Novel medicinal plants uses for the treatment of respiratory disorders - An overview from Madyan Swat, Pakistan

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Research

Abstract

Background: Rural people living in Madyan Valley, Swat, Pakistan, rely extensively on medicinal plants for treating respiratory chest infections, cough, cold, asthma and bronchitis. Therefore, the present aims to identify specific medicinal plants for the treatment of respiratory diseases and analysis of different types of preparation for relieving respiratory ailments.

Methods: Accordingly, men and women were interviewed using medicinal herb data sheets, supplemented with a transect walk. Uses, modes of preparation, storage and collection habitats of individual plants used for treating respiratory disorders were identified and recorded. Medicinal plants' natural habitat provided a platform to further explore the active medicinal properties unknown to the community. Medicinal plant data were quantitatively measured using measurement models such as relative frequency citation (RFC); use value (UV) and fidelity level (FL).

Results: The study recorded fifty-one plant species belonging to 32 families used for relieving respiratory diseases. Lamiaceae was the largest family with six species followed by Asteraceae and Apiaceae. About 30% of women knew the active medicinal properties, compared to 53% of men. The elderly women who had a deeper knowledge of plant remedies dispensed the plants in infusions, decoctions, and syrups; however, the most common form of intake was sundried powder typically administered with water.

Conclusions: Herbal treatments in Northern Pakistan are reliable, inexpensive alternatives for treating respiratory conditions. We recommend appropriate management and the promotion of the cultivation and conservation of medicinal plants. In addition, raising awareness of the importance of medicinal plants for respiratory conditions must be established.

Keywords: Medicinal plants, herbal preparations, respiratory diseases, traditional medicine, Northern Pakistan

Background

Humans have been using plants for different purposes since their earlier settlements, thereby developing a close relationship. Approximately, 35000 to 70000 medicinal plants are used all over the world (Ali and Qaiser, 2009; Shuaib *et al.* 2014) and 70 to 80% of the world population uses traditional medicine for treating various ailments and disease states (Shah

et al. 2016; Hussain *et al*. 2018; Shuaib *et al*. 2018). In developed countries, 25% of the medical drugs are based on plants and their derivatives while in Pakistan, 75% of the population is dependent on traditional medicine (Abbasi *et al*. 2013; Ahmad *et al*. 2014; Bibi *et al*. 2014; Sharif *et al.* 2022). In the last few years, ethnobotany in Pakistan has gained momentum and several studies have been conducted in different parts of the country (Abbasi *et al*. 2013; Ahmad *et al*. 2014; Ullah *et al*. 2013; Bibi *et al*. 2015). Different researchers have reported various uses of medicinal plants from different areas of Pakistan (Abbasi *et al*. 2009; Kayani *et al*. 2014; Kayani *et al*. 2015; Shuaib *et al.* 2021).

The local communities exploit plants for local use as well as for respiratory disorders (Sharif *et al*. 2022; Ullah *et al.* 2021). About 80% population of Pakistan is rural households where medicinal plants are easily available. While the lower financial conditions and unavailability of modern health facilities in rural areas limit the access of local people to synthetic medicines. Moreover, people are aware of the harmful effects of synthetic products and are realizing the importance of a more natural way of life (Said and Saeed, 1996). Respiratory disorders are major health challenges across the globe, and in developing countries, a major cause of sickness both in the elderly and children. In most cases, respiratory disorders particularly those relating to the upper respiratory tract (URT) are characterized by cough and sputum. These symptoms are prevalent and adversely affect the quality of life (Lopes *et al*. 2014; Alamgeer *et al*. 2018). Bussmann and Glenn (2010) documented 91 plant species as herbal respiratory remedies in Northern Peru, out of which 15 species belonged to the Asteraceae family. They described how respiratory disorders were treated successfully using herbal preparations mostly derived from plant leaves, whole plants, flowers and stems. More recently, Lawal *et al*. (2020) compiled and documented an inventory of several wild plant species from the Fabaceae family; local communities in Nigeria use these plant remedies extensively for treating the cough associated with respiratory disorders, a practice that is widespread among these communities.

Throughout Pakistan, rural communities rely extensively on herbal medicine to cure common health problems (Yaseen *et al.* 2019; Rahman *et al.* 2021). The use of medicinal plants in chest infections including cough, cold, asthma and bronchitis is popular throughout the rural regions. For instance, *Allium sativum* is widely used to cure respiratory tract infections, *Aloe barbadensis* is used in cough and asthma, and *Aloe vera* is used as a cough suppressant (Hussain *et al*. 2018; Alamgeer *et al*. 2018; Shinwari & Qaiser 2011). Sher *et al*. (2016) have previously reported that different Pakistani communities use fresh grounded leaves of *Asparagus officinalis* taken orally with water to treat throat infections and other disorders of the respiratory system. Similarly, Shaheen *et al*. (2017a, 2017b) have documented 16 medicinal plant species that are used successfully to relieve various respiratory symptoms. Traditionally all herbal preparations were derived from plants, as either simple forms of various plant parts or complex forms of crude extracts, blends, etc. The primary paybacks of using plant-derived medicines are considered to be relatively harmless than synthetic substitutes, offering profound therapeutic potential.

In many parts of the world, herbal remedies for the treatment of respiratory disorders are common practice. Similarly, respiratory disorders are common in the study area due to their remoteness, cold and harsh climatic conditions as well as limited healthcare facilities. The people of the area depend on the indigenous plant resources to treat various respiratory diseases such as lung disorders, pleural cavity, bronchial tubes, trachea, and upper respiratory tract and of the nerves and muscles to breathe, asthma, bronchitis, common cold, cough and whooping cough (Kayani et al. Numbers of plants with medicinal importance are used to treat respiratory disorders in the area from one generation to another generation, especially by rural populations and forest ethnic communities (Shuaib et al. 2021). For instance, (Younis et al.2018) documented to the extensive use of medicinal plant species for the treatment of respiratory diseases in Pakistan. The authors reported that the high occurrence of cough is treated with 56% of the 384 therapeutic plants used for different respiratory diseases (Assiri, 2018).

