

Diversity of Plants, Traditional Knowledge, and Practices in Local Cosmetics: A Case Study from Alexandria, Egypt¹

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In this study, we explored the diversity of traditional knowledge and plants that have cosmetic values in Alexandria, Egypt. Ethnobotanical data were collected from 396 local Alexandria women using semistructured interviews. Data were analyzed using informant consensus factor (F_{IC}) and fidelity level (FL) metrics. In total, 27 plant species, belonging to 27 genera and 17 families, were identified as local cosmetic resources. Overall, 63% of these plants (17 species) are used in the form of oils, while the most frequently used organ is plant leaves (41% of all species). *Rosmarinus officinalis* L. and *Cinnamomum verum* L. have the largest number of cosmetic uses (8 uses for each). The highest F_{IC} value was 0.98 for the hair treatment category followed by eyes (0.96), female hormones (0.96), skin (0.93), and face treatment (0.93). Plants with the highest citations in this study for hair treatment were *Olea europea* L. (54% of all citations) and *Lawsonia inermis* L. (48% of citations). The most important species according to their fidelity level were *Lawsonia inermis* L. (FL = 87%) and *Eruca sativa* L. (FL = 84%) in hair treatments, *Linum usitatissimum* L. (FL = 83%) as a source of female hormones, *Avena sativa* L. (FL = 63%) for beautification of women's faces, and *Jasminum grandiflorum* L. (FL = 46%) for skin treatments. Demographic factors such as education and age play a significant role in the use of herbal remedies. The study reveals the importance of plants in the local cosmetic industry. The high fidelity score and informant consensus factor suggests that traditional knowledge could potentially guide the search for modern cosmetic products.

Key Words: Ethnomedicinal plants, cosmetics, fidelity level, informant consensus factor, ethnobotany.

Introduction

Plants provide enormous benefits to humanity, including foods, fibers, medicine, and many others. The diversity of plants known to be used in traditional medicine worldwide is estimated at ~10,000–

53,000 species (McChesney et al. 2007; Schippmann et al. 2002). These plants have contributed enormously to the discovery of modern drugs (Lahlou 2013); for example, almost half of all modern anti-cancer small molecules are either natural plant products or their derivatives (Newman and Cragg 2012). In Africa, up to 90% of the human population depends directly on traditional medicine (Farnsworth et al. 1985; Hostettman et al. 2000; Mander et al. 2007; Van Staden 1999). Due to the importance of health issues, most ethnobotanical research has focused on documenting the diversity and traditional uses of medicinal plants locally and globally (Nolan and Turner 2011). As

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a result, other ethnobotanical use categories, such as cosmetics, are overlooked in some regions. Nevertheless, the cosmetic industry is booming globally. In 2011, sales of the top 100 cosmetic companies reached USD 195 billion, with an annual increase of 10.6% (Weil 2012). And one-third of the ingredients used in cosmetic products are plant extracts (Schmidt 2012). Therefore, documenting the diversity and knowledge of plants used for cosmetic purposes has considerable potential commercial value.

Egypt is known for its rich and diverse traditional knowledge of useful plants, including cosmetics. The use of plants for cosmetic purposes in Egypt dates back to the age of the pharaohs (Manniche 1989). Ancient Egyptians' knowledge of herbal medicine and cosmetics has been well documented in the Ebers papyrus, with 876 prescriptions of 328 natural components (El-Demerdash 2001).

There are a few recent studies conducted on ethnomedicinal plants used in modern Egypt (e.g., AbouZid and Mohamed 2011). These studies indicated that approximately 23% of the Egyptian population relies on medicinal plants for their health care (IDSC 2010). Nonetheless, documented knowledge of medicinal plants used by modern Egyptian women for cosmetic purposes is scant. There are several reasons to believe that Egypt is rich in traditional cosmetic practices and in plants that have cosmetic value. For example, Nefertiti, the female pharaoh Hatshepsut, and the Greco-Roman queen Cleopatra who lived in Alexandria, Egypt, were all known in their ancient world for their unique beauty and for their use of local plants as cosmetics (Graves-Brown 2010). This is an indication that Alexandria could potentially be rich in traditional cosmetic knowledge. Because traditional knowledge is transmitted orally across generations, it is likely that some of this knowledge could have been lost, prompting the need to document existing traditional knowledge before it disappears.

The main objective of this study was to explore and document the diversity of traditional knowledge, practices, and plant species used in modern Egypt for cosmetics. To reach this objective, we focused on Alexandria, the ancient capital of Egypt, well known for its contribution to Egyptian as well as world civilization.

