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ORIGINAL RESEARCH article

The potential of endemic medicinal plants in the central regions of Abyan Governorate, Yemen for sustainable pharmaceutical applications

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Abstract: The potential of endemic medicinal plants in Yemen for sustainable pharmaceutical applications is home to a diverse and unique flora, with a significant proportion of endemic and near-endemic species that are traditionally used in folk medicine. This study documents 16 medicinal plant species from Abyan Governorate, Southeastern Yemen, and analyzes their traditional therapeutic uses and the extent to which they have been phytochemically investigated. The majority of these species are used to treat skin diseases, wounds, and burns. However, the findings indicate that 56.3% of these plants have not yet been studied for their active compounds. The Asclepiadaceae family was the most represented among the studied taxa, yet remains largely chemically unexplored. The study emphasizes the importance of preserving ethnobotanical knowledge and recommends future phytochemical screening and pharmacological validation of under-researched species for sustainable use in pharmaceutical development.

Introduction

Yemen hosts a unique plant diversity characterized by a high rate of endemism. It is rich in endemic and near-endemic species, with an estimated 661 species, of which 456 are endemic to Yemen alone. This accounts for approximately 16.0% of the flora that exists exclusively within the country [1], making Yemen a valuable source for sustainable pharmaceutical research. The population's reliance on traditional medicine rather than pharmaceutical drugs is primarily due to financial constraints [2]. Recent studies have demonstrated a strong relationship between plant-based chemical compounds and the treatment of various diseases including diabetes, cancer, and cardiovascular diseases [3-5]. Furthermore, the growing use of antibiotics has led to antimicrobial resistance, highlighting an urgent need for plant-derived compounds to reduce dependence on antibiotics [6, 7]. Sustainability has become a central focus in modern pharmaceutical research. The development of sustainable medicines requires the responsible use of natural resources, especially medicinal plants, in a manner that ensures environmental protection and economic efficiency [8, 9]. Endemic medicinal plants are considered promising alternatives to synthetic compounds. More than half of the studied endemic plants have not been investigated phytochemically; thus, this study aims to document the traditional uses of endemic and near-endemic medicinal plants and to identify which species have been chemically studied to

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determine their active compounds. This will help establish a database that can later support pharmaceutical industries and promote the sustainable use of natural resources represented by these unique plant species.

Materials and methods

Study area: The study was conducted in the central regions of Abyan Governorate, Southeastern Yemen, including the districts of Al-Wadheea (Al-Wadi), Lawdar, and Mudiyah. Abyan lies approximately 427 km southeast of the capital Sana'a and covers a total area of 16,943 km². According to the 2004 census, the governorate had a population of 433,819, with an annual growth rate of 2.5%. Lawdar and Mudiyah districts cover areas of 2,166 km² and 992 km², respectively [10]. These regions are characterized by semi-arid conditions and support diverse flora, including numerous endemics and near-endemic species.

Data collection: A total of 39 local informants, comprising 29 males and 10 females, with age between 30 and 70 years, participated in the ethnobotanical survey. The informants were chosen based on their traditional knowledge of medicinal plants and included shepherds, housewives, and traditional healers. Ethnobotanical data were collected through semi-structured interviews and questionnaires administered to elderly residents and traditional healers in the central regions of Abyan Governorate. The survey focused on identifying endemic and near-endemic plant species used in traditional medicine, the parts used, methods of preparation, and the diseases treated.

Field work and specimen collection: Field visits were conducted to collect plant specimens and document their traditional uses. The study took place between January and May 2025. The following tools were used: a Canon camera for photographic documentation, scissors for cutting plant parts, plastic bags and newspapers for temporary storage, and a plant press for specimen preservation. Notes were recorded in a field notebook to document local names, methods of use, and the ecological conditions of the plant species.

Plant identification: Collected specimens were dried, pressed, and identified using standard taxonomic references [11-14]: Herbarium comparison was performed when necessary to verify the scientific names and ensure accurate identification.

Data analysis: The documented species were analyzed in terms of taxonomic classification (families and species), endemism status (endemic vs. near-endemic), parts of the plant used for therapeutic uses and whether the species had previously been chemically investigated for active compounds. Quantitative data were calculated as percentages to determine the most commonly used plant parts and the proportion of species studied for their phytochemical properties.

