

RESEARCH ARTICLE

Medicinal Plant Diversity and Utilization in the Argo District of Badakhshan Province, Afghanistan

Abdul Hallim Majidi¹ 



¹Badakhshan University, Faculty of Education,
Department of Biology,
Fayzabad, Afghanistan

ORCID: A.H.M. 0000-0001-6387-0220

Received: 20.07.2022

Revision Requested: 21.07.2023

Last Revision Received: 12.01.2023

Accepted: 25.01.2023

Published Online: 09.03.2023

Correspondence: Abdul Hallim Majidi
hallimm1@gmail.com

Citation: Majidi, A.H. (2023). Medicinal Plant Diversity and Utilization in the Argo District of Badakhshan Province, Afghanistan. *Turkish Journal of Bioscience and Collections*, Advance Online Publication. <https://doi.org/10.26650/tjbc.1145726>

Abstract

Objective: Plants have long been used for medicinal purposes and to treat various illnesses. Despite the rich potential of the Argo District in the Badakhshan province of Afghanistan, no studies have attempted to study its medicinal plant diversity. This study aims to fill this gap and identify the diversity of medicinal plants in the study area.

Materials and Methods: Field surveys and interviews were conducted between May and October 2021, by using semi-structured questionnaires. 136 informants, from 113 households in 16 villages, were interviewed and respondents were selected randomly. Additionally, transect walks in the field were used to collect medicinal plants in the study area and the collected specimens were stored in the laboratory of Biology Department at Badakhshan University.

Results: The study found 49 medicinal plant species, belonging to 44 genera and 26 families, to have medicinal properties. The largest percentage of herbal plants belonged to the families of Rosaceae 10%, Fabaceae 10%, Asteraceae 8%, Apiaceae 6%, Brassicaceae 6%, and Amaranthaceae 4% in reducing order of frequency of reported use. The highest genera were *Ziziphora* and the lowest genera were *Portulaca*. In terms of habit formation, herbs were the highest percentage at 80%, followed by trees at 14%, and shrubs at 6%. The highest percentage of utilizable plant parts were the leaves (24%), roots (23%), fruits (17%), flowers (14%), seeds (12%), and shoots (10%).

Conclusion: The local people used 49 different species of medicinal plants to treat a variety of ailments, including headaches, dysentery, cough, fever, gastritis, hypertension, diarrhea, anemia, and wounds.

Keywords: Argo district, Medicinal plant diversity, Conservation, Traditional knowledge, Diseases

Introduction

Medicinal plants are a significant source of healthcare and an economic component of biodiversity. Identifying and documenting medicinal plants is important for conservation and sustainable utilization (Rahman *et al.*, 2012). Medicinal plants have been used all over the globe for thousands of years as natural medicines and palliatives. Today, traditional medicine serves as the primary healthcare of 80% of the world's population (Mi & Mach, 2012). Some of the rural population have traditional knowledge of medicinal plants, which is transmitted from generation to generation (Shrestha & Dhillion, 2003). Plants provide people with food, medicines, fodder for livestock, and

also materials for the construction of houses (Hassan *et al.*, 2019; Ishtiaq *et al.*, 2012). Medicinal plants are vital raw materials for the production of traditional and modern medicines (Ali & Alamgir, 2014). Medicinal plants play a significant role in the economic and cultural lives of people around the world (Kamble *et al.*, 2018).

People of the Argo District in Badakhshan province of Afghanistan utilize different medicinal plants to treat various diseases. Humanity has been utilizing plants for medicinal purposes since pre-history. For many centuries, herbs and their derived medicines have played an important role in health and ailments management (Okoye *et al.*, 2014a), and more than 50,000 plant species are utilized for medicinal purposes around the globe, of which nearly

