



Ethnobotanical documentation of Harike Wildlife Sanctuary (Ramsar Site), Punjab, India: A case study

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Research

Abstract

Background: Harike Wildlife Sanctuary (HWS) is a natural bank of medicinal plants and native flora; therefore regular monitoring is required to maintain such diversity. The objective of the present study is to document the medicinal plants used by local people settled around HWS besides to develop a systematic record of traditionally used medicinal plants.

Methods: The data was collected with the help of a semi-structured questionnaire following the snowball sampling method. People with some knowledge of medicinal plants were targeted for gathering information. To confirm the plant availability and identification, various field surveys were conducted along with informants across the habitat types within Harike Wildlife Sanctuary. Besides the harvest time of different wild plants mentioned by informants and the database is prepared for useful medicinal plants.

Results: A total of 85 species from 79 genera and 51 families were mentioned by informants for the treatment of 40 types of health ailments. Leaves (25% species) are the most used plant part and decoction (19 species) is the most used method for the preparation of the drug, while the most frequent administration of the drug is oral (85% species). The ethnobotanical indices like Use Value, Relative Importance and Fidelity Level (FL) of each species have been derived from the primary dataset.

Conclusion: Even though the study area also has access to contemporary healthcare services, the study found that numerous species are utilized to treat a wide range of medical conditions. By creating an effective plan, the current study may help to preserve medicinal and aromatic plants.

Keywords: Harike-wetland, Ethnobotany, Fidelity Level, Medicinal plants, Use Value, Punjab

Background

Traditional health management practices with medicinal plants have been supporting human civilizations globally and are being used to extract useful phytochemicals to produce modern medicine (Schippmann *et al.* 2002). Medicinal plants are usually accessible in plenty, particularly in the tropics. The effectiveness of any healthcare system endures due to suitable medicines. The marginal communities of society are unable to afford the cost of modern medicines hence medicinal plants are essential for healthcare (Rao 1991). Around 80% of people in Asia and Africa use traditional medicine (Oyebode *et al.* 2016). The Ayurveda, Unani and Siddha healthcare systems evolved with medicinal plants in the course of a sequence of several centuries. Seventy-five percent of the needs

of the third world are met by an estimated 6,000 species utilised in traditional and herbal medicine, while 3,000 plants have been formally recognized for their therapeutic benefits (Laldingliani *et al.* 2022). About 80% of the population of developing countries is actively engaged in using medicinal plants to treat health ailments (Hamilton 2004). The continuous rapid destruction of natural habitats is leading to the shrinking of the sources leading to the loss of biodiversity as well as the population of medicinal plants. Therefore, the studies of ethnobotanical are important for developing conservation strategies (Panigrahi *et al.* 2021). The use of traditional knowledge of plant materials for disease treatment and prevention has gotten a lot of attention from the plant-based research community, which has led to an increase in drug discovery based on phytochemicals (Newman and Crag 2007; Anupama *et al.* 2014). There are many bioactive compounds usually acquired from plants. Few medicinal plants like *Tribulus terrestris* and *Urena lobata* has been identified as a repository of diosgenin and quercetin, respectively, *Acacia catechu* contains catechin and a climber *Basella alba* produces carotenoids (Khare 2008). . Harike village is located alongside Harike village is located along Harike Wetland from centuries which is also a confluence zone for two major Himalayan rivers. In addition, Harike Wetland, a section of HWS, is associated with six habitat types, making this place rich in flora that may be beneficial for medicinal purposes. The Harike village area is significant to Punjab's history and culture, therefore it's possible that people here generated their own methods for treating illnesses with the help of nearby medicinal plants. The objective of the present study is to document the medicinal plants used by local people settled around HWS besides developing a systematic record of traditionally used medicinal plants, methods for using different parts of medicinal plants for treatment of various ailments. This study also examines species richness of medicinal plants in different months in a year and variety of medicinal plant species found in various habitat types besides documenting the time period of different medicinal plants present in HWS.

Materials and Methods

Study area

The study is one of the largest man-made wetland of north India, established in 1952 at the confluence of Beas and Sutlej rivers and designated as a Ramsar site in the year 1990, i.e. Harike Wildlife Sanctuary (HWS). It is located between 31°05'15" to 31°14'15" N Lat. and 74° 55'30" to 75° 07'30" E Long. in the state of Punjab. The sanctuary is spreading over an area of approximately 86 sq. km (Fig 1), sharing its boundaries with Ferozpur, Tarn Taran and Kapurthala districts of the state of Punjab. Harike wetland is also a foundation of the extensive Indira Gandhi Canal with two channels, Rajasthan (650 km) and Ferozpur (51.3 km), which provide water supply to Punjab, Haryana and Rajasthan states. The sanctuary is surrounded by agricultural fields and villages, the major population is engaged in mixed farming. Harike and Marrar village is the largest and smallest village around the sanctuary respectively. Developing fine communication between informants is necessary therefore gathering information always starts with informal talks. After developing a familiarity with the informant, numerous questions had been asked. The diversity of habitats in the Sanctuary supports many medicinal plants with a high population including *Withania somnifera*, *Terminalia bellirica*, *Boerhavia diffusa*, *Bacopa monnieri* and *Centella asiatica*. The Sanctuary is interspersed with agricultural fields and villages.

Ethnobotanical data collection

Ethno-botanical data was collected through semi-structured interviews and observations were recorded during the field surveys held between September 2019 and March 2021. A total of 110 informants were interviewed and the composition of informants include medicinal plant collectors, traditional drug makers, farmers, daily wage laborers, and government servants. A Semi-structured questionnaire was used for data collection following snowball sampling (Goodman 1961 , Arafa *et. al.* 2021, Bhagawan & Kusumawati 2020). The field observations with some informants have been made for the confirmation of plant species mentioned for the treatment of ailments. A total of 72 field surveys have been carried out following the line transit method (Buckland *et. al.* 2007) across the habitat types in HWS to record the status and distribution of medicinal plants mentioned by informants. In each field visit, one-kilometer line transit in each habitat type has been covered to record data, each line transit is repeated 3 times in each season (summer, monsoon, post-monsoon, and winter). Direct and indirect evidence has also been recorded for the collection of medicinal plants from the sanctuary. The wild plants mentioned by the informant have been identified by following Nair 1978 and Sharma 1990 with some online resources like www.theplantlist.org, <http://www.flowersofindia.net>, and www.efloras.org were used. Plants species were photographed from the field and a voucher specimen of pictures has been submitted to the herbarium of the Wildlife Institute of India.



Figure 1. Location of villages along Harike Wildlife Sanctuary

Data analysis

Use Value

To find out the significant plant species used by people, the Use Value (UV) index is calculated according to Rossato *et al.* (1999) and Silva & Albuquerque (2004).

$$UV: \sum U_i / N_i$$

U_i = Number of uses mentioned by all informants.

N_i = Number of the informant.

For example: if informant A has mentioned 2 uses and informant B has mentioned 6 uses, therefore, the Use Value will be $(2+6)/2 = 4$.

Relative Importance Index

The Relative Importance Index is calculated by following Bennett & Prance (2000).

$$RI = NUC + NT$$

NUC = number of use categories of a given species divided by the total number of most versatile species in use categories.

NT = is given by the number of kinds of uses attributed to a given species divided by the total number of types of uses attributed to the most important taxon.

Fidelity level

This is adapted from Friedman *et al.* (1986) to determine the particular medicinal plant used for certain ailments. A high percentage shows that the given species is used by people for the treatment of a particular ailment.

$$\text{Fidelity level (FL)} = I_p / I_u \times 100$$

I_p = number of informants that cited the principal use of the species.

I_u = the total number of informants that cited the species for any purpose.

The Distribution of medicinal plants has been recorded from wild sources after direct field visits conducted on monthly basis from September 2019 to March 2021. A timeline chart for the availability of medicinal plants in the HWS has also been mentioned in the study.

Results and Discussion

Demographical details

A total of 110 informants from six villages (22 from Makhu, 28 from Harike, 8 from Marrar, 15 from Kiriyan, 10 from Kambo-Dhaiwala and 27 from Chamba Kalan) belonged to different age groups and gender (87 men and 23 women) were interviewed for ethnobotanical use of plants, including literacy level and occupation (Table 1). The literacy level of informants was in the order: of Illiterate (42.7%) > below matric (40.9%) > above matric (16.4%). The informants from the age group above 50 years were found to be more aware of the use and identification of medicinal plants. During the investigation, 3 individuals were found engaged in practicing drug preparation and sale, while 5 individuals were involved in the collection of medicinal plants. The knowledge of medicinal plants has been observed at a young age (< 40 years), but they were unable to identify the wild medicinal plants, besides many elder informants also accepted that there is a depletion in the population of medicinal plants and a loss of biodiversity due to habitat destruction and conversion of habitats into agricultural fields.

