Characterization of some olive cultivars (*Olea europaea* L.) in Egypt using morphological methods

Aly, M. A.[1]; Ezz, Thanaa M.[1], Rasmy, M. R.[2] and Khodier, Shimaa M.[3]

1 Fac. Agric., Saba Basha, Alex. Univ.

2 Plant Pathology Research Institute (ARC)

3 Postgraduate student: e-mail: shimaa_khodier@yahoo.com

ABSTRACT

This investigation was carried out during 2007 and 2008 seasons on nine olive cultivars (*Olea europea*, L.) namely: Chemlaly, Kalamata, Maraky, Egizy, Watikin, Meloky, Hamedy, Manzanillo and Kronaky, grown in the experimental farm, Faculty of Agriculture (Saba-Basha), Alexandria University, Egypt. Characterization and identification of these cultivars were done using 18 morphological characters including leaf, inflorescence, fruit and pit characters to calculate the morphological variations. The quantitative and qualitative characters measured for the nine cultivars were used together to compute the relative similarity or dissimilarity of these cultivars using the software SPSS program-version 10. The value of squared Euclidean distances for the nine cultivars ranged from 0.00 to 96.23. The lowest squared Euclidean distance was (4.51) between cultivars Egizy and Maraky and (5.45) between cultivars Maraky and Meloky, that may indicate a close relation of the cultivars. The highest distance was (96.23) between Egizy and Kronaky and (90.95) between Hamedy and Kronaky, that indicated Egizy and Kronaky cultivar are apart from each other. The dendrogram of the proximities of the nine cultivars showed two clusters. The first cluster had two cultivars: Chemlaly and Kronaky, while the second cluster had seven cultivars.

Keywords: Olives, *Olea europaea*, characterization, cultivars, Egypt, morphology

INTRODUCTION

Olives are one of the most extensively cultivated fruit crops in the world. In 2009, 9.9 million hectares were planted with olive trees, which is more than twice the amount of land devoted to apples, bananas or mangoes, produced about 18.24 million tons (FAO STAT, 2010). Statistics of Egyptian Ministry of Agriculture for the year 2009 indicated that a total area of about 158,058 feddans are grown to olive of which 90,344 feddans outside the Nile valley as newly reclaimed land. The total production is about 449,009 tons. Distribution of incorrectly labeled olive and the global spread of vegetative propagated cuttings over hundreds of years changing their names have caused the current problem of homonyms and synonyms (Cimato and Attilio, 2008). It is difficult to identify and classify olive (*Olea europaea* L.) varieties, which are estimated as being close to 2,000 in number. Morphological and physiological traits are widely used for this purpose, but they are strongly dependent on the environmental factor, consequently it is difficult to resolve the issues that arise concerning synonymy and homonymy (Vergari *et al.*, 1999). Usually, the morphological traits require only simple equipment but it is subjected to environmental

influences (De Vicente and Fulton, 2003). Morphological characters did not ensure a complete characterization. Indeed, environmental factors render difficult the cultivar identification on the basis of the phenotype (Bronzini de Caraffa *et al.*, 2002). Phenotype is the combination of individual traits resulting from a genotype and its interaction with the environment. Assessment of phenotypic variation focuses on morphological traits-those characteristics that define the shape and appearance of a set of individuals. Morphological descriptors have been used for characterization and identification of olive cultivars, i.e., fruit, endocarp and leaf traits (Abdine *et al.*, 2007; Cimato and Attilio, 2008). Fruit, endocarp, leave and infloresence traits were used for characterization of olive cultivars (Idrissi and Ouazzani, 2007; Hosseini-Mazinani *et al.*, 2008; Ulas and Gezerel, 2008). It was found that fruit, endocarp and leaf traits had a high identification potential for the studied varieties (Idrissi and Ouazzani, 2007). Also, Del Río and Caballero (2008) used fruit weight, flesh/stone ratio and oil yield for characterization of olive cultivars. Al Ibrahem *et al.* (2008) found that up to 60% of the observed variation may be ascribed to the olive stone aspect ratio descriptor alone. Some of these traits can be considered as 'genetic' if their presence in related individuals is heritable and not dependent on the environment, meaning that they are associated with a particular DNA sequence (De Vicente and Fulton, 2003). This procedure has been performed in olive to identify varieties, to study olive genetic diversity and used to determine the relationships between varieties (Ganino *et al.*, 2007; Helally, 2008; Durgac *et al.*, 2010 and Sheidai *et al.*, 2010).

The present study aimed to characterize and identify 9 olive cultivars using different morphological characteristics and to establish the relative relatedness between each of these varieties.

MATERIALS AND METHODS

Nine olive cultivars (*Olea europea*, L.), namely, Chemlaly, Kalamata, Maraky, Egizy, Watikin, Meloky, Hamedy, Manzanillo and Kronaky, grown in the experimental farm, Faculty of Agriculture (Saba-Basha), Alexandria University, were used for this experiment. Three mature trees (16 Years old) were used to represent each cultivar to make the morphological, biochemical and genetic analysis. Morphological characteristics were measured for each cultivar at both studied seasons 2007 and 2008 as used by Cantini *et al.* (2002).

