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*Original Article*

# Ethnobotanical Survey and Market-based Assessment of Medicinal Plants Consumption in Benghazi, Libya

**Khadija Omar[1], Esraa Aref[1], Musbah Mohammed[1], Tarek Mukassabi[1]***
[1]*Department of Botany, Faculty of Sciences, University of Benghazi, Benghazi, Libya*
***Email.*** *tarek.mukassabi@uob.edu.ly*

**Abstract**
This study evaluates the therapeutic applications and the commercial consumption of 34 medicinal and aromatic plants from 37 herbal shops in Benghazi city in eastern Libya. Data on monthly sales quantity, used parts, flowering times and medicinal use were gathered through structured interviews with herbalists and plant nomenclature was confirmed and cross-checked against the Flore of Libya Booklets. Data were statistically analysed by Minitab®. The plant species *Pimpinella anisum* demonstrated the highest mean monthly consumption. Significant differences in sales were observed across individual shops, and the Al-Sabery area recorded the highest commercial turnover, 72.4 kg/month. The Flora of Libya exhibited a distinct biogeographical distribution of medicinal plants in Libya. Al-Jabal Al-Akhdar zone contained the highest species diversity, whereas the Fezzan and Saharan zones were dominated by xerophytes. Our findings highlight a heavy reliance on traditional phytotherapy targeting gastrointestinal, metabolic, respiratory, and dermatological conditions, emphasising the need for regulatory oversight and sustainable sourcing.
**Keywords.** Medicinal Herbs, Flora, Ethnobotany, Benghazi, Libya.

## Introduction

The use of medicinal plants represents a fundamental cornerstone supporting healthcare systems across numerous developing nations, where access to conventional medical services remains limited by economic, geographical and infrastructural constraints [1]. Previous studies indicate that over 60% of the global population, up to 80% in developing countries, depends directly on traditional botanical remedies to meet their primary healthcare needs [2]. This considerable reliance highlights the critical role of phytotherapeutic resources in sustaining community health, particularly in regions where modern pharmaceutical alternatives are either unaffordable or inaccessible [3]. Across North Africa, the use of medicinal plants is among the region's oldest traditions, holding deep social and health significance for both urban and rural communities [4].

In Libya, herbal medicine remains a component of daily life, valued not only for its cultural heritage, but also as an accessible, safe and affordable approach to healthcare. Biochemically, these botanical resources provide a rich spectrum of bioactive secondary metabolites, including alkaloids, flavonoids, terpenoids and phenolic compounds, exhibiting proven antibacterial, antifungal, antiparasitic and insecticidal properties. This is alongside clinical applications in managing chronic pathologies such as diabetes mellitus, cardiovascular disorders and oncological conditions [5]. Situated in northeastern Libya along the southern Mediterranean Basin, the Cyrenaica region includes its primary urban and commercial centre, Benghazi city, which is very close to Al Jabal Al Akhdar, which occupies a phytogeographically distinct and ecologically vital locus within the Mediterranean biodiversity hotspot [4]. A field survey across the region has documented approximately 89 taxa with empirically validated therapeutic applications, alongside several endemic species unique to this Mediterranean microclimate [7]. Floristic characterisation reveals strong dominance among specific botanical families, with Lamiaceae comprising 9% of the floristic composition, represented by key therapeutic species including *Phlomis floccosa* D. Don, *Rosmarinus officinalis* L., *Marrubium vulgare* L., *Satureja thymbra* L., *Salvia fruticosa* Mill. and *Thymbra capitata* (L.) Cav. [7]. The Apiaceae family accounts for 8% of floristic composition, exemplified by *Ammi majus* L., *Apium graveolens* L., *Conium maculatum* L., *Cuminum cyminum* L., *Deverra tortuosa* (Desf.) DC., *Eryngium campestre* L. and *Thapsia garganica* L. [7]. Asteraceae contribute 7%, comprising *Artemisia campestris* L., *Artemisia herba-alba* Asso, *Carthamus lanatus* L., *Launaea nudicaulis* (L.) Hook. f. and *Phagnalon rupestre* (L.) DC. The Brassicaceae family is additionally represented by species such as *Capsella bursa-pastoris* (L.) Medik., *Raphanus raphanistrum* L., *Sinapis alba* L., *Moricandia arvensis* (L.) DC. and *Eruca vesicaria* subsp. *sativa* (Mill.) Thell. [7].

Despite the reflective legacy and therapeutic reliance on these taxa, wild flora in eastern Libya faces increased environmental pressure. Rapid population growth, urban expansion, agricultural intensification, climate variability and unmanaged overharvesting have driven severe habitat degradation and population decline across vulnerable botanical species [6, 8]. The loss and endangerment of these natural biodiversity stocks directly threaten the sustainability of local healthcare practices, exacerbate biodiversity loss and destabilise fragile Mediterranean ecosystems [6]. Conservation biologists have increasingly emphasised that the erosion of ethnobotanical knowledge parallels the decline of plant populations, creating a dual crisis of cultural and biological extinction [4, 6]. Whereas regional botanical surveys have outlined the species and plant communities' diversity, quantitative studies evaluating the specific patterns of consumption, market dynamics, frequency of use, and ethnobotanical applications within the urban centre of Benghazi remain critically limited [1, 7]. This knowledge gap impedes the development of structured conservation strategies and sustainable healthcare policies developed to the needs of urban populations.


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Understanding which species are most frequently used, for which therapeutic indications and by which demographic segments is essential for prioritising conservation efforts and ensuring the continued availability of these vital medicinal resources. Therefore, this study aims to identify the direct use, frequency of consumption and primary therapeutic indications of medicinal plants in eastern Libya. By documenting current ethnobotanical use within this urban Mediterranean region, the research provides critical data to support both sustainable healthcare application and biodiversity conservation. Furthermore, the findings will contribute to the broader understanding of ethnobotanical interactions in rapidly urbanising environments within biodiversity hotspots, offering a foundation for future conservation interventions and public health initiatives in the region.