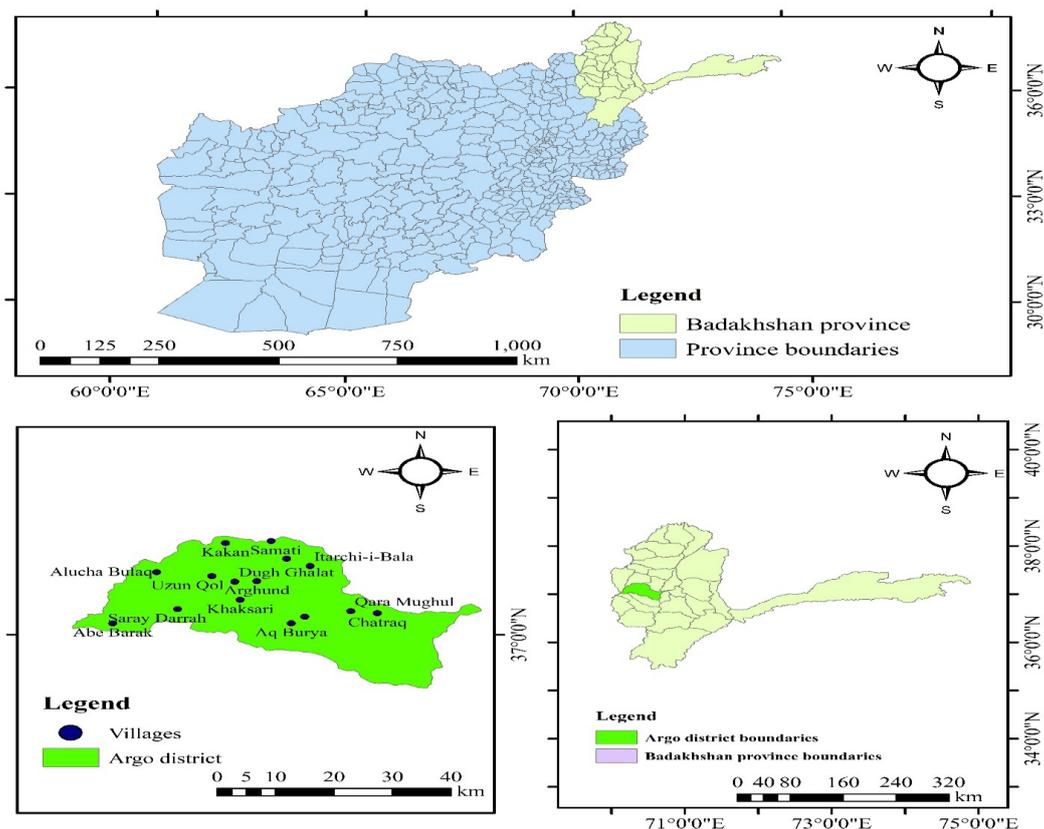


Figure 1. a) Indicates the whole of Afghanistan, b) shows Badakhshan Province and c) implies the exact research area.

13% are flowering plants. Local, national and international interest in medicinal plants has grown in recent years, leading to a rise in demand (Sakkir *et al.*, 2012). Medicinal plant parts (roots, fruits, rhizomes, leaves, flowers, seeds, stem, and bark) can be utilized in different forms such as teas, fresh crude forms, and decoctions, powdered plant material, or extracted forms of medicinal agents (water or juices, extracts, essential oils, tinctures, resins, balsams). Furthermore, medicinal plants can also be significant sources of nutrition as they contain many biologically active substances like essential oils or vitamins (Mi & Mach, 2012). Medicinal plants are harvested from a vast range of plants, which are mostly wild. Certainly, the demand for wild resources has risen day by day (Chen *et al.*, 2016). Medicinal plants and associated traditional knowledge are endangered in the study area. Continued utilization, habitat degradation, and unsustainable harvesting are the main threats to medicinal plants. Traditional knowledge is furthermore hampered by the loss of medicinal plant diversity. Medicinal plants play an important role in the health care and economy of the local people (Okoye *et al.*, 2014b). This study aims to identify the medicinal plant diversity of the Argo District in the Badakhshan province of Afghanistan.

Materials and Methods

Study area

The current study was conducted in Argo District situated in Badakhshan Province, Afghanistan. Argo is one of 28 districts in the Badakhshan Province, and it covers an area of 1031 km² (Fig. 1). Its geographical coordinates are 70°44'6" to 70°6'22"E and 36°52'22" to 37°13'53"N. The area is very rich in medicinal plant species and topographically it is a mountainous region located to the west of the city of Faizabad. The climate of the Argo district is typically a continental interior mountainous region. The winter is characterized by cold temperatures (average 0.52°C), heavy snow and substantial amounts of precipitation (average 5.6). The summers are warm (average 21.67°C) and dry (precipitation 1.07 on average). Spring is a transition period, with increasing temperatures and some rain (NASA, 2021). The dominant plant species in the study area were pistachios, pears, and almonds. Most people in the Argo district are poor, with the majority being farmers, and more than 95% of the population depends on traditional agriculture. The majority of the population is dependent on sheep, goats, and cattle for milk production, and two tribes (Uzbek and Tajik) live in the area. The

agricultural plants in the area are wheat, barley, peas, maize, etc. Overgrazing and unsustainable harvesting of plants are the main deleterious forces causing the loss of medicinal plant diversity.

