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Survey and Assessment of Chemical Composition and Biological Activity of Some Wild Plants Growing in the Egyptian Eastern Desert

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- ✓ *Zilla spinosa*;
- ✓ *Schouwia purpurea;*
- ✓ *Farsetia;*
- ✓ *Moringa peregrina;*
- ✓ *Limonium axillare;*
- ✓ *Dodonaea viscosa.*

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Abstract

Within the framework of our program for scientific research and exploration for the discovery of new drug raw materials in the Egyptian eastern desert, which extends parallel to the Red Sea coast approximately 1200 km south of Cairo, we focus on the discovery of the areas where these plants grow. The plants were examined in terms of the chemical content of the active chemical groups, as well as study the impact of water and alcoholic extracts on microorganisms. From these plants, five plants belonging to Brassicaceae family i.e.: *Morettia phillaeana*, *Schouwia purpurea, Zilla spinosa* and two species belonging to the genus *Farsetia; F. longiliqua* and *F. stylosa* were chosen. Also, other three plants were collected belonging to other families. These plants were *Limonium axillare* (Plumbaginaceae), *Moringa peregrine* (Moringaceae) and *Dadonaea viscosa* (Sapindaceae), which collected from wild shrub populations growing in sandy soils in Egyptian eastern desert. They were tested against ten strains of microorganism. Phytochemical investigation of the alcoholic extracts of the aerial parts of the tested plants showed the different profile of their contents. *Limonium, Zilla, Moringa* and *Dodonaea* were the richest plants in chemical constituents which may explain their activity against most of the tested organisms. In most cases the activities of the water extracts exceed those of the alcoholic extracts. The higher activity of the water extract may be due to its higher polarity which leads to better extraction of the chemical compounds from the plants. This may play an important role in folkloric use of these plants in treatment of some human infections.
This study revealed that the four aforementioned plants are valuable antibacterial agents and their potential use in the ailments caused by bacteria; however, their use should be substantiated by *in vivo* experiments.

1. Introduction

Traditional healers in rural areas in many developing countries use medicinal plants as traditional medicines [1-2]. They claim that medicinal plants, when compared with synthetic medicines, they are more effective, cheaper, and have less side effects than synthetic drugs. Low-income people in developing countries use plants for the treatment of common infections [3]. The resistance in human pathogens developed from drugs against commonly used antibiotics has been lead to a search for new antimicrobial substances from natural [4]. Screening of medicinal plants for antimicrobial activities is important for finding potential new compounds for therapeutic use.
Crucifereae or (Brassicaceae) is a large family of 3709 species belonging to 375 genera [5]. In Egypt the family was represented by 53 genera and 105 species. Some species belonging to this family used as medicinal plants and vegetables. They are used as, anticancer [6], antifungal [7], antibacterial [8], antirheumatic [9] and have a potent insecticidal effect [10]. Five plants belonging to family Crucifereae were selected to determine their chemical compositions and antimicrobial activity, namely; *Morettia phillaeana*, *Schouwia purpurea, Zilla spinosa, Farsetia longiliqua* and *Farsetia stylosa.* Also *limonium axillare*, *Moringa, peregrine* and *Dodonaea viscosa* plants belonging to Plumbaginaceae, Sapindaceae and Moringaceae families respectively, were investigated.
Zilla spinosa has important uses in the folk medicine and is one of the most common plant species of Crucifereae family. It is used as a drink against kidney and gall bladder stones [11]. Previous phytochemical study of *Z. spinosa* led to the separation of glucosinolates of progotrin, goitrin, free sinapine, and some other chemical

