Morphological and Biochemical Characterization of Three Olive "*Olea europaea* L." Cultivars in Palestine

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ABSTRACT

Nabali Baladi , Nabali Mohassan and Souri are the predominant olive cultivars in Palestine. In order to investigate morphological intercultivar variability, samples were taken from leaves, flowers, fruits and stones from trees of the three cultivars. Oil was also extracted from fruits of the three cultivars for biochemical analysis. Notable significant differences among the cultivars were observed in all characteristics considered, including; tree canopy, leaves, inflorescence and fruit characterstics. The acidity, peroxide number and the spectro-photometer absorbencies in ultra-violet were low of the oils of the three cultivars. Most cultivars had an oleic content of about 60% or higher except for the 'Nabali Mohassan'. The sterol composition and content were quite different in the three cultivars. The 'Nabali Baladi' had a relatively high value of Δ-7stigmastenol. All of the biochemical values (acidity, peroxide number, absorbencies in ultra-violet, fatty acid composition, sterol composition and content) used to evaluate oil quality were within the IOC trade standards.

Keywords: *Olea europaea* L., Cultivars, Morphology, Olive Oil, Characterization.

INTRODUCTION

The cultivated olive (*Olea europaea* L.) is a long-lived evergreen tree native to the Mediterranean basin (Poljuha *et al.,* 2008, Breton et al., 2006). It is the most important fruit trees produced commercially in most of the Arab countries. Palestine is a major producer of olives with an annual average production of 200,000 tons fruit and 20000 tons of oil (PCBS, 2007), Hundreds of olive cultivars are grown in different regions all over the world. Bartolini *et al*. (1993) have ascertained about 1200 named olive cultivars with over 3000 synonyms throughout the world. There are much confusion and uncertainty concerning the identity of the olive trees (Baali-Cherif and Besnard, 2005, Ozkaya *et al*. 2008). Different techniques have been used to evaluate olive diversity. Morphological and biological characters have been widely used for descriptive purposes and are commonly used to distinguish olive cultivars (Barranco and Rallo, 1985; Del Rio, 1994; Cantini *et al*., 1999; Barranco *et al.,* 2000; Leva 2009). Significant differences in 24 morphological characters were observed in 8 olive populations, a genetic difference of about 30% was revealed when comparing eight variants of 'Nabali' (Wiesman *et al*. 1997). On the other hand, it was reported that AFLP and SSR data were only able to characterize specific olive varieties and identify erroneous denominations and cases of synonymy (Rotondi et al., 2003). However, Ozkaya et al., (2006) showed that, classification based on RAPD markers could not be related to known morphological information about accessions

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Received on 23/12/2012 and Accepted for Publication on 30/4/2013.

considered to represent olive cv. Derik Halhali in Turkey.

In Palestine, there are different olive cultivars known, among the most dominant cultivars are; Nabali Baladi, Nabali Mohassan and Souri. 'Nabali Baladi' is one of the most wide spread local cultivar in Palestine, it is suitable as a table and oil purpose. Its name comes from a village (Bier Nabala) near Jerusalem. 'Nabali Baladi' is sensitive to adverse weather conditions during flowering and thereby characterized with an inconstant and alternate bearing (Aljabi, 2007). Nabali Mohassan is another important local cultivar, it is a high producing cultivar, but highly influenced by biennial bearing, suitable for both table olive and oil. For Souri cultivar, is also wide spread in Palestine , it has been originated in Sour in Lebanon, it is a high producing cultivar, used for table and oil production, it is highly influenced by biennial bearing.

To date, very few studies have evaluated the morphological, phenological, bio-agronomical and productive characteristics of Palestinian' olive cultivars, therefore, in the this study, we report on the morphological, phenological and biochemical characterization of three local olive cultivars. To our knowledge, this is the first approach to charactrize olive germplasm in Palestine.

MATERIALS AND METHODS

Experimental Location

The investigation was conducted in Qalqilia district, the area falls within the semi-coastal region of Mediterranean climate, with moderate summer and warm winter, the average rain fall is 500 mm, soil is fertile of 0.5 meter depth, it is classified as terra rosa, brown rendzinas, the texture is loamy to clay.

Plant Material

Nine olive trees were chosen after accurate field observations in the whole Qalqilia area as representative of true cultivars. Three analyzed cultivars (Nabali Baladi, Nabali Mohassan and Souri) were represented by four, three and two 30 years old tree in their "On" year. All the collected measurements were conducted during the year 2010 starting from February 2010 to December 2010.

