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ANTIMICROBIAL ACTIVITY OF ESSENTIAL OIL FROM ACHILLEA FRAGRANTISSIMA (FORSSK.) SCH.BIP.(ASTERACEAE) GROWING WILD IN NORTH BEKAA, LEBANON

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ABSTRACT

Essential oil of fresh aerial parts of *Achillea fragrantissima* growing wild in Lebanese steppe was obtained by hydrodistillation and analyzed using Gas Chromatography and GC/Mass spectrometry.

Antimicrobial activityof the essential oil against 5 bacteria and 2 fungi was determined by diffusion and microdilution methods.

The results revealed a yield of 1.25 % v/w fresh weight of essential oil that had a yellowish color and pleasant fragrant aroma. Fifty onecompounds were identified.Artemisia ketone (29.97%), α-Thujone (13.34%), Germacrene (11.5%) followed by α-Cubebene (6.25%), Spathulenol (3.63%), β-Sesquiphellandrene (3.52%) and γ-Muurolene (3.27%) were the main components.

The oil displayed a high degree of inhibitory activity against the tested five bacteria: *S. aureus, E. coli, E. faecalis,S. enteritidis, P. aeruginosa*that was equal or greater than that of several commonly prescribed antibiotics. The oil also showed high antifungal activity against both *C.albicans* and *A.fumigatus*with the latter exhibiting higher susceptibility to the oil than that againstthe antifungalNystatine.

This study presents the first report on the chemical composition of the essential oil of Lebanese *A.fragrantissima,*and confirms the traditional therapeutic use of the plant. Further pharmacological research is needed to exploit this potential either alone or in combination with existing antibiotics as a promising contribution to the discovery of novel drugs against infections diseases.

Keywords: Achillea fragrantissima; Asteraceae;GC-MS, Essential Oil, Antimicrobial Activity, Lebanon.

I. INTRODUCTION

Medicinal plants have for millennia served as a valuable source for therapeutic agents in traditional medicine. Numerous historical records as well as modern ethnobotanical and pharmacological studies have presented a good evidence on their importance in the treatment of a wide range of diseases. The genus *Achillea* L. (Asteraceae), commonly known as Yarrow, is represented by more than 140 fragrant perennial herbaceous species widespread in Southern Europe, Mediterranean and Middle East regions (Nemeth and Bernath, 2008). The name of the genus was designated after the hero Achilles of the Greek *mythology* Iliad for his use of the plant for wound healing during the Trojan War (Benedek et al., 2007). In Arabic countries, *Achillea* species locally named as *Qaysoon*, *Gesoom* or *Bu'eithraan* (Ahmed et al., 1990; Elmann et al., 2011 and Gamil et al., 2014) are widely used in traditional medicine. Specifically, *A. fragrantissima* is indicated in the treatment of many different ailments (Palombo and Semple, 2001). Decoctions and infusions of the aerial part of this speciesareused against fever, common cold, inflammations and high blood pressure.It is also used asanthelmintic, carminative and urinary tract antiseptic. Chronic diseases such as rheumatism, arthritisand other inflammatory disorders, (El-Ashmawy, 2017), diabetes mellitus, skin inflammations, wounds are also treated by these preparations (Said et al., 2002). Furthermore, the inhalation of fumigationof *A. fragrantissima* is reported to have calmative effect to cure bronchitis and spasms (Oranand Al-Eisawi1998) and to have insecticidal as well as rodenticidal activities (Hifnawi et al. 2001). Recent pharmacological studies have confirmed the anti-inflammatory activities of the plant and demonstrated its antioxidant, antiproliferative capacity and oxidative stress (Eissa et al., 2014; Hammad et al 2013). Moreover, this plant is also shown to be effective against protozoal disease such as *Trypanosoma evansi* (El-Ashmawy et al., 2017). In 2013, a US patent application

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was obtained by Alenad and Al-Jaber for the use of its extract in the treatment of chronic myeloid leukemia cells (US 2014/0314886 A1). More recently, the extract of aerial plant was also reported for its cancer preventive activity (Hamed et al., 2016)

A. fragrantissima is rich in polyphenolics, tannins and flavonoids,and chemical composition of the essential oils from different originshas shown that Santolina alcohol, Artemisia ketone, cis-Thujone and trans-Thujone constitute the main compounds (El Deeb, 1985; Fleisher and Fleisher, 1993; Hifnawy et al., 2001; El Shazly et al., 2004 andGoswamy et al., 2016).