constituents which have biological activities comprising antioxidant, hepatoprotective, cytotoxic and antiviral activities [12-13].
The genus *Faresita* is represented by three species that grown in Egypt, the most common is *F. aegyptia*, while the other two species were not almost investigated.
Morettia phillaeana is one of two *Morettia* species occur in Egypt[14]. Its smell is characteristic. Investigation of the methanolic extract of the flowering aerial parts of *M. phillaeana* revealed the presence of flavonoids [15-16], which possess some *in vitro* antibacterial activity [17]. Local residents use this plant as food for chickens and sheep. It has also been used as a component in folk medicine for several ailments.
Schouwia purpurea is spread from Mauritania, throughout the Sahel, Sahara and northern Africa to Djibouti and Somalia; also in Arabia. *Schouwia purpurea* is considered as a vegetable, that is important as a fodder and food in the Sahara and Sahel [18].
Moringa peregrine belongs to family Moringaceae. Its different parts are edible and used in folk medicine to treat many diseases [19] e.g. abdominal tumors, hysteria scurvy, paralytic attacks, prostate troubles, sores and skin infections.
Dodonea viscosa Linn., plant (family Sapindaceae), has many traditional benefits from different parts (stem, leaves, seeds, roots, bark and aerial parts). They used as antibacterial, analgesic, antiviral, anti-inflammatory, antiulcer and antioxidant [20].
Limonium axillare belongs to family Plumbaginaceae which are characterized by many biological and medicinal actions such as antiviral, antimicrobial and antitumural [21]. The cited literature showed many biological benefits of these plants in human health, and significance in plants as well as their microbial production. [19, 22, 23]
This work was conducted to investigate and evaluate phytochemical constituents and antimicrobial activities of the selected plants located in the Egyptian eastern desert.

2. Experimental details

2.1. Plant materials

Eight wild plants were collected from wild shrub populations growing in sandy soils in Egyptian eastern desert (Gebel Elba region approximately 1200 km south of Cairo) . Five plants belonging to family Crucifereae, namely; *Morettia phillaeana*, *Schouwia purpurea, Zilla spinosa, Farsetia longiliqua* and *Farsetia stylosa* were collected. Also *limonium axillare*, *Moringa, peregrine* and *Dodonaea viscosa* plants belonging to Plumbaginaceae, Sapindaceae and Moringaceae families, respectively, were collected.
Identification of the species was achieved by staff of the Plant Classification department at the National Research Centre [24-25]. Voucher specimens are kept in the herbarium of NRC, Cairo, Egypt.

2.2. Preparation of the crude extracts

2.2.1. Alcoholic extract

The 80% ethanolic extracts are prepared following the process described [26]; 100 g of the aerial parts of each plant dried in the oven at 40 °C and reduced to powder. They were separately macerated with the 80% ethanol and allowed to stand for 72 hrs and then filtered. The filtrates were then evaporated under reduced pressure and dried using a rotary evaporator at 50°C. Dried extracts were stored in labeled sterile screw capped bottles at 5°C in the refrigerator, until when required for use.

2.2.2. Water extract

Dried powder (100 g) of each plant was macerated in distilled water at room temperature for 24 hrs. The macerates were filtered and evaporated under vacuum till dryness. The residues were dissolved in ethanol and used for measuring the antimicrobial activity of the water extracts.

2. 3. Phytochemical screening

Plants were screened for carbohydrates and/ or glycosides; sterols and/ or triterpenes, flavonoids, tannins, saponins, coumarins and alkaloids, applying the standard procedures.

2.3.1. *Flavonoids*

Half g of the alcoholic extracts was defatted with petroleum ether. The defatted residue was dissolved in 20 ml of 80% ethanol and filtered. The filtrate was used for the following tests: 5 ml of the dilute ammonia solution was added to the portion of the aqueous filtrate of each plant extract followed by the addition of concentrated H_2SO_4. The appearance of the yellow coloration indicates the presence of flavonoids [27].

2.3.2. *Sterols, polyterpenes*
Using Liebermann reagent allows identifying these compounds, Blue-green ring between layers indicates the presence of steroids and pink- purple ring indicates the presence of terpenes [28].

2.3.3. *Polyphenols*
To 1 ml of alcoholic extract, 2 ml of distilled water followed by a few drops of 10% aqueous ferric chloride solution were added. Formation of blue or green color indicated the presence of phenols [27].

2.3.4. *Tannins*
Search for catechin tannins was made using Stiasny's reagent. Five ml of alcoholic extract were evaporated to dryness. After adding 15 ml of Stiasny reagent to the residue, the mixture was kept in a water bath at 80°C for 30 min. The observation of a precipitate in large flakes characterized catechin tannins.
For gallic tannins, the previous solution was filtered. The filtrate was collected and saturated with sodium acetate. The addition of $Fecl_3$ drops causes the appearance of a blue-black coloration, indicating the presence of gallic tannins [29].