Morphological Characterization

Morphological description was performed according to the International Olive Council standards (IOC) (Barranco *et al*., 2000). In total, 46 characteristics of tree (13), leaf (3), inflorescence (6), fruit (14), stones (6), and phenology (4) were measured. The following characteristics were measured:

1. Tree: The hieght of the tree (H1) from the ground to the top of canopy, hieght of trunk (H2) from the ground up to the start of the canopy, hieght of the lower part of the canopy (H3) from the ground, circumference below branching (C1) and trunk circumference (C2) at 30-40 cm from the ground were mesured.

2. Fruiting shoot: Shoot length**,** calculated as a total shoot length (cm)**,** using 20 shoots per tree for each cultivar, located around the tree at shoulder level**,** the number of nodes**,** per each calculated shoots, and internode length, was calculated as a total shoot length (cm)/number of nodes, using 20 shoots per tree for each cultivar, located around the tree at shoulder level.

3. Leaf: Observations were made on samples of 100 healthy adult leaves/tree for each cultivar, collected from the middle part of one-year-old shoots chosen from among the most representative ones on the south facing side of the tree at shoulder level. The following characteristics were evaluated and classified: Length **(**short (< 5 cm), medium (5-7 cm) and long (> 7 cm), width **(**narrow (< 1 cm), medium (1-1.5 cm) and broad (> 1.5 cm), shape (determined by the Length/Width ratio) (elliptic (L/W < 4), elliptic-lanceolate (L/W = 4-6) and lanceolate (L/W > 6).

4.Inflorescence: Observations were made on samples of 25 inflorescences per tree at the white stage

collected from the middle part of fruiting shoots chosen from among the most representative ones on the south facing side of the tree. The following characteristics were evaluated: length, short (< 25 mm), medium (25-35 mm) and long (> 35 mm), peduncle length: On the same 25 healthy inflorescence during the white bud stage, maximum width, number of flowers/inflorescence (low (< 18), medium (18-25), high (> 25) and ovary apportions, which was estimated by calculating the total number of flowers and the total number of flowers without ovary from random samples of 50 inflorescences per tree at full bloom.

5. Fruit: Fruit growth was calculated based on samples of 50 fruits per tree collected from the middle part of fruiting shoots chosen from among the most representative ones on the south facing side of the tree. Very small or very large olives were discarded from the samples). Fruit samples (50 fruits per tree) were taken every two weeks starting from full bloom to the begining of November, samples were randomly taken from the external portion of the canopy from the 4 directions, stored in plastic bages in a cool place, fresh and dry weight were measured for the 50 fruits together.

5.1 Fruit ripening: fruit ripening was determined on 100 fruits per tree for each cultivar, samples were taken from the middle part of the most representative fruiting shoots facing the south**.** The following characteristics were evaluated and classified for each characteristic: Weight**,** low (< 2 g), medium (2-4 g), high (4-6 g) and very high (> 6 g), shape**,** determined by the **l**ength/**w**idth ratio and classified as: Spherical (L/W < 1.25), ovoid (L/W = 1.25-1.45) and elongated (L/W > 1.45)) and colour at full maturity **(**black, violet and red).

6. Endocarp (Stone) : Observations were made on samples of 100 endocarps per tree for each cultivar taken from the fruits used for morphological characterization, the following characteristics were evaluated and classified: **Weight,** low (< 0.3 g), medium (0.3-0.45 g), high (0.45-0.7 g) and very high > 0.7 g), **shape,** determined by the **l**ength/**w**idth ratio(spherical (L/W < 1.4), ovoid (L/W = 1.4-1.8),elliptic (L/W = 1.8-2.2) and elongated (L/W > 2.2)), **number of grooves,** determined according to the number of grooves that can be seen from the stalk insertion point, low (< 7), medium (7-10) and high (> 10).

7. Phenology: The phenology was characterised every week during flowering stage and every 2 week during fruit growth through direct observations of the labelled trees. The following phenological phases were reported in the description of the three cultivars: Start of vegetative growth (bud bursting), which corresponds to the time when apical and lateral buds swell and lengthen. New leaves, nodes and internodes are formed at the apex of the new shoots. The new vegetation is easily distinguishable because its green colouration is lighter than that of the previous vegetation, full bloom, which corresponds to the time when about 50% of the flowers are opened. Moreover, there is complete separation of petals, lengthening of stamens and stylus, which make the stigma visible, and full opening of the anthers, pit hardening, which corresponds to the time when the increase in fruit size, which has reached about 50% of its final size, slows down and the endocarp progressively lignified, fruit turning (veraison), which corresponds to the time when the epicarp turns from green to pale green/pale yellow, due to the reduction of chlorophyll, and pigmentation starts.

8. Fruit ripening indices, determined from the beginning of October to the end of November, every 2 weeks,fruit drop, was measured for the selected trees by chosen 4 small branches per tree in the 4 directions, the branches were wrapped in net bags and dropped fruits were collected and counted every 15 days. During the last observation the number of olives still on the branch were counted, the fruit retention force (resistance) was measured by using a hand-held dynamometer on about 50 olives/tree. The fruit detachment force was expressed

in Newton (N) and was considered (low < 4 N, medium 4 - 6 N and high> 6 N). Maturation index (MI) was measured on a sample of 100 olive fruits collected and separated into eight colour categories, as follows : 0:Fruit surface is deep green and the fruit is firm, 1: Fruit surface is yellowish green and fruit starting to soften, 2: < 50% of the fruit surface is red, 3: > 50% of the fruit surface is red, 4: 100% of the fruit surface is purple, 5: 100% of the fruit surface is purple or black; 50% of the flesh is purple, 6: 100% of the fruit surface is purple or black; > 50% of the flesh is purple and 7: 100% of the fruit surface is purple or black; 100% of the flesh is purple.

MI was calculated by multiplying the number of fruits of each colour category by the number with that colour category (0–7). Fresh and dry fruit weight were determined by weighing samples of 100 olives per tree one by one for fresh wieght, then drying them in an oven until constant weight, pulp (flesh) to pit ratio (fresh and dry wieght) was determined on samples of 25 olives per tree.

Biochemical Analysis

For oil analysis, 10 kg of healthy olive fruits from each tree were harvested during November 2011, at the same stage of ripening (70 % of olives just turned dark-coloured and the remaining were still green) according to Poljuha et al. (2008).

The olives were crushed with a lab hammer mill, then the mash was malaxed for 30 minutes and centrifuged, the oil was separated, after filtration, A total of 36 characteristics were determined on the oil, according to the IOC procedures indicated within parentheses: Acidity, expressed as % of free oleic acid (EEC Reg. n. 2568/91), peroxide number, expressed as meq. of O_2/kg of oil (EEC Reg. n. 2568/91), Spectrophotometric absorbency in ultra-violet (K232, K270 and ΔK) (EEC Reg. n. 2568/91) , fatty acid composition, expressed as % (EEC Reg. n. 796/2002), sterol composition expressed as % and content expressed as mg/kg of oil (EEC Reg. n. 2568/91) , total polyphenols content of the oil, expressed as mg of gallic acid/kg of oil, (Montedoro et al., 1992).

Statistical Analysis

Collected data were anlyzed using SAS sofware (SAS, 1996). Averages and standard error of the mean were calculated for the different paramters. In order to compare the studied characters among the three cultivars, each cultivar was considered as a treatment and each tree as an experimental unit, therefore, one way analysis of variance was conducted for differnt parameters followed by a mean seperation test (LSD). A cluster analysis was also conducted for the measured characters.

RESULTS AND DISCUSSION

Morphological Description

The methodology used in this characterization was based on the recommendations of the IOC (2000) with refer to analysis of 46 characters including the tree, leaves, flowers, fruits and endocarp**.** Notable significant differences between the cultivars were observed in all characteristics considered (Table 1,2,3,4). Tree canopy was high for the Nabali Baladi cultivar, medium for Souri, and low for Nabali Mohassan but without significant differences among them. Regarding the fruiting shoot, both 'Nabali Baladi' and ' Souri' exhibited similar characters of their fruiting shoots. Similar leaf dimensions were observed for the three cultivars. There was difference in the inflorescence characterstics among the three cultivars. The highest inflorescence length was with 'Nabali Mohassan' followed by ‘Souri‘, the smaller length was with ‘Nabali Baladi‘. Similar trend was obtained with peduncle dimension, regarding the number of flowers per inflorescence, the smaller number was with 'Nabali Baladi', percent of perfect flower was high in 'Nabali Mohassan' followed by 'Nabali

