Indian Journal of Traditional Knowledge
Vol 25(4), April 2026, pp 348-358
DOI: 10.56042/ijtk.v25i4.22987

Ethnobotanical knowledge and phenolic profiles of plants used for hypertension management in the Algerian steppe, North Africa

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Received 22 September 2025; revised 27 March 2026; accepted 03 April 2026

This study explores ethnobotanical practices in the Algerian steppe, focusing on medicinal plants traditionally used to manage hypertension and their phenolic profiles. A survey based on a semi-structured questionnaire was carried out with 250 herbalists to collect socio-demographic and botanical data, and the phenolic profiles of medicinal plants were analyzed. The survey identified 35 plant species distributed across 19 botanical families, with Lamiaceae, Asteraceae, and Apiaceae being the most dominant. The six most frequently cited species were *Allium sativum*, *Thymus algeriensis*, *Laurus nobilis*, *Curcuma longa*, *Coriandrum sativum*, and *Moringa oleifera*. Plant parts used included aerial parts, leaves, seeds, and flowers, with decoction and infusion as primary preparation methods. Phytochemical profiling by HPLC detected 37 phenolic compounds across the six selected species. *Allium sativum* showed the highest content (56.70 µg/g DW), mainly composed of rhamnetin and sinapic acid. *Thymus algeriensis* and *Laurus nobilis* were rich in flavonoids such as kaempferol, catechin, and rutin. *Curcuma longa* displayed curcuminoids, *Coriandrum sativum* contained chlorogenic acid, while *Moringa oleifera* contained chlorogenic acid, catechin, and rutin, revealing distinct species-specific phenolic profiles. These findings emphasize the importance of ethnopharmacological knowledge in hypertension management and offer a scientific basis for future pharmacological and clinical investigations.

Keywords: Bioactive compounds, High blood pressure, Phytotherapy, Phenolic composition, Traditional medicine

IPC Code: Int Cl.[26]: A61K 36/00

Arterial hypertension is a major public health concern, affecting approximately 1.4 billion adults worldwide, particularly in low- and middle-income countries, where access to conventional healthcare is still limited and screening remains insufficient[1]. In these contexts, populations frequently rely on traditional herbal remedies, which underlines the importance of understanding the role of medicinal plants in local healthcare systems[2].

Medicinal plants continue to play an important role in primary care. In North Africa, phytotherapy is still deeply rooted in local cultural practices[3]. The Algerian steppe, characterized by arid and semi-arid conditions, hosts a rich diversity of medicinal plants traditionally used for therapeutic purposes. However, this orally transmitted knowledge is progressively threatened by modernization and declining interest among younger generations[4].

Numerous ethnobotanical studies have reported the use of medicinal plants in hypertension management. Recent research in phytochemistry and pharmacology has shown that many of these plants contain bioactive compounds with potential antihypertensive effects[5]. Moreover, polyphenolic compounds, particularly flavonoids and phenolic acids, may produce vasodilatory effects and inhibit angiotensin-converting enzyme activity, thereby contributing to blood pressure regulation[6].

Despite these advances, hypertension in the Algerian steppe remains poorly documented, as most

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studies are either general in scope, mentioning hypertension among multiple uses, or restricted to specific geographic areas. The present study aimed at documenting medicinal plants traditionally used for hypertension management in the Algerian steppe and to characterize the phenolic profiles of the most frequently cited species, in order to explore their potential ethnopharmacological relevance.

Materials and Methods

Study area

The research was carried out in the Algerian steppe[7], one of the largest steppe regions in North Africa, covering over 20 million hectares (Fig. 1). It forms a transitional zone between coastal Algeria and the Sahara, located between the 400 mm and 100 mm rainfall isohyets. The steppe extends for about 1,000 km, with widths ranging from 300 km in the west and center to less than 150 km in the east. The climate varies from semi-arid in the north to arid in the south. Vegetation is sparse and discontinuous, with more than thirty perennial and ephemeral species that occur seasonally.

Ethnobotanical survey

Field investigations were carried out between 2022 and 2025 in seven provinces: Naâma, El Bayadh, Laghouat, Djelfa, M'Sila, Biskra, and Tebessa. Data collection focused on medicinal plants traditionally used for hypertension. Semi-structured interviews were conducted with 250 herbalists, selected for their role in local phytotherapy. The questionnaire covered two aspects: (i) socio-demographic information (sex, age, education, and years of experience) and (ii) ethnobotanical knowledge. This included plant names (scientific and vernacular), botanical families, sources of supply, plant parts used, preparation methods, dosage (typical daily intake), frequency of use, and duration of treatment. All data were carefully recorded for each medicinal species reported by herbalists.

The scientific identification of plant species was carried out using internationally recognized online botanical databases, including Plants of the World Online[8] and World Flora Online[9], which helped ensure the accuracy and consistency of the scientific names in accordance with current taxonomic standards.