Materials and Methods

STUDY AREA

Alexandria was built by Alexander the Great in 331 B.C.E. in the northern part of Egypt. It is located along the Mediterranean Sea and currently occupies an area of 300 km². The population of Alexandria is 4,609,000 inhabitants, of which 49% are women (SIS 2014). The governorate of Alexandria includes urban and rural areas, and about 40% of the Egyptian industries are found around the city of Alexandria (Nasr 1995). Villages surrounding the city lack sufficient modern medical facilities. As a result, the use of traditional medicine is the norm (Schmidt 2012).

ETHNOBOTANICAL DATA COLLECTION

Data were collected in 2012–2013 using semistructured interviews in a random sample. Our respondents were women over 15 years of age living in rural and urban areas of the Alexandria governorate (Fig. 1). Respondents were interviewed by ten trained interviewers who helped nonliterate women to fill out the questionnaires. During the interviews, we recorded women's knowledge of traditional cosmetic practices and plants involved in these practices. We showed women some illustrations of plants reportedly used in cosmetics and asked about their knowledge of the use (if any) of these plants in traditional cosmetics. Interviews and general discussions with women were intended to record information on which plants are used for cosmetic ends, the plant parts used, and the methods of application. We also asked informants about the sources of their knowledge of traditional cosmetics, and how often they used traditional cosmetic products. In addition, we documented their degree of preference regarding modern and traditional plant-based cosmetics. Questionnaires (Appendix 1—Electronic Supplementary Material [ESM]) were distributed to 500 women, but only information from the 396 women who completed the questionnaires was analyzed in this study. All local plant names recorded were botanically identified using various sources (Bedevian 1994; Boulos 1991). These plants were sampled, vouchered, and stored in the Egypt Barcode of Life project database (www.egyptbol.org) hosted by the Department of Floriculture, Ornamental Horticulture and Garden

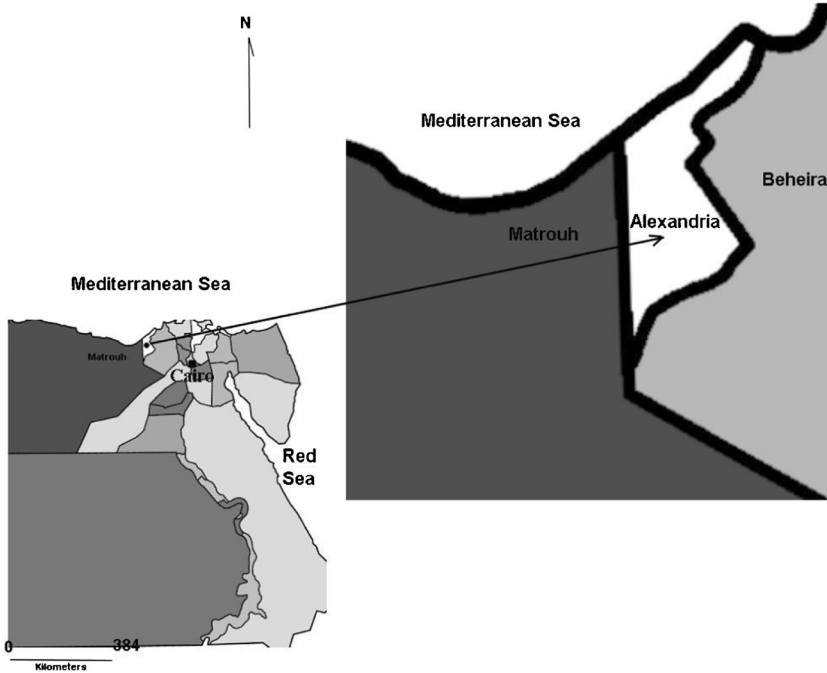


Fig. 1. Source of the recommendation to use herbal remedy in natural beauty solutions.

Design of the Faculty of Agriculture, at the Alexandria University, Egypt (voucher No. Hosam00570–Hosam00597). Free and informed consent following Egyptian legislation was obtained and the study was reviewed by the IRB committee of the High Institute of Tourism, Hotels and Computer, El-Syoutf, Alexandria, Egypt.

DATA ANALYSIS

Our data analysis followed three steps. First, we grouped all documented cosmetic uses into nine categories; each of these categories was labeled according to the body part or function to which it is applied. These categories are (1) skin (antiaging, dark spots, sunburn, deodorant, whitening, scrub, tattoo), (2) face (hair removal, moisturizing, nourishing, antiaging, whitening), (3) hair (hair coloring, scalp treatment, hair growth stimulation, hair mask and nourishing), (4) eye (lashes, moisturizing, puffiness, black circles, antiaging), (5) oral (teeth whitening, breath refreshment, antibacterial), (6) lips (scrub, moisturizing), (7) massage (increasing blood circulation, relaxing, anti-inflammatory), (8) female hormones (breast augmentation, reducing menstrual pain, blessing mode), and (9) cellulite.

