An Insight into Indigenous Ethnobotanical Knowledge of Medicinal and Aromatic Plants from Kashmir Himalayan Region

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Research

Abstract

Background: Documenting traditional knowledge of medicinal plants has enabled researchers to obtain a good understanding of the consumption patterns of plants for basic healthcare purposes. This study highlighted the ethnobotanical significance of medicinal and aromatic plants in the biodiversity hotspot landscape of the western Himalayan region of Kashmir.

Methods: Extensive field visits were made to collect traditional ethnobotanical knowledge from the study area through group discussions in the local language using the questionnaire method. The acquired data was then analyzed using quantitative ethnobotanical measures such as Use Value (UV) and Relative Frequency of Citation (RFC).

Results: Our findings revealed 72 plant species belonging to 51 genera and 16 families. The dominant families recorded were Lamiaceae and Apiaceae followed by Polygonaceae. Among plant parts, leaves were the most frequently used, followed by roots. The majority of the studied plants were herbaceous, accounting for 90.3% of the area flora. Based on the medicinal plant use category, 72 plant species with medicinal uses were identified. According to the Use Value and Relative Frequency Citation, *Saussurea costus* and *Angelica cyclocarpa* had remarkably high values of 1.38 and 0.68, respectively.

Conclusions: These findings complement the considerable plant knowledge of the local population, confirming the traditional usage of plants in indigenous healing. People in Muzaffarabad continue to have vital information about native flora, even though younger individuals are losing it as a consequence of socioeconomic changes. There is a need to raise awareness among local populations about the sustainable use and conservation of medicinal flora.

Keywords: Medicinal plants, Kashmir Himalayas, Field survey, Ethnobotanical knowledge, Aromatic plants

Background

Medicinal and aromatic plants are used for their biologically active compounds to alleviate, treat, or prevent ailments, or they are recognized for the intense, characteristic fragrance emitted by their leaves and blossoms (Máthé, 2015, Arshad *et al.* 2023). It is not possible to define therapeutic plants completely accurately. The phrases "medicinal" and "aromatic" plants are frequently used interchangeably nowadays. In general, medicinal and aromatic plants are plants that are used for therapeutic purposes, such as preventing and treating ailments, as well as promoting overall health (Temel *et al.* 2018, Sofowora *et al.* 2013). However, for a more detailed explanation, the phrase "medicinal plant" refers to plants that have the potential to be used in the treatment of one or more organs or that contain compounds that can be used to create helpful medications. Aromatic plants, on the other hand, are products that are commonly used in the production of perfumes and spices. Furthermore, they provide the essential elements for the production of a variety of important industrial chemicals (Kumari *et al.* 2019). Essential oils, minerals, alkaloids, flavonoids and nutrients are found in medicinal aromatic plants' roots, leaves, fruits, flowers and seeds. Because of their therapeutic characteristics, these elements offer medicinal and nutritional benefits (Rahmati *et al.* 2022). Certain volatile compounds found in medicinal and aromatic plants are known as essential oils. Distillation, fermentation and expression are all methods used to extract essential oils. These oils can contain over 100 unique compounds, with the primary ingredients accounting for around 85% of the essential oils and the other compounds present in insignificant amounts (Miguel, 2010, Waheed *et al.* 2020).

Globally, medicinal and aromatic plants have a wide range of natural occurrences and ecological activities, including defense against insects, fungus, illnesses, and herbivorous animals, as well as phytochemicals with established or potential biological activity. This adaptability extends to their diverse human applications, which include herbal medicine, food and feed additives, cosmetics, and more (Máthé, 2015, Kumar *et al.* 2017, Haq *et al.* 2020). Medicinal and aromatic plants can be used in a variety of ways, including roots, leaves, flowers, tubers, seeds, bark, or aerial parts, as well as fresh and dry forms, crushed or powdered, and extracts prepared in a variety of ways (Akarca *et al.* 2015). The Lamiaceae family is renowned for its therapeutic benefits as well as the variety of species containing considerable amounts of essential oils. Plants' therapeutic characteristics can be found in their essential oils, leaves, bulbs, flowers, tubers, fatty acids, fruits, stems, gums, roots, seeds rhizomes, and wood (Tepecik, 2021, Haq *et al.* 2021). They are regarded as the most precious assets for any country and play an important role in the agricultural sector, earning them the title of "green gold" by the scientific community. According to WHO data, medicinal and aromatic plants play a crucial role in many countries' traditional healthcare systems (Barata *et al.* 2016).

Because of their potential to prevent and treat diseases, medicinal plants are extremely important in biology, medicine, and veterinary research. These plants' low cost and lack of negative effects have expanded their popularity throughout history. Plant secondary metabolites are thought to have properties that contribute to plant extracts' antibacterial, anti-inflammatory, antioxidant and insecticidal properties (Kumar *et al.* 2005, Waheed *et al.* 2023b). The growing interest in the medical capabilities of medicinal plants and their byproducts has resulted in a thriving plant trade and a greater emphasis on agriculture (Solidum, 2014). However, the advancement of modern medicine has resulted in an increase in medication intake, which has given rise to a variety of difficulties in humans. Excessive drug usage, in particular, can have serious negative impacts on the human body. In contrast, the use of botanical resources for therapeutic purposes is less common in advanced nations (Özyiğit, 2022, Waheed *et al.* 2022, Waheed *et al.* 2023). Currently, in the western Himalayan region, the elderly are primarily responsible for preserving this vital traditional indigenous knowledge (Haq *et al.* 2021, Waheed *et al.* 2023a). The dissemination of information and the distribution of these plant materials have both been aided by human movement. The Kashmir Himalayas are renowned for their biodiversity and are a rich source of bioactive substances (Alam *et al.* 2023). There is little scientific validation when it comes to the identification of the bioactive components, potential adverse effects, and overall usefulness of the plants those Himalayan inhabitants employ for medical purposes, despite several studies exploring these aspects.

Indigenous communities are custodians of traditional medicinal plant knowledge and possess vital information regarding the multipurpose applications of plants (Manzoor *et al.* 2023b). As previously stated, the future well-being of future generations must maintain the traditional ethnomedicinal knowledge of plants across the region in many areas. Indigenous medicinal knowledge is dwindling, despite its importance. More research is needed to document medicinal plants and analyze their active constituents, pharmacological potential, conduct clinical studies, and produce innovative drugs (Hameed *et al.* 2021, Ishtiaq *et al.* 2020, Rubab *et al.* 2020, Shuaib *et al.* 2021). Although medicinal and aromatic plants have considerable potential to treat human ailments, there is a lack of scientific and clinical understanding about the mechanisms of action of these

plants, making it difficult to use them directly as human pharmaceuticals (Sharma *et al.* 2021). Due to the remoteness of the study area and the unavailability of healthcare facilities, local populations are dependent on these natural resources for the treatment of various ailments. Therefore, additional scientific investigation can aid in the discovery of new substances that may be turned into extracts or medications to treat a variety of medical conditions. Keeping in view the therapeutic potential of medicinal and aromatic plants, this study was designed and carried out in the western Himalayan region of Kashmir to document indigenous knowledge about medicinal and aromatic plants (MAPs) in the Division Muzaffarabad, AJK.