Table 1. Demographic information

Variable	Category	Number of individuals
Gender	Male	87
	Female	23
Age	<30 years	6
	30-40 years	20
	40-50 years	22
	> 50 years	62
Educational level	Illiterate	47
	< matriculation	45
	>matriculation	18

Taxonomic details

A total of 85 species belonging to 79 genera and 51 families have been mentioned by the informants to treat 40 ailments (Table 2). The maximum number of species was recorded from Fabaceae family (4 species), followed by Apiaceae, Apocynaceae, Brassicaceae, Euphorbiaceae, Lamiaceae, Myrtaceae, Papaveraceae, Rutaceae, Solanaceae, Zingiberaceae (3 species each) and Amaranthaceae, Amaryllidaceae, Combretaceae, Cucurbitaceae, Lythraceae, Malvaceae, Meliaceae, Moraceae, Phyllanthaceae, Poaceae (2 species each), while 30 families were represented by single species. Herbs (51.8%) were recorded as the most used habit of medicinal plants mentioned by informants followed by trees (27.1%), shrubs (11.8%), climbers (7.1%) and grasses (2.4%). Muthu *et al.* (2006) carried out an ethnobotanical survey during October 2003 to April 2004 in Kancheepuram district of Tamil Nadu, India. They recorded 85 species of plants spread in 76 genera belonging to 41 families to treat various illnesses with dominated families like Euphorbiaceae (7 species) and Verbenaceae (5 species) but in the case of HWS it's Fabaceae (4 species) and Euphorbiaceae (3 species). Muthu *et al.* (2006) recorded Herbs (39 species), trees (21 species), shrubs (14 species) and climbers (11 species). Another study conducted by Parvaiz, (2014) in Mangowal, District Gujrat, Punjab, Pakistan. He revealed that native people use about 40 plant species from 22 families to treat a range of illnesses and problems, including asthma, ulcers, gonorrhoea, piles, stomach pain, and skin issues. Haq *et al.* (2021) documented 105 ethnobotanically significant plants belonging to 39 families from area of Ladakh in the Indian Trans-Himalayas zone. They also recorded Fabaceae and Lamiaceae as dominating family. There are 49 species common to the study conducted by Sidhu *et al.* (2011) with major species like *Allium cepa*, *Acacia nilotica*, *Allium sativum*, *Aegle marmelos*, *Brassica campestris*, *Bryophyllum pinnatum*, *Argemone mexicana*, *Azadirachta indica*,

Citrus reticulata and *Euphorbia hirta*. The study conducted in the Kapurthala district of Punjab by Kaur *et al.* (2017) shows that 29 species are common with major species like *Abutilon indicum*, *Achyranthes aspera*, *Aegle marmelos*, *Asparagus racemosus*, *Cinnamomum zeylanicum*, *Cassia fistula*, and *Ficus benghalensis*. However, Sidhu *et al.* (2012) reported 50 species common in the Jalandhar district of Punjab including *Achyranthes aspera*, *Argemone mexicana*, *Bacopa monnieri*, *Bryophyllum pinnatum*, *Calotropis procera*, *Brassica campestris*, *Camellia sinensis*, *Carica papaya*, *Cannabis sativa*, *Cassia fistula*, *Curcuma longa*, *Embllica officinalis*, *Ficus palmate*, *Fumaria indica* and *Piper nigrum*.

Table 2. Number of species, genera and families according to habit

Habit	Species	Genus	Family
Climber	6	5	4
Grasses	2	2	1
Herbs	44	41	26
Shrubs	10	10	3
Trees	23	21	17

Species used for various ailments

The ailments mentioned by the informants have been classified under 15 major ailments' categories along with the medicinal plant species (Fig 2) used are in following order: Gastro-intestinal with 48 species [ailments: constipation (15 species), diarrhea (12 species), indigestion (7 species), piles and stomachache (5 species each), gastritis (3 species), ulcer (1 species)] > Circulatory with 19 species [ailments: diabetes (13 species), anemia (3 species), blood pressure (2 species), blood infection (1 species)] and General with 17 species [ailments: fever (8 species), cough & cold (5 species), headache (3 species), bee sting (1 species)] > Dental with 11 species [ailments: bad breath (1 species), periodontitis (5 species) and toothache (5 species)], Skeleton and Muscle with 10 species [ailments: arthritis (2 species), body pain (5 species), weakness (3 species)], Respiratory with 9 species [ailments: asthma (5 species), lung infection (4 species)] and Dermatological with 9 species [ailments: skin disease (5 species), cut and Wound (4 species)] > Vital organs with 7 species [ailments: Cardiovascular disease (1 species), Kidney stone (2 species), Liver disorder (4 species)] and Vector-Borne with 7 species [ailments: malaria (3 species), dengue (4 species)] and Body heat [ailment: Heatstroke] with 7 species > Mental with 6 species [ailments: memory loss (1 species), mental disorder (3 species), insomnia (2 species)], Genital with 6 species [ailments: sexual disorder (4 species), urinary tract infections (1 species), azoospermia (1 species)] and Hair with 6 species [ailment: hair loss] > Hepatic with 2 species [ailment: jaundice] > Ophthalmic with 1 species [ailment: eye irritation]. Panghal *et al.* (2010) reported 8 species for treatment of male fertility problems and cough, 7 species for female sex problems and fever, 6 species for eye problems, and skin diseases, 5 species for treatment of fistula, wound healing, and jaundice, 4 species for treatment of piles, mental diseases, abdominal problems and tooth ache. A total of 101 types of medicinal uses have been reported by Gras *et al.* (2019), in which anticatarrhal (59 species) and stomachic (58 species) were mentioned. A detailed description of each medicinal plant recorded in the present study is mentioned in Annexure II.

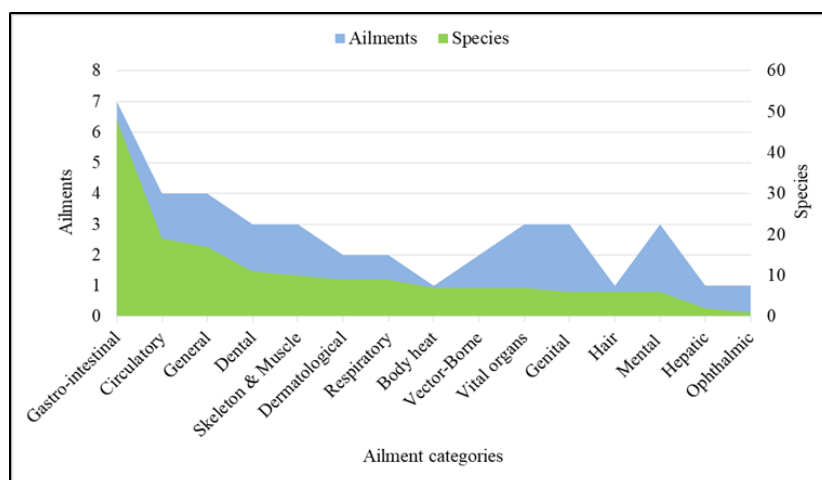


Figure 2. Number of Species recorded under various ailment categories. .

Plant parts used

The plant parts used (Fig 3) for medicinal purposes to treat various ailments are in the following order: Leaves (26 species) > Fruits (22 species) > Whole plant (14 species) > Seeds (11 species) > Roots (9 species) > Stem \approx Rhizome (5 species each) > Latex (4 species) > Flower \approx Bark (3 species) > Oil (2 species). Khan *et. al* (2022) reported leaves (29 species) are the main plant part used in medicinal practices followed by roots (22), whole plants (9), seeds (8), 6 species for bark, flowers, and fruits. 5 species significant for rhizomes, 3 species for shoots and twigs. Similarly Mir *et. al* (2021) found roots were most utilized amongst the parts of plants, with 25% species of usage, followed by whole plant (22%), rhizomes (15%), leaves (13%), flowers (10%), fruits, seeds and bark (5%). Bhat *et. al* (2021) mentioned whole parts of the plants (26.17%) and the leaves (24.30%) are used frequently for treatment of different ailments in the Kashmir regions.

The species like *Achyranthes aspera*, *Azadirachta indica*, *Withania somnifera*, *Moringa oleifera* and *Carica papaya* contribute for leaves; *Aegle marmelos*, *Cordia myxa*, *Kigelia africana*, *Mangifera indica*, *Moringa oleifera*, *Musa paradisiaca*, *Phyllanthus emblica*, *Terminalia bellirica*, *Ziziphus nummularia*, and *Vachellia nilotica* for fruits; *Bacopa monnieri*, *Centella asiatica*, *Coriandrum sativum*, *Sisymbrium irio*, *Phyllanthus niruri*, *Euphorbia hirta*, *Cuscuta reflexa*, and *Fumaria indica* as whole plant; *Abrus precatorius*, *Achyranthes aspera*, *Asparagus officinalis*, *Azadirachta indica*, *Boerhavia diffusa*, *Beta vulgaris*, *Ficus palmate*, and *Solanum virginianum* for roots; *Brassica campestris*, *Cleome viscosa*, *Piper nigrum*, *Sisymbrium irio*, *Trachyspermum ammi*, *Vachellia nilotica*, and *Trigonella foenum-graecum* for seeds; *Curcuma longa*, *Zingiber officinale*, *Allium sativum*, and *Allium cepa* for rhizome; *Azadirachta indica*, *Mimusops elengi*, *Achyranthes aspera*, *Nerium oleander* and *Pongamia pinnata* for stems; *Ficus palmata*, *Ficus benghalensis*, *Calotropis procera*, and *Argemone mexicana* for latex; *Azadirachta indica*, *Cinnamomum verum*, and *Terminalia arjuna* for bark; *Catharanthus roseus*, *Hibiscus rosa-sinensis*, and *Syzygium aromaticum* for flowers and *Brassica campestris*, and *Ricinus communis* for oil.

Source for collection of medicinal plants

The medicinal plants were collected by the local inhabitants from various sources, such as wilderness areas, agricultural lands, wilderness areas/agricultural lands and market (Fig 4) The study area is primarily dominated by agricultural fields, which supports many cultivated species, among them 23 species used for medicinal purposes as cited by the informants, *Curcuma longa*, *Allium sativum*, *Zingiber officinale*, *Bryophyllum pinnatum*, *Ocimum tenuiflorum*, *Brassica campestris*, *Ocimum basilicum*, *Raphanus sativus*, *Trigonella foenum-graecum*, *Beta vulgaris*, *Murraya koenigii*, and *Allium cepa* was the common species. However, species like *Asparagus officinalis*, *Mangifera indica*, *Phyllanthus emblica*, *Syzygium cumini*, *Psidium guajava*, *Moringa oleifera*, *Melia azedarach*, *Papaver rhoeas*, *Mangifera indica* and *Nerium oleander* were collected from the wilderness areas. The maximum species (45 species) were collected from the wilderness areas according to informants and the prominent species were *Tinospora cordifolia*, *Datura metel*, *Cannabis sativa*, *Tribulus terrestris*, *Phyla nodiflora*, *Pedaliium murex*, *Cordia myxa*, *Withania somnifera*, *Achyranthes aspera*, *Ricinus communis*, *Bacopa monnieri*, *Calotropis procera* and *Lawsonia inermis*. The species like *Piper longum*, *Piper nigrum*, *Trachyspermum ammi*, *Syzygium aromaticum*, *Camellia sinensis*, *Amomum subulatum*, and *Cinnamomum verum* were procured from the market only.

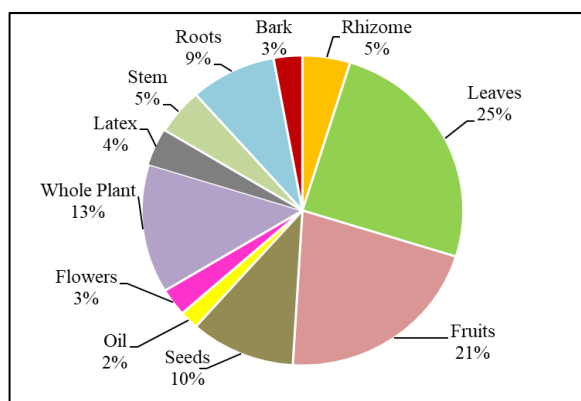


Figure 3. Plant parts used

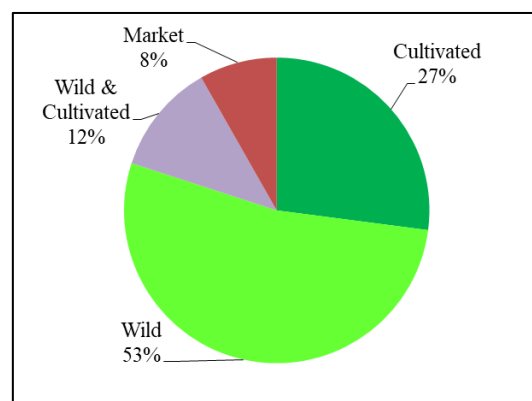


Figure 4. Sources of medicinal plants

Preparation of Drug

Various modes of consumption of medicinal plants for the treatment of different ailments mentioned by informants are shown in Fig 5. The treatment of different ailments with the change in combination is in the following order:

Decoction (19 species) > Raw form (18 species) > Fresh juice (17 species) > Powder (10 species) > Blend (9 species) > Fresh fruits (6 species) > Paste (6 species) > Smoke ≈ Fry (1 species each) The use of powder (40.19%) forms is most preferred method preparation of a drugs was documented in the areas of the Kashmir Himalaya by Bhat *et. al* (2021) followed juice (22.43%), decoction (14.95%), paste (13.08%), and chewed (9.35%). Treasure *et. al* (2020) reported decoction (38.54%) as frequent mode of drug preparation followed by was crushing (38.05%), maceration (11.72%), cook (4.88%), and 3.91% was infusion. Mir *et. al* (2021) also mentioned decoction (25%) as the most common method of medicine preparation followed by powder (18%), paste (17%), raw (8%), and juice (7%) in the high-altitude of Kashmir, Northern Himalaya.

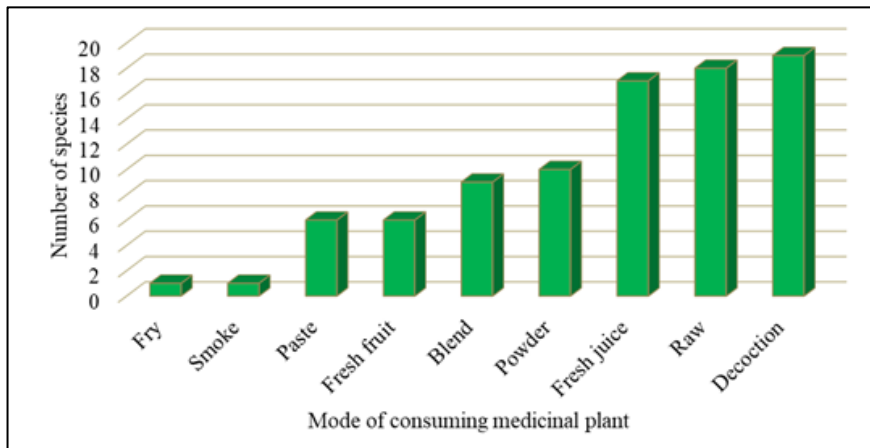


Figure 5. Mode of consuming medicinal plants

The important species used for decoction: *Tinospora cordifolia*, *Justicia adhatoda*, *Fumaria indica*, *Cleome viscosa*, *Cinnamomum verum*, *Chenopodium ambrosioides*, *Amomum subulatum*, *Piper nigrum*, *Curcuma longa* and *Zingiber officinale*; as raw forms: *Abutilon indicum*, *Allium sativum*, *Azadirachta indica*, *Euphorbia hirta*, *Euphorbia prostrata*, *Withania somnifera* and *Zingiber officinale*; as fresh juice: *Aegle marmelos*, *Punica granatum*, *Phyllanthus niruri*, *Citrus aurantium*, *Lagenaria siceraria*, *Raphanus sativus*, *Allium cepa* and *Carica papaya*; as powder: *Abrus precatorius*, *Curcuma longa*, *Terminalia bellirica*, *Tribulus terrestris*, *Vachellia nilotica*, *Withania somnifera* and *Tribulus terrestris*; as blend or juice: *Aegle marmelos*, *Carica papaya*, *Brassica campestris*, *Beta vulgaris*, *Zingiber officinale*, *Ricinus communis*, *Hibiscus rosa-sinensis*, *Mangifera indica* and *Ficus palmata*; as fresh fruits: *Cordia myxa*, *Phyllanthus emblica*, *Ziziphus nummularia* and *Syzygium cumini*; as paste: *Lawsonia inermis*, *Mimusops elengi*, *Oxalis corniculata*, *Papaver rhoeas* and *Phyla nodiflora*, while *Cannabis sativa* as smoke and *Sisymbrium irio* as fry administered to cure the various ailments.