Data analysis

Responses were entered into a database and analyzed with Microsoft Excel 2016. Descriptive statistics were used to compute indices quantifying the cultural importance of plants. The Relative Frequency of Citation (RFC=FC/N; FC: number of informants who mentioned the use of the species and N: total number of respondents) measured the proportion of informants citing each species. The Family Importance Value ($FIV=FC_{family}/Ns$; FC_{family}: relative frequency of species citations in a given

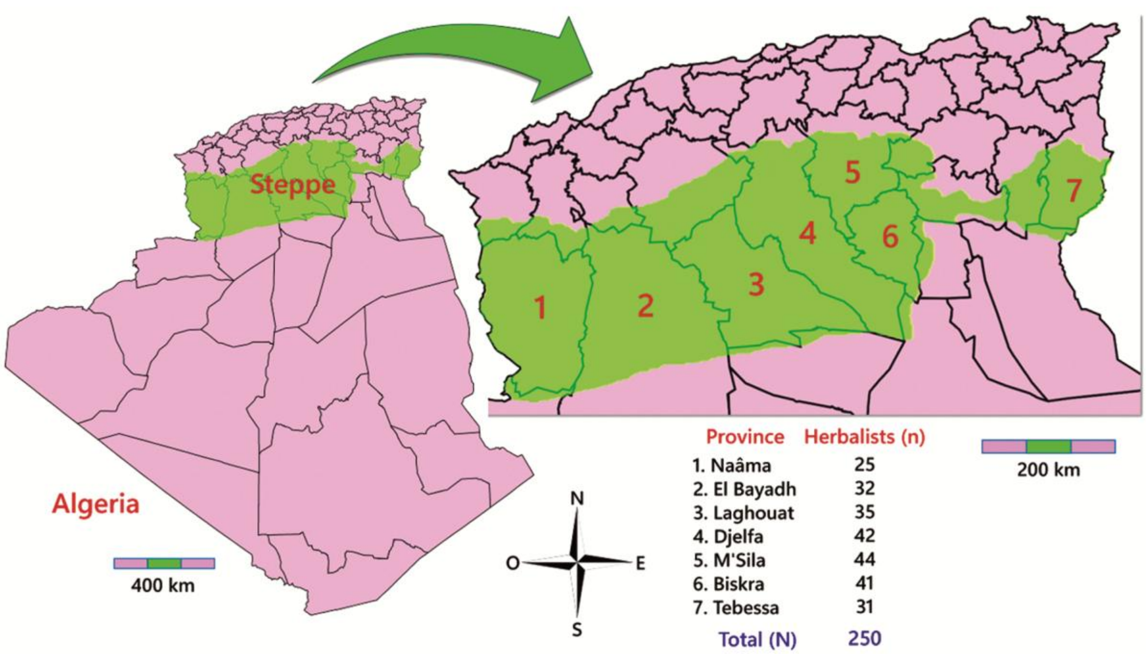

Fig. 1 — Geographical presentation of the studied Algerian steppe area[7]

family and Ns: number of species in the same family) assessed the relative importance of plant families based on informant citation[10]. These indices helped evaluate the traditional significance of both species and families in hypertension management.

Phytochemical analysis

Based on ethnobotanical findings, six of the most frequently cited species traditionally used for hypertension management were selected for phytochemical profiling to characterize their phenolic profiles: *Allium sativum* (bulb), *Thymus algeriensis* (aerial part), *Laurus nobilis* (leaf), *Curcuma longa* (rhizome), *Coriandrum sativum* (seed), and *Moringa oleifera* (leaf). With the exception of *A. sativum* bulbs, which were purchased fresh from the local market, peeled, and immediately ground to a fine paste using an Ultraturrax homogenizer (T25 Basic, Germany) at 7,000 rpm for 5 min, all other plant materials were obtained from herbalists in their naturally dried form, as sold. These materials were ground using an A11 basic mill (IKA, Staufen, Germany) to particles smaller than 500 µm and stored in airtight containers at room temperature until further phytochemical analysis[11].

Phenolic compounds were extracted using solid–liquid extraction. A paste of *A. sativum* bulbs and powdered samples of *T. algeriensis* aerial parts, *L. nobilis* leaves, *C. longa* rhizomes, *C. sativum* seeds, and *M. oleifera* leaves (5 g) were extracted with 100 mL of methanol (99.98%) and stirred magnetically for 30 min. After centrifugation at 5000 rpm for 10 min, the supernatants were collected and concentrated under reduced pressure using a rotary evaporator (BÜCHI R-200) to remove the solvent. The concentrated extracts were subsequently reconstituted in methanol and filtered through a 0.45 µm syringe filter prior to HPLC analysis. High-performance liquid chromatography (Agilent 1260 Infinity quaternary LC, Germany) analysis was performed using a C18 reversed-phase column (Thermo Electron, Dreieich, Germany; 4.6×250 mm, 3 µm) with UV detection at 254 nm (Shimadzu SPD6AUV detector). The mobile phase consisted of two solvents: (A) 70% acetonitrile in water and (B) 0.1% formic acid in water. A gradient elution was applied as follows: 10-25% A (0-25 min), 25-80% A (25-35 min), and 80-100% A (35-50 min). The flow rate was set to 0.5 mL/min, and the column temperature was maintained at 40°C. Identification of phenolic compounds was performed by comparison with authentic standards, while an internal standard was used to ensure accurate quantification and minimize matrix interference.

Statistical analysis

Quantitative variables were expressed as means, while qualitative variables were presented as frequencies (RFC, FIV) and percentages (gender, age group, education level, professional experience, plant parts, and preparation modes). Graphical outputs were produced using OriginPro-2024 and Microsoft Excel. Statistical analysis was carried out using appropriate tests according to data type. Categorical variables were analyzed using the Chi-square test followed by multiple pairwise comparisons with Bonferroni correction. Ethnobotanical indices (RFC and FIV) were assessed using the Kruskal-Wallis test. For phytochemical data (n=3), comparisons between species were performed using one-way ANOVA followed by Tukey's post hoc test. A significance level of $p<0.05$ was applied for all analyses.