Materials and Methods

Geography and Demography of Kashmir

The Himalayan region of Azad Jammu and Kashmir (AJK) is geographically distinguished by hilly mountains, valleys, and some flat plains. The region has a subtropical-highland climate, with elevations ranging from 360 m in the south to as high as 6325 m in the north (Figure 1). There are numerous stunning landscapes around the country, showing the attraction of cascading rivers, twisting streams, and thick woods with sparkling flora. The state of AJK is situated between 33°54′-34° 44′ North latitude and 73° 31′-74° 50′ East longitude (Shaheen *et al.* 2023, Manzoor *et al.* 2023b, Rashid *et al.* 2018). It shares a border with Jammu and Kashmir, a state governed by India and divided by the Line of Control. It shares a border with Khyber Pakhtunkhwa on the west and a border with Gilgit Baltistan on the north. It is connected to it and is situated in the southern part of Punjab, Pakistan. The Gujrat district of Punjab forms its southern border. Its eastern boundary is with the occupied Jammu and Kashmir Region, and its western border is with the Kahota district, the Murree region, and KPK. Parallel to Gilgit-Baltistan's Kaghan Valley and Astor sites is the upper Alpine region of the Neelum (Bhutto *et al.* 2019). The area has a population of approximately 4.045 million and is expanding on average at a pace of 2.69% per year. It is made up of 5134 square miles. With deep valleys and rugged, undulating terrain, the scenery is primarily hilly and mountainous. The region experiences a subtropical to humid climate, with average maximum summertime temperatures between 25°C and 34°C and wintertime minimum average temperatures between 4°C and 10°C (Khan *et al.* 2021, Sohail *et al.* 2023). The mountainous region of Kashmir provides freshwater to low-lying areas via numerous sources such as snowfall, glaciers, permafrost, avalanches, glacial lakes, and rainfall. When these frozen forms of water melt, they contribute to the rivers and streams that flow downstream in Kashmir (Dar & Nordenstam, 2014). The total forest area of Azad Jammu and Kashmir (AJK) spans around 566,969 hectares or 42.6% of the region's total land area. This forested area is much larger than the 3% of land designated as public forestland. This region has a high level of floral diversity due to its unique geographical and climatic characteristics (Khan *et al.* 2012; Shaheen *et al.* 2017). Azad Jammu and Kashmir's inhabitants have distinct cultures and speak a variety of indigenous languages such as Kashmiri, Pahari, Gojri, and Hindko. Furthermore, the local population speaks and understands Urdu (Rashid *et al.* 2018).

Ethnographic and Socio-economic variables of the region

The socioeconomic situations of indigenous peoples vary greatly and are often marked by relative poverty. The ethnicity of the region is diverse in terms of caste and includes Chaudhary, Syed, Raja, Maliks, Mughals, Abbasi, Khwaja, Sudhans, Butt and Awans (Rashid *et al.* 2018, Shaheen *et al.* 2017). There are often few sources of income available outside of forestry, agriculture, and a few types of trade and businesses. The area's rural residents, who depend mostly on agriculture and livestock make up the majority of the population. Domestic animal ownership among residents of these localities is a sign of higher socioeconomic standing within a family. The majority of people in this area are farmers, some with government jobs earning a daily wage, and a few people running small businesses. Rainfall is primarily responsible for the agricultural economy of this region's flat landscape. The main agricultural products grown in the region include maize, bean, wheat, rice and potato (Dar *et al.* 2012). By providing locals with work opportunities, tourism has considerably improved the socioeconomic conditions of the region. The local population has discovered employment prospects, including hotels, restaurants, and transportation services (Amjad & Arshad, 2014, Shaheen *et al.* 2017).

Data Collection

Ethnobotanical data was collected in the Muzaffarabad division, which includes Muzaffarabad, Neelum Valley, and Jehlum Valley. A total of 130 informants were selected randomly, most preferably older; 102 men and 28 women were surveyed, and data was collected by using group discussions mostly in local languages and the questionnaire method (Table 1).

Plant Collection and Identification

Several field visits were organized to 15 villages in three districts named Taobutt Bala, Seri, Baboon, Magre Behak, Surgan Narr, Kel, Nagan, Jabsar, Batlian, Saran, Bheri, Nari Syedan, Taredha, Bana Mola, and Kandhor Behak within the research area to collect information about how the locals use the plants that grow there. Plant specimens were collected, and each plant was labeled with its native name. Pressing, drying, and mounting these plant samples on herbarium sheets was done

with care. The identification of these specimens was aided by the use of the "Flora of Pakistan" as a guide and by following (Stewart *et al.* 1972) as well as other internet resources. By browsing each plant name in the World Online Flora, plant names were checked and authenticated.

