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RESEARCH ARTICLE

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MORPHOLOGICAL CHARACTERIZATION AND BIOLOGICAL ACTIVITY OF SOME ETHNO-MEDICINAL PLANTS OF SINAI-EGYPT

ABSTRACT:

Multiple approaches of taxonomic analyses (e.g., documentation of the biological origin and morphological characteristics) are important for characterizing herbal drugs in a systematic manner to reach authentication, and thus maintaining herbal drug efficacy. Sixteen ethno-medicinal plant species belonging to sixteen genera and ten families collected from Wadi Alarbaeen of Saint Catherine, Sinai, Egypt were investigated macro- and micromorphologically. 70% ethanolic extracts of these plants also were investigated for their biological activity *versus* different microorganisms. Results showed that powerfull activity was recorded for some studied taxa *viz*. *Achillea fragrantissima*, *Alkanna orientalis*, *Artemisia judaica, Asclepias sinaica, Capparis spinosa*, *Fagonia glutinosa, Matthiola arabica*, *Nitraria retusa*, *Origanum syriacum*, *Peganum harmala, Phlomis aurea*, *Pyrethrum santolinoides*, *Retama raetam, Teucrium polium* and *Verbascum sinaiticum*. These plants of medicinal importance were fully described macro- and micromorphologically for easier and more accurate identification. The conclusion of the obtained results was that morpho-anatomical characters and biological activity not only provide characters for their correct taxonomic authentication, but also serve as standard data for the quality assessment of the pharmaceutical preparation of herbal drugs.

KEY WORDS:

Antimicrobial Activity, Medicinal Plants, Morphology, Sinai

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INTRODUCTION:

Unique type of vegetation of Saint Catherine mountains is due to wide variation in climate and due to their specific geomorphologic formations. South Sinai mountains shows greater biodiversity than in the rest of Egypt. A large area of the region was declared a protectorate in 1996. Saint Katherine protectorate is a unique floristically diverse spot in the Middle East. 44% of Egypt's endemic plants present in this specific spot. About 1261 species were recorded in Sinai (Bolous, 1995). 472 plant species are surviving in south Sinai (Fayed and Shaltout, 2004) of these 19 species are endemic (Bolous, 1995).

Sinai Peninsula is considered as one of the major known sources for ethno-medicinal plants in the Arabian deserts. There is voluminous but fragmentary work concerning macro-morphological characteristics of Egyptian wild medicinal plants. To cite but a few one can refer to the work of Bolous (1999), Tackholm (1974), and Batanouny (1999).

Desert plants were used extensively by Bedouins in their habitats. Many ethno-medicinal plant species from Sinai have been identified and their use documented in some ethno-herbal literatures (Bailey and Danin, 1981; Bolous, 1983). These literatures include

plants used in folk medicine by the Bedouins in Sinai as antimicrobia agents, and for some diseases treatment.

One of the major means of identification of ethno-medicinal plants is the anatomical method that play an important role in checking adulteration, fraud and substitution (Pandey, 2004).

Previous studies showed that all 16 plants have antibacterial and antifungal activities except *Asclepias sinaica* that showed no antimicrobial activity, *Verbascum sinaiticum* that showed antibacterial but not antifungal activity, *Alkanna orientalis* that has only activity against GM +ve bacteria and *Matthiola arabica* whose antibacterial activity is unknown and exhibiter no antifungal effect (El-Sayed *et al*., 2013; Hammad *et al*., 2014; Husein *et al*., 2014; Khan *et al*., 2014; Mahboubi and Mahboubi, 2014; Mariem *et al*., 2014; Janaćković *et al*., 2015; Mohamed *et al*., 2015).

The conducted study aimed to examine the ability of morphological criteria and antimicrobial activity of studied taxa to authenticate the drug in both forms *viz*. intact and powdered.

MATERIAL AND METHODS:

The present study including 16 species occupied South Sinai, Egypt, representing 16 genera. Plant materials were collected from Wadi Alarbaeen of Saint Catherine.

Taxonomically authentication of the wild Egyptian species reached according to Tackholm (1974) and Bolous (2002), Voucher specimens were deposited at Herbarium of Botany Department, Faculty of Science, Beni suef University, Beni suef, Egypt.

Morphological investigation:

Whole plant:

Macromorphological description of the whole plant, inflorescence, flower, fruit and seed was performed on living specimens under study or compiled from literatures.

Stem and Lamina Anatomy:

Stem segments and a portion of the middle of lamina with midrib were fixed in FAA then stored in 70% ethanol. All sections were made with hand microtome at 10-20 µm then double stained with safranine/light green combination; mounted in Canda Balsam according to the customary method of (Johansen, 1940); investigated by LM; Reichert Microstar IV microscope was used for photographing at the central research laboratory, Botany department, Faculty of science, Beni suef University. Cumulative plates and tables were presented to clarify the extracted data. Terminology of Eames (1929) and Koller and Rost (1988) was followed to describe the micromorphological characters.

Stomatography (LM andSEM):

Stomatographic investigation was carried according to the traditional method of (Stace, 1965). For scanning electron microscopy, small pieces (7 mm^2) of the plant material (leaves) were fixed on SEM stubs with double-sided tape, gold-coated in SPI-Module sputter coater, examined and documented photographically with Jeol JSM 5200 at different magnifications (750X-1500X).

Antimicrobial investigation:

Sampling and processing of plant material:

Sampling of plant material was carried out during April (growing season) of 2012 from Wadi Alarbaeen of Saint Catherine. Samples were air-dried in the shade, was ground to a fine powder. Pressed voucher herbarium specimen was processed for each taxa and deposited in the Herbarium of the Botany Department, Faculty of Science, Beni Suef University. Flowers or fruits of specimens were collected to facilitate taxonomic identification. Aerial parts of 16 wild taxa belonging to 16 genera from 10 families were randomly collected (Table 1).

Extraction method:

About 12 g. of plant material (mainly fine powdered leaves) was soaked in 100 ml 70% ethyl alcohol overnight for maceration in order to produce crude extracts with a wide range of active compounds. The mixture was stirred for ten minutes and allowed to settle for five min. The supernatant was filtered by use of a Whatman no. 1 filter paper. The extracts were weighed and re-dissolved (0.1% w: v) in 70% ethyl alcohol. Each extract was recovered in 70% ethyl alcohol at a concentration of 100 mg/ml. Then, Whatman No. 3 filter paper discs (5 mm of diameter), impregnated with 10 µL of extracts at 100 mg/mL (1 mg per disc), were placed on the surface of agar (Khafagi and Dewedar, 2000).

