Evaluation of Some Productive and Technological Traits in Local and Introduced Olive Cultivars (Olea Europaea L.)

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Abstract

This research aims to evaluate some productive and technological traits for 12 olive cultivars (Olea europaea L.), to select the best of them for Propagation, and genetic improvement programs. Samples were collected from 10 introduced and 2 local cultivars, during the years 2015 and 2016, from Bouka Center in Lattakia, Syria.

Cultivars were evaluated for technological and productive traits. Three trees/cultivar were analyzed. Data were subjected to ANOVA analysis.

For technological traits, the fruit weight average varied between cultivars. The highest weight was found in Spanish Gordal (10.3 g) while the lowest weight was found in Algerian Chemlal cultivar (1.44g.) For stone trait, the weight average ranged between medium and very big weight. All olive cultivars showed high reflux% except Chemlal and Frantoio where they had low value.

Highest value of oil percentage (26.6%) was detected in Frantoio cultivar and the lowest value was in Gordal cultivar (13.4%).

Concerning the productive traits, the highest tree production of fruits was in Tanche (36.67kg/tree) and the lowest one was in Trilia cultivar (1.67 kg/tree). Picholine, Coratina, Frantoio and Khdairi cultivars showed stable yield between years while alternate bearing phenomenon was more obvious in the rest of cultivars.

Keywords:

Olive, oil percent, fruit weight, Productive traits, Technological traits.

I. INTRODUCTION

The Olive (*Olea europaea* L.) is a long-lived evergreen tree, native to the eastern coast of the Mediterranean basin, where more than 90% of olive resources are located. Its habitat is determined by the Mediterranean climate, which is characterized by relatively mild winters and hot, dry summers. The area belonging to this climate type lie between 30º and 45º north and south latitudes. Olives are grown under various climatic (altitude, temperature, rainfall) and soil conditions, which had contributed to the conservation of genetic variation of olives ([1], [2]). Syria has been known as one of the most popular countries in terms of production and export of olive oil for more than 3000 years, and olive tree still has a widespread as a wild tree in the North-west Mountains of Syria ([3], [4]).

Olive cultivation is mainly concentrated in the Mediterranean basin countries, and according to FAO statistics, the world's cultivated area of olive trees reached (10.272.547 hectares) in (2014) with total production exceeded 15 million tons, only about 10 % of them is used for table olives, while the major remaining percentage is channeled into oil production [5].

Spain is the leading country in the ranking for olive production, Syria holds the sixth place in world olive production with more than one million tons of olive fruits in 2012 [6].

The evaluation of olive as commercial varieties must be done using several characteristics and parameters, such as morphological characters, genetic components, adaptation to the environmental conditions in the planted area in order to determine the agricultural and productivity characteristics of the olive variety under these circumstances (Tolerance to diseases and pests, productivity, cultivation purpose, fruit size, oil quality and quantity) ([7], [8]).

A comparison study of several worldwide olive cultivars (from Spain, Italy, France, Morocco, Australia, USA) has been done based on different characters such as tree vigor, productivity, alternate bearing, fruit size, oil content, pit to pulp ratio, flowering and maturity dates, fatty acid and polyphenol content. The results indicate significant differences between olive cultivars [1].

A particular variety of olive may be planted on a large geographical area, although it is not the best variety, this is due to the fact that other varieties has not been tested in the same area. In several countries, new varieties of olive with improved yields, higher quality or better resistance to pests and diseases replaced the old varieties. For example, the

variety "Lechin de sevilla" was covered a large geographical area of Spain (125000 hectares). Despite the distinctive agricultural properties for this variety (high levels of vegetative growth, tolerance to drought and low temperatures, high alkaline soil and its oil quality is one of the most desirable varieties), but due to its small fruit size and low oil content, it was replaced by new olive varieties [9].

Another study of olive has focused on the vegetative characteristics, floral biology, fruit characteristics, oil percentage, and yield of eleven olive cultivars planted in a research station in Iran (Arbequina, Amygdalolia, Bledy, Roghani, Zard, Sevillana, Koroneiki, Conservalia, Gordal Sevillana, Manzanilla, and Mission) for five years, indicated significant morphological differences between the cultivars, and allowed the distribution of the cultivars into different groups [10] For example, the three cultivars (Sevillana, Manzanilla, and Gordal Sevillana) can be used for canning, and the two varieties (Amygdalolia and Conservalia) were suitable in subtropical areas for canning and oil, while the other two varieties (Arbequina and Koroneiki) can be grown as oil cultivars in subtropical climate.

Three Egyptian olive cultivars (Maraki, Sewia, and E52) were compared with two international olive cultivars suitable for Egypt environmental conditions (Coratina from Italy and Koroneiki from Greece). The study based on fruit characters, flowering and chemical parameters of oil during two seasons (2011-2012) [11].

Results indicated that, fruit and stone weight were the lowest in 'Koroneiki' variety and very high in 'Sewia', and the content of Oil (%) was the highest in two Egyptian cultivars (Maraki and E52), compared with the others 'Coratina', 'Sewia' and 'Koroneiki'. Furthermore, the cultivar (Coratina) was characterized by high fruit weight, produced the highest yield (46.67 and 60 kg/tree) in the two seasons (2011, 2012), while the cultivar (E52) showed a criterion of alternate bearing during the two seasons, where great decrease of yield was noted from the first season (36.67 kg/tree) to (7.50 Kg/tree) in the second season [1].

The behavior of (28) international olive cultivars planted in the conditions of Viola climate (Albania) was studied [12]. Different technological characteristics were shown and most varieties (18) grouped and considered as large fruit varieties, three others were as small fruit varieties, four as medium fruit varieties and three were as very large fruit varieties. Furthermore, the studied cultivars showed different oil content ranging from 10.88 to 24.7%, but 70% of the cultivars had low oil content (below 18%) and different fruit yield (0-65 kg/tree).

Lattakia, in Syria, is well-known for olive production where it represents about 12% of Syria's total olive production. The main olive cultivar grown in Lattakia is "Khdairi" which formed 85% from the total olive trees in the city, followed by Dermlali and other sparse varieties include "Sorani" and "Frantoio". The planting of Frantoio has been increased in the last years due to its adaptation to Syrian coastal conditions and to its tolerance to olive peacock eye spot compared to native varieties, in addition to its yield stability, despite of its small fruits which make it difficult to harvest. The adoption of an olive variety for a particular area is of critical importance; especially for the olive trees which need several years to produce fruits. Several olive cultivars may exceed in their positive growth and yield characteristics the common grown varieties but as they has not been tested enough, they are not used at economical level [8].

Up to date, the imported international olive cultivars have not been tested under the Syrian coast climatic conditions, in spite of its distinctive characters and wide distribution through the Mediterranean region. In Syria, all previous studies were based on morphological, physiological or molecular characters [13], production, pests and diseases of local cultivars or wild olive trees [14]. Therefore, our study aimed to evaluate some international imported olive cultivars in comparison with two local cultivars of olive in Lattakia.

II. MATERIAL & METHODS

A. Plant Material

The study was conducted throughout two growing seasons (2015) and (2016), in Bouka Center for Researches and Plant Production, Lattakia, Syria. The field is of 15 acres surface, located at 36 meters above sea level, with a mean annual rainfall of 783.75 mm, and mean temperature of 20.3 OC.

Twelve olive cultivars were selected for the study, two of them were local and ten are introduced cultivars (Table 1). Three trees of 35 year-old were chosen from each cultivar, they were planted at a distance of 9x9 m. No irrigation was provided and all other maintenance service was similar for all trees. Soil chemical and physical characteristics were determined at soil laboratory at the Center of Scientific Agricultural Research (Table 2).

Table1. Cultivar Names, Origin and the Purpose of Cultivation of the 12 Studied Cultivars.

Cultivar	Origin	Purpose	Cultivar	Origin	Purpose
Khdairi	Syria	Dual purposes	Frantoio	Italy	Olive oil
Dermlali	Syria	Dual purposes	Coratina	Italy	Dual purposes
Chemlal	Algeria	Olive oil	Gordal	Spain	Table olive
Chemlaly	Tunisia	Olive oil	Zorzalina	Spain	Dual purposes
Tanche	France	Dual purposes	Trilia	Turkey	Dual purposes
Picholine	France	Dual purposes	Konservolia	Greece	Dual purposes

Table 2. Chemical and Physical Characteristics of the Soil Samples Collected from the Experimental Area.

Soil depth (cm)	Saturated Paste		g/100g soil			P.P.M							Physical characteristics		
	PH	EC	Calcium carbonat	Active calcium	Organic matter	N	P	K	Fe	Cu	Mn	Zn	Sand %	Silt %	Clay %
30-0	7.72	0.66	52.4	21.8	3	6.5	29	318	3.65	6.45	3.62	1.367	27	31	42
30-60	7.73	0.51	50.8	21.8	2.53	8	24	300	4.88	6.53	3.17	0.94	28	30	42

***B) Studied Parameters*:**

Two types of parameters were used in this study, the first was technological parameter (fruit weight, stone weight and reflux percentage), and the second was the productive one (tree yield and oil content).

1) ***Fruit Weight/g*:**

40 fruits from each tree at ripening stage (when color change is completed) were randomly collected from the middle part of the most representative fruiting shoots at shoulder level and from the four directions of the tree. The very small and very large fruits have been excluded, the remaining fruits weighted, and classified according to the International Olive Council recommendations [9] as follow:

- low (< 2 g)
- medium (2-4 g)
- high (4-6 g)
- very high (> 6 g).

2) ***Stone (Endocarp) Weight/g:***

Data was collected from samples of 40 stones (endocarps) for each cultivar, taken randomly from the fruits used for morphological characterization. Stones were cleaned and weighted, then classified according to the International Olive Council recommendations [9] as follow:

- low (< 0.3 g)
- medium (0.3-0.45 g)
- high (0.45-0.7 g)
- very high (> 0.7 g).

3) ***Percentage of Reflux (pulp/fruit %):***

100 fruits from each tree at ripening stage were randomly collected and weighted. The separation of the flesh was done manually. After separation, the stones were cleaned and weighted. The percentage was calculated according to the following equation:

Reflux % (Pulp/fruit %) = (whole fruit weight – stone weight)/(whole fruit weight)x100.

4) ***Oil Percentage Based on Fruit Wet Weight (oil content %):***

About 200g of fruits from each tree were crushed with a hammer mill and kneaded for 30 min. Oil was extracted by Soxhlet extraction apparatus, using acetone as an organic solvent. The resulting oil was weighted, and the percentage of oil was expressed on the basis of wet weight of fruits. For

each sample, three replicates were prepared and analyzed. Based on oil content%, cultivars were divided into groups according to the International Olive Oil Council recommendations [15] as follow:

- low (< 20%),
- medium (20-26%)
- high (>26%).

5) ***Yield (Kg/tree):***

Fruits of each tree was harvested during ripening stage (the second and third week of October). Olive fruits from each tree was weighted and the average yield was calculated for each cultivar.

6) ***Statistical Analysis:***

The analysis of variance for the obtained data in both seasons was performed by GenStat program (version, 12), using analysis of variance (ANOVA) tests. Mean separation was analyzed using Duncan's multiple range test or LSR at suitable levels of probability, because the number of studied cultivars was more than five.

III. RESULTS AND DISCUSSION

Data for technological characteristics [fruit weight (g), stone weight (g) and Percentage of pulp/fruit] and productive traits [average tree yield (kg\tree), percentage of oil based on wet weight] were collected for the years 2015 and 2016. Averages for the two year were calculated for all traits (Tables 3 and 4). Different levels of variations were detected between the studied cultivars and for all parameters (Figures 1, 2 and 3).

A. Technological Characters:

1) ***Fruit Weight (g)*:**

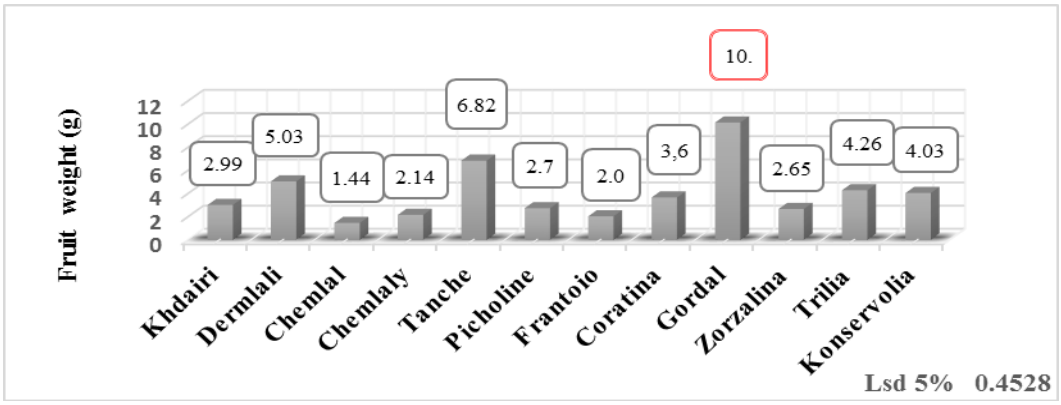
Fruit weight is one of the most important characters of olive, especially for cultivars to be used as olive table cultivars. Cultivars with average fruit weight less than (2.5 g) are usually classified as oil cultivars, while cultivars with fruits bigger than (2.5 g) are classified as table olive cultivars. The data indicated that the fruit weight varied significantly from low (Chemlal), medium (Khdairi, Chemlaly, Picholine, Frantoio, Coratina, and Zorzalina), big (Dermlali, Trilia, and Konservolia) and to very big fruits (Gordal and Tanche) (figure 1). The highest fruit weight (10.12 g) was showed in Gordal, with significant differences, while, lowest weight (1.44 g) was recorded in Chemlal cultivar.

The results shown that fruit weight averages were in accordance with the reference ratios of the average fruit weight mentioned by [9], especially for Picholine, Frantoio, Konservolia, Zorzalina and Tanche. It is interesting to note that some introduced cultivars (Chemlaly-Tunisia, Trilia-Turkey and Gordal-Spain) have produced fruits, in the climatic conditions of Lattakia, with higher weight than that produced under their original conditions and areas, While the averages of fruit weight in Algerian Chemlal and Spanish Coratina cultivars were smaller than the same cultivars in their areas of origin. Fruit weight is considered as a highly variable character influenced by many factors. The genotype of the cultivar is the most affective factor, also tree yield in the "on" year where where too much fruit is set, leading to low fruