *S. graffithii.*

Used parts of medicinal plants

Different parts of plants, as well as the whole plant, were used for the treatment of several diseases (Figure 4). Leaves (25%) were the most frequently used part cited, followed by the flowers (13%) and fruits (11 %). The remaining used parts of plants were in decreasing order roots (10%), seeds and gums (8%), whole plant (4%), rhizomes, branches, cones, kernels, and capsules (2%).

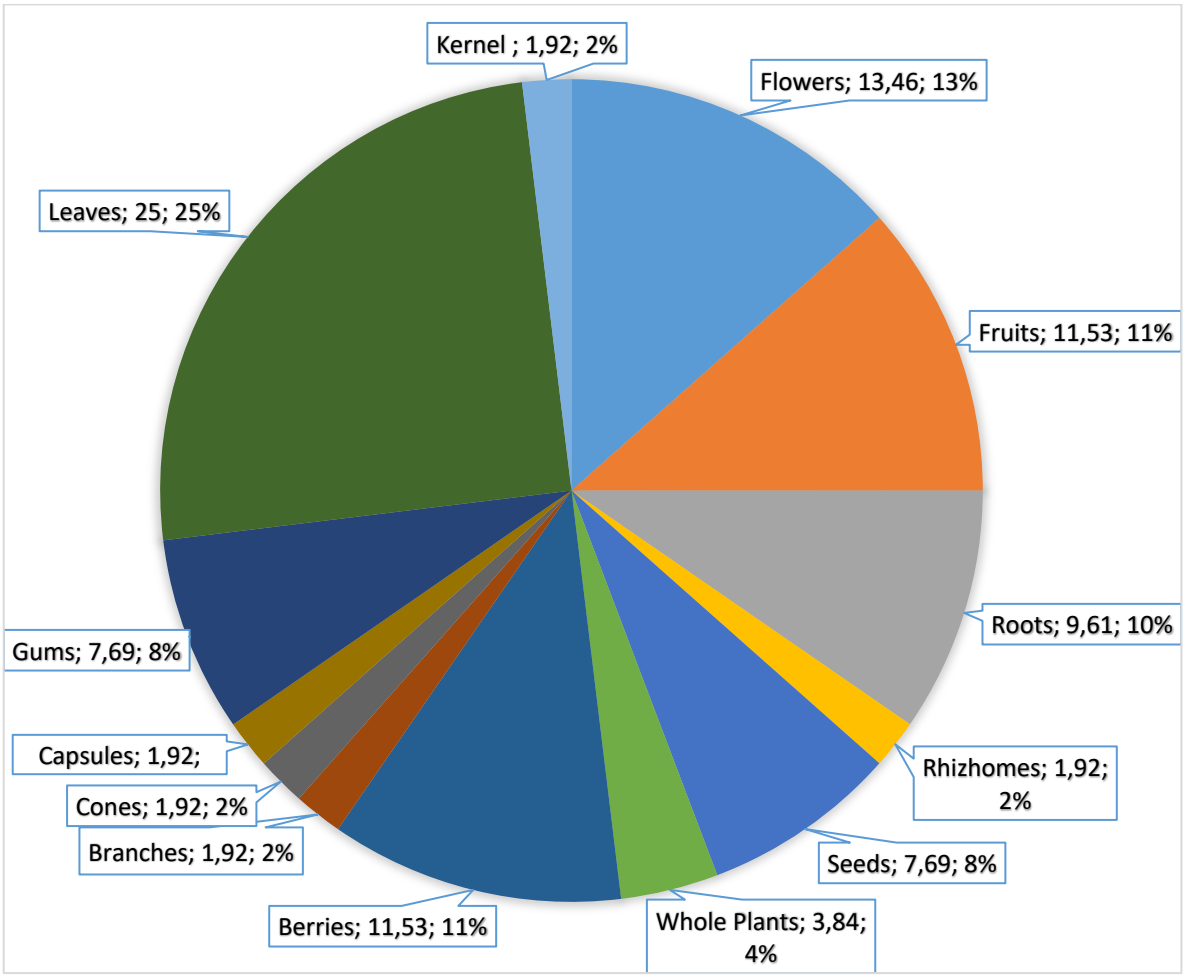

Figure 4. Percentage of different plant parts used by the local community.