A- Leaf characteristics

The first four characteristics of leaves are quantitative and the fifth is qualitative. All following characteristics were recorded in samples of 40 mature leaves taken at random in mid-April during both seasons under the study (whole tree, different direction and different tree height) from each tree of all studied cultivars (Antonio *et al.*, 1999). Petiole length (cm), leaf length (L, cm), leaf width (W, cm), leaf ratio (L/W), which is an indication for

the leaf shape. It is divided into three categories: Elliptic, Elliptic-lanceolate and Lanceolate.

B- Inflorescence characteristics

The following characteristics were recorded in samples of 20 inflorescences from each tree/ cultivar in mid-April in both seasons. The length of petiole of the inflorescence (peduncle) (cm), the length of the inflorescence (cm), number of flowers per inflorescence and perfect flowers % according to Dimassi *et al.* (1999).

C- Fruit characteristics

At harvest time, six quantitative characteristics were considered in a sample of 20 fruits from each experimental tree for both seasons 2007 and 2008. The following characteristics were measured and calculated according to Antonio *et al.* (1999), Tous *et al.* (1999) and Fourati *et al.* (2002): Fruit length (L, cm), fruit width (W, cm), L/W fruit ratio which indicates the fruit shape, fruit volume (cm^3), fruit weight (g) and flesh percentage to fruit weight (%).

D- Pit characteristics

The following characteristics were measured and recorded according to Antonio *et al.* (1999): Pit weight (g), pit length (L, cm), pit width (W, cm) and L/W pit ratio.

Statistical analysis

Analysis of variance was performed for all measured traits (morphological) in order to test the significance of variance among cultivars (Steel and Torrie, 1980). Moreover, calculations were performed using the software packages of Minitab Inc. (2003) for computing ANOVA of variables and SPSS Inc. (2006) for cluster analysis.

RESULTS AND DISCUSSION

A- Leaf characteristics

The results of leaf characteristics (petiole length, leaf length & width and leaf length/width ratio which indicates leaf shape) are presented in Table (1).

Respecting, petiole length, it was found that the average petiole length of the two years (2007 and 2008) was differed significantly.The longest was noted in Egizy (0.52 cm), followed by Chemlaly and Manzanilo (0.48 and 0.48 cm). There was no significant difference between Chemlaly and Manzanilo as well as between Maraky (0.46 cm) and Watikin (0.45 cm), was followed by Meloky then Hamedy and Kalamata. It was found that there is no difference between Hamedy and Kalamata cultivars in petiole length while Kronaky Cv. (0.30 cm) was found to be significantly the shortest petiole length between the studied cultivars.

Regarding to leaf length, the data presented in Table (1), showed that the average leaf length of the two years (2007 and 2008) was significantly longer in Manzanilo (5.84 cm) and Kalamata (5.72 cm). On the

other hand, the shortest leaf length was found in Watikin (4.71 cm) Kronaky (4.59 cm) as compared with that of the other cultivars. In the other studied cultivars namely, Hamedy, Meloky, Maraky, Chemlaly and Egizy, it was in between these extremes.

According to leaf width, the average leaf width was measured in 80 leaves for each cultivar of the two years (2007 and 2008). The average ranged from 1.86 cm to 1.07 cm. It was found that Kalamata cultivar (1.86 cm) had significantly the widest leaf width, followed by Chemlaly, Kronaky, Meloky, Maraky and Hamedy cultivars. Comparing of that of the other cultivars, the average leaf width was significantly the narrowest in Watikin (1.11 cm) and Egizy (1.07cm) cultivars.

As for the average leaf length/width ratio, it was ranged from 4.96 to 3.18 cm. The highest value was in Hamedy (4.96) and Egizy (4.85) cultivars as compared with the other cultivars. The average leaf length/width ratio was significantly the lowest in Manzanilo (3.34) and Kalamata (3.18). The average leaf length/width ratio indicates leaf shape. It was found that the average leaf length/width ratio of Hamedy, Egizy, Maraky, Meloky and Watikin Cvs were 4.96, 4.85, 4.47, 4.44 and 4.43 cm, respectively. All of them indicated the leaf shape of elliptic-lanceolate while the average leaf length/width ratio in Kronaky, Chemlaly, Manzanilo and Kalamata Cvs. were 3.56, 3.46, 3.34 and 3.18, respectively, which indicated the elliptic leaf shape according to Cimato and Attilio (2008). The same trend was reported by Cantini *et al.* (2002), Mulas *et al.* (2002), Tous *et al.* (2002) and Taamalli *et al.* (2006). Moreover, Sheidai *et al.* (2010) performed morphological analyses on 8 brown olive populations of Iran using 24 morphological characters. ANOVA test showed significant difference in leaf length and leaf width among different populations and PCA analysis showed that the leaf characteristics (venation, width, trichome, colour in the ventral and dorsal surfaces).