Thus, the therapeutic properties of medicinal plants have a significant role to play in the treatment of respiratory conditions. In addition, further investigation should be directed to medicinal plants that relieve the symptoms of the latest threatening respiratory disorders - respiratory syncytial viruses (RSV) and Coronavirus 2019 (COVID-19) that spread easily through droplets, sneezing, or close physical contact. Venu and Austin (2020) for instance, identified that 40 medicinal plants exhibited significant antiviral activities; these can lead to a novel source of treatment and management of respiratory syncytial viruses (RSV) and COVID-19 disorders. The present study aimed to demonstrate that: 1) the medicinal plants of mountain regions of the Madyan Valley offer valuable treatment for respiratory disorders; 2) that medicinal plants need to be further investigated so that reliable and inexpensive herbal treatments can remain available for the communities' healthcare.

Materials and Methods

Geo-ethnography of the Study Area

The study was conducted in eight villages including Madyan, Chail, Bashigram, Shankoo, Tangi, Banda, Tangar, Kwanda of the Madyan Valley, situated in the Northern part of district Swat, Pakistan (Figure 1). It is located at approximately 35°08′24′′ N latitude and 72°32′08′′ E longitude with the river Swat on the Westside and Shangla district on the East, Khwazakhela on the South and Bahrain valley to the North represented specifically by twin sister peaks of Mankyal (Ahmad *et al.* 2014). Based on geo climate along with latitude, altitude and monsoon rains, the study area is considered to be included in a moist temperate zone. The weather of the study area is highly severe in winter with a minimum mean recorded temperature of −2.4°C and December to January being the coldest months, while summer is comparably moderate with a recorded maximum mean temperature of 36.3°C. The total forest cover is over an area of 975 ha, while 2530 ha of wasteland and pastures. The high mountains of Hindu Kush surround the area, partially separated from the rest of the District by Hindu Raj Mountain (Shinwari and Gilani, 2003; Sher *et al*. 2015). The altitude of the study area ranges from 1300 m Madyan Bridge (Soor Pull) to 3505 m in Bashigram Lake. Local people rely heavily on medicinal plant treatment for relieving common ailments. The majority of the people depend on livestock- buffalo, cows, and goats for milk production. Also, farm work practices are being carried out by the people of the study through animals including mules, donkeys, and horses (Table 1). Many inhabitants travel to different cities of Pakistan and to foreign countries (*Dubai, Saudi Arabia, Malaysia*) to earn a living. People in the study area also occupied various government functions; medical doctors, teachers, police officers and government servants.

Figure 1. Map of District Swat. (Source: Forest Department, Swat Pakistan).

Table 1. Ethnicity, source of income, age and illiteracy of respondents

Informants	%	Source of Income	%	Age Group	%
Male	54	Agricultural activities	61	20-40	40
Female	46	Timber cutting	11	41-51	21
Literates	34	Govt. servant	8	52-62	18
Illiterates	66	Work in foreign country	7	> 62	21
		Local business	13		
Ethnic groups	Madyan, Chail: Majo Khel Miangan				
	Bashigram: Akhunkhel				
	Shankoo, Tangi, Banda, Tangar, Kwanda: Tenants and Kohistanis				

Medicinal plants data collection

A multi-disciplinary team including three female members (a field social organizer, a livestock specialist, and a medical herbalist), and three male members (an ethnobotanist, a sociologist, and a homeopathic pharmacist) conducted the study over six months in Madyan, Swat Valley from December 2017 to May 2018.

The questionnaires were devised to identify the knowledge of rural men, women and their immediate families regarding the collection of medicinal plants along with their use in a community. In these areas, women are seldom interviewed, and this was a unique opportunity to investigate their plant knowledge. The medicinal plant database was therefore designed to capture detailed information on specific plant species that women and the community commonly used. The database also provided an opportunity to compare women's knowledge with local men's knowledge (Shaheen *et al*. 2017a; 2017b).
The Forest Department in district Swat provided information on the study area. It was observed that communities in these areas were actively engaged in medicinal plant collection. The team conducted an initial meeting in December 2017 to brainstorm some ideas so that the flaws of the study research design could be identified. All reflections were considered and integrated accordingly. Four strategies were devised: a general meeting with the local communities to introduce the study, interviews with the women with the female team, interviews with the men with the male team, and a local transect walk.

The general meeting was usually held in a local Hujra (*male meeting place*) whenever possible, attended by all team members, male members of the community, resourceful people, occasionally local hakims, collectors and sellers of medicinal plants. Team members introduced their areas of expertise, together with the purpose of the study. Given the cultural aspects, the meeting was important for the overall study as it allowed us to understand the purpose of the study, and subsequently to give their agreement to facilitate the interviews with women.

The female team divided women into two groups and interviewed in places like the women's homes, schools, and from house to house. Wherever possible, household meetings were pre-arranged to interview the women. As it was essential to gain the women's trust, the team provided a brief introduction and the purpose of the study. This encouraged women to talk freely and openly. Questionnaires and medicinal plants data sheets were completed during the interview. Group interviews with the male team were an extension of the general meeting and took place following the departure of the female team members. Medicinal plant data sheets were completed to gain an insight into the provided information. All interviews were conducted following the code of Ethics of the International Society of Ethnobiology, ensuring that prior consent was granted and complied with the American Anthropological Association.

