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Extraction of Essential Oils from Afghanistan Medicinal Plants Using Microwave and Conventional Methods

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Abstract: Afghanistan has many kinds of volatile-oil-rich and not-fully-utilized flora. This article represents a review on Afghanistan medicinal plants contain essential oils. Lamiaceae, Asteraceae and Apiaceae are the most important botanical families which are widely found and used as traditional medicines, food and spices in Afghanistan. Over 215 plants which are used in traditional therapy in Afghanistan, 93 plants contain essential oils. Twenty-two plants contain essential oils applied to microwave extraction techniques and forty-nine plants contain essential oils applied to conventional extraction techniques. Totally 41 extracted species belong to above mentioned botanical families that could be found in Afghanistan too. But still there are some species of these families which are endemic in Afghanistan and not studied yet.

Key words: Afghanistan medicinal plants, essential oils, conventional extraction, microwave extraction.

1. Introduction

Afghanistan is a mountainous country which has a dry climate with very hot summers and very cold winters (+51 and -52.2 °C). This fluctuation of climate has effect on habitude of exploitation of agricultural land and the usage cycle of plants. Afghanistan has more than 5,000 plant species. About 1,200 plant species are endemic [1]. And a great number of plant species are used in traditional medicines [2]. Also most of these floras are volatile-oil-rich but not-fully-utilized.

Traditional medicines are the oldest medical practices in societies which are used long before modern medicines. Different nations, cultures and custom of different nations beholden their growth and development to the use of medicinal plants. According to WHO (World Health Organization) more than 80% of world's population used medicinal plants. It is not just in developing countries but also in USA, UK and other developed countries the usage of herbal medicines is growing up.

In Afghanistan also traditional medicinal therapy has been used since centuries. People of Wakhan Corridor, in Pamir mountain of Afghanistan one of the most remote and insular areas in the world is using local herbal medicines for treatment of infectious disease, fever and pain [3]. Different way of usage of medicinal plants is common in Afghanistan. The most common traditionally way is boiling herbs or making herbal tea by decoction of flowers, leaves or stems of plant in water and then the extract is filtered, while numerous people are in unscientifically manner treat their health problems with plants. Villagers in Pamir mountain of Afghanistan and Tajikistan are using fresh and dried medical plants for treatment and prevention of gastrointestinal, dermatological, kidney illness and hypotension, pain relief etc. [4].

The aim of this study is to show the importance of Afghanistan medicinal plants and its usage for both domestic and industrial people in future. In this article we have reviewed two methods of extraction: microwave and conventional applied widely for extraction of essential oil from plant. Furthermore, the

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spread of essential oil in three most important botanical families in the world (Lamiaceae, Apiaceae and Compositae), as well as the native species of Afghanistan belong to some great genus of these families and contain essential oil is discussed here.

2. Essential Oil

Essential oils in plants are complex mixtures of volatile substances, presented at low concentrations and broadly used in folk medicine for treatment and debarment of different human illness, as well as in the perfume industries especially in production of shampoos, hair lotions, bathing lotion and as disinfectants also in pharmaceutical sectors and in the food and human nutrition [5-7].

The yield and chemical composition of essential oils of a single species of the genus are affected by following factors: Method of extraction, geography or edaphic of growth of plant, collecting period and environmental conditions. Ocimum sanctum shows an increase in essential oil in plant collected from region of Kerala compared two plants collected from Maharahtra of India. Also the amount of essential oil was high in sample collected in winter compared to sample collected in summer [8].

Essential oils have been extracted by hydro-distillation, steam distillation and soxhlet extraction from decades. These techniques take from hours to days and require plenty amount of water, therefore, resulting in the losses of volatile compounds, degradation of unsaturated or ester compounds through thermal or hydrolytic effects and toxic solvents residue in the extract. These drawbacks have led to the developing of new alternative techniques in extraction such as supercritical carbon dioxide, supercritical fluids, ultrasound and microwave extractions [9-11].

Microwaves are form of electromagnetic energy at frequency between 300 MHZ and 300 GHz [12]. The frequency of 2.45 GHz is the most reputed and has a substantial effect on the rate of various chemical and food industries processes [13]. Advancements in microwave extraction have resulted in new techniques for instance compressed air microwave distillation (CAMD), vacuum microwave hydro distillation (VMHD), microwave hydro-distillation (MWHD), solvent free microwave extraction (SFME), microwave-accelerated steam distillation (MASD), microwave steam distillation (MSD) and microwave hydro diffusion and gravity (MHD). Nowadays, more than 500 articles have been published on the topics of microwave extraction [14]. Utilization of microwaves in extraction process has demonstrated to diminish the extraction time and volume of solvent required. Therefore, these methods are environmentally friendly and consuming less energy compared to conventional methods [15].

3. Spread of Essential Oil in Botanical Families

Lamiaceae (Labiatae), Apiaceae (Umbelliferae) and Asteraceae (Compositae) are the most interesting botanical families and there are large numbers of publications which have been reported worldwide.

Essential oils occurred widely in the plant kingdom. In 64 plants families, about 400 species produced essential oil. From viewpoint of essential oil production, the most important families are Asteraceae (Compositae), Lamiaceae (Labiateae) and Apiaceae (Umbelliferae). Fifteen species of each above-mentioned family produce essential oils in a large scale. Fabaceae, Rutaceae, Lauraceae, Cupressaceae, Pinaceae, Zingiberaceae, Myrtaceae, Rubiaceae and Burseraceae are the other important families producing essential oils [16]. Same species of these families are found in Afghanistan too and are utilized in folk medicines largely.

Brackle et al. [1] have shown distribution of these botanical families in Afghanistan. Jeppesen and his co-workers have studied the antibacterial effect of some species of Lamiaceae and Compositae families from Pamir mountain of Afghanistan [3]. A regional research in Behsood in a remote and impoverished

district of Maidan-wardak province of Afghanistan showed that most people in this area have used plants for treatment of different disease which belonged to Lamiaceae, Apiaceae and Asteraceae families.

Seventy-seven botanical families are represented as medicinal plants of Afghanistan traditionally used by people [2]. Over them, thirty-seven families contain essential oil. Tables 1 and 2 show Afghanistan medical plants contain essential oil.

3.1 Lamiaceae (Labiateae)

Lamiaceae botanical family contains 210 genera and 3,500 species [1]. The Lamiaceae family is rich in aromatic species. Therefore, these plants are used as culinary herb, folk medicines and perfumes in many countries. In Lamiaceae family the volatile oil is distributed on the aerial parts of plant [17].

In Afghanistan, 234 species of Lamiaceae family are found in which 67 of them are endemic [1]. Fifteen plants of Lamiaceae family are introduced as medicinal plant [2]. Thirteen plants of this family contain essential oil. *Nepeta laevigata*, *Salvia hydrangea*, *Salvia macrosyphon* and *salvia rhytidea* were extracted by conventional methods [18-22]. Table 1 shows the species of Lamiaceae family extracted by conventional methods. *Mentha longifolia* and *Stachys lavandulifolia* were extracted by SFME method, *Mentha piperita* was extracted by MADD and MAHD and *Ocimum basilicum* was extracted by MAE and SFME [23-28]. Table 2 shows the species of Lamiaceae family extracted by different microwave extraction methods. For all these plants the aerial parts were utilized for essential oil extraction in both HD and microwave extraction methods, but in case of *Salvia macrosyphon* and *salvia rhytidea* the seeds also were used for essential oil extraction.

Nepeta is the largest genera of the Lamiaceae family, and extensively used in folk medicine because of their antispasmodic, diuretic, antiseptic, antitussive and antiasthmatic activities. Most *Nepeta* species are rich in essential oils [29]. In Afghanistan, genus *Nepeta* comprises of 49 species in which 17 of them are endemic.

Salvia is another large genus in Lamiaceae family comprise of many species which have been widely used in traditional medicine therapy. A large amount of genus *salvia* is economically important and used as spices and flavouring agent [30]. The therapeutic properties of *Salvia* are related to their essential oils. The species of *Salvia* bear the attributes of antioxidant, antimicrobial, antifungal, and aromatic [31]. In Afghanistan 25 species of this genus exist over them five species are endemic and have not been studied yet. Table 3 shows the endemic species of Afghanistan belonging to genus *Nepeta*, *Salvia*, *Mentha* and *Thymus*.

3.2 Apiaceae (Umbelliferae)

Apiaceae is a large botanical family which composed of 300-455 genera and more than 3,000 species. The Apiaceae family is usually aromatic plant. Therefore, various Umbelliferae genera are used in industries because of their aromatic and medical virtues [32, 33].

In Afghanistan, 214 species of Apiaceae family are found in which 56 of them are endemic [1]. Totally, 15 plant of Umbelliferae family are introduced as medical plant [2]. Thirteen of these plants contain essential oils. *Conium maculatum*, *Daucus carota*, *Dorema ammoniacum*, *Ferula foetida*, *Prangos pabularia* are extracted by conventional methods [34-38]. Different microwave extractions were applied for essential oil extraction of *Anethum graveolens*, *Opium graveolens*, *Carum carvi*, *Carum copticum*, *Coriandrum sativum*, *Cuminum cyminum*, *Foeniculum vulgare* and *Pimpinella anisum* [39-49]. Tables 1 and 2 show the species of Apiaceae family extracted by conventional and microwave extraction methods. Almost the seeds of these plants were treated for extracting essential oil except for *C. Maculatum*, *O. graveolens* and *A. graveolens* whose leaves and aerial parts were used for oil extraction.

Table 1 Afghanistan medicinal plants applied to conventional extraction methods.

Local name in Afghanistan	Botanical name	Family name	Parts used for study	Bioactivity	Extraction method
Bozbash	*Nepeta laevigata (Don) Hand. Mzt.*	Lamiaceae	Leaves	Fever, Sore throat,	SD [18]
Surkh Sawij	*Salvia hydrangea* L.	Lamiaceae	Aerial part	Carminative, Spasmolytic, anti-inflammation	HD [19]
Kanawcha	*Salvia macrosyphon boiss*.	Lamiaceae	Aerial part Seeds	Emollient, anti-tussive	HD [20] [21]
Malangan	*Salvia rhytidea benth*.	Lamiaceae	Flowers Leaves Seeds	Expectorant, anti-tussive, emollient	HD [22]
Margig	*Conium maculatum* L.	Umbeliferae (Apiaceae)	Leaves Flowers	Toxic	HD [34]
Zardak	*Daucus carota* L.	Umbeliferae (Apiaceae)	Seeds	Column analgesic, Diuretic, Stomachic	SD [35]
Ganda Firoza	*Dorema ammoniacum* Don.	Umbeliferae (Apiaceae)	Fruits	Antimicrobial activity	HD [36]
Heng	*Ferula foetida (bunge) Regel*.	Umbeliferae (Apiaceae)	Gum-Resin	Spasmolytic, anthelmintic	HD [37]
Burboo	*Prangos pabularia* Lindl.	Umbeliferae (Apiaceae)	Leaves Fruits Umbel	Antiseptic, diuretic, aphrodisiac, digestive disorders, scars, bleeding	HD [38]
Boemadaran	*Achillea santolina* L.	Compositae	Aerial part	Antimicrobial, anti-inflammatory, antigastritis	HD [50]
Aqha Anqara	*Anacyclus pyrethrum* L.	Compositae	Root Aerial part	Antimicrobial activity, analgesic, antigastritis, anthelmintic	HD [51]
Mastar	*Artemisia alba* L.	Compositae	Aerial part	Antipyretic, diuretic, anthelmintic, anti-diabetic, leishmanicidal,antibacterial, antifungal	HD [52] [53]
Bahman Safid	*Centaurea behen* L.	Compositae	Aerial part	Cytotoxic, antibacterial, anti-inflammatory, hypotensive	HD [54]
Pirtaran	*Chrysanthemum parthenium Pers*.	Compositae	Flowers	Anti-migraine, anti-arthritis, anti-psoriasis, antibacterial, antioxidant, insecticide	HD [55]
Kasni	*Cichorium intybus*	Compositae	Aerial part	Anti-hypatotic, anti-diabetic, anti-malaria antipyretic	HD [56]
Zanjabir Shahi	*Inula helenium* L.	Compositae	Roots	Anti-bacterial, cerebral analgesic	HD [57]
Kahoo	*Lactuca sativa* L.	Compositae	Seeds Leave	Anti-microbial, antifungal, anti-bacterial, sedative, branchopulmonary infection	HD [58] [59]
Zrad Sarak	*Matricaria disciformis* DC. *Tripleurospermum disciformis* (C. A. Mey.) Sch. Bip.	Compositae	Aerial part	Gastrotonic, carminative, tranquilizer, antifungal, hair tonic, antihemorrhage	HD [60]

(table 1 continued)

Local name in Afghanistan	Botanical name	Family name	Parts used for study	Bioactivity	Extraction method
Parisiawashan	*Adiantum capillus-veneris* L.	Adiantaceae	Leaves	Expectorant, diuretic, laxative, anti-diarrheal	HD [61]
Kalpura	*Aerva javanica* (Burn. f.) Spreng.	Adiantaceae	Leaves Stem Seeds	Anti-gastritis,anti-diabetic, diuretic, sedative	Dry SD [62] HD [63]
Khenjak	*Pistacia khinjuk stocks*.	Anacardiaceae	Aerial part	Sedative, digestion disorders, tonic, toothache, astringent	HD [64]
Gule Gowzuban	*Echium amoenum* L.	Betulaceae	Flowers	Tonic, tranquilizer, diaphoretic, anti-pneumonia, cough suppressant	HD [65]
Korgiah	*Capparis spinosa* L.	Capparaceae	Aerial part	Analgesic, anthelmintic, expectorant, diuretic	HD [66]
Chambli	*Lonicera caprifolium* DC.	Caprifoliaceae	Flowers	Anti-bacterial, antiviral, antioxidant	HD [67]
Awri (Khardal)	*Brassica hirta moench.*	Cruciferae	Seeds	Bronchopulmonary infection, menstruation disorders, anti-neuralgia, anti-pneumonia	SD [68]
Tarboz Abujahel	*Citrullus colocynthis schrad.*	Cucurbitaceae	Seeds	Laxative, anti-cathartic, antioxidant, anti-hypersensitive, ant-diabetic, immunostimulant, anti-bacterial	HD [69]
Abhal	*Juniperus sabina* L.	Cupressaceae	Fruit Leaves	Anti-neoplastic, abortive, antibacterial, antifungal	SD [70]
Amla	*Emblica officinalis gaertn.*	Euphorbiaceae	Fruits Seeds	Anti-bacterial, diuretic, laxtative, hair tonic, anti-insomnia, anti-hemorrhage	SD [71]
Bed Anjir	*Ricinus communis* L.	Euphorbiaceae	Aerial part	Anti-microbial, anti-inflammation, anti-diabetic, liver disorders, laxative	HD [72]
Shahtara	*Fumaria parviflora* Lam.	Fumariaceae	Aerial part	Anti-histaminic, insecticidal	HD [73]
Shirinboya	*Glycyrrhiza glabra* L.	Leguminosae	Leaves	Anti-inflammatory, anti-fungal, anti-cancer, antioxidant, anti-bacterial	HD [74]
Shanbalilia (Hulba)	*Trigonella Foenum Graecum* L.	Leguminosae	Aerial part Seeds	Anti-diabetic, anti-fever, antioxidant, anti-inflammation, anti-microbial	HD [75] SE [76]
Anjir	*Ficus carica* L.	Moraceae	Leaves	Anti-hemoroidal,anti-anemic, stimulant	HD [77]
Bartang	*Plantago lanceolata* L.	Plantagianaceae	Fruit Leaves	Emollient, antitussive	HD [78] SE
Anjabar	*Polygonum bistorta Gaecke.*	Polygonaceae	Flowers	Antioxidant, refreshing, stimulant	HD [79]
Anar	*Punica granatum* L.	Portulacaceae	Seeds Flowers	Anti-diabetic, astringent, anti-diarrhea	CP/HD [80] [81]
Gulab	*Rosa centifolia* L.	Rosacea	Flowers	Mild Anti-viral and bactericidal, cooling, relaxing, toning, anti-asthma	SE [82]
Fuwa	*Rubia tinctorum*	Rubiaceae	Aerial part	Amenorrhea, dropsy, jaundice	HD [83]

(table 1 continued)

Local name in Afghanistan	Botanical name	Family name	Parts used for study	Bioactivity	Extraction method
Sadab	*Ruta graveolens* L.	Rutaceae	Aerial part	For digestive disorders	HD [84]
Rita	*Sapindus trifoliatus* L.	Santalaceae	Seed	Detergent, surfactant, emulsionant	HD [85]
Murche Surkh	*Capsicum annuum*	Solanaceae	Fruits	Flavoring agent, Food dye	SD [86]
Datura	*Datura stramonium*	Solanaceae	Aerial part	Anti-bacterial, antioxidant, spasmolytic, anti-asthmatic, aphrodisiac	SD [87]
Sag Angorak	*Solanum nigrum* L.	Solanaceae	Leaves Arial parts	Anti-ulcer, analgesic, sedative, anti-tuberculoses, anti-tumor, antioxidant, anti-inflammatory	HD [88]
Panirband	*Withania coagulans* Dunal.	Solanaceae	Fruits	Emetic, stomachic, anti-diabetic	SD [89]
Susan bekh (Benafsha)	*Viola odorata* L.	Violaceae	Aerial part	Anti-inflammatory, expectorant, diuretic, antioxidant, as perfume	SD [90]
Espand	*Peganum harmala* L.	Zygophyllaceae	Leaves Seeds	Erosive, hypnotic, antispasmodic, anodyne, emetic	HD [91] [92]
Benafsha Tokhom(Lale Sarnegon)	*Fritillaria imperialis* L.	Liliaceae	Aerial part	Cardiac stimulant	HS [93]
Koknar	*Papaver somniferum* L. Var. Album L.	Papaveraceae	Seeds	As adjuvant for medical diagnostics, as a carrier for cancerostatics in the treatment of hepatocellular carcinoma and cyclosporine A.	SPME [94]
Bang Dana	*Cannabis Sativa* L.	Cannabaceae	Bud	Narcotic	SD [95]

HD	Hydro-distillation
SD	Steam distillation
SE	Steam extraction
SPME	Solid phase micro extraction
CP/HD	Cold Press/Hydro-distillation

Table 2 Afghanistan medicinal plants applied to microwave extraction methods.

Local name in Afghanistan	Botanical name	Family name	Part used for study	Bioactivity	Extraction methods
Raihan (Nazebo)	*Ocimum basilicum* L.	Lamiaceae	Aerial part	Antimicrobial, antioxidant	MAE [12] SFME [15]
Pudina	*Mentha longifolia* (L.) Huds.	Lamiaceae	Aerial part	Anti-inflammation, carminative, antiemetic, diaphoretic, antispasmodic, analgesic, anticatharrral, stimulant	SFME [23] [24]
Nana	*Mentha piperita* L.	Lamiaceae	Leaves	Antiseptic, smoothing, antispasmodic, tonic, vasodilator	MADD [25] OAHD&MAHD [26]
Zarafshan	*Stachys lavandulifolia vahl*.	Lamiaceae	Aerial part	Anxiolytic, sedative	MAHD [27] [28]
Shebet	*Anethum graveolens* L.	Umbeliferae (Apiaceae)	Leaves Seed	Anti-fungal, diuretic	MAE [39]
Ajmood (Karafs)	*Opium graveolens* L.	Umbeliferae (Apiaceae)	Aerial parts	Carminative, stomachic, diuretic, emmenagogue, anti-rheumatism	MAE [40]
Zire Siah	*Carum carvi* L.	Umbeliferae (Apiaceae)	Seed	Perfumes, fragrances, spices, digestive disorders	MAE [41] MDG [42] MAWD [43]
Badian Sabez	*Pimpinella anisum* L. *Anisum vulgare*	Umbeliferae (Apiaceae)	Seeds	Carminative, antispasmodic, antiseptic, expectorant, stomachic, diuretic, diaphoretic, stimulant	MAWD [43]
Jawani	*Carum copticum benth.*	Umbeliferae (Apiaceae)	Seed	Antispasmodic, stimulant, tonic, carminative, antidiarrheal	SFME [44]
Gashniz	*Coriandrum sativum* L.	Umbeliferae (Apiaceae)	Leaves Seeds	Analgesic, antispasmodic, febrifuge, carminative, digestive	MAHD [45] MAE [46]
Zire Asel	*Cuminum cyminum* L.	Umbeliferae (Apiaceae)	Seeds	Spices, column analgesic, antioxidant	MAWD [43] SFME [44] [47] ISFME [46] MAE [48]
Badian Raziana	*Foeniculum vulgare gaertn*.	Umbeliferae (Apiaceae)	Fruits	Carminative, antioxidant, antibacterial, antifungal, mosquito repellent	MAWD [43] MAE [48] IMAE [49]
Afsantin	*Artemisia absinthium* L.	Compositae	Aerial part	Antifungal, antimicrobial, carminative, digestive disorders	SFME [96]
Hublqurtom (Masor)	*Carthamus tinctorius* L. (Safflower)	Compositae	Flowers	Analgesic, antispasmodic, emollient, anti-arthritis, cardiovascular, hypotensive	MD/SPME [97] [98]