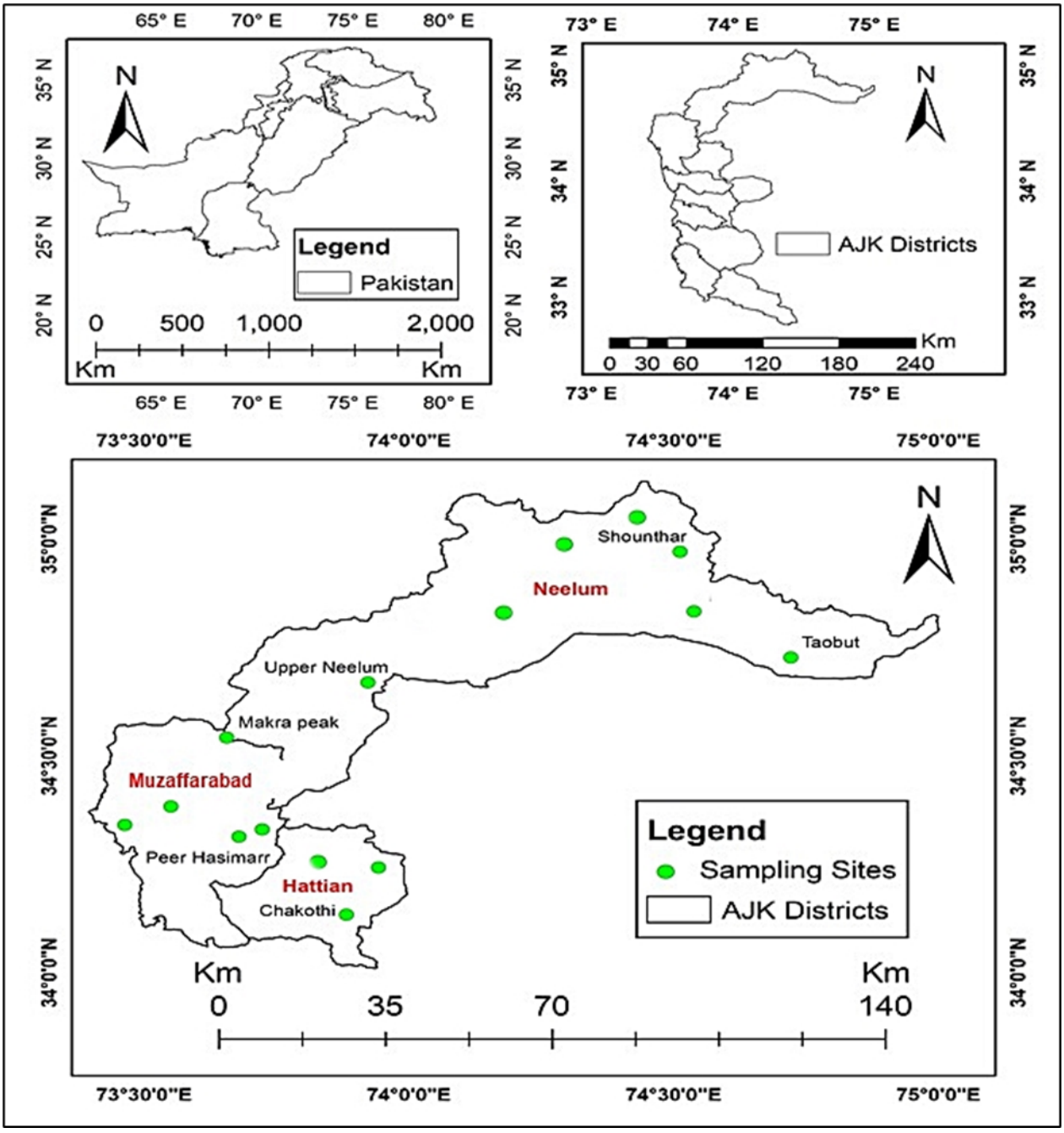

Figure 1. Study area map showing the locations of sampling sites in the Kashmir Himalayan Region

Table 1. Demographic features of informants, gender ratio, age level, education level, and socio-economic background.

Gender	**Informants N=130**	**Percentage**
Men	102	83.08%
Women	28	16.92%
Informants age group		
Between 28-40	13	10%
Between 41-65	45	34.61%
> 65 years	72	55.39%

Informants' education level		
Intermediate or above	17	13.07%
Middle Level	14	10.76%
Primary Level	24	18.46%
Illiterate	75	57.69%
Social Livelihood		
Farmers	35	26.92%
Local Hakims	07	5.38%
Traders	19	14.61%
Shopkeepers	23	17.69%
Woodcutters	09	6.92%
Herbalists	27	20.76%
Local handicrafts	10	7.69%

Quantitative data analysis

First of all, a detailed inventory of plants was created for future review, including information about plant parts used for phytoremediation and any therapeutic characteristics. Individual indices were then calculated:

Use value (UV)

The local identification and citation of plants within a certain region determines their significance, which is referred to as Use Value (UV) and it was calculated by following (Mirzaman *et al.* 2023, Sharif *et al.* 2022). It was calculated as follows:

$$UV=\sum Ui/N$$

Where Ui' is the use reports of the particular species while 'N' is the total no of informants in the study.

Frequency of citation (FC)

The most frequently used plant species by the local population of the area were determined using frequency of citation (FC) as followed by Tardío & Pardo-de-Santayana (2008) findings.

FC = Number of times a particular species was mentioned /total no of times that all species were mentioned *100

Relative frequency citation (RFC)

It indicates the significance of each species and is determined using the formula provided by Tardío & Pardo-de-Santayana (2008) based on the frequency of citation (FC) (the number of informants mentioning the use of species). The FC value is divided by the total number of informants who took part in the survey (N), without taking the disease categories into account. Its value ranges from "0" to "1".

$$RFC=FC/N$$

Results and Discussion

Flora of division Muzaffarabad

An ethnobotanical survey in the Muzaffarabad division revealed a total of 72 plant species, which were categorized into 51 genera and 16 plant families. Herbaceous plants were the most commonly used in the research area, accounting for 90.3% of the ethnobotanical plant species identified. Shrubs made up 8.3% of the flora, with trees accounting for the least at 1.4% (Figure 2). The Lamiaceae family was the most dominant, with 22 species, closely followed by the Apiaceae family, which included 20 species. Therophytic life forms predominated in the research area, accounting for 40.27% of the total, whereas hemicryptophytes represented 37.5%. In comparison, the less studied life forms, chameophytes and phanerophytes, each contributed 1.38% (Figure 3). Microphylls were the most prevalent in the research area, accounting for 52.77% of the total, followed by nanophylls at 18.05%. Megaphylls, the least studied leaf form accounted for only 4.16% (Figure 4). Our results are similar to the previous studies in the study area (Manzoor *et al.* 2023a, 2023b, Mirzaman *et al.* 2023). This resemblance shows that various ethnic communities in Kashmir with diverse cultural backgrounds use plants in comparable ways. Our findings of medicinal plant diversity are consistent with earlier studies undertaken in the same vegetation zones of AJ&K and

Pakistan, involving a greater or lesser number of plant species (Shaheen *et al.* 2017, Mahmood *et al.* 2012, Awan *et al.* 2011, Haq *et al.* 2020). Furthermore, the study found that elderly people (90%) tend to be more knowledgeable about plant benefits than younger people (10%) and when literacy rates climbed, respondents' ethno-medical knowledge decreased (Table 2). This phenomenon can be ascribed to educated people preferring contemporary healthcare systems over old ones, this phenomenon is similar to the results of Jan *et al.* (2017).

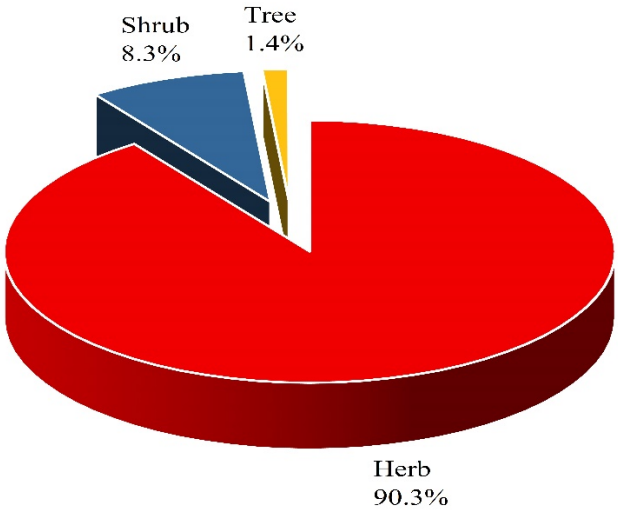

Figure 2. Percentage of growth form of aromatic plants recorded from Kashmir Himalayan Region