The transect walk took place after the completion of male and female interviews. With the guidance of selected male members of the community, local habitat and availability of locally used medicinal plants were identified. The visual experience enabled the botanical/Latin identification of the plants and the recording of other endemic species and their medicinal properties unknown to the community.

Several plant specimens were collected along with altitudinal gradients and field notes, including the plant habitats, height, flower color and shape of the fruits, were gathered before collection of plant specimens. Geographic coordinates and altitude were recorded with a GPS. In addition, photographs of the plant in their original habitats were also taken. Plant samples were then mounted on standard herbarium sheets and brought to the Herbarium at Swat University (SWAT) for future reference. Specimens were identified with the help of the flora of Pakistan (Nasir and Ali, 1972-1994) and other relevant literature. All specimens were confirmed with identified specimens located in the herbarium (Swat) and scanned pictures were compared with existing specimens in various online virtual herbaria. Plant names were also confirmed from the Flora of Pakistan. During interviews, local people provided useful medicinal information about plants for specific disorders and other uses like food, timber, and fuel. Whenever possible, an audio and visual recording was used to capture the subtleties of the collected data and to gain a deeper understanding of information, so that it may be accurately analyzed.

Local knowledge was quantitatively assessed using various measurements including Use value (UV), relative frequency citation (RFC) and fidelity level (FL). RFC is used to reveal consensus between informants on the uses of local medicinal plants in the area (Ullah *et al.* 2013).

RFC was calculated using the formula: RFC= FC/N (0<RFC<1).

Where FC is the frequency of citation (number of informants who mention the plant species) while N is the total number of informants. Use value is highly significant to measure all possible uses of a species locally without seeing its relative frequency citation (Kayani *et al.* 2014).

UV was determined using the formula of UV= u/n,

where U is the use of a plant to treat diseases and n is the number of informants reporting diverse uses of species.

Similarly, fidelity level is the percentage of informants claiming the uses of a specific plant for the same main use and was calculated according to Alexiades (1996) using the formula FL (%) =Ip/Iux100,

where 'Ip is several use reports cited for a given species for a specific disease category and Iu is a number of use reports cited for a given species. High FL values point to plants for which all use reports referring to the same disease category, while low FL values point to species that are used for different ailments (Musa *et al.* 2011).

Results and Discussion

Medicinal plant diversity and treated ailments

A total of 67 respondents provided data on 51 different plant species used for the relief of respiratory diseases in the traditional system of medicine. Among these, the percentage of male respondents was 54% while 46% were female, 34% were literate and 66% were illiterate. A total of 21% of respondents were above the age of 62, 40% were between the ages of 20 to 40, and 21% were between the ages of 41 to 51, and 18% were between the ages of 52 to 62. Some previous studies reported that the rationale for the high percentage of male informants is that it was considerably simpler to obtain information from males than from women. The Age statistics showed that people between the ages of 60 and 80 are the ones who are most knowledgeable about traditional medicines followed by those with ages between 20-40 years and then 40-60 years (Ullah *et al*. 2023).

The results revealed a total of 51 plant species belonging to 32 families with 255 use reports; all used for respiratory disorders (UR). These included Acoraceae (1 spp) Asteraceae (4 spp) Solanaceae (2 spp) Lamiaceae (6 spp) *Amaryllidaceae* (3 spp) Araceae (1 spp) Asphodelaceae (1 spp) Pteridaceae (1 spp) Apiaceae (4 spp) Ranunculaceae (2 spp) Saxfragaceae (1 spp) Berberidaceae (2 spp) Brassicaceae (1 spp) Ebenaceae (1 spp) Rosaceae (2 Spp) Fumeraceae (1 spp) Geraniaceae (1 spp) Fabaceae (1 spp) Oxilidaceae (1spp) Scropshulariaceae (2 spp) Polygonaceae (1 spp) Anacardiaceae (1 spp) Punicaceae (1 spp), Papaveraceae (1 spp) Platanaceae (1 spp) Taxaceae (1 spp) Liliaceae (1 spp) Valerianaceae (2 spp) Verbenaceae (1 spp) Violaceae (1 spp) Rutaceae (1 spp). Lamiaceae was the largest family with six species considered significantly higher followed by the Asteraceae and Apiaceae family. The remaining families had two or less than two species of ethnobotanical importance (Figure 2). In terms of habitat distribution, as shown in Figure 3, the dominant taxa were herbs (41; 80%) followed by shrubs (6; 11%) and trees (4; 9%).