Materials and Methods

Field surveys and interviews were conducted between May and October 2021, by using semi-structured questionnaires. 136 informants (89 males and 47 females) from 113 households in 16 villages (Itarchi, Afaqi, Taqcha Dara, Samad, Kakan, Qara Kamar, Alocha Bulaq, Uzon Qul, Dugh Ghalat, Khak Sari, Aq burya, Arghund, Sarai Darrah, Qara Mughul, Chatraq, and Ganda Chashma) were interviewed. The respondents were residents of the

region aged 30 to 65 (Ssegawa & Kasenene, 2007; Uddin *et al.*, 1970). The transect walks method was used to collect specimens. Some local people helped with the collection of plant species in the field. The collected specimens were stored in the laboratory of the biology department at Badakhshan University. During the interviews, the author asked the following questions. Which medicinal plant species are found in this area? Which part of the plant do you use? Which diseases do you treat with medicinal plants? Household informants were selected randomly in each village. The head of the household, as well as other knowledgeable adults, were interviewed. In each village, at least six respondents were interviewed. Every plant was recorded according to its local (Uzbek and Dari) names,

Table 1. Documentation of medicinal herbs by scientific name, local name, habit, parts used, and diseases that can be cured.

S. No	Scientific name	Coll. no	Family	L. name	Habit	Part use	Diseases that can be cured
1	<i>Achillea filipendulina</i> Lam	7	Asteraceae	Zarsarak	Herb	Flower	Gastritis
2	<i>Centaurea repens</i> L	13	Asteraceae	Talkha	Herb	Leaf	Fever and Diabetes
3	<i>Alhagi pseudalhagi</i> (M. Bieb.) Desv.	9	Fabaceae	Yantagh	Herb	Shoot, Root	Liver and Stomach ulcers
4	<i>Althaea officinalis</i> L	21	Malvaceae	Gulkhairy	Herb	Leaf, Flower	Kidney stone
5	<i>Amaranthus retroflexus</i> L	41	Amaranthaceae	Taj khoros	Herb	Flower	Intestine infection
6	<i>Anchusa azurea</i> Mill	8	Boraginaceae	Kokmaraz	Herb	Flower	Cough remedy
7	<i>Artemisia absinthium</i> L	38	Asteraceae	Irmashiwaq	Herb	Leaf	Intestine infection
8	<i>Astragalus sieversianus</i> Pall	43	Fabaceae	Pakhtawot	Herb	Fruit	Kidney infection
9	<i>Berberis vulgaris</i> L.	22	Berberidaceae	Zerk	Herb	Root	Indigestion, Traumatic pain
10	<i>Brassica oleracea</i>	47	Brassicaceae	Karam	Herb	Leaf	Hypertension
11	<i>Bunium persicum</i> (Boiss.) B. Fedtsch	39	Apiaceae	Gow zira	Herb	Seed	Stomach aches
12	<i>Biebersteinia multifida</i> DC	23	Biebersteiniaceae	Qantepar	Herb	Root	Hemostatic for post-natal bleeding
13	<i>Capparis spinosa</i> L	14	Capparidaceae	Kawer	Herb	Fruit	Gastrointestinal diseases
14	<i>Capsella bursa-pastoris</i> (L.) Medik	40	Brassicaceae	Mamabiti	Herb	Shoot	Dysentery and Uterine infection
15	<i>Carum carvi</i> L	24	Apiaceae	Zira	Herb	Seed	Dyspepsia and Diuretic
16	<i>Cichorium intybus</i> L	6	Asteraceae	Chachratqi	Herb	Root, Shoot	Fever, Improve digestion
