Unveiling the Indigenous Ethnomedicinal knowledge of Genus *Nepeta* from Azad Jammu & Kashmir, Pakistan

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Research

Abstract

Background: Medicinal plants have a high value to humans due to their medicinal constituents and potential biological consequences. The current study provides valuable insights into the *Nepeta* genus and its significant ethnobotanical worth within the rich diversity landscape of the division of Muzaffarabad.

Methods: Ethnomedicinal data was gathered by using a questionnaire and the group discussion method. Group discussions were carried out in local dialect to facilitate clear communication with local populations. The quantitative metrics were applied to the data, such as use value (UV), relative frequency citation (RFC), and informant's consensus factor (ICF).

Results: The members of the *Nepeta* genus are mostly distributed in the subtropical to alpine zone. A total of 22 medicinal plants were recorded in the study area. These medicinal plants are extensively used by local communities for the treatment of nine major disease categories. The most frequently used medicinal remedy is decoction (38.46%). Therophyte and microphylls were recorded as the dominant life and leaf forms, respectively. Among the medicinal plants, herbs (100%) were most frequently used by the local populations of Kashmir, whereas leaves (44.4%) were used for the treatment of various ailments. Additionally, the highest value of ICF was calculated for the cold and fever category (0.89).

Conclusions: The *Nepeta* genus exhibits therapeutic properties that are promising for several kinds of disorders; however, clinical research is required to confirm preclinical results. Incorporating conservation strategies while providing basic amenities to residents will help with the restoration and conservation of the local flora in Muzaffarabad.

Keywords: Ailments, Ethnobotanical uses, Lamiaceae, *Nepeta*, Western Himalayas

Background

The Lamiaceae family is one of the largest groups of angiosperms, with about 7,000 species and over 240 genera. This family, which is widely spread and has significant medicinal and commercial significance, is highly aromatic (Zaman *et al.* 2020). The Lamiaceae family is one of the most diversified and widespread in terms of ethnomedicine, and its medicinal effectiveness is determined by the concentration of volatile oils (Sarac & Ugur, 2007). Most of the species in the Lamiaceae family are extremely aromatic because they have glandular structures on the outside that release volatile oil (Giuliani & Maleci, 2008, Gul *et al.* 2019a, 2019b). This oil has applications in the pesticide, perfumery, aroma, cosmetic, and pharmaceutical industries (Özkan 2008).

Nepeta is one of the most significant genera in the Lamiaceae (Labiatae) family. The scientific name of the genus, *Nepeta*, was taken from the ancient Italian city of "Nephi" (Hussain *et al.* 2008). It is also known as Glechoma and Cataria, and it has over 280 annual and perennial species in the world (Formisano *et al.* 2011). These aromatic medicinal plants are mostly found in temperate parts of Asia, Europe, North America, and North Africa (Shakeri *et al.* 2014). *Nepeta* has the greatest species diversity in two distinct regions: Iran and the Western Himalayas. According to investigations by (Jamzad *et al.* 2003), these regions have recorded the highest number of *Nepeta* species. These plants are recognized for their fascinating blossoms with a pleasant aroma, and their pollen grains have six colpi (Gul *et al.* 2019c).

Since different *Nepeta* species have different therapeutic benefits, they are used in traditional medicine in multiple forms (Salehi *et al.* 2018). These include febrifuge, emmanagogic, antitussive, diuretic, antiasthmatic, antispasmodic, and sedative properties (Mamadalieva *et al.* 2017). Additionally, they are applied externally as astringents and antiseptics for treating snake and scorpion bites and dermatological diseases in children (Emami *et al.* 2017). Particular species of *Nepeta*, including *Nepeta ispahanica*, *Nepeta binaloudensis*, *Nepeta bracteata*, *Nepeta pogonosperma*, and *Nepeta pungens*, are highly valued in Iran as plants for medicinal purposes, while *Nepeta crispa* is used in cooking (Bahmani *et al.* 2014). Catnip has acquired popularity in pharmaceutical formulations due to its numerous therapeutic characteristics. It has also been shown to successfully treat hyperactive gastrointestinal and respiratory conditions such as colic, diarrhea, cough, asthma, and bronchitis (Duke 2002).

Studies on the therapeutic potential of several *Nepeta* species have focused on the secondary metabolites and essential oils produced by these plants (Sharma *et al.* 2021). These active constituents have shown potential in treating a variety of ailments, including angina pectoris, tachycardia, heart weakness, and cardiac thrombosis, as well as stings from snakes and scorpions, gum disease, liver disease, and kidney problems (Formisano *et al.* 2011, Sharma *et al.* 2019, Salehi *et al.* 2018, Sharma *et al.* 2021). Furthermore, these *Nepeta* species have a variety of medicinal properties, including sedatives, antiseptics, antitussive, anti-asthmatics, expectorants, diuretics, antispasmodics, antipyretics, fungicidal, and antibacterial agents. In addition, they have antibacterial and insecticidal effects (Patial *et al.* 2019, Salehi *et al.* 2018).

The Himalayan Mountain region is home to a diverse range of medicinal and food plants and is regarded as a significant hub of biocultural diversity or biocultural refugia (Stryamets *et al.* 2021). The indigenous communities of the geographical region are more dependent on non-timber forest products, as they derive their livelihood from plant-derived components that are immensely important to the management of traditional healthcare systems (Haq *et al.* 2021, Shafiq *et al.* 2022). Plants play an essential role in the lives of indigenous peoples living in the Himalayan Mountains, as they provide both food and medicine (Asif *et al.* 2021, Rahman *et al.* 2018). Traditional knowledge is the subject of discussion by current ethnobiologists as a result of rapid globalization and modernization. According to studies, the remarkable shift in culture has prompted traditional ecological knowledge to decline, if not disappear entirely (Fernandez-Gimenez & Estaque, 2012).

