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State of the Art of Diabetes mellitus herbal Medicine in the western Mediterranean coastal region of Egypt

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Abstract

The study area is highly rich with many natural plant products that can be utilized for the treatment of Diabetes mellitus (DM). Nevertheless, the knowledge of these plant-derived remedies has not been extensively researched. Consequently, the present study focuses on documenting the plant-based remedies and to measure and evaluate the abundance and distribution of these species in the study area. Data of the present study was collected in five field trips from four different human communities distributed along the north Mediterranean coastal region of Egypt. The ethnobotanical information was collected through talking with local people, fieldwork technique and searching for ethnobotanical information in folklore. Results showed that Artemisia herba-alba, Olea europaea and Artemisia monosperma at Burg El-Arab location were acknowledged to treat DM., Trigonella foenum-graecum mentioned by the largest number of informants, followed by Artemisia monosperma at Omayed location. For Dabaa, 50% of the informants agreed that Pituranthos tortuosus and Trigonella foenum-graecum were used to treat DM followed by Lupinus termis, Morus alba, and Olea europaea. Citrullus colocynthis, and Hordeum vulgare followed by Silybum marianum, Retama raetam, and Trigonella foenum-graecum were of significant importance for DM treatment in Matruh region. For all locations, the largest number of species was prepared by decoction while other species were prepared by infusion or in the form of powder or eaten fresh.

Keywords: *Ethnobotany, Diabetes mellitus, Phytotherapy, Phytosociology, Conservation*

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I. Introduction

Diabetes mellitus (DM) is a metabolic disorder of multiple etiology distinguished by chronic hyperglycemia with interruption of carbohydrates, fats and proteins metabolism arising from defects in insulin secretion, insulin action or both **(Kumar *et al.*, 2020a)**. Worldwide, 1.5 million deaths are exactly ascribed to DM worldwide and that it will be the 7th main cause of death by 2030 (**Msopa and Mwanakasale, 2019)**. In 2019, 8.9 million Egyptians be afflicted with DM, and that this number will grow to 16.9 million diabetics Egyptians by the year 2045 **(Saeedi *et al.*, 2019)**. Increase in inactive lifestyle, consumption of energy-rich diet and obesity are some of the major factors causing the rise in the number of diabetics in Egypt.

Natural plant-based therapies for DM have been proven to be safe and effective alternatives medications, and details about more than 400 plants are available in the literature (**Samarakoon *et al.*, 2020**). There is a search for an alternative treatment to synthetic drugs since they bear some side effects which outweigh the beneficial effects **(Naveen and Urooj, 2021**). **Grover *et al*. (2002)** stated that more than 1123 plant species have been used ethnopharmacologically or experimentally to treat symptoms of DM. There are more than 200 pure compounds from plant sources that have been estimated to decrease blood glucose level **(Ayua *et al*., 2021)**.

In Egypt, the region of the north-western Mediterranean coast, indigenous people tend to be dependent upon medicinal plants and often possess exceptional medicinal plant knowledge. However, exposure to modern culture, increased trade, and access to modern conveniences (including modern medicines) are altering the distribution and extent of local knowledge and use of herbal remedy in these societies **(El-Darier *et al*., 2001 and 2007)**. Ethnobotany and ethnomedicinal studies are today considered as the most effective method of designation new medicinal plants or refocusing on those plants reported in earlier studies for the possible extraction of beneficial bioactive compounds **(Sargin, 2015)**. The interrelationship between ethnobotany and ecology of medicinal plants were studied to identify the plant species used for treatment of DM and promote the conservation of medicinal plants as well as the traditional knowledge associated with them, so that long-term biodiversity values would not be lost **(Bussmann, 2002)**.

The present study is an endeavor to document the plants used in the treatment of DM in four social communities [Burg-El-Arab (I); Omayed (II); Dabaa (III) and Matruh (IV)] distributed along the north-western Mediterranean coastal region of Egypt. The study documents preservation and dissemination of this folk knowledge and may provide useful information in such field as, pharmacology, phytotherapy, and agriculture science, thus contributing to development and management of the region.

II. Materials and Methods

Ethnobotanical Studies

Data were collected in 5 field trips during 2019 and 2020 from four different human communities at Burg-El-Arab (I); Omayed (II); Dabaa (III) and Matruh (IV) distributed along the north Mediterranean coastal region of Egypt. Fieldwork was considered with collecting the information using 'open-ended'' interviews **(Martin, 1995)** based on a structured questionnaire where specific questions were asked to a sample of adults (>50 years old) at each location (Burg-El-Arab 11, Omayed 9, Dabaa 12, and Matruh 2 individuals). A total of 34 adults, comprising 29 men and 5 women were interviewed in the four locations.

Data Analysis

A formula named "Treat Value" suggested by **El-Darier *et al.* (2001)** was applied as follows: VT =ΣT/n where: VT = treat value of an ethnospecies, T = number of citations for each ethnospecies relative to (n) = total number of locations.