(table 2 continued)

Local name in Afghanistan	Botanical name	Family name	Part used for study	Bioactivity	Extraction methods
Gole Babuna	*Matricaria chamomilla* L.	Compositae	Flowers	Antibacterial, antifungal, antiviral, antiparasitic, spasmolytic, antioxidant	MAE [99] [100]
Pista	*Pistacia vera* L.	Anacardiaceae	Fruit Leaves Gum	Antidiarrheal, sedative, alimentary	MAHD [101]
Archa dana (Sarwe Kohi)	*Juniperus excelsa bieb.*	Cupressaceae	Aerial part	Menstrual analgesia anti-tussive, anti-bronchitis, anti-tuberculosis	SFME [102] [103]
Zafaran	*Crocus sativus*	Iridaceae	Stigma Corm	Antispasmodic, expectorant, aphrodisiac	MAE [104]
Henna (Khina)	*Lawsonia inermis roxb.*	Lythraceae	Leaves	Cosmetics, antioxidant	MAHT [105] [106]
Siah dana	*Nigella sativa* L.	Ranunaculaceae	Seeds	Anti-asthmatic, anti-tumor, antiviral, antibacterial, anti-inflammatory, anti-malarial, antihypertensive, anti-diabetic, anti-atherosclerotic, gastroprotective, antioxidant, anti-cholesterol	MSD [107]
Samaruq	*Rhus coriaria* L.	Therebintaceae	Fruits Leaves Flowers	Antiseptic, food flavoring agent, antioxidant, antimicrobial	MAE [108]
Panj Angusht	*Vitex negundo* L.	Verbenaceae	Leaves	Anthelmintic, antibacterial	SFME [109] MAHD

MAHD	Microwave Assisted Hydro-distillation
MSD	Microwave Steam Distillation
MASE	Microwave Assisted Steam Extraction
MAHT	Microwave Assisted Hydro-thermal Extraction
MD/SPME	Microwave Distillation/Solid Phase Micro extraction
OAHD	Ohmic Assisted Hydro-distillation
ISFME	Improved Solvent Free Microwave Extraction
MAWD	Microwave Assisted Water Distillation
SFME	Solvent Free Microwave Extraction

Table 3 The endemic species of Afghanistan plant in the genera of three botanical families comprise essential oil.

	Compositae		Apiaceae		Lamiaceae	
No.	Species	Genus	Species	Genus	Species	Genus
1	*A. andersiana*	Artemisia	*F. afghanica*	Ferula	*N. amicorum*	Nepeta
2	*A. bicolor*	Artemisia	*F. costata*	Ferula	*N.barfakensis*	Nepeta
3	*A. dumosa*	Artemisia	*F. dictyocarpa*	Ferula	*N.bellevii*	Nepeta
4	*A. ghazniensis*	Artemisia	*F. ghorana*	Ferula	*N. freitagii*	Nepeta
5	*A. ghoratensis*	Artemisia	*F. glabra*	Ferula	*N. juncea*	Nepeta
6	*A. Kandaharensis*	Artemisia	*F. hedgeana*	Ferula	*N. nawarica*	Nepeta
7	*C. codringtonii*	Centaurea	*F. heratensis*	Ferula	*N. paktiana*	Nepeta
8	*C. heratensis*	Centaurea	*F. kandahrica*	Ferula	*N. persica*	Nepeta
9	*I. sericeo-villosa*	Inula	*F. myrioloba*	Ferula	*N. podlechii*	Nepeta
10			*F. nuristanica*	Ferula	*N. polyodonta*	Nepeta
11			*F. pachycaulos*	Ferula	*N. rechingeri*	Nepeta
12			*F. rechingeri*	Ferula	*N. subincisa*	Nepeta
13			*F. stenoloba*	Ferula	*N. uberrima*	Nepeta
14			*F. trachelocarpa*	Ferula	*S. ariana*	Salvia
15			*F. trachyphylla*	Ferula	*S. maymonica*	Salvia
16			*F. xanthocarpa*	Ferula	*S. pterocalyx*	Salvia
17					*S. rechingeri*	Salvia
18					*S. tetrodonta*	Salvia
19					*M. longifolia (austroafghanica)*	Mentha
20					*M. royleana (afghanica)*	Mentha
21					*T. koeieanus*	Thymus