Ethnobotanical documentation examines how populations interact with their environment, including traditions and cultural beliefs about how to use specific plants (Arshad *et al.* 2014, Silva *et al.* 2011, Verpoorte *et al.* 2005). These surveys are crucial for finding new medications and emphasizing the value of indigenous medicinal herbs (Cox 2000). Indigenous groups are stewards of traditional knowledge and hold essential knowledge about how to use a plant for multiple purposes. This traditional wisdom has been passed down through generations and is inextricably related to their daily activities and the environmental resources in their surroundings (Sharma 1998). Indigenous people struggle to retain their traditional knowledge, which leads to the need for a complete evaluation of this knowledge for better healthcare in isolated regions, as pointed out by national and worldwide organizations (Panyaphu *et al.* 2011). Despite its significance, indigenous medicinal knowledge is diminishing. Further investigation is required to document medicinal plants, analyze their components, perform clinical trials, and develop novel medications. Although medicinal plants of genus *Nepeta* have a significant potential to treat human ailments, there is a dearth of scientific and clinical knowledge regarding these plants' methods of action,

which makes it challenging to employ them directly as human medications (Sharma *et al.* 2021). The current ethnobotanical survey was conducted in the western Himalayan region of Kashmir. The study area is mostly rural and lacks modern healthcare facilities due to its remoteness. So, the majority of local communities living in these mountainous areas rely heavily on these medicinal plants for basic healthcare purposes. Keeping in view the therapeutic potential of these *Nepeta* species, this study was designed and conducted to document the traditional usage of *Nepeta* species sampled from different geographical locations in the western Himalayan region of Kashmir. *Nepeta* species demand in-depth knowledge, and ethnobotanical and ethnomedicinal understanding determines their therapeutic effectiveness.

Materials and Methods

Study area

Current research work was carried out in 10 villages of division Muzaffarabad, Azad Jammu and Kashmir. Division Muzaffarabad consists of three districts, Neelum Valley, Muzaffarabad, and Jhelum Valley (Figure 1). The village names include Leswa, Khawaja Trar, Dana, Ban Behak, Charan, Jabbi, Snae Behak, Banri, Domailan, and Bara Sar. The study area is located in the western Himalayan region between longitude 73–75 and latitude 33–36, with an elevational range of 500–4500 m (Figure 1) (Akbar 2017, Shaheen *et al.* 2019, Khan *et al.* 2021). The topography is generally steep and mountainous, with deep ravines, uneven terrain, and undulations. It is surrounded on the south by the Punjab Province's Gujrat district, on the east by the occupied Jammu and Kashmir Region, and on the west by the districts of Kahota, Murree Region, and KPK. The area experiences a subtropical to moderately humid climate. In the winter season, maximum temperatures often range from 25 to 34 degrees Celsius, while low temperatures typically fall between 4 and 10 degrees Celsius (Pak-Met, 2018, Shaheen *et al.* 2017a, Khan *et al.* 2022). Along with Urdu, the residents of Azad Jammu and Kashmir have a variety of cultural backgrounds and speak a variety of regional or local languages, including Kashmiri, Pahari, Hindko, and Gojri.