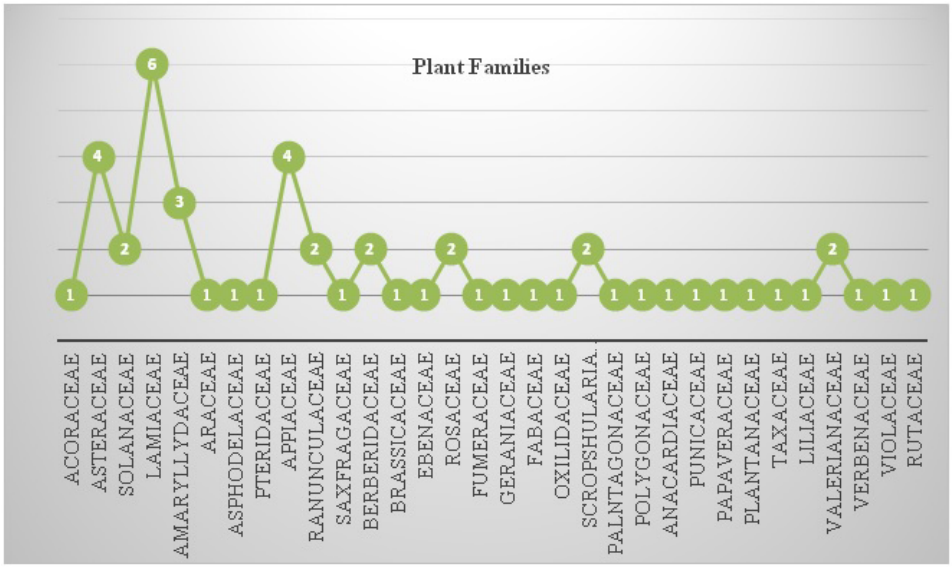

Figure 2. Families of the 51 plants species

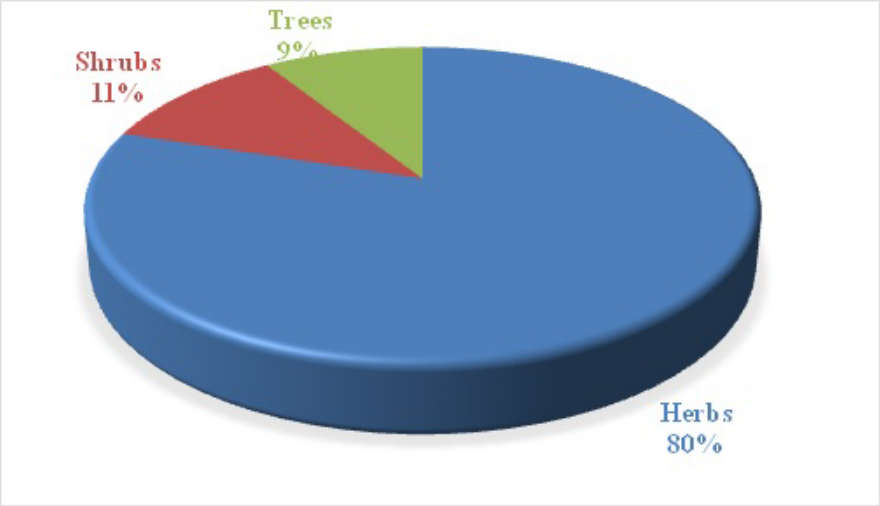

Figure 3. Habitat distribution of the 51 medicinal plant species

The most important species which had 100% fidelity values were *Asparagus officinalis*, *Plantago lanceolata*, *Portulaca oleracea* and *Valeriana jatamansi* (used for fever); *Taxus baccata* and *Vitex negundo* (used for asthma); *Ajuga bracteosa, Allium sativum*, *Bunium persicum*, *Diospyros lotus*, and *Lathyrus apache* (used for cough); *Asphodelus tenuifolius* (for lung infection); *Artemisia scoparia*, *Chenopodium Botrys*, *Geranium wallichianum*, *Isodon rugosus* (used for general respiratory discomfort) and, *Polygonum aviculare* (for throat infection) Plant species like *Rananculus muricatus*, *Oxalis corniculata* and *Fragaria nubicola* possessed 50% fidelity values (Table 2).

The most significant plants were *Mentha longifolia* (UV 0.22), *Trachyspermum ammi* (UV 0.22), *Zanthoxylum armatum* ((UV 0.20), *Allium sativum* (UV 0.19), *Ammi visnaga* (UV 0.19), *Mentha piperita* (UV 0.16), *Papaver somniferum* (UV 0.16) and *Punica granatum* (UV 0.15) as given in Table 3. Local people were found using various parts of medicinal plants, leaves, shoots, roots, fruits, seeds, flowers, bark, bulbs and sometimes the whole plants (Figure 4). The common recipes for medicinal plants were part boiled in water and then used for high fever (*Acorus calamus*), or, washing leaves before boiling in water, soaking it overnight and drunk before breakfast as given in Table 4.

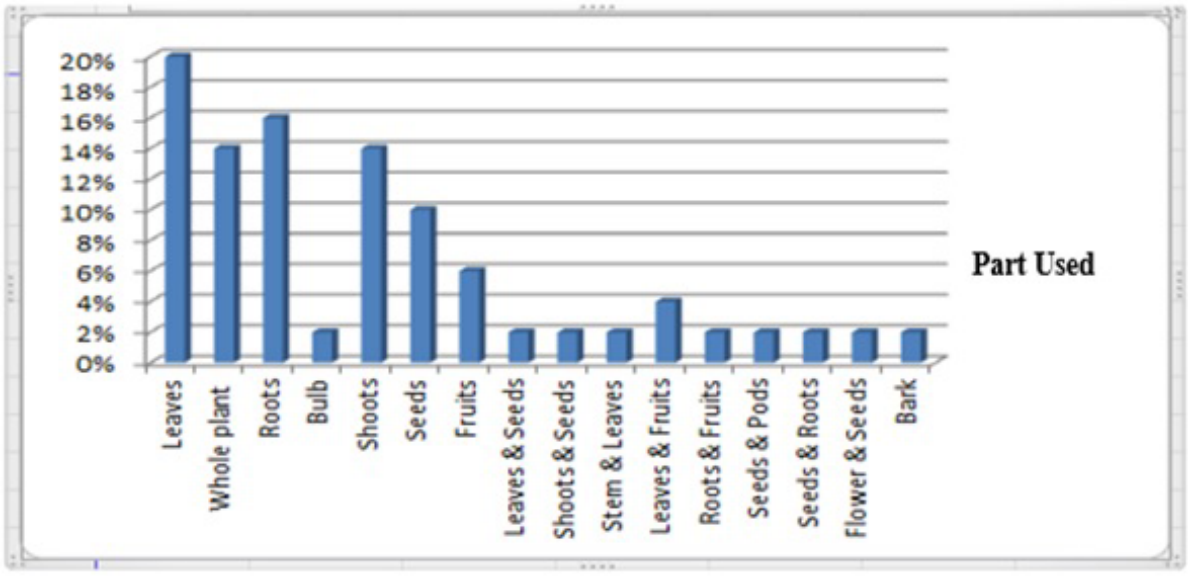

Figure 4. Parts of medicinal plants used in the preparations

Table 2. Medicinal plants for specific disease and Fidelity values.