Results and Discussion

Socio-demographic characteristics of herbalists interviewed

The socio-demographic profile of herbalists in the Algerian steppe revealed a clear predominance of men (94%), whereas women represented only a small proportion of practitioners (Fig. 2). Similar patterns have been reported in other regions[12]. This distribution reflects the prevailing socio-cultural context, in which the herbal trade is largely dominated by men.

Regarding practitioners' age, the 20-40 years (44.4%) and 40-60 years (38.4%) groups are predominant, with percentages that do not differ significantly (Fig. 2). Younger participants under 20 years (6.8%) and older individuals over 60 years (10.4%) are noticeably underrepresented, a pattern also reported in ethnobotanical studies of indigenous medicinal plants used in the Algerian semi-arid region[12]. This distribution may reflect declining youth involvement, likely driven by urbanization and improved access to biomedical care, as well as the lower participation of older individuals due to age-related limitations and retirement, despite their recognized role as custodians of ethnomedicinal knowledge[13].

The results of the educational level analysis show that all categories exhibit statistically significant differences ($p<0.05$), revealing a distribution characterized by a strong representation of secondary

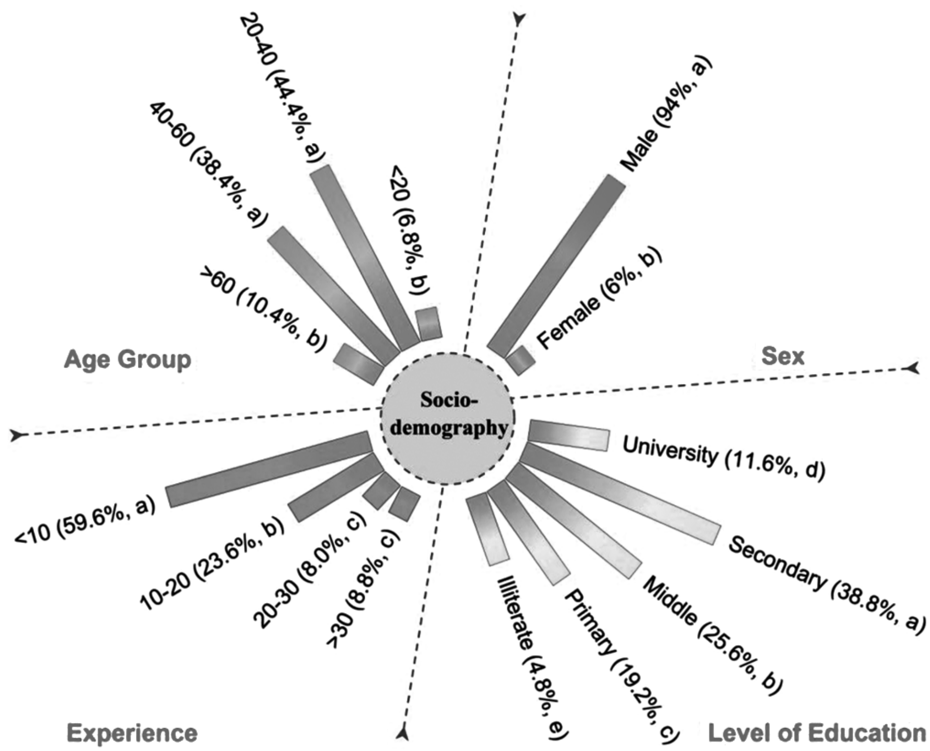

Fig. 2 — Sociodemographic characteristics of herbalists interviewed in the Algerian steppe for hypertension management. Differences between categories were assessed using the Chi-square test followed by multiple pair wise comparisons with Bonferroni correction. Percentage values followed by different letters indicate statistically significant differences between categories ($p<0.05$; a>b>c>d>e)

education (38.8%), followed by middle school level (25.6%) and primary education (19.2%), while higher education (11.6%) remains poorly represented and illiteracy is marginal (4.8%) (Fig. 2). This study reveals that interest in traditional medicine extends across all levels of education within the population. This contrasts with several earlier surveys conducted in Algeria and North Africa, where illiteracy among herbalists often reached significant levels[14].

Among the 250 practitioners surveyed, more than half had less than 10 years of experience, indicating a relatively recent involvement in herbal practice (Fig. 2). Practitioners with 10-20 years of experience represented an intermediate group (23.6%), while those with 20-30 years and over 30 years of experience were at a low rate and statistically similar, with about 8% each. This trend may reflect the gradual decline of long-term practitioners of traditional medicine, which can be attributed to several factors, including the aging and retirement of experienced healers and the increasing dominance of biomedical healthcare systems, which have progressively marginalized indigenous healing practices, leading to the weakening of intergenerational knowledge transmission[15].

Diversity of medicinal plants

A total of 35 species belonging to 19 botanical families were recorded as being traditionally used for hypertension management (Supplementary Appendix SI). The most represented families were Lamiaceae (8 species), followed by Asteraceae (3), Apiaceae (3), and Rosaceae (3), whereas the remaining families were represented by only one or two species. The highest family importance values were recorded for Zingiberaceae (0.66) and Amaryllidaceae (0.51), reflecting their strong cultural relevance and consistent medicinal use. In contrast, Tamaricaceae was the least cited family, with a markedly low FIV (0.04). The predominance of Lamiaceae, Asteraceae, and Apiaceae is consistent with previous ethnobotanical studies, which attribute their frequent use to their richness in phenolic and flavonoid compounds with cardiovascular benefits[16].