Administration of Drug

The drugs administered orally were 84.7% and the major species were *Withania somnifera*, *Phyllanthus emblica*, *Piper longum*, *Terminalia arjuna*, *Tinospora cordifolia*, *Vachellia nilotica*, *Phyllanthus emblica*, *Raphanus sativus* and *Justicia adhatoda*. The drugs administered topical were 11.8% and the major species were *Ageratum conyzoides*, *Argemone mexicana*, *Calotropis procera*, *Cuscuta reflexa*, *Eclipta prostrata*, *Ficus palmata*, *Hibiscus rosa-sinensis*, *Lawsonia inermis*, *Mimusops elengi* and *Nerium oleander*. However, the drugs administered orally/topical were 3.5% and the species were *Allium cepa*, *Azadirachta indica* and *Mangifera indica*. Sukumaran *et. al* (2021) reported most frequent method of drug administration is oral (53%) from the Pechiparai hills of Kanyakumari Wildlife Sanctuary, Western Ghats, India. similarly Tefera and Kim, (2019) reported Oral (74%) as most frequent ways of administration from southern Ethiopia. Bibi *et. al* (2022) also found oral (56.1%) route is frequent mode of drug administration while 31.2% of medicinal plants were used for both oral and topical applications in the Tanawal area located in Western Himalayas, Pakistan.

Use Value

The UV of medicinal plants ranged from 1.8 to 0.3 in the study area. The higher UV indicates more utilization of a species. Species with high UV are *Tinospora cordifolia* and *Curcuma longa* (1.8 each), *Piper longum* and *Allium sativum* (1.2 each), *Zingiber officinale* (1.0), *Euphorbia hirta*, *Azadirachta indica* and *Justicia adhatoda* (0.9 each) and *Withania somnifera* (0.8). However, species with low UV are *Fumaria indica* (0.09), *Pedaliium murex* (0.09), *Tribulus terrestris* (0.08), *Cannabis sativa* (0.06), *Phyllanthus niruri* (0.06) and *Datura metel* (0.03). The UV of documented species is given in Annexure II.

Relative Importance (RI)

The RI (Annexure II) has been driven by the number of ailment categories for a particular species and the number of uses for concerned species, therefore the species which were recorded under various uses with multiple ailment categories exhibit higher value. The higher RI of medicinal plants suggests the level of awareness and use for the treatment of various ailments. In the present study, the higher RI were recorded for *Allium sativum* with RI value 2 (7 uses under 5 ailment categories) followed by *Azadirachta indica* with RI value 1.86 (6 uses under 5 ailment categories), *Curcuma longa* with RI value 1.51 (5 uses under 4 ailment categories) and *Withania somnifera*, *Punica granatum*, *Oxalis corniculata* and *Cleome viscosa* with RI value 1.37 (each with 4 uses under 4 ailment categories). The least RI value (0.34) was recorded for *Ricinus communis*, *Ficus benghalensis*, *Amomum subulatum*, *Hibiscus rosa-sinensis*, *Lawsonia inermis*, *Argemone mexicana*, *Catharanthus roseus*, *Ficus palmata* and *Sisymbrium irio*.

Fidelity Level (FL)

FL is useful to know the most preferred species used by the informants for treating certain ailments and is given in Table 3. The FL specifies that certain species are used for the treatment of a particular ailment and is expressed in the percentage, given in Table 3. The FL values for different ailments like fever, blood infection and constipation were 70%, 80% and 40%, respectively shown by *Fumaria indica*. Similarly, FL values of *Withania somnifera* were 91.8% for malaria, 94.1% for sexual disorder and 65.9% for Stomachache. The species with 100% FL values for the treatment of certain ailments include *Catharanthus roseus* (Diabetes), *Camellia sinensis* (Diarrhea) *Cleome viscosa* (Fever), *Mimusops elengi* (Periodontitis), *Argemone mexicana* (Skin disease), *Amomum subulatum* (Indigestion), *Datura metel* (Insomnia) and *Phyllanthus niruri* (Jaundice).

Table 3. Fidelity Level of each species under various ailments

Species	Fidelity level
Anemia	
<i>Beta vulgaris</i> L.	76 2
<i>Phoenix sylvestris</i> (L.) Roxb.	90 0
<i>Punica granatum</i> L.	92 3
Arthritis	
<i>Vachellia nilotica</i> (L.) P.J.H. Hurter & Mabb.	87 5
<i>Calotropis procera</i> (Aiton) Dryand	88 2
Asthma	
<i>Allium cepa</i> L.	90 0
<i>Justicia adhatoda</i> L.	67 3
<i>Withania somnifera</i> (L.) Dunal	80 0
<i>Syzygium cumini</i> var. <i>cumini</i> L.	28 6
<i>Sisymbrium irio</i> L.	100 0
Azoospermia	
<i>Ficus benghalensis</i> L.	100 0
Bad breath	
<i>Ocimum basilicum</i> L.	46 3
Bee sting	
<i>Oxalis corniculata</i> L.	32 0
Blood infection	
<i>Fumaria indica</i> (Hauskn.) Pugsley	80 0
Blood pressure	
<i>Zingiber officinale</i> Roscoe	45 7
<i>Allium sativum</i> L.	27 6
Body pain	
<i>Ziziphus nummularia</i> (Burm f.) Wight & Arn	71 4
<i>Brassica rapa</i> var. <i>rapa</i> L.	83 9
<i>Calotropis procera</i> (Aiton) Dryand	58 8
<i>Phoenix sylvestris</i> (L.) Roxb	80 0
<i>Curcuma longa</i> L.	73 9
Cardiovascular disease	
<i>Terminalia arjuna</i> (Roxb. ex DC.) Wight & Arn	100 0

Cold and cough	
<i>Solanum virginianum</i> L.	57 1
<i>Achyranthes aspera</i> L.	61 5
<i>Zingiber officinale</i> Roscoe	83 0
<i>Brassica rapa</i> var. <i>rapa</i> L.	87 1
<i>Trachyspermum ammi</i> (L.) Sprague	87 5
<i>Piper nigrum</i> L.	88 9
<i>Justicia adhatoda</i> L.	90 9
<i>Piper longum</i> L.	92 7
<i>Allium sativum</i> L.	96 6
<i>Syzygium aromaticum</i> (L.) Merr. & L.M. Perry	97 6
<i>Curcuma longa</i> L.	97 8
<i>Ocimum tenuiflorum</i> L.	98 4
<i>Cinnamomum verum</i> J Presl	100 0
<i>Cleome viscosa</i> L	76 9
Constipation	
<i>Ziziphus nummularia</i> (Burm f.) Wight & Arn .	71 4
<i>Fumaria indica</i> (Hauskn.) Pugsley	40 0
<i>Aloe vera</i> (L.) Burm f.	43 5
<i>Psidium guajava</i> L.	83 3
<i>Beta vulgaris</i> L.	85 7
<i>Terminalia bellirica</i> (Gaertn.) Roxb.	76 5
<i>Murraya koenigii</i> (L.) Spreng.	73 1
<i>Mangifera indica</i> L	71 4
<i>Phyllanthus emblica</i> L.	89 7
<i>Carica papaya</i> L	76 9
<i>Kigelia africana</i>	94 4
<i>Cleome viscosa</i> L	76 9
<i>Cordia myxa</i> L.	100 0
<i>Raphanus sativus</i> L.	77 8
<i>Ricinus communis</i> L.	100 0
Cut and wound	
<i>Azadirachta indica</i> A. Juss.	58 0
<i>Eclipta prostrata</i> (L.) L.	73 9
<i>Brassica rapa</i> var. <i>rapa</i> L.	64 5
<i>Oxalis corniculata</i> L	80 0
<i>Bryophyllum pinnatum</i> (Lam.) Oken	41 7
<i>Ageratum conyzoides</i> L.	100 0
Dengue	
<i>Nyctanthes arbor-tristis</i> L.	81 5
<i>Tinospora cordifolia</i> (Willd.) Miers	82 9
<i>Carica papaya</i> L	92 3
<i>Punica granatum</i> L.	88 5
Diabetes	
<i>Azadirachta indica</i> A. Juss.	53 6
<i>Moringa oleifera</i> Lam	87 5
<i>Terminalia bellirica</i> (Gaertn.) Roxb.	88 2
<i>Murraya koenigii</i> (L.) Spreng.	46 2
<i>Justicia adhatoda</i> L.	78 2
<i>Syzygium cumini</i> var. <i>cumini</i> L.	95 2
<i>Allium sativum</i> L.	34 5
<i>Catharanthus roseus</i> (L.) G. Don.	100 0
<i>Lagenaria siceraria</i> (Molina) Standl.	100 0
<i>Melia azedarach</i> L.	100 0
<i>Momordica charantia</i> L.	100 0