In Lebanon, *A. fragrantissima* is reported as most abundant Achillea species in the steppe region of Hermel in the North East part of the country (Mouterde, 1983). Extracts, infusion, decoction and essential oils are traditionally used through oral and external applications in the treatment of several diseases, particularly, diabetes, cancer, bronchitis and stomach ailments and wound healings.

To the best of our knowledge there has been no studies in Lebanon on the chemical composition of the essential oil nor on the antimicrobial activities of *A. fragrantissima.* Hence, the objective of the present study was to investigate the essential oils yield percent and the composition of the fresh aerial parts of the plantcollected from Hermel-North Bekaa, Lebanon, as well as to screen the antimicrobial efficacy of the oil.

II. MATERIAL AND METHODS

Plant material

Freshaerial parts (400g) of the wild growing *A. fragrantissima* (Figure-1)*were collected at* random from the steppe of Hermel in North Bekaa-Lebanon in June 2017 at Latitude 34.426765 N, Longitude 36.412766 E and Altitude 700 m) (Figure-2).

The species identification was performed based on the taxonomic keys of the "New Flora of Lebanon and Syria" (Mouterde, 1983). Voucher specimen was deposited at the Herbarium of the Department of Botany and Medicinal plants, Faculty of the Agriculture, University Holy Spirit, Kaslik, Lebanon.

Figure 1.Achillea fragrantissima (Forssk.) Sch.Bip. (Asteraceae) Growing wild in North Bekaa, Lebanon Hydrodistillation of essential oil

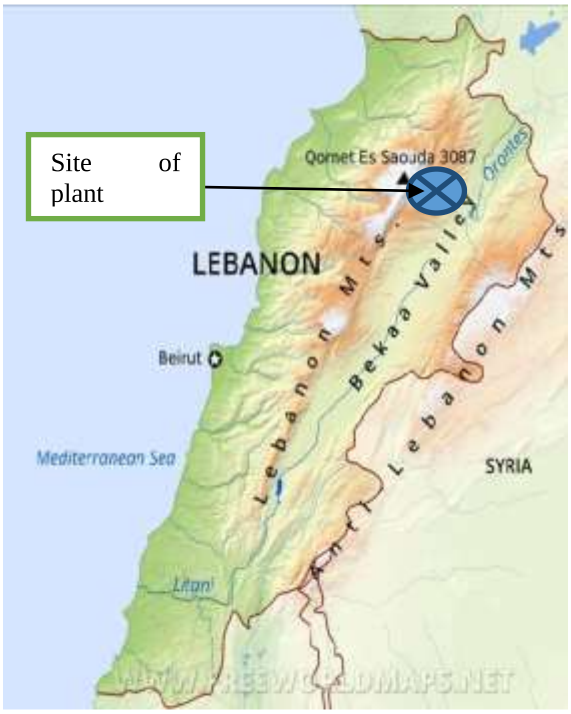

Figure 2.Site of plant collection,Source: Free World Maps.

Fragmented plant material was used for essential oil isolation by hydrodistillation using Clevenger type apparatus for 4 hours according to the standard procedure of the 6th Edition of European Pharmacopeia (2008).

Gas Chromatography (GC) and GC/Mass spectrometry (MS) analysis

GC and GC/MS analysis of the oils were performed by Agilent Technologies 7890 gas chromatography equipped with a Flame Ionization Detector (FID) and a HP-5MS 5% capillary column (30m x 0.25mm x 0.25 µm film thickness). Mass spectra were recorded at 70 e^{-}V of electron energy and a mass range of 50-550 m/Z. The carrier gas was Helium at a flow of 0.8 mL/min.