17	<i>Conium maculatum</i> L	48	Apiaceae	Baldirghan	Herb	Seed	Headaches
18	<i>Crataegus songarica</i> K Koch	46	Rosaceae	Dolana sarigh	Tree	Flower, Fruit	Heart pain
19	<i>Crataegus altaica</i> (Loudon) Lange	25	Rosaceae	Dolana	Tree	Flower, Fruit	Heart diseases and laxative
20	<i>Crambe kotschyana</i> Boiss	5	Brassicaceae	Tatron	Herb	Root	Toothache
21	<i>Datura stramonium</i> L	35	Solanaceae	Bangi divana	Herb	Seed	Toothache
22	<i>Descurainia sophia</i> (L.) Webb ex Prantl	15	Brassicaceae	Khawaglan	Herb	Root, Seed	Diarrhea
23	<i>Elaeagnus angustifolia</i> L	33	Elaeagnaceae	Senjed	Tree	Fruit, Root	Wounded skins, Dysentery
24	<i>Ficus johannis</i> Boiss.	26	Moraceae	Anjir	Tree	Fruit, Leaf	Abdominal pains
25	<i>Fumaria officinalis</i> L	32	Fumariaceae	Shatara	Herb	Leaf, Flower	Skin diseases
26	<i>Glycyrrhiza glabra</i> L	4	Fabaceae	Biya	Herb	Root	Stomach diseases
27	<i>Glycyrrhiza uralensis</i> Fisch	7	Fabaceae	Biya qadkota	Herb	Root	Stomach diseases
28	<i>Hordeum vulgare</i> L.	16	Poaceae	Arpa	Herb	Seed	Urinary tract disorders
29	<i>Juglans regia</i> L	45	Juglandaceae	Yanqaq	Tree	Fruit, Leaf	Cardiac, Gum disease
30	<i>Marrubium anisodon</i> K Koch	37	Lamiaceae	Telvateg	Herb	Leaf	Respiratory diseases
31	<i>Morus alba</i> L	44	Moraceae	Toot	Tree	Leaf	Urinary system diseases
32	<i>Peganum harmala</i> L	30	Zygophyllaceae	Ispand	Herb	Leaf	Analgesic for sick person
33	<i>Plantago lanceolata</i> L	3	Plantaginaceae	Zof mida barg	Herb	Root	Gastritis
34	<i>Plantago major</i> L	2	Plantaginaceae	Zof kata barg	Herb	Leaf	Wound, Tumor
35	<i>Polygonum aviculare</i> L	29	Polygonaceae	Tarmaq	Herb	Shoot	Intestinal infection
36	<i>Portulaca oleracea</i> L	17	Portulacaceae	Semiz wit	Herb	Shoot	Dysentery
37	<i>Prunus sogdiana</i> Vassilcz	20	Rosaceae	Alocha	Tree	Fruit	Increase appetite
38	<i>Cullen drupacea</i> (Bunge) C.H. Stirt	18	Fabaceae	Aqourak	Herb	Seed	Skin diseases
39	<i>Ribes nigrum</i> L.	12	Grossulariaceae	Qorakat	Shrub	Leaf, Fruit	Hypertension
40	<i>Punica granatum</i> L	19	Punicaceae	Anar	Tree	Fruit Peel	Diarrhea
41	<i>Rosa canina</i> L	28	Rosaceae	Itburon	Shrub	Leaf, Root	Gastrointestinal diseases
42	<i>Rosa fedtschenkoana</i> Regel	31	Rosaceae	Qara tikan	Shrub	Fruit Root	Cough, Dysentery
43	<i>Rumex confertus</i> Willd	1	Polygonaceae	Shilkha	Herb	Leaf	Diarrhea
44	<i>Spinacia turkestanica</i> Iljin	34	Amaranthaceae	Palak	Herb	Shoot	Anemia
45	<i>Leontodon taraxacum</i> L	42	Asteraceae	Qaquf	Herb	Leaf	Anemia
46	<i>Trichodesma incanum</i> (Bunge) A.DC	36	Boraginaceae	Kampirchpan	Herb	Root	Wounds
47	<i>Ungernia victoris</i> Vved. Ex Artjushenko	49	Amaryllidaceae	Amonqara	Herb	Bulb	Wounds
48	<i>Ziziphora clinopodioides</i> Lam	11	Lamiaceae	Kokwiti chaqili	Herb	Shoot	Hypertension
49	<i>Ziziphora pedicellata</i> Pazij & Vved	10	Lamiaceae	Kokwiti	Herb	Shoot	Hypertension