III. Results

Ethnobotanical Studies

In the present survey, fourteen families were mentioned by informants **(Table 1)**. Among these families, Asteraceae and Fabaceae attained the highest number of plant species (four species for each). On the other hand, ten families were represented by only one species. By comparing the four studied locations, Burg El-Arab proved to harbor the largest number (21species) of the surveyed medicinal plants. *Camellia sinensis*, *Retama raetam* and *Teucrium polium* were not represented in this region. With respect to Omayed and Dabaa locations, ten and thirteen species were represented respectively. Finally, Matruh attained the lowest number (five species) of the recorded species. At the four studied locations, *Trigonella foenum-graecum*, *Pituranthos tortuosus* and *Olea europaea* achieved the highest Treat Values (3.25, 2.75 and 2.25 respectively) while there are six species attained the lowest Treat Value (0.25 for each).

Table 1. Plant species incidence at the four studied locations and calculated treat value.

Family/Species	Species incidence at each location				Treat value (VT) =ΣT/n
	Burg El-Arab	Omayed	Dabaa	Matruh	
Amaryllidaceae					
Allium cepa var.	1	-	-	-	0.25
Allium sativum L.	1	-	-	-	0.25
Pancratium maritimum L.	1	-	-	-	0.25
Apiaceae					
Pituranthos tortuosus Desf.	3	2	6	-	2.75
Astraceae					
Achillea santolina L.	1	-	-	-	0.25
Artemisia herba- alba Asso.	5	-	1	-	1.5
Artemisia monosperma Delile	4	3	1	-	2
Silybum marianum (L.) Gaertn.	2	-	-	1	0.75
Cucurbitaceae					
Citrullus colocynthis L. Schrad.	2	1	-	2	1.25
Fabaceae					
Lupinus termis L.	2	2	4	-	2
Medicago sativa L.	1	-	-	-	
Retama raetam (Forssk.) Webb & Berthel.	-	-	2	1	0.75
Trigonella foenum-graecum L.	2	4	6	1	3.25
Lamiaceae					
Marrubium vulgare L.	1	-	3	-	1
Teucrium polium L.	-	1	3	-	1
Thymus capitatus Hoffmanns. & Link.	3	1	2	-	1.5
Lythraceae					
Punica granatum L.	1	-	-	-	0.25
Moraceae					
Morus alba L.	1	-	4	-	1.25

Oleaceae					
Olea europaea L.	**5**	**-**	**4**	**-**	**2.25**
Plantaginaceae					
Globularia arabica Jaub. & Spach	**2**	**-**	**1**	**-**	**0.75**
Poaceae					
Hordeum vulgare L.	**1**	**1**	**2**	**2**	**1.5**
Ranunculaceae					
Nigella sativa L.	**1**	**1**	**-**	**-**	**0.5**
Rhamnaceae					
Ziziphus spina-christi (L.) Willd	**1**	**-**	**-**	**-**	**0.25**
Theaceae					
Camellia sinensis (L.) Kuntze	**-**	**2**	**-**	**-**	**0.5**

The scientific names of the different surveyed plant species, their organs that are recorded to be used for cure of DM, the method used for their preparation, and the herbal formula at the four studied locations is presented in **Table 2**. It is worthy to mention that about 47.6 % (10 species) of the total number of species at Burg El-Arab were prepared for remedy of DM by decoction, 23.8% (5 species) by infusion, 19% (4species) in the form of powder, and 14.3% (3 species) eaten fresh. Five species of the recorded plant species were mentioned at Omayed to be used in a complex or a single herbal formula while the remainder is used in a single herbal formula**)**. About 40% of the recorded species are prepared by decoction, and about 30% are prepared by infusion, while others are prepared by different methods such as topically and powder. More than 50% of the recorded species at Dabaa location are prepared by decoction. The rest of species are used by a variety of methods such as infusion, powder, and topically. Each one of plant species at Matruh is used by a variety of preparation methods like decoction, powder, and topically. About 60% of the plant species are used singly.

Table 2. Organ, method of preparation and type of herbal formula (S: simple; C: complex) of the medicinal species surveyed at the four studied locations.