The use of leaves as the main part in the ethnobotanical survey has often been documented in several reports (Bibi *et al.* 2014), Moreover, some survey carried out in deserts areas such as in Sindh desert of Pakistan, and the report of (Yaseen *et al.* 2018) in Tarfaya Province in Morocco have shown the use of leaves as the main part of plants. This frequency of the use of leaves can be explained by the synthesis of many classes of bioactive compounds in leaves that are pharmacologically active against many diseases (Xavier *et al.* 2015). Due to ecological conditions the medicinal plants were collected in summer and few in autumn. *C. spinosa, J. regia* and *M. alba* were collected too much in a year and the rest were collected rarely in a year. Majority of men collect medicinal plants, but women

also collect some plants or plant parts, such as various parts of *E. angustifolia,* seeds of *A. graveolens* and leaves of *M. longifolia*. Women mostly do the process of drug preparation, at home or at kitchen as some preparations require heat, grinding and filtration. *A. graveolens, C. spinosa, J. regia, E. angustifolia, M. alba, C. intybus* and *P. somniferum* were prepared in summer and stored for a long time.

Informant Agreement Ratio

The informant agreement ratio (IAR) measures the uniformity or agreement of interviewed respondents in specific Use-categories, such as cooked vegetable or spice. We documented IARs in Hindukush range, Tehsil Mastuj, Chitral, (Table 1). According to the findings, *Medicago sativa*, *Convolvulus arvensis, Morus alba, Plantago lanceolata* and *P. major* had a high IAR of 0.9. i.e., the locals predominantly consumed these plants.

Use Value (UV)

Use Value is used in ethnobotany to assess the relative importance of single species. UV values range from 1 to 0, with UV equal to or close to 1 indicating high use in a region. A species becomes less important as the UV approaches zero. UV ranges in our study species ranged from 0.7 to 0.01. *Mentha longifolia, Medicago sativa* and *Morus alba* had the highest (0.7) UV value (Table 1, Figure 5).