Citation frequency of species

The six most frequently cited species for hypertension management in the Algerian steppe are *Allium sativum*, *Thymus algeriensis*, *Laurus nobilis*, *Curcuma longa*, *Coriandrum sativum*, and *Moringa oleifera* (Fig. 3). Among them, *A. sativum*

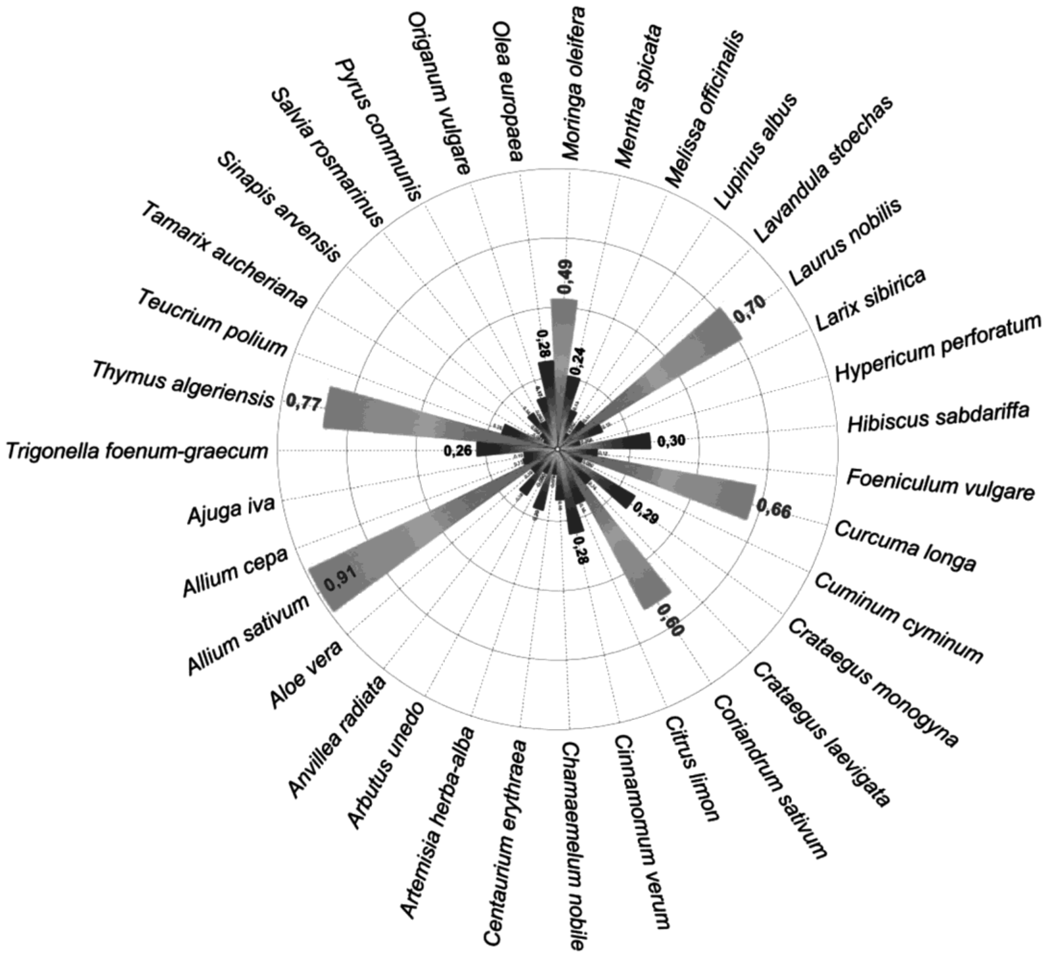

Fig. 3 — Radial plot illustrating the relative frequency of citation for plants used in hypertension management

(RFC=0.91) ranked first in terms of citation, consistent with previous ethnobotanical and clinical reports supporting its use in cardiovascular health[17].

T. algeriensis (RFC=0.77), a North African endemic species, was the second most cited species. Its antihypertensive use remains poorly documented despite its importance in traditional medicine. The only identified report originates from a general study conducted in the Biskra region[18], located in the Algerian steppe, suggesting a potentially steppe-specific use, which confers originality to our findings and highlights a localized therapeutic knowledge that remains poorly explored. Widely used across the Mediterranean, *L. nobilis* (RFC=0.70) has been reported for hypertension management in an ethnobotanical study[19]. Leong highlighted the protective role of *C. longa* in the management of arterial hypertension[20].

Traditionally used for digestive and cardiovascular disorders, coriander has also been cited for hypertension management, with an RFC of 0.60. Its use has been well documented, thereby confirming its extensive diffusion in traditional medicine throughout the Mediterranean region[21]. Although not endemic, *M. oleifera* (RFC=0.49) is increasingly integrated and adopted in the region due to its medicinal reputation. Its effectiveness in regulating blood pressure was reported in a clinical study conducted with 30 hypertensive patients[22]. In other studies, *M. oleifera* leaf extract was reported to induce a significant reduction in blood pressure in hypertensive subjects[22,23].

