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The Role of Endemic Medicinal Plants in The Self-Sufficiency of Afghanistan's Pharmaceutical Sector

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ABSTRACT

Afghanistan is a mountainous country bordered by arid lands with a unique climate that fosters rich biodiversity. According to current data, Afghanistan is home to approximately 5,000 species of flowering and vascular plants. Of these, 29% are endemic, around 700 species possess medicinal and aromatic properties, and 120 species are commonly used in traditional Afghan medicine. Some of these plants are cultivated, while others, found in the wild, hold potential for domestication. However, years of internal conflict have led to the illegal exploitation and export of these valuable natural resources. To promote sustainable economic growth and strengthen Afghanistan's position within a globalized economy, it is essential to recognize these resources' actual and potential benefits, particularly medicinal plants (MPs). For a primarily agricultural country like Afghanistan, enhancing plant production offers an economic pathway for developing a viable platform for exports at an industrial level. This review highlights key endemic MPs of Afghanistan, underscoring their potential to advance the pharmaceutical sector. Investment in these plants' cultivation and mass production could support the country's economic self-sufficiency. The main objectives of this study are to emphasize the role of endemic MPs in the growth of Afghanistan's pharmaceutical industry and to introduce significant MPs that, with proper cultivation and preservation, could bolster public health and economic stability by attracting attention from relevant officials.

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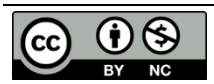

Introduction

Historically, medicinal plants (MPs) have played a significant role in the development of societies, and their use has been prevalent since ancient times and remains so today. Nearly 70% of the population in developing countries directly rely on traditional medicine for primary healthcare (Jeelani et al., 2018; Karunamoorthi et al., 2013). Similarly, industrialized countries indirectly depend on MPs for medicinal products (Farnsworth et al., 1985; Chapman & Chomchalow, 2005). Estimates indicate that 25% of modern medicines and 18% of the 150 most prescribed drugs are derived from herbal sources (Astutik et al., 2019). Incorporating

various MPs into the pharmaceutical, cosmetic, and food industries by domestic and international manufacturers establishes an important foundation for economic development and stability. This is particularly significant in the case of endemic MPs, where scientific research initiatives can further promote their commercial potential.

Afghanistan, a mountainous and landlocked country, possesses a rich diversity of MPs, approximately 29% of which are endemic. These resources are crucial to the country's economic and commercial development (Majidi, 2023). According to available data, agriculture and livestock are vital components of Afghanistan's gross domestic product (GDP) (FAO, 2023), with about 85% of the population engaged in farming. Although most of Afghanistan's domestic production stems from agricultural products, only one-eighth of its land is arable (Agriculture and Forestry, 2023). Afghanistan has a total of 2.5 million hectares of arable land, encompassing 1 million hectares of forests, 0.63 million hectares of grasslands, and 1.4 million hectares of dry croplands (Maletta & Favre, 2003).

Approximately 5,000 species of flowering plants are found in Afghanistan, including 700 species classified as medicinal and aromatic, and currently, 120 species are used in traditional Afghan medicine. Some of these plants, such as garlic, saffron, coriander, and anise, are cultivated, while others, such as licorice, caraway, asafoetida, parsnip, colchicum, and cumin, grow wild but have the potential for domestication. For example, caraway has been successfully domesticated in Herat province, and it is now grown annually (Babury, 2019).

Endemic MPs are a valuable resource for achieving self-sufficiency in various sectors. As a developing nation, Afghanistan's economy primarily relies on domestic products, with agricultural exports accounting for 12% of the country's GDP. Beyond their export value, endemic MPs are essential for Afghanistan's traditional medicine and commercial and industrial self-sufficiency. Many local pharmaceutical companies, striving to reduce reliance on imported pharmaceutical products, heavily depend on endemic MPs due to their accessibility, affordability, and unique properties. However, internal conflicts, political instability, lack of regulatory frameworks, and limited public awareness about the types, importance, and sustainable use of endemic MPs have threatened their populations and diversity, especially for species exploited for illegal export.