## Methods

### *Area of Study*

The city of Benghazi is the second largest city in Libya. It is located on the eastern coast of the country and the southern Mediterranean at 32° 7' N, 20° 4' E, and has a population of more than one million people [10]; it is considered a trade market centre in the east of the country. There are ninety-two (92) herbal shops distributed across the city [10]. Our estimation of the number of current functional shops is 189 one hundred and eighty-nine, and this study covered thirty-seven herbal shops, the city has been divided into three areas: the first area in the eastern part of the city named Area A ( includes Al-Sabry, Al-Selmany, Hay Al-Salam and Shebna), the second area which is located in the center of the city named Area B (includes Al-Kish, Sidi Hesin, Al-Berka and Al-Majouri) and the third area was located in the western part of the city which was in this study named Area C (includes Al-Quarsha, Al-Hwary, Qaryunis, Fuwayha and Beloun).

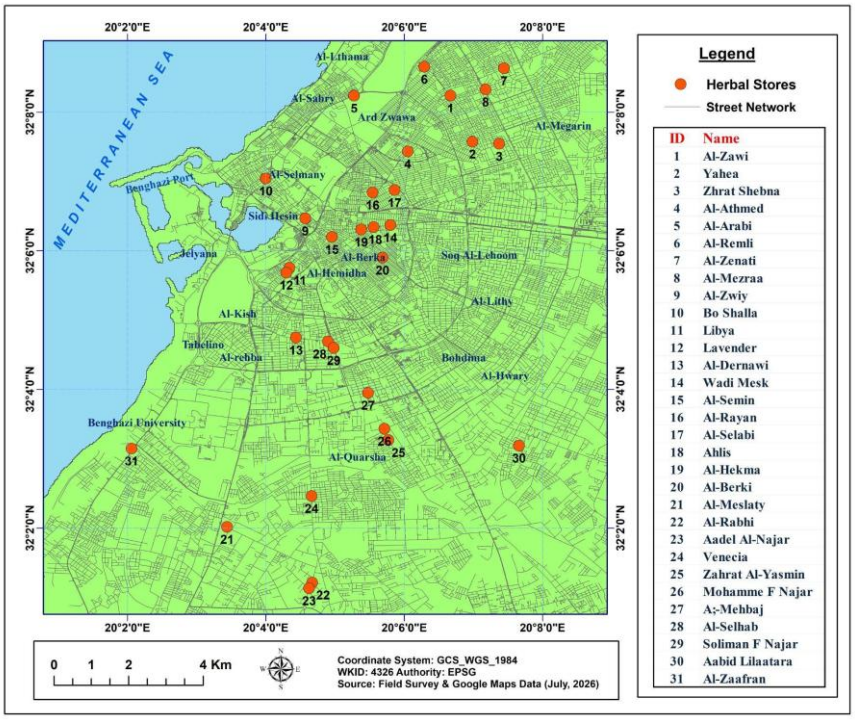


***Figure 1. The geographical distribution of all herbal shops across Benghazi City.***

*The eastern area (shops 1-8), central area (shops 9-20) and western area (shops 21-31). Due to technical issues, six shops are not shown on the map, which are (Al-Haj 32), (Ayham 33), (Al-Sudani 34), (Huwaya 35) in region A, (Ahlis II, 36) and (Al-Dernawi II, 37) in region C.*

### *Data Collection and Analysis*

Data regarding monthly consumption and the specific plant parts used were collected for thirty medicinal plant species and four types of oils from thirty-seven herbal shops. Data concerning geographical distribution (global and local), scientific and local names, plant descriptions, and flowering times were obtained from the reference Flora of Libya [9]. Additionally, individual interviews were conducted with herbal medicine practitioners to document medicinal uses and the effects of excessive use. A one-way ANOVA was conducted to assess differences in monthly consumption of 34 medicinal and aromatic plant species. Another one-way ANOVA was performed to examine differences in monthly consumption across three administrative areas in Benghazi (Central: n = 12, East: n = 12, West: n = 13). Moreover, one-way ANOVA showed a significant difference in monthly consumption across the 37 shops. The statistical application of Minitab version 17® was used in this study.

## Results

### *Monthly Consumption*

The overall difference in consumption across taxa did not reach statistical significance ($F_{(33, 1175)}$ = 1.39, $p$ = 0.072, $R^2$ = 3.75).


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But post hoc Tukey HSD testing identified *Pimpinella anisum* (66,167.9 g) as having the highest monthly consumption, differing significantly from low-volume species, whereas *Linum usitatissimum* (6,951.1 g) and *Trigonella foenum-graecum* (14,435.3 g) exhibited intermediate values. The remaining 31 plant species showed uniformly lower monthly consumption with no significant pairwise differences ($p > 0.05$) (Table 1). The main effect of the areas was not statistically significant at the standard alpha level ($F_{(2, 1206)} = 2.29$, $p = 0.102$, $R^2 = 0.38$). Although the mean monthly consumption in Area A (M = 9,501 g) was descriptively higher than in Area C (M = 4,662 g) and Area B (M = 1,520 g), and the high group variance within Area A SD = 91,932), the assumption of homoscedasticity was violated (Table 1). Moreover, one-way ANOVA showed a significant difference in monthly consumption across the 37 shops ($F_{(36, 1172)} = 1.63$, $p = 0.012$, = 4.76). Post-hoc comparisons using Tukey's HSD test indicated that Shop No. 5 (M = 72,404) had significantly higher mean monthly consumption than all other shops ($p < 0.01$). However, no significant differences were observed among the remaining 36 shops ($p > 0.05$). Moreover, one-way ANOVA demonstrated a significant main effect of address location on monthly consumption ($F_{(29, 1179)} = 2.01$, $p = 0.001$, $R^2 = 4.72$). Tukey's HSD post-hoc test identified that mean consumption in Al-Sabery (M = 72,404g) was significantly higher than in the remaining residential addresses ($p < 0.01$).