Plant parts used

The ethnobotanical survey conducted in the Algerian steppe highlights a marked predominance of aerial parts (34.29%) over leaves (22.86%) in the traditional management of hypertension (Fig. 4). This finding is in agreement with numerous ethnopharmacological studies carried out across the Mediterranean and North Africa, where leaves and

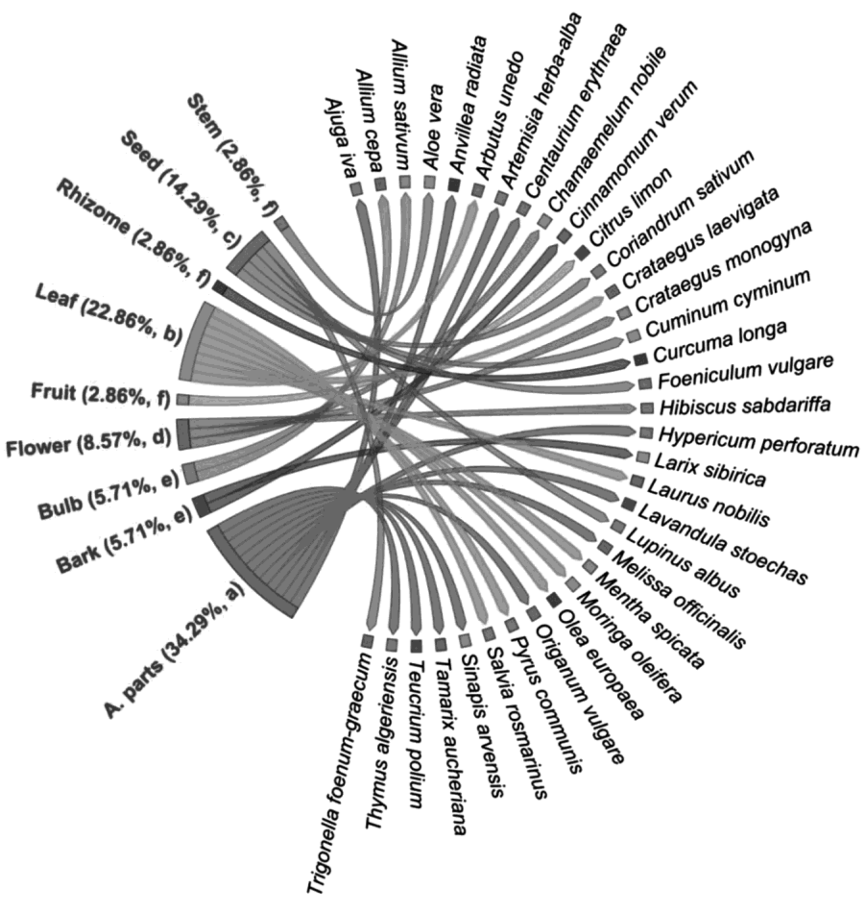

Fig. 4 — Chord diagram showing plant parts used in hypertension management. Differences between categories were assessed using the Chi-square test followed by multiple pair wise comparisons with Bonferroni correction. Percentage values followed by different letters indicate statistically significant differences between categories ($p<0.05$; a>b>c>d>e>f)

aerial parts are the most frequently employed due to their availability, richness in secondary metabolites, and ease of preparation.

The frequent use of *L. nobilis*, *Mentha spicata*, and *Olea europaea* leaves is widely documented in other regions of the Mediterranean basin, where these species are recognized for their effectiveness against cardiovascular disorders, particularly hypertension. Likewise, the aerial parts of *T. algeriensis* and *Origanum vulgare* are extensively employed in Algeria, supporting the central role of Lamiaceae in traditional antihypertensive pharmacopeia[24].

Seeds rank third (14.29%), with *Trigonella foenum-graecum*, *Coriandrum sativum*, and *Foeniculum vulgare* being the most cited species. Their frequent use reflects the application of aromatic seeds for their diuretic and digestive effects, often associated with blood pressure regulation.

Flowers account for 8.57% of the reported plant parts, represented mainly by *Hibiscus sabdariffa* and *Crataegus monogyna*, two species widely recognized for their cardioprotective properties[25]. In contrast, barks (5.71%), bulbs (5.71%), fruits (2.86%), rhizomes (2.86%), and stems (2.86%) are only marginally mentioned, which may indicate lower accessibility or a more restricted ethnobotanical transmission.

Relationship between plant parts and preparation methods

In the traditional pharmacopoeia of the Algerian steppe, the selection of plant parts and preparation methods appears to be closely linked, possibly indicating empirical practices influenced by extraction convenience and the perceived effectiveness of specific preparations. Decoction emerges as the predominant preparation method, particularly for leaves (26.67%), aerial parts (26.67%), and seeds (20%) (Fig. 5). This pattern is consistent with ethnopharmacological studies reporting decoction as a commonly used method for extracting water-soluble compounds, including polyphenols such as tannins[26],