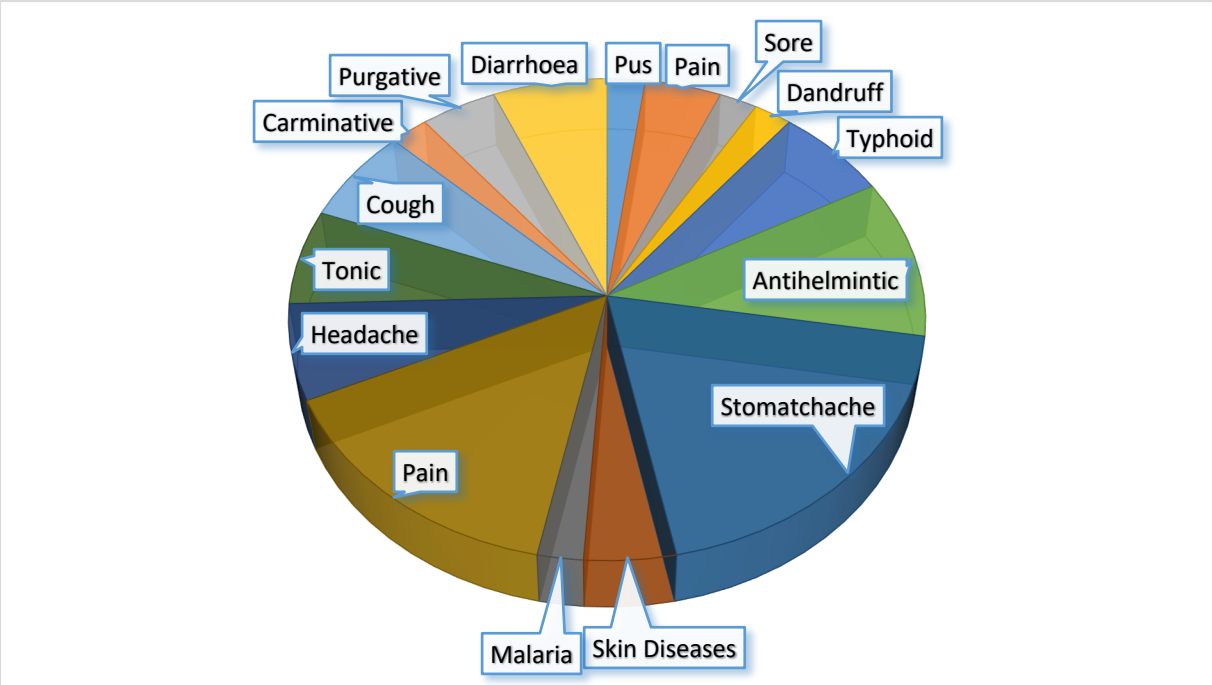

Figure 5. Showing therapeutic potential of the pants.

Kifayatullah *et al.* (2017) suggested that *A. maritima* improves the quality of naswar. It is given to typhoid patients for stomachache discomfort, abdominal pain, tonic, intestinal worm, anthelmintic, and dysentery reasons. Also utilized as a source of energy. The dry and fresh leaves (instantly boiled) of *A. parviflora* are used to treat stomach and abdominal pain, as well as to lower blood pressure in Chitral valley. Moreover, these plants constitute main component of an ecosystem and ensure stability and sustainability of that ecosystem. All animals are depending on food, shelter, and other requirements necessary for their survival. It is estimated that there are 35,000 to 70,000 medicinal plants, used as folk medicinal in worldwide (Haq & Badshah 2021, Hussain *et al.* 2022). The people of the study area have maintained the traditional lifestyles depending on wild and cultivated plants for food, fuel, fodder, construction material and crude drugs. Yarkhun & Torkhow, which are at distance from Booni, modern medicines were less accessible to the people and therefore, people depend too much on traditional system of medicine and this agrees with Ali & Qaisar (2009) and Shah & Hussain (2012).

The present study found that older people preferred to use traditional remedies and had knowledge about medicinal plants uses and methodology of crude drug preparation. The crude drugs prepared by them seemed to be more effective as compared to youngsters who had no traditional knowledge of medicinal plants and their uses. In fact, they use allopathic medicines.

This investigation also showed that Hakims and herbal drug shops were non-existent in the study areas. The villagers preferred allopathic drugs to the herbal drugs. They felt that collection of medicinal plants and preparation of crude drugs following long recipes is the wastage of time. On the other hand, the majority of the people were very poor and cannot effort allopathic drugs and collect medicinal plants from natural habitat. In the study area there is no gas, electricity, and telephone system. There is no jeep-able road in Boroghol. Majority of the mountains were without forests, but abound in medicinal plants, which were mostly herbs and shrubs. They were the sole sources of fuel during the winter.