Given the importance of Afghanistan's endemic MPs as national assets, their unique value across various industrial sectors, including the pharmaceutical industry, and the exceptional degree of endemism in Afghanistan's flora compared to neighboring countries, a comprehensive study of this flora is both urgent and necessary. This review article explores the significance of endemic MPs in developing Afghanistan's pharmaceutical sector and highlights the main endemic MPs that could contribute to this growth. Investing in their cultivation and large-scale production could enhance economic self-sufficiency. The key objectives of this research are to encourage the use, cultivation, preservation, and application of Afghanistan's highly endemic MPs, raise public awareness, and attract the attention of relevant officials to this valuable resource.

The aims of this study are as follows:

1. To describe the importance of endemic MPs for developing Afghanistan's pharmaceutical sector.
2. To introduce some of the key endemic MPs of Afghanistan that are essential for the growth and self-sufficiency of the country's pharmaceutical industry.

Investigating the Importance of Afghanistan's Geographical Location and Climatic Features on its Flora

Geographical Location

Afghanistan, with a total area of 652,089 square kilometers, is a Central Asian country positioned between 29°30' to 38°39' north latitude and 60°30' to 73°50' east longitude. The landscape is defined by prominent mountain ranges, including the Hindu Kush, Baba Mountain, Tirband Turkestan (featuring peaks like Safidkoh, Siahkoh, Firouzkoh), and Spin Ghar. The country's highest peak, Noshaq, stands at 7,485 meters in the eastern Hindu Kush, while Shah Foladi rises to 5,332 meters in Baba Mountain. The western (Nimroz and Farah deserts) and northern (Laili Desert near the Amu River) regions are marked by vast deserts, deep valleys, elevated plateaus, and mountain basins, such as the fertile valleys of Khodaman and Kabul. This rugged, mountainous topography characterizes Afghanistan as a unique and ancient region (Breckle et al., 2013).

Geologically, Afghanistan is predominantly mountainous, with some regions lying at lower altitudes. In the north, the areas around Faryab and Jawzjan provinces, extending up to the Amu River, range from 300 to 600 meters above sea level. The western region, encompassing the area from the Amu River to the Hindu Kush and around the Helmand River, as well as provinces like Farah, Nimroz, Helmand, and parts of Sistan, along with Nangarhar, generally sits within this altitude range (Humlum, 1959). The central parts of Afghanistan, dominated by the Hindu Kush, rise from west to northeast, where elevations reach 7,000 meters or higher. According to Humlum (1959) and Yelen (1977), the Hindu Kush range stretches from west to east, effectively dividing the country into northern and southern regions.

Climate

The climate of Afghanistan is extremely dry due to the high mountains. The temperature fluctuates in different areas. The temperature at the peak of winter in some areas (Punjab-Bamyan) has been recorded as up to -52 degrees Celsius, and also at the peak of summer heat in some desert areas of the country (Farah and Zaranj-Nimroz) reaches up to +51 degrees Celsius.

In Afghanistan, there are five basic natural units based on topography, which express the amount of rainfall and snow according to geomorphological characteristics. These units include the Hindu Kush mountain, with altitudes higher than 4500 meters with an average

annual rainfall of more than 700 mm; Central regions, with an altitude between 1250-4500 meters and an average annual rainfall of 700-200 mm; North and southwest deserts and semi-desert areas, with altitudes between 500-1250 meters and average annual rainfall of 100-200 mm; Southwest desert areas, with altitudes of 500-1000 meters and average annual rainfall of less than 100 mm; and a low latitude band along the eastern borders, influenced by the summer monsoon rains of the Indian subcontinent, which receive more than 1000 mm of rain per year (Breckle *et al.*, 2010).