The initial column temperature was set at 60°C for 1 minute programmed toincrease to 280°C at a rate of 4°C/min. The split ratio was 1:40. The injection temperature was set at 300°C.The purity of Helium gas was 99.99 %. A sample of 1 µL was injected manually in the split mode. Components identification was based on retention indices and comparison with mass spectral data of authentic standards and computer matching with Wiley 229, Nist 107, Nist 21 libraries as well as by comparing the fragmentation patterns of the mass spectra with those reported in the literature.

III. ASSESSMENT OF ANTIMICROBIAL ACTIVITY

Bacterial and fungal strains

Certified bacterial and fungal strains (Medi Mark, Europe) were used in screening the antimicrobial effect of *Achillea. fragrantissima*essential oil. Among the tested bacterial strains, *Staphylococcus aureus*(ATCC BAA-1026) and *Enterococcus faecalis*(ATCC29212) were Gram positive,*Escherichia coli*(ATCC 11303), *Salmonella enteritidis*(ATCC 13076) and*Pseudomonas aeruginosa*(ATCC 9027)were Gram negative, and two pathogenic fungal strains *Aspergillus fumigatus*(ATCC 204305) and*Candida albicans*(ATCC 10231).

Assessment of growth inhibition zone by disc diffusion method

The antimicrobial and antifungal activity of essential oil was carried out by disc diffusion method. Amount of 100 µL of suspension containing 10^6 CFU/mL of microorganisms were spread on cultures of Müller Hinton agar medium (Merck). Sterile 6 mm diameter filter paper discs (Whatman N◦ 3) impregnated with 10 µL of essential oil were placed on the agar.

Standard reference discs of the antibiotics Oxacillin (1µg), Ticarcillin (75µg), Carbenicillin (100µg), Colistin (25µg), Piperacillin (100µg), Erythromycin (15µg) and Tetracycline (30µg) were used as standard antimicrobial positive controls while Nystatine (100µg) was used as standard antifungal positive control. A blank disc was used as a negative control. The bacterial cultures were incubated at 37°C for 24 h, whereas *C.albicans* and *A.fumigatus* were incubated at 27°C for 48 h and 5 days, respectively. The diameter of growth inhibition zones around discs were measured using a Caliper. The test was run in triplicate and the mean values and Standard deviation SD were computed (Bonev et al., 2008).

Determination of minimum inhibitory concentration (MIC) by microdilution method

Minimum inhibition concentration of *A. fragrantissima*defined as the lowest concentration of an antimicrobial agent that inhibits the visible growth of a microorganism after overnight incubation was determined using the microdilution dilution method (CLSI, 2012). This test was performed based on five stock concentrations of the oil (50 mg/mL, 25 mg/mL, 10 mg/mL, 5 mg/mL and 2.5 mg/mL) employing doubling serial dilutions of the oil in 5 ml Muller Hinton Broth (MHB). Microdilution wells containing 100 µL of standardized suspension of tested microorganisms added to 100 µL of a suspension of MHB and *A. fragrantissima*essential oil of different concentrations. The microplates were incubated overnight at 37ºC. All the tests were performed in triplicates and average values were determined.

IV. RESULTS AND DISCUSSION

Composition of essential oil

The fresh aerial parts of *A.fragrantissima*yielded 1.25 % v/w fresh weight of essential oil that had a yellowishcolor and pleasant fragrant aroma. The GC and GC-MS analysis of the oil revealed the identification of 51 compounds representing 99.91 % of total oil (Table1). Oxygenated monoterpenes (56.66%) including Artemisia ketone (29.97%) and α-Thujone (13.34%) constituted the main compounds of the oil followed by

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sesquiterpene hydrocarbons (30.58%) represented by Germacrene-D (11.5%), α-Cubebene (6.25%), β-Sesquiphellandrene (3.52%), γ-Muurolene (3.27%) and β-Eudesmol (2.45%). Whereas oxygenated sesquiterpenes formed 10.23% with Spathulenol (3.63%) being the major component. Monoterpene hydrocarbons contributing to only 1.23% of the oil was mainly constituted of Santolina-triene (0.32%) and Trans-Isolimonene (0.28%).