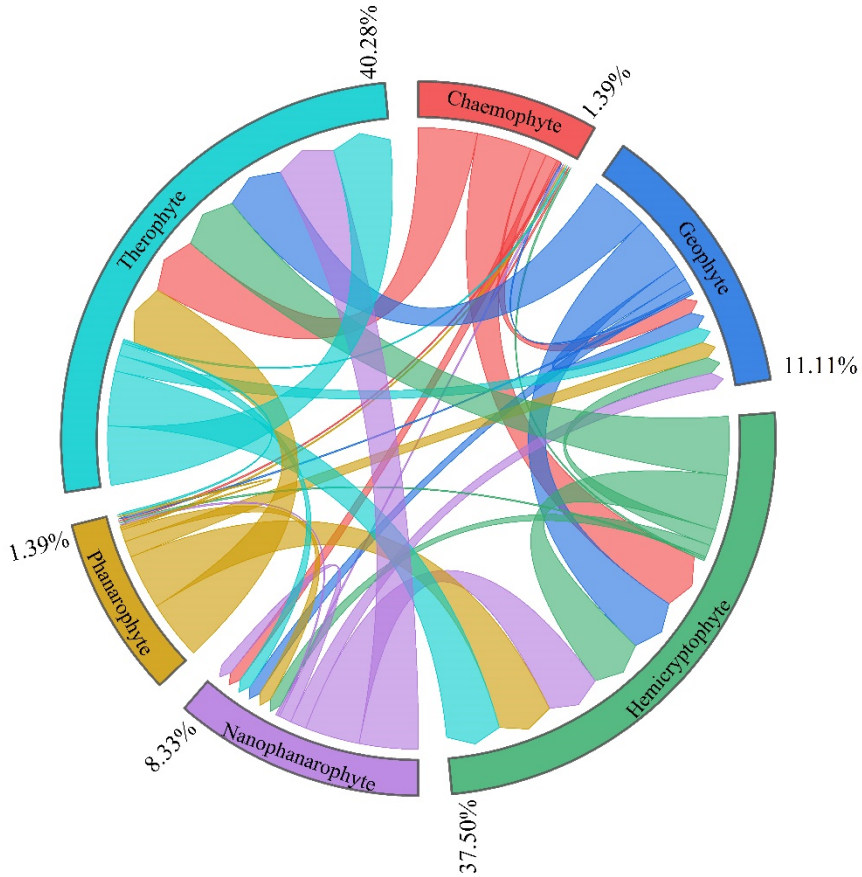

Figure 3. Life form categories of medicinal and aromatic plants recorded from Kashmir Himalayan Region

Table 2. List of medicinal and aromatic plants with ethnobotanical uses, as well as ethnobotanical indices, recorded from Muzaffarabad division

Taxa	Family	Habit	Life form	Leaf form	Parts Used	Traditional Ethnobotanical uses	Voucher No.	UV	RFC
Allium humile Kunth	Amaryllidaceae	H	Ge	Np	Wp	Locals use all parts of the plant as a general flavor component in their daily cooking	SKW-5051	1.08	0.61
Angelica cyclocarpa (C.Norman) M.Hiroe	Apiaceae	H	Th	Mg	Rh	Influenza, cough, constipation, cold, asthma Dried rhizome boiled in a cup of tea and taken before bed for 5–6 days	SKW-5052	1.25	0.68
Angelica glauca Edgeworth	Apiaceae	H	Th	Mg	R	The combination of water and dried root powder can be used to treat gastrointestinal disorders and respiratory tract infections. When exposed to the cold, several plants' roots are boiled and combined with molasses to treat dyspepsia. This treatment reduces pain while also raising the body's core temperature. Additionally, dyspnea is treated using it	SKW-5053	0.75	0.58
Bupleurum longicaule W all. ex DC.	Apiaceae	H	He	Na	R	This chemical, which also has the capacity to cause perspiration, can help with liver diseases. It is also efficient at reducing inflammation and fever in the chest and belly. It is useful for alleviating flatulence and promoting digestion. Furthermore, it is used in the treatment of malaria and many types of fevers	SKW-5054	0.42	0.19
Bupleurum tenuissimum L.	Apiaceae	H	He	Na	R, St, L	Its roots are eaten due to its fragrance. Whole plant is used as fodder for domestic animals	SKW-5055	0.52	0.12
Bupleurum clarkeaum (Wolff). E. Nasir	Apiaceae	H	He	Na	R, St, L	Its roots are eaten due to its fragrance. Whole plant is used as fodder for domestic animals	SKW-5056	0.18	0.14
Bupleurum marginatum Wall. ex DC.	Apiaceae	H	He	Na	R, St, L	Its roots are eaten due to its fragrance. Whole plant is used as fodder for domestic animals	SKW-5057	0.26	0.22
Chaerophyllum capnoides (Decne.) Benth. ex C.B.Clarke	Apiaceae	H	Th	Lp	R, St, L	Root is edible and eaten as fresh. It is used as fodder for domestic animals	SKW-5058	0.43	0.25
Chaerophyllum reflexum Aitch.	Apiaceae	H	Th	Lp	R, St	Root is edible and eaten as fresh. It is used as fodder for domestic animals	SKW-5059	0.26	0.15

Chaerophyllum villosum Wall. ex DC.	Apiaceae	H	Th	Lp	S, St, L	Seed are used to cure kidney and urinary disorder. Areal part of plant are used as fodder for livestock	SKW-5060	0.15	0.16
Coriandrum sativum L.	Apiaceae	H	He	Na	L, Fr	Carminative, vegetables	SKW-5061	0.82	0.58
Cortia depressa (D.Don) C. Norman	Apiaceae	H	He	Mi	F, L	Used to cure Fever, rheumatism, sedative and stomachache. Arial plant parts also used as fodder	SKW-5062	0.35	0.20
Ferula jaeschkeana Vatke.	Apiaceae	H	He	Mi	Gu, Lat, L, Rh	Used as a stomach tonic, to treat skin wounds, to treat rheumatic disorders, to treat cough, and to treat asthma. Rhizome to heal wounds, boils, burns, cuts and other skin problems. Dried leaves used as fodder for livestock	SKW-5063	0.26	0.32
Foeoniculum vulgare Miler.	Apiaceae	H	Th	Na	L, S	Diuretic, digestive disorders	SKW-5064	0.75	0.62
Heracleum canescens Lindl.	Apiaceae	H	He	Na	R	Root powder is applied to heal wound. Root paste is used for skin problems. It is also used as fodder for domestic livestock	SKW-5065	0.55	0.19
Heracleum cachemiricum C.B. Clarke	Apiaceae	H	He	Mi	R	Dried root powder used with water to cure gastrointestinal disorder and respiratory tack infection. In order to alleviate dyspepsia brought on by the cold weather, plant roots are boiled and mixed with molasses. This concoction increases body temperature and relieves discomfort. Dyspnea is also treated using it	SKW-5066	0.19	0.27
Pimpinella diversifolia DC.	Apiaceae	H	He	Mi	Fr, L	Fruit used to cure Cough and cold, Gas trouble, indigestion. Dried leaves are grinded with salt, and the resulting powder is consumed orally with water	SKW-5067	0.18	0.11
Pleurospermum candollei Benth.ex C.B.Clarke	Apiaceae	H	Th	Na	Fr	Fruit can help with stomach pain, kidney pain, gas, and dyspepsia. Additionally, it serves as fodder	SKW-5068	0.29	0.15
Pleurospermum stellatum Benth.	Apiaceae	H	Th	Na	L, S	Stomatitis is treated by burning the plant material, mixing the ash with butter, and applying it to the tongue	SKW-5069	0.30	0.21
Seseli libanotis (L.) W.D.J. Koch	Apiaceae	H	Ch	Mi	R	Rood power is used to cure Rheumatic disorder	SKW-5070	0.17	0.19