Assay of antimicrobial activity:

Evaluation of antimicrobial activity of 70% ethyl alcohol crude extracts were performed *versus* three strains of bacteria *viz*. two strains of Gram +ve (1) *Bacillus subtilis* (NRS-744); and (2) *Staphylococcus aureus* (B-767), and one strain of Gram -ve (3) *Escherichia coli* (B-3704), a yeast (4) *Candida albicans* (Y-477), and a filamentous fungus (5) *Fusarium solani*. An inoculum of each bacterial strain was suspended in 5 ml. of nutrient broth and incubated at 37°C overnight. Yeast and dermatophytic fungi were suspended in 5 ml sabouraud dextrose broth and incubated at 30°C for 48–72 h. The inoculated cultures were diluted 1: 10 with broth. Crude herb extracts were screened for antimicrobial activity by using the disc diffusion assay (Ericsson and Sherris, 1971). The antimicrobial criteria of the studied taxa subjected to numerical analysis by using CAP software to assess if these criteria can be used for taxonomic segregation.

Table 1. The Studied Taxa.

No.	Taxa	Family
1.	*Achillea fragrantissima* Sch.Bip. -- Flora 38: 13. 1855 (IK)	Asteraceae
2.	***Aerva tomentosa* Forssk.** -- Fl. Aegypt.-Arab. p. cxxii. 170; Lam. Encyc. i. 46. (IK) **=** *Aerva javanica (Burm. f.) Juss. ex Schult.*	Amaranthaceae
3.	*Alkanna orientalis* Boiss. -- Diagn. Pl. Orient. ser. 1‹ 4: 46. 1844 [Jun 1844] (IK) ≡*Anchusa orientalis L. (basionym)*	Boraginaceae
4.	*Artemisia judaica* Lour. -- Fl. Cochinch. 2: 489. 1790 [Sep 1790] (IK)	Asteraceae
5.	***Asclepias sinaica Muschl***. -- Man. Fl. Egypt ii. 753 (1912). (IK) = Gomphocarpus *sinaicus Boiss.*	Asclepiadaceae
6.	*Capparis spinosa* L. -- Sp. Pl. 1: 503. 1753 [1 May 1753] (IK)	Capparaceae
7.	***Fagonia glutinosa*** Delile -- Fl. Egypte 230. t. 28. f. 2. (IK) =*Fagonia glutinosa Delile var. grandiflora Boiss.* =*Fagonia glutinosa Delile var. nuda Hadidi*	Zygophyllaceae
8.	***Matthiola arabica*** Boiss. -- Ann. Sci. Nat.‹ Bot. sér. 2‹ 17: 49. 1842 (IK) =*Matthiola arabica Velen.*	Brassicaceae
9.	*Nitraria retusa* Asch. -- Verh. Bot. Vereins Prov. Brandenburg 18: 94. 1876 (IK)	Zygophyllaceae
10.	***Origanum syriacum*** L. -- Sp. Pl. 2: 590. 1753 [1 May 1753] (IK) =*Origanum maru L.* = *Majorana crassifolia Benth.*	Lamiaceae
11.	***Peganum harmala* L.** -- Sp. Pl. 1: 444. 1753 [1 May 1753] (IK)	Zygophyllaceae
12.	***Phlomis aurea* Decne. -- Ann. Sci. Nat.‹ Bot. sér. 2‹ 2: 251. 1834 (IK)**	Lamiaceae
13.	***Pyrethrum santolinoides DC. -- Ann. Sci. Nat.‹ Bot. sér. 2‹ 2: 264. 1834 (IK)*** *= Tanacetum sinaicum (Fresen.) Delile ex Bremer and Humphries.* *=Santolina sinaica Fresen.*	Asteraceae
14.	***Retama raetam Webb and Berthel.*** *-- Hist. Nat. Iles Canaries (Phytogr.). ii. 56. (IK)*	Leguminosae
15.	***Teucrium polium* L.** -- Sp. Pl. 2: 566. 1753 [1 May 1753] (IK)	Lamiaceae
16.	***Verbascum sinaiticum* Benth.** -- Prodr. [A. P. de Candolle] 10: 236. 1846 [8 Apr 1846] (IK)	Scrophulariaceae

RESULTS AND DISCUSSION:

Section A: Macro-morphological characters (Fig. 1):

In the ongoing section, the morphological criteria of the taxa under investigation are introduced to facilitate deducing the major diagnostic features.

Habit; subshrub in *Origanum syriacum* and *Teucrium polium*, herb in *Aerva tomentosa*, *Alkanna orientalis*, *Fagonia glutinosa, Matthiola Arabica* and *Phlomis aurea*, or shrub in the remainings.

Stem branching; branched in nineteen taxa or unbranched in *Phlomis aurea*.

Arrangement of leaves; alternate/spirally rosette in *Verbascum sinaiticum*, opposite in *Asclepias sinaica*, *Fagonia glutinosa, Origanum syriacum, Phlomis aurea* and *Teucrium polium* or alternate in nine taxa.

Leaf composition; pinnatified in *Origanum syriacum*, pinnately lobed in *Pyrethrum santolinoides,* dissected in *Artemisia judaica*, dissected twice or more in *Peganum harmala*, compound trifoliate in *Fagonia glutinosa* or simple in the remaining taxa.

Blade shape; Linear/narrow-ovate in *Aerva tomentosa*, Oblanceolate to elliptic in *Artemisia judaica*, ovate/orbicular in *Capparis spinosa*, Oblong/ovate to rhombic in *Fagonia glutinosa,* obovate-cuneate in *Nitraria retusa*, Oblong/ovate in *Origanum syriacum*, Linear in *Phlomis aurea*, Oblong/elliptic in *Pyrethrum santolinoides*, Oblong-linear in *Teucrium polium*, elliptic in *Verbascum sinaiticum*, Oblong/lanceolate in *Achillea fragrantissima* and *Alkanna orientalis* or linear/lanceolate in *Asclepias sinaica, Matthiola arabica* and *Peganum harmala*.

Blade apex; rounded (*Achillea fragrantissima*), mucronate, obtuse to emarginated in *Capparis spinosa*, acuminate in *Fagonia glutinosa*, retuse or crenate-dentate in *Nitraria retusa*, subacute in *Teucrium polium*, cuspidate in *Verbascum sinaiticum,* obtuse in *Artemisia judaica*, *Matthiola Arabica, Origanum syriacum* and *Pyrethrum santolinoides* or acute in *Aerva tomentosa, Alkanna orientalis, Asclepias sinaica, Peganum harmala* and *Phlomis aurea*.