Table (1): Averages of leaf characteristics of the nine olive cultivars during 2007 and 2008 seasons

Cultivar	Petiole Length (cm)			Leaf Length (L) cm			Leaf Width (W) cm			L / W			Leaf Shape
	2007	2008	average	2007	2008	Average	2007	2008	Average	2007	2008	average	
Chemlaly	0.4	0.5	0.5	4.8	5.1	5.0	1.5	1.5	1.5	3.3	3.6	3.5	Elliptic
Egizy	0.5	0.5	0.5	4.9	5.0	5.0	1.1	1.1	1.1	4.8	4.9	4.9	Elliptic-Lanceolate
Hamedy	0.4	0.4	0.4	5.4	5.4	5.4	1.1	1.1	1.1	5.0	4.9	5.0	Elliptic-Lanceolate
Kalamata	0.4	0.4	0.4	5.7	5.8	5.7	1.9	1.8	1.9	3.1	3.3	3.2	Elliptic
Kronaky	0.3	0.3	0.3	4.6	4.6	4.6	1.3	1.3	1.3	3.5	3.7	3.6	Elliptic
Manzanilo	0.5	0.5	0.5	5.8	5.9	5.8	1.1	1.1	1.1	5.3	5.4	3.3	Elliptic
Maraky	0.5	0.5	0.5	4.9	5.1	5.0	1.1	1.2	1.2	4.4	4.5	4.5	Elliptic-Lanceolate
Meloky	0.4	0.4	0.4	5.4	5.4	5.4	1.2	1.3	1.2	4.7	4.3	4.4	Elliptic-Lanceolate
Watikin	0.4	0.5	0.5	4.7	4.7	4.7	1.1	1.1	1.1	4.5	4.4	4.4	Elliptic-Lanceolate
$LSD_{0.05}$	0.04	0.04	0.02	0.26	0.25	0.25	0.10	0.10	0.05	0.38	0.38	0.27	

B- Inflorescence characteristics

The results of inflorescence characteristics are presented in Table (2). The results indicated that there were significant differences among cultivars in peduncle length, inflorescence length, number of flowers per inflorescence and percentage of perfect flowers.

In view of peduncle length, it was found that cultivars differed significantly in the average peduncle length in the two seasons 2007 and 2008. The least significant difference ($LSD_{0.05}$) between cultivars was 0.10 cm. No significant difference was found between Watikin (1.38 cm) and Egizy (1.35 cm) as they had the longest peduncle length. Cultivars Manzanilo, Maraky, Kalamata and Meloky which had the peduncle length of 1.28, 1.28, 1.23 and 1.22 cm, respectively, did not differ significantly. The shortest peduncle length was found in Kronaky cultivar (0.92 cm).

The average length of the inflorescence ranged from 3.70 to 2.78 cm for all studied cultivars. It was found that the longest inflorescence was detected for Manzanilo (3.70 cm) and Watikin (3.55 cm). No significant differences were observed between Manzanilo and Watikin. Also, there was no significant differences were found among Egizy, Kalamata, Maraky, Kronaky and Hamedy cultivars which were 3.32, 3.31, 3.20, 3.10 and 3.09 cm, respectively, while the shortest value was obtained from Chemlaly cultivar (2.78 cm).

As for the average number of flowers per inflorescence of the two seasons 2007 and 2008 for the studied olive cultivars, it was found that cultivars differed significantly. It was ranged from 10.47 to 18.12. The highest average number of flowers per inflorescence was observed in watikin (18.12), while the lowest average number was detected in Chemlaly (10.47).

Regarding the average percentage of perfect flowers per inflorescence, it was noticed that the highest values were for Chemlaly (99.74%), Kronaky (98.49%) and Watikin (98.44%) with no significance difference. On the contrary, the lowest one was Hamedy (87.09%). For cultivars Kalamata, Meloky, Manzanilo, Maraky and Egizy, it was in between these two extremes. It was found that Hamedy Cv. differed significantly from Chemlaly, Kronaky and Watikin but it did not differ, significantly, from the rest of cultivars. The results obtained by Dimassi *et al.*, (1999) revealed that the number of flowers per inflorescence ranged between 16 for Chondrolia Chalkidikis to 44 for Lianolia Kerkiras. The lowest percentage of perfect flowers was recorded on the northern side of the tree and in the top of the shoots and the highest in the southern side and in the middle of each flowering shoot. Among the six cultivars tested «Adramitini», «Cordal» and «Kothreiki» were self-fruitfull, while «Chondrolia Chalkidikis», «Karydolia» and «Manzanillo» were partially self-unfruitful.