Selinum wallichianum (D C.) Raizada & H.O. Saxena	Apiaceae	H	He	Na	St, L	Decoction is used for Cold and cough. Also used as fodder for domestic livestock	SKW-5071	0.41	0.26
Achillea millefolium L.	Asteraceae	H	He	Lp	Wp	Stomachache, urinary complaints, blood purification, toothache, antiseptic, mouth ulcers. Flowers used as a tonic for coughing, heart and brain complaints	SKW-5072	0.59	0.33
Saussurea costus (Falc.) Lipsch.	Asteraceae	H	Th	Mg	Rh	Oil is antiseptic, disinfectant, cardiac stimulant, expectorant, and carminative, diuretic. Treat arthritis, ulcers, asthma and dysentery, Constipation, joint pain, stomach disorders, weakness, worm killing, toothache, and backache and sugar. Dried rhizome powder mixed with four givens to goats in a disease locally called “Bagri” and after delivery weakness	SKW-5073	1.38	0.66
Senecio chrysanthemoides DC.	Asteraceae	H	Th	Mi	L, F	Fresh leaves and flowers are crushed. Extract is used to cure stomach and liver problems	SKW-5074	0.72	0.62
Sonchus asper (L.) Hill.	Asteraceae	H	Th	Mi	Wp, L	Whole plant is given to livestock to get proper amount of milk especially when their calf is dead. Leaves are cooked as vegetable and are also considered good for abdominal pain.	SKW-5075	0.52	0.20
Arnebia benthamii L.	Boraginaceae	H	Ge	Mi	Rh	Dried rhizome is used for Joint pain, stomachache, fever, ulcer and Scurvy	SKW-5076	1.23	0.63
Brassica compestris L.	Brassicaceae	H	Th	Mi	L, S, F	Fodder and vegetable	SKW-5077	1.05	0.21
Capsella bursa-pestoris Medic.	Brassicaceae	H	Th	Mi	S, L	Astringent, vegetables	SKW-5078	0.52	0.21
Eruca sativa L.	Brassicaceae	H	Th	Mi	S, L	Hair tonic and antidandruff, vegetables	SKW-5079	0.23	0.25
Nasturtium officinale R.B	Brassicaceae	H	Th	Mi	L	Purgative, emetic, vegetables	SKW-5080	0.28	0.16
Cannabis sativa L.	Canabanaceae	H	Th	Mi	F, L	Sedative, anodyne & narcotic	SKW-5081	0.68	0.24
Elaegnus umbellata Thumb	Elaegnaceae	S	Np	Mi	F, W	Cardiac stimulant, fuel wood, fruit	SKW-5082	0.53	0.14
Geranium wallichianum Fisch	Geraniaceae	H	He	Mi	L, R, F	Extract of the root is used for the treatment of Hepatitis, Jaundice, Kidney and Spleen complaints, extract of the flower used for blood	SKW-5083	1.02	0.56

						purification. Decoction of leaves and flowers mixed with water for making Kahwa and utilized for the purpose Rheumatic and Arthritis pains			
Juglans regia L.	Juglandaceae	T	Ph	Me	S, Bar, L, W	Eczema, fruit, timber and as a toothache	SKW-5084	1.10	0.58
Ajuga bracteosa Wall. ex Bth.	Lamiaceae	H	He	Me	Wp	Local healers believe that decoction is beneficial in treating epilepsy, as well as jaundice, sore throats, and blood purification	SKW-5085	1.08	0.61
Ajuga parviflora Bth.	Lamiaceae	H	He	Me	R, L	Hepatitis is treated using decoction. It relieves fever and is beneficial in the treatment of tonsils	SKW-5086	0.43	0.14
Isodon rugosus (Wall. ex Bth.) Codd	Lamiaceae	S	Np	Mi	L	The dried foliage is chewed to relieve toothaches, and a combination derived from the leaves is used to treat rheumatism, wound healing, fever, skin problems hypertension, and as an antiseptic	SKW-5087	0.65	0.20
Lamium album L.	Lamiaceae	H	Th	Mi	L, St	Trauma, hypertension, fracture, uterine hemorrhage and paralysis	SKW-5088	0.48	0.32
Marrubium vulgare L.	Lamiaceae	H	Th	Mi	Wp	Tonic, carminative and beneficial for urinary problems	SKW-5089	0.26	0.20
Mentha arvensis L.	Lamiaceae	H	He	Mi	L	Respiratory infections and gastritis issues are treated with the leaves paste, which is also used to treat vomiting, nausea, and diarrhea	SKW-5090	0.66	0.32
Mentha longifolia L.	Lamiaceae	H	He	Mi	L, F	In the treatment of cholera, a decoction of the leaves is used to reduce vomiting, as a refrigerant, and as a carminative. Flower extract is used to treat hypertension	SKW-5091	0.26	0.14
Mentha royleana Wall. exBenth.	Lamiaceae	H	He	Mi	L	Antioxidant activity, Antioxidant activity	SKW-5092	0.33	0.19
Mentha spicata L.	Lamiaceae	H	He	Mi	L	Salad and Making tea for treating vomiting	SKW-5093	1.19	0.14
Micromeria biflora (Buch.- Ham.ex D. Don) Bth.	Lamiaceae	H	Th	Lp	Wp	Stimulant and carminative	SKW-5094	0.28	0.19
Nepeta erecta (Royle ex Benth.) Benth.	Lamiaceae	H	Th	Mi	L	laxative	SKW-5095	0.25	0.07

Nepeta laevigata (D.Don) Hand.-Mazz.	Lamiaceae	H	Th	Mi	S	Dysentery	SKW-5096	0.32	0.15
Nepeta podostachys (Briq.) A.L.Budantzev	Lamiaceae	H	Th	Mi	Ap	Aromatic and useful to treat fever	SKW-5097	0.31	0.18
Origanum vulgare L.	Lamiaceae	H	Th	Mi	Wp	Useful for treating toothaches and earaches in addition to urinary issues	SKW-5098	0.88	0.60
Ocimum basilicum L.	Lamiaceae	H	He	Me	F, L	Devil's effects, fragrance and avoiding mosquitoes	SKW-5099	0.27	0.08
Phlomoides bracteosa (Royle ex Benth.) Kamelin & Makhm.	Lamiaceae	H	He	Me	Ap	Forage	SKW-5100	0.25	0.12
Prunella vulgaris L	Lamiaceae	H	Th	Mi	Wp	Used to promote expectoration, serve as an antiseptic, and lower body temperature during instances of high fever. It is also applied to the treatment of hemorrhoids	SKW-5101	0.33	0.19
Salvia lanata Roxb.	Lamiaceae	H	Th	Mi	Wp	A paste of leaves is applied to the toes to remove the bad smell (fungal infection)	SKW-5102	0.22	0.20
Salvia moorcroftiana Wall. ex Bth	Lamiaceae	H	Th	Mi	Wp	Wound healing is achieved by using fresh leaves with *Brassica campestris* oil	SKW-5103	0.25	0.18
Salvia nubicola Wall. ex Sweet	Lamiaceae	H	Th	Mi	Wp	Making pastes used as emulsion	SKW-5104	0.26	0.25
Salvia plebeia R.Br	Lamiaceae	H	Th	Na	Wp	Astringent, diuretic and vermifuge	SKW-5105	0.25	0.12
Thymus linearis Jalas.	Lamiaceae	H	He	Na	Wp	Decoction with oil give to relive cold and improve digestion in cattle, also increase milk production in cows, goats and sheep. Cure Abdominal pain, chest pain, fever, reduce obesity, tea is taken to control blood pressure. Suppression of urine, constipation and shivering. Leaves and flower powder strengthen teeth, gum infections, bleeding gums	SKW-5106	1.09	0.20