Second, we assessed the variability of plant usages in cosmetics within each of the nine categories. This assessment was done using the informant consensus factor (F_{IC}), defined as follows: $F_{IC} = \frac{nur-nt}{nur-1}$ (Heinrich et al. 1998; Trotter and Logan 1986), where *nur* is the number of usages reported for a category and *nt* the number of plant species reported to be used in that particular category. F_{IC} values vary between 0 and 1. A value close to 1 indicates strong consensus among informants, that is, a large proportion of the informants use the same species for the same purpose. When close to 0, F_{IC} value indicates a strong disagreement among informants.

We ranked species based on their claimed effectiveness in a particular use. This allowed us to determine a rank-order priority for all species documented in this study. This ranking was done using Friedman et al.'s (1986) fidelity level index (FL) calculated as follows:

$FL = \frac{I_p}{I_u} \times 100$ (Friedman et al. 1986); I_p is the number of informants who independently indicated the use of a species in a particular cosmetic application; I_u is the total number of informants who mentioned the plant for any use. We interpret FL

values as follows: low, when FL is 0–50%, moderate when between 51–75%, and high when FL > 75%.

Finally we explored the relationships between demographic data and the mean values of plant uses based on one-way ANOVA (SPSS V. 18, PASW). The dependent variables were the nine use categories (skin, face, hair, eyes, oral, lips, massage, female hormones, and cellulite); the independent variables were age, occupation clusters, education level, and marital status. Tukey's HSD post-hoc tests were performed to test for significant differences among demographic groups.

Results and Discussion

POPULATION STRUCTURE OF THE INFORMANTS

Table 1 summarizes the social parameters characterizing our sample of 396 women involved in the study. Respondents belong to all age groups, but the majority (~56%) were 15–35 years of age. They come from various education backgrounds, but a large proportion (~40%) were illiterate, while ~33% had between a secondary and university level of education. This ratio of illiterate vs. educated

women who participated in this study matches well with the most recent figures released by the Egyptian government (CAPMAS 2014). We also sampled across professions (20% students, 26% housewives, and 29% working women in the public sector) and marital status (47% married women and 32% single).

DIVERSITY OF PLANTS TRADITIONALLY USED IN LOCAL COSMETICS

In total, 27 plant species distributed across 27 genera and 17 families were recorded as locally used as traditional cosmetics in Alexandria (Table 2). The largest families of cosmetic plants were Lamiaceae (15%, 4 species) and Rosaceae (11%, 3 species), with only 1–2 species reported for the 15 remaining families. The top rank of Lamiaceae is not surprising for several reasons. First, the Lamiaceae represents 3% of the Egyptian flora and includes over 72 genera and hundreds of species and local cultivars (Boulos 1991; Khedr et al. 2002). The cosmetic importance of species in this family could therefore be a consequence of its representation in local flora. Second, Lamiaceae contains many medicinal plants that are of global importance, such as mint, basil, rosemary, lavender, and marjoram (Peter 2012). This is the case in Egypt (AbouZid and Mohamed 2011; Elansary and Mahmoud 2014a,b), Morocco (Khabbach et al. 2011), Iran (Nasab and Khosravi 2014), Pakistan (Farooq et al. 2012), and the Americas (Moerman et al. 1999).

A range of plant parts, except roots, are used for cosmetic purposes in Alexandria (Table 2). Leaves are the most commonly used plant part in traditional cosmetics; across all the 27 species documented, leaves of 11 species (41%) are used. The contribution of leaves to traditional cosmetics in Alexandria is higher than that reported for other parts of Egypt, e.g., in Beni-Sueif (33%, AbouZid and Mohamed 2011) and Morocco (20%, Khabbach et al. 2011). This is possibly a result of the differences in floristic composition or in traditions across geographic regions (Saslis-Lagoudakis et al. 2014). The second most important organ is fruit (30%, 8 species), followed by flowers (11%, 3 species), and seeds (7%, 2 species). The least used plant organs in local cosmetics are bark and rhizomes (~4%, 1 species). Our observation that plant roots are not used is interesting from a conservation perspective as this suggests that access to traditional cosmetic products would not require the need to uproot the plants. Nonetheless, a continued harvest

Table 1. DEMOGRAPHIC CHARACTERISTICS OF PARTICIPATING WOMEN (N = 396).