Climate Diversity of Afghanistan

Afghanistan has diverse ecological and climatic conditions, which means this country has a very diverse plant flora. In total, the country has four climatic zones, including different regions. The mentioned climatic zones, along with the regions included, are listed below:

- Continental zone: This climatic zone consists of very high areas (Alpine) and includes Nuristan, Badakhshan, Hindu Kush mountains, Herat, Hazarajat, Kabul, Logar, Ghazni, Paktia, Paktika and Parwan.
- Steppic zone: It consists of dry and low slopes including Nimroz, Helmand, Farah, areas surrounding Amu River, Agcheh, Andkhoi, Shurtipe, Hayratan, Rastaq and Dasht Laili.
- Semi-desert zone (Subtropics): includes Nangarhar, Khost, Kandahar and Farah areas.
- The Mediterranean climate includes the far areas and surrounding mountain Spinghar in Nangarhar (World Bank Group, 2021).

Due to its special geographical location and climate diversity, Afghanistan has different species of plants. It is one of the few countries in the world where the most variety and distribution of plants can be observed. Plant diversity in this country is affected by the influence of neighboring countries' climatic conditions. On the other hand, Afghanistan is surrounded by drought and is a very dry land whose resources are completely dependent on rained snowfall in the fall and winter seasons (Clark, 2012).

The documents in hand prove that during more than three decades of insecurity and imposed internal wars, not only our agricultural, industrial, cultural, historical, and social sectors have suffered irreparable damages and injuries, but also natural resources, especially flora of some important MPs, such as species and varieties of *Glycyrrhiza* in the western basin (Shindand-Herat) and the northern parts of the country, species of *Ferula* in the northern and central regions (Baghlan, Samangan, Badakhshan, Bamyan, Ghor), Colchicum, white turmeric, pennyroyal, pistachio and dozens of other medicinal and exportable plants during the years 1372-1382 were being lost and extinct due to improper collection and were placed under the red line (Sharrock *et al.*, 2014). It should be acknowledged that the main reason and factor for the destruction and extinction of these important MPs (national natural resources of the country) is the irrational and non-standard collection of MPs by not observing the

existing laws regarding the protection of the country's forests and grasslands based on indiscriminate exploitation and application of biased foreign policies aimed at destroying Afghanistan's natural resources and national wealth.

Plant Flora of Afghanistan

Afghanistan is mountainous with diverse ecological conditions, allowing for various plants and rich biodiversity. The country's floristic composition is influenced by different neighboring regions, which play a significant role in its plant growth and greenery. Combined with a dry climate and low precipitation, these factors contribute to stark differences in climate across Afghanistan, from the northern regions to the south, east, and west, as well as between low-altitude areas and mountainous regions (Breckle et al., 2013).

One of the most comprehensive early resources on Afghanistan's flora is the *Flora Iranica* by Rechinger, a study that began in 1963 and was completed by 1976, covering approximately 180 plant families (Breckle, 2007). Numerous shorter scientific articles have since been published on the flora in various parts of the country. Detailed studies on Afghanistan's flora were largely conducted before the crisis of Soviet aggression and the subsequent internal conflicts.

Afghanistan is a relatively arid country with a high percentage of desert and semi-desert areas. Yet, it has a significantly higher number of vascular plant species than more humid countries like Germany (Freitag et al., 2010). Groombridge (1992) estimated approximately 3,500 plant species in Afghanistan, with about 30-35% being endemic. New discoveries could add an estimated 5-10% to this total. Researchers predict Afghanistan may ultimately have around 5,000 plant species, with 25-30% being endemic. From a biogeographic perspective, Afghanistan's flora includes elements from the Circumboreal, Holarctic, Central Asian, Himalayan, Irano-Turanian, and Sindhi desert regions. These zones further subdivide into areas like the Pamir, Wakhan, central Afghan mountains, and the western and eastern Hindu Kush (Öztürk et al., 2022).

Humidity and altitude also play significant roles in the country's floral diversity. A small area in the east and southeast experiences monsoon rains from the Indian Ocean, classifying it within a subtropical zone. Altitude affects plant growth across the country, enabling a variety of ecosystems, including arable lands, subtropical zones with water resources, and high-altitude Alpine areas, all of which contribute to the development of a complex and diverse flora (Noroozi et al., 2019).

According to scientific records, Afghanistan's flora includes around 5,000 vascular plants in 1,086 genera and 149 families, including 23 genera and 50 species of pteridophytes, 8 genera and 24 species of gymnosperms, 195 genera and 817 species of monocotyledons, and 860 genera and 3,935 species of dicotyledons (Babury, 2019). Of these species, 1,215 (about 29%) are endemic. Eight main plant families—Asteraceae, Fabaceae, Brassicaceae, Apiaceae, Lamiaceae, Caryophyllaceae, Boraginaceae, and Poaceae—comprise more than half of Afghanistan's plant species (Podlech & Anders, 1977).

Endemism is an important biological term used to define a country's position in terms of its natural resources. A taxon (classification unit of plant or animal) is called endemic when it is not found in any other area of the world except in a certain area or place. Sub-endemism is the existence of plants or animals in a large natural location, mostly in a certain geographic area or environment (Breckle et al., 2013).

The endemism of Afghanistan's plant flora is higher than that of neighboring countries such as Iran, Pakistan, Uzbekistan, Turkmenistan, and Tajikistan (Table 3) (Czudek, 2006). According to the conducted studies, the degree of endemism of the plant flora of Afghanistan is close to that of the important Mediterranean countries such as Greece, Italy, and Egypt and lesser than Turkey, and it emphasizes the opinion of plant genetics and intact natural wealth (Table 1 and 2).

Table 1. Some important plant families with the number of genera, species and the percentage of endemism of the corresponding species in the plant flora of Afghanistan (Breckle et al., 2013).

Plant Families	Number of Genus	Number of Species	Number of Endemic Species	Degree of Endemism
Asteraceae	136	704	239	34%
Fabaceae	54	663	277	41.77%
Brassicaceae	84	253	54	21.34%
Apiaceae	78	214	79	37%
Lamiaceae	47	234	99	42.30%
Caryophyllaceae	32	190	74	38.94%
Boraginaceae	30	147	54	36.7%
Poaceae				Less

Table 2. Endemic genera of plant flora of Afghanistan (Breckle et al., 2010; Breckle et al., 2013).

Plant Families	Number of Endemic Genera	Gener
Apiaceae	5	– *Kandaharia* – *Mostigosciadium* – *Pinocantha* – *Pyromidoptera* – *Registaniella*
Catyophyllaceae	4	– *Kabulianthe* – *Pentastemonodiscus* – *Ochotonophila* – *Scleranthopsis*
Brassicaceae	3	– *Cyphocardamum* – *Pseudodraba* – *Veselskya*
Asteraceae	2	– *Chamaepus* – *Thiarocarpus*
Chenopodiaceae	1	– *Halarchon*
Papaveraceae	1	– *Cryptocapnos*
Plumbaginaceae	1	– *Bukinaczia*

Table 3. Comparing the plant flora of neighboring countries with the plant flora of Afghanistan considering the geographical area (Czudek, 2006; Breckle et al., 2013)

Country	Area (Km^2)	Number of Vascular Plants Taxon	Degree of Endemism (%)	Number of Vascular Plant Species
Afghanistan	652089	5035	24.2	4872
Iran	1640000	8200	23	7000
Pakistan	880254	5700	7.8	5200
Tajikistan	143000	5000	20	4500
Turkmenistan	488100	3000	11.1	2200
Uzbekistan	447400	3700	20	3700

Certain genera and families of flowering plants exhibit high endemism within Afghanistan's flora, as outlined in Tables 4 and 5. In the large family Asteraceae (Compositae), more than 500 species are known, including 100 species of *Artemisia*. The second-largest genus in this family, after *Astragalus*, is *Cousinia*, as referenced in Table 5. In *Flora Iranica*, Rechinger (1972) recorded 355 species of *Cousinia*, of which 61 were newly identified. Of the approximately 144 species of *Cousinia* in Afghanistan's flora, 93 are endemic, with the remaining 198 species found in Iran, 40 in Turkmenistan, 31 in Pakistan, and 21 in Iraq's flora (Amiri et al., 2020).