Results

Floristic analysis: A total of 16 endemic and near-endemic plant species were recorded. Some species were endemic to Yemen only, while others were near-endemic to the Arabian Peninsula. These species belonged to six families. The family Asclepiadaceae was dominant, represented by five plant species (31.3%), followed by the family Aloeaceae with four species (25.0%), and Euphorbiaceae with three species (18.8%). The remaining families were each represented by a single species (**Figure 1, Table 1**).

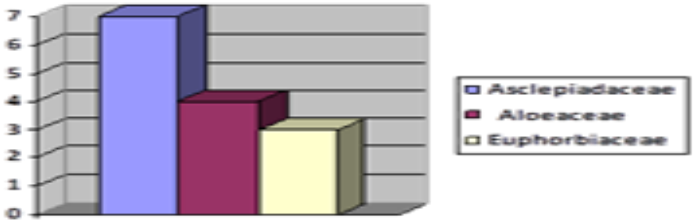

Figure 1: The plant families containing the highest number of endemic species with documented medicinal uses

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Table 1: Documented endemic and near-endemic medicinal plant species in Abyan, Yemen

Family	Scientific name	Plant part used	Traditional use	Phytochemical status
Aloeaceae	*Aloeidendron sabaeum* (Schweinf.) Boatwr & J.C. Manning*	Aqueous extract	Treatment of skin diseases	It has been studied [15]
	Aloe lavranosii Reynolds*	Aqueous extract	Treatment of constipation and burns Treatment of skin diseases	Its active compounds have not been studied
	Aloe vacillans Forssk**	Aqueous extract and dried roots	The dried stems are burned and the smoke is inhaled to treat respiratory disorders, while the sap is used to treat eye inflammations, wounds, burns, and skin blisters	Its active compounds have not been studied
	Aloe lanata T.A. McCoy & Lavranos*	Aqueous extract	Treatment of burns, blisters, and skin diseases	Its active compounds have not been studied
Apocynaceae	*Ceropegia awdeliana* (Deflers) Bruyns	Whole plant	Treatment for diabetes and cancerous diseases	Study by [16]
	Ceropegia deflersiana (Lavranos) Bruyns	Whole plant	Skin diseases	Its active compounds have not been studied
	Cynanchum forskaolianum (Schult) Meve & Liede	Dried Stem	A remedy for respiratory disorders, in which the dried stems are burned and the smoke is inhaled	Its active compounds have not been studied
	Desmidorchis adenensis (Deflers) Meve & Liede	Whole plant	Treatment of burns and skin diseases	Its active compounds have not been studied
	Monolluma hexagona (Lavranos) Meve & Liede	Whole plan	Treatment for burns and worms treatment for diabetes	It has been studied [17]
	Monolluma.quadrangula (Forssk) Plowes	Whole plan	Treatment for diabetes and cancerous diseases	Al-It has been studied [18, 19]
Euphorbiaceae	*Euphorbia inarticulata* Schweinf**	Latex	Skin diseases, wounds, burns	Its active compounds have not been studied
	Euphorbia hadramautica E.G. Baker **	Latex	Treatment for hemorrhoids, used topically	Its active compounds have not been studied
	Euphorbia greuteri N. Kilian, Kürschner & P. He*	Latex	Treatment of wounds and burns	Its active compounds have not been studied
Lamiaceae	*Ocimum forsskaolii* Benth***	Leaves	Skin diseases	It has been studied [20]
Resedaceae	*Reseda sphenocleoides* Defl **	Leaves	Treatment of female infertility	Its active compounds have not been studied
Zygophyllaceae	*Fagonia hadramautica* Beier & Thulin *	Leaves	Treatment of kidney stones	Its active compounds have not been studied

*=Endemic, **=Near endemp

Analysis of plant parts used in traditional medicine: The most commonly used part was the whole plant, accounting for 31.3% of the uses. This may indicate that some plants are utilized in their entirety to achieve the desired therapeutic effect, or because their medicinal properties are distributed throughout all parts of the plant. Equally used parts: The leaves, latex, and aqueous extract were each used at an equal rate of 18.8%, suggesting a balanced significance of these parts in the preparation of traditional medicine (**Table 2**). Least used parts: The aqueous extract with dried roots and the stem were the least used, each at 6.3%.

Table 2: Plant part used

	Plant part used	Number	Percentage
	Whole plant	5	31.25
	Leaves	3	18.75
	Latex	3	18.75
	Aqueous extract	3	18.75
	Aqueous extract and dried roots	1	6.25
	Dried stem	1	6.25

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It was found that 37.5% of the recorded species had previously been studied, while 62.5% remained unstudied (**Table 3, Figure 3**). The most frequently cited uses of the species for disease treatment were as follows: Skin diseases and burns: Treated by more than 10 species. Diabetes: Treated by two species. Respiratory diseases, infertility, kidney disorders, hemorrhoids, and cancer: Each is treated by one to two species.

Table 3: The number of studied and unstudied species

Number of studied and unstudied species	Number	Percentage
Its active compounds have not been studied	11	68.75
It has been studied	6	37.5

Discussion

Floristic analyses revealed the dominance of the Asclepiadaceae family, which aligns with the findings of the previous study cited [21]. However, this differs from the results of the study [21], where the dominant family was reported to be Asteraceae. According to the updated APG IV classification system, the former Asclepiadaceae family is now treated as a subfamily (Asclepiadoideae) under the Apocynaceae family (The Angiosperm Phylogeny Group, 2016). This taxonomic revision has been supported by morphological evidence, as indicated by Madani and others [22]. Moreover, the dominance of the Asclepiadaceae family may reflect not only its environmental abundance but also its widespread reputation in folk medicine for treating various ailments. The region's harsh semi-arid climate may have contributed to the proliferation of xerophytic species rich in active compounds, which calls for further ecological and phytochemical investigations. Interestingly, all species belonging to the Asclepiadaceae family were reported to involve the use of the entire plant, meaning that all parts are utilized. This observation is consistent with the findings of a previous study [23], which suggests that the medicinal value might be distributed throughout the plant in this family. The results indicate that the whole plant is the most commonly used part, which may reflect the widespread presence of active compounds across all parts of the plant. This contrasts with the previous findings, where the leaves were reported as the most frequently used part [24, 25]. As for the least used parts, they were the dried roots and aqueous extracts, in addition to stems, each with a usage rate of 6.3%. This may be attributed to the difficulty of preparation or the limited known therapeutic value of these parts in the studied sample. The high percentage of unstudied species (62.5%) indicates a significant gap in phytochemical and pharmacological research, warranting further studies to identify active constituents that may have future pharmaceutical applications.

Skin diseases and burns were among the most commonly treated conditions, likely due to the ease of topical application. The direct use of latex, sap, or plant pulp is practical and does not require complex preparation. This supports traditional knowledge and the possibility that these plants contain effective compounds with dermatological benefits, such as flavonoids, anthraquinones, tannins, saponins, and essential oils, which are known for their anti-inflammatory, antimicrobial, and wound-healing properties [7, 26, 27]. As for the plant *Monolluma quadrangula* (synonym: *Caralluma quadrangula),* previous studies have indicated its richness in various active compounds, such as triterpenes, flavonoids, and glycosides, which are known for their antioxidant, anti-inflammatory, and anticancer properties [28]. Previous studies revealed the presence of active compounds such as hydroxyoplopan-4-one, dihydroxy-eudesm-4(15)-ene, and rutin (quercetin-rhamno-pyranosyl-D-glucopyranose) [29, 30]. Despite these findings, data on the pharmacological activity of this plant remain limited, necessitating more detailed studies to validate its traditional medical uses, especially in wound healing and infection control. Additionally, the traditional use of *Caralluma quadrangula* in diabetes treatment aligns with scientific evidence [31, 32], which confirmed its efficacy in reducing blood sugar levels in diabetic

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animal models. Regarding *Aloe lanata* and *Aloe vacillans,* two species endemics to Yemen, they have only been studied for their antibacterial activity, without any phytochemical investigations to identify the active compounds responsible for this effect [33]. Therefore, further studies are recommended to isolate and identify these compounds, which could contribute to the development of new antimicrobial agents. It also recommends to validating traditional knowledge through laboratory studies and to collaborating with local healers and research institutions.