In spite of the expected variability usually noted in the essential oils of a specific species from different origins, striking similarities between this oil and that obtained by steam distillation of the fresh aerial parts of the plant from the North Badia in Jordan (Al-Sohaili and Al Fawwaz, 2014) and two regions in Egypt (Negev desert and the Sinai) (Fleisher and Fleisher, 2011), were observed. Artemisia ketone and α-Thujone constituted 19.87%, and 12.36%, respectively, of the oil from Jordan. The values of these compounds ranged between 13.2 – 23.8% for Artemisia ketone and 25.5 – 36.5% for α-Thujone of the plant from Egypt (Negev desert and the Sinai) (Fleisher and Fleisher, 2011). Such resemblance may be attributed to the similarities in the physiological responses of the plant to the similar semiarid Mediterranean-Steppe climate and soil textures characterizing the origins of the plants in this and the aforementioned studies (Table 2). On the contrary, considerable qualitative and quantitative variabilities between the oils in the herein study and other studies from different origins are evident in Table 2. Such variations may be further highlighted by the results obtained from different ecoregions in Egypt illustrating the influence of changing ecological niches on the oil composition(Sanli and Karadogan, 2017). In Egypt,Caryophyllene oxide (23.50%) and 1-Terpinen-4-Ol (11.15%) were the main components of the plant from Alexandria(Choucry, 2016), while cis-Thujone (28.4%), Santolina alcohol (16.1%), Artemisia ketone (14.8%) andtrans-Thujone (12.5%) were the main constituents from Allamain desert and Sinai Peninsula (Almadiy et al., 2016). Whereas, Thujone (33.97%), Trans-2,7-dimethyl- 4,6-octadien-2-ol (24.40%) were the major components in Sinai**(Zeedan** et al., 2014). Additionally, the differences noted between the oils of the wild and cultivated forms from North Jordan also illustrate the important influence of the growing conditions even under the same ecological conditions (Hazem et al., 2012).The observed similarities or variabilities emphasize the general consensus that chemotype, genetic variations, nutritional status of the plant, nature of soil, collection timing, and the extraction method as well as the ecological differences (climatic, seasonal and geographical) have influences on the composition of plant essential oils (Arumugam et al., 2016).

Table 1. Chemical composition of fresh areal parts of Achillea fragrantissima (Forssk.) Sch.Bip. (Asteraceae) from North Bekaa, Lebanon (June 2016).

RT	Library/ID	Area%
6.5446	Santolina-triene	0.32
9.5428	Yomogi alcohol	0.4
10.0063	Eucalyptol	0.01
12.6842	**Artemisia ketone**	**29.97**
14.87	**α-Thujone**	**13.34**
15.7111	Thujone	2.1
15.8885	α-Pinene	0.08
16.0258	Sabinol	0.34
16.3635	Camphene	0.55
16.8555	Pinen-3-one	0.53
17.5422	Cis-Geraniol	1.84
17.6566	Terpinen-4-ol	0.21
18.0743	3-Cyclohexene-1-methanol	1.32
18.349	4-Methoxyacetyl-1,4-Hexadiene	1.26
18.8067	Amylene hydrate	0.60
18.9784	Estragole	0.58
19.0814	Dicyclopropyl Methanone	0.31
22.1198	3-Methyl-2-butenoic acid, 3-methylbut-2-enyl ester	0.68