Trillium govanianum Wall. ex Royle,	Melanthiaceae	H	Ge	Me	Rh	Root decoction used as a tonic and emetic. The ethanol extract made from the rhizome and Arial parts has antifungal potential and is used to treat ailments including rheumatism. It is also used to produce hormones that are comparable to those engaged in sexual activity and in birth control tactics. Additionally, the extract is used to treat blood cancer, heart illness, rheumatoid arthritis, eye pain, joint pain, and rheumatism	SKW-5107	1.19	0.25
Sinopodophyllum hexandrum (Royle) T.S.Ying	Podophyllaceae	H	Ge	Me	R, Fr	Root extract is purgative, stomachache; treat liver and bile diseases, wounds and skin diseases. Fruit is laxative	SKW-5108	0.57	0.20
Aconogonon alpinum (All.) Schur.	Polygonaceae	S	Np	Mi	Wp	Aerial parts are cooked as vegetables and roots are used by females in case of leucorrhea	SKW-5109	0.26	0.12
Bistorta affinis Greene	Polygonaceae	H	Ge	Mi	F, L, R	Root powder with milk is given in Fever, body pain, and muscle contraction	SKW-5110	0.42	0.25
Bistorta amplexicaulis (D.Don) Green.	Polygonaceae	H	Ge	Mi	L, R	Animals' general weakened condition is treated with roots. Root powder used to treat flue, urinary disorder, fever, cough, sore throat, joint pain, oral inflammations, mouth ulcers, dysentery, diarrhea and hemoptysis. Flower tea is used to treat the stomach problems Leaf decoction in high dose cause abortion, Leaf paste cause wound healing, treat dysentery	SKW-5111	1.03	0.32
Fagopyrum esculentum Moench	Polygonaceae	H	He	Me	L, S	Decoction of seed grains used in diarrhea, vegetable for weakness and constipation, leaf paste and root juice used to cure headache, fever, rheumatism and urinary disorders	SKW-5112	0.36	0.28
Oxyria digyna (L.) Hill	Polygonaceae	H	He	Mi	F, L	Flowers used in diarrhea. Vegetable for stomach problems and constipation	SKW-5113	0.32	0.28
Rheum webbianum Royle	Polygonaceae	H	He	Ma	L, S, R	The plant's root paste is used externally to cure muscular injuries, while the plant's stem can be eaten as food. The root paste is also ingested to	SKW-5114	0.55	0.27

						cure a variety of ailments, such as internal wounds, cuts, wounds, dysentery, mumps, headaches, earaches, constipation, stomachaches, swelling of the throat and blood purification. The plant's root, when powdered, functions as a purgative, astringent, and tonic and is especially helpful for indigestion. The root powder is used to treat fever, whiten the skin, lower acidity and purify the blood			
Rumex dentatus L.	Polygonaceae	H	He	Me	L	Astringent and as a vegetable	SKW-5115	0.58	0.37
Rumex hastatus L.	Polygonaceae	S	Np	Mi	L	Diuretic, vegetables and stomachic	SKW-5116	0.27	0.25
Rumex nepalensis Sprengel	Polygonaceae	H	He	Me	L, Rh	Skin diseases, cough, leaf infusion used as a stomachache, treat dysmenorrhea, root decoction used to relive pulmonary disorders. Used as a Vegetable in constipation. Root paste has anti-lice properties. Animals suffering from constipation and lung issues can be treated with root decoction	SKW-5117	0.35	0.19
Aconitun chyasmenthium Stapf ex HolMe	Ranunculaceae	H	Ge	Mi	F, Rh	People with asthma are given a mixture of flowers and honey, and animals with foot and mouth illness are treated with a paste prepared from the roots. Root decoction is used in measles and mumps. Boiled roots in water are given in general weakness of cattle. Also used in heart diseases, joint pains, high fever, stupor, soothing as well as diuretic and anti-diabetic	SKW-5118	0.25	0.07
Aconitum heterophyllum Wall. ex Royle	Ranunculaceae	H	Ge	Mi	Rh	Rhizome paste is used to the chest to treat illnesses like cough, pneumonia, colds, diarrhea, fever, headache, dyspepsia, piles, and diabetes	SKW-5119	1.14	0.64
Skimmia laureola (Dc.) Steph.	Rutaceae	S	Np	Me	L	Repel the evils, Leaf's powder applied on small pox, remove worms of colic. A leaf decoction is used to cure obesity and as an insect repellent	SKW-5120	0.58	0.35

Zanthoxylum aromatum D.C.	Rutaceae	S	Np	Mi	Fr, W	Aromatic, fuel wood, toothache, fruit, fencing and gums	SKW-5121	0.78	0.50
Verbascum thapsus L.	Scrophulariaceae	H	Th	Me	F, L	Dried leaves are smoked for mental relaxation. Paste of leaves id used for wound healing. Tea of leaves is given to cure cold and dysentery. Also used as fodder. Flowers are crushed in water and used as hair dye	SKW-5122	0.36	0.31

Abberevations: where Ph= Phanarophytes, Np= Nanophanarophytes, He= Hemicryptophytes, Ge= Geophytes, Ch= Chameophytes. Th= Therophytes, Mg= Megaphylls, Me= Mesophylls, Mi= Microphylls, Np= Nanophylls, Lp= Laptophylls, H= Herb, S= Shrub, T= Tree, Wp= Whole Plant, Rh= Rhizome, R= Root, St= Stem, L= Leaves, F= Flower, Fr= Fruit, Gum= Gum, Lat= Latex, W= Wood, Bar= Bark, Ap= Aerial parts.