Women's Characteristics	Number	Frequency (%)
Age		
15–25	118	30
26–35	102	26
36–45	97	24
46–55	58	15
55 or above	21	5
Education Level		
Illiterate	13	3
Primary	20	5
Secondary	154	39
University	209	53
Marital Status		
Single	128	32
Married	187	47
Divorced	48	12
Widowed	33	8
Occupation		
Student	80	20
Housewife	102	26
Self-employed business	34	9
Public sector	113	29
Private sector	67	17

Table 2. MEDICINAL PLANT SPECIES, PLANT PARTS USED, AND AILMENTS TREATED BY LOCAL WOMEN OF ALEXANDRIA, EGYPT.

Family	Scientific name	Local name	Voucher No.	Plant part used	Preparation	Use/ailment treated (No. of uses mentioned, FL)
(1) Apiaceae	<i>Petroselinum crispum</i> L.	Bakdounes	Hosam00570	Leaves	Fresh leaves, leaf oil, leaf infusions	Skin (10, 10), face (22, 23), hair treatment (64, 67)
(2) Araceae	<i>Cocos nucifera</i> L.	Gouz El-hind	Hosam00571	Fruits	Fruit, oil from the kernel	Skin (36, 19), face (21, 11), hair treatment (92, 49), eye (18, 10), lips (10, 5), massage (6, 3), cellulite (3, 2)
(3) Asteraceae	<i>Matricaria chamomilla</i> L.	Kamomil	Hosam00572	Flowers	Flower infusions	Skin (6, 4), face (4, 3), hair treatment (78, 52), eye (61, 41)
(4) Brassicaceae	<i>Eruca sativa</i> L.	Gargir	Hosam00573	Leaves	Leaf juice, seed oil	Face (17, 16), hair treatment (89, 84)
(5) Euphorbiaceae	<i>Ricinus communis</i> L.	Karwah	Hosam00574	Seeds	Seed oils	Hair treatment (76, 70), eye (32, 30),
(6) Geraniaceae	<i>Pelargonium graveolens</i> L.	Ertet	Hosam00575	Leaves	Leaf essential oil	Skin (12, 44), face (4, 15), hair treatment (3, 11), massage (8, 27)
(7) Lamiaceae	<i>Lavendula officinalis</i> L.	Lavender	Hosam00576	Leaves	Leaf essential oil	Hair treatment (21, 40), massage (32, 60)
(8) Lamiaceae	<i>Ocimum basilicum</i> L.	Rihan	Hosam00577	Leaves	Leaf essential oils	Skin (2, 4), face (8, 14), hair treatment (44, 77), oral (3, 5)
(9) Lamiaceae	<i>Rosmarinus officinalis</i> L.	Rosemary or Hassa Leban	Hosam00578	Leaves	Fresh or dried leaves in infusions and decoctions, in addition to leaf essential oils	Skin (28, 19), face (19, 13), hair treatment (81, 54), eye (4, 3), oral (2, 1), lips (2, 1), massage (8, 5), cellulite (6, 4)
(10) Lamiaceae	<i>Salvia officinalis</i> L.	Mariamiah	Hosam00579	Leaves	Leaf oil	Skin (3, 16), face (5, 26), cellulite (11, 58),
(11) Lauraceae	<i>Cinnamomum verum</i> L.	Qirfah	Hosam00580	Bark	Bark as flakes or powder	Skin (6, 8), face (16, 21), hair treatment (11, 15), oral (2, 3), lips (18, 24), massage (12, 16), female hormone (8, 11), cellulite (2, 3)
(12) Lauraceae	<i>Persea americana</i>	Afokado	Hosam00581	Fruits	Fresh crushed fruits and fruit oils	Skin (12, 24), face (13, 26), hair treatment (25, 50)
(13) Liliaceae	<i>Aloe vera</i> L.	Al-Sabr	Hosam00582	Leaves	Gel	Skin (24, 19), face (34, 27), hair treatment (68, 54)
(14) Linaceae	<i>Linum usitatissimum</i> L.	Ketan	Hosam00583	Seeds	Seeds and seed oils	Skin (2, 17), female hormone (10, 84)
(15) Lythraceae	<i>Lausonia inermis</i> L.	Henna	Hosam00584	Leaves	Leaf powder	Skin (29, 13), hair treatment (190, 87)
(16) Lythraceae	<i>Punica granatum</i> L.	Romaan	Hosam00585	Fruits	Fruit juice, fruits, fruit cover	Face (8, 22), hair treatment (28, 78)
(17) Oleaceae	<i>Jasminum grandiflorum</i> L.	Yasmin	Hosam00586	Flowers	Flower oil	Skin (18, 46), face (5, 13), hair treatment (10, 26), massage (6, 15)

(Continued)

TABLE 2. (CONTINUED).

	Family	Scientific name	Local name	Voucher No.	Plant part used		Preparation	Use/ailment treated (No. of uses mentioned, FL)
					Fruits	Fruit oil		
(18)	Oleaceae	<i>Olea europaea</i> L.	Zaitoun	Hosam00587	Fruits	Fruit oil	Skin (42, 14), face (19, 7), hair treatment (212, 73), eye (7, 2), lips (5, 2), massage (2, 1), cellulite (3, 1)	
(19)	Penulaceae	<i>Corylus avellana</i>	Bondok	Hosam00588	Fruits	Fruit oil, fruit coat infusion	Skin (10, 17), face (4, 7), hair treatment (41, 68), massage (3, 5), cellulite (2, 3)	
(20)	Poaceae	<i>Avena sativa</i> L.	Shofan	Hosam00589	Seeds	Ground seeds	Skin (10, 37), face (17, 63)	
(21)	Poaceae	<i>Cymbopogon citratus</i> L.	Hashishat Al-laimon	Hosam00590	Leaves	Leaf oil, leaf infusions	Skin (9, 26), face (4, 11), hair treatment (12, 34), oral (10, 29)	
(22)	Rosaceae	<i>Malus domestica</i> L.	T ofah	Hosam00591	Fruits	Fruit, apple cedar vinegar	Skin (12, 27), face (11, 24), hair treatment (22, 49)	
(23)	Rosaceae	<i>Prunus dulcis</i> L.	Louze	Hosam00592	Fruits	Fruit oil	Skin (18, 11), face (23, 14), hair treatment (99, 62), eye (3, 2), lips (2, 1), massage (4, 3), female hormone (10, 6)	
(24)	Rosaceae	<i>Rosa hybrida</i> L.	Ward	Hosam00593	Flowers	Petals, aromatic rose water, and rose oil	Skin (20, 20), face (58, 58), lips (5, 5), massage (17, 17)	
(25)	Rutaceae	<i>Citrus x lemon</i> L.	Laimon	Hosam00594	Fruits	Lemon juice	Skin (17, 31), face (10, 18), hair treatment (8, 15), oral (20, 36)	
(26)	Simmondsiaceae	<i>Simmondsia chinensis</i> L.	Hohoba	Hosam00595	Leaves	Leaf oil	Skin (29, 27), face (23, 22), hair treatment (17, 16), lips, massage (9, 8), cellulite (20, 19)	
(27)	Zingiberaceae	<i>Zingiber officinale</i> L.	Ganzabil	Hosam00596	Rhizomes	Powdered dried or fresh rhizomes in powder or decoctions, essential oils	Skin (15, 13), face (23, 20), hair treatment (51, 44), eye (5, 4), oral (3, 3), lips (18, 15), massage (2, 2)	

of leaves and bark could have negative impacts on plant populations over the long term (Gaoue et al. 2013). The diversity of traditional cosmetic knowledge is not only expressed in term of plant parts used but also in term of cosmetic products. Overall, five plant extracts are traditionally used for cosmetic purposes (Table 2), but the most dominant extract is oil (63% of all plants, 17 species). This supports previous studies where the cosmetic values of several plants have been linked to their oil content (AbouZi and Mohamed 2011; Nasab and Khosravi 2014).

PLANTS USED IN TRADITIONAL COSMETICS: FIDELITY LEVELS AND INFORMANT CONSENSUS FACTORS

Overall, *Rosmarinus officinalis* L. and *Cinnamomum verum* (8 Citations for each) followed by *Cocos nucifera* L., *Olea europea* L., *Zingiber officinale* L., and *Prunus dulcis* L. (7 Citations for each) are the most frequently cited plants by Alexandria women for cosmetic purposes. However, when taking each category of usages into account, the most cited plants are different. For example, in the category of hair treatment, *O. europea*, *Lawsonia inermis*, and *P. dulcis* were the most cited plants. *O. europea* was cited by 212 women (i.e., ~54% of informants) as widely used in hair treatment. This plant is particularly used for its oils as anti-dandruff and for moisturizing, nourishing, and scalp treatment. The leaves of *L. inermis* (190 women, 48% of informants), a plant commonly known as “henna,” are transformed into powder and used to dye women’s hair. This hair-dyeing practice using henna is ancient in Egypt, dating back to the pharaohs (Dioscorides 1655; Manniche 1989). Also, additional studies confirm the traditional value of this plant in ancient Egypt, especially in the treatment of “evil-smelling feet” (Alpin 1980; Manniche 1989). In the present day, *L. inermis* is still widely used not only in Egypt, but also in several North African countries such as Morocco (Khabbach et al. 2011), where the plant is used as a hair dye (Chukwu et al. 2011), but also for its phytochemical properties that can be antimicrobial (Muhammad and Muhammad 2005), anti-inflammatory, (Liou et al. 2013), and anti-cancer (Zumrutdal et al. 2008). The third most cited plant in hair treatment was *P. dulcis* (99 women, 25% of informants), known as almond tree, which is also used for its oil as anti-dandruff, moisturizing, and nourishing. Almond tree is also a well-known

plant in ancient Egypt in traditional cosmetics (Alpin 1980).