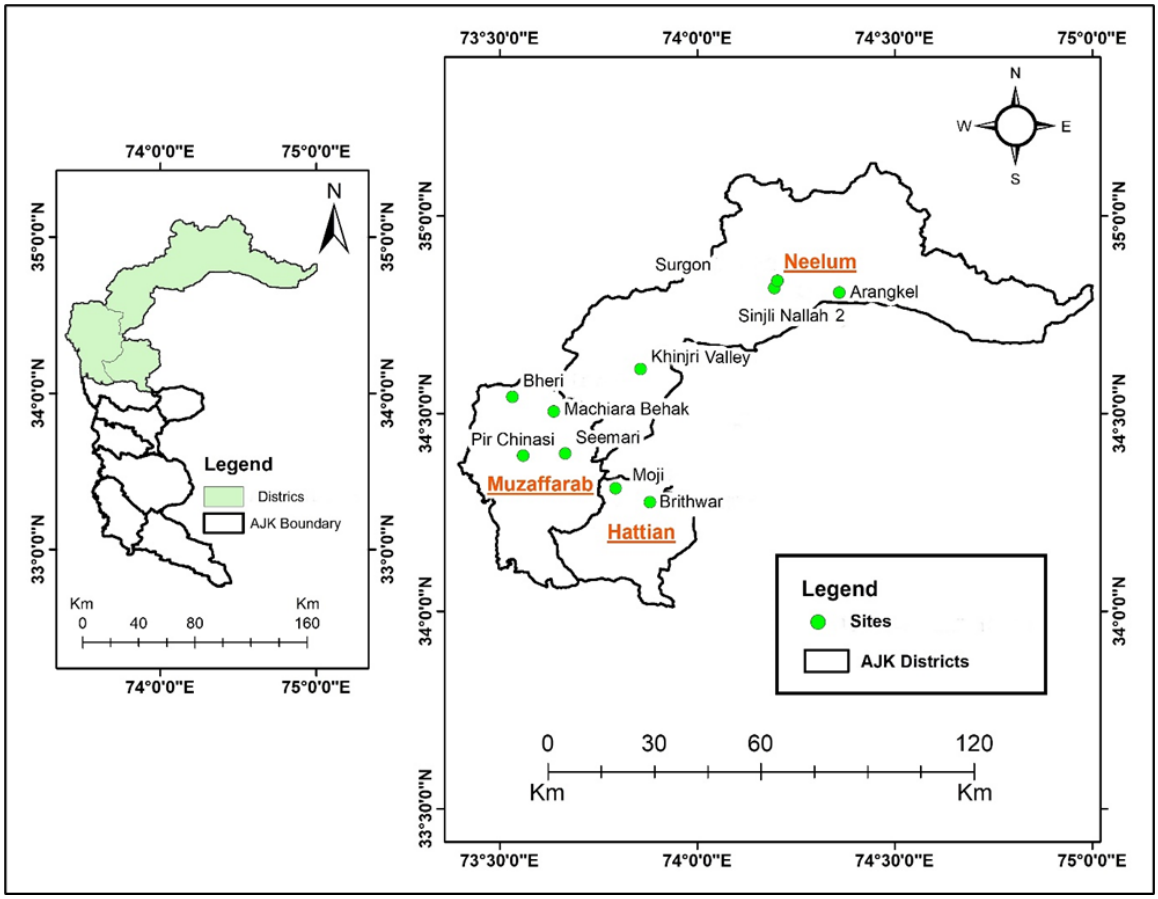

Figure 1. Study area map of genus *Nepeta* in the Western Himalayan region of Kashmir

Data collection

The ethnobotanical data was collected by using a questionnaire and the group discussion method in 10 different villages of division Muzaffarabad (Table 1). A total of 84 informants were surveyed. The majority of informants are older than 40 years old: 52 men, 21 women, and 11 local hakims. Before the documentation of ethnobotanical data, each respondent was

informed about the purpose and objectives of the research to gain their cooperation by following the code of ethics (ISE Code of Ethics, 2006). To facilitate communications with local peoples, group discussions were carried out in local languages (Phari, Hindko, and Gojri).

Table 1. *Nepeta* species, Locality, Coordinates, and elevation in the western Himalayan region of Kashmir.

Species Name	Locality	Voucher Number	Coordinates	Habit	Elevation (m)
Nepeta annua Pall.	Shounthar Valley	AMP-34677	34°59'27.32''N, 74°31'48.22''E	Herb	3490
Nepeta campestris Benth.	Bakri Dana	AMP-34678	34°18'36.91''N, 73°44'29.11''E	Herb	2873
Nepeta cataria L.	Leepa Valley	AMP-34679	34°19'30.18''N, 73°49'43.00''E	Herb	1706
Nepeta clarkei Hook.f.	Leepa Valley	AMP-34680	34°16'40.11''N, 73°54'54.36''E	Herb	2370
Nepeta coerulescens Maxim.	Surgan Valley	AMP-34681	34°58'50.04''N, 73°13'42.24''E	Herb	3304
Nepeta connata Royle ex Benth.	Ban Behak	AMP-34682	34°30'42.30''N, 73°38'55.78''E	Herb	2827
Nepeta discolor Royle ex Benth.	Sar wali Behak	AMP-34683	34°49'49.97''N, 74°40'43.08''E	Herb	3719
Nepeta elliptica Royle	Banri Behak	AMP-34684	34°32'22.14''N, 73°36'13.24''E	Herb	2522
Nepeta erecta Benth.	Katha chugali	AMP-34685	34°26'17.73''N, 73°45'29.43''E	Herb	2470
Nepeta eriostachya Benth.	Peerchenasi	AMP-34686	34°23'39.37''N, 73°34'54.91''E	Herb	3000
Nepeta floccosa Benth.	Kel Domailan	AMP-34687	34°57'24.87''N, 74°27'37.64''E	Herb	3408
Nepeta glutinosa Benth.	Nalah Kel	AMP-34688	34°50'26.55''N, 74°25'44.93''E	Herb	3255
Nepeta govaniana Benth.	Brithwar	AMP-34689	34°15'24.30''N, 73°51'08.33''E	Herb	2895
Nepeta hindostana Haines	Lawat	AMP-34690	34°42'59.14''N, 73°56'48.88''E	Herb	2387
Nepeta laevigata (D.Don) Hand.-Mazz.	Lawat	AMP-34691	34°42'49.26''N, 73°56'09.00''E	Herb	2812
Nepeta lagopsis Benth.	Kel Valley	AMP-34692	34°50'37.76''N, 74°21'26.02''E	Herb	2387
Nepeta longibracteata Benth.	Shounthar Valley	AMP-34693	34°53'50.37''N, 74°31'08.41''E	Herb	4167
Nepeta nervosa Royle ex Benth.	Samgam	AMP-34694	34°55'10.64''N, 74°12'44.57''E	Herb	2561
Nepeta paulsenii Bariq	Ban Behak	AMP-34695	34°34'36.05''N, 73°34'36.33''E	Herb	3228
Nepeta podostachys Benth.	Seri top	AMP-34696	34°50'20.75''N, 74°32'51.53''E	Herb	3306
Nepeta raphanorhiza Benth.	Snae Behak	AMP-34697	34°17'16.40''N, 73°54'22.18''E	Herb	2162
Nepeta salviaefolia Cham.	Jabbi Behak	AMP-34698	34°17'07.80''N, 73°54'53.58''E	Herb	2334

Ethnographic and socio-economic variables

Indigenous people's financial status varied but was typically low as well. The area exhibits a rich ethnography with an array of ethnic groups, including Chaudhary, Syed, Raja, Maliks, Mughals, Khwaja, Abbasi, Awan's, and Butts. Except farming, forestry, and a few other trades and businesses, the region's sources of income are incredibly limited. The vast majority of people live in rural areas, where they mostly rely on farming, collecting medicinal plants, and rearing livestock. Rainfall plays a major role in these regions' agricultural economies. Rice, potatoes, maize, and wheat are the main crops grown in the agricultural region (Habib *et al.* 2013). Tourism has significantly improved the socioeconomic status of its inhabitants by creating job opportunities.