***Table 1. Monthly consumption of medicinal herbs in the three areas across Benghazi city. Areas: A = Eastern Benghazi, B = Central Benghazi and C = Western Benghazi. For shop locations (see Fig. 1).***

| | Plant | Mean Monthly Consumption (g) | | | Total (g) |
|---|---|---|---|---|---|
| | | Area A | Area B | Area C | |
| 1 | *Acacia nilotica* (L.) Willd. ex Delile | 573.3 | 204.4 | 295.6 | 1073.3 |
| 2 | *Ajuga iva* (L.) Schreb. | 151.5 | 53.823 | 62.1 | 267.3 |
| 3 | *Allium cepa* L. | 3847.1 | 1506.8 | 1226.5 | 6580.2 |
| 4 | *Artemisia herba-alba* Asso | 2095.9 | 19975 | 708.5 | 22779.1 |
| 5 | *Capparis spinosa* L. | 229.4 | 2450 | 996.8 | 3676.1 |
| 6 | *Citrullus colocynthis* (L.) Schrad. | 420.3 | 488.2 | 987.4 | 1895.8 |
| 7 | *Crataegus oxyacantha* auct. | 404.4 | 130.9 | 170.6 | 705.9 |
| 8 | *Cyperus esculentus* L. | 428.2 | 74.1 | 5900 | 6402.4 |
| 9 | *Eucalyptus* spp. | 132.6 | 186 | 134.1 | 452.8 |
| 10 | *Hordeum vulgare* L. | 1031.1 | 106.8 | 7088.2 | 8226.2 |
| 11 | *Cichorium spinosum* L. | 426.5 | 222.2 | 1029.4 | 1678.1 |
| 12 | *Juniperus phoenicea* L. | 765.8 | 531.2 | 2458.8 | 3755.8 |
| 13 | *Lavandula multifida* L. | 1019.7 | 300.7 | 1470.6 | 2791 |
| 14 | *Lepidium sativum* L. | 2364.7 | 1021.3 | 3558.8 | 6944.9 |
| 15 | *Linum usitatissimum* L. | 1579.1 | 2210.3 | 3161.7 | 6951.2 |
| 16 | *Ocimum basilicum* L. | 452.1 | 176.9 | 1264.7 | 71893 |
| 17 | *Olea europaea* L. | 400 | - | 117.6 | 15.2 |
| 18 | *Origanum majorana* L. | 1492.6 | 524.3 | 1248.5 | 3265.4 |
| 19 | *Peganum harmala* L. | 1420.6 | 13710 | 1169.1 | 16299.7 |
| 20 | *Phagnalon rupestre* L. | 530.6 | 295.3 | 734.1 | 1560 |
| 21 | *Pimpinella anisum* L. | 57503.2 | 2605.9 | 6058.8 | 66167.9 |
| 22 | *Portulaca oleracea* L. | 311.8 | 110.3 | 139.4 | 561.5 |
| 23 | *Punica granatum* L. | 21500 | 707.5 | 1764.7 | 23972.2 |
| 24 | *Quercus coccifera* L. | 7170 | 120.6 | 102.9 | 7393.5 |
| 25 | *Rosmarinus officinalis* L. | 2622.9 | 944.9 | 3388.2 | 6956 |
| 26 | *Salvia fruticosa* Mill. | 800.6 | 820.9 | 1119.1 | 2740.6 |
| 27 | *Thymus capitatus* (L.) Hoffmanns. & Link | 4630.1 | 600 | 1888.2 | 7118.4 |
| 28 | *Torilis arvensis* (Huds.) Link | 2586.5 | 673.5 | 3257.4 | 6517.4 |
| 29 | *Trigonella foenum-graecum* L. | 6467.6 | 1497.1 | 6470.6 | 14435.3 |
| 30 | *Ziziphus spina-christi* (L.) Desf. | 2985.3 | 963.8 | 2879.4 | 76828.5 |
| 31 | *Cocos nucifera* L.* | 395.9 | 293.8 | 837.4 | 1527.1 |
| 32 | *Simmondsia chinensis* (Link) C.K.Schneid.* | 300.9 | 214.4 | 631.8 | 1147.1 |


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|---|---|---|---|---|---|
| 33 | *Prunus dulcis* (Mill.) D.A.Webb* | 300.9 | 214.4 | 631.8 | 1635.6 |
| 34 | *Rosa damascena* Mill.* | 469.4 | 357.4 | 764.117 | 1590.9 |

** Oil (extract)*

***Medicinal use***

The provided 34 medicinal plants and plant-derived oils detail their botanical names, local Arabic names, plant form, life form, parts used, intended therapeutic applications, and associated adverse side effects or toxicity risks (Table 2).

***Range of Aliments***

The plants included in this study showed a broad spectrum of physiological systems and therapeutic applications. Several species alleviate digestive discomfort, constipation, cramps, and ulcers. *Acacia nilotica* and *Cocos nucifera* aid digestive clearing and combat stomach bacteria, *Hordeum vulgare* and *Linum usitatissimum* assist digestion, and *Punica granatum* treats gastritis. Notably, certain plants manage blood glucose, lipids, and vascular tone. *Allium cepa*, *Portulaca oleracea*, and *Olea europaea* regulate blood sugar and pressure, *Crataegus oxyacantha* and *Linum usitatissimum* support cardiovascular function, and *Cyperus esculentus* aids weight gain and anaemia management. Moreover, some other medicinal plants target formulations addressing joint wear, inflammation, and pain. *Capparis spinosa*, *Citrullus colocynthis*, and *Lepidium sativum* are utilised for cartilage repair, joint stiffness, arthritis, and muscle tension. Species such as *Eucalyptus* spp., *Ocimum basilicum* and *Thymbra capitata* are applied to clear congestion, treat colds, and dilate bronchi. Various oils and extracts focus on wound healing, hydration, and skin repair. *Rosa damascena* and *Simmondsia chinensis* treat acne and hydrate skin; *Ziziphus spina-christi* is used for body exfoliation and hair care, and *Cocos nucifera* soothes cracked skin, eczema, and psoriasis. On the other hand, plants like *Salvia fruticosa* manage PCOS and menstrual cycles (also known as polycystic ovarian syndrome; it is a common hormonal disorder that affects women and people with ovaries during their reproductive years), *Trigonella foenum-graecum* boosts estrogen/testosterone and aids postpartum recovery, *Peganum harmala* targets male sexual weakness, and *Torilis arvensis* acts as a nerve sedative. Finally, *Phagnalon rupestre* helps eliminate kidney stones, while *Quercus coccifera* serves as a tonic for pediatric bedwetting and urinary retention.