The high number of cosmetic application citations is reflected in the fidelity level (FL) figures, as several highly cited plants also score high in FL ranking (Table 2). In particular, *L. inermis* and *E. sativa* showed the highest FL scores of 87% and 84%, respectively. They were followed by *Linum usitatissimum* L. with an FL score of 83% in the category of female hormones. Only two taxa were used in the female hormone category—*C. verum* and *L. usitatissimum*. *C. verum* is used to reduce menstrual pain. The seeds of *L. usitatissimum* are natural sources of phytoestrogens, which are plant-derived molecules that possess estrogen-like properties and are used by women to prevent breast cancer and control menopause (Albertazzi and Purdie 2002). Furthermore, *O. europea* scored fourth (FL = 73%) in hair treatment category. Although this species scores lower than *L. inermis* in FL ranking in the hair treatment category, it appears to be more popular in local cosmetics than *L. inermis* as indicated by their overall citations: *O. europea* (73% of all citations) vs. *L. inermis* (55% of all citations). However, *P. dulcis* has a moderate FL score of 62% in hair treatment category.

The highest FL score found for the beautification of women’s face was 63%, a moderate score, and this was for the species *Avena sativa* L. The seeds of *A. sativa* are used for peeling, face masks, and as a facial scrub. Rose water derived from *Rosa hybrida* was also used in face beautification as a face tonic and for pore control (FL = 58%). Other moderate scores were found for *Lavendula officinalis* L., particularly for its use as a massage oil (FL = 60%), and *Salvia officinalis* (56%), which is used in cellulite treatments. In the remaining categories of cosmetic uses, FL values were low. This is the case for *Matricaria chamomilla* L. (FL = 41%) in the category of eye beautification. It is also true in the oral category for the plant *Citrus × lemon* L. (FL = 36%).

We also assessed the informant consensus factor (F_{IC}) of all categories of cosmetic usages (Table 3). All categories had high F_{IC} values, ranging from 0.80 to 0.98. The highest F_{IC} value was found for hair treatment (0.98), followed by eyes (0.96), female hormones (0.96), and skin and face treatments (0.93). These high values further support the heavy reliance of Alexandria women on plant extracts as cosmetic products, and can be explained by the negative side effects and high cost of synthetic (modern) body lotions (Sandhya et al. 2012).

Table 3 INFORMANT AGREEMENT FACTOR FOR DIFFERENT MAJOR USE CATEGORIES.

Use category	Number of taxa	Number of use reports in each category (NUR)	Informants' consensus factor (F_{IC}) ^a
Skin	26	370	0.93
Face	25	368	0.93
Hair	27	1,342	0.98
Eye	6	130	0.96
Oral	7	40	0.85
Lips	12	69	0.84
Massage	15	109	0.87
Female hormones	2	28	0.96
Cellulite	10	47	0.80

SOURCES OF TRADITIONAL COSMETIC KNOWLEDGE AND PRACTICES IN ALEXANDRIA

To further document traditional knowledge in our study area, we asked three questions. First, how is traditional cosmetic knowledge transmitted or acquired? During this assessment, eight sources were reported (Fig. 2). Families and friends were cited in 23% of cases, whereas 20% of respondents noted that local magazines and the media are reliable sources of information about traditional cosmetic practices. Other sources noted local herbal shops (17%) and the internet (14%). Formal structures such as pharmacies, beauty salons, and dermatologists were less often referred to as important sources of traditional cosmetic knowledge (Martin 2004).

We also asked how frequently local women rely on plants for their beautification. The results (Fig. 3) show that 78% of women rely on traditional plant products for their cosmetic needs, whereas only 22% indicate that they have never used them before. Among the 78% who rely on traditional

plant products, the frequency of use varies: 30% use cosmetic herbal remedies once a week, 20% use them once a month, and 9% use them every 1 to 6 months. We also queried our informants in terms of their knowledge of cosmetic plant safety (Fig. 4.) A large proportion (46%) indicated that it is a very safe practice, whereas 29% perceived it to be fairly safe. However, 11% did not know anything about safety issues of traditional cosmetics, and only 5% and 2% believed the practice to be very unsafe and unsafe, respectively.