Baladi'. Larger fruit was obtained in 'Nabali Mohassan' followed by 'Nabali Baladi', however 'Souri' has the smaller fruit size. Similar trend was obtained with stone dimensions. Fruit drop percent was high in 'Souri' the fruit retetion force (FRF) was high in 'Nabali Mohassan', the maturation index (MI) was very high in 'Souri' (3.15) compared to the MI of both 'Nabali Baladi' and 'Nabali Mohassan' which was 0.52 and 0.72, respectively. The highest pulp/pit ratio values as fresh weight were recorded for 'Nabali Mohassan' followed by 'Nabali Baladi'. However, regarding the pulp/pit ratio as dry weight, both 'Nabali Baladi' and 'Nabali Mohassan' recorded similar value higher than that of Souri cultivar. The pulp firmness was significantly higher in 'Nabali Mohassan' compared with the other cultivars, stone fresh wt was higher in both 'Nabali Baladi' and 'Nabali Mohassana, however, fresh wt was high in Nabali Mohassen, subsequently, similar trend was observed with pulp to pit ratios. The result was consistent to other investigators (Hannachi et al., 2008). The small the standard error within each sample indicated high uniformity of the characteristics measured. Most of the chosen characteristics are suitable for discriminating between varieties (Polujah, 2008). Some characteristics like inflorescence length, flower number, fruit, stone mass, *etc.* can vary due to exogenous factors (environment, cultivation technology, *etc.*). In the case of uncertainty in category defining, measuring has been repeated on the larger sample. According to Bartolini et al. (1998) and Barranco et al. (2000), biometric indexes should always be accompanied by a detailed morphological description of the organs (inflorescence, leaf, fruit, and stone) of olive varieties. However the characterstics of perfect flowers were simillar to other reports (Fernndez-Escobar *et al*., 1992; Cuevas *et al*., 1999). On the other hand, the FRF was high for the three cultivars investigated, therefore, the use of mechanical harvest need to be carfully considered in developing cultural practices (Martin, 1994).

In fact, biometric values alone were not able to detect differences among some varieties morphologically similar but characterized by different biological and agronomical behavior.

Phenological Data

Phenological data are shown in table 4 e. The data indicated similar start of vegetative growth within the first week of February, however, there was slight varaition in full bloom, but all cultivars reached full bloom between late April and early May, bit hardening was also similar for the three cultivars starting from mid june for 'Nabali Baladi' to early July for the two other cultivars, fruit development is mainly related to the blooming time which was earlier in 'Nabali Baladi', fruit coloration started in mid October for 'Souri' until early November in 'NabaliMohassan', the percen of fruit drop until the end of October was ranged from 3 in 'nabali Baladi' to 9 in 'Souri', this percent is not considered as a high and is highly related to biotic and abiotic factors.

Table 1. Tree canopy characteristics of the different cultivars. Average values of 2-4 trees± SE.

Cultivar	Tree Canopy						
	Height (H1)(m)	Av. Diameter (m)	Height from the ground 1 (H3.1) (m)	Height from the ground 2 (H3.2) (m)	Height from the ground 3 (H3.3) (m)	Height from the ground 4 (H3.4) (m)	Av. height from the ground (m)
Nabali Baladi	4.35 ±0.49	4.77±0.47	0.54±0.07	0.54±0.24	0.32±0.13	0.49±0.22	0.47±0.10
Nabali Mohassan	4.26 ±0.17	5.17±0.22	0.73±0.10	0.77±0.12	1.05±0.26	0.63±0.10	0.79±0.07
Souri	4.18 ±0.38	6.34±0.26	0.48±0.38	0.90±0.3	0.97±0.47	1.51±0.05	0.96±0.06

Table 2. Vegetative growth characterstics of the different cultivars. Average value of 2-4 trees ±SE

Numbers followed by the same letter are not differ significantly according to LSD test at 0.05 P-value.

	Trunk			Fruiting shoot			Leaf		
Cultivar	Height until branching (H2) (m)	Circumfe-rence below branching (C1) (m)	Circumference at 30-40 cm from the ground (C2) (m)	Length (cm)	Nodes (No.)	Internode length (shoot L / nodes No.) (cm)	Length (cm)	Width (cm)	Shape (L / W)
Nabali Baladi	1.01 ns ±0.26	0.62 ±0.08	0.89±0.05 a	20.04 ±0.15 b	13.21 ±0.20 a	1.53 ±0.02 c	5.58 ±0.16 ns	1.46 ±0.04 a	3.85 ±0.10 b (Elliptic)
Nabali Mohassan	0.91 ±0.14	0.52 ±0.02	0.70±0.03 b	20.82 ±0.07a	12.35 ±0.10 b	1.69 ±0.01 b	5.94 ±0.12	1.32 ±0.02 b	4.57 ±0.02 a (Elliptic)
Souri	1.30 ±0.50	0.55 ±0.05	0.64±0.10 b	17.87 ±0.42c	9.98 ±0.12c	1.83 ±0.04 a	5.81 ±0.04	1.52 ±0.00 a	3.88 ±0.02 b (Elliptic)