Blade margin; dentate in *Achillea fragrantissima*, undulate (*Alkanna orientalis*), revolute (*Asclepias sinaica*), scarious in *Matthiola Arabica and Pyrethrum*

santolinoides or entire in the remaining studied taxa. Petiole detection; sessile in *Artemisia judaica*, subsessile in *Retama raetam* or petiolate in the remaining taxa. This is in agreement with Batanouny (1999), Farhat (2012), Bolous (2002), and Brullo *et al*. (2013).

Inflorescence; dense racemose branches in *Artemisia judaica*, solitary axillary in six taxa or terminal in the remainings. Cyme/umbellate (*Asclepias sinaica*), corymbose in *Pyrethrum santolinoides*, paniculate (*Artemisia judaica* and *Matthiola Arabica*), cymose in *Fagonia glutinosa* and *Peganum harmala*, raceme in *Nitraria retusa*, *Retama raetam, Teucrium polium* and *Verbascum sinaiticum* or panicle in *Achillea fragrantissima, Aerva tomentosa, Alkanna orientalis, Origanum syriacum* and *Phlomis aurea*.

Flowers/inflorescence; many in six taxa or few in the remaining taxa.

Flowers; unisexual (*Achillea fragrantissima* and *Aerva tomentosa*) or bisexual in the remainings. Subsessile (*Matthiola Arabica*), pedicellate (*Capparis spinosa Nitraria retusa* and *Retama raetam*) or sessile in the remainings. zygomorphic in *Fagonia glutinosa, Phlomis aurea, Pyrethrum santolinoides, Retama raetam* and *Teucrium polium* or actinomorphic in the remainings.

Calyx; four sepals in five taxa or five in the remainings. Shape of sepals; funnel in *Alkanna orientalis,* ovate/oblong in *Fagonia glutinosa*, linear/oblong in *Matthiola arabica*, Obovate/oblong in *Peganum harmala*, slender in *Pyrethrum santolinoides*, bell-shaped in *Teucrium polium*, Linear-oblong/elliptic in *Verbascum sinaiticum*, ovate in *Aerva tomentosa* and *Asclepias sinaica* or tubular in *Achillea fragrantissima, Origanum syriacum* and *Phlomis aurea.* Cohesion; poly-sepalous in five taxa or gamo-sepalous in the remainings.

Corolla; greenish white in *Nitraria retusa*, yellowish white in *Peganum harmala*, purplish/pink in *Fagonia glutinosa* and *Matthiola arabica,* white in five taxa or yellow in the remaining investigated taxa. Petal shape; funnel (*Alkanna orientalis*), valvate (*Asclepias sinaica*), obovate in *Capparis spinosa*, spathulate in *Fagonia glutinosa*, linear to oblong-obovate in *Matthiola Arabica*, limb in *Phlomis aurea,* cylindric in *Pyrethrum santolinoides*, cupulate in *Verbascum sinaiticum*, oblong/obovate in *Aerva tomentosa* and *Peganum harmala* or tubular in the remaining studied taxa. Number of petals; two in *Aerva tomentosa*, four in *Capparis spinosa* and *Matthiola arabica* or five in the remaining studied taxa. Petals cohesion; polypetalous in four taxa or gamopetalous in the remaining investigated taxa.

Androecium; ten stamens (*Fagonia glutinosa*), six in *Matthiola arabica*, fifteen in *Nitraria retusa* and *Peganum harmala*, four in *Origanum syriacum, Phlomis aurea* and *Teucrium polium* or five in the remaining studied taxa. Direction of anthers; absent (*Aerva tomentosa*), extrose in four taxa or introse in the remainings.

Gynoecium; ovary inferior in four taxa or superior in the remainings. Subsessile in *Achillea fragrantissima* and *Matthiola arabica* or sessile in the remainings. Ovules; three in *Matthiola arabica*, five in *Asclepias sinaica* and *Fagonia glutinosa*, two in four taxa or one in remaining studied taxa. Stigma form; obconical (*Pyrethrum santolinoides*), spherical in *Verbascum sinaiticum*, filiform in *Aerva tomentosa* and *Teucrium polium*, capitate in four taxa or papillate in four taxa.

Fruit; drupe in *Nitraria retusa*, legume in *Retama raetam*, berry in *Asclepias sinaica* and *Capparis spinosa*, schizocarp in *four taxa*, achene (*Achillea fragrantissima, Alkanna orientalis, Artemisia judaica* and *Pyrethrum santolinoides*) or capsule in the remaining studied taxa. Colour; white (*Aerva tomentosa*), purpule/white in *Matthiola arabica*, red in *Alkanna orientalis* and *Nitraria retusa*, pale green (*Origanum syriacum*), orange/brown (*Peganum harmala*), violet (*Phlomis aurea*), light brown/dark brown in *Teucrium polium*, green in *Capparis spinosa and Retama raetam* or yellow in the remaining studied taxa. Dehiscence; indehiscent in *Achillea fragrantissima, Aerva tomentosa and Retama raetam* or dehiscent in the remainings. Shape of fruit; sub-globose in *Aerva tomentosa*, ovoid (*Alkanna orientalis*), narrowly obovoid (*Artemisia judaica*), ellipsoid in *Capparis spinosa*, pear-shaped in *Nitraria retusa*, oblong in *Pyrethrum santolinoides*, elliptic to subglobose in *Verbascum sinaiticum*, glabrous in *Matthiola Arabica* and *Phlomis aurea*, oblong/ovoid in *Achillea fragrantissima, Origanum syriacum* and *Teucrium polium* or globose (*Asclepias sinaica, Fagonia glutinosa* and *Peganum harmala*). This is in agreement with Batanouny (1999) and Bolous (2002).