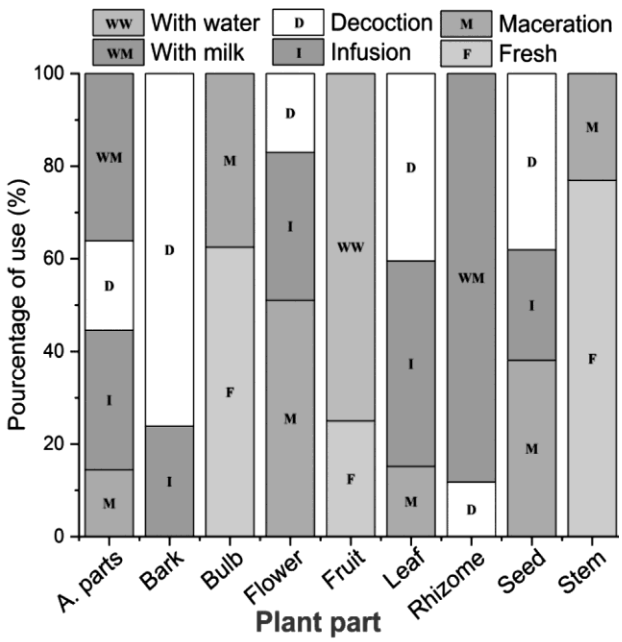

Fig. 5 — Bar diagram illustrating the percentage of preparation modes for different plant parts used in hypertension management

which are well documented for their antihypertensive properties[27]. Prolonged heating during decoction may enhance metabolite release and reduce certain antinutritional factors present in certain parts such as seeds[28]. The frequent use of decoction may therefore contribute to the perceived effectiveness for species such as *Olea europaea* leaves, whose antihypertensive effects have been reported in recent studies[29].

Infusion ranks second, particularly for aerial parts (41.67%) and leaves (29.17%). As a milder hot-water extraction method, it may be more suitable for heat-sensitive compounds, including certain flavonoids, many of which are soluble in hot water yet sensitive to prolonged heating, making infusion more appropriate than decoction in such cases[30]. Infusion may also facilitate the extraction of some volatile or semi-volatile constituents, although to a limited extent, which have been associated with vasorelaxant activity. These observations suggest that traditional preparation methods may partially align with the physicochemical properties of plant metabolites, without necessarily implying intentional optimization.

Maceration (20% for aerial parts and seeds each) is also commonly employed. As a cold extraction technique, maceration is particularly suitable for thermolabile molecules such as anthocyanins. The use of fresh plant material (33.33% for bulbs, fruits, and stems) is mainly applied to succulent organs rich in volatile sulfur compounds, such as *A. sativum*; this practice helps preserve compounds that are thermolabile and readily degraded by heat. Less common practices, such as preparation with milk and water, appear to significantly improve sensory acceptability while increasing phenolic content and antioxidant activity, thereby indicating improved metabolite bioavailability.

Dosage, frequency, and duration of treatment

The dosage, frequency, and duration of medicinal plants traditionally employed for the treatment of hypertension in the Algerian steppe are summarized in Supplementary Appendix SI. Distinct therapeutic patterns are observed: some species are used at high doses, others at lower doses. Administration frequencies fall into three categories, with some plants given as a single daily dose, many administered 1-2 times per day, and those requiring sustained action given 2-3 daily doses.

Treatment duration varies among species, indicating differences in intended therapeutic effects and safety considerations. Short-term regimens of 3-5 weeks as with *A. herba-alba* and *T. polium*, likely reflect safety concerns or rapid onset of action. In contrast, extended treatments of 8-12 weeks with *A. sativum*, *C. monogyna*, and *C. laevigata* underline their role in chronic cardiovascular care and long-standing recognition of efficacy. Shorter uses of *L. stoechas* or *A. iva* suggest a supportive rather than a primary purpose.

Based on their citation frequency, six of the most frequently reported species (*Allium sativum*, *Thymus algeriensis*, *Laurus nobilis*, *Curcuma longa*, *Coriandrum sativum*, and *Moringa oleifera*) were selected for phytochemical analysis, allowing the characterization of their phenolic profiles and the identification of compounds potentially underlying their traditional use.

Phenolic profiles of the most used plants

HPLC analysis showed clear differences in phenolic diversity and abundance among the six main antihypertensive plants of the Algerian steppe (Table 1). *A. sativum* had the highest content (56.70 µg/g DW), with rhamnetin as the main compound, followed by *T. algeriensis* (42.54 µg/g DW) and *C. longa* (37.69 µg/g DW). *L. nobilis* reached 31.09 µg/g DW, characterized by catechin and rutin, while lower values were found in *C. sativum* (20.77 µg/g DW) and *M. oleifera* (13.24 µg/g DW), both rich in chlorogenic acid derivatives and flavonoids.

Table 1 — Phenolic profiles of the six most frequently cited plants used for hypertension management

Compound	Time	*Allium sativum*	*Thymus algeriensis*	*Laurus nobilis*	*Curcuma longa*	*Coriandrum sativum*	*Moringa oleifera*
Gallic acid	7.48	0.63±0.05^{a}	0.35±0.03^{b}	0.19±0.03^{cd}	0.15±0.01^{d}	0.17±0.01^{d}	0.30±0.05^{bc}
Kaempferol	11.58	-	9.56±1.12^{a}	3.06±0.37^{b}	-	-	1.25±0.18^{c}
Protocatechuic acid	12.36	-	-	0.7±0.11	-	-	-
Hydroxytyrosol	12.55	-	-	-	-	0.04±0.01^{a}	0.05±0.01^{a}
Rhamnetin	12.72	45.78±1.26	-	-	-	-	-
Caffeic acid	17.26	3.3±0.24^{c}	-	4.8±0.67^{b}	-	7.7±0.56^{a}	0.53±0.07^{d}
Catechin	17.42	-	5.56±0.07^{b}	8.62±1.12^{a}	-	-	2.5±0.35^{c}
Tyrosol	17.46	0.09±0.01	-	-	-	-	0.03±0.01
Chlorogenic acid	18.37	-	-	1.38±0.17^{c}	-	12.2±0.01^{a}	3±0.45^{b}
Rosmarinic acid	19.93	-	6.25±1.11^{a}	0.5±0.07^{b}	-	-	0.1±0.01^{c}
Epicatechin	20.72	-	4.45±0.25	-	-	-	-
Curcumin	21.10	-	-	-	18.75±2.15	-	-
Isorhamnetin	21.76	-	-	-	5.5±0.05	-	-
Vanillic acid	21.86	0.12±0.01^{b}	0.26±0.09^{a}	0.07±0.01^{c}	-	0.02±0.02^{d}	0.13±0.02^{b}
Hesperidin	22.17	-	2.25±0.58	-	-	-	-
Syringic acid	23.70	0.27±0.05^{a}	0.23±0.02^{a}	0.01±0^{c}	-	-	0.08±0.01^{b}
Luteone	24.06	-	1.15±0.05	-	-	-	-
Benzoic acid	24.23	-	-	-	0.05±0.01^{b}	0.35±0.05^{a}	0.05±0.01^{b}
Vanillin	29.41	0.03±0.01^{b}	-	-	-	0.01±0.00^{c}	0.05±0.01^{a}
Quercetin 3-arabinoside 7-glucoside	30.12	0.09±0.01^{a}	-	-	-	0.1±0.05^{a}	-
p-coumaric acid	30.33	0.06±0.01^{c}	-	0.25±0.03^{b}	-	0.02±0.01^{d}	0.38±0.05^{a}
Demethoxycurcumin	31.47	-	-	-	7.15±1.12	-	-
Rutin	32.19	0.03±0.01^{d}	0.19±0.01^{c}	7.45±1.12^{a}	-	-	2±0.24^{b}
Luteolin 7-O-glucoside	32.87	-	4.54±0.24^{a}	-	0.8±0.05^{b}	-	0.75±0.10^{b}
Ferulic acid	33.16	-	-	0.94±0.11^{a}	-	-	0.18±0.03^{b}
Apigenin-7-Rhamnoglucoside	33.65	0.21±0.01^{b}	0.50±0.10^{a}	-	-	-	0.13±0.02^{c}
3-O-methylquercetin	35.25	-	-	-	-	-	0.08±0.01
Myricetin	35.42	-	-	0.18±0.03^{a}	-	-	0.13±0.02^{a}
Quercetin	36.97	0.03±0.01^{c}	-	-	0.33±0.10^{b}	0.02±0.01^{c}	0.88±0.15^{a}
Luteolin	37.89	-	-	1.86±0.26^{a}	-	-	0.3±0.04^{b}
Apigenin	38.35	0.12±0.01^{cd}	0.22±0.05^{bc}	1.08±0.17^{a}	0.32±0.05^{b}	0.09±0.01^{d}	0.23±0.04^{bc}
Trans-cinnamic acid	38.59	0.12±0.01^{a}	-	-	0.08±0.02^{ab}	0.05±0.02^{bc}	0.03±0.00^{c}
Valoneic acid bilactone	41.80	-	2.21±0.75^{b}	-	4.56±1.10^{a}	-	-
Kaempferol-3-glucuronide	42.25	-	4.82±1.10	-	-	-	-
Sinapic acid	42.65	5.82±0.52^{a}	-	-	-	-	0.08±0.01^{b}
Total		56.70^{a}	42.54^{b}	31.09^{d}	37.69^{c}	20.77^{e}	13.24^{f}

"-": not detected, results are expressed as µg/g DW. Values are expressed as mean ± SD (n=3). Differences between species were assessed using one-way ANOVA followed by Tukey's post hoc test. Different letters indicate statistically significant differences between species ($p<0.05$; a>b>c>d>e>f).

Garlic, the most cited (RFC=0.91), also showed the richest phenolic profile, supporting its perceived efficacy. Likewise, *T. algeriensis* (RFC=0.77) exhibited high cultural value with flavonoid richness. Conversely, *M. oleifera*, which presented the lowest phenolic content among the studied plants, showed a modest RFC (0.49), indicating both its relatively recent introduction to the region and its progressively recognized antihypertensive effects. Although present in lower amounts, its phenolic compounds may still play a relevant role by enhancing antioxidant defenses and supporting endothelial function, thereby contributing to its overall cardiovascular benefits[31].

The HPLC profile of garlic was dominated by rhamnetin (45.78 µg/g DW), along with notable levels of sinapic acid and caffeic acid. Flavonoids and phenolic acids have been reported to produce vasodilatory, antioxidant, and ACE-inhibitory activities, which may contribute to blood pressure regulation[32]. In addition to phenolic compounds, garlic is especially known for its organosulfur compounds, particularly allicin, diallyl disulfide, and S-allyl cysteine. These compounds have been reported to improve endothelial function, promote vasodilation through nitric oxide pathways, and reduce arterial stiffness[33]. Clinical trials have shown that standardized garlic preparations can significantly reduce both systolic and diastolic blood pressure, supporting its potential role in cardiovascular health. Thus, the combination of abundant phenolics and sulfur metabolites accounts for garlic's outstanding position both in traditional pharmacopoeia and modern cardiovascular medicine.