Species				
	Burg El-Arab	**Omayed**	**Dabaa**	**Matruh**
Achillea santolina	Flowering branches, Infusion, C or S	-	-	-
Allium cepa	Bulb & Leaves, Eating fresh, S	-	-	-
Allium sativum	Bulb, Eating fresh, S	-	-	-
Artemisia herba- alba	Roots, Decoction, C or S	-	Roots, Decoction, C or S	-
Artemisia monosperma	Whole plant, Decoction, C or S	Seeds, Infusion, C or S	Whole plant, Decoction, C or S	-
Camellia sinensis	-	Leaves, Decoction, C or S	-	-
Citrullus colocynthis	Whole plant, Infusion, S	Fruits & Seeds, Topically, S	-	Fruits & seeds, Topically, S
Globularia arabica	Whole plant, Decoction, C or S	-	Whole plant, Decoction, C or S	-
Hordeum vulgare	Grains, Powder, S	Seeds, Powder, S	Grains, Powder, C or S	Grains, Powder, C or S
Lupinus termis	Seeds, Decoction, S	Seeds, Powder, C or S	Seeds, Decoction, C or S	-
Marrubium vulgare	Leaves, Decoction, S	-	Leaves, Decoction, C or S	-
Medicago sativa	Whole plant, Decoction, S	-	-	-
Morus alba	Leaves, Decoction, S	-	Leaves, Decoction, S	-
Nigella sativa	Seeds, Powder & Infusion, C or S	Seeds, Powder, C or S	-	-
Olea europaea	Leaves, Infusion, C or S	-	Leaves, Infusion, S	-
Pancratium maritimum	Bulb, Eating fresh, S	-	-	-
Pituranthos tortuosus	Whole plant, Decoction, C or S	Flowering branches, Decoction, S	Flowering branches, Decoction, C or S	-
Punica granatum	Flowers & Peel, Powder& Decoction, S	-	-	-
Retama raetam	-	-	Whole plant, Decoction, S	Whole plant, Decoction, S
Silybum marianum	Whole plant, Decoction, C or S	-	-	Seeds, Hot infusion, S
Teucrium polium	-	Whole shoot, Decoction, S	Vegetative,	-

			Infusion, C or S	
Thymus capitatus	Whole plant, Decoction, C or S	Flowering branches, Infusion, C or S	Flowering branches, Infusion, C or S	-
Trigonella foenum-graecum	Seeds, Decoction, S	Seeds, Decoction, C or S	Seeds, Decoction, C or S	Seeds, Decoction, C or S
Ziziphus spina-christi	Leaves, Infusion, S	-	-	-

IV. Discussion

Diabetes mellitus (DM) is the most prevalent disorder, affecting more than 300 million people worldwide (**Bordoloi and Dutta, 2014**). The efficacy of herbal drugs is significant and they have declined side effects than the synthetic allopathic medicines **(Yang *et al.*, 2020)**. It is remarkable to mention that the indigenous knowledge related to the medicinal uses of plant species and their availability in the environment of native populations in the region is threatened. Therefore, the present study seeks to serve invoke more interest in bio screening of as many medicinal plants as possible for their hypoglycemic potential. Such efforts will aid development of novel plant-derived antihyperglycemic agents. There is an urgent need of recording all ethnobotanical and ethnopharmacological information before they are lost.

In the current work, a sample of adult persons (≥ 50 years old) at each of four locations selected to represent the main population distributing along the north-western coastal region of Egypt were interviewed. A total of 34 adults, comprising 29 men and 5 women were interviewed in the four studied locations. Human sample enumerated a total number of species used for treatment of DM in all locations of the present study as 24 plant species including 12 wild (W) and 12 cultivated (C). The highest percentages of the recorded medicinal plants listed in Fabaceae family, this is in accordance with the study carried out by **Kadir *et al.* (2012)**. This predominance could be explained by world-wide high number of species (19,400 species) of this family (**Marles and Farnsworth, 1995**).

Burg El-Arab location includes more people with rich indigenous knowledge transported from other sites and with a higher ratio of educational classes, beside the dominance of different methods of acculturation therefore attained the maximum number of mentioned medicinal species compared with the rural locations such as Matruh which is still characterized by lacking such health care centers. The obtained results were inconsistent with those recorded by **El-Darier *et al.* (2001**) on the ethnobotany of diuretic plants.

Several studies claimed that traditional healers are able to diagnosis DM in their patients by observing symptoms such as excessive urination and loss of weight **(Mukhtar *et al.*, 2019)**. The depth of the ethnomedicinal knowledge on the uses of local species in the present work varied greatly according to the cultural background, the degree of modernization, educational state, the age, and the possibility for medical health care centers. In addition, there is a knowledge gap between old and young people, men and women and between educated and uneducated people. People older than 50 years of age (70% of the total number of informants), possessed greater knowledge of medicinal plants and their uses than younger people (30 % of the total number of interviewees); similar findings were observed in other studies (**Ishola *et al*., 2014**).

All plant parts were used to treat DM; seeds and leaves were the most abundantly utilized plant parts. This corresponds with the studies carried out by **Tounekti *et al.* (2019**). The majority of seeds are rich in flavonoids (**Shirley, 1998**) which are thought to have health-promoting properties due to their high antioxidant activity and free radical scavenging ability. Leaves are a main part of plant, which the primary source of photosynthesis and easy to collect and use leaves (**Ali *et al.*, 2017**). Besides, they are rich in therapeutically active secondary metabolites and essential oils (**Tripathy, 2015**). Leaves have no harmful effects on the survival of medicinal plants, whereas collecting roots or whole plants may cause severe threat to local flora (**Tounekti *et al.*, 2019**). Herbal medicines are prepared in a variety of ways. Decoction and infusion were the commonly used method for herbal preparation in the present study such as found in other countries (**Teixidor Toneu *et al.*, 2016**).

In conclusion, conventional use of many antidiabetic plants of Egypt can be rationalized by the presence of active compounds found in those plants. The documentation could be important for the conservation of these plants and represent the preliminary information required for future phytochemical investigation.

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