Table 3. Inflorescence characteristics of the different olive cultivars. Average value ±SE

Numbers followed by the same letter are not differ significantly according to LSD test at 0.05 P-value

	Inflorescence				Flowers	
Cultivar	Length (cm)	Peduncle length (cm)	Max width (cm)	No. flowers / inflorescence	% of perfect flowers	% of ovary abortion
Nabali Baladi	2.09±0.07 b	0.58±0.02 b	0.93±0.01 c	12.41±0.87 b	86.00±0.58 c	14.00±0.58 a
Nabali Mohassan	2.91±0.09 a	0.73±0.03 a	1.22±0.01 a	17.72±0.90 a	100.00±0.00 a	0.00±0.00 c
Souri	2.65±0.03 a	0.64±0.00 ab	1.14±0.02 b	17.80±0.20 a	97.50±0.50 b	2.50±0.50 b

Table 4 a. Fruit characteristics of the different cultivars. Average values of 2-4 trees ± SE.

	Fruit			Stone			
Cultivar	**Length (cm)**	**Width (cm)**	**Shape (L / W)**	**Length (cm)**	**Width (cm)**	**Shape (L / W)**	**Number of grooves**
Nabali Baladi	1.96±0.07b	1.24±0.08b	1.61±0.06ab (Elongated)	1.53±0.01b	0.60±0.02b	2.66±0.08a (Elongated)	8.68±0.12c
Nabali Mohassan	2.23±0.01a	1.56±0.02a	1.46±0.03b (Ovoid)	1.60±0.01a	0.73±0.01a	2.22±0.03b (Elliptic)	12.77±0.23b
Souri	1.60±0.03c	0.95±0.00c	1.70±0.03a (Elongated)	1.51±0.01b	0.720±00a	2.10±0.01b (Elongated)	13.95±0.05a

Numbers followed by the same letter are not differ significantly according to LSD test at 0.05 P-value

Table 4 b. Fruit characteristics of the different cultivars. Average values of 2-4 ± SE.

	Fruit		
Cultivar	**Fruit drop**	**Fruit Removal Force (N)**	**Maturation Index**
Nabali Baladi	0.04 ±0.01 c	454±23.79 b	0.52±0.02 c
Nabali Mohassan	0.09±0.01b	560.2±13.12 a	0.77±0.01 b
Souri	0.15±0.01a	417.8±13.12 b	3.15±0.15 a

Numbers followed by the same letter are not differ significantly according to LSD test at 0.05 P-value

Table 4 c. Fruit characteristics of the different cultivars. Average values of 2-4± SE.

Cultivar	**Avr. Pulp firmness (g)**	**Fruit fresh weight (g)**	**Stone fresh weight (g)**	**Flesh fresh weight (g)**	**Pulp-to-pit ratio (FW)**
Nabali Baladi	526.1±8.73 b	2.47±0.12 b	0.51±0.01 ab	2.01±0.12 b	4.05±0.19 b
Nabali Mohassan	629.5±5.13 a	3.32±0.12 a	0.53±0.02 a	2.94±0.14 a	5.62±0.11 a
Souri	450.4±7.20 c	1.67±0.01 c	0.46±0.01 b	1.22±0.02 c	2.71±0.05 c

Numbers followed by the same letter are not differ significantly according to LSD test at 0.05 P-value

Table 4 d. Fruit characteristics of the different cultivars. Average values of 2-4 trees ± SE.

Cultivar	Fruit dry weight (g)	Stone dry weight (g)	Flesh dry weight (g)	Pulp-to-pit ratio (DW)
Nabali Baladi	1.34±0.05 a	0.38±0.01 a	0.97±0.04 a	2.57±0.07 a
Nabali Mohassan	1.33±0.07 a	0.38±0.01 a	0a.96±0.06 a	2.54±0.08 a
Souri	0.40±0.37 b	0.33±0.02 b	0.47±0.04 b	1.44±0.17 b

Numbers followed by the same letter are not differ significantly according to LSD test at 0.05 P-value