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28.4425	Sabinyl acetate	0.62
32.5108	1,5,5-Trimethyl-6-methylene-cyclohexene	2.22
33.2089	Benzenepropanoic acid, ethyl ester	0.22
34.113	**α-Cubebene**	**6.25**
36.2301	**Germacrene D**	**11.5**
36.4533	**γ-Muurolene**	**3.27**
36.6822	Epiglobulol	1.23
37.6377	β-Cadinene	0.58
38.0554	**β-Sesquiphellandrene**	**3.52**
38.4502	Isomethylionone	0.39
38.6391	2-Phenylanisole	0.59
38.8851	**Spathulenol**	**3.63**
39.074	Salvial-4(14)-en-1-one	0.59
39.2113	Ethyl hydrocinnamate	0.87
39.3543	L-Calamenene	0.69
39.423	Cyclopropylidene-3,3-dimethylcyclohex-5-ene diepoxide	0.31
39.7663	4,7-Methanoazulene, 1,2,3,4,5,6,7,8-octahydro-1,4,9,9-tetramethyl-, [1S-(1.alpha.,4.alpha.,7.alpha.)]-	1.32
39.9666	β-Eudesmol	2.45
40.1096	(1R)-(+)-Trans-Isolimonene	0.28
40.1726	Isoaromadendrene epoxide	0.30
40.2985	Endo-8-hydroxy-cycloisolongifolene	0.63
40.3957	Limonene diepoxide	1.21
40.5617	Vitispirane	0.35
41.0538	Methyl hydrocinnamate	0.16
41.2082	Copaenol	0.24
41.3456	α-Caryophylladienol	0.39
41.7232	Isoeugenol	0.17
42.118	Perhydrofarnesyl acetone	0.24
42.6673	Nonadecane	0.07
42.8733	E-2-Tetradecen-1-ol	0.15
43.1308	(S)-valine	0.70
45.0877	o-Tolyl methylcarbinol	0.10
48.4294	Palatinol	0.22

Monoterpenes hydrocarbons	1.23
Oxygenated monoterpenes	56.66
Sesquiterpenes hydrocarbons	30.58
Oxygenated Sesquiterpenes	10.23
Others compounds	1.21
Total	99.91

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Table 2. Content of the principal essential oil (%) of aerial parts of A. fragrantissima fromdifferent countries of the Middle East and this study.

Country	Main Chemical Composition	Citation
Lebanon (North Bekaa)	Artemisia ketone (29.97%); α-Thujone (13.34%); Germacrene D (11.5%); α-Cubebene (6.25%); Spathulenol (3.63%); β-Sesquiphellandrene (3.52%).	This study
Jordan (North Badia)	Artemisia ketone (19.87%) ; β-Sesquiphellandrene (14.57%); Carvacrol (13.44%); α-Thujone (12.36%); Artemisyl acetate (6.06%); β-Thujone (3.91%) ; trans-Sabinyl acetate (3.62%).	Al-Sohaili and Abdullah, 2014
Jordan (cultivated in Hashemite University, Zarqa)	4-Terpineol (15.65%); Linalool (11.0%); Carvone (9.42%); β-Phellandrene (6.2%); γ-Terpinene (5.6%) ; β-Pinene (4.55%); Verbenone (4.42%) ; Cedrol (3.0%) ; p-Cymene (2.95%); α-Thujone (2.4%).	Hazem et al., 2012
Egypt (North coast of Alexandria)	Caryophyllene oxide (23.5%); 1-Terpinen-4-ol (11.15%) ; Viridifloral (9.84%); Guaienol (9.84%); p-Cymen-3-ol (8.21%); β-Bisabolene (6.88%); Yomogi alcohol (6.43%).	Choucry, 2017
Egypt (Allamain desert and Sinai Peninsula)	Cis-Thujone (28.4%); Santolina alcohol (13.1%), Artemisia Ketone (16.8%); trans-Thujone (12.5%); Camphor (4.7%); Yomogi alcohol (3.2%); 1,8-Cineole (2.7%).	Almadiy et al. 2016
Egypt (Sinai Peninsula)	α-Thujone (33.97%); trans 2,7-dimethyl 4,6-octadiene-2-ol (24.4%); 2,5,5-Trimethyl 3,6-heptadien-2-ol (8.23%); Eucalyptol (8.17%); Artemisia alcohol (3.49%).	**Zeedan** et al. 2014
Egypt (Sinai desert-vicinity of Sader Hetan)	cis-Thujone (29.48%); Santolina alcohol (18.29%); Artemisia ketone (15.24%); trans-Thujone (10.83%); trans-Pinocarveol (6.83%); Yomogi alcohol (4.35%).	El Shazly et al., 2004
(Egypt) Negev desert and the Sinai	α-Thujone (25.5 – 36.5%); Artemisia ketone (13.2 – 23.8%); Santolina alcohol (12.5 – 21.2%).	Fleisher and Fleisher, 2011
Jordan (Al Jubeiha-suburb of Amman)	Artemisia ketone (32.46%) ; β-Sesquiphellandrene (15.05%); α-Thujone (9.92%); Carvacrol (6.28%);β-Thujone (6.26%); Artemisyl acetate (6.05%).	Hamad et al., 2014
Iraq (Karbala)	Thujone (57.5%); Santolina alcohol (31.4%); Eugenol (5.4%); Santolinatriene (2.6%).	Abaas et al., 2013
Egypt (Saint Catherine, South Sinai)	Thujone (33.97%);trans-2,7-dimethyl- 4,6octadien-2-ol (24.40%); 2,5,5-trimethyl-3,6-heptadien-2-ol (8.23%); Eucalyptol (8.17%); 1,5-Heptadien-4-one-3,6-trimethyl (7.65%); Artemisia alcohol (3.49%); Santolina triene (1.97%).	**Zeedan** et al., 2014