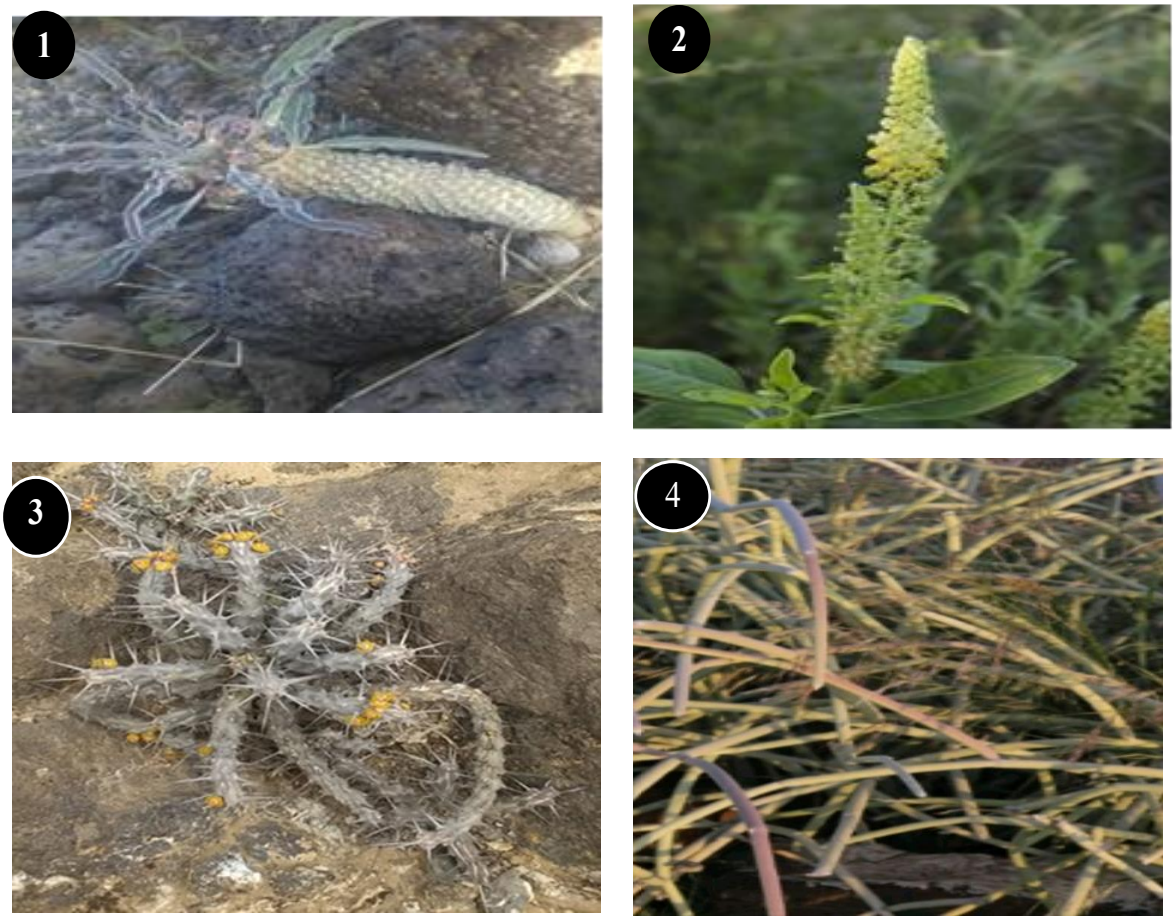

Figure 3: 1-*Euphorbia hadramautica, 2-Reseda sphenocleoide*, *3-Euphorbia greuteri, 4-Desmidorchis adenensis*

Conclusion: This study documented 16 endemic and near-endemic medicinal plant species in Abyan Governorate, highlighting their traditional uses and phytochemical status. A significant portion of the species (56.3%) remains chemically unexamined, indicating a major research gap.

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Author contribution: MAO conceived and designed the study. Both authors contributed to the data collection. MAO conducted the data analysis and interpretation. Both authors jointly drafted and critically reviewed the manuscript for intellectual content. Both authors approved the final version of the manuscript and agreed to be accountable for all aspects of the work.
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Ethical considerations: The authors confirm that all ethical standards were observed throughout the research process, including the avoidance of plagiarism, obtaining informed consent where applicable, and refraining from data fabrication, falsification, duplicate publication, or simultaneous submission.
Data availability statement: The raw data that support the findings of this article are available from the corresponding author upon reasonable request.
Author declarations: The authors confirm that they have followed all relevant ethical guidelines and obtained any required IRB and/or ethics committee approvals.