The genus *Ferula*—the old-world plant, belongs to Apiaceae family and has some 130 species distributed throughout the Mediterranean area and Central Asia. The plants of this genus are good source of biologically active compounds such as derivatives and sulfur containing compounds [33]. These plants are frequently used as spices and in the provision of local drugs. Some species are used in folk medicine for the treatment of skin infections and hysteria [110]. The Afghanistan flora comprises of 31 species of *Ferula*, of which 16 of them are endemic. Table 3 shows the endemic species of *Ferula* genus in Afghanistan [1].

3.3. Compositae (Asteraceae)

Compositae botanical family contains 9,000 genera and about 20,000 species. Over 180 species are used for medical purposes [111].

In Afghanistan, 705 species of Compositae family are found in which 192 of them are endemic [1]. Shafique et al. [2] introduced seventeen species of Compositae family as medical plants of Afghanistan. Among them, fifteen species are containing essential oil. *Achillea santolina*, *Anacyclus pyrethrum*, *Artemisia alba*, *Centaurea behen*, *Chrysanthemum parthenium*, *Cichorium intybus*, *Inula helenium*, *Lactuca sativa* and *Matricaria disiformis* are extracted by HD [50-60]. *Artemisia absinthinum*, *Carthamus tinctorins* and *Matricaria chamomile* are extracted by different microwave extraction methods [96-100]. Essential oil in the Compositae family is distributed in all parts of the plants. In *A. santolina*, *C. behan*, *Artemisia* genus, *C. intybus*, and *M. disiformis* the essential oil was extracted from aerial part while for *A. pyrethrum*, *I. helenium*, *L. sativa* seeds and for *C. parthenium*, *C. tinctorins* and *M. chamomile* flowers were used for extraction. Tables 1 and 2 show conventional and microwave extraction of plants belong to Compositae family.

Genus *Artemisia* is one of the most abundant plants in Compositae family in the world and has special

interest because of botanical and pharmaceutical properties. Terpenoids are one of the major constitutes of this genus which makes it the most momentous source of biological compounds [112]. In Afghanistan, the genus *Artemisia* consists of 54 species, sex of which are endemic [1]. Table 3 shows the endemic species of *Artemisia* genus in Afghanistan.

4. Essential Oil in Afghanistan

A number of small companies in Afghanistan produce essential oils from bitter orange blossom (Gule narinj) and rose which are used by perfume industries in France [113]. As well as, in Afghanistan, much amount of essential oil is extracted from medicinal plants by boiling water and making tea or by adding seeds or aerial parts of plants in food and cooking them in the kitchen in everyday life of normal people. In these methods less amount of essential oil is extracted. A conventional extractor is specially designed and is difficult to use in houses, but nowadays microwave ovens are available in many markets with reasonable prices and some people already use in their kitchen in cities [114].

5. Conclusions

The purpose of this review was to show the importance of Afghanistan medicinal plants and their utilization in domestic and industrial areas. Two methods of extraction: microwave and conventional extraction applied widely for extraction of essential oil from plant were reviewed in this article.

Species from Compositae, Lamiaceae and Apiaceae which contain much amount of essential oils are widely spread in Afghanistan and traditionally used by people as food, spices and medicines.

Extractions of essential oils from plants which are not endemic plants of Afghanistan have been done in other countries. As the yield and chemical composition of essential oils affected by growth place of a single species, study of species of botanical families from Afghanistan is highly recommended.

Also the native flora in these families still includes many plants for instance genus Artemisia which may contain essential oil, have not been studied yet and can result in new products for pharmaceuticals, perfumes and cosmetics industries.

Given the fact that microwave energy is increased the extracted amount of essential oil and the time of extraction decreased. Therefore, this study may encourage domestic people to use a microwave oven for extracting much amount of essential oil in their kitchen in very short time and take the advantage of both food and medicine from the plants which they use in their daily life as food.

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