Table (2): Averages of inflorescence characteristics of the nine olive cultivars during 2007 and 2008 seasons

Cultivar	Peduncle length (cm)			Infl. Length (cm)			No. flowers / Infl.			Perfect flowers (%)		
	2007	2008	Average	2007	2008	Average	2007	2008	Average	2007	2008	Average
Chemlaly	1.0	1.1	1.1	2.8	2.7	2.8	10.4	10.6	10.5	99.7	99.8	99.7
Egizy	1.3	1.4	1.4	3.1	3.6	3.3	12.9	13.2	13.1	92.2	88.8	90.5
Hamedy	1.0	1.1	1.0	2.9	3.2	3.1	12.1	12.7	12.4	85.3	88.9	87.1
Kalamata	1.2	1.3	1.2	3.6	3.1	3.3	16.3	16.0	16.2	95.5	94.3	94.9
Kronaky	0.9	0.9	0.9	2.9	3.3	3.1	12.5	15.8	14.2	98.8	98.2	98.5
Manzanilo	1.5	1.1	1.3	3.9	3.5	3.7	10.6	13.9	12.3	96.5	91.9	94.2
Maraky	1.4	1.2	1.3	3.4	3.0	3.2	17.1	13.5	15.3	98.9	82.8	90.9
Meloky	1.2	1.3	1.2	3.1	3.0	3.1	15.5	12.7	14.1	99.3	90.2	94.7
Watikin	1.4	1.4	1.4	3.5	3.6	3.6	21.1	15.1	18.1	99.4	97.5	98.4
LSD0.05	0.11	0.13	0.10	0.23	0.25	0.23	0.02	0.03	1.03	2.9	3.8	11.4

C- Fruit characteristics:

Fruit characteristics are presented in Table (3). Fruit length (L) cm, fruit Width (W) cm, (L) / (W), fruit Shape, fruit volume, fruit weight (g), weight class and flesh %. For fruit length, the average fruit length for the two years 2007 and 2008 differed significantly between cultivars. Kalamata was the longest cultivar in fruit length (2.87 cm) Chemlaly (2.75cm) then Maraky (2.68cm) while Kronaky CV. was the shortest cultivar in fruit length (1.75cm).

Regarding fruit width, the average fruit width found to be significantly different. No significant difference was found between cultivars Maraky, Egizy, Watikin and Hamedy. These cultivars were significantly the highest cultivars in fruit width. The lowest fruit width was found in Kronaky cultivar (1.10cm).The ratio L/W (length of fruit/width of fruit) was calculated for the nine cultivars in the two seasons 2007 and 2008. Cultivars differed significantly in the average of the two seasons of this ratio. It was found that Chemlaly cultivar had significantly the highest L/W ratio while cultivars Egizy, Meloky and Watikin which had the same value (1.34) were found to be the lowest ratios. The other cultivars had L/W ratios in between these extremes. This ratio is an indicator for the fruit shape as cited by (Cimato and Attilio, 2008). As they cited that ratio between the length (L) and width (W) : <1.25 is spherical, 1.25-1.45 is ovoid, >1.45 is elongated. It was found that cultivars Chemlaly, Kalamata and Kronaky to be elongated while cultivars Manzanilo, Hamedy, Maraky, Egizy, Meloky and Watikin found to be ovoid.

Fruit volume was, also, measured and averaged for the two years 2007 and 2008. It was found that the average fruit volume differed significantly between cultivars (Table 4). It was noticed that Egizy cultivar (5.45 cm^3), Hamedy (5.32 cm^3) and Maraky (5.27 cm^3) had the highest fruit volume. That was followed by Watikin (5.15 cm^3) which differed significantly from Egizy but it did not differed significantly from Hamedy and Maraky. As for fruit weight, it was found that the average fruit weight of the two seasons 2007 and 2008 differed significantly between the nine studied cultivars. Egizy was found to be significantly the highest fruit weight (5.49 g). That was followed by Watikin (4.84g) and Maraky (4.80g). No significant difference was found between Watikin and Maraky. That was followed by Hamedy (4.36g) and Meloky (4.26g). The lowest cultivar in fruit weight was Kroknaky (1.08g). That was near to that mentioned with Tous *et al.* (2002). They found that Kronaky produced the smallest fruits (average fruit weight 0.8 g). Cultivars were classified according to fruit weight into three groups according to (Cimato and Attilio, 2008). It was found that cultivars Egizy, Watikin, Maraky, Hamedy and Meloky to be high in fruit weight. Manzanilo, Kalamata and Chemlaly were classified as medium weight fruits. While cultivar Kronaky was classified as low weight fruit.

The average flesh % (Table 4) was found to differ significantly between cultivars. This percent was ranged from 85.47 % to 70.21 %. Watikin (85.47%) was found to be significantly the highest cultivar in flesh % in fruit. Del Río and Caballero (2008) found that, fruit weight varied from 1 to 10.4 g, with a mean value of 4 g and flesh/stone ratio from 4 to 1.7, with an average of 2.8. Dry matter fruit oil percentage was from 24 to 60%, with a mean of 45%. Observed intervals of variation are very wide, but cultivars of medium to small values of fruit size (4.8-1.6), flesh/stone ratio (7.7 to 4.7) and dry matter oil percentage (48.5 to 34.5%) do predominate. Fruit of bigger size show a higher flesh/stone ratio (r = 0.7**), although the relationship between these two parameters and the whole fruit oil percentage may be very variable (r = 4). Also, Ulas and Gezerel (2008) measured tree, fruit characteristics for numerous local and some standard olive (*Olea europaea* L. *sativa*) cultivars growing in Çukurova region in Turkey. They found that, Küncülü (KilisYağlık), Yerli (Erkence) are not different cultivars. Adana Topağı, Sarı Ulak, EdremitYağlık, Mavi, Gemlik cultivars showed clear superiority to the other cultivars in Çukurova ecological conditions.

Table (3): Averages of fruit characteristics of the nine olive cultivars indicating fruit shape during 2007 and 2008 seasons

Cultivar	Fruit length (L) cm			Fruit Width (W) cm			(L) / (W)			Fruit Shape
	2007	2008	Average	2007	2008	Average	2007	2008	Average	
Chemlaly	2.8	2.7	2.8	1.4	1.3	1.4	2.0	2.1	2.1	Elongated
Egizy	2.6	2.6	2.6	2.0	2.0	2.0	1.3	1.3	1.3	Ovoid
Hamedy	2.5	2.8	2.6	1.9	2.0	2.0	1.3	1.4	1.4	Ovoid
Kalamata	2.9	2.8	2.9	1.8	1.7	1.7	1.7	1.7	1.7	Elongated
Kronaky	1.9	1.6	1.8	1.2	1.0	1.1	1.6	1.5	1.6	Elongated
Manzanilo	2.6	2.5	2.5	1.9	1.7	1.8	1.4	1.4	1.4	Ovoid
Maraky	2.6	2.8	2.7	1.9	2.0	2.0	1.3	1.4	1.4	Ovoid
Meloky	2.3	2.6	2.5	1.8	1.9	1.9	1.3	1.4	1.3	Ovoid
Watikin	2.6	2.6	2.6	2.0	1.9	2.0	1.3	1.4	1.3	Ovoid
$LSD_{0.05}$	0.11	0.13	0.06	0.10	0.11	0.05	0.08	0.08	0.06	

Table (4): Averages of fruit characteristics of the nine olive cultivars during 2007 and 2008 seasons

Cultivar	Fruit Volume (cm^3)			Fruit Weight (g)			Weight Class	Flesh %		
	2007	2008	Average	2007	2008	Average		2007	2008	average
Chemlaly	3.0	2.7	2.8	2.7	2.6	2.6	Medium	73.3	67.1	70.2
Egizy	5.5	5.4	5.5	5.2	5.7	5.5	High	81.7	84.6	83.2
Hamedy	4.6	6.1	5.3	4.4	4.4	4.4	High	81.8	79.5	80.6
Kalamata	4.7	4.1	4.4	3.5	4.3	3.9	Medium	80.2	81.0	80.6
Kronaky	1.4	0.9	1.2	1.1	0.9	1.1	Low	72.9	81.8	77.4
Manzanilo	5.0	4.1	4.6	4.8	3.9	3.9	Medium	77.5	78.0	77.7
Maraky	5.0	5.5	5.3	4.7	5.9	4.8	High	81.7	86.2	83.9
Meloky	4.4	4.7	4.6	3.9	4.7	4.3	High	82.0	84.4	83.2
Watikin	5.4	4.9	5.2	5.0	4.8	4.8	High	84.5	86.4	85.5
$LSD_{0.05}$	0.5	0.6	0.3	0.5	0.6	0.4		1.6	1.6	1.5

D- Pit characteristics

The studied pit characteristics were pit weight (g), weight class, pit length (L) cm, pit Width (W) cm and (L/ W).

Regarding pit weight, it was found that cultivars differed significantly in the average pit weight of the two years of study 2007 and 2008 (Table 5). Average pit weight ranged from 0.97g to 0.23g. The highest pit weight was found in cultivars Hamedy (0.97g) and Manzanilo (0.94g). Kronaky was the lowest in pit weight. The other cultivars were in between these extremes. Cultivars had been classified into three groups according to their pit weight by using the method of (Cimato and Attilio, 2008). Cultivars Hamedy, Manzanilo, Egizy, Kalamata, Maraky, Meloky and Watikin were classified to be very high in pit weight and Chemlaly as high in pit weight while Kronaky was classified to be low in pit weight.

Regarding pit length, olive cultivars under study differed significantly as shown in Table (6). The average pit length of the two seasons 2007 and 2008 was the highest in Chemlaly (2.28 cm). That was followed by Kalamata (2.18 cm) then Maraky, Hamedy and Manzanilo which had a pit length of 1.84, 1.80 and 1.80cm, respectively. Those cultivars had no significant difference in between as well as in between Watikin, Egizy and Melokywhich had a pit length 1.71, 1.70 and 1.67 cm, respectively. The shortest pit length was noticed in Kronaky (1.34cm).