<i>Terminalia arjuna</i> (Roxb. ex DC.) Wight & Arn.	66 7
<i>Trigonella foenum-graecum</i> L.	100 0
Diarrhea	
<i>Ziziphus nummularia</i> (Burm f.) Wight & Arn.	35 7
<i>Tribulus terrestris</i> L.	55 6
<i>Aloe vera</i> (L.) Burm f.	76 1
<i>Aegle marmelos</i> (L.) Correa	81 0
<i>Psidium guajava</i> L.	83 3
<i>Trachyspermum ammi</i> (L.) Sprague	70 8
<i>Euphorbia prostrata</i> Aiton	89 7
<i>Oxalis corniculata</i> L.	80 0
<i>Camellia sinensis</i> (L.) Kuntze	100 0
<i>Cynodon dactylon</i> (L.) Pers.	100 0
<i>Euphorbia hirta</i> L.	95 2
<i>Musa x paradisiaca</i> L.	100 0
Eye irritation	
<i>Allium cepa</i> L.	80 0
Fever	
<i>Azadirachta indica</i> A. Juss.	79 7
<i>Fumaria indica</i> (Hauskn.) Pugsley	70 0
<i>Aegle marmelos</i> (L.) Correa	71 4
<i>Nyctanthes arbor-tristis</i> L.	88 9
<i>Tinospora cordifolia</i> (Willd.) Miers	92 1
<i>Curcuma longa</i> L.	82 6
<i>Cleome viscosa</i> L.	100 0
<i>Terminalia arjuna</i> (Roxb. ex DC.) Wight & Arn.	55 6
Gastritis	
<i>Zingiber officinale</i> Roscoe	38 3
<i>Allium sativum</i> L.	43 7
<i>Mentha piperita</i> L.	85 0
Hair loss	
<i>Beta vulgaris</i> L.	61 9
<i>Eclipta prostrata</i> (L.) L.	87 0
<i>Phyllanthus emblica</i> L.	57 7
<i>Cuscuta reflexa</i> Roxb	100 0
<i>Hibiscus rosa-sinensis</i> L.	100 0
<i>Lawsonia inermis</i> L.	100 0
Headache	
<i>Citrus aurantium</i> L.	60 6
<i>Punica granatum</i> L.	61 5
<i>Centella asiatica</i> (L.) Urb	97 6
Heatstroke	
<i>Citrus aurantium</i> L.	69 7
<i>Chrysopogon zizanioides</i> (L.) Roberty	54 6
<i>Coriandrum sativum</i> L.	76 2
<i>Bacopa monnieri</i> (L.) Wettst	83 3
<i>Mangifera indica</i> L.	89 3
<i>Oxalis corniculata</i> L.	92 0
<i>Centella asiatica</i> (L.) Urb	78 1
Indigestion	
<i>Aloe vera</i> (L.) Burm f	69 6
<i>Zingiber officinale</i> Roscoe	38 3
<i>Ocimum basilicum</i> L.	87 0
<i>Moringa oleifera</i> Lam	62 5
<i>Terminalia bellirica</i> (Gaertn.) Roxb.	58 8

<i>Murraya koenigii</i> (L.) Spreng	88 5
<i>Phyllanthus emblica</i> L.	68 0
<i>Allium sativum</i> L.	43 7
<i>Amomum subulatum</i> Roxb.	100 0
<i>Mentha piperita</i> L.	85 0
Insomnia	
<i>Cannabis sativa</i> L.	100 0
<i>Datura metel</i> L.	100 0
Jaundice	
<i>Phyllanthus niruri</i> L.	100 0
<i>Raphanus sativus</i> L.	100 0
Kidney stone	
<i>Boerhavia diffusa</i> L.	55 0
<i>Bryophyllum pinnatum</i> (Lam.) Oken	95 2
Liver disorder	
<i>Solanum virginianum</i> L.	71 4
<i>Achyranthes aspera</i> L.	35 4
<i>Moringa oleifera</i> Lam	81 3
<i>Murraya koenigii</i> (L.) Spreng	84 6
<i>Syzygium cumini</i> var. <i>cumini</i> L.	81 0
Lung infection	
<i>Tinospora cordifolia</i> (Willd.) Miers	27 6
<i>Piper longum</i> L.	52 9
<i>Ocimum tenuiflorum</i> L.	39 3
<i>Cleome viscosa</i> L.	84 6
Malaria	
<i>Tinospora cordifolia</i> (Willd.) Miers	44 7
<i>Punica granatum</i> L.	46 2
<i>Withania somnifera</i> (L.) Dunal	91 8
Memory loss	
<i>Bacopa monnieri</i> (L.) Wettst	58 3
Mental disorders	
<i>Cannabis sativa</i> L.	57 1
<i>Datura metel</i> L.	66 7
<i>Papaver rhoeas</i> L.	100 0
Periodontitis	
<i>Achyranthes aspera</i> L.	30 8
<i>Azadirachta indica</i> A. Juss.	37 7
<i>Psidium guajava</i> L.	55 6
<i>Pongamia pinnata</i> (L.) Pierre	73 9
<i>Vachellia nilotica</i> (L.) P.J.H. Hurter & Mabb	81 3
<i>Nerium oleander</i> L.	53 3
<i>Syzygium aromaticum</i> (L.) Merr. & L.M Perry	78 1
<i>Cordia myxa</i> L.	66 7
<i>Mimusops elengi</i> L.	100 0
Piles	
<i>Euphorbia prostrata</i> Aiton	79 3
<i>Kigelia africana</i>	88 9
<i>Chenopodium ambrosioides</i> L.	100 0
<i>Euphorbia hirta</i> L.	100 0
<i>Phyla nodiflora</i> (L.) Greene	100 0
Sexual disorder	
<i>Tribulus terrestris</i> L.	77 8
<i>Abutilon indicum</i> (L.) Sweet	40 0
<i>Asparagus officinalis</i> L.	81 0

<i>Boerhavia diffusa</i> L.	90 0
<i>Withania somnifera</i> (L.) Dunal	94 1
<i>Allium sativum</i> L.	54 0
<i>Abrus precatorius</i> L.	100 0
<i>Pedaliium murex</i> L.	100 0
Skin disease	
<i>Aloe vera</i> (L.) Burm f	80 4
<i>Brassica rapa</i> var. <i>rapa</i> L.	58 1
<i>Curcuma longa</i> L.	62 0
<i>Argemone mexicana</i> L.	100 0
<i>Ficus palmata</i> Forssk	100 0
Stomachache	
<i>Citrus aurantium</i> L.	48 5
<i>Chrysopogon zizanioides</i> (L.) Roberty	72 7
<i>Azadirachta indica</i> A. Juss.	69 6
<i>Ocimum basilicum</i> L	68 5
<i>Euphorbia prostrata</i> Aiton	86 2
<i>Withania somnifera</i> (L.) Dunal	65 9
<i>Kigelia africana</i> L.	94 4
<i>Centella asiatica</i> (L.) Urb	78 1
<i>Chenopodium ambrosioides</i> L.	62 5
<i>Euphorbia hirta</i> L.	63 5
<i>Phyla nodiflora</i> (L.) Greene	70 0
Toothache	
<i>Achyranthes aspera</i> L.	76 9
<i>Pongamia pinnata</i> (L.) Pierre	87 0
<i>Vachellia nilotica</i> (L.) P.J.H. Hurter & Mabb.	62 5
<i>Nerium oleander</i> L.	90 0
<i>Syzygium aromaticum</i> (L.) Merr. & L.M. Perry	43 9
Ulcer	
<i>Azadirachta indica</i> A. Juss.	55 1
Urinary tract infections	
<i>Coriandrum sativum</i> L.	61 9
Weakness	
<i>Abutilon indicum</i> (L.) Sweet	80 0
<i>Asparagus officinalis</i> L.	52 4
<i>Boerhavia diffusa</i> L.	80 0

Collection of medicinal plants

HWS is a mosaic of 6 major habitat types and each habitat type supports population of wild medicinal plants viz. Plantation (16 species of trees, 2 species of shrubs, 18 species of herbs, 1 species of grass, and 4 species of climbers), Agricultural fields (7 species of trees, 1 species of shrub, 12 species of herbs, 1 species of grass, and 1 species climber), Swampy (9 species of trees, 9 species of herbs, 2 species of grass, and 2 species climbers), Wetland (5 species of trees, 6 species of herbs, and 1 species of grass), Sandy (6 species of trees, 10 species of herbs, and 2 species of grass), and Ravine (5 species of trees, 2 species of shrubs, 13 species of herbs, 1 species of grass, and 1 species of climber) which support a variety of medicinal plants are shown in Fig 6. The harvesting time of different medicinal plants has been recorded to estimate the annual availability of wild medicinal plants for locals. A total of 45 medicinal plant species are collected from the wild and the mean number of species available for harvesting is 25.4 ± 8.4 species in a year at any point in time.