Plant Collection & Identification

Several field visits were made from March to September 2023 for the collection of traditional ethnomedicinal knowledge as well as for the collection of plant specimens. All collected plants were not in the flowering and fruiting stages during the collection of ethnobotanical data. So, these areas were again revisited for the collection of plant specimens. All collected specimens were dried, pressed, and pasted on the standard herbarium sheet using standard protocols. Plant species were identified by herbarium scientist Dr. Mushtaq Ahmad and then confirmed from native flora (Flora of Pakistan) (Hassan *et al.* 2011). The biological spectrum of the genus *Nepeta*, including life and leaf spectra, was measured by following the method of Shaheen *et al.* (2023).

Data Analysis

Use Value

The use value (UV) is an essential metric that describes the relative importance of species (Phillips *et al.* 1994). The UV can be calculated by using the following formula:

$$UV=\Sigma Ui/N$$

Where Ui represents the total number of uses claimed by an informant for a particular species and N represents the total number of informants.

Relative Frequency Citation

Ethnobotanical data was analyzed using the important metric of relative frequency citation (RFC). Relative frequency citation demonstrates the importance of local plant species based on frequency citation (FC), dividing the total number of informants (N) in the ethnobotanical survey. The greater value of RFC represents the significance of species (Albuquerque *et al.* 2006). Relative frequency citations can be calculated using the formula:

$$RFC=FC/N$$

Informant Consensus Factor

The Informant Consensus Factor (ICF) calculates whether traditional informants regularly used the same plant species (Heinrich *et al.* 2009). ICF is estimated based on the informant's native knowledge using the following formula:

$$ICF=Nur-Nt/Nur-1$$

where Nur is the total number of reports for all cases of each disease category, and Nt is the total number of plant species used in that category. ICF values range from 0 to 1.

Results

Diversity of Genus *Nepeta*

The ethnobotanical survey documented 22 *Nepeta* species from the Muzaffarabad division (Table 2). These species were collected from various geographical locations with a diverse elevational range from 500 to 4500 m. *Nepeta* genus belongs to the family Lamiaceae. All the collected *Nepeta* species were herbaceous. The floral diversity of the *Nepeta* genus, family, voucher number, ailments, remedies, modes of administration, and used parts are presented in Table 2.

A total of 32 remedies were used by the local communities for the treatment of various diseases. Nine plant species (*Nepeta cataria, Nepeta discolor, Nepeta erecta, Nepeta eriostachya, Nepeta floccose, Nepeta glutinosa, Nepeta govaniana, Nepeta laevigata*, and *Nepeta salviaefolia*) were identified as having more diversified uses for the cure of more than three diseases. Two species (*Nepeta coerulescens* and *Nepeta hindostana*) were used for the treatment of two diseases. The rest of 11 species were used for the treatment of only one type of disease (Table 2). The rest of the 11 species were used for the treatment of only one type of disease (Table 2). The most frequently used plant parts are leaves (44.4%), whereas decoction is the most frequently utilized remedy (Figure 2). The life form results of documented flora indicate that therophyte (68.18%) was the dominant life form, followed by hemicryptophyte with a percentage of 31.82%, whereas microphyll (86.36%) is the dominant leaf form category, followed by nanophyll (13.64%).

Table 2. Taxonomic diversity of genus *Nepeta*, ethnobotanical uses, Medicinal remarks, and Ethnobotanical indices of division Muzaffarabad.