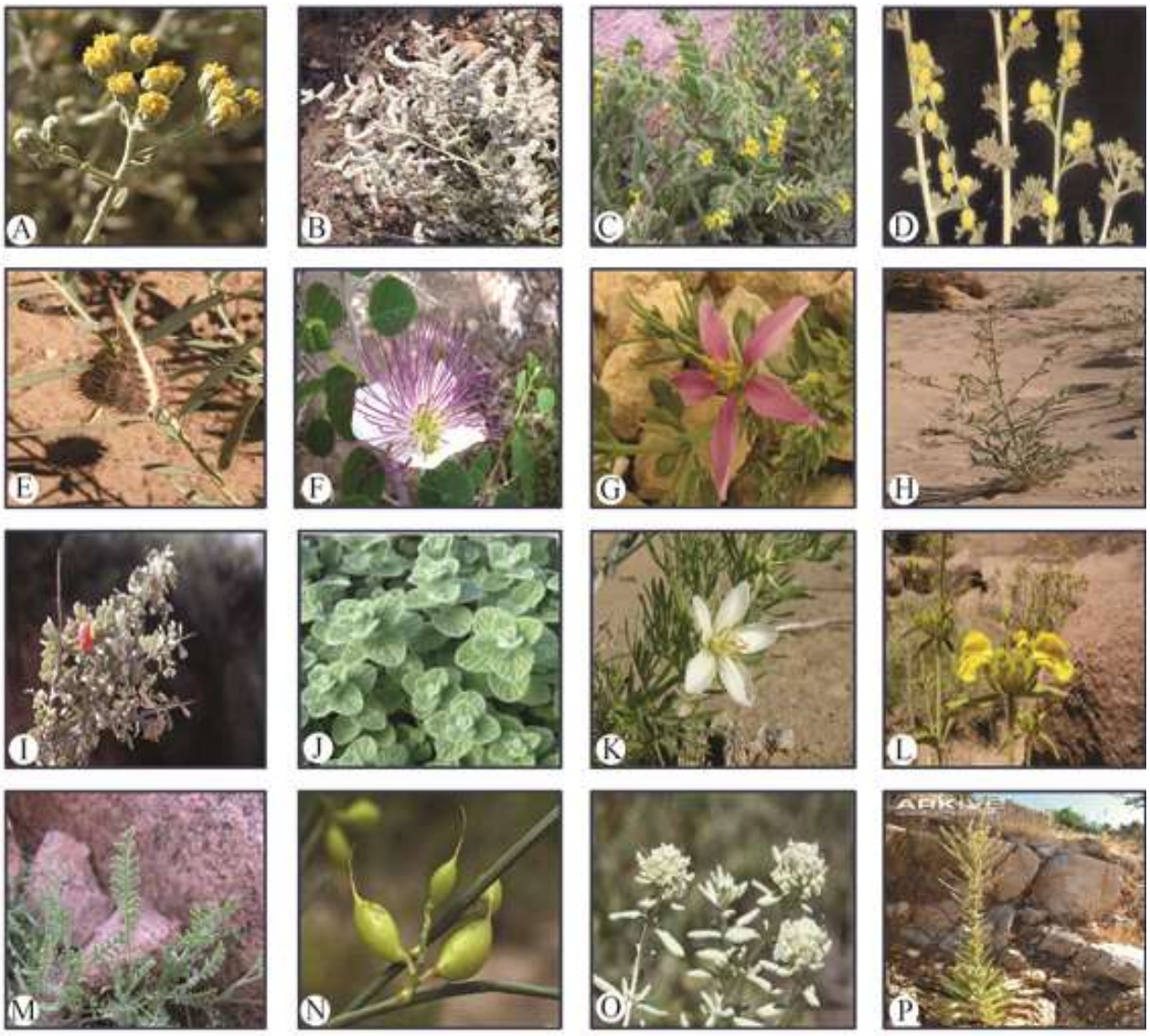

Fig. 1. Photographs of studied taxa (A) *Achillea fragrantissima* (B) *Aerva tomentosa* (C) *Alkanna orientalis* (D) *Artemisia judaica* (E) *Asclepias sinaica* (F) *Capparis spinosa* (G) *Fagonia glutinosa* (H) *Matthiola arabica* (I) *Nitraria retusa* (J) *Origanum syriacum* (K) *Peganum harmala* (L) *Phlomis aurea* (M) *Pyrethrum santolinoides* (N) *Retama raetam* (O) *Teucrium polium* (P) *Verbascum sinaiticum*.

Section B: Micro-morphological characters (Figs 2-5):

In the ongoing section, the micromorphological characteristics of the investigated taxa are introduced.

Stem; angular (*Aerva tomentosa*, *Artemisia judaica and Fagonia glutinosa*), square (*Origanum syriacum, Phlomis aurea* and *Pyrethrum santolinoides*) or terete in the remaining investigated taxa.

Trichomes; Eglandular trichomes; Unicellular/unbranched and multicellular/branched in *Matthiola Arabica* and *Verbascum sinaiticum*, wanting in *Capparis spinosa and Peganum harmala,* Unicellular/unbranched in *Achillea fragrantissima*, *Alkanna orientalis* and *Origanum syriacum,* multicellular–branched in four taxa or multicellular–unbranched in the remainings. Glandular trichomes; Uni- and multicellular head with multicellular stalk (*Phlomis aurea*), multicellular head and multicellular stalk (*Artemisia judaica* and *Verbascum sinaiticum*), Unicellular head and unicellular stalk in *Achillea fragrantissima*, *Alkanna orientalis* and *Nitraria retusa*, Unicellular head-multicellular stalk in four taxa or wanting in the remainings.

Cuticle; thin (*Asclepias sinaica*, *Nitraria retusa* and *Pyrethrum santolinoides*) or thick in the remainings. Periderm; subepidermal in *Aerva tomentosa* or wanting in the remainings.

Epidermal cells; tangential/papillose in *Aerva tomentosa*, tangential in *Fagonia glutinosa* and *Origanum syriacum*, rectangular in *Teucrium polium*, papillose, radial and tangential in *Achillea fragrantissima and Pyrethrum santolinoides,* radial to tangential in *Asclepias sinaica, Phlomis aurea and Verbascum sinaiticum* or radially in the remaining.

Ground tissue; 1-6 rows of Parenchyma in *Aerva tomentosa*, 4-6 rows in *Capparis spinosa*, absent in *Nitraria retusa*, seven rows in *Retama raetam*, three rows in *Teucrium polium,* one row in *Achillea fragrantissima* and *Fagonia glutinosa*, 7-9 rows in *Artemisia judaica and Pyrethrum santolinoides,* 4-5 rows in *Origanum syriacum* and *Verbascum sinaiticum*, two rows in *Matthiola Arabica* and *Phlomis aurea*, 2-3 rows (*Alkanna orientalis, Asclepias sinaica and Peganum harmala*); **Chlorenchyma**; six rows in *Capparis spinosa*, 4-5 rows in *Matthiola Arabica*, five rows in *Peganum harmala*, 3-4 rows in *Achillea fragrantissima and Fagonia glutinosa four rows in Retama raetam and Teucrium polium,* absent in four studied taxa or 2-3 rows in the remaining studied taxa. **Collenchyma**; 5-Angular and 2-Lamellar in *Achillea fragrantissima*, 2-3 angular in *Artemisia judaica*, 1-3 lamellar in *Fagonia glutinosa*, 4-angular in *Nitraria retusa*, 10-Annular and 4-5 lamellar in *Phlomis aurea*, 5-6 Annular in *Pyrethrum santolinoides*, 2-3 lamellar in *Retama raetam*, 2 Angular in *Teucrium polium,* 3-4 angular in *Aerva tomentosa* and *Asclepias sinaica*, 5-6 Angular (*Alkanna orientalis* and *Verbascum sinaiticum*), absent in *Capparis spinosa* and *Matthiola Arabica* or 5-Angular in *Origanum syriacum* and *Peganum harmala.* **Sclerenchyma**; absent in *Origanum syriacum* or present in the remaining. **Pith**; relatively narrow (*Asclepias sinaica* and *Retama raetam*) or wide in the remaining. Pith cell wall; thin in four studied taxa, lignified in six studied taxa or slightly lignified in the remaining studied taxa. Internal appearance of pith is hollow in *Alkanna orientalis*, *Origanum syriacum* and *Peganum harmala* or solid in the remaining.