Table (5): Averages of pit weight of the nine olive cultivars during 2007 and 2008 seasons

Cultivar	Pit weight (g)			Weight class
	2007	2008	Average	
Chemlaly	0.7	0.6	0.7	High
Egizy	0.9	0.8	0.8	Very High
Hamedy	0.8	1.1	1.0	Very High
Kalamata	0.9	0.8	0.8	Very High
Kronaky	0.3	0.2	0.2	Low
Manzanilo	1.1	0.8	0.9	Very High
Maraky	0.9	0.8	0.8	Very High
Meloky	0.7	0.7	0.7	Very High
Watikin	0.8	0.6	0.7	Very High
$LSD_{0.05}$	0.08	0.09	0.06	

For pit width, it was found that the average pit width of the two seasons 2007 and 2008 differed significantly between the nine studied cultivars. The widest pit was significantly found in Hamedy (0.92cm). That was followed by Egizy and Maraky which had the same pit width value (0.89cm). The other cultivars differed significantly in pit width from each other. It was found that the studied olive cultivars differed significantly in the average L/W ratio of the two years of study 2007 and 2008. It was noticed that Chemlaly cultivar had significantly the highest ratio (3.23). That was followed by Kalamata which had the value of L/W = 2.56 then Kronaky (L/W=2.27). Manzanilo, Maraky and Watikin did not significantly differ in L/W ratio as they had L/W = 2.09, 2.09 and 2.05, respectively. That was followed by Hamedy and Meloky. They had L/W ratio = 1.96 and 1.95, respectively. No significant difference was found between them. Egizy was the lowest cultivar in L/W ratio which was 1.94. The ratio of pit length/ pit width (L/W ratio) is an indication of the pit shape (Cimato and Attilio, 2008). The studied olive cultivars were classified according to pit shape into two groups. Chemlaly, Kalamataand Kronaky were classified as elongated pit shape. While cultivars Manzanilo, Maraky, Watikin, Hamedy, Meloky and Egizy were classified as elliptic pit shape.

Table (6): Averages of pit characteristics of the nine olive cultivars during 2007 and 2008 seasons

Cultivar	Pit length (L) cm			Pit width (W) cm			L /W			Pit shape
	2007	2008	Average	2007	2008	average	2007	2008	average	
Chemlaly	2.3	2.2	2.3	0.7	0.7	0.7	3.2	3.2	3.2	Elongated
Egizy	1.7	1.7	1.7	0.9	0.9	0.9	1.9	2.0	1.9	Elliptic
Hamedy	1.7	1.9	1.8	0.9	1.0	0.9	2.0	2.0	2.0	Elliptic
Kalamata	2.2	2.2	2.2	0.9	0.9	0.9	2.6	2.6	2.6	Elongated
Kronaky	1.4	1.3	1.3	0.6	0.6	0.6	2.4	2.2	2.3	Elongated
Manzanilo	1.8	1.8	1.8	0.9	0.9	0.9	2.1	2.1	2.1	Elliptic
Maraky	1.7	1.9	1.8	0.9	0.9	0.9	2.0	2.2	2.1	Elliptic
Meloky	1.6	1.8	1.7	0.4	0.9	0.6	1.9	2.0	2.0	Elliptic
Watikin	1.7	1.8	1.7	0.8	0.8	0.8	2.0	2.1	2.1	Elliptic
$LSD_{0.05}$	0.10	0.10	0.04	0.04	0.04	0.02	0.15	0.14	0.10	

Generally, Ulas and Gezerel (2008) measured stone characteristics for numerous local and some standardt olive (*Olea europaea* L. *sativa*) cultivars growing in Çukurova region in Turkey. For example; Küncülü (KilisYağlık), Yerli (Erkence) are not different cultivars. Adana Topağı, Sarı Ulak, EdremitYağlık, Mavi, Gemlik cultivars showed clear superiority to the other cultivars in Çukurova ecological conditions. Sheidai *et al.* (2010) performed morphological analyses on 8 brown olive populations of Iran using 24 morphological characters. Number, and distribution of grooves in the endocarp and fruit characteristics (apex, base, and shape) are the most variable characters among the brown olive populations studied. Morphological analyses suggested the presence of intra-specific variations.

Cluster analysis

The morphological parameters (the quantitative and qualitative characters measured) of the nine cultivars were used together to compute the relative similarity or dissimilarity of these cultivars according to Van Ooyen, (2001) (Table 7). The value of squared Euclidean distances for the nine cultivars ranged from 0.00 to 96.23. The zero value represents a total similarity and might refer to the case of the same cultivar. The values above zero represent the dissimilarity from that particular cultivar. The squared Euclidean distance was as low value (4.51) between cultivars Egizy and Maraky and (5.45) between cultivars Maraky and Meloky, that may indicate

a close relation of the cultivars. The distance was as high value (96.23) between Egizy and Kronaky and (90.95) between Hamedy and Kronaky, that may indicate that Egizy and Kronaky cultivar are apart from each other. The same trend was found between cultivars Hamedy and Kronaky. Different values were in between cultivars indicating different degrees of dissimilarities.

The dendrogram of the proximities of the nine cultivars (Fig. 1) showed two clusters. The first cluster had two cultivars: Chemlaly and Kronaky. While the second cluster had seven cultivars connected through several branches. Its first sub-cluster includes Egizy and Maraky with nearly close distance. Its second sub-cluster consists of Egizy, Maraky and Meloky. Its third sub-cluster contains Hamedy in addition to those of the second sub-cluster. The fourth sub-cluster has Manzanilo, Hamedy, Meloky, Maraky and Egizy. The fifth sub-cluster has six cultivars: Watakin, Manzanilo, Hamedy, Meloky, Maraky and Egizy. The second cluster contains seven cultivars: Kalamata, Watakin, Manzanilo, Hamedy, Meloky, Maraky and Egizy.