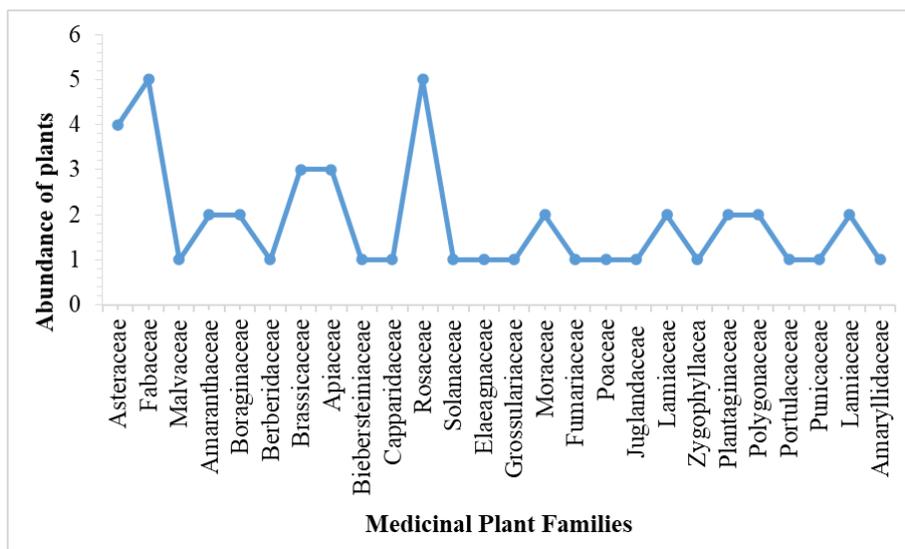


Figure 2. Illustrate plant families utilized as medicine for different ailments

Table 2. Documented genera of medicinal plants

<i>Achillea</i>	<i>Astragalus</i>	<i>Carum</i>	<i>Elaeagnus</i>	<i>Morus</i>	<i>Ribes</i>	<i>Ungernia</i>
<i>Acroptilon</i>	<i>Berberis</i>	<i>Cichorium</i>	<i>Ficus</i>	<i>Peganum</i>	<i>Punica</i>	<i>Ziziphora</i>
<i>Alhagi</i>	<i>Brassica</i>	<i>Conium</i>	<i>Fumaria</i>	<i>Plantago</i>	<i>Rosa</i>	
<i>Althaea</i>	<i>Bunium</i>	<i>Crataegus</i>	<i>Glycyrrhiza</i>	<i>Polygonum</i>	<i>Rumex</i>	
<i>Amaranthus</i>	<i>Biebersteinia</i>	<i>Crambe</i>	<i>Hordeum</i>	<i>Portulaca</i>	<i>Spinacia</i>	
<i>Anchusa</i>	<i>Capparis</i>	<i>Datura</i>	<i>Juglans</i>	<i>Prunus</i>	<i>Taraxacum</i>	
<i>Artemisia</i>	<i>Capsella</i>	<i>Descurainia</i>	<i>Marrubium</i>	<i>Psoralea</i>	<i>Trichodesma</i>	

and samples of the recorded trees, shrubs, and herbs were identified with the help of Medicinal Plants of Central Asia: Uzbekistan, and Kyrgyzstan, and other previous works (Eisenman *et al.*, 2013). According to Jeppesen *et al.* (2012), “the flora of Badakhshan Mountains is in general related to the Tibetan and Central Asian floras”. An herbal shop survey was also carried out. Furthermore, we visited the shops in the city of Faizabad, and the center of Badakhshan province where traditional local healers (hakim) sell herbal medicines. MS. Excel 2013 was used in the analysis.

Result and Discussion

In the study, a total of 49 medicinal plant species belonging to 44 genera and 26 families were identified as having medicinal properties (Table 1). The highest percentage of medicinal plants belonged to the families of Rosaceae (10%), Fabaceae (10%), Asteraceae (8%), Apiaceae (6%), Brassicaceae (6%), Amaranthaceae (4%), and Boraginaceae (4%) in reducing order of frequency of reported utilization (Fig. 2). The percentage of medicinal plant diversity utilized for different ailments is summarized in (Fig. 2). In terms of species, herbaceous plants were

the most abundant source of medicinal plants (80% of all species), followed by trees (14%), and shrubs (6%) (Fig. 3). The study found that 49 plant species have been used by local people to cure 17 diseases such as headache, dysentery, cough, fever, gastritis, hypertension, diarrhea, anemia, wounds, respiratory diseases, skin diseases, and gastrointestinal diseases, etc.

In this study, 136 informants were interviewed. Informants aged 50 and over generally knew medicinal plants better than younger informants. Some informants knew 12 medicinal plant names and utilized them to treat

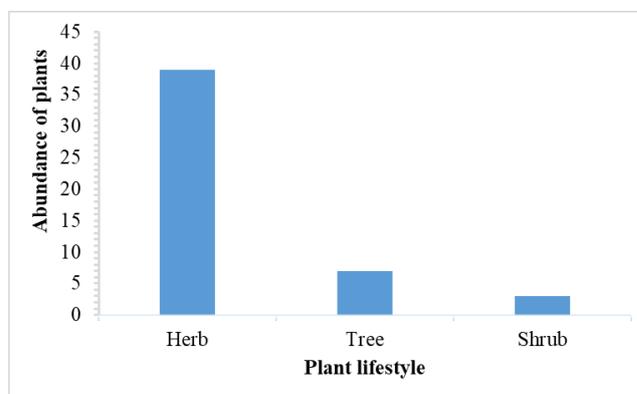


Figure 3. The lifestyle of medicinal plant diversity in the study area.

diseases; several of these plants were specifically utilized to treat gastritis and hypertension. The most mentioned medicinal plants were Ziziphora, Fern-leaf yarrow, Camel's thorn, Caraway, Liquorice, Syrian rue, and figs (Table 1). In this study, the author documented 49 species of medicinal plants belonging to 44 genera (Table 2) and 26 families in the Argo district of Badakhshan Province. The highest genera in the study region were Ziziphora, Crataegus, Glycyrrhiza, Plantago, and Rosa. Other genera have only one species. The majority of the medicinal plant species were found in the district's northern section and along the Kokcha river pathway.