The Fabaceae family ranks second after Asteraceae, with an estimated 400-500 species, including the genus *Astragalus*, which has the highest species count. The Brassicaceae family (Cruciferae) includes around 250 species, particularly the genus *Brassica*, which has nutritionally valuable plants like cabbage, mustard, and radish. Afghanistan's flora contains over 150 species from the Poaceae family (Graminae), including important agricultural genera such as wheat, rice, sorghum, barley, and sugarcane, as well as herbs like *Agropyron*, *Poa*, *Arundo*, *Cymbopogon*, *Andropogon*, *Festuca*, *Bromus*, and *Stipa*. Additionally, over 180 species in the Lamiaceae family (Labiatae), including *Phlomis*, *Thymus*, *Mentha*, *Nepeta*, *Origanum*, and *Eremostachys*, have been recorded in Afghanistan's flora (Breckle & Rafiqpoor, 2011).

The Apiaceae family (Umbelliferae) contains more than 100 species, many medicinally significant. For example, *Ferula* species, such as *F. asafetida*, are valuable exports unique to Afghanistan and the genus *Dorema*. Similarly, halophyte plants in the Chenopodiaceae family, including *Arthrophytum*, *Halocharis*, *Halostachys*, *Suaeda*, and *Salsola*, are prevalent in Afghanistan's flora. About 13 species from the Orchidaceae family, which thrive in Himalayan regions with Mediterranean climates, are established in Afghanistan. Furthermore, around 35 species from the Iridaceae family are known in Afghanistan's flora. Of the 23 *Eremurus* species documented in *Flora Iranica*, 19 are found in Afghanistan. Likewise, among 34 species of tulips, 17 are present in Afghanistan (Breckle & Rafiqpoor, 2011).

Afghanistan's flora is shaped by human activities, mountainous terrain, and arid desert areas, which maintain a largely natural flora dependent on winter precipitation. Rainfall in the southern regions is irregular, while the northern and eastern regions experience increased rainfall, enhancing plant diversity. In eastern Afghanistan, monsoon rains during summer further contribute to species diversity. Notably, the country's endemic flora may play a significant role in areas like traditional medicine and ethnobotanical use, supporting the growth of Afghanistan's pharmaceutical, food, and cosmetic industries. The country's flora also has economic potential, contributing to genetic diversity, resource sustainability, and ecosystem preservation on both national and global levels (Breckle, 2007).

Badakhshan, located in the Pamirs, is considered one of Eurasia's biodiversity hotspots. Russian research has identified 95 endemic plant species in the Badakhshan region, including 50 in Tajikistan's Badakhshan, 36 in Afghanistan's Badakhshan, and 9 along their shared

border. These plants are not found elsewhere in Afghanistan or Tajikistan. Of these species, 39 are endangered in Tajikistan's Badakhshan and should be included in the relict list, with potential inclusion in Tajikistan's Red List of endangered species. Afghanistan's Badakhshan has 24 endangered species, which should be added to Afghanistan's National Red List (Olonova et al., 2021; Degtjareva et al., 2019).

Table 4 Some genera and families of flowering plants with the highest degree of endemism in the plant flora of Afghanistan (Breckle et al., 2010).