Disease categories	Plant Name	IP	IU	FL%
Fever	*Acorus calamus* L.	6	10	60
	Atropa acuminata Royle ex Lindl.	5	7	71
	Asparagus officinalis subsp. prostratus (Dumort.) Corb.	1	1	100
	Allium cepa. L	3	5	60
	Nasturtium officinale R.Br.	2	3	67
	Podophyllum hexandrum Royle	3	4	75
	Plantago lanceolata L.	3	3	100
	Portulaca oleracea L.	4	4	100
	Rubus ulmifolius Schott	2	3	67
	Ranunculus muricatus L.	1	2	50
	Valeriana jatamansi Jones	6	6	100
Asthma	*Artemisia biennis* Willd.	5	7	71
	Papaver somniferum L.	9	11	81
	Taxus baccata L.	3	3	100
	Vitex negundo L.	1	1	100
Cough	*Ajuga bracteosa* Wall.	6	6	100
	Allium sativum L.	13	13	100
	Aconitum contortum Finet & Gagnep	2	3	67
	Bunium persicum (Boiss.) B.Fedtsch.	5	5	100
	Diospyros lotus L.	1	1	100
	Foeniculum vulgare Mill.	3	4	75
	Fumaria indica (Hausskn.)	2	3	67
	Lathyrus aphaca L.	3	3	100
	Mentha × piperita L	9	11	81
	Mentha longifolia (L.) L.	12	15	80
	Oxalis corniculata L.	1	2	50
	Trachyspermum ammi (L.) Sprague	13	15	87
	Punica granatum L.	9	10	90
Lung infection	*Arisaema flavum* (Forssk.) Schott	5	6	83
	Asphodelus tenuifolius Cav.	13	13	100
	Ammi visnaga (L.) Lam.	12	13	92
	Micromeria biflora (Buch.-Ham. ex D.Don)	2	3	67
	Fragaria nubicola (Lindl. ex Hook.f.) Lacaita	1	2	50
	Viola pilosa Blume	5	9	56
	Picrorhiza kuroa rolye	1	2	50
	Pistacia chinensis Bunge	2	3	67
Chest pain	*Adiantum incisum* Forssk.	4	5	80
	Berberis lycium Royle	3	4	75
	Brassica camprestris L	1	2	50
	Cichorium intybus L	1	2	50
	Echinops echinatus Roxb.	2	3	67
	Verbascum thapsus L.	2	4	50
Respiratory disorder	*Artemisia scoparia* Waldst.	2	2	100
	Chenopodium botrys L.	3	3	100
	Geranium wallichianum D.Don ex Sweet	7	7	100
	Isodon rugosus (Wall. ex Benth.) Codd	2	2	100
Throat Infection	*Bergenia ciliata* (Haw.) Sternb.	3	4	75
	Urginea indica (Roxb) Kunth	3	4	75
	Polygonum aviculare L.	1	1	100
Sneezing	*Zanthoxylum armatum* DC.	11	14	77

Table 3. Categories of medicinal plants, use report and use values. VSN (Voucher specimen number).

Coll No.	Botanical Name	Plant Family	Local Name	Disease Cured	Habit	(UR)	UV
SS601	*Acorus calamus* L.	Acoraceae	Skhawaja	Fever	Herb	10	0.15
SS602	*Artemisia biennis* Willd.	Asteraceae	Tarkha	Asthma	Herb	7	0.10
SS603	*Atropa acuminata* Royle ex Lindl.	Solanaceae	Bargak	Fever	Herb	10	0.15
SS604	*Ajuga bracteosa* Wall.	Lamiaceae	Bhooty	Cough	Herb	6	0.09
SS605	*Allium sativum* L.	Amaryllidaceae	Uooga	Cough	Herb	13	0.19
SS606	*Arisaema flavum* (Forssk.) Schott	Araceae	Marjaray	Lung Infection	Herb	6	0.09
SS607	*Asphodelus tenuifolius* Cav.	Asphodelaceae	Gra pyaz	Lung Infection	Herb	13	0.19
SS608	*Adiantum incisum* Forssk.	Pteridaceae	Sumbal	Chest Pain	Herb	5	0.07
SS609	*Asparagus officinalis* (subsp. *prostratus* (Dumort.) Corb.	Asparagaceae	Tendorhai	Fever	Herb	1	0.01
SS610	*Artemisia scoparia* Waldst. & Kitam.	Asteraceae	Jawkey	Respirator y disorder	Herb	2	0.03
SS611	*Allium cepa* L.	Amaryllidaceae	Piaz	Fever	Herb	5	0.07
SS612	*Ammi visnaga* (L.) Lam.	Apiaceae	Spiarkia	Lung Infection	Herb	13	0.19
SS613	*Aconitum contortum* Finet & Gagnep	Ranunculaceae	Zahar mora	Cough	Herb	3	0.04
SS614	*Bergenia ciliata* (Haw.) Sternb	Saxifragaceae	Gat Panra	Throat infection	Herb	4	0.06
SS615	*Berberis lycium* Royle	Berberidaceae	Kwaray	Chest Pain	Shrub	4	0.06
SS616	*Brassica campestris* L	Brassicaceae	Sharsham	Chest Pain	Herb	2	0.03
SS617	*Bunium persicum* (Boiss.) B.Fedtsch.	Apiaceae	Thora Zeera	Cough	Herb	5	0.07
SS618	*Brunsvigia rosea* Hann.	Amaryllidaceae	Hann	Fever	Herb	2	0.03
SS619	*Cichorium intybus* L.	Asteraceae	Aspa botay	Chest Pain	Herb	3	0.04
SS620	*Diospyros lotus* L.	Ebenaceae	Toor Amluk	Cough	Tree	1	0.01
SS621	*Echinops echinatus* Roxb.	Asteraceae	Ghana	Chest Pain	Herb	3	0.04
SS622	*Fragaria nubicola* (Lindl. ex Hook.f.) Lacaita	Rosaceae	Zmakin Toot	Lung Infection	Herb	2	0.03
SS623	*Foeniculum vulgare* Mill.	Appiaceae	Kaga Velaney	Cough	Herb	4	0.06
SS624	*Fumaria indica* (Hausskn.)	Fumariceae	Papra	Cough	Herb	3	0.04
SS625	*Geranium wallichianum* D.Don ex Sweet	Geraniaceae	Srazela	Respirator y disorder	Herb	7	0.10
SS626	*Isodon rugosus* (Wall. ex Benth.) Codd	Lamiaceae	Sperkay/k rachai	Respirator y disorder	Shrub	2	0.03
SS627	*Lathyrus aphaca* L.	Fabaceae	Kurkaman ay	Cough	Herb	3	0.04
SS628	*Mentha* × *piperita* L.	Lamiaceae	Podeena	Cough	Herb	11	0.16
SS629	*Mentha longifolia* (L.) L.	Lamiaceae	Velaney	Cough	Herb	15	0.22
SS630	*Micromeria biflora* (Buch.-Ham. ex D.Don)	Lamiaceae	Naria shamakai	Lung Infection	Herb	3	0.04
SS631	*Nasturtium officinale* R.Br.	Brassicaceae	Talmira	Fever	Herb	3	0.04
SS632	*Oxalis corniculata* L.	Oxilidaceae	Manzakee n Tarukay	Cough	Herb	2	0.03