Finally, we conducted one-way ANOVA to test the relations among socio-demographic characteristics and cosmetic use categories (Table 4). There were significant differences between older women (aged ≥ 56) and younger women (aged 15–25) in most use categories. Hair and face treatment categories, however, represented exceptions to this general trend, as older and younger women share not only similar knowledge of traditional hair and face cosmetic treatments but also are similarly inclined to apply these treatments. The 26–35 age group showed significant differences compared to women

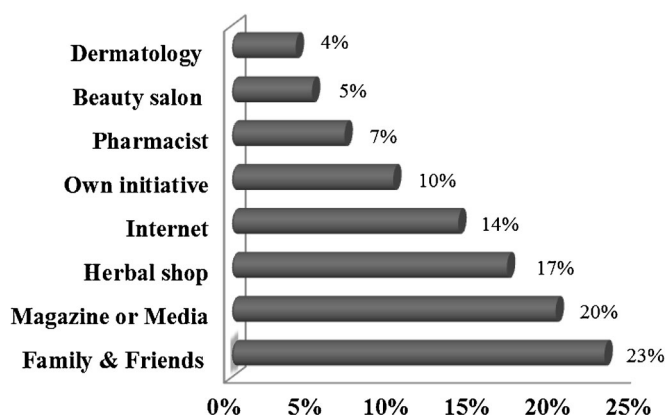


Fig. 2. Source of the recommendation to use herbal remedy in natural beauty solutions.

Frequency of herbal remedies among Alexandria women

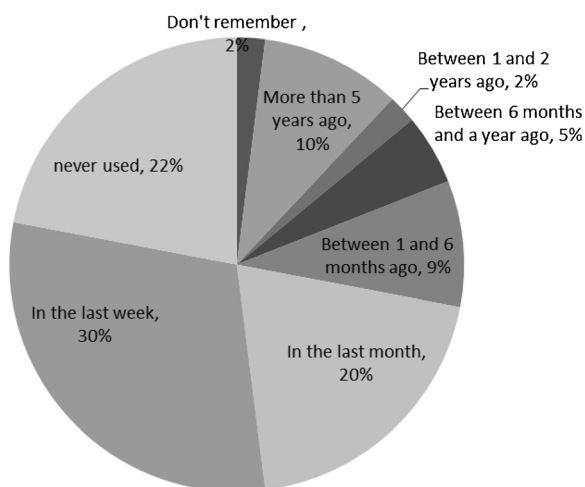


Fig. 3. Frequency of use of herbal remedies among 396 Alexandria women in 2012–2013.

aged ≥ 56 in the skin, eyes, massage, and cellulite use categories. We further found that nonliterate women are more interested in the use of herbal products for skin and hair treatments than university women. However, university women showed significantly higher mean values for the use of herbal remedies for massage and cellulite. Marital status was only a factor in the case of skin and cellulite treatment;

married women use cosmetic medicinal plants for their skin and as cellulite treatment more than widowed women.

The type of occupation also plays a major role in the use of herbal remedies. We discovered that students and housewives use more cosmetic medicinal plants for their skin, face, hair, lips, and massage treatments than women who work outside of the

Safety margin ratio of Alexandria women

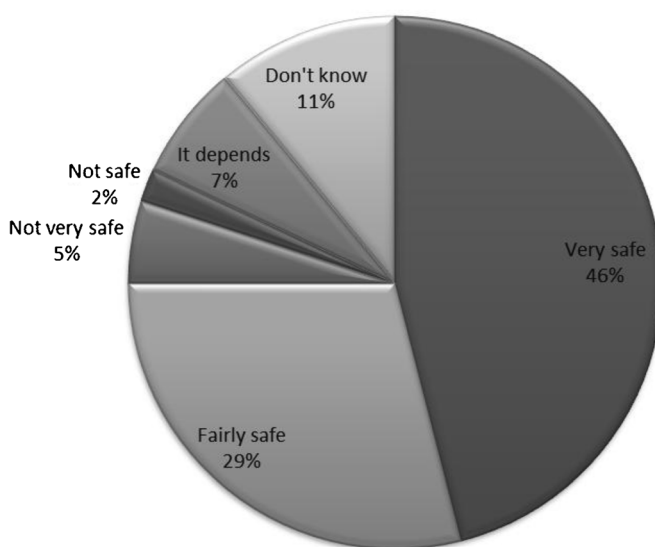


Fig. 4. Safety margin of the commonly used herbal medicine by women in Alexandria.

Table 4. RESULTS OF ANOVA ANALYSIS OF THE RELATIONSHIPS BETWEEN SOCIO-DEMOGRAPHIC CHARACTERISTICS AND PLANT USE CATEGORIES (N = 396).