Plant Genus	Plant Family	Number of Plant Species	Number of Endemic/ Semi-Endemic Plants	Remarks
Bunium	Apiaceae	12	5	Essence producing plants
Ferula	Apiaceae	31	18	
Trachyspermum	Apiaceae	7	6	Main source of thymol and carvacrol
Artemisia	Asteraceae	54	10	
Cousinia	Asteraceae	154	121	
Echinops	Asteraceae	17	10	Main source of quinolone alkaloids
Tanacetopsis	Asteraceae	7	6	
Tanacetum	Asteraceae	8	7	
Taraxacum	Asteraceae	59	11	
Arnebia	Asteraceae	17	9	Endemic and semi-endemic
Heliotropium	Boraginaceae	13	5	Endemic and semi-endemic
Mattiastrum	Boraginaceae	14	12	Endemic and semi-endemic
Onosma	Boraginaceae	8	4	
Trichodesma	Boraginaceae	8	5	Endemic and semi-endemic
Erysimum	Brassicaceae	18	10	Endemic and semi-endemic
Lepidium	Brassicaceae	19	6	Endemic and semi-endemic
Mathiola	Brassicaceae	13	8	Endemic and semi-endemic
Acanthophyllum	Caryophyllaceae	34	15	Endemic and semi-endemic
Mesostemme	Caryophyllaceae	6	5	Endemic and semi-endemic
Ochotonophila	Caryophyllaceae	3	3	
Saponaria	Caryophyllaceae	4	2	
Silene	Caryophyllaceae	60	22	Endemic and semi-endemic
Haloxylon	Chenopodiaceae	8	2	
Salsola	Chenopodiaceae			Edible and medicinal
Astragalus	Fabaceae	319	16/154	
Hedysarum	Fabaceae	16	10	Endemic and semi-endemic
Onobrychis	Fabaceae	33	18	Endemic and semi-endemic
Oxytropis	Fabaceae	86	47	Endemic and semi-endemic
Trigonella	Fabaceae	32	17	

Corydalis	Papaveraae	23	8	
Nepeta	Lamiaceae	49	26	Endemic and semi-endemic
Phlomis	Lamiaceae	8	4	
Phlomoides	Lamiaceae	30	22	
Scutellaria	Lamiaceae	22	16	
Salvia	Lamiaceae	25	9	
Dracacephalum	Lamiaceae	10	4	
Acantholimon	Plumbaginaceae	76	65	Endemic and semi-endemic
Dionysia	Primulaceae	12	11	
Aquilegia	Ranunculaceae	9	6	Endemic and semi-endemic
Delphinium	Ranunculaceae	21	11	
Ranunculus	Ranunculaceae	43	9	

Table 5. Families and plant genera with the highest degree of endemism in the plant flora of Afghanistan (Breckle et al., 2013)

Plant Families/Genera	Degree of Endemism (%)	Degree of Semi-endemism (%)	Total Degree of Endemism (%)
Boraginaceae	26.5	13.6	40.1
Lamiaceae	29.3	13.4	42.7
Iridaceae	40.0	5.7	45.7
Plumbaginaceae	66.7	12.9	79.6
Primulaceae	34.9	4.6	39.6
Astragalus	48.8	4.7	53.5
Cousinia	67.5	10.4	77.9

Plant Diversity of Afghanistan

The plant diversity of Afghanistan is in relatively good condition, especially in the eastern areas such as Kunar, Nuristan, and Badakhshan and the slopes of the eastern and western Hindu Kush (Baba mountain, Par and Pamizad) (Shank, 2008). The plant flora of the abovementioned areas is similar to those of countries like India, Italy, Angola, Japan, Azerbaijan, etc. The global plant diversity map shows Afghanistan's plant diversity in blue and indigo lines. The blue line shows 1,500-2,000 and 2,000-3,000 plant species per 10,000 km^2. The plant flora of Afghanistan is richer than that of Germany. Even though in Afghanistan, areas such as Tiure in Ghor, Darvaz in Badakhshan, all over the eastern slopes of the country, valleys in the northwestern regions of Afghanistan (Par and Pamizad) and neighboring mountains of Waziristan (Argun and southern areas) have not been studied and it is expected to discover new species in the mentioned areas (Breckle et al., 2013).