Scientific Name	Ailments	Medicinal Remarks	Mode	Plant Part	UV	RFC
Nepeta annua Pall.	Headache	5–10 gm of seeds are soaked overnight in water; an infusion is obtained and used 2-3 times daily for 3–4 days.	Infusion	Se	0.62	0.62
Nepeta campestris Benth.	Joint pain	Oil is astringent and is applied as a massage around the joints.	Oil	Se	0.42	0.52
Nepeta cataria L.	Toothache, Vomiting, Tonsillitis, Dysentery, Nerve relaxant, swollen throat, Asthma, Cough	An extract of 25–40 gm of fresh leaves mixed with water is used to cure respiratory diseases. A cup of juice made from 15-20 mg of grinded leaves and flowers was used to cure different ailments twice a day for one week.	Juice, Extract	Le, Fl	1.62	0.98
Nepeta clarkei Hook.f.	Swollen thorat	Oil is astringent and is applied as a massage around the swollen throat.	Oil	Ar	0.29	0.33
Nepeta coerulescens Maxim.	Neck and thorat pain	The oil is astringent and applied as a massage around the neck region.	Oil	Le	0.50	0.77
Nepeta connata Royle ex Benth.	Coomon cold	An extract of 10–15 gm of fresh leaves is used on the chest before going to bed in the evening, twice a week.	Extract	Le	0.44	0.69
Nepeta discolor Royle ex Benth.	Cough, Cold, Fever, Tuberculosis	A decoction of leaves is used for the treatment of coughs and fevers. Fresh leaf decoction of 70–100 mg is used for the treatment of tuberculosis for 2–3 months.	Decoction	Le	0.87	0.82
Nepeta elliptica Royle	Stomach problems	An infusion of seeds (5–10 mg) is given to children for the treatment of stomach problems. A decoction of fresh leaves is used for the treatment of stomach problems.	Infusion/Decoction	Se, Le	0.45	0.67
Nepeta erecta Benth.	Cough, Cold, Fever	A decoction of leaves is used for the treatment of cough, cold, and fever twice a day for one week.	Decoction	Ar	0.69	0.67
Nepeta eriostachya Benth.	Fever, Cold, eye problems	A decoction of the whole plant is used for the treatment of cough and fever twice a day for one week. An extract of 25–40 gm of fresh leaves mixed with water is used to cure eye diseases.	Extract	Le, Wp	0.73	0.77
Nepeta floccosa Benth.	Cold, Cough, Fever	Decoction of leaves is used for the treatment of cough and fever 2-3 times daily for 3–4 days.	Decoction	Le	0.61	0.40
Nepeta glutinosa Benth.	Muscular dystrophy, Pneumonia, Internal hemorrhage, fever, diarrhea	20–30 mg of leaf bud's decoction is used to cure different ailments. A leaf-bud decoction is used for the treatment of pneumonia, usually before going to bed in the evening. Dried leaf powder is mixed with oil (Desi ghee) and used for massage to cure muscular dystrophy.	Decoction	Lb	1.29	0.91
Nepeta govaniana Benth.	Cold, Influenza, Menstrual problems, Sore throat	Decoction of leaves is used for the treatment of cough and fever twice a day for one week. Dried leaf powder is fried in oil (ghee)	Decoction	WP	1.23	0.85

		and then used for the treatment of female menstrual disorders for 5-8 days.				
Nepeta hindostana Haines	Fever, pain relief	Decoction of leaves is used for the treatment of fever 2-3 times daily for 3–4 days. The whole plant is used for relieving the gripping pain of colic.	Extract/Decoction	Wp	0.92	0.51
Nepeta laevigata (D.Don) Hand.-Mazz.	Fever, Colds, Sore thorat, dysentry, Headache	Oil is astringent and is applied as a massage around the throat. An infusion of seeds (15–20 mg) is given for the treatment of dysentery. A decoction of leaves is used for the treatment of cough and fever twice a day for one week.	Infusion/Decoction	Wp, Se	1.12	0.86
Nepeta lagopsis Benth.	wound healing	20–40 mg of whole plant paste is applied externally to cuts and wounds for 5–10 days.	Paste	Wp	0.23	0.50
Nepeta longibracteata Benth.	Stomach problems	The dried whole plant (20–30 mg) is ground into powder form. A half-spoon of powder is taken mostly before breakfast on an empty stomach for 5–10 days.	Powder	Wp	0.58	0.37
Nepeta nervosa Royle ex Benth.	Brian relaxing	250–400 mg of dried leaves are smoked to induce relaxation (locally known as Hukka or Chilam).	Others	Le	0.44	0.50
Nepeta paulsenii Bariq	Liver problems	20–30 mg of leaf decoction is used to cure whole-liver problems.	Decoction	Le	0.55	0.41
Nepeta podostachys Benth.	kidney problems	A decoction of 20–35 gm of the whole plant is used daily for 5-8 days.	Decoction	Wp	0.45	0.74
Nepeta raphanorhiza Benth.	Digestive problems	A half-spoon of leaf and flower powder mixed with water or milk is taken on an empty stomach to cure stomach problems.	Powder	Le, Fl	0.56	0.55
Nepeta salviaefolia Cham.	Infertility, Leucorrhea, Backache	30–40 gm of dried plant powder is used with 3-5 sips of warm water for 5 days.	Powder	Le	0.86	0.89

Abbreviations: Se=Seeds, Le=Leaves, Fl=Flowers, Wp=Whole plant, Lb=Leaf buds, Ar=Aerial parts, Th=Therophyte, H=Hemicryptophyte. Mi=Microphylls, Na=Nanophylls, UV= Use value, RFC= Relative frequency citation.