Table (7): Proximity matrix for the nine olive cultivars based on the measured morphological data of 2007 and 2008 seasons

Cultivars	Squared Euclidean Distance								
	Chemlaly	Egizy	Hamedy	Kalamata	Kronaky	Manzanilo	Maraky	Meloky	Watikin
Chemlaly	**0**								
Egizy	**72.9**	**0**							
Hamedy	**70.5**	**12.1**	**0**						
Kalamata	**45.0**	**40.8**	**42.0**	**0**					
Kronaky	**55.1**	**96.2**	**91.0**	**79.3**	**0**				
Manzanilo	**58.2**	**13.7**	**16.9**	**31.6**	**83.1**	**0**			
Maraky	**64.9**	**4.5**	**12.7**	**25.7**	**84.6**	**17.4**	**0**		
Meloky	**52.1**	**10.1**	**13.8**	**24.8**	**57.9**	**13.7**	**5.5**	**0**	
Watikin	**79.6**	**21.6**	**44.0**	**31.5**	**80.1**	**32.0**	**12.1**	**15.7**	**0**

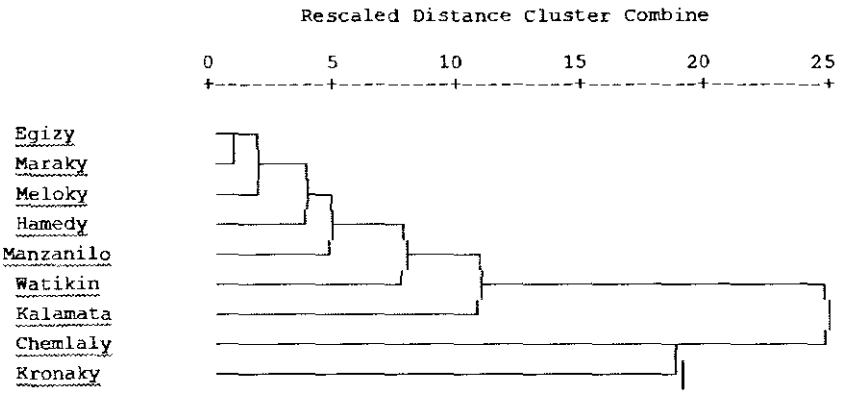

Fig. (1): Dendrogram of the proximities of the nine olive cultivars based on the measured morphological characters averaged for the years of observation

REFERENCES

Abdine M., Abdel Hamid R., Nseir A., Wazaz N., Kothomi G., Jaafar A.M., Contento F. and Famiani F. 2007. Characterization of the main Syrian olive cultivars: Morphological characterstics, puplished by: the Italian Cooperation project "Technical Assistance for the Improvement of Olive Oil Quality in Syria" June 2007.

Al Ibrahem A., Bari A. and Rashed M.M. 2008. Olive eneic diversity of Palmyra under threat. Acta Hort. 791: 143-147.

Antonio C., Claudia C. and Graziano S. 1999. Collection and characterization of olive (*Olea europaea* L.) gerplasm resources in Tuscany. Acta Hort., 474: 155-158.

Bronzini de Caraffa V., Maury J., De Rocca Serra D., Giannettini J. and Besnard G. 2002. Genetic characterization of olive tree (*Olea europaea* L.) intended for oil production in Corsica. Acta Hort., 586: 163-166.

Cantini C., Cimato A. and Sani G. 2002. Multivarite analysis of the Tuscan olive gerplasm. Acta Hort., 586: 101-104.

Cimato A. and Attilio C. 2008. Conservation, characterization, collection and utilization of the genetic resources in olive. Technical paper by Common Fund for Commodities (CFC), the International Olive Council (IOC) and the Istituto per la Valorizzazione del Legno e delle Specie Arboree (WALSA).

De Vicente M.C. and Fulton T. 2003. Using molecular marker technology in studies on plant genetic diversity. [Online] IPGRI, Rome, Italy and Institute for Genetic Diversity, Ithaca, New York, USA.

Del Rio C. and Caballero J. M. 2008. Variability and classification of olive cultivars by fruit weight, flesh/stone ratio and oil percentage. Acta Hort., 791:39-44.

Dimassi K., Therios I. and Balatsos A. 1999. The blooming period and self-fruitfulness in twelve Greek and three foreign cultivars. Acta Hort., 474: 275-278.

Durgac C., Y. Kiyga and Ulas M. 2010. Comparative molecular analysis of old olive (Olea europaea L.) genotypes from Eastern Mediterranean Region of Turkey. Afric. J. Biotech., 9(4): 428-433.

FAO Stats 2010. Database. http://faostat.fao.org.

Fourati H., Cossentini M., Karray B. and Khlif M. 2002. Classification of olive trees according to fruit and oil characterization. Acta Hort. 586: 141-145.

Ganino T., Beghè D., Valenti S., Nisi R. and Fabbri A. 2007. RAPD and SSR markers for characterization and identification of ancient cultivars of Olea europaea L. in the Emilia region, Northern Italy. Gen. Res. & Crop Evol., 54(7): 1531-1540.