Table 4 e. Some phenological characters of the three olive cultivars

Character	Cultivar		
	'Nabali Baladi'	'Nabali Mohassan'	'Souri'
Start of veg. growth	Early February	Early February	Early February
Full bloom	Late April	Early May	Early May
Pit hardening	Mid June	Early July	Early July
Start of fruit color turning	Late October	Early November	Mid October
Fruit drop (%) until the end of October	3	5	9

Biochemical Analysis (Oil Analysis)

The results showed that oil content as dry weight was higher in 'Nabali Baladi' (55.63%) compared to 46.77 and 40.3 in both 'Nabali Mohassen' and 'Souri'. The acidity of oil in the tested cultivars were very low ranging from 0.17 in 'Nabali Mohassen' to 0.37 in 'Nabali Baladi', peroxide number of the oils of all cultivars was very low (Table 5). The spectro-photometer absorbencies in ultra-violet were also low; including k323, K270 and the Δ K , the polyphenol content was very high in 'Nabali Baladi' (380 mg/kg oil. Most cultivars had an oleic content of about 60% or higher (Table 6). Only the 'Nabali Mohassan' had a lower value (56.42%) that was associated with relatively high amounts of palmitic and linoleic acids. The sterol composition and content were quite different in the cultivars (Table 7). The 'Nabali Baladi' had a relatively high value of Δ-7 stigmastenol.

All of the parameter values (acidity, peroxide number, absorbencies in ultra-violet, fatty acid composition, sterol composition and content) used to evaluate oil quality were within the IOC trade standards. The high oil content in 'Nabali Baladi' and 'Souri' shows their high effciency in accumulating oil in the fruit and confirm the high ability of these cultivars in producing oil and is in agreement with the fact that these cultivars together are the main ones for oil production in Palestine. For instance, the low percent of female flower abortion observed in this study comapred to similar studies (Hannachi and Marzouk 2012) indicated the higha ability to produce commercial profitable crop (Mehri and Mehri-Kamun 2007). The medium or high fresh fruit weight and pulp/pit ratio for both 'Nabli Baladi' and 'Nabali Mohassan', as well as the moderate oil content of 'Nabali Mohassan' confirm their suitability to be used as dual purpose cultivars. It should be noted that all the oils produced by the olive cultivars met the IOOC trade standards applied to extra virgin olive oils. The only

exceptions was 'Nabali Baldi' which had excessively high Δ-7-stigmastenol levels. Further evaluation to determine if environment and/or harvesting time affect Δ-7-stigmastenol content are needed.

Table 5. Free acidity, peroxide number, spectrophotometer absorbencies in ultra-violet (K 232, K 270, Δk) and total polyphenol of oils of the different olive cultivars. The IOC trade standard (TS) values for extra virgin olive oils are reported in the last line.

Cultivar	Date	% oil (DW)	Acidity (%)	Peroxide (Meq O2/kg)	K232 (nm)	K270 (nm)	Δ K	T. Polyph. (mg/kg oil)
Nabali Baladi	14/11	55.63	0.32	6.25	1.76	0.11	-0.003	380
Nabali Mohassan	14/11	46.77	0.17	7.6	1.7630	0.1030	-0.001	128
Souri	14/11	40.3	0.28	6.1	1.523	0.087	-0.001	217
IOOC-TS			< 0.8	≤ 20.0	≤ 2.50	≤ 0.22	≤ 0.01	

Table 6. Fatty acid composition of oil of different olive cultivars. The IOC trade standard (TS) values for extra virgin olive oils are reported in the last line.

Cultivar	Palmitic	Palm-itoleic	Eptade-canoic	Eptade-cenoic	Stearic	Oleic	Linoleic	Linolenic	Eico-Sanoic	Eicos-Enoic
Nabali Baladi	15.5	0.9	0.12	0.15	3.56	66.2	12.8	0.84	0.43	0.25
Nabali Mohassan	20.48	1.7	0.07	0.1	2.53	56.42	17.02	1.02	0.4	0.26
Souri	15.49	1.23	0.04	0.06	2.35	70.11	9.3	0.97	0.26	0.19
IOOC-TS	7.5-20.0	0.3-3.5			0.5-5.0	55.0-83.0	3.5-21.0	< 1.0		

Table 7 a. Sterol composition (%) of oil of different olive cultivars. The IOC trade standard (TS) values for extra virgin olive oils are reported in the last line.