2.3.5. *Alkaloids*
Alkaloids were characterized using Bouchardat's reagent (iodo-iodized reagent) and Dragendorff 'reagent (iodobismuthate of potassium reagent). Six ml of the alcoholic extract were evaporated to dryness. The residue is taken up in 6 ml alcohol at 60°C. The addition of 2 drops of Dragendorff's reagent on the alcoholic solution developed a precipitate or orange color. Adding 2 drops of Bouchardat's reagent on the alcoholic solution gave a reddish-brown precipitate which indicated a positive reaction [30]

2.3.6. *Saponosides*
Ten ml aqueous total extract in a test tube was shaken for 15 s and allowed to stand for 15 min. A height of persistent foam greater than 1 cm indicates the presence of saponins [31].

2.3.7 Anthraquinones
The plants were extracted with chloroform and dilute ammonia is added to it. The ammonical layer becomes pink to red due to the presence of anthraquinones derivative (Borntranger's test) [32].

2.4. Biological Activity
2.4.1 Extract preparation
The dry residue of the tested plants was dissolved in alcohol to give concentration of 100 µg/ml.

2.4.2. Microorganism strains
The alcoholic extracts antimicrobial activities were as tested against four gram-negative bacterial strains (*Escherichia coli, Proteus vulgaris, Pseudomonas fluroscens and Salmonella typhi*), Four gram positive strains: (*Bacillus subtilis* -NRRL–B543)*, Lactobacillus breveis, Staphylococcus aureus and Achromobacter sp*), one fungal strain (*Aspergillus niger*) and one yeast strain (*Candida albicans*). Test organisms used were obtained from Faculty of Agriculture, Cairo University.

2.4.3 Agar diffusion method
Nutrient agar was used for the cultivation of bacteria and yeast, and Czapek-Dox's medium for cultivation of fungal species. In this method, pre-sterilized Whatman No.1 filter paper discs (5 mm in diameter) (Whatman International Ltd., Maidstone, England) were impregnated with 100 µl of the extract (100 µg/ml), allowed to dry (to get rid of the alcohol) and applied on the surface of agar plates freshly seeded with standard inocula of young cultures, 24-hrs-old bacteria, yeast, and 7-days-old fungi. The plates of test organisms were then incubated at 27° C for 24 hrs for bacteria and yeast and for 48 hrs for fungi. At the end of the incubation period, the inhibition zones were measured (results are the average of triplicate measurements) [33].

3. Results and Discussion
In the context of our program for scientific research and exploration for the discovery of new drug raw materials in the Egyptian eastern desert, we focus on the discovery of the areas where these plants grow. The survey and assembling of most of the wild plants of various Egyptian eastern desert areas were during the period from October through May of each year, where, it was observed that most wild plants grown in the beginning of the rainfall in these areas (starting from October). So, the period of December to March is the most important

growing period of the wild plants in these areas. The plants were collected from different areas during the growing seasons 2015- 2016, according to the place and the date shown in Table 1. From the collected plants, five plants belonging to Brassicaceae family i.e.: *Morettia phillaeana*, *Schouwia purpurea, Zilla spinosa,* and two species belonging to the genus *Farsetia; F. longiliqua* and *F. stylosa.* Also other three plants were investigated belonging to different families. These plants were *Limonium axillare* (Plumbaginaceae), *Moringa peregrine* (Moringaceae) and *Dodonaea viscosa* (Sapindaceae), which were collected from wild shrub populations growing in sandy soils in the Egyptian eastern desert, approximately 1200 km south of Cairo. The plants were examined in terms of the chemical content of the active chemical groups and tested against ten strains of microorganism.

Table 1. Families, locations and dates of collection of the investigated plants.

Plant Name	Family	Location	Collection Date
Dodonaea viscosa	Sapindaceae	Wadi Yahmib (GA)	Apr- 2016
Farsetia longiliqua	Brassicaceae	Wadi hedreba, kansisrob, Hadabet Al-fote	Dec-2015
Farsetia stylosa	Brassicaceae	Wadi Yahmib (GA)	Dec-2015
Limonium axillare	Plumbaginaceae	Coastal road- El-Quuser	Oct. Dec 2015
Morettia phillaeana	Brassicaceae	Bir El- Gahellia (GA)	Dec-2015
Moringa peregrina	Moringaceae	Wadi kansisrob, -(GA)	Dec-2015
Schouwia purpurea	Brassicaceae	Coastal road- Halaieb	Mar-2016
Zilla spinosa	Brassicaceae	Coastal road- El-Quuser	Dec-2015

GA = Gebel Elba region

3.2. Chemical constituents

Most chemical constituents of the plants are biologically active and are responsible for different activities as antimicrobial, antifungal antioxidant and anticancer [34]. The biologically active secondary metabolites exert their activities through different mechanisms. Studying of the chemical constituents and biological activities of the plants is a demand for the discovery of new therapeutic agents.