The plant parts utilized for medical preparations were flowers, fruits, leaves, roots, seeds, and bulbs (Fig. 4). In some cases, the whole plant including the roots was utilized. The highest frequently utilized plants part were leaves (24%), roots (23%), fruits (17%), flowers (14%), seeds

(12%), and shoots (10%). Roots generally contain a high concentration of bioactive compounds. It is worth mention that removing roots can have significant detrimental effects on plant regeneration and survival (Shrestha & Dhillon, 2003; Ssegawa & Kasenene, 2007; Uddin *et al.*, 1970).

The majority of those interviewed were familiar with the species' use in the treatment of several ailments such as gastritis, kidney infections, diarrhea, coughs, toothaches, fever, and headaches. Elders and close family friends or locals shared knowledge of the technique of collection, the portions used, and ailments that can be healed. However, other ailments, such as hypertension and abdominal problems, were mainly limited to elders and traditional medical professionals. During the survey, it was found that the Hakims (experts) in the region knew more about medicinal plants. Furthermore, elders, particularly women, are more informed than younger people, and indigenous knowledge about local plant species was passed down orally from one generation to the next. Local people collected medicinal plants mostly for their consumption (70%) followed by commercial purposes (30%) (Mukul *et al.*, 2007; Sher *et al.*, 2020). During the study we visited some herbalist shops in Faizabad city, where they sell hundreds of medicinal plant species, who shared information about tens of medicinal plant species inhabiting the Badakhshan region (Fig. 5).

Similar studies have been done in Afghanistan and other countries. Our outcomes correspond with research that reported that the people of the Shahgram valley in Pakistan's Swat district traditionally utilized 90 medicinal plants, of which (13) plants were utilized for diarrhea, and (11) for gastrointestinal diseases (Hassan *et al.*,

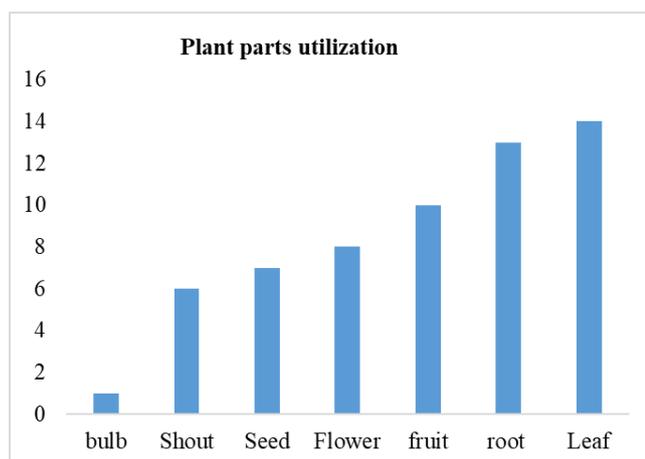


Figure 4. Illustrates medicinal plant parts used in various diseases in the study area.



Figure 5. Displays herbalist shops in Faizabad City

2019); and a survey in the Phulbari Upazila region of Bangladesh that documented a total of 86 medicinal plant species used by the Santal community to treat a variety of diseases (Uddin *et al.*, 1970). Furthermore, our findings agree with those reported by Amini (2017), who recorded 37 (54%) medicinal plants for the treatment of digestive system diseases from 68 medicinal plant species in the Gul dara District of Kabul, Afghanistan. Another study documented that most of the medicinal plant species were found to have more than a single therapeutic utilization. In Southern Uganda, 163 medicinal plants (23.5%) were utilized to treat gastrointestinal diseases, and (0.5%) of the medicinal plant species were utilized for the treatment of cardiovascular, circulatory diseases, and hypertension (Ssegawa & Kasenene, 2007). Another study identified 144 medicinal plant species which are used to treat a total of 49 diseases. The highest numbers of medicinal plant species were recorded to cure coughs and fever (Pandey *et al.*, 2017).