***Table 2. The total medicinal herbs in the local market and their uses. Medicinal uses were based on interviewees' statements***

| No | Scientific Name | Local Name | Plant Form | Life Form | Part Used | Medicinal Use | Side Effects |
|---|---|---|---|---|---|---|---|
| 1 | *Acacia nilotica* (L.) Willd. ex Delile | القرض | Tree | Perennial | Pods | Gum cleaning [11], wound treatment [12], treatment of corns [13] | Digestive system disorders [14] |
| 2 | *Ajuga iva* (L.) Scherb. | شندقورة | Herb | Perennial | Leaves Stems | Treatment of digestive system disorders [15], inflammation [16] | Low toxicity [17] |
| 3 | *Allium cepa* L. | بصل مطحون | Herb | Biennial | Bulbs | Blood sugar regulation [18], cardiovascular support [19], immune enhancement [20] | Intense itching, rhinoconjunctivitis , blurred vision, bronchial asthma, sweating [21] |
| 4 | *Artemisia herba-alba* Asso | الشيح | Sub-shrub | Perennial | Leaves Stems Flowers | Anthelmintic, antispasmodic, antirheumatic, antibacterial agent [22] | Low toxicity [23] |
| 5 | *Capparis spinosa* L. | القبار | Shrub | Perennial | Leaves | Treatment of headache, fever, convulsions, diabetes, toothache, dysmenorrhea, skin disease, kidney disease, liver disease, rheumatism, ulcers, haemorrhoids and sciatica [24] | Renal toxicity at high doses [25] |


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|---|---|---|---|---|---|---|---|
| 6 | *Citrullus colocynthis* (L.) Schrad. | الحنظل | Herb | Perennial | Fruits | Diuretic, hypolipidemic, anticancer, antimicrobial [26] | Colitis** |
| 7 | *Crataegus oxyacantha* auct. | الزعرور | Shrub or Small tree | Perennial | Leaves Flowers | Vasodilatory, antioxidant, mild positive inotropic, antiarrhythmic properties [27] | Hypotension, respiratory paralysis, and cardiac arrest [28] |
| 8 | *Cyperus esculentus* L. | حب عزيز | Herb | Perennial | Seeds | Antibacterial, antioxidant [29] | Potential allergic reactions [30] |
| 9 | *Eucalyptus* spp. | الكافور | Tree | Perennial | Leaves | Relief of congestion, respiratory disorder (e.g., cough, cold, sinusitis) [31] | Depressed level of consciousness, ataxia, seizures, and vomiting in children [32] |
| 10 | *Hordeum vulgare* L. | الشعير | Herb | Annual | Bran | Anti-inflammatory, management of obesity and cancer, mineral and vitamin supplementation [33] | Malignant tumours in celiac patients [34] |
| 11 | *Cichorium spinosum* L. | الهندباء | Sub-shrub | Caespitose perennial | Aerial parts, Roots | Prevention and treatment of Alzheimer's Disease [35] | Heartburn, acute hypoglycemia, hypotension, skin rash** |
| 12 | *Juniperus phoenicea* L. | العرعار | Tree or Shrub | Perennial | Leaves, Cones | Renal suppression, acute and chronic cystitis, bladder catarrh, leucorrhea, amenorrhea [36] | Gastrointestinal irritant [37] |
| 13 | *Lavandula multifida* L. | الخزامة | Dwarf shrub | Annual | Flowers | Anti-inflammatory activity [38] | Drowsiness, burping, eructation, nausea, diarrhoea, headache [39] |
| 14 | *Lepidium sativum* L. | حب الرشاد | Herb | Annual | Seeds | Bone fracture healing, galactagogue (promoting lactation), iron supplement [40] | Histopathological liver toxicity [41] |
| 15 | *Linum usitatissimum* L. | الكتانية | Erect herb | Annual or biennial | Seeds | Anticancer, antioxidant, antimicrobial, antiobesity, antidiabetic, antidiarrheal [42] | Causes toxicity due to Trypsin-related toxicity, hormonal side effects in pregnancy and young males due to lignans [43] |
| 16 | *Ocimum basilicum* L. | الريحان | Herbaceous | Perennial | Leaves | Kidney disorders, earache, menstrual | Contains promutagenic and |


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| | | | | | | irregularities, arthritis [44] | procarcinogenic alkenylbenzenes; safety precautions required for essential oil concentration [45] |
| 17 | *Olea europaea* L. | الزيتون | Trees | Perennial | Leaves<br>Fruit Oil | Antioxidant, antiatherogenic, hypoglycemic properties [46] | Generally safe even at high doses [47] |
| 18 | *Origanum majorana* L. | البردقوش | Herb | Perennial | Leaves<br>Stems | Antimicrobial, antioxidant, anticancer, antimutagenic, nephroprotective and hepatoprotective activities [48] | Safe at normal doses, potential genotoxicity at high doses [49] |
| 19 | *Peganum harmala* L. | الحرمل | Herb | Biennial | Leaves | Carminative, galactagogue, diuretic, emmenagogue, antithrombotic and analgesic [50] | Gastrointestinal disturbances, neurotoxicity, and narcotic effects [51] |
| 20 | *Phagnalon rupestre* L. | عشبة الارنب | Herb | Perennial | Aerial parts | Treatment of kidney disorder [52] | Gastric upset** |
| 21 | *Pimpinella anisum* L. | كمون الحلو | Herb | Annual | Seeds | Cytoprotective, anti-gastric ulcer, antisecretory, and antioxidative properties [53] | Impaired blood circulation** |
| 22 | *Portulaca oleracea* L. | بليبشة / الرجلة | Succulent herb | Annual | Leaves | Anti-inflammatory, antidiabetic, muscle relaxant, antitumor, hepatoprotective, antioxidant, anti-insomnia, analgesic, gastroprotective, neuroprotective, wound healing, antiseptic activities [54] | Kidney stones [55] |
| 23 | *Punica granatum* L. | قشور الرمان | shrub or small tree | Perennial | Fruit outer skin (rind) | Antioxidant, anticarcinogenic, anti-inflammatory, management of cardiovascular disease, diabetes, dental conditions, erectile dysfunction [56] | Gastrointestinal problems, flu-like symptoms, urinary tract disorders, allergic reactions [57] |
| 24 | *Quercus coccifera* L. | البلوط | Tree | Perennial | Leaves<br>Fruits | Anticancer, antioxidant [58] | Mild hepatotoxicity, nephrotoxicity, weight loss [59] |


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| 25 | *Rosmarinus officinalis* L. | اكليل الجبل | Shrub | Perennial | Leaves | Antimicrobial, antioxidant, antiapoptotic, antinociceptive, neuroprotective properties [60] | Nephrotoxicity, hepatotoxicity, reproductive toxicity, and teratogenicity at high doses [61] |
| 26 | *Salvia fruticosa* Mill. | التيه | Herb Sub-shrub | Perennial | Leaves | Antibacterial properties, treatment of gastrointestinal infections [62] | Adverse effects on fertility [63] |
| 27 | *Thymus capitatus* (L.) Hoffmanns. & Link | الزعتر | Dwarf shrub | Perennial | Leaves | Management of diabetes, fever, cough, flatulence, skin inflammation, indigestion, asthma, rheumatism, diarrhoea, influenza, analgesic, stimulant, sedative and antiseptic agent [64] | Anticoagulant effects ** |
| 28 | *Torilis arvensis* (Huds.) Link | القميله | Herb | Annual | Aerial part | Antioxidant, antimicrobial and antiseptic properties, treatment of gastrointestinal disorders [65] | Increased risk of bleeding, headache, dizziness** |
| 29 | *Trigonella foenum-graecum* L. | الحلبة | Herb | Annual | Seeds | Carminative, gastric stimulant, antidiabetic, galactagogue, hypocholesterolemic, antihyperlipidemic, antioxidant, hepatoprotective, antibacterial, antifungal, antiulcer, antilithiogenic, anticarcinogenic [66] | Neurodevelopmental and neuropathological effects and anti-implantation and abortifacient activities (contraindicated during pregnancy due to saponins) [67] |
| 30 | *Ziziphus spina-christi* (L.) Desf. | السدر | Small tree | Perennial | Leave | Treatment of fever, pain, dandruff, wounds, ulcers, inflammatory conditions, asthma and ophthalmic diseases, antibacterial, antifungal, antioxidant, antihyperglycemic, and antinociceptive activities [68] | Elevated liver enzymea [69] |
| 31 | *Cocos nucifera* L.* | زيت جوز الهند | Tree | Perennial | Bulbs | Anti-inflammatory, antioxidant, antimicrobial [70] | Skin and eye irritation, respiratory tract irritation upon inhalation [71] |


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| 32 | *Simmondsia chinensis* (Link) C. K. Schneid.* | زيت الجوجوبا | Shrub | Perennial | Seeds | Treatment of colds, dysuria, and obesity, antioxidant, antimicrobial, anticancer, anti-acne, anti-psoriatic, wound healing and hepatoprotective activities [72] | Accumulation of oil on the skin's surface** |
| 33 | *Prunus dulcis* (Mill.) D.A.Webb* | زيت اللوز الحلو | Tree | Perennial | Seeds | Rich in vitamins E and K (promotes skin regeneration and elasticity) [73] | Abdominal colic, nausea, and hypercholesterolemia in fat-sensitive individuals** |
| 34 | *Rosa damascena* Mill.* | زيت الورد | Erect shrub | Perennial | Petals | Antimicrobial, antioxidant, anti-inflammatory, analgesic ،antidepressant, immune system disorders [74] | Skin rash, irritation, and headache** |

** Oil (extract)*
***Information obtained from the interviewees and had no scientific support.*

***Floristic and Biogeographical Analysis***

Based on the Flora of Libya [9], the local geographical distribution demonstrates a clear floristic segregation driven by Libya's Mediterranean, steppe, and the arid Saharan bioclimatic zones. The medicinal herbs in the Flora of Libya are heavily represented by Lamiaceae (*Rosmarinus officinalis*, *Thymbra capitata*, *Salvia fruticosa*, *Ajuga iva*, *Lavandula multifida*, *Origanum majorana* and *Ocimum basilicum*) and Asteraceae (*Artemisia herba-alba*, *Cichorium spinosum* and *Phagnalon rupestre*). These families reflect typical Mediterranean maquis and semi-arid adaptations. The majority of wild indigenous species exhibit peak flowering during early to mid-spring (March–May), corresponding to post-winter precipitation periods. Arid and Saharan species (e.g., *Citrullus colocynthis*, *Acacia nilotica* and *Peganum harmala*) show prolonged or late-season flowering extending into autumn and winter.

***Primary Phytogeographical Regions in Libya***

Al-Jabal Al-Akhdar (Cyrenaica Plateau) is the richest region of plant species in Libya, characterised by high-moisture Mediterranean maquis, forest pockets, and coastal wadis. The main locations in the Cyrenaica Plateau are Shahat (Cyrene), Susa (Apollonia), Ras Al-Hilal, Wadi El-Kuf, El-Marj (Barce), Derna and Tokra, and the main characteristic medicinal flora are *Juniperus phoenicea*, *Quercus coccifera*, *Salvia fruticosa*, *Cichorium spinosum*, *Torilis arvensis* and *Phagnalon rupestre* (Table 3). Nafusa Mountains (Gebel Nefousa & Tripolitanian Steppe) represent the sub-humid to arid transitional pre-desert zone. The key locations are Gharian, Yefren, Jado, Nalut, Al-Asaba, and Wadi Louti. Their dominant medicinal herbs are *Artemisia herba-alba*, *Lavandula multifida*, *Thymbra capitata*, *Ajuga iva* and *Trigonella foenum-graecum* (Table 3). Coastal Tripolitania and Murqub are located on the coastal plains and stabilised low-altitude sands; the most common locations are Tripoli, Tajura, Sabratha, Msallata (El-Gussbat), Al-Khoms and El-Naggaza. The characteristic medicinal flora in this region is *Thymbra capitata*, *Rosmarinus officinalis*, *Cyperus esculentus* and *Origanum majorana* (Table 3). Moreover, the Southern Arid and Fezzan oases, which are deep Saharan environments, are characterised by extreme xerophytes and halophytes. The key localities in this region are Sebha, Ghat (El-Birkit), Sokna, Kufra, Germa, Wadi Ajal and Gebel Uweinat. The most common medicinal taxa in this region are *Acacia nilotica*, *Citrullus colocynthis*, *Ziziphus spina-christi*, *Tamarix* spp. and *Peganum harmala* (Table 3). For plant species that are identified for cultivation or ornamental purposes, the most common species are (e.g., *Allium cepa*, *Pimpinella anisum*, *Hordeum vulgare*, *Linum usitatissimum* and *Rosa damascena*) (Table 3).


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***Table 3. Comprehensive inventory of 34 plant species documented in the local medicinal herb market in Benghazi, and their scientific and local names, plant family, local and global geographical distribution and flowering season (Flora of Libya, 1977-1989) [9].***

| No | Scientific Name | Local Name | Family | Local Distribution | Global Distribution | Flowering Season |
|---|---|---|---|---|---|---|
| 1 | *Acacia nilotica* (L.) Willd. ex Delile | القرض | *Mimosaceae* | Sokna, between Sebha and Germa, Tajirhi, Ghat El Birkit, Gebel Uweinat | Afro-Asian species, widely introduced and cultivated | Jun – Dec |
| 2 | *Ajuga iva* (L.) Scherb. | شندقورة | *Lamiaceae* | Sabrata, Msallata, ElGussbat, Jado, Al Jabal Al Akhdar, Beida, Shahat | S. & C. Europe, N. Africa, Syria, Palestine & Pakistan | Mar - Apr |
| 3 | *Allium cepa* L. | بصل مطحون | Alliaceae | Planted | Cultivated almost throughout the world | May – Jun |
| 4 | *Artemisia herba-alba* Asso | الشيح | Asteraceae | Wadi Louti,Gharian, Yefren, Wazzin, Wadi Ain Romia, Marwah | West Southern France, Spain, North Africa, Syria, and extending into West & Central Iran | Nov - Feb |
| 5 | *Capparis spinosa* L. | القبار | Capparaceae | Al-Jabal Al-Akhdar | S. Europe eastwards to Australia | May – Aug |
| 6 | *Citrullus colocynthis* (L.) Schrad. | الحنظل | *Cucurbitaceae* | Kabau, Nalut towards Wazen, 7 km to Bugrain, Ghat, Barkat, Agdabia, Sirt | S. Europe, N. Africa, Arabian Peninsula, eastwards to India and Ceylon | Almost throughout the year. |
| 7 | *Crataegus oxyacantha* auct. | الزعرور | *Rosaceae* | Reported from Tripoli (Sidi Misri), near Khoms | Europe, probably introduced in Libya | Mar –May |
| 8 | *Cyperus esculentus* L. | حب عزيز | *Cyperaceae* | Tajura, Tripoli and Ghat | North temperate America. Macaronesia | Apr – Dec |
| 9 | *Eucalyptus* spp. | الكافور | *Myrtaceae* | Planted in most cities on the coastal line | Australia; has been introduced to the rest of the world | Mar - Jul |
| 10 | *Hordeum vulgare* L. | الشعير | *Poaceae* | Planted almost everywhere | Cultivated throughout the world | Mar - Apr |
| 11 | *Cichorium spinosum* L. | الهندباء | *Asteraceae* | Ras al Hilal, Tokra, Sussa, Near Shahat | Mediterranean region | May - Aug |
| 12 | *Juniperus phoenicea* L. | العرعار | *Gymnosperms* | Al Jabal Al Akhdar, Benghazi, Tolmeta, Tocra, El-Marj, El-Beida, Derna, Marsa Susa, Tarhuna | Libya, Algeria, Morocco, Mediterranean region of Europe, Turkey, Cyprus, Palestine | Mar - Apr |
| 13 | *Lavandula multifida* L. | الخزامة | *Lamiaceae* | Gharian, between Shakshouk & Janawan, Wadi El-Majnin, Gebel Nefousa, Azizia on the way to Gharian. | N. Africa (Morocco to Egypt), Spain, Arabian Peninsula, Syria. Palestine to Iran | Mar - Apr |
| 14 | *Lepidium sativum* L. | حب الرشاد | *Brassicaceae* | Benghazi, Derna, Jagbub | Egypt, West Asia | Feb – Mar |
| 15 | *Linum usitatissimum* L. | الكتانية | *Linaceae* | Tripoli, Faculty of Pharmacy, Al-Faateh University, also reported from Barce (El Merj) and Augila. | Known from cultivation only | Mar - Apr |
| 16 | *Ocimum basilicum* L. | الريحان | *Lamiaceae* | Tripoli, Kufra | Africa, Asia, Malaysia. | All year round |