Secondary growth; aspect is separated strands in four studied taxa or continuous strands in the remaining. Rays at fascicular region; uniseriate (*Asclepias sinaica*) or wanting in the remaining. **Xylem** content fibers at interfascicular region (*Origanum syriacum and Peganum harmala*) or fibers and vessels in the remaining. **Rays** at interfascicular region; uniseriate (*Achillea fragrantissima, Aerva tomentosa* and *Asclepias sinaica*) or wanting in the remaining. **Cambium**; wanting in *Peganum harmala* or detected in the remaining studied taxa. Raphides; in *Aerva tomentosa, Phlomis aurea and Verbascum sinaiticum* or druses in the remaining studied taxa.

Leaf; flattened adaxially in *Fagonia glutinosa*, depressed adaxially in six studied taxa or raised adaxially in the remaining studied taxa.

Trichomes; Eglandular trichomes; unicellular/unbranched and multicellular/unbranched and branched (*Aerva tomentosa*), unicellular/branched in *Matthiola arabica*, uni- and multicellular/unbranched in *Alkanna orientalis and Origanum syriacum*, multicellular/unbranched in *Asclepias sinaica* and *Teucrium polium,* multicellular, branched (*Phlomis aurea* and *Verbascum sinaiticum*), unicellular-unbranched in *Fagonia glutinosa*, *Nitraria retusa* and *Pyrethrum santolinoides* or absent in the remaining studied taxa. Glandular trichomes; multicellular head with uni- and biseriate stalk (*Fagonia glutinosa*), unicellular head and unicellular stalk (*Nitraria retusa*), uni- and multicellular heads with multicellular stalk in *Phlomis aurea*, multicellular head and multicellular stalk (*Matthiola arabica* and *Verbascum sinaiticum*), unicellular head and multicellular stalk (*Alkanna orientalis, Origanum syriacum* and *Teucrium polium*) or absent in the remaining.

Cuticle; thin in *Alkanna orientalis* and *Fagonia glutinosa* or thick in the remaining studied taxa. Shape of epidermal cells; oval in *Alkanna orientalis*, tangentially elongated in *Fagonia glutinosa*, radial, tangential and papillose in *Matthiola arabica*, radial in *Artemisia judaica*, *Nitraria retusa Verbascum sinaiticum*, tangential in four taxa, tangentially elongated in *Fagonia glutinosa*, oblong/ovoid (*Matthiola Arabica*), radial in *Phlomis aurea*, barrel-shaped in *Aerva tomentosa, Alkanna orientalis* and *Teucrium polium*, radial (*Artemisia judaica, Nitraria retusa* and *Verbascum sinaiticum*)or Tangential/radial in five studied taxa.

Mesophyll tissue; isolateral in *Fagonia glutinosa*, dorsiventral in 6 taxa or isobilateral in the remaining. Palaside rows number; three in *Asclepias sinaica* and *Phlomis aurea*, one row in five taxa or two rows in the remaining. Palaside; extended adaxially and discontinuous abaxially at midrib region present in *Artemisia judaica*, Palaside extended in six taxa or not extended in the remaining studied taxa. **Collenchyma**; angular in *Phlomis aurea*, absent in seven taxa or annular in the remaining. **Parenchyma**; five rows in *Capparis spinosa*, 1-2 rows in *Matthiola Arabica,* 5-7 rows in *Nitraria retusa*, two rows in *Origanum syriacum*, 5-6 rows in *Peganum harmala*, 3-4 rows in *Aerva tomentosa*, *Alkanna orientalis and Teucrium polium*, 2-3 rows in *Fagonia glutinosa, Pyrethrum santolinoides and Verbascum sinaiticum* or 4-5 rows in the remaining studied taxa.

Vascular tissue; crescent form in seven taxa or centric single in remaining.

Crystals; solitary in *Matthiola Arabica*, raphides (*Phlomis aurea*), wanting in *Verbascum sinaiticum* or druses in the remaining. Stomata; at lower and upper surfaces in five taxa or present at lower epidermis in the remaining studied taxa. Stomata type paracytic in *Asclepias sinaica*, diacytic in *Teucrium polium* or anomocytic in the remaining.

Upon SEM investigation it was found that, wall sculpture colliculate in *Nitraria retusa* and

Teucrium polium, reticulate in *Retama retam*, lineate in *Asclepias sinaica*, rugose in *Achillea fragrantissima*, scalariform in Peganum harmala or ruminate in the remaining. This is in accordance with Dinç and Öztürk (2008), Osman (2012), Dehshiri and Azadbakht (2012), Mammen *et al*. (2013), and Tekin *et al.* (2013).