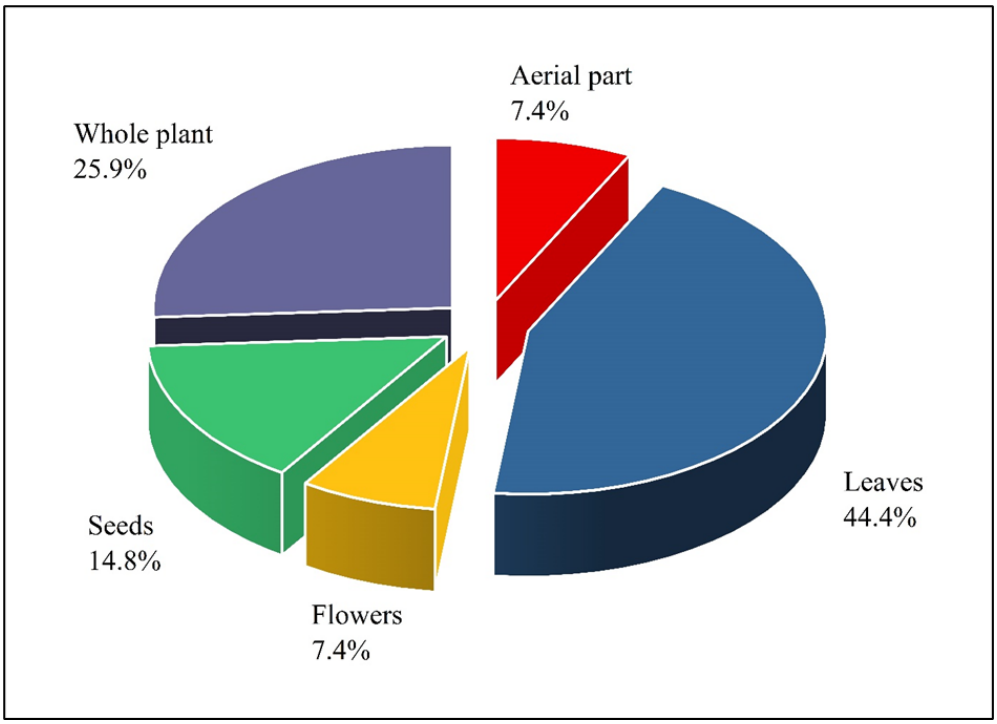

Figure 2. Percentage of part used for the treatment of various ailment

Preparation of Remedies

Various parts of medicinal plants were used for the preparation of different remedies, like flowers, leaves, seeds, aerial parts, and whole plants. The most frequently used remedies by the local populations are decoction (38.46%), followed by extracts (15.38%), infusion (11.54%), oil (11.54%), powder (11.54%), juice (3.85), paste (3.85%), and others (3.85%) (Figure 3). Among the genus *Nepeta*, leaves (44.4%) were the most dominant plant part used by the local community, followed by the whole part (25.9%), seeds (14.8%), flowers (7.4%), and aerial part (7.4%) (Figure 2).

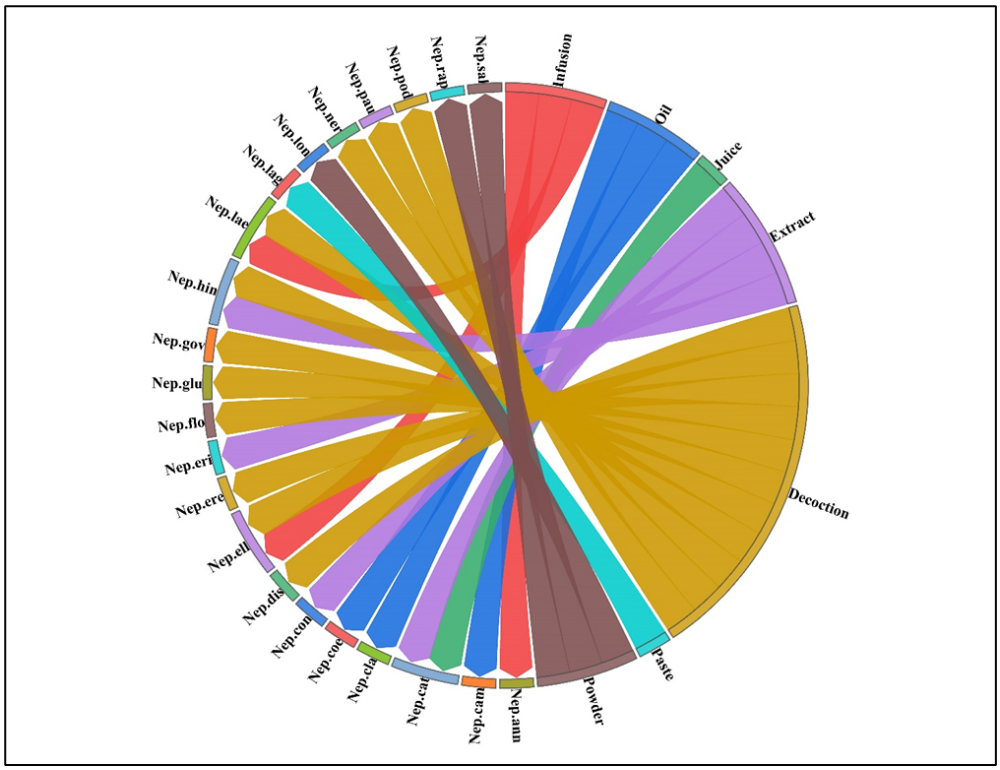

Figure 3. Chord diagram depicting the mode of administration and species used for ethnomedicinal purpose

Ailments Treated

The gathered ethnobotanical data on ailments was classified into nine various categories: Cold and fever (9 remedies), respiratory disorders (8 remedies), digestive disorders (5 remedies), oral, dental, hair, and ENT disorders (4 remedies), nervous system disorders (2 remedies), gynaecological problems (2 remedies), injuries and wound healing (2 remedies), liver and kidney disorders (2 remedies), and joint pain (1 remedy) (Figure 4).