T. algeriensis displayed a rich profile of kaempferol, catechin, rosmarinic acid, and luteolin-7-O-glucoside. These compounds are strong antioxidants and vascular protectors. Rosmarinic acid has been shown to inhibit angiotensin-converting enzyme and induce vasorelaxation[34], while kaempferol and luteolin are associated with improved endothelial function and reduced vascular inflammation[35]. Catechin, widely studied in green tea, contributes to nitric oxide-mediated vasodilation and reduced oxidative stress[36]. The combined presence of these bioactive flavonoids may help explain the plant's widespread citation in hypertension management and may partly reflect its empirical reputation in local pharmacopoeia.

L. nobilis was characterized by a notable presence of catechin, rutin, luteolin, and ferulic acid, supporting earlier reports[3]. Catechin and rutin are known for improving vascular elasticity and reducing blood pressure by enhancing nitric oxide bioavailability. Luteolin exerts vasodilatory and anti-inflammatory actions in vascular smooth muscle, while ferulic acid demonstrates antioxidant and antihypertensive activity by modulating vascular reactivity[37]. These findings support ethnobotanical reports describing *L. nobilis* as a plant of cardiovascular interest in the Mediterranean region and provide further support for its traditional use in hypertension management.

Turmeric's phenolic profile was dominated by curcumin (18.75 µg/g DW) over demethoxycurcumin, alongside isorhamnetin. Curcumin is among the most extensively studied natural compounds for cardiovascular health, with evidence suggesting that it may improve endothelial function, reduce oxidative stress, and exert anti-inflammatory effects, which could in turn help regulate blood pressure[38]. Demethoxycurcumin shares similar antioxidant and vasoprotective effects, while isorhamnetin enhances vascular relaxation and provides anti-inflammatory benefits[39]. The abundance of curcuminoids in turmeric supports its traditional use for hypertension and cardiovascular diseases, as further supported by experimental and clinical evidence[40].

Coriander (*C. sativum*) contains high levels of chlorogenic acid and caffeic acid, both of which have well established antihypertensive effects. Chlorogenic acid reduces blood pressure through improved endothelial-dependent vasodilation and inhibition of glucose-induced vascular damage[41]. Caffeic acid also promotes vasorelaxation and inhibits vascular smooth muscle proliferation[42]. These phenolic acids, together with minor flavonoids such as apigenin, may account for coriander's dual traditional use in digestive and cardiovascular ailments, and its reported hypotensive activity across the Mediterranean.

M. oleifera presented a modest but diverse profile, with quercetin, catechin, rutin, and chlorogenic acid as key compounds. Quercetin is among the most documented flavonoids for hypertension management, with clinical studies confirming its ability to lower systolic and diastolic blood pressure[43]. Catechin and rutin provide synergistic antioxidant and vasodilatory effects, while chlorogenic acid reinforces hypotensive action. Animal studies have shown that moringa leaf extracts significantly reduce blood pressure[44]. This supports the progressive incorporation of *M. oleifera* into the regional pharmacopoeia despite its non-native origin.

A strong positive correlation was observed between the relative frequency of citation and the total phenolic content of the studied species (r=0.97), suggesting that the most frequently cited plants tend to exhibit higher levels of phenolic compounds. This relationship suggests a possible convergence between traditional knowledge and phytochemical composition, supporting the ethnopharmacological relevance of the selected species.

Conclusion

This study examines the ethnobotanical use of medicinal plants in the management of hypertension in the Algerian steppe and presents the phenolic profiles of the most frequently cited species. Based on ethnobotanical relevance, six highly cited species (*Allium sativum*, *Thymus algeriensis*, *Laurus nobilis*, *Curcuma longa*, *Coriandrum sativum*, and *Moringa oleifera*) were selected for HPLC analysis, which identified the presence of various phenolic compounds. *Allium sativum* showed comparatively higher levels of detected compounds, while the other species displayed distinct phenolic profiles. The overlap between citation frequency and chemical profiles supports local practices and highlights the pharmacological potential of plants used in the Algerian steppe. Further studies are required to validate these results through targeted *in vitro* and *in vivo* investigations.

Supplementary Data

Supplementary data associated with this article is available in the electronic form at https://nopr.niscpr.res.in/jinfo/ijtk/IJTK_25(4)(2026)348-358_SupplData.pdf

Acknowledgments

The authors express their gratitude to the herbalists of the Algerian steppe for sharing their knowledge throughout the study.

Author Contributions

Conceptualization: YKK, MBB; Methodology: YKK, MBB, IF; Data collection: YKK, MBB, MK, MD, KS; Formal analysis: YKK, MBB, IF; Writing & original draft: YKK, MBB; Writing, review & editing: YKK, MBB, IF; Funding acquisition: YKK, MBB, IF, HA; Supervision: YKK, MBB, MD, KS.

Conflict of Interest

The authors declare no conflict of interest.

Informed Consent

The authors explained the study objectives to each participant before conducting the interviews, and verbal informed consent was obtained from all informants prior to every interview, discussion, or completion of the questionnaire, in accordance with the code of ethics of the International Society of Ethnobotany.

Data Availability

The datasets generated and analyzed during this study are available from the corresponding author upon reasonable request.

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