Helally A. M. 2008. Evaluation and identification of nine olive cultivars (*Olea europaea* L.) grown in Nobaria region of Egypt using agrobbiological traits and RAPD markers. Ph.D Thesis, Alex. Univ., Fac. Agric., Egypt.

Hosseini-Mazinani S.M., Samaee S. M., Ataei S., Sadeghi A. and Mirmansoori A. 2008. Multivariate analyses of intra-cultivar variation of local olive cultivar in northern part of Iran using morphological traits. Acta Hort., 791:65-71.

Idrissi A. and Ouazzani N. 2007. Apport des descripteurs morphologiques á l'invetaire et a l'identification des variétiés d'olivier (*Olea europaea* L.). Plant Gen. Res. Newslet., FAO-Bioversity Issue No.136, 1-10.

Minitab Inc., 2003. Minitab release 14 Statistical Software, Minitab Inc. USA.

Mulas M., Cauli E. and Francesconi A. H. D. 2002. Advancs in the study of wild olive genetic resources. Acta Hort., 586: 121-123.

Sheidai M., Noormohammadi Z., Dehghani A., Parvini F., Hoshiar-Parsian H. and Hosseini-Mazinani M. 2010. Intra-specific morphological and molecular diversity in brown olive (*Olea cupidata*) of Iran. Science Asia 36:187-193.

SPSS Inc., 2006. SPSS for Windows version 10.0 Statistical Chicago Software, SPSS Inc.

Steel, R. G. D. and J. H. Torrie 1980. Principles and procedures of statistics: A biometrical approach. Mc Graw- Hill, USA.

Taamalli W., Geuna F., Banfi R., Bassi D., Daoud D. and Zarrouk M. 2006. Agronomic and molecular analyses for the characterization of accessionsin Tunisian olive germplasm collections. Electro. J. Biotech., 9(5): 467-481.

Tous J., Romero A. and Diaz I. 1999. Fruit and oil characteristics of five Spanish olive cultivars. Acta Hort., 474: 939-642.

Tous J., Romero A., Plana J. and Hermoso J. F. 2002. Behavior of ten Mediterranean olive cultivars in the northeast of Spain. Acta Hort., 586: 113-116.

Ulas M. and Gezerel O. 2008. Studies on the morphological, phonological and pomological characteristics of some olive oil cultivars in Çukurova region. Acta Hort., 791:103-107.

Van Ooyen, A. 2001. Theoretical aspects of pattern analysis. New Approaches for the Generation and Analysis of Microbial Fingerprints. Amsterdam, The Netherlands: Elsevier, 31-45pp.

Vergari G., Patumi M. and Fontanazza G. 1999. Varietal discrimination of 15 genotypes of olive (*Olea europaea* L.) belonging to cv. Manzailla. Acta Hort., 474: 141-145.

الملخص العربي

تمييز بعض أصناف الزيتون بمصر باستخدام الطرق المورفولوجية

محمود أحمد علي[١]، ثناء مصطفى عز[١]، محمد رفعت رسمي[٢] وشيماء مصطفى خضير[٣]

١ كلية الزراعة سابا باشا جامعة الاسكندرية

٢ معهد بحوث أمراض النبات (مركز البحوث الزراعية)

٣ طالبة دراسات عليا- كلية الزراعة (سابا باشا)

أجريت هذه الدراسة خلال موسمي ٢٠٠٧، ٢٠٠٨ علي تسعة أصناف من الزيتون (*Olea europea*, L.) وهي شملالي، كلاماتا، مراقي، عجيزي، وطيقين، ملوكي، حامضي، منزانيللو، كروناكي النامية في المزرعة التجريبية لكلية زراعة سابا باشا التابعة لجامعة الأسكندرية، مصر. لتوصيف وتمييز أصناف الزيتون محل الدراسة حيث درست ١٨ صفة مورفولوجية شملت كلا من الورقة، النورة، الثمرة والنواة. استخدمت كل البيانات المورفولوجية للصفات الكمية والوصفية المقاسة للأصناف التسع لحساب درجة التشابة والأختلاف بين الأصناف باستخدام برنامج كمبيوتر SPSS موديل ١٠. وقد تراوحت المسافات بين الأصناف التسع من صفر الي ٢٣,٩٦. وكانت هذه المسافة أقل ما يمكن بين صنفي عجيزي ومراقي (٤،٥١) وبين الصنفين مراقي وملوكي (٤٥،٥) وهذا يدل على وجود علاقة قريبة بين هذه الأصناف. كما أوضحت النتائج أن أكبر مسافة وجدت بين الصنفين عجيزي وكروناكي (٩٦،٢٣) وبين الصنفين حامضي وكروناكي (٩٥،٩٠) وهذا يدل على درجة كبيرة من عدم التشابه بين الصنفين عجيزي وكروناكي. وقد أوضح التحليل العنقودي للأصناف التسع أنه يوجد تجمعين فقط. الاول يحتوي على صنفين هما شملالي وكروناكي بينما الثاني يحتوي على بقية الأصناف.