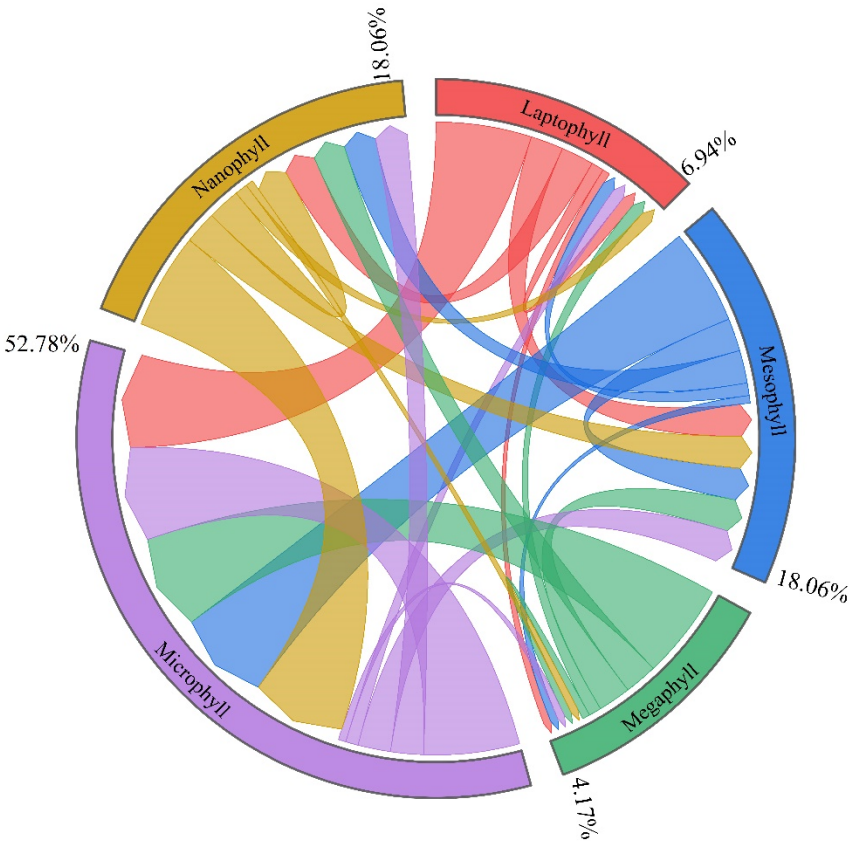

Figure 4. Leaf size classification of medicinal and aromatic plants recorded from the Kashmir Himalayan Region

Use Categories

The medicinal and aromatic plants were classified into eight categories: medicinal, food, tea, vegetables, spices, oil, eaten raw and fruit. The most often used category was medicinal, which included 72 plant species. Following that, there were seven species chosen as vegetables, five as tea, and six as spices. Food and oil were the least used categories, with only one and two plant species, respectively. In terms of contribution, medicinal plants accounted for 75.8%, vegetables for 7.4%, spices for 6.3%, tea for 5.3%, fruit and oil each accounted for 2.1%, and food for 1.1% (Figure 5, Table 2). The maximum number of plant species utilized to treat various ailments described in this study can be investigated extensively for the construction of modern herbal pharmaceutical companies. The validity of our findings was reinforced by PCA, revealing variations corresponding to species' use preferences. PC1 explains 64% of the variance in use preference, while PC2 accounts for the remaining 13.3%. The principal component analysis showed the dominant medicinal and aromatic plants are *Nepeta podostachy, Rheum webbianum, Trillium govanianum, Saussurea costus* and *Phlomoides bracteosa*.

Part Used

The use of various plant parts differs according to the category of application. In terms of plant parts usage, leaves were the most typically used, with 40 plant species using them. Roots from underground portions were used by 16 species, as were rhizomes from 8 species. Locals in the Muzaffarabad division used entire plant parts from 12 different plant species. Residents used the flowers of 12 species, the seeds of 9 species, and the fruits of 5 species as reproductive organs. Furthermore, the aerial parts of three plant species were used entirely by the inhabitants. Many plant species had many portions that were used for different reasons, such as gum, latex, and bark. Our results in terms of plant part used are comparable and almost similar to the results of (Shaheen *et al.* 2013, Haq *et al.* 2021, Mirzaman *et al.* 2023). These ingredients have a long history of use in traditional medicine and as food. The potential of medicinal and aromatic plants is vast and untapped, despite their long history of use. The fact that ignoring their genetic resources would result in massive losses in the future highlights the significance of sustaining a harmonious balance between plants, animals, and people. The use of medicinal and aromatic herbs has expanded from disease treatment to disease prevention over time, depending on various periods.

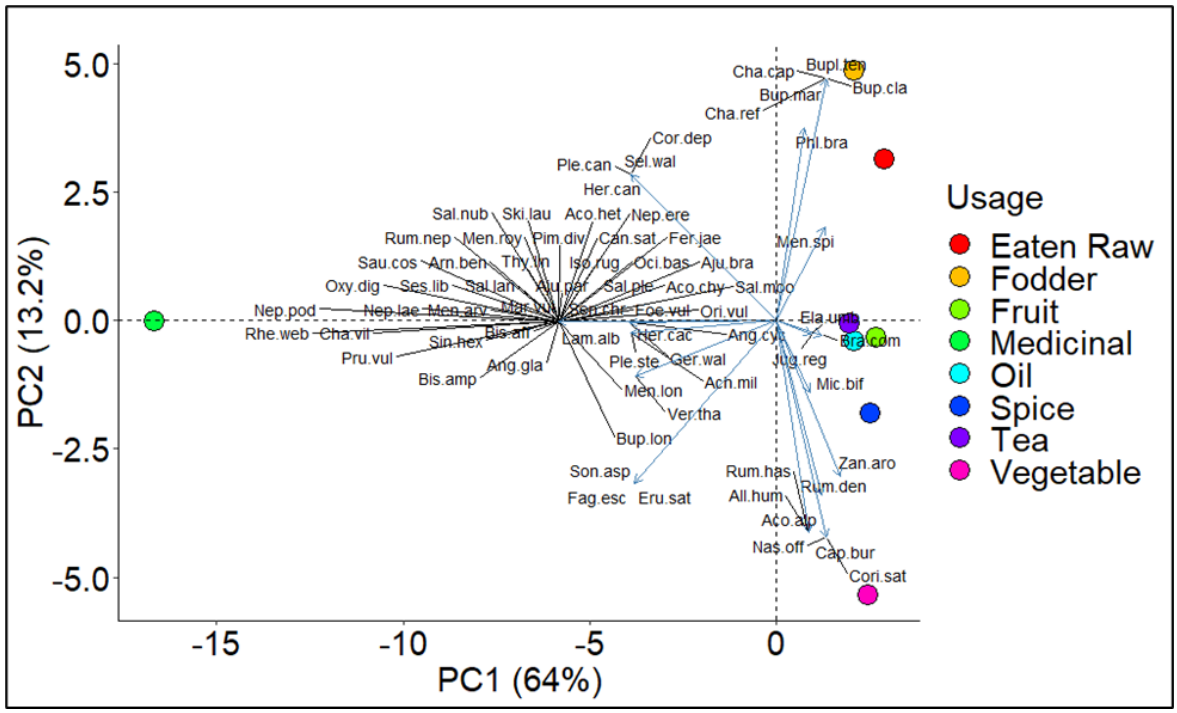

Figure 5. Principal Component Analyses (PCA) biplot of different usage investigated in the Himalayan region of Kashmir