SS633	*Picrorhiza kurroa* Rolye	Scrophulariaceae	Karoo	Lung Infection	Herb	2	0.03
SS634	*Polygonum aviculare* L.	Polygonaceae	Anjabar	Throat infection	Herb	1	0.01
SS635	*Podophyllum emodi* Wall.ex Royle	Berberidaceae	Bankakri	Fever	Herb	4	0.06
SS636	*Pistacia chinensis* Bunge	Anacardiaceae	Shnia/Kakrasingi	Lung Infection	Tree	3	0.04
SS637	*Punica granatum* L.	Punicaceae	Narsaway	Cough	Shrub	10	0.15
SS638	*Plantago lanceolata* L.	Plantaginaceae	Ugda Jabia	Fever	Herb	3	0.04
SS639	*Platanus orientalis* L.	Plantaginaceae	Chinar	Fever	Tree	4	0.06
SS640	*Papaver somniferum* L.	Papaveraceae	Qash Qash	Asthma	Herb	11	0.16
SS641	*Rubus ulmifolius* Schott	Rosaceae	Karwara	Fever	Shrub	3	0.04
SS642	*Ranunculus muricatus* L.	Ranunculaceae	Ziarh Gulay	Fever	Herb	2	0.03
SS643	*Taxus baccata* L.	Taxaceae	Banhya	Asthma	Tree	3	0.04
SS644	*Trachyspermum ammi* (L.) Sprague	Apiaceae	Ghra sperkai	Cough	Herb	15	0.22
SS645	*Urginea indica* (Roxb.) Kunth	Liliaceae	Jangali piaz	Throat infection	Herb	4	0.06
SS646	*Valeriana jatamansi* Jones	Valerianaceae	Shingatai	Fever	Herb	2	0.03
SS647	*Vitex negundo* L.	Verbenaceae	Marwandai	Asthma	Herb	1	0.01
SS648	*Viola pilosa* Blume	Violaceae	Banafsha	Lung Infection	Shrub	9	0.13
SS649	*Valeriana jatamansi* Jones	Valerianaceae	Mushk-e-bala	Fever	Herb	6	0.09
SS650	*Verbascum thapsus* L.	Scrophulariaceae	Kharghwag	Chest Pain	Herb	4	0.06
SS651	*Zanthoxylum armatum* DC.	Rutaceae	Dambara	Sneezing	Shrub	14	0.20

Table 4. Medicinal plants, local name, part used and modes of preparation

Botanical Name	**Local Name**	**Part of plant use**	**Ailments**	**Mode of preparation**
Acorus calamus L.	Skhawaja	Leaves	Fever	Leaves are boiled in water and left-over night, drunk before breakfast
Artemisia biennis Willd.	Tarkha	Whole plant	Asthma	Powdered roots, leaves and floral parts are taken with milk twice daily
Atropa acuminata Royle ex Lindl.	Bargak	Roots	Fever	Dried powdered roots are grounded, and mixed with butter oils and taken with milk
Ajuga bracteosa Wall.	Bhooty	Whole plant	Cough	Leaves and young shoots are boiled in water and drunk
Allium sativum L.	Uooga	Whole plant	Cough	Leaves are boiled in water and decoction is used thrice a day
Arisaema flavum (Forssk.) Schott	Marjaray	Roots	Lung infection	Roots are boiled in water and extract is used
Asphodelus tenuifolius Cav.	Gra pyaz	Bulb	Lung infection	Bulbs are boiled and decoction taken twice a day
Adiantum incisum Forssk.	Sumbal	Leaves	Chest Pain	Dried leaves boiled in water and drunk