Afghanistan has varied geo-climatic conditions and possesses high medicinal plant diversity, hundreds of which are traditionally utilized. A comparison of medicinal plants in the region shows that the maximum medicinal plants were herbs, followed by trees and the lowest were shrubs (Table 3). Unfortunately, because of the continuous war and conflict, medicinal plant diversity was not surveyed in all provinces of Afghanistan. However, in 1987 it was reported that 215 medicinal plants were utilized traditionally in different regions of Afghanistan (Amini, 2017). Nonetheless, we were unable to collect medicinal plants from all provinces of Afghanistan. Hence, more

Table 3. Comparison table of the medicinal plant used to treat different diseases.

The lifestyle of medicinal plants	Herb	Shrub	Tree	Total
Abundance of plants	39	3	7	49
Diseases treated by medicinal plants				
Stomach and Intestine infection	11	1	-	12
Hypertension	3	1	-	4
Kidney infection	3	-	1	4
Wound and skin diseases	5	-	1	6
Dysentery	2	1	-	3
Toothache	2	-	-	2
Heart diseases	-	-	3	3
Anemia	2	-	-	2
Diarrhea	3	-	1	4
Respiratory diseases	2	-	-	2
Fever	2	-	-	2
Headaches	1	-	-	1
Dyspepsia and diuretic	1	-	-	1
Hemostatic for post-natal bleeding	1	-	-	1
Analgesic for the sick person	1	-	-	1
Increase appetite	-	-	1	1
Total	39	3	7	49

efforts are required to identify and document medicinal plant diversity in Afghanistan. According to some experts, the Badakhshan province in Afghanistan has a vast range of medicinal plants.

In the study area, unsustainable harvest of medicinal plants, overgrazing, and habitat loss are very frequent activities that have a strong negative influence on medicinal plant diversity (Sakkir *et al.*, 2012; Zlatković *et al.*, 2014). Medicinal plants are a natural wealth and their conservation is important for ecological, economic, and scientific reasons. Currently, there are no previous reports on medicinal plant diversity from the northern part of Afghanistan. Therefore, these findings are critical for the conservation of medicinal plant species and future studies on traditional medicine.

Conclusion

In the current study, 49 medicinal plant species from 26 families were identified in the Argo district of Badakhshan Province. Herbs made up 80%, trees 14%, and shrubs 6%. Most of the medicinal plant species were found in the district's northern section and along the Kokcha river pathway. The parts of the medicinal plant utilized as medicine are leaves, roots, shoots, flowers, fruits, and seeds. The study found that 49 plant species have been used by locals in the study areas to treat a variety of ailments such as headaches and toothache, dysentery, cough, fever, gastritis, hypertension, diarrhea, anemia, respiratory diseases, skin diseases and gastrointestinal diseases, etc. However, unsustainable harvesting, overgrazing, and habitat degradation threaten the medicinal plant diversity in the study area.

Acknowledgment: I am thankful to the local people for their help during this study.

Peer Review: Externally peer-reviewed.

Conflict of Interest: The author has no conflict of interest to declare.

Financial Disclosure: The author declared that this study has received no financial support.

References

- Ali, A., & Alamgir, A. (2014). Medicinal plant diversity in Chittagong, Bangladesh : A database of 100 medicinal plant Medicinal plant diversity in Chittagong, Bangladesh : A database of 100 medicinal plants. October.