Independent variable	N	Mean Score for Dependent Variable												
		Skin	Face	Hair	Eye	Oral	Lips	Massage	Female hormone	Cellulite				
Age														
15-25	118	4.63 ^b	4.15	4.69	3.36 ^b	4.51 ^b	4.78 ^b	2.86 ^b	4.83 ^b	2.26 ^a				
26-35	102	4.64 ^b	4.08	4.46	3.03 ^b	4.48	4.63	3.48 ^b	4.54	3.85 ^b				
36-45	97	4.69 ^b	3.91	4.36	2.75 ^b	4.30	4.06	3.05 ^b	4.20	3.32				
46-55	58	4.86 ^b	3.86	4.26	2.82 ^b	4.03	3.87	2.94 ^b	3.82	3.77				
56 or above	21	3.31 ^a	3.18	4.18	1.53 ^a	2.91 ^a	2.52 ^a	1.64 ^a	2.61 ^a	3.02				
F Value		3.03*	1.20	0.28	4.53*	2.30*	3.89*	4.81*	2.68*	1.85*				
Education level														
Illiterate	13	4.31 ^b	4.02 ^b	4.17	3.76	4.98	3.67	1.88 ^a	3.71	1.53 ^a				
Primary	20	4.26 ^b	3.54	4.59	3.77	4.86	4.46	3.06	4.23	2.87 ^b				
Secondary	154	3.85	3.30	4.43	4.01	4.97	4.23	3.37	3.82	3.11 ^b				
University	209	2.73 ^a	3.12 ^a	4.69	4.31	4.35	4.05	3.68 ^b	4.52	3.59 ^b				
F Value		3.63*	2.74*	1.03	1.02	0.91	1.78	2.49*	0.98	4.28*				
Marital Status														
Single	128	4.61 ^b	4.33	4.55	4.21	4.13	3.78	3.86	4.27	3.56				
Married	187	4.55 ^b	4.08	4.46	4.00	4.16	3.26	4.29	4.34	4.13 ^b				
Divorced	48	3.76	4.25	4.19	3.83	3.94	3.18	3.37	4.26	3.89				
Widowed	33	2.71 ^a	3.93	4.13	3.59	3.77	3.03	3.31	3.97	2.52 ^a				
F Value		3.37*	1.13	1.56	0.93	0.97	0.86	0.83	0.91	2.74*				
Occupation														
Student	80	4.78 ^b	4.08 ^b	4.73 ^b	3.39	3.73	4.62 ^b	4.21 ^b	2.72 ^a	3.25 ^a				
Housewife	102	4.40 ^b	3.79 ^b	4.66 ^b	4.42	4.57 ^b	4.55 ^b	4.17 ^b	4.51 ^b	4.94 ^b				
Self-employed	34	3.77	3.52	4.52 ^b	3.95	3.34	3.62	3.99 ^b	3.53	4.86				
Public sector	113	3.85 ^b	3.57 ^b	4.05 ^b	4.35	3.56	3.74 ^b	4.12 ^b	4.02	4.41				
Private sector	67	2.39 ^a	2.63 ^a	2.24 ^a	3.76	3.00 ^a	2.12 ^a	1.73 ^a	3.73	4.02				
F Value		3.76*	3.57*	4.25*	1.93	3.17*	3.93*	4.03*	2.74*	2.75*				

*Significant at the $p < 0.05$ level.

^{a,b}The mean difference is significant at the $p < 0.05$ level in post hoc tests in a column.

home. Students and housewives tend to have less income than working women, hence their higher interest in cheaper cosmetics. This is not universally the case, however. A study in the U.S. reported that level of education and income as well as age is associated with the use of herbal remedies (Hanyu et al. 2000). However, Alencar et al. (2014) reported that knowledge of medicinal plants was not related to age or gender in Brazil. And in Finland, women who had relatively high social status were the most interested in herbal remedies (Hemminki et al. 1991), suggesting that knowledge and use of herbal remedies may be context specific. In Egypt, which is a developing country, branded pharmaceutical drugs are costly and thus not within the financial means of the low income community. Hence, herbal remedies are much more common among lower-income groups, such as students, housewives, and nonliterate women.

Conclusions

Our study is the first to explore the diversity of medicinal plants used for cosmetic purposes in Alexandria Egypt. We documented 27 ethnomedicinal plants that also are used in the local cosmetic industry. The vast majority of these plants produce essential oils that are already well known in Egyptian ethnomedicine (EDI 2013) for the treatment of gastrointestinal and skin diseases. Interestingly, none of these plants is Red Listed yet (IUCN 2014), but adequate monitoring is necessary to prevent unsustainable harvest of these important plants. The socioeconomic value of these plants lies principally in their use in the treatment of women's hair, skin, and face. All categories of plant usage score high in fidelity level (FL), with strong consensual agreement (F_{IC}) among informants. High scores in these areas could potentially guide the search for new cosmetic products of global interest. We also found that socio-demographic factors such as age, education, occupation, and marital status may play a role in the use of medicinal plants as cosmetics.

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