Conservation

Some medicinal plants were disappearing from their natural habitat due to intense biotic pressure, deforestation and over grazing. A growing pressure has been developed on *H. rhamnoides, J. polycarpos, E. angustifolia* and *A. maritima* used as firewood, and their deforestation has increased due to over population. Similar findings were also reported by Ali (2020), who stressed that sea buckthorn (*H. rahmnoides*) is a member of the Elaeagnaceae family. Gilgit-Baltistan and Chitral, are the world's top producers of sea buckthorn, accounting for 90 percent of global production. Due to a lack of information of the plant's economic, medicinal, and nutritional importance, *H. rahmnoides* is only utilized for fencing and firewood in many areas of Gilgit-Baltistan and Chitral. It contains a variety of bioactive substances, including amino acids, flavonoids, and vitamins A, C, and E. This lack of effort to sustain these plants may result in their depletion from natural habitats (Rafalska *et al.* 2017). Regarding the conservation status of medicinal plants, Zaidi (1998) reported that *H. rhamnoides* (abundant) in northern areas and Chitral, *B. ciliata* (rare) in Begusht valley. *R. emodi* (endangered), *C. govaniana* (vulnerable) while, *E. gerardiana* in Bomburat valley. *A. euchroma* and *B. ciliata* (endangered) in Chumarkan valley while, *R. emodi* rare in Astore valley. *T. serphyllum* was also rare in Bomburat, Begusht, Chumarkan and Astore valley. *R. emodi* rhizomes are used in the treatment of stomachaches, fevers, and heart disorders in the local area. The principal active phytochemical ingredients of *R. emodi* are free anthraquinones such as physcion and chrysophanol, rhein, emodin, and aloe-emodin (Khayal 2019). There is also a need for legal laws in terms of conservation and protection. Human activities such as house construction, dam construction, over-harvesting, and grazing have been identified as the main threats to local biodiversity, and this, combined with high demand for medical herbs on the market, puts increased pressure on plant taxa in the Himalayas and around the world (Bhat *et al.* 2021). Keeping in view this condition, it is suggested that *H. rhamnoides, J. polycarpos, E. angustifolia* and *A. maritima* should be considered the priority species of the investigated area and conserved as these species are currently used for the treatment of different diseases.

In the present study overgrazing was another factor for the deterioration of medicinal plants. Four species were rarely found in the study area. *B. ciliata*, *T. serphyllum* and *Z. clinopodiodes* were found at (3500-3700 m) and were (unpalatable) while *C. govaniana* was found at (2600-2800 m) and was unpalatable. Flowers of *B. ciliata* were palatable to goats. These rare species can be cultivated as they have good adoptability to local climates and have high market values. These species can be cultivated for benefits to the community. Similar findings were also reported by Jan *et al.* (2021) from district Buner, Pakistan.

The present study revealed that no well-organized system for the cultivation of medicinal plants exists. This might be due to an unawareness of the people regarding medicinal uses, cultivation, seed collection, sowing, harvesting, collection, drying, storage, age of plants and marketing value of medicinal plants. The collection method of medicinal plants is unscientific. These results were supported by Ali & Qaisar (2009) who stated that in Chitral valley, the use of plant resources is also a source of income, besides fulfilling their various utilitarian needs. The plant collectors were often herders, shepherd or other poor village dwellers of the population.

The other reason for not cultivating medicinal plants was lack of land. Most of the people in study areas possessed as little 1-1,5 ha of land. According to Haq *et al.* (2021), sustainable use and management of wild resources can help to improve livelihoods, food security, and poverty alleviation and have a significant role in aboriginal people's livelihood support in terms of subsistence and money production.

We found a number of medicinal plants that have traditionally been used to treat various diseases in Chitral, Pakistan similar to Fatima *et al. (*2018). Overpopulation, agricultural practices, developmental work, habitat destruction, deforestation and overgrazing were the main biotic stresses which severely threatened the phylodiversity. Conservation should be encouraged.

Conclusion and recommendations

The traditional uses of medicinal plants were studied in Tehsil Mastuj, District Chitral. Among the studied plants, 38 plants were used for the treatment of various ailments and diseases. Cultivation of medicinal plants should be promoted to improve the livelihoods of rural communities, and financial as well as technical assistance could help the farmers to establish nurseries for rare medicinal plants of high altitudes to produce quality seed and planting stock for pilot scale cultivation. The local people should be trained for proper collection, drying, storage and preservation of medicinal plants.

Declarations

List of abbreviations: Not applicable.
Ethical approval and consent to participate: All interviewees gave oral prior informed consent.
Availability of data: The data used in this work are available.
Consent to publication: Not applicable.
Conflict of interest: The authors declare that there is no conflict of interest.
Funding: No research grant is involved in this research.
Authors' contributions: GD and SAJ designed the study; GD and SAJ conducted the fieldwork, NUU and IA conducted the main statistical analysis; GD and NUU wrote the manuscript, S prepared map, RWB revised the data analysis and the manuscript; all authors read, corrected, and approved the manuscript.

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