- Amini, M. H. (2017). Medicinal Plants Used Traditionally in Guldara District of Kabul, Afghanistan. *International Journal of Pharmacognosy and Chinese Medicine*, November. <https://doi.org/10.23880/IPC-16000118>
- Chen, S. L., Yu, H., Luo, H. M., Wu, Q., Li, C. F., & Steinmetz, A. (2016). Conservation and sustainable use of medicinal plants : problems , progress , and prospects. *Chinese Medicine*, 1–10. <https://doi.org/10.1186/s13020-016-0108-7>
- Eisenman, S., Zaurov, D., & Struwe, L. (2013). *Medicinal Plants of Central Asia, Uzbekistan and Kyrgyzstan*. Springer. PP 17-269.
- Hassan, N., Ud, M., Ul, F., Abdullah, I., Zhu, Y., Jinlong, W., Nisar, M., Iqbal, I., Fazal, S., Sajid, S., Irfanullah, S., Naeem, I., Sarwar, A., Ihsan, M., Khan, H., Zeb, U., & Debregeasia, F. (2019). Acta Ecologica Sinica Identi fi cation and quantitative analyses of medicinal plants in Shahgram valley , district swat , Pakistan. *Acta Ecologica Sinica*. <https://doi.org/10.1016/j.chnaes.2019.05.002>
- Ishtiaq, M., Mumtaz, A. S., Hussain, T., & Ghani, A. (2012). Medicinal plant diversity in the flora of Leepa Valley, Muzaffarabad (AJK), Pakistan. *African Journal of Biotechnology*, 11(13), 3087–3098. <https://doi.org/10.5897/AJB11.2711>
- Jeppesen, A., Soelberg, J., & Jäger, A. (2012). Antibacterial and COX-1 Inhibitory Effect of Medicinal Plants from the Pamir Mountains, Afghanistan. *Plants*, 1(2), 74–81. doi:10.3390/plants1020074
- Kamble, M. Y., Mane, S. S., Murugan, C., & Jaisankar, I. (2018). Diversity of Ethno-Medicinal Plants of Tropical Islands – With Special Reference to Andaman and Nicobar Islands. In *Biodiversity and Climate Change Adaptation in Tropical Islands*. Elsevier Inc. <https://doi.org/10.1016/B978-0-12-813064-3/00003-X>
- Mi, L., & Mach, L. (2012). Antioxidant Activity and Protecting Health Effects of Common Medicinal Plants (Vol. 67). <https://doi.org/10.1016/B978-0-12-394598-3.00003-4>
- Mukul, S. A., Uddin, M. B., & Tito, M. R. (2007). Medicinal Plant Diversity and Local Healthcare Among the People Living in and Around a Conservation Area of Northern Bangladesh. *Int. J. For. Usuf. Mngt.*, 8(2), 50–63.
- Okoye, T. C., Uzor, P. F., Onyeto, C. A., & Okereke, E. K. (2014a). 18 Safe African Medicinal Plants for Clinical Studies. In *Toxicological Survey of African Medicinal Plants*. Elsevier Inc. <https://doi.org/10.1016/B978-0-12-800018-2.00018-2>
- Okoye, T. C., Uzor, P. F., Onyeto, C. A., & Okereke, E. K. (2014b). 18 Safe African Medicinal Plants for Clinical Studies. <https://doi.org/10.1016/B978-0-12-800018-2.00018-2>
- Pandey, N. C., Bhatt, D., Arya, D., Chopra, N., Upreti, B. M., Joshi, G. C., & Tewari, L. M. (2017). Diversity of ethno-medicinal plant : A case study of Bageshwar district Uttarakhand. 5(2), 11–24.
- Rahman, M. A., Begum, K., Rashid, M. E., & Harun-Ur-Rashid, M. (2012). Medicinal plant diversity in the flora of Bangladesh and their conservation: 2. A report on ten angiosperm families. *Plant Archives*, 12(2), 1023–1035.
- Sakkir, S., Kabshawi, M., & Mehairbi, M. (2012). Medicinal plants diversity and their conservation status in the United Arab Emirates (UAE). 6(7), 1304–1322. <https://doi.org/10.5897/JMPR11.1412>
- Sher, H., Inamuddin, Khan, Z., Bussmann, R. W., & Rahman, I. U. (2020). Medicinal plant diversity of Hindubag Mountain, Lalku valley, district Swat. *Ethnobotany Research and Applications*, 20, 1–13. <https://doi.org/10.32859/era.20.09.1-13>
- Shrestha, P. M., & Dhillon, S. S. (2003). Medicinal plant diversity and use in the highlands of Dolakha district, Nepal. *Journal of Ethnopharmacology*, 86(1), 81–96. [https://doi.org/10.1016/S0378-8741\(03\)00051-5](https://doi.org/10.1016/S0378-8741(03)00051-5)
- Ssegawa, P., & Kasenene, J. M. (2007). Medicinal plant diversity and uses in the Sango bay area, Southern Uganda. *Journal of Ethnopharmacology*, 113(3), 521–540. <https://doi.org/10.1016/j.jep.2007.07.014>
- Uddin, M. Z., Hassan, M. A., & Sultana, M. (1970). Ethnobotanical survey of medicinal plants in Phulbari Upazila of Dinajpur District, Bangladesh. *Bangladesh Journal of Plant Taxonomy*, 13(1), 63–68. <https://doi.org/10.3329/bjpt.v13i1.596>
- Zlatković, B. K., Bogosavljević, S. S., Radivojević, A. R., & Pavlović, M. A. (2014). Traditional use of the native medicinal plant resource of Mt. Rtanj (Eastern Serbia): Ethnobotanical evaluation and comparison. *Journal of Ethnopharmacology*, 151(1), 704–713. <https://doi.org/10.1016/j.jep.2013.11.037>
- NASA, (2021). https://disc.gsfc.nasa.gov/datasets/FLDAS_NOAH001_G_CA_D_001/summary