Use value (UV) of Medicinal and aromatic plants

The Use Value (UV) of Medicinal and Aromatic Plants is an important indicator for evaluating the utility of various plant species as well as the local population's awareness of these plants. *Saussurea costus* stood out in the research region with a very high UV value of 1.38. Other plant species with significant UV values included *Angelica cyclocarpa* (1.25), *Arnebia benthamii* (1.23), *Trillium govanianum* (1.19), *Mentha spicata* (1.19), *Aconitum heterophyllum* (1.13), *Juglans regia* (1.1), *Thymus linearis* (1.09), *Allium humile* (1.07), *Brassica compestris* (1.05), *Bistorta amplexicaulis* (1.03), and *Geranium wallichianum* (1.02). *Chaerophyllum villosum* (0.14), *Seseli libanotis* (0.16), *Pimpinella diversifolia* (0.17), *Bupleurum clarkeaum* (0.18), *Heracleum cachemiricum* (0.19), *Salvia lanata* (0.22), and *Eruca sativa* (0.23) had lower UV values (Table 1). Furthermore, Juglans regia is more prevalent in several Himalayan valleys, bark is thought to be beneficial in the treatment of arthritis and toothache and wood is used to make furniture due to its high quality (Taha & Al-wadaan, 2011, Dar *et al.* 2012, Khan *et al.* 2013, Haq *et al.* 2021, Mirzaman *et al.* 2023). The high usage and reliance of people on these plants demonstrates the deep relationship between indigenous communities and local flora, notably for the treatment of common diseases. Because of the existence of active biochemical components that are effective for disease elimination, locals use them as a source of food or medicine (Kayani *et al.* 2014, Farooq *et al.* 2019, Waheed *et al.* 2023b). The advantages of aromatic and medicinal plants are precious assets that are available to all living things. People frequently rely extensively on synthetic products in today's world of technology and medicinal innovations. However, a significant number of people continue to use herbs and medicinal plants to cure a variety of illnesses. Due to its few negative effects, easy availability, and cost, they favor these natural therapies. Promoting the establishment of important medicinal plants among local communities is advantageous to reduce pressure on the surrounding vegetation. It would be beneficial to encourage the locals to grow aromatic plants that are both medicinally and economically valuable and to help them set up small medicinal plant reserves on their lands (Manzoor *et al.* 2023a).

Relative Frequency Citation (RFC)

Angelica cyclocarpa had the highest Relative Frequency of Citation (RFC) score of 0.68, suggesting that it was used by the majority of informants. *Saussurea costus* (0.66), *Aconitum heterophyllum* (0.64), *Senecio chrysanthemoides* (0.61), and *Allium humile* (0.60) were the next plants with RFC scores in the upper teens. The lowest RFC values were found in *Aconitum chasmanthum* (0.07), *Pimpinella diversifolia* (0.11), *Salvia plebeia* (0.12), *Bupleurum tenuissimum* (0.12), and *Bupleurum clarkeaum* (0.13). The current study's relative frequency citation results are consistent with previous studies from Kashmir's Himalayan region (Mirzaman *et al.* 2023, Manzoor *et al.* 2023a). The therapeutic efficacy of ethnomedicinal plants with high UVs and RFCs values must be evaluated and demonstrated (Yaseen, 2019, Bahadur *et al.* 2020). While plants with low UV properties are important, Amjad *et al.* (2017) argue that their low UV levels suggest a lack of awareness among local communities about their benefits, limiting the dissemination of information to potential users.

These findings can be summarized as follows: The study area's population has a deep awareness of plant knowledge and continues to include plants in their daily lives. Herbs are important in local plant utilization, with the Lamiaceae family being the most common and diversified of all plant groups. The vast majority of these plants are used for medical purposes in local communities. Several species served numerous functions in diverse categories of utilization. Leaves were especially common since they were used for a variety of purposes. Furthermore, subsurface sections were extensively used, posing potential harm to the region's unique plant life. Quantitative assessments revealed that *Saussurea costus* was the dominating plant species in the study region in terms of use value since it was used in various categories and was cited frequently, indicating its importance. *Angelica cyclocarpa*, *Arnebia benthamii*, *Mentha spicata*, *Juglans regia*, *Trillium govanianum* and *Aconitum heterophyllum* were among the notable species. The great abundance of these species emphasizes local populations' reliance on indigenous plant life, highlighting the necessity of protecting these resources for future generations. As a result, a sustainable utilization pattern is required to conserve these rare and vital species for future generations. This reliance on phytoremediation for humans and cattle is comparable to previous records from the Himalayan region (Bahadur *et al.* 2022, Abas *et al.* 2017, Ahmad *et al.* 2017, Dar *et al.* 2012). In this context, current research makes essential recommendations for long-term public health strategies for prevention measures and effective illness mitigation methods. These results can be compared to those of other Himalayan populations around the world (Khan *et al.* 2013, Abas *et al.* 2017, Singh *et al.* 2017, Rashid *et al.* 2018, Farooq *et al.* 2019, Haq *et al.* 2023a). The current findings show significant variety in ethnobotanical practices as a result of the diversity of flora species and topography. Throughout history, traditional practitioners and midwives have carried out their responsibilities and offered vital support to people. It is critical to explore the indigenous people's traditional wisdom to improve their primary healthcare system, guaranteeing future generations' benefit. The immense collection of knowledge, data, and resources generated in this area must be shared globally and transmitted to future generations.

Conclusion

The local populations residing in the mountainous regions of Kashmir possess substantial knowledge about medicinal plants. The current study documented 72 medicinal and aromatic plants that were commonly utilized by local populations for the cure of various diseases. The Lamiaceae family was recorded as a dominant family, whereas herbaceous plants were frequently utilized. In plant part use patterns, leaves were mostly utilized for making various kinds of remedies. *Angelica cyclocarpa* and *Saussurea costus* are the most important species in the study area. Due to the remoteness of the study area and the lack of modern healthcare facilities, the majority of populations are dependent on these medicinal plants to treat various diseases. Anthropogenic activities like overharvesting, fire, and deforestation put pressure on the medicinal plant diversity of Kashmir. Due to the abovementioned problems, we suggest sustainable conservation and effective management of medicinal and aromatic plants in Kashmir on a priority basis to conserve these species as well as traditional knowledge for future generations.

Declarations

Ethics approval and consent to participate: The ethical guidelines for the survey of rural and indigenous communities provided by the International Society of Ethnobiology (available online: www.ethnobiology.net/whatwe-do/coreprograms/iseethics-program/code-of-ethics) were carefully followed. Before interviews, formal verbal consent (regarding data collection and publication) of each participant was taken. This study was authorized by the Department of Plant Sciences, Quaid-I-Azam University, and Islamabad, Pakistan. All participants provided oral prior informed consent.

Conflict of interest: We all authors have no conflict of interest to declare.

Consent for publication: “Not applicable” in this section.

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

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

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Authors' contributions: M.A, and M.Z. designed and supervised the entire study, M.M, S.W.G. and H.S. conducted field surveys and collected data. S.W.G., M.M., T.M., F.U.R. and S.S. contributed in data arrangement, presentation and analysis. S.W.G., S.M.H., and M.W. played a role in the statistical interpretation of data. S.W.G and M.M. wrote the first draft of the manuscript.

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