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|---|---|---|---|---|---|---|
| 17 | *Olea europaea* L. | ورق الزيتون | *Oleaceae* | Along the northern coastal belt of Libya | Cultivated in subtropical regions of the world, especially in the Mediterranean region. | Feb -Mar and fruits Sept –Jan |
| 18 | *Origanum majorana* L. | البردقوش | *Lamiaceae* | Misurata and Tripolitania Suk El-Juma, Gargaresh. Zawia, Wadi Alkuf | S. Europe, N. Africa & S.W. Asia, naturalised in other Mediterranean countries. | May – Aug |
| 19 | *Peganum harmala* L. | الحرمل | *Zygophyllaceae* | Garian-Stadium, Yefren, Derna on the way to Tobruk, Al-Jabal Al-Akhdar | N. Africa, S. Europe, Asia Minor, Middle East, S. Russia, Iran, Afghanistan, Pakistan, Kashmir, Tibet, India and Australia | Mar – Oct |
| 20 | *Phagnalon rupestre* L. | عشبة الارنب | *Asteraceae* | Gebel Nefousa, Tripoli, El-Naggaza, El Khumus, Coefia (North of Benghazi), Desert North of Agedabia towards Zuetina, Wadi Mahbool, Baida to Derna coastal road, Shahat | Mediterranean region & S.Spain | Mar - May |
| 21 | *Pimpinella anisum* L. | كمون الحلو | *Apiaceae* | Planted | S. Europe | Apr – Jul |
| 22 | *Portulaca oleracea* L. | بليبشة / الرجلة | *Portulacaceae* | Tripoli, Al-Fateh University Campus, 25-30 km from Benghazi on the way to Benina Airport, Kufra. Also reported from Sokna, Benghazi, Aoudjila, Sebha, Tibesti. | Mediterranean region (Europe & N. Africa), Sudan & S. Africa, S.W. Asia to Pakistan | Mar – Jul |
| 23 | *Punica granatum* L. | قشور الرمان | *Punicaceae* | Tripoli, 13 km from Ras El-Hilal towards Gubba, Hania, Wadi Derna. | Mediterranean countries of N. Africa, Balkan, Asia Minor, Armenia-Kurdistan, Iran, Afghanistan, Pakistan & India (Himalayas), Japan, China, S. Africa & S. America. | Apr – Jul |
| 24 | *Quercus coccifera* L. | البلوط | *Fagaceae* | Al-Jabal Al-Akhdar, Wadi El Teir, Derna, along the coastal road to Susa, halfway between Cyrene (Sahat) and Appolloni (Mersa Susa), in Wadi Roseyt, upper stream of Wadi El Kouf | Mediterranean region of Europe & N. Africa | Mar – Apr |
| 25 | *Rosmarinus officinalis* L. | اكليل الجبل | *Lamiaceae* | Gebel Nefousa, Tripoli, Naggaza, Khoms, Msallata, Al-Jabal Al-Akhdar, Shahat, Ras El-Hilal | Portugal. N.W. Spain. Mediterranean region of S. Europe, N. Africa, Middle East & Turkey | Throughout the year. |
| 26 | *Salvia fruticosa* Mill. | التيه | *Lamiaceae* | Al-Jabal Al-Akhdar, 5km from Shahat on the way to Susa, between El Merj-Tolmetta, Derna. Wadi Derna | Canary Islands & N. Africa. | Mar - May |
| 27 | *Thymus capitatus* (L.) Hoffmanns. & Link | الزعتر | *Lamiaceae* | Yefren, Khoms. Qasr Khiar, El Naggaza near Qasr-Khiar, Near Ragrag Tejween, Gebel Nefousa, Nalut-Ejwabia, Al-Jabal Al-Akhdar, Benghazi | Mediterranean region of Europe and Africa, except Southern France | Apr – Jul |
| 28 | *Torilis arvensis* (Huds.) Link | القميلة | *Apiaceae* | Shahat, 13 km from Ras-el-Hilal on the way to Derna. | W. & C. Europe, Mediterranean region. Caucasia to N. Iran | Mar – Jun |


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|---|---|---|---|---|---|---|
| 29 | *Trigonella foenum-graecum* L. | الحلبة | *Fabaceae* | El-Asaba, 24 km from Garian, El-Jaley: 5 km after Asaba | Mediterranean area: A species of doubtful origin, widely cultivated and often found as an escape from cultivation in Europe, Asia and Africa. | Feb – Apr |
| 30 | *Ziziphus spina-christi* (L.) Desf. | السدر | *Rhamnaceae* | Benghazi, Al-Jabal Al-Akhdar area, Wadi Ajial, Ghat | Sudan, Ethiopia | Sep – Apr |
| 31 | *Cocos nucifera* L.* | زيت جوز الهند | *Arecaceae* | - | - | - |
| 32 | *Simmondsia chinensis* (Link) C.K.Schneid.* | زيت الجوجوبا | *Simmondsiaceae* | - | - | |
| 33 | *Prunus dulcis* (Mill.) D.A.Webb* | زيت اللوز الحلو | *Rosaceae* | - | - | - |
| 34 | *Rosa damascena* Mill.* | زيت الورد | *Rosaceae* | Planted | - | Early summer |

** Oil (extract)*

## Discussion

This study provides a comprehensive quantitative and ethnobotanical evaluation of medicinal and aromatic plant trade across the urban landscape of Benghazi city. By surveying 37 commercial herbal dispensaries across three distinct geographic areas, our findings demonstrate how deeply ingrained traditional phytotherapeutic practices remain within contemporary urban centres, serving as primary or complementary healthcare resources across multiple physiological indications. Quantitative analysis revealed notable variations in monthly consumption volumes among taxa and retail outlets. *Pimpinella anisum* exhibited the highest aggregate consumption (M=66,167g), followed by high-volume utilisation of Linum usitatissimum, *Trigonella foenum-graecum*, *Artemisia herba-alba* and *Punica granatum*. The heavy demand for *P. anisum* and *T. foenum-graecum* aligns with their versatile roles in daily culinary practices and household remedies targeting gastrointestinal ailments, metabolic regulation, and postpartum recovery.