Nine species found throughout the year for medicinal use are (tree: *Azadirachta indica*, *Ficus benghalensis*, *Ficus palmata*, *Mimusops elengi*, *Pongamia pinnata*, *Terminalia arjuna*, *Vachellia nilotica*, shrub: *Calotropis procera* and herb: *Withania somnifera*). It has been observed that there is seasonal variability in the availability of medicinal plants for collection as shown in (Fig 7). There are 13 medicinal plant species available for harvest in the winter season (January-February) including species like *Abrus precatorius*, *Ageratum conyzoides*, *Sisymbrium irio* and *Ziziphus nummularia*. A total of 27 species including *Tribulus terrestris*, *Cleome viscosa*, *Argemone mexicana*,

Justicia adhatoda, and *Boerhavia diffusa* are available for harvest in summer season (March-June), wherein 37 species comprising *Euphorbia hirta*, *Bacopa monnieri*, *Centella asiatica*, *Cordia myxa*, *Datura metel*, *Nyctanthes arbor-tristis* and *Tinospora cordifolia* can be found in monsoon season (July-September). However, 27 species including *Chrysopogon zizanioides*, *Kigelia africana*, *Pedaliium murex*, *Terminalia bellirica* and *Ricinus communis* are available for harvest in the post-monsoon season (October-December). Some medicinal plants are seasonal and hence not available throughout the year for use. The timeline chart of medicinal plants available in the field is given in Annexure I.

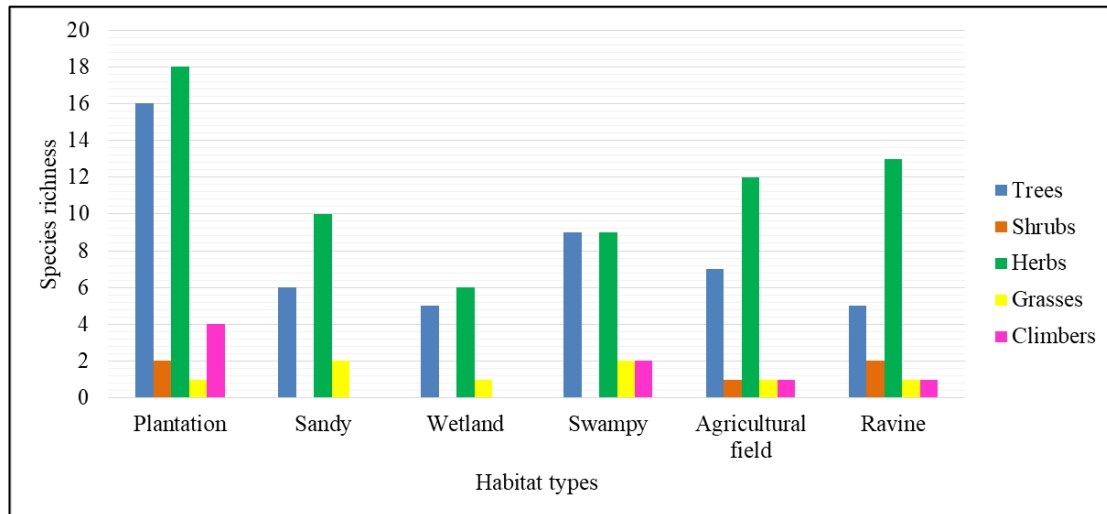


Figure 6. Species richness of wild medicinal plants across the habitat types

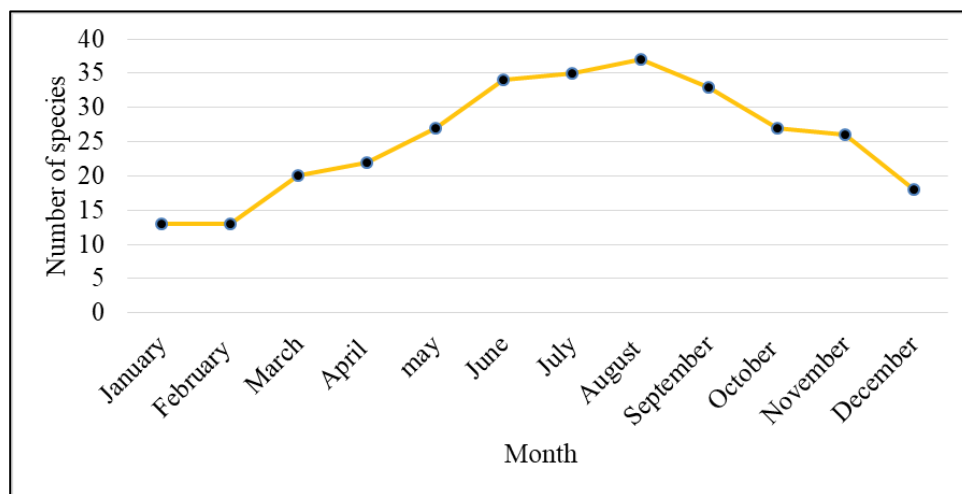


Figure 7. Availability of wild medicinal plant species as per month

Discussion

The current study has identified some medicinal plants with significant efficacy in treating specific health issues. Informants acknowledged that a variety of important wild medicinal plants had been distributed throughout the HWS, but these plants are now restricted to a few locations. Ethnobotanical indices such as the Use value, Relative Importance Index, and Fidelity level of wild medicinal plants also expanded on the effectiveness of medicinal plants for different ailments. The high-Fidelity level of any medicinal plant concerning a particular ailment indicates that people use that specific plant at large. Das *et al.* 2018 and Suwardi *et al.* 2020 have also shown how important it is to keep an inventory record of traditional ethnobotanical research for the conservation and sustainable consumption of wild medicinal plants.

Conclusion

Even though the study area also has access to contemporary healthcare services, the study found that numerous species are employed to treat a wide range of medical conditions. The species of wild medicinal plants that are

common in various settings have been identified through the current investigation. This study includes primary information on traditionally utilized wild medicinal plants and their distribution throughout the various habitat types of HWS in addition to information on conservation. The gene pool of medicinal plants enables the acquisition of germplasm for ex-situ or in-situ conservation on certain habitat types. The ideal period for germplasm extraction might be supported by the timeline chart of the medicinal plant. The documentation of plant uses in traditional medicine aids in the creation of accurate information about the customary healthcare culture.

Declarations

Abbreviations: HWS (Harike wildlife sanctuary), UV (use value), RI (Relative importance), FL (fidelity level),

Ethics statement: Guidelines have been followed during data collection as mentioned in the International Society of Ethnobiology (2008) (<http://ethnobiology.net/code-of-ethics>). Informants were told about this research work in the local language and verbal consent was taken from all the informants.

Availability of data and materials: All the data are mentioned in this paper.

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Declaration of competing interest: The authors declare that there is no conflict of interest.

Authors' contributions: All of the fieldwork, data analysis, and writing work was completed by S G. All work has been supervised and directed by BSA. The final manuscript was read and approved by both authors.

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Annexure II

Details of medicinal plants mentioned by informants are given below

ADM: Mode of Administration of medicinal plants (O: oral, T: Topical); Parts used: (Lf: Leaves, Rt: Roots, Sm: Stem, Rz: Rhizome, Wp: Whole plants, Fl: Flowers, Lx: Latex, Sd: Seeds, Fr: Fruits, Oi: Oil, Br: Bark). ; Habit: (H: Herbs, T: Trees, S: Shrubs, C: Climbers, G: Grasses).

Family	Species	Local name	Habit	Use	Parts used	Method	ADM	Use value	Relative Importance	Voucher No
Acanthaceae	<i>Justicia adhatoda</i> L.	Baykr, Vasaakaa	H	Diabetes, asthma, cold and cough	Lf	Decoction of leaves is used for ailments	O	0.86	1.17	WII/HAR IKE/SG/107
Amaranthaceae	<i>Achyranthes aspera</i> L.	Puthkanda	H	liver disorder, Toothache, periodontitis and Cough.	Rt, Lf, Sm	Decoction of leaves is used for a liver disorder, roots for toothache and stem used for cough	O	0.76	1.17	WII/HAR IKE/SG/127
	<i>Beta vulgaris</i> L.	Chakunder	H	Anemia, hair loss and constipation,	Rz, Lf	Raw form and Juice are used, and fresh leaves are cooked	O	0.27	1.03	
Amaryllidaceae	<i>Allium cepa</i> L.	Pyaz, gannda	H	Eye irritation and Asthma	Rz	Fresh juice with honey is used for Asthma and some drops of fresh juice are used for eye irritation	O, T	0.40	0.69	WII/HAR IKE/SG/132
	<i>Allium sativum</i> L.	Lehsen	H	Blood pressure, Diabetes, sexual disorder, cold, cough, indigestion and gastric	Rz	The raw form is used, and two or three cloves are taken with honey for erectile dysfunction.	O	1.15	2	WII/HAR IKE/SG/133
Anacardiaceae	<i>Mangifera indica</i> L.	Amb	T	Heatstroke and constipation	Fr	Unripe fruit boiled with water for eating and paste of leaves is applied on the body for heatstroke	O, T	0.25	0.69	WII/HAR IKE/SG/048
Apiaceae	<i>Centella asiatica</i> (L.) Urb.	Brahmi-buti	H	Heatstroke, headache and stomachache	Wp	Fresh juice is used for headaches and heatstroke	O	0.47	1.03	WII/HAR IKE/SG/158
	<i>Coriandrum sativum</i> L.	Dhania	H	Heatstroke, urinary tract infections	Wp	Fresh juice with drops of lemon juice is used for urinary tract infections	O	0.38	0.69	WII/HAR IKE/SG/167