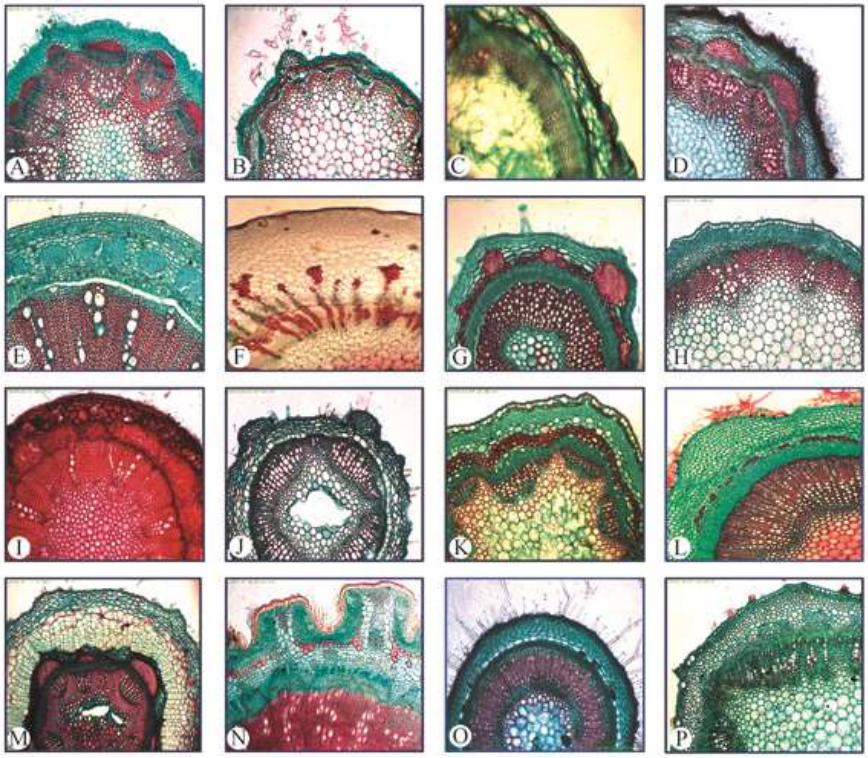

Fig. 2. Photomicrographs of stem anatomy (A) *Achillea fragrantissima* (B) *Aerva tomentosa* (C) *Alkanna orientalis* (D) *Artemisia judaica* (E) *Asclepias sinaica* (F) *Capparis spinosa* (G) *Fagonia glutinosa* (H) *Matthiola arabica* (I) *Nitraria retusa* (J) *Origanum syriacum* (K) *Peganum harmala* (L) *Phlomis aurea* (M) *Pyrethrum santolinoides* (N) *Retama raetam* (O) *Teucrium polium* (P) *Verbascum sinaiticum*. × 200

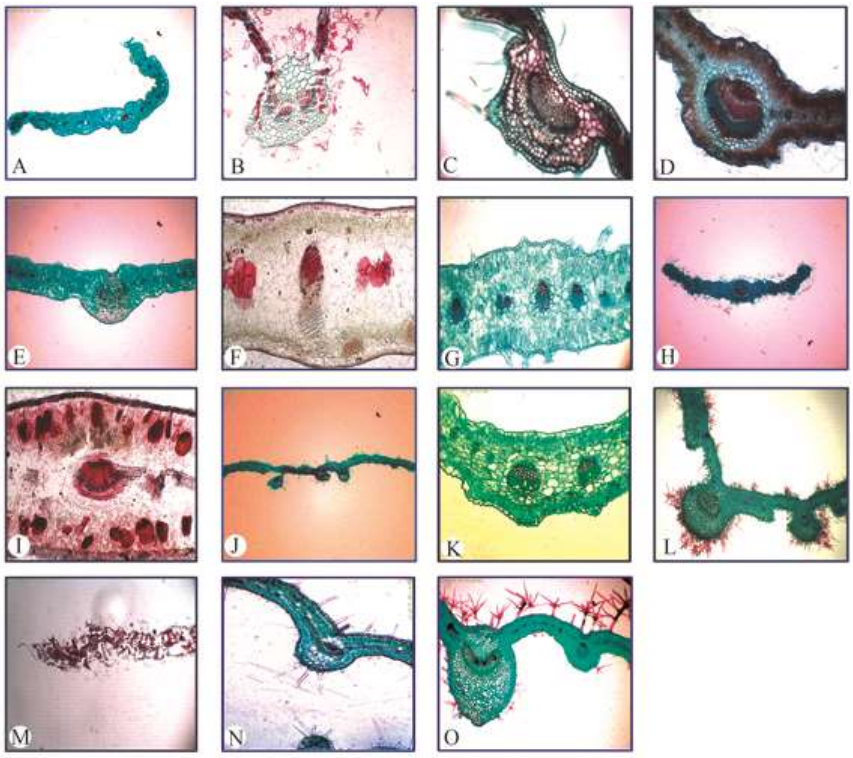

Fig. 3. Photomicrographs of lamina anatomy (A) *Achillea fragrantissima* (B) *Aerva tomentosa* (C) *Alkanna orientalis* (D) *Artemisia judaica* (E) *Asclepias sinaica* (F) *Capparis spinosa* (G) *Fagonia glutinosa* (H) *Matthiola arabica* (I) *Nitraria retusa* (J) *Origanum syriacum* (K) *Peganum harmala* (L) *Phlomis aurea* (M) *Pyrethrum santolinoides* (N) *Teucrium polium* (O) *Verbascum sinaiticum.* × 200

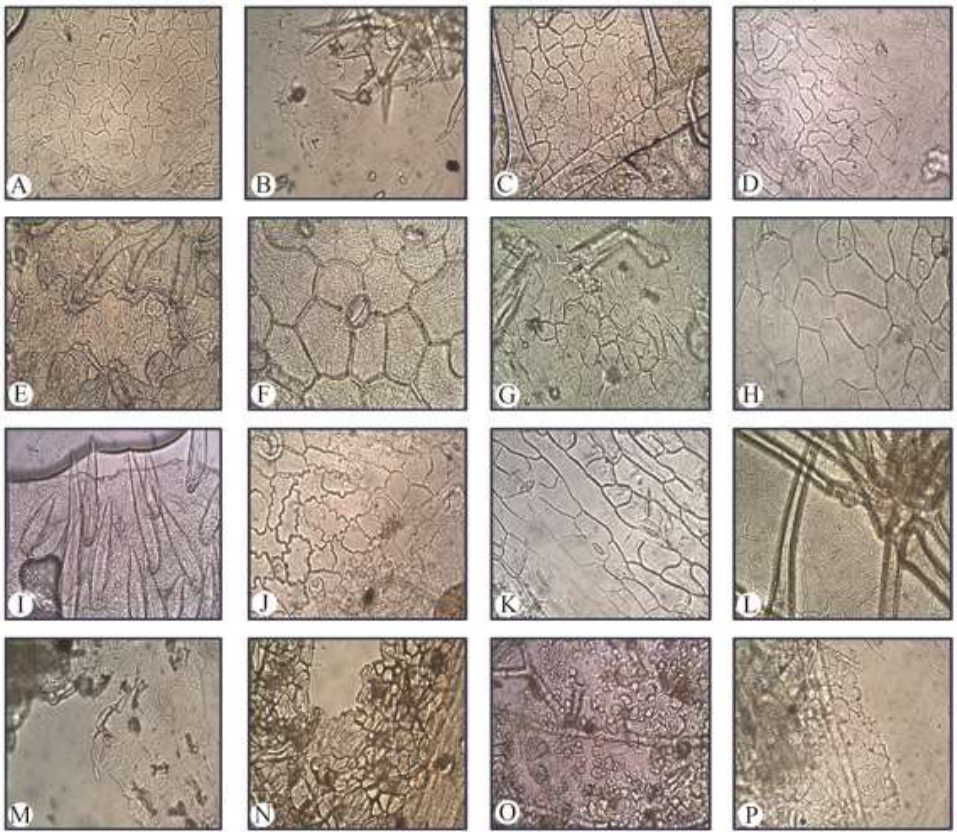

Fig. 4. Photomicrographs of blade abaxial surface (A) *Achillea fragrantissima* (B) *Aerva tomentosa* (C) *Alkanna orientalis* (D) *Artemisia judaica* (E) *Asclepias sinaica* (F) *Capparis spinosa* (G) *Fagonia glutinosa* (H) *Matthiola arabica* (I) *Nitraria retusa* (J) *Origanum syriacum* (K) *Peganum harmala* (L) *Phlomis aurea* (M) *Pyrethrum santolinoides* (N) *Teucrium polium* (O) *Verbascum sinaiticum.* × 400