Asparagus officinalis subsp. *prostratus* (Dumort.) Corb.	Tendorhai	Whole plant	Fever	Powdered roots are mixed with sugar and taken with milk
Artemisia scoparia Waldst. & Kitam.	Jawkey	Shoot	Respiratory disorders	Boiled in water at night and used in the morning
Allium cepa L.	Piaz	Whole plant	Fever	Dried leaves grounded to a powder and taken orally
Ammi visnaga (L.) Lam.	Spiarkia	Seeds	Lung infection	Seeds are boiled in water with sugar and used to alleviate respiratory disease.
Aconitum contortum Finet & Gagnep	Zahar mora	Roots	Cough	The dried pulverized roots are mixed with butter oil and taken orally.
Bergenia ciliata (Haw) Sternb.	Gat Panra	Root	Throat infection	Powdered roots are mixed with sugar and used with milk.
Berberis lycium Royle	Kwaray	Root	Chest pain	Dried ground roots are taken orally
Brassica camprestris L	Sharsham	leaves/ seeds	Chest pain	Fresh leaves and young shoots are taken thrice a day to treat the condition
Bunium persicum (Boiss.) B.Fedtsch.	Thora Zeera	Seeds	Cough	Seeds are boiled and decoction is used twice a day
Brunsvigia rosea Hann.	Hann	Leaves	Fever	Leaves are boiled in water and decoction is taken thrice a day
Cichorium intybus L	Aspa botay	Leaves	Chest pain	Leaves are boiled in water and used twice a day
Diospyros lotus L.	Toor Amluk	Fruit	Cough	Fresh fruit is mixed with honey and decoctions are taken twice daily
Echinops echinatus Roxb.	Ghana	Leaves	Chest pain	Fresh leaves are taken to cure the disorder
Fragaria nubicola (Lindl. ex Hook.f.) Lacaita	Zmakin Toot	Shoots	Lung infection	Young shoots' paste is used
Foeniculum vulgare Mill.	Kaga Velaney	Seeds	Cough	Seeds are taken directly with water
Fumaria indica (Hausskn.)	Papra	Leaves	Cough	Dried grounded rhizomes into powder are cooked and taken once in a day
Geranium wallichianum D.Don ex Sweet	Srazela	Roots	Respiratory disorder	Fresh and ground leaves are boiled in water and drunk
Isodon rugosus (Wall. ex Benth.) Codd	Sperkay/kra chai	Shoot & seed	Respiratory disorder	Boiled in water with add sugar used at nighttime
Lathyrus aphaca L.	Kurkamana y	Seeds	Cough	Boiled in water to cure cough
Mentha × *piperita* L.	Podeena	Shoots	Cough	Boiled in water with added sugar used at nighttime
Mentha longifolia (L.) L.	Velaney	Shoot	Cough	Stem and leaves are chewed, and juices boiled in water & drunk to cure respiratory disease
Micromeria biflora (Buch.-Ham. ex D.Don) Benth	Naria shamakai	Stem, leaves	Lung infection	Diabetic patients chew the leaves are to decrease sugar level
Nasturtium officinale R.Br.	Talmira	Shoot	Fever	Dried shoots are boiled and used to cure disorder
Oxalis corniculata L.	Manzakeen tarukey	Whole plant	Cough	Dried shoots are boiled and then used to cure disorder
Picrorhiza kuroa rolye	Karoo	Roots/F ruit	Lung infection	Fruit are roasted in mustard oil, and grounded
Polygonum aviculare L.	Anjabar	Leaves	Throat infection	Fresh ground leaves are taken orally, Fruits are boiled in a decoction

Podophyllum hexandrum Royle	Bankakri	Leaves	Fever	Extract is mixed with sugar
Pistacia chinensis Bunge	Shnia/Kakra singi	Fruit	Lung infection	Fruits are boiled in water. Extract used mixed with sugar
Punica granatum L.	Narsaway	Leaves/ fruit	Cough	Dried fruit are grounded to powder and taken orally
Plantago lanceolata L.	Ugda Jabia	Leaves	Fever	Boiled in water at night and used at morning to cure fever
Platanus orientalis L.	Chinar	Bark	Fever	Bark is boiled in water and drunk
Papaver somniferum L.	Qash Qash	seeds/p ods	Asthma	Pods or seeds are boiled in water. Extract is mixed with sugar
Rubus ulmifolius Schott	Karwara	leaves/f ruit	Fever	Boiled in water at night and used in the morning
Ranunculus muricatus L.	Ziarh Gulay	Flower	Fever	Extracts from flower are used to cure disease
Taxus baccata L..	Banhya	Leaves	Asthma	Dried leaves then boiled in water, filtered and extract is used orally
Trachyspermum ammi (L.) Sprague	Ghra sperkai	Shoot	Cough	Leaves are boiled in water, filtered and extract is used orally
Urginea indica (Roxb.) Kunth i	Jangali piaz	Whole plant	Throat infection	Leaves are boiled in decoction and used to cure throat &lung infection
Valeriana jatamansi Jones	Shingatai	Seeds/r oots	Fever	Decoction of seeds is taken orally
Vitex negundo L.	Marwandai	Roots	Asthma	Roots are grounded and mixed with wheat flour and butter oil
Viola pilosa Blume	Banafsha	Shoot	Lung infection	Leaves are boiled in water, filtered and extract is use orally
Valeriana jatamansi Jones	Mushk-e-bala	Roots	Fever	Roots are boiled in water and extract is used to cure disease
Verbascum thapsus L.	Kharghwag	Flower & seed	Chest pain	Seeds decoction taken orally

Discussion

People living in Madyan Valley are historically dependent on medicinal plants found in the region for treating various health problems. They have a strong tradition of ethno-medicine and for earning an income (Sher *et al*. 2015). The data for treating respiratory diseases with medicinal plants were gathered from the local women and men and the elderly, experienced in herbal home care. We documented the ethnobotanical knowledge of local people and showed that a total of 51 plant species belonging to 32 families had 255 use reports which were used specifically for the treatment of respiratory disorders. We also consulted traditional herbal medicine practitioners and local herbal traders; in consultation with the current literature. The respondents reported medicinal plants that were used for different purposes and treating different ailments.