Antimicrobial Activity

The results of the antimicrobial activity of the oil against five bacterial strains and two fungal strains using the disc diffusion assay are presented in Table 3. It is evident that the tested strains displayed high degree of susceptibility against the investigated oil with *S. aureus* being the most sensitive (45±0.1mm), followed by *E. coli* (40±0.2 mm), *E. faecalis* (38±0.2mm), followed by *S. enteritidis* (31±0.3mm) and *P. aeruginosa*(30±0.2mm), respectively. Table 3 also shows that the oil generally exhibited equal or greater antibacterial activity when compared with the tested antibiotics namely Oxacillin, Ticarcillin, Carbenicillin, Colistin, Piperacillin, Erythromycin, and Tetracycline. This is highly apparent in the case of the antibiotic Oxacillin, against which all the tested bacterial strains were completely resistant. In accordance with these results *S. aureus* displayed a MIC value of 0.1 mg/ml confirming its highest susceptibility to the oil. This was followed by *C. albicans* (1.5 mg/ml), *E. coli* and *A. fumigatus*(2.0 mg/ml), *E. faecalis* and *S. enteritidis* (2.5 mg/ml). Nevertheless, in spite of the high susceptibility of *P. aeruginosa* observed by the disc diffusion assay, the respective MIC value reached 7.5 mg/ml (Table 4). This may be a result of the attributes of the experimental conditions, particularly the medium chosen for growthof this specific bacteria on the antimicrobial activity of the oil (Friedman et al., 2004; Gomez-Lopez et al., 2005 and Rodriguez-Tudela et al., 2003).

With regards to the yeast*C.albicans* and the fungus*A. fumigatus*, the inhibition zones displayedsimilar diameters (15mm) which were around half of that of Nystatine (31±0.2mm) with C.*albicans*,but higher than of the same antibiotic with *A.fumigatus* (10±0.1mm).

Table 3. Mean±SD growth inhibition zones (mm) of A. fragrantissimaand a group of antibiotics*against the tested microorganisms.

Oil and Antibiotics / Microorg.	*A. frag.* oil	OX. 1µg /disc	TI. 75µg /disc	CB. 100µg /disc	CL. 25µg /disc	PI. 100µg /disc	E. 15µg /disc	TE. 30 µg /disc	Nys. 100µg /disc
E.coli	40 ± 0.2	0.0	33 ± 0.1	36 ± 0.5	18 ± 0.2	25 ± 0.1	12 ± 0.2	27 ± 0.1	-
S.enteritidis	31 ± 0.3	0.0	30 ± 0.8	30 ± 0.1	18 ± 0.2	25 ± 0.1	19 ± 0.1	25 ± 0.2	-
P.aeruginosa	30 ± 0.2	0.0	20 ± 0.5	32 ± 0.6	19 ± 0.1	29 ± 0.4	15 ± 0.1	7 ± 0.3	-
S.aureus	45± 0.1	0.0	0.0	15 ± 0.5	0	0	0	40 ± 0.2	-
E.faecalis	38 ± 0.2	0.0	25 ± 0.3	35 ± 0.1	16 ± 0.3	32 ± 0.3	30 ± 0.1	20 ± 0.1	-
C.albicans	15± 0.1	-	-	-	-	-	-	-	31 ± 0.2
A.fumigatus	15± 0.2	-	-	-	-	-	-	-	10 ± 0.1