	<i>Trachyspermum ammi</i> (L.) Sprague	Ajwain	H	Diarrhea, cold and cough	Sd	Seeds are taken with water.	O	0 44	0 83	
Apocynaceae	<i>Catharanthus roseus</i> (L.) G. Don.	Sadabahar	H	Diabetes	Lf, Fl	Fresh leaves and flowers are used	O	0 09	0 34	WII/HAR IKE/SG/1 57
	<i>Nerium oleander</i> L.	LaaL.kanir e	S	Toothache and. periodontitis	Sm	Soft twigs are chewed for clean teeth	T	0 27	0 49	WII/HAR IKE/SG/1 12
	<i>Calotropis procera</i> (Aiton) Dryand	Akk, Akha	S	Body pain and Arthritis	Lf, Lx	leaves are heated with mustard oil and tied up joints	T	0 15	0 49	WII/HAR IKE/SG/0 87
Arecaceae	<i>Phoenix sylvestris</i> (L.) Roxb.	Desi Khajur	T	Body pain, Anemia	Fr	Fruit is used	O	0 18	0 69	WII/HAR IKE/SG/0 59
Asparagaceae	<i>Asparagus officinalis</i> L.	Shataavari	H	Weakness and sexual disorder	Rt	Powdered roots are used	O	0 19	0 69	WII/HAR IKE/SG/3 00
Asteraceae	<i>Ageratum conyzoides</i> L.	Knar	H	Cut and wound	Lf	Leaves juice is applied to cut to block the bleeding	T	0 17	0 49	WII/HAR IKE/SG/1 30
Bignoniaceae	<i>Kigelia africana</i> L.	Balum Kheera	T	Piles, stomachache and constipation	Fr	A powdered form of dried fruit is used	O	0 16	0 83	WII/HAR IKE/SG/0 42
Boraginaceae	<i>Cordia myxa</i> L.	Lasodaa	T	Constipation and. periodontitis	Fr	Fresh fruits are used for. periodontitis	O	0 22	0 69	WII/HAR IKE/SG/0 21
Brassicaceae	<i>Raphanus sativus</i> L.	Muli	H	Constipation and Jaundice	Rt	Fresh juice and raw form is used	O	0 16	0 69	WII/HAR IKE/SG/2 53
	<i>Brassica campestris</i> Hook f. & Thoms.	Saro	H	Body pain, Skin diseases, cut, cold and cough	Sd, Oi, Lf	Oil is used for various ailments	O	0 53	1 17	WII/HAR IKE/SG/1 51
	<i>Sisymbrium irio</i> L.	khubakala n	H	Asthma	Wp, Sd	The fresh plant is cooked for use.	O	0 08	0 34	WII/HAR IKE/SG/2 65
Cannabaceae	<i>Cannabis sativa</i> L.	Phang	H	Insomnia, mental disorders	Lf	Leaves are smoked and leave juice is used.	O	0 06	0 49	WII/HAR IKE/SG/1 53
Caricaceae	<i>Carica papaya</i> L.	Papita	T	Constipation and Dengue	Lf,Fr	Fresh juice of leaves and ripe fruits are used	O	0 24	0 69	WII/HAR IKE/SG/0 15

Chenopodiaceae	<i>Chenopodium ambrosioides</i> L.	Chandan bathua	H	Piles and Stomachache	Lf	Decoction of leaves is used for Stomachache	O	0 15	0 69	WII/HAR IKE/SG/1 80
Cleomaceae	<i>Cleome viscosa</i> L.	Bagra, Hulhul	H	Fever, constipation, lung infection. and cough	Lf, Sd	The decoction is used.	O	0 12	1 37	WII/HAR IKE/SG/1 62
Combretaceae	<i>Terminalia arjuna</i> (Roxb. ex DC.) Wight & Arn.	Arjun	T	Cardiovascular disease, diabetes,. Fever	Br	Decoction of bark is used.	O	0 16	1 03	WII/HAR IKE/SG/0 79
	<i>Terminalia bellirica</i> (Gaertn.) Roxb.	Bahera	T	Diabetes, constipation, Indigestion	Fr	The powdered form of dried fruit is used	O	0 15	0 83	WII/HAR IKE/SG/0 78
Compositae	<i>Eclipta prostrata</i> (L.) L.	Bhringraz	T	Hair loss and cut	Wp	Boiled with olive oil to apply to hair	T	0 21	0 69	WII/HAR IKE/SG/1 82
Convolvulaceae	<i>Cuscuta reflexa</i> Roxb.	Amarvalli	H	Hair loss	Wp	Boiled in mustard oil applied to hair	T	0 11	0 94	WII/HAR IKE/SG/3 14
Crassulaceae	<i>Bryophyllum pinnatum</i> (Lam.) Oken	Patherchat ta	H	Kidney stone, cut and wound	Lf	Raw leaves are used for kidney stones	O	0 75	0 83	WII/HAR IKE/SG/1 52
Cucurbitaceae	<i>Momordica charantia</i> L.	Karela	C	Diabetes	Fr	Fresh juice is used.	O	0 06	0 34	WII/HAR IKE/SG/3 22
	<i>Lagenaria siceraria</i> (Molina) Standl.	Loki	C	Diabetes	Fr	Fresh juice is used	O	0 19	0 34	WII/HAR IKE/SG/3 13
Euphorbiaceae	<i>Euphorbia hirta</i> L.	Dudhi	H	Diarrhea, Piles and stomachache	Wp	The raw form is taken empty stomach for Piles	O	0 89	0 83	WII/HAR IKE/SG/1 87
	<i>Euphorbia prostrata</i> Aiton	Choti dudhi	H	Piles, Diarrhea and Stomachache	Wp	The raw form is taken empty stomach for Piles	O	0 26	0 83	WII/HAR IKE/SG/1 88
	<i>Ricinus communis</i> L.	Arand	S	Constipation	Oi	Seed oil with water is used for Constipation	O	0 69	0 34	WII/HAR IKE/SG/1 16
Lamiaceae	<i>Mentha piperita</i> L.	Putna	H	Indigestion and gastric,	Wp	Fresh juice mixed with water for drinks	O	0 18	0 49	
	<i>Ocimum basilicum</i> L.	Ram Tulsi	H	Indigestion, Stomachache and. bad breath	Lf	Fresh leaves and decoction are used	O	0 49	0 83	WII/HAR IKE/SG/2 28

	<i>Ocimum tenuiflorum</i> L.	Tulsi	H	Cold and cough, lung infection	Lf	A decoction is used.	O	0 55	0 83	WII/HAR IKE/SG/2 29
Lauraceae	<i>Cinnamomum verum</i> J. Presl.	Dalchini	T	Cold and cough	Bk	Decoction of bark is used for colds and coughs	O	0 8	0 69	
Fabaceae	<i>Abrus precatorius</i> L.	Ghunchi	C	Sexual disorder	Rt	Powder of roots is used	O	0 15	0 34	WII/HAR IKE/SG/2 98
	<i>Pongamia pinnata</i> (L.) Pierre	Karanj, Sukhchain	T	Toothache and periodontitis	Sm	Soft twigs are chewed for cleaning teeth	O	0 12	0 49	WII/HAR IKE/SG/0 63
	<i>Trigonella foenum-graecum</i> L.	Methi	H	Diabetes	Sd	Seeds are soaked in water for ten hours; water is used for drinking after filtering seeds	O	0 26	0 34	WII/HAR IKE/SG/2 83
	<i>Vachellia nilotica</i> (L.) P.J.H. Hurter & Mabb.	Babool	T	Arthritis, periodontitis and toothache	Fr, Sd	The powdered form of dried fruit is used	O	0 15	0 83	WII/HAR IKE/SG/0 83
Lythraceae	<i>Punica granatum</i> L.	Annar	S	Anaemia, dengue, malaria and headache	Fr	Fresh juice and raw form are used	O	0 24	1 37	WII/HAR IKE/SG/1 15
	<i>Lawsonia inermis</i> L.	Mehdi	S	Hair loss	Lf	A paste of leaves is applied to the scalp	T	0 12	0 34	WII/HAR IKE/SG/0 43
Malvaceae	<i>Abutilon indicum</i> (L.) Sweet	Kangi	H	Weakness and sexual disorder	Lf	Raw leaves are used	O	0 18	0 69	WII/HAR IKE/SG/1 26
	<i>Hibiscus rosa-sinensis</i> L.	GudhaL.	S	Hair loss	Fl	Flowers are boiled in mustard oil and then applied to hair.	T	0 14	0 34	WII/HAR IKE/SG/1 01
Meliaceae	<i>Azadirachta indica</i> A. Juss.	Neem	T	Stomachache, Diabetes, Fever, periodontitis, wound and ulcer	Rt, Lf, Sm, Fr, Bk	Raw leaves, fruits, bark and root decoction are used.	O T	0 88	1 85	WII/HAR IKE/SG/0 10
	<i>Melia azedarach</i> L.	Bakain	T	Diabetes	Lf	Fresh leaves are chewed	O	0 10	0 34	WII/HAR IKE/SG/0 50
Menispermaceae	<i>Tinospora cordifolia</i> (Willd.) Miers	Giloya	C	Malaria, dengue, lung infection and fever	Bk	Decoction of bark is used for various ailments	O	1 80	1 17	WII/HAR IKE/SG/3 28