The Importance of Endemic Medicinal Plants in the Development of Afghanistan's Pharmaceutical Sector

Medicinal plants (MPs) are crucial in Afghanistan's pharmaceutical, health, and cosmetic industries. Endemic MPs contain pharmacologically active chemical compounds that can be used directly as medicine or as precursors for synthesizing new medicinal compounds (Sofowora et al., 2013; Bhat, 2021).

Today, a wide range of medicinal compounds derived from MPs, such as cardiac glycosides from *Digitalis* species, anticancer alkaloids like vinblastine and vincristine from *Catharanthus roseus*, taxol from *Taxus baccata*, and antimalarial drugs such as chloroquine and primaquine from quinoline in *Cinchona* species and *Echinops* fruits, have revolutionized modern drug development.

Afghanistan's endemic plants include many aromatic MPs widely used in traditional medicine, cosmetics, and perfumery. These plants could be essential natural resources for Afghanistan's medicinal and aromatic industries (Tewari & Tiwari, 2022).

Notably, in the Apiaceae family, genera such as *Semenovia*, *Torillis*, *Trachyspermum*, *Carum*, *Apium*, *Bunium*, *Cuminum*, *Ferula*, and *Angelica*, as well as in the Lamiaceae family, important genera such as *Origanum*, *Marrubium*, *Melissa*, *Mentha*, *Nepeta*, *Phlomis*, *Dracocephalum*, *Hyssopus*, *Phlomoides*, *Salvia*, *Scutellaria*, *Stachys*, *Thymus*, and *Ziziphora*, are rich in essential oils and oleo gum resins (notably *Ferula* spp.). The Poaceae family includes aromatic plants like *Andropogon* and *Cymbopogon*, valued for their essential oils' high quality and pricing. Additionally, aromatic MPs from the Myrtaceae, Rosaceae, Asteraceae, Rutaceae, Caprifoliaceae, and Elaeagnaceae families may significantly boost Afghanistan's medicinal and economic sectors (Shank, 2008).

In the large Asteraceae family, *Cousinia* is a notable genus with 154 species in Afghanistan's flora, of which 121 are endemic. Phytochemical studies have shown high levels of phenolics, rutin, and rutinoid flavonoids in these plants, which exhibit cytotoxic effects and are used in medical research to treat human liver cancer cells (HepG2) (Pasayeva et al., 2021).

The Fabaceae family is another major family in Afghanistan, notably with the *Astragalus* genus. Globally, *Astragalus* contains 2000-3000 species, of which 319 are found in Afghanistan's flora, with 170 being endemic, reflecting a 54% endemism rate. Chemical analyses of *Astragalus* species have revealed various gums (especially tragacanth), polysaccharides, saponins, flavonoids, simple sugars, and compounds such as caffeic acid, chlorogenic acid, emodin, gentisin, and cytosterol. Many *Astragalus* species have demonstrated anti-inflammatory, immune-enhancing, anti-diabetic, anti-tumor, cardiovascular protective, antioxidant, and anti-aging effects (Bratkov et al., 2016).

In a study by Chinese scientist Mao Xli (2012), it was found that 350 species of the genus *Oxytropis*, another significant genus in the Fabaceae family, are known worldwide. Of these, 150 species are reported in China, with over 80 registered in the northeastern and northwestern regions. In Afghanistan's flora, there are 80 species of *Oxytropis*, of which 47 are endemic or semi-endemic, highlighting its valuable natural wealth (Breckle et al., 2013). Scientific explorations have identified over 127 chemical compounds in these plants, including flavonoids, alkaloids, saponins, and lignans, many of which are used in traditional medicine to treat colds, inflammation, swelling, boils, pain, and various forms of bleeding. Additionally, these plants are effective for tumor treatment and prevention and have notable

anti-inflammatory, antiseptic, neuro-endocrine system support, and homeostasis properties (Rehman et al., 2017).