* OX: Oxacillin, TI: Ticarcillin, CB: Carbenicillin, CL: Colistin, PI: Piperacillin,E: Erythromycin,TE: Tetracycline and Nys: Nystatine.

Table 4.MICmean ±SD values of the A.fragrantissima essential oil against the tested microorganisms.

Microorganisms	*E. coli*	*S. enteritidis*	*P. aeruginosa*	*S. aureus*	*E. faecalis*	*C. albicans*	*A. fumigatus*
MIC mg/ml	2± 0.1	2.5 ± 0.1	7.5 ± 0.1	0.1± 0.01	2.5 ± 0.1	1.5 ± 0.1	2 ± 0.1

The findings clearly indicate that the essential oil of *A. fragrantissima*possesses a powerful wide spectrum of antimicrobial inhibitory potentialsexhibiting more efficacy than some commonly prescribed antibiotics (Table 3). Although the comparison with the previouslyreported antimicrobial properties of the oil may not be absolutelylegitimatedue to the highvariability in composition and assessment assays, similar high efficacy was reported against several pathogenic (Bacillus cereus, Staphylococcus aureus, Escherichia coli and Pseudomonas aeruginosa), food spoilage microorganism including (cheese, meat, milk, and tomato) and theORF virus (a parapox virus)(Barel et al., 1991; Hazem et al., 2012; Hammad, 2014;Zeedan et al., 2014; Almadiy et al., 2016; Al-Sohaili and Al-Fawwaz, 2014). Theseantimicrobial properties may be mostly attributed to the major components of the essential oil. Nevertheless, the interactive functions of minor components may also have an important role. This potential has been indicated in a recent study that has shown that the essential oilexertsa greater antibacterial activity when compared tosome of its main components such as Artemisia ketone or cis-thujone alone (Almadiy et al., 2016). It has been postulated that antimicrobial activities of the essential oil of *A. fragrantissima*may be attributed to the synergistic effect of both main and minor components indicating thatseveral mechanismspossibly acting on several targets potentiatethe antimicrobial influence. Moreover, the growth inhibition diameters and MIC values indicated in Tables 3 and4, clearly illustrate that the oil had similar efficacy againstGram-positive and Gram-negative bacteria. Similar results have been recently reported by Almadiy and co-investigators on the plant from Egypt (Almadiy et al. 2016). This antimicrobial effect may be primarily associated with the oil destabilization effect of the cellular architecture leading to the breakdown of integrity and increased permeability of cell membrane, thus, disrupting many cellular activities including energy production, membrane transport, and other metabolic regulatory functions (Swamy et al., 2016). At this end, the release of five polypeptides, leakage of K+ ions into the incubation medium and the inhibition of respiration as well as the reduction of ATP content were reported in E. coli cells treated withthe essential oil of *A. fragrantissima*(Barel and Yashphe, 1989).

V. CONCLUSION

This study presents first report on the chemical composition and antimicrobial activity of the essential oil of the aerial parts of wild *A.fragrantissima* from Lebanon. The reported findings confirm the traditional therapeutic value of the plant and indicate the high potential of its essential oil as a source for antimicrobial agents. Comprehensive research aiming at fully exploiting this potential either alone or in combination with existing antibiotics and other therapies, might contribute to the discovery of noveldrug of antimicrobial natural components in combating infectious diseases. The identification of active components and relevant mechanisms of action also stand for another set of ambitious requirements.

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