Moraceae	<i>Ficus benghalensis</i> L.	Bod	T	Azoospermia	Lx	Latex is used.	O	0 18	0 34	WII/HAR IKE/SG/0 31
	<i>Ficus palmata</i> Forssk.	Anjiri	T	Skin diseases	Rt, Lx	Mixtures of latex with milk are used	T	0 04	0 34	WII/HAR IKE/SG/0 34
Moringaceae	<i>Moringa oleifera</i> Lam.	Sojna	T	liver disorder, diabetes and. indigestion	Lf, Fr, Sd	Leaves are cooked, and powdered seed and decoction of the fruit are used	O	0 15	1 03	WII/HAR IKE/SG/0 53
Musaceae	<i>Musa x paradisiaca</i> L.	Kela	T	Diarrhea	Fr	Fruit is used with curd	O	0 39	0 34	WII/HAR IKE/SG/0 55
Myrtaceae	<i>Psidium guajava</i> L.	Amrood	T	Diarrhea, constipation and. periodontitis	Fr, Lf	Fruits and leaves are used.	O	0 16	0 83	WII/HAR IKE/SG/0 67
	<i>Syzygium cumini</i> var. <i>cumini</i> L.	Jamun	T	Diabetes, asthma, liver disorde	Sd, Fr	Fresh fruits and powdered forms of dried seeds are used.	O	0 19	1 03	WII/HAR IKE/SG/0 74
	<i>Syzygium aromaticum</i> (L.) Merr. & L.M.. Perry	Long	H	Periodontitis, toothache and cough.	Fl	Decoction and raw form are used	O	0 37	0 83	
Nyctaginaceae	<i>Boerhavia diffusa</i> L.	Itsit	H	Weakness, kidney stone and sexual. disorder	Rt, Lf	Powder from roots and fresh juice of leaves are used.	O	0 37	1 03	WII/HAR IKE/SG/1 48
Oleaceae	<i>Nyctanthes arbor-tristis</i> L.	Harsingar	T	Fever and dengue	Lf	A decoction is used.	O	0 25	0 69	WII/HAR IKE/SG/0 57
Oxalidaceae	<i>Oxalis corniculata</i> L.	Tinpatiyaa, Khatti Buti	H	Diarrhea, wound, bee sting and heatstroke	Wp	Paste of the whole plant is used.	O	0 23	1 37	WII/HAR IKE/SG/2 31
Papaveraceae	<i>Argemone mexicana</i> L.	Kandiali	H	Skin disease	Lx	Fresh juice is applied to the skin	T	0 11	0 34	WII/HAR IKE/SG/1 42
	<i>Fumaria indica</i> (Hauskn.) Pugsley	Pittapaapa raa	H	Constipation, fever and blood infection	Wp	A decoction is used for fever.	O	0 9	1 03	WII/HAR IKE/SG/1 94
	<i>Papaver rhoeas</i> L.	LaaL.Posta	H	Mental disorders	Sd	Paste of seeds is used	O	0 05	0 34	WII/HAR IKE/SG/2 32

Pedaliaceae	<i>Pedaliium murex</i> L.	Brihatgoks hura, Bda Gokhru	H	Sexual disorder	Fr	A powdered form with milk is used.	O	0 09	0 034	WII/HAR IKE/SG/2 34
Phyllanthaceae	<i>Phyllanthus emblica</i> L.	Amla	T	Hair loss, indigestion and constipation	Fr	Fresh fruits and powdered forms of dried fruit are used	O	0 20	0 83	WII/HAR IKE/SG/0 60
	<i>Phyllanthus niruri</i> L.	Bhui Aaamala	H	Jaundice	Wp	Fresh juice is used	O	0 06	0 34	WII/HAR IKE/SG/2 41
Piperaceae	<i>Piper longum</i> L.	Maga	C	Cold and cough, lung infection	Fr	Fruit Powder with honey is used for dry cough	O	1 16	0 83	
	<i>Piper nigrum</i> L.	Kali-mirch	C	Cold and cough	Sd	A decoction is used	O	0 75	0 49	
Plantaginaceae	<i>Bacopa monnieri</i> (L.) Wettst	Choti-bhrami	H	Heatstroke and memory loss	Wp	Raw form and Juice are used.	O	0 25	0 69	WII/HAR IKE/SG/1 45
Poaceae	<i>Chrysopogon zizanioides</i> (L.) Roberty	Khas	G	Stomachache and heatstroke	Rt	Fresh juice is used for heatstroke.	O	0 10	0 89	WII/HAR IKE/SG/3 37
	<i>Cynodon dactylon</i> (L.) Pers.	Dup	G	Diarrhea	Wp	Decoction is used.	O	0 07	0 34	WII/HAR IKE/SG/3 39
Rhamnaceae	<i>Ziziphus nummularia</i> (Burm f.) Wight & Arn.	Jharberi, Choti beri	S	Body pain, constipation and. diarrhea	Fr	Fresh fruits are used.	O	0 13	0 83	WII/HAR IKE/SG/1 24
Rutaceae	<i>Aegle marmelos</i> (L.) Correa	Bael	T	Diarrhea and fever	Fr	Fresh juice of the fruit is used	O	0 15	0 69	WII/HAR IKE/SG/0 04
	<i>Citrus aurantium</i> L.	Nimbu	S	Heatstroke, headache and stomachache	Fr	Fresh juice is used for ailments	O	0 30	1 03	WII/HAR IKE/SG/0 92
	<i>Murraya koenigii</i> (L.) Spreng	Karipattaa	S	Liver disorder, diabetes, indigestion and constipation	Lf	Fresh leaves are cooked.	O	0 47	1 17	WII/HAR IKE/SG/1 10
Sapotaceae	<i>Mimusops elengi</i> L.	Mulshri	T	Periodontitis	Sm	A paste of soft twigs is applied to the gums.	T	0 11	0 34	WII/HAR IKE/SG/0 52
Solanaceae	<i>Datura metel</i> L.	Kala-Datura	H	Mental disorders, Insomnia	Sd	Three to four seeds with water are taken	O	0 03	0 49	WII/HAR IKE/SG/1 76

	<i>Solanum virginianum</i> L.	Kateri	H	Cold and cough and liver disorder	Rt	A decoction is used.	O	0 06	0 83	WII/HAR IKE/SG/2 69
	<i>Withania somnifera</i> (L.) Dunal	Akksen	H	Malarial, stomachache, asthma and sexual disorder	Lf, Rt	Raw leaves with turmeric and ginger are chewed to control high fever	O	0 77	1 37	WII/HAR IKE/SG/2 95
Theaceae	<i>Camellia sinensis</i> (L.) Kuntze	Chai	S	Diarrhea	Lf	Dry leaves mixed with sugar are taken with water.	O	0 29	0 34	
Verbenaceae	<i>Phyla nodiflora</i> (L.) Greene	Gorakhmundi	H	Piles and Stomachache	Wp	Paste form is used.	O	0 09	0 49	WII/HAR IKE/SG/2 40
Xanthorrhoeaceae	<i>Aloe vera</i> (L.) Burm f.	Kuwar	H	Diarrhea, indigestion, skin disease and constipation	Lf	Leaves juice is used.	O	0 42	0 97	
Zingiberaceae	<i>Amomum subulatum</i> Roxb.	Bari ilaichi	H	Indigestion	Fr	A decoction made from fruits with milk is taken.	O	0 16	0 34	
	<i>Curcuma longa</i> L.	Haldi	H	Body pain, fever, skin disease, cold and cough,.	Rz	Powdered and decoction form is used.	O	1 79	1 51	WII/HAR IKE/SG/1 72
	<i>Zingiber officinale</i> Roscoe	Adrak	H	Blood pressure, cold and cough, Indigestion and gastric	Rz	Raw form and decoction is used.	O	1 00	1 31	
Zygophyllaceae	<i>Tribulus terrestris</i> L.	Pakhda	H	Diarrhea, a sexual disorder	Fr	A powdered form of dried fruit is used	O	0 13	0 83	WII/HAR IKE/SG/2 77