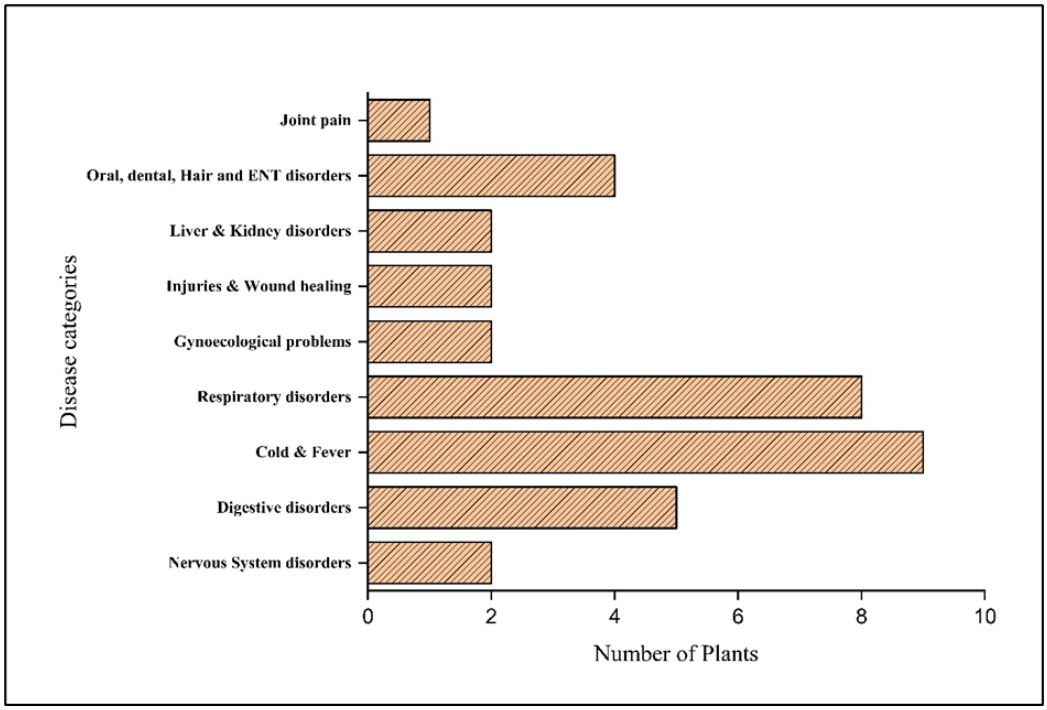

Figure 4. of species are used for treating various ailments

Use Value

Use value (UV) is an important tool for the identification of the most valuable plant species in the region for detailed pharmacological research. The UV of the studied species ranges from 1.62 to 0.23 (Table 2). The highest value of UV was calculated for *Nepeta cataria* (1.62), followed by *Nepeta glutinosa* (1.29), *Nepeta govaniana* (1.23), *Nepeta laevigata* (1.12), *Nepeta hindostana* (0.92), *Nepeta discolor* (0.87), and *Nepeta salviaefolia* (0.86).

Relative Frequency Citation

RFC is a crucial indicator for evaluating the importance of various species in treating various diseases based on how frequently they are referenced by local people. The relative frequency of citations ranged from 0.98 to 0.33 (Table 2). The highest value of RFC was reported for *Nepeta cataria* (0.98), followed by *Nepeta glutinosa* (0.91), *Nepeta salviaefolia* (0.89), *Nepeta laevigata* (0.86), *Nepeta govaniana* (0.85), *Nepeta discolor* (0.82), and *Nepeta eriostachya* (0.77).

Informant Consensus Factor

To develop a consensus among the informants' different ailments reported from the study area, they were classified into nine categories. The informant's consensus factor was determined based on disease categories because single medicinal taxa are used to treat 2 to 3 or more disease groups. The ICF value ranged from 0.89 to 0.67. The highest value of ICF was calculated for the cold and fever category (0.89), whereas the lowest ICF was calculated for the joint pain category (0.67). The codominant categories are respiratory disorders (0.88), digestive disorders (0.82), oral, dental, hair, and ENT disorders (0.80), and gynaecological problems (0.80).

Discussion

Observations

The ethnobotanical documentation results revealed that 22 species of the genus *Nepeta* were used for the cure of diverse ailments by local populations in the division of Muzaffarabad. The *Nepeta* genus belongs to the family Lamiaceae, as the Kashmir region of the western Himalayas is very diverse in terms of floral diversity (Alam *et al.* 2023, Haq *et al.* 2020, Waheed *et al.* 2023a). Lamiaceae, Compositae, Ranunculaceae, Rosaceae, and Poaceae have been reported as dominant families

from the western Himalayas by several other researchers as well (Shaheen *et al.* 2011, Bano *et al.* 2013, Khan *et al.* 2022, Haq *et al.* 2023). The documented genus *Nepeta* is comprised of herbaceous species collected from diverse elevational ranges from 500 to 4500 m. Furthermore, the Lamiaceae family consists of mostly herbaceous vegetation and increases in number due to an increase in elevation (Khan *et al.* 2021, Haq *et al.* 2022a, Haq *et al.*, 2023a). Modern healthcare facilities are unavailable in these areas due to their remoteness, and local populations heavily rely on traditional medicinal systems for primary healthcare purposes (Haq *et al.* 2021, Ibrahim *et al.* 2019). The family Lamiaceae contains a variety of chemicals, including flavonoids, alkaloids, sterols, etc., that are used for the cure of diverse ailments (Kayani *et al.* 2014).

Remedy Preparation and Treatment

Thirty-two remedies were recorded for the cure of various ailments in the study area. The majority of recorded remedies were used for multipurpose diseases. The female informants in the study area have better knowledge about the preparation of remedies as compared to the male informants, who are out of work due to the unavailability of jobs and poverty (Awan *et al.* 2021, Rossato *et al.* 1999, Waheed *et al.* 2022). Local hakeems are only familiar with those medicinal plants that are easily available in the local markets. Among the documented ethnobotanical flora, leaves (44.4%) are the plant parts with the highest usage pattern in the local populations. Due to the presence of chemicals such as alkaloids in the leaves, they can be used as potential pharmaceuticals for healthcare purposes (Haq *et al.* 2021, Arshad *et al.* 2023, Khan & Badshah 2019, Khan *et al.* 2022, Ibrahim *et al.* 2019). A decoction is the most frequently used remedy because local people easily harvest the leaves and then crush them to make medications. The severity of the disease and the age of the patient are the main factors in the duration and dosage of medications, according to the knowledge provided by local informants. Similar kinds of results were reported from different areas, which supports our results (Khan & Badshah 2019, Amjad *et al.* 2020, Asia *et al.* 2019, Rashid *et al.* 2018, Haq *et al.*2023b).