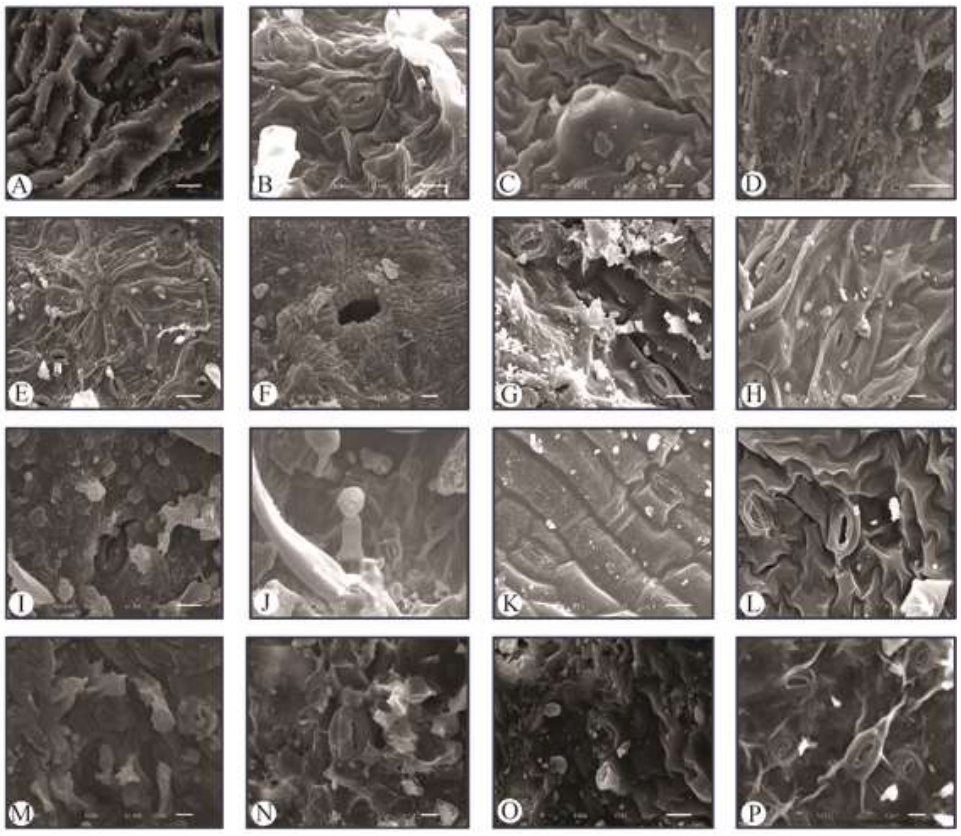

Fig. 5. SEM photomicrographs of abaxial lamina surface (A) *Achillea fragrantissima* (B) *Aerva tomentosa* (C) *Alkanna orientalis* (D) *Artemisia judaica* (E) *Asclepias sinaica* (F) *Capparis spinosa* (G) *Fagonia glutinosa* (H) *Matthiola arabica* (I) *Nitraria retusa* (J) *Origanum syriacum* (K) *Peganum harmala* (L) *Phlomis aurea* (M) *Pyrethrum santolinoides* (N) *Teucrium polium* (O) *Verbascum sinaiticum.*

Section C: Antimicrobial activities of studied taxa (Table 2):

In the ongoing investigation, 16 crude extracts from 16 plant species, showed different levels of antimicrobial activity against Gram +ve and Gram -ve bacteria, a yeast and filamentous fungus. The sixteen plant species were active *versus* some of the tested strains. Powerfull activity was detected for some plants *viz*. *Achillea fragrantissima*, *Alkanna orientalis*, *Artemisia judaica, Asclepias sinaica, Capparis spinosa*, *Fagonia glutinosa, Matthiola arabica*, *Nitraria retusa*, *Origanum syriacum*, *Peganum harmala, Phlomis aurea*, *Pyrethrum santolinoides*, *Retama raetam, Teucrium polium* and *Verbascum sinaiticum*.

This activity is due to water-soluble active compounds of the plants not lipid-soluble compounds as the solvent used is 70%ethanol.

Few higher plant species exist on earth have been reported for therapeutic potential (Deans and Svoboda, 1990). The present investigation clarifies that all investigated plants showed antimicrobial activity. Similar activity noted for the closely related species to cite but a few, the essential oil of *O. syriacum* exhibits a powerful antifungal action against *Fusarium oxysporum*, *Aspergillus niger* and *Penicillium* spp. (Daouk *et al*., 1995), essential oils prepared from *Teucrium polium* showed antimicrobial activities *versus B. subtilis*, *Micrococcus glutamicus*, *E. coli*, *Aspergillus fumigatus*, *A. niger*, *C. albicans*, *M. canis* and *Trichophyton rubrum* (Ayoub, 1990). The lyophilized infusion from flowers of *Verbascum thapsiforme* showed antiviral activity *versus* influenza and *Herpes simplex* (Zgórniak-Nowosielska *et al*., 1991).

Ethanolic extract of the flowering tops of *Teucrium polium* exhibited a detectable activity *versus* both Gram positive and negative bacteria (Autore *et al*., 1984). *Artemisia judaica* is used as folk medicine to cure diseases of skin (Bolous, 1983). Antimicrobial action of crude extracts of *Alkanna orientalis*, *Phlomis aurea* and *Verbascum sinaiticum*; that collected from Sinai have no records as ethno-botanical herbs for therapy among the Bedouins. Skin irritation occurs upon contact with the aerial parts of them, which might have prevented their folk uses as traditional antibiotic agents. The discovery of the cytotoxic potential of four flavonoids isolated from *V. sinaiticum* shoots (Afifi *et al*., 1993) demonstrates that pharmacologically active compounds may be discovered from plants with unfavorable characteristics.