Cultivar	Coles-terol	Brassicas terol	24-Metilenc-olesterol	Campe-sterol	Camp-estanol	Stigma-sterol	Delta-7-Campe-sterol	Delta 5,23-Stigmas-tadienol	Clero-sterol	Beta-sitosterol
Nabali Baladi	0.4	<0.1	0.52	2.66	0.3	1	0.2	<0.1	1.1	85.6
Nabali Mohassan	<0,1	<0,1	<0,1	3	<0,1	1.3	<0,1	<0,1	1.1	90.1
Souri	0.5	<0,1	0.1	2.6	<0,1	1.7	<0,1	<0,1	1.2	86.1
IOOC-TS	< 0.50	< 0.10		< 4.00		< campe-sterol				

Table 7 b. Sterol composition (%) of oil of different olive cultivars. The IOC trade standard (TS) values for extra virgin olive oils are reported in the last line.

Cultivar	Sito-stanol	Delta-5-avena-sterol	Delta-7,9 (11)-stigma-stadienol	Delta-5,24-stigma-stadienol	Delta-7-stigma-stenol	Delta-7-avena-sterolo	Total Beta-sitosterol	Eryth ridol + uvaiol	Total sterols
Nabali Baladi	0.37	4.9	<0.1	0.5	1	1.2	93.2	2.5	1613.3
Nabali Mohassan	0.3	2.4	<0,1	0.5	0.4	0.5	94.4	1.7	1,583.2
Souri	0.6	5.4	<0,1	0.4	0.5	0.9	93.6	0.8	1,673.2
IOOC-TS					< 0.50				> 1000

The tree diagram obtained by cluster procedure using the 6 variables accounted for tree height and diameter, 34 variables of leaf, flowers, fruits and stone and 28 variables of oil shows the three cultivars grouped in three clusters. 'Nabali Baladi' and 'Nabali Mohassen' in one cluster and 'Souri' in the other cluster (Fig 1,2 and 3). In fact both 'Nabali Baladi' and 'Nabali Mohassan' were characterized by larger fruit and stone dimensions as well as pulp/pit ratio compared to Souri cultivar, in addition, fruit drop percent and MI were higher in 'Souri' , the same trend was observed with oil charactererstcis, in which similarity was clear for both 'Nabali Baladi' and 'Nabali Mohassen' which resulted to be genetically close compared to Souri cultivar. Both Nabali Baladi and Mohassen cultivars thought to be originated in Palestine, however, 'Souri' thought to be orginated in Lebanon.

This study defined for the first time in Palestine the biometric characterstics of tree, leaves flowers, fruits, and oil analysis of three local olive cultivars. The different origin of the three cultivars could explain the observed variations in their characters. In addition, the high mean fruit weight of the three cultivars, mainly 'Nabali baladi' (3.32 gm), and the high oil content (55.6% as dry wt.) described them very suitable in this area and have shown considerable adaptability to microclimate conditions. Therefore, good potential exists to improve yield and quality for domestic and export markets. In addition, the excellent oil quality of the studied cultivars, can be profitably exploited in an olive breeding progarm. This study has been established to resolve the confusion in local olive cultivar identity, at this stage, this study has revealed much about the performance of these cultivars, however, the study was limited to one location. An expanded study in different environment is essential to determine the results of all studied characters under different conditions. The results of this study have provided important information about Palestinian olive germplasm. Since only one year of observation of olive oil samples was considered for chemical analyses, the reported results are indicative, but a more complete database of chemical characteristics based on several years of observation is needed. In addition, molecular data, are needed in order to detect the level of reliability for the morphological parameters and to provide information on which parameters should be useful to discriminate olive cultivars.

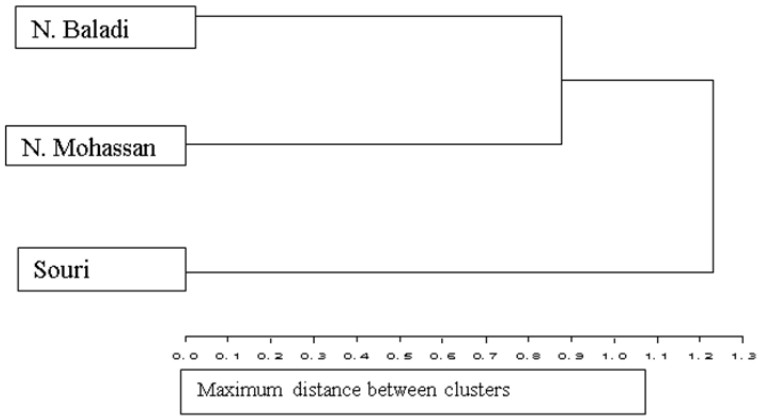

Figure 1. Dendrogram obtained by tree morphological indexes on three olive cultivars.

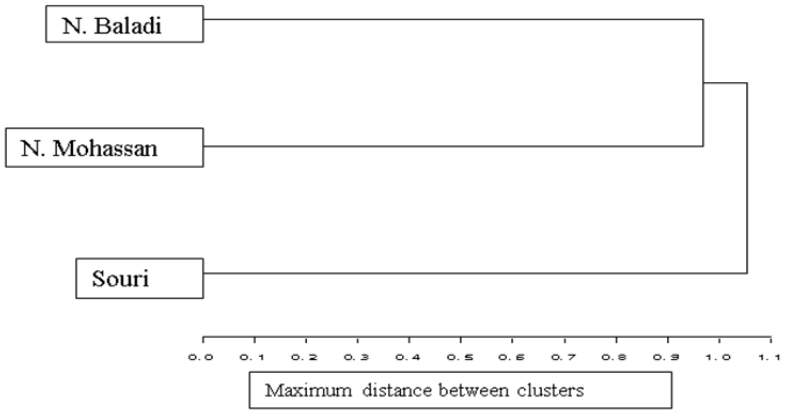

Figure 2. Dendrogram obtained by Leaf, flower, fruit and stone morphological indexes on three olive cultivars.

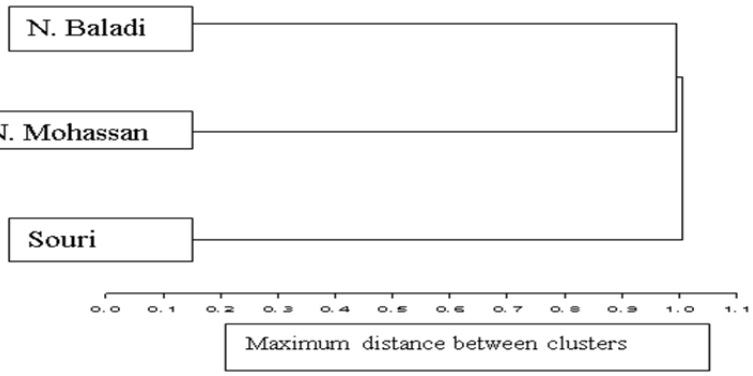

Figure 3. Dendrogram obtained by oil indexes on three olive cultivars

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التوصيف الشكلي والبيوكيماوي لثلاثة أصناف من الزيتون (*Olea europaea* L.) في فلسطين

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ملخص

تعد اصناف النبالي البلدي، المحسن والصوري من اكثر اصناف الزيتون انتشارا في فلسطين، وتنتشر على نطاق واسع في مناطق زراعة الزيتون في الضفة الغربية جميعها. ويوجد اختلاف واضح في المواصفات المظهرية بين الاصناف وداخلها، ويعزى هذا الاختلاف الى التغير في الظروف البيئية، وليست الصفات الجينية. ومن اجل البحث عن الاختلافات بين الاصناف، تم جمع عينات من الاوراق، والازهار، والثمار، والبذور من اجل تصنيفها مظهريا، كما تم استخلاص عينات من الزيت من هذه الاصناف لتحليلها كيماويا. لوحظ وجود اختلافات كبيره بين الاصناف الثلاثة في معظم المواصفات التي تمت دراستها وتضمنت صفات: غطاء الشجرة، الاوراق، الازهار و الثمار. كما تم قياس درجة الحموضة للزيت والرقم البيروكسايدي وامتصاص الضوء *(spectro-photometer)* في الاشعه فوق البنفسجية، وكانت منخفضة في عينات الزيت المفحوصة جميعها. معظم الاصناف كانت تحتوي على نسبة حوالي 60% او اكثر قليلا من حامض الاوليك، باستثناء النبالي المحسن، تباينت الاصناف في محتوى وتركيب الستيرولات. أظهر الصنف النبالي البلدي وجود نسبة عالية من *Δ-7stigmastenol*. كانت التحاليل البيوكيماوية جميعها (الحموضة، البيروكسايد، الامتصاص للاشعه فوق البنفسجية، الاحماض الدهنية ومحتوى وتركيب الستيرولات) التي استخدمت في تحليل جودة الزيت، وفق مواصفات مجلس الزيت والزيتون العالمي *(IOC)*.

الكلمات الدالة: الزيتون، أصناف، مورفولوجيا، زيت الزيتون، توصيف.

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تاريخ استلام البحث 2012/12/23 وتاريخ قبوله 2013/4/30.