Use Value

The quantitative metrics were applied to the ethnobotanical field data to evaluate the significance of the genus *Nepeta* from the Muzaffarabad division. Use value is a significant ethnobotanical tool that represents the worth of species based on their uses in local communities and also prioritizes the conservation of taxa (Umair *et al.* 2017). Use value also identifies valuable medicinal plant taxa for future research based on UV. In division Muzaffarabad, the highest use value was calculated for *Nepeta cataria* (1.62), followed by *Nepeta glutinosa* (1.29), *Nepeta govaniana* (1.23), *Nepeta laevigata* (1.12), and *Nepeta hindostana* (0.92). The highest use value indicates the multipurpose uses of species in the study area. The high use value of the studied taxa revealed the association and dependency of local communities on the surrounding flora and explored the usage pattern of the surrounding flora for basic healthcare purposes (Khan & Badshah 2019, Kayani *et al.* 2014, Mirzaman *et al.* 2023, Rashid *et al.* 2018, Waheed *et al.* 2023b). Overexploitation of medicinal plants exacerbates immense pressure on local flora wealth, which needs to be conserved efficiently by involving local communities (Shaheen *et al.* 2020, Hill *et al.* 2020, Haq *et al.* 2021, Bahadur *et al.* 2023).

Relative Frequency Citation

Relative frequency citation is a quantitative ethnobotanical tool that is used to determine the importance of a species for the treatment of various ailments as mentioned by the informants (Hussain *et al.*, 2019). The species with the highest value of RFC are *Nepeta cataria* (0.98), followed by *Nepeta glutinosa* (0.91), *Nepeta salviaefolia* (0.89), *Nepeta laevigata* (0.86), *Nepeta govaniana* (0.85), and *Nepeta discolor* (0.82). Higher RFC values indicate that medicinal plants are excessively utilized for primary healthcare purposes, which ultimately leads to threats to the local flora (Ahmad *et al.* 2017, Mukherjee *et al.* 2017, Ibrahim *et al.* 2019, Khan & Badshah 2019). These medicinal plants with RFC values are invaluable for the drug discovery process. Excessive use may result in the extinction of such culturally significant plants in the region. This baseline information may help to comprehend the value of these widely used species in the area and is beneficial to their conservation through an in-depth assessment of vulnerability categorization (Vitalini *et al.* 2013).

Informants' consensus factor

Informants' consensus factor indicates that a single medicinal plant is used for the cure of various ailments. The highest value of ICF was calculated for the cold and fever category (0.89), followed by respiratory disorders (0.88), digestive disorders (0.82), oral, dental, hair, and ENT disorders (0.80), and gynaecological problems (0.80). Cold and fever problems are caused by several factors, such as unhygienic conditions, low temperatures, heavy snowfall, sudden weather changes, and frosting during the winter season (Farooq *et al.* 2019, Murad *et al.* 2013). The second-highest ICF value was calculated for respiratory disorders. Respiratory disorders are also caused by harsh winter conditions, high levels of humidity, air pollution, and abrupt weather circumstances (Dilbar *et al.* 2023, Qaseem *et al.* 2019, Ghorbani *et al.* 2011).

The current study results provide valuable insight into the genus *Nepeta* ethnobotanical uses by the local populations of the division of Muzaffarabad. Local populations are still heavily dependent on medicinal plant resources for basic healthcare management. All the taxa studied were herbaceous and utilized as herbal medicine. In the used part categories, leaves were most frequently used, whereas decoction is the most frequently utilized remedy for the cure of various ailments. The quantitative ethnobotanical metrics showed that *Nepeta cataria* is the most significant species, having the highest values of RFC and UV. While the codominant taxa include *Nepeta glutinosa* and *Nepeta salviaefolia*. Nepeta cataria was reported as the most diverse species among the genus *Nepeta* because it is used for the cure of eight different diseases.

Conclusion

The traditional medical system has been used for a long time for primary healthcare purposes. Current research offers comprehensive insights into the usage pattern of *Nepeta* species in the Muzaffarabad division. This study documented 22 genera of *Nepeta* species through an ethnobotanical survey. These *Nepeta* species were utilized by local communities for the treatment of various ailments. *Nepeta cataria* was calculated as the most important species in the study area. Due to the remoteness and unavailability of modern healthcare facilities, local communities are heavily dependent on these natural resources to sustain their lives in hilly areas. Anthropogenic activities like the over-expropriation and smugling of these medicinal plants put immense pressure on these highly valuable medicinal plants. So, we suggest that the government and forest department prioritize conservation measures for medicinal plants as well as traditional ethnobotanical knowledge to safeguard them 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. The PRA (Participatory rural appraisal) approach mentioned in the Kyoto Protocol (2017) was applied with the consent of the informant.

Consent for Publication: Not applicable.

Availability of data and materials: All data regarding the manuscript is presented in the article.

Competing Interest: The authors declare that they have no conflict of interest regarding this manuscript.

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Authors Contribution: M.M. and M.A conceptualized study. M.M, H.S., and S.W.G. conducted fields and ethnobotanical data collection. M.M., M.Z, and S.W.G. writing the original draft. S.S. and T.M. review and editing. M.A. and M.Z. Supervised the study.

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