Table 2. Antimicrobial activity of crude extracts of Sinai plant species collected، listed in the same order as in table 1

Plant species	Inhibition zone (mm.) at different microbial species				
	Escherichia coli	*Bacillus subtilis*	*Staphylococcus aureus*	*Candida*	*Fusarium solani*
Achillea fragrantissima	8-11	11-14	11-14	17-20	-
Aerva tomentosa	5-8	5-8	5-8	5-8	-
Alkanna orientalis	11-14	14-17	11-14	8-11	-
Artemisia judaica	8-11	11-14	8-11	8-11	-
Asclepias sinaica	5-8	8-11	5-8	5-8	-
Capparis spinosa	8-11	8-11	8-11	5-8	-
Fagonia glutinosa	8-11	8-11	5-8	8-11	-
Matthiola arabica	5-8	8-11	8-11	5-8	-
Nitraria retusa	8-11	8-11	8-11	-	-
Origanum syriacum	8-11	8-11	8-11	8-11	-
Peganum harmala	8-11	8-11	8-11	5-8	-
Phlomis aurea	-	5-8	5-8	5-8	-
Pyrethrum santolinoides	8-11	11-14	8-11	8-11	-
Retama raetam	8-11	11-14	8-11	8-11	-
Teucrium polium	8-11	8-11	8-11	8-11	-
Verbascum sinaiticum	8-11	11-14	8-11	8-11	-

In conclusion, all studied taxa showed different antimicrobial activity against Gram positive and negative bacteria, a yeast and a filamentous fungus. *Achillea fragrantissima, Alkanna orientalis, Artemisia judaica, Pyrethrum santolinoides, Retama raetam* and *Verbascum sinaiticum* showed strong activity against some test organisms. So they can be effective against infectious diseases. In addition, morpho-anatomical characters and antimicrobial activity not only provide characters for their precise taxonomic authentication, but

also serve as data standardization for the quality assessment of the pharmaceutical preparations of herbal drugs.

Upon numerical analysis of the antimicrobial activity the produced phenogram (Fig. 6) indicated that the three examplers of Asteraceae viz. *Achillea fragrantissima*, *Artemisia judaica* and *Pyrethrum santolinoides* joined together in one group, in addition to the two examplers of Nitrariaceae viz. *Peganum harmala* and *Nitraria retusa* lied together in another group. The present result indicates the importance of the antimicrobial activity and may be used as a valuable taxonomic tool for species segregation but this hypothesis needs further study.

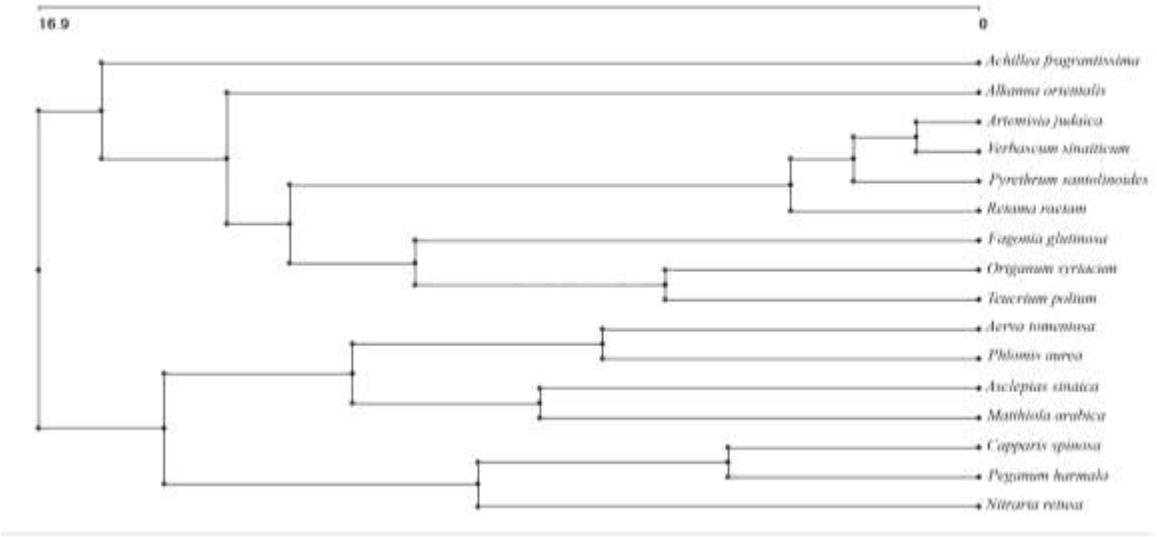

Fig. 6. UPGMA Dendrogram Based on the Antimicrobial Activity of the Studied Taxa.

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التوصيف المورفولوجي والنشاط البيولوجي لبعض نباتات الطب الشعبي في سيناء، مصر

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تتميز سانت كاترين بكساء نباتي فريد ويرجع ذلك إلى التنوع الواسع في المناخ والطبيعة الجغرافية التي ليس لها مثيل. وتعد شبه جزيرة سيناء واحدة من أهم مناطق التنوع النباتي في مصر. كما تعد أحد أهم مصادر النباتات الطبية في الصحاري العربية. وتشير دراسات كانت قد أجريت على مستخلصات هذه النباتات أن لها تأثير مضاد للبكتيريا والفطريات. تضمنت هذه الدراسة 16 نوع نباتي تندرج تحت 16 جنس تابعين لعشر فصائل نباتية وقد تم تجميع النباتات المعنية بالدراسة من وادي الاربعين في سانت كاترين بجنوب سيناء-مصر. تم تعيين الصفات المورفولوجية الكبرى للسيقان، الاوراق، النورات، الازهار، الثمار والبذور إمّا من عينات حية أو من المراجع. أما الصفات التشريحية فقد سجلت من قطاعات مجهرية للساق والورقة وتحضيرات (سلخات) من بشرة نصل الورقة العلوي والسفلى باستخدام المجهر الضوئي وقدتم تحضير مستخلصات من النباتات محل الدراسة لاختبار تأثيرها المضاد للميكروبات بتجفيفها وتحضير 70% مستخلص كحول إيثيلى لكل نبات واختبار تأثير هذه المستخلصات على بكتيريا موجبة وسالبة الجرام وعلى فطريات وحيدة الخلية ومتعددة الخلايا (خيطية). أظهرت النتائج ان الصفات المورفولوجية للنباتات والصفات التشريحية للساق والورقة ذات قيمة تشخيصية كبيرة على مستوى الانواع المدروسة. كما أوضحت النتائج أن كل النباتات المعنية بالدراسة كان لها تأثير مضاد للميكروبات على مدى واسع يتراوح من التأثير الضعيف للمتوسط وقد كان لبعض النباتات تأثير فعّال ضد البكتيريا والفطريات. وبالتالي فان هذه النباتات يمكن أن تستخدم في علاج الامراض المعدية حيث أن لها تأثير واضح مضاد للبكتيريا والفطريات.