The therapeutic properties of medicinal plants in this study confirmed the work of other researchers. For instance, Khan *et al*. (2014) recorded similar observations of the species *Cichorium intybus* and found similar therapeutic applications for chest pains. We also identified that *Verbascum thapsus* was used for chest pain and showed similar results to those reported by Shinwari *et al*. (2011). Our results shows that *Acorus calamus, Ammi visnaga Atropa acuminata* were used for lung infections as Ahmad *et al*. (2014) reported. Our study also highlighted that *Artemisia scoparia, Allium cepa, Cichorium intybus*, *Adiantum incisum* and *Berberis lycium* were used for asthma, cough, and chest pain respectively, as previously reported in Alamgir *et al*. (2018). We also found that *Acorus calamus, Ammi visnaga*, *Ajuga bracteosa*, *Arisaema flavum, Artemisia scoparia, Berberis lyceum, Mentha piperita, Nasturtium officinale* and *Mentha longifolia* were effective in relieving lung infection, asthma, fever, chest pain and cough as reported previously (Ibrar *et al*. 2007; Ali and Qaiser,2009; Sher *et al*. 2013, 2016; Shuaib *et al.* 2019). In addition, our study confirmed the findings of Khan *et al*. (2014) who reported that *Foeniculum vulgare* was used for a lung infection and *Micromeria biflora* for treating cough. Our study also showed that besides respiratory disorders, leaves were also used for treating other ailments including heart problems, and joint and back pain.

In addition, we identified that women relied extensively on traditional medicine. However, it was observed that men possessed greater knowledge of medicinal plants (51%) than women (29%). This is unlike the High Atlas of Morocco where women had a higher medicinal plant knowledge compared to men (Montanari and Teixidor-Toneu, 2020) and more generally across Morocco (Abouri *et al.* 2012; Fakchich and Elachouri, 2014). This may be partly due to cultural norms as men mostly operate outside the household in the studied area. Further, women administered herbal preparations to both adults and children. The elderly and children received particular plants suited to their specific age and ailments. Medicinal plants in the study area were found effective for treating various ailments as previously reported in Ahmad *et al.* (2013). Women diagnosed with ailments included diarrhea, skin infections, bites, dysmenorrheal pain (period pain), arthralgia (joint pain) with ease, using rudimentary techniques, based on "cold" or "heat" in the body. However, preparations of medicinal plants were unsophisticated, the place and type of storage for medicinal plants varied, using poor techniques such as non-airtight containers and storage in partial sunlight. Women dispensed the plants in the forms of infusions, decoctions, and syrups; however, the most typical method was swallowing the dried powdered plant with water. Cultivation and marketing were not a priority for the women throughout the study. Further, older women of the community were more knowledgeable than the younger generations. In Northern Pakistan as in other developing countries, traditional knowledge and cultural diversity are increasingly threatened by erosion as many traditional societies are pulled into a globalized economic framework (Geck, 2016; Montanari, 2014; Turner and Turner 2008; Weckmüller *et al*. 2019). In urban Pakistan for instance, the popularity of convenient drugs has grown exponentially over the past few years and approximately 90% of a household budget is spent on synthetic drugs.

Threats and conservation of medicinal plants

We also identified that many medicinal plants are under severe threat of extinction; their number decreasing rapidly due to the ignorance of the local people as discussed in previous studies (Ahmad *et al.* 2014; Hosseini *et al.* 2021; Ajaib *et al.* 2021). Most people and particularly the younger generations are unaware of the vital role of medicinal plants; they are ignorant of their uses for medicinal purposes and of other important functions, they provide provision of food, timber, shelter, and trade. In addition, most people and government officials seem to lack interest in the conservation of medicinal plants, exacerbating further the major biodiversity threats. With these factors in mind, the loss of medicinal plant knowledge in the communities is threatening and urgent measures and initiatives need to be undertaken before the traditional knowledge vanishes completely from the communities. Moreover, effective approaches should be needed to control of human interventions for over-exploitation of medicinally important plants and deforestation. Development of home gardens and protected areas, reforestation and conducting awareness-raising seminars or walks could bring a magnificent change. It is a need of time to employ community-based governmental biodiversity conservation practices for the maintenance of the sustainable use of medicinal plants and their products.

Conclusion

Herbal medicine related to respiratory disorders is vital for local inhabitants living in this part of Northern Pakistan. Equally vital is the ability of local people to self-medicate and sustain alternative forms of treatment in the absence of medical facilities. Given the urgent need for constant access to local medicinal plants for herbal treatment, we recommend that appropriate management for the conservation of plants used for the treatment of respiratory diseases is established. The local government needs to provide educational programs to raise awareness about the importance of medicinal plants discussed in this article. The government also needs to supply the local people with modern technology to promote sustainable cultivation and conservation of medicinal plants for the cure of respiratory diseases. The local government needs to provide alternative sources of fuel so that they do not have to resort to the local biodiversity for their needs.

Declarations

Ethics approval and consent to participate: This study was authorized by the Department of Center for Plant Sciences and Biodiversity, University of Swat, Pakistan. All participants provided oral prior informed consent.

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Author's contribution: Shazia dilbar collected the field data, Hassan Sher, Ahmad Ali supervised this work, Zahid Ullah, Muhammad Shuaib, Saraj Bahadur and Muhammad Yaseen participated in data analysis and the final revision of the manuscript. All the authors approved the final manuscript after revision.

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