Conclusion

Afghanistan's flora comprises approximately 5,000 vascular and flowering plant species, with around 29% being endemic or semi-endemic. This level of endemism is higher than in neighboring countries such as Iran, Pakistan, Uzbekistan, Turkmenistan, and Tajikistan and is comparable to the flora of key Mediterranean countries like Greece, Italy, and Egypt, though lower than Turkey. This high degree of endemism indicates Afghanistan's rich natural heritage and genetic diversity. The flora includes 149 plant families: 11 angiosperm families, 4 gymnosperm families, 28 monocotyledon families, and 108 dicotyledon families. Notably, eight large plant families contain a high number of endemic species: Asteraceae, Fabaceae, Brassicaceae, Apiaceae, Lamiaceae, Caryophyllaceae, Boraginaceae, and Poaceae, which collectively represent over half of the country's plant species. Endemic plants are considered a national treasure, valued across multiple domains. They are essential to Afghanistan's ecosystem and are valuable resources for ethnobotanical studies, traditional medicine, and the development of pharmaceutical, food, and cosmetic industries. Endemic plants also support economic growth, provide employment opportunities, and are key exports for the country.

Endemic plants offer a strong scientific and clinical research foundation, especially for discovering new drugs. Cultivating these plants, particularly medicinal plants (MPs), could generate employment opportunities. Given their unique genetic traits, endemic plants are resilient against harsh environmental conditions and contribute to oxygen production and carbon dioxide absorption, supporting the survival of other organisms. These plants help resolve environmental issues and mitigate climate anomalies by reducing atmospheric pollution. Most endemic plants are free from pesticides and herbicides. Their colorful, fragrant flowers attract pollinators like honey bees, promoting the pollination of edible plants and supporting the beekeeping industry and honey production.

Conflict of Interest: The author(s) declared no conflict of interest.

Recommendations

- Comprehensive national-level studies on endemic plants should be conducted to compile Afghanistan's plant flora. The lack of scientific information has hindered the proper processing of these plants for medicinal and food products, leading to marketing challenges.
- Sustainable use of these plants should be ensured to prevent resource depletion and the extinction of certain plant species.
- To optimize the potential of these resources for Afghanistan's future needs, it is essential to domesticate and cultivate a selection of plants from the country's flora.

- Proper conservation measures should be implemented to prevent the destruction of endemic plants, and unsustainable harvesting practices should be avoided.
- Endemic medicinal plant products should undergo standardized processing to validate their safety and efficacy.
- Comprehensive studies should be conducted to evaluate key endemic MPs' medicinal and economic value.
- Large-scale research projects using modern scientific methods should be launched to domesticate significant endemic plant species.
- The government should implement protective measures to manage endemic plants at risk of extinction and degradation.
- Appropriate resources and organized short-term expert-led training courses are needed to address the lack of suitable collection equipment and trained personnel.
- Access to updated technological, market, and marketing information remains a challenge; necessary steps should be taken to address this.
- Endemic plants should be comprehensively studied at the national level (compilation of the plant flora of Afghanistan). Due to the lack of scientific information about these plants, the processing of their medicinal and food products has not been done properly, leading to problems in their marketing.
- Proper use of these plants should be observed to prevent the reduction of resources and the extinction of certain plant species.
- To optimize the resource capacity of these plants to fulfill the country's future needs, it is necessary to domesticate and cultivate several plants of the country's flora.
- To prevent the extinction and destruction of endemic plants, appropriate protective conditions should be considered, and their non-standard and irrational use should be avoided.
- Endemic medicinal plant products should be processed and standardized to validate their safety and effectiveness.
- The medicinal and economic value of the important endemic MPs should be comprehensively studied and evaluated.
- Large research projects using modern scientific methods should be implemented to domesticate the important species of endemic plants.
- The government should take special relevant measures to manage endemic plants at risk of extinction and destruction.

- The lack of suitable collection equipment and trained personnel is also considered one of the basic challenges, and experts must supervise proper procurements and organize short-term courses.
- Lack of access to the latest technological, market, and marketing information is another obstacle, and necessary measures should be taken to solve it.

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