Chemical groups found in the 80% alcoholic extracts of the tested plants are shown in Table 2. Phytochemical investigation of the alcoholic extracts revealed the variation between the tested plants.

Table 2. Phytochemical screening of 80 % alcoholic extract of some growing wild plants in Egypt

Plant Name	Carbohydrates and /or glycoside	Sterol and terpenes	Flavonoids	Tannins	Alkaloids	Saponins	Coumarins	Anthraquinones
Dodonaea viscosa	moderate	moderate	moderate	moderate	Absent	moderate	Absent	Absent
Farsetia longiliqua	High	moderate	moderate	Low	Low	Absent	Absent	Low
Farsetia stylosa	High	moderate	moderate	Low	Low	Absent	Low	Absent
Limonium axillare	moderate	moderate	High	High	High	Absent	Absent	High
Morettia phillaeana	High	Low	High	Absent	Absent	Absent	Absent	Absent
Moringa peregrina	moderate	moderate	moderate	moderate	moderate	Absent	Absent	Absent
Schouwia purpurea	moderate	High	High	Absent	Absent	Absent	moderate	Absent
Zilla spinosa	High	Moderate	High	moderate	High	Absent	moderate	High

Morettia phillaeana is rich in carbohydrates and flavonoids. It contains low amounts of sterols and/or terpenes. Data in Table 2 show the absence of tannins, alkaloids, saponins coumarins and anthraquinones from *M. phillaeana.*

Concerning *Schouwia purpurea,* results revealed that the plant contains high amounts of sterols and/or terpenes and flavonoids, moderate amounts of carbohydrates and/or glycosides and coumarins, while the other chemical groups as tannins, alkaloids, saponins and anthraquinones are absent.

The chemical profiles of the two Farsetia spp are almost the same. They contained high amounts of carbohydrates and/or glycosides, moderate amounts of terpenes and/or sterols and flavonoids, low amounts of tannins, alkaloids and coumarins, while anthraquinones and saponins were not detected.

Zilla spinosa was the richest plant in variety and amounts of chemical constituents. It contained high amounts of carbohydrate and/or glycosides, flavonoids, alkaloids and anthraquinones. It contained moderate amounts of sterols and/or terpenes, coumarins and tannins, while only saponins were not found in the plant.

Dodonaea viscosa and *Moringa peregrina* contained moderate amounts of carbohydrates and/or glycosides, sterols and/ or terpenes, flavonoids and tannins, while the presence of alkaloids and saponins varied between the two plants, with the absence of coumarins in both plants.

Limonium axillare contained high amounts of flavonoids, tannins, alkaloids and anthraquinones, while saponins and coumarins were not detected.

From the above results it is clear that the tested plants are rich in carbohydrates and/or glycosides and flavonoids, while saponins are absent except in *Dodonaea*. Sterols and/or terpenes were found in all tested plants with variable amounts. Alkaloids were found only in *Zilla, Limonium, Moringa* and *Farsetia spp.* Coumarins were detected only in *Zilla* spinosa, *Farsetia spp.* and *Schouwia purpurea* in different ratios. *Zilla* and *Limonium* were the only tested plants containing anthraquinones. The presence of flavonoids in *Morettia* and *Zilla* was previously reported by Burham [15], Salwa *et al* [16] and Toumy *et al* [35], respectively. The occurrence of coumarins in *Zilla* was also stated earlier El-Shrabasy and Naima Zayed [36].

3.2. Antimicrobial activity

3.2.1. Antimicrobial activities of 80 % alcoholic extract

The antimicrobial activities of the tested plants are compiled in Table 3. The activities against microorganisms were tested using four gram positive and four gram negative bacteria, one yeast and one fungus.

Table 3. Antimicrobial activities of the 80 % alcoholic extract of some growing wild plants in the Egyptian eastern desert.

Test	Inhibition zone (mm in diameter) ± SE								
	Plant								
Bacteria (G -ve)	*I*	*II*	*III*	*IV*	*V*	*VI*	*VII*	*VIII*	Standard 100µg/
Escherichia coli	7 ± 0.14	N-A	20 ± 0.23	N-A	N-T	10±0.43	10±0.50	11± 0.33	16 ± 0.6
P. vulgaris	N-A	N-A	10 ± 0.42	N-A	N-T	13±0.62	+	9±0.27	21 ± 0.90
P. Fluroscens	N-A	N-A	NA	N-A	N-T	20±0.95	+	NT	26± 0.39
S. typhi	N-A	N-A	NA	N-A	N-T	13±0.71	9±0.28	10±0.17	19 ± 0.83
Bacteria (G +ve)									
B. subtilis-NRRL-B543)	N-A	N-A	20 ± 0.57	N-A	N-T	10±0.33	9±0.19	11±0.14	24± 0.51
C. sp	N-A	N-A	7 ± 0.11	N-A	N-T	14±0.24	8±0.13	7±0.29	N-T
L. Breveis	N-A	N-A	14 ± 0.09	N-A	N-T	12±0.49	+	10±0.35	N-T
Staph.Aureus	N-A	N-A	N-A	N-A	N-T	16± 0.77	+	+	22 ± 0.80
Yeast									
C. albicans	N-A	N-A	N-A	N-A	N-T	20±0.89	9±0.08	10±0.50	12 ± 0.53
Fungi									
A. niger	N-A	N-A	N-A	N-A	N-T	13±0.29	7±0.11	N-T	9 ± 0.30

N-T= not tested, N-A= not active, + = Low activity, *I: Morettia phillaeana, II: Schouwia purpurea, III: Zilla spinosa, IV: Farsetia longiliqua, V: Farsetia stylosa, VI: Limonium axillare, VII: Moringa peregrina, VIII: Dodonaea viscosa,* standard for bacteria= amoxicillin, standard for yeast and fungi=canestin.

Schouwia purpurea and *F. longiliqua* showed no antimicrobial activity against all tested strains. *Morettia phillaeana* showed weak activity against *E. coli*. These results are in agreement with earlier report about the activity of *M. philaeana* against *E. coli* [16]. This report also suggested that *M. phillaeana* extract was inactive

against S. *aureus* and *C. albicans*.

Zilla spinos has the highest antimicrobial activity among the tested plants. It is active against three gram positive strains; *B. subtilis*, *C. sp* and *L. breveis*. The highest activity was against *B. subtilus* (inhibition zone 20 mm in diameter) followed by *L. breveis* (inhibition zone 14 mm in diameter) and the least activity was against *C. sp*. (Inhibition zone 7 mm in diameter). *Zilla* is also active against two gram negative strains; *E. coli* (inhibition zone= 20 mm in diameter) and *P. vulgaris* (inhibition zone=10 mm in diameter), while *C. albicans* and *A. niger* were insensitive to the plant extract. Some investigators reported that *Z. spinosa* alcoholic extract was inactive against fungi and active against *E. coli* [36].

Results in Table 3 showed that *Limonium axillare* has a broad spectrum antibacterial and antifungal activities, where it is active against all tested strains. Its activities against *C. albicans* and *A. niger* is higher than those of the standard.

Dodonaea viscosa also has wide antimicrobial spectrum since it is active against yeast, fungi and most of the tested gram negative and gram positive bacteria. It is followed by *Moringa peregrina* which is also active against yeast and fungi, but its activity is lower against gram negative and gram positive bacteria.

3.2.1. Antimicrobial activities of water extract

Data in Table 4 represent the antimicrobial activities of water extracts of the tested plants. Comparing the antimicrobial activities of water extracts and the alcoholic extracts of the selected plants (Tables 3 and 4) revealed that the water extracts showed the same trend as the alcoholic extracts, where the water extract of *Zilla, Limonium, Moringa* and *Dodonaea* have antimicrobial activities as in the case of the alcoholic extracts, while both the water and alcoholic extracts of the other tested plants are inactive.

Table 4. Antimicrobial activities of water extract of some growing wild plants in the Egyptian eastern desert.

Test	Inhibition zone (mm in diameter) ± SE								
	Plants								
Bacteria (G -ive)	*I*	*II*	*III*	*IV*	*V*	*VI*	*VII*	*VIII*	Standar 100µg/
E. coli	N-A	N-A	12±0.55	N-A	N-T	15±0.94	12±0.33	15±0.72	16 ± 0.
P. vulgaris	N-A	N-A	12±0.71	N-A	N-T	13±0.98	+	12±0.55	21 ± 0.
P. fluroscens	N-A	N-A	NA	N-A	N-T	20±0.79	+	12±0.67	26 ±0.
S. typhi	N-A	N-A	NA	N-A	N-T	13±0.68	13±0.14	14±0.38	19 ± 0.
Bacteria (G+ ive)									
B. subtilis-NRRL–B543)	N-A	N-A	12±0.60	N-A	N-T	20±0.99	12±0.08	15±0.80	24± 0.5
C. sp	N-A	N-A	+	N-A	N-T	14±0.84	12±0.32	13±0.09	N-T
L. breveis	N-A	N-A	14±0.73	N-A	N-T	12±0.75	+	+	N-T
Staph. aureus	N-A	N-A	N-A	N-A	N-T	16±0.60	+	12±0.19	22 ± 0.
Yeast									
C. albicans	N-A	N-A	N-A	N-A	N-T	12±0.17	14±0.36	14±0.47	12 ± 0.
Fungi									
A. niger	N-A	N-A	N-A	N-A	N-T	13±0.25	NA	NA	9 ± 0.3

N-T: not tested, N-A: not active, + = Low activity, *I: Morettia phillaeana, II: Schouwia purpurea, III: Zilla spinosa, IV: Farsetia longiliqua, V: Farsetia stylosa, VI: Limonium axillare, VII: Moringa peregrina, VIII: Dodonaea viscosa,* standard for bacteria= amoxicillin, standard for yeast and fungi=canestin.

Water extracts of *Limonium, Moringa* and *Dodonaea* have higher or equal activities than those of the alcoholic extracts, while the opposite is true for *Zilla* where the alcoholic extract is more active (diameter of the inhibition zones) against most of the sensitive organisms than the alcoholic extract.

Huge numbers of secondary metabolites having antimicrobial activity are produced by plants [37]. Secondary metabolites that posse's antimicrobial activities are classified into three groups: alkaloids, phenolics and terpenes. The largest groups of secondary metabolites that have showed antimicrobial activity are the phenolics and polyphenols. Phenols, phenolic acids, flavonoids, flavonols, flavones, quinones, coumarins and tannins are main subclasses in this group of compounds. Chemically, phenols consist of a hydroxyl functional group (-OH) pound to an aromatic phenolic group. The number and site(s) of hydroxyl groups on the phenol group are related to their relative toxicity to microorganisms, knowing that increased hydroxylation increased toxicity [38]. Quinones form irreversible complexes with nucleophilic amino acids in proteins [38]. Surface-exposed adhesins,

cell wall polypeptides and membrane-bound enzymes are a probable target in the microbial cells. Plants synthesized flavones, flavonoids and flavonols as a response to microbial infection which explain their antimicrobial activity in vitro against a wide range of microorganisms [38]. Their activity is due to the ability to form complexes with soluble and extracellular proteins and to form complexes with bacterial cell walls. Microbial membranes may also be disrupted by lipophilic flavonoids [38]. Tannins are composed of two groups, condensed and hydrolyzable tannins. Their mode of antimicrobial action may be due to a property known as astringency related to their ability to inactivate microbial adhesions, enzymes and cell envelope transport proteins. Macrophages have been found to be stimulated by coumarins, which could have an indirect negative effect on infections [38].The antibacterial action of terpenes is considered to involve membrane disturbance by the lipophilic compounds. So, addition of a methyl group, which causes increasing in the hydrophilicity of diterpenoids, leading to reducing their antimicrobial activity drastically [38]. Alkaloids are characterized by being heterocyclic nitrogen compounds derived from amino acids and have alkaline properties due to the presence of nitrogen. Their activity as antibacterial agents is due to their capacity to inhibit cell respiration, intercalate with DNA, and enzymes inhibition (esterase, DNA-, RNA-polymerase) [39].

Conclusion

Phytochemical investigation of the alcoholic extracts of the aerial parts of the tested plants showed the different profile of their contents. *Limonium, Zilla, Moringa* and *Dodonaea* were the richest plants in active ingredients which may explain their activity against most of the tested organisms. In most cases the activities of the water extracts exceed those of the alcoholic extracts. The higher activity of the water extract may be due to its higher polarity which leads to better extraction of the chemical compounds from the plants. This may play an important role in folkloric use of these plants in treatment of some human infections.

This study revealed that the four mentioned plants are valuable antibacterial agents and their potential use in the ailments caused by bacteria; however their use should substantiated by *in vivo* experiments.

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