Geographically, while macro-level differences among the eastern, central and western study areas did not reach statistical significance ($p$ = 0.102) due to internal group variance, highly localised retail centres showed pronounced commercial dominance. Specifically, herbal shops in the Al-Sabri area (notably shop no. 5) recorded significantly higher throughput (M = 72,404 g, $p < 0.01$) compared to other residential addresses. Al-Sabri historically functions as a key commercial and wholesale thoroughfare in Benghazi, concentrating patient traffic and retail turnover from surrounding peri-urban communities. The recorded inventory reflects strong taxonomic clustering within Lamiaceae (e.g., *Rosmarinus officinalis*, *Thymbra capitata*, *Salvia fruticosa* Mill., *Ajuga iva* L., *Lavandula multifida* L.) and Asteraceae (*Artemisia herba-alba* Asso, *Cichorium spinosum*, *Phagnalon rupestre*. This dominance corresponds with the characteristic Mediterranean and steppe flora of northeastern Libya. Indigenous upland species such as *Juniperus phoenicea*, *J. communis*, *Quercus coccifera*, *Salvia fruticosa* and *Torilis arvensis* represent relict Mediterranean vegetation adapted to the higher moisture regimes of Al-Jabal Al-Akhdar. In the region of the Pre-Desert Steppe and Arid Saharan Zones, Xerophytic taxa such as *Artemisia herba-alba*, *Citrullus colocynthis*, *Peganum harmala* and *Acacia nilotica* originate from arid and Saharan rangelands. Moreover, cultivated and introduced exotics, widely commercialised seeds and lipid derivatives (*Pimpinella anisum*, *Linum usitatissimum*, *Cocos nucifera*, *Simmondsia chinensis*) highlight an active commercial supply chain supplementing wild-harvested Libyan flora with imported and cultivated commodities. The documented ethnopharmacological applications span seven primary clinical domains, which are gastrointestinal [75], metabolic/cardiovascular [76], musculoskeletal [77], respiratory [78], dermatological [79], reproductive/hormonal [80] and renal systems [81]. However, widespread reliance on potent botanical drugs presents significant toxicological concerns. Species such as *Citrullus colocynthis* and *Peganum harmala* contain active cucurbitacins [82] and beta-carboline alkaloids [83], respectively; excessive self-administration carries acute risks of severe purgation [84][85], mucosal haemorrhage [86][87], neurotoxicity [88][89] and renal impairment. *Artemisia herba-alba*, frequently used for gastrointestinal cramps [90] and glycemic control [91], contains thujone [92] fractions associated with neurotoxicity and potential abortifacient risks [93].

The widespread use of *Salvia fruticosa* and *Trigonella foenum-graecum* for endocrine-related issues (such as PCOS [94][95], glycemic modulation [96][97] and hormone balance [97]) underscores their potent bioactive phytochemistry and


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the necessity of clinical standardisation. The reliance of urban herbal markets on wild-harvested perennial shrubs and slow-growing tree species (*Juniperus phoenicea*, *Quercus coccifera* L., *Thymbra capitata* and *Salvia fruticosa*) poses direct ecological pressure on eastern Libyan ecosystems [7]. Unsustainable harvesting, combined with recurring habitat fragmentation, drought, and land-use change across Al-Jabal Al-Akhdar, accelerates the loss of regional wild germplasm. Developing cultivation protocols for high-demand indigenous species, standardising commercial quality control, and establishing sustainable harvesting regulations are vital steps toward conserving Libya's unique phytodiversity while safeguarding traditional botanical medicine [98]. Determining the exact number of herbal shops in Benghazi proved challenging, since official records list only 92 licensed commercial shops selling herbal materials [10], whereas our field survey identified approximately 189 active herbal shops across the city. This marked discrepancy highlights the urgent need for regulatory authorities to establish closer oversight of this rapidly growing sector.

A pervasive local misconception suggests that "if medicinal herbs do not benefit you, they will not harm you." However, our findings refute this notion; excessive consumption can cause severe medical complications, underscoring the critical need for standardised, controlled dosages. Notably, species of *Teucrium* (locally known as Al-Ja'ada) were virtually absent from the surveyed shops, despite the presence of 13 wild *Teucrium* species in Libya, several of which are endemic to the country or restricted to Cyrenaica. Only one shop displayed a lone *Teucrium* sample, which was excluded from our formal analysis. This reflects a persistent taxonomic challenge; non-specialists working in herbal shops cannot reliably distinguish between closely related congeneric species. It is concluded that current consumption rates of medicinal herbs in eastern Libya's primary urban centre do not currently appear to pose an immediate threat to regional wild flora, suggesting that local natural populations remain relatively stable at present.

## Conclusions

This study provides a quantitative assessment of medicinal plant use in Benghazi, Libya in 2026. The statistical analysis shows that overall plant consumption varies across species, led prominently by *Pimpinella anisum*. Commercial market dynamics are driven more by seller location rather than broad regional differences. Geographically, the Libyan flora demonstrates clear bioclimatic segregation, ranging from Mediterranean maquis to Saharan xerophytes. Ultimately, these results link local ethnobotanical practices with ecological data, providing a baseline for future pharmacognostic research, conservation planning and public health policy regarding herbal medicine. However, current consumption rates of medicinal herbs in the main city of eastern Libya do not appear to pose an immediate threat to wild plant populations, suggesting that for now, the consumption of medicinal herbs in the local market in Benghazi city does not appear to be one of the threats that threaten the abundance and stability of the local wild vegetation.

### *Recommendations*

Seemingly, it is important to establish standardised quality control measures and dosage guidelines across herbal shops that will be crucial to prevent any probabilities of future toxicity or adverse reaction incidents. Furthermore, while current data reveals no immediate overconsumption of wild plant species in Benghazi's markets, proactive conservation strategies are still necessary to protect high-demand species native to fragile habitats such as Al Jabal Al Akhdar and the Saharan oases. Also, regulatory efforts should especially target high-volume retail shops like those at Al-Sabri district. Finally, bridging traditional practices with evidence-based medicine will require focused pharmacological and clinical studies on commonly sold taxa, including the most sold herbs *Pimpinella anisum*, *Linum usitatissimum*, and *Trigonella foenum-graecum*.

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### *Ethical Statement*

The authors confirm that all ethnobotanical surveys, vendor interviews and plant collection protocols complied with relevant institutional and national guidelines. Informed consent was obtained from all participating shop owners, and commercial confidentiality has been strictly maintained. The study did not involve endangered or protected plant species, and no invasive human clinical trials or animal testing were conducted.

### *Conflict of Interest*

The authors declare that they have no known competing financial interests or personal relationships that could have influenced the work reported in this paper. The research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest. Tarek Mukassabi has conceptualised the study, developed the methodology and supervised the research design.


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All authors contributed to the study conception. Khadija S. Omar and Esraa H. Aref carried out material preparation, data collection and data preparation. The experiment design for this study was organised by Tarek A. Mukassabi, who also analysed the data and wrote the first draft of the manuscript. Musbah F. Mohammed assisted with double-checking the data, figures and final version of the manuscript. All authors revised and annotated later drafts and read and approved the final manuscript.

**Data Availability**
The datasets produced and examined in this study are available from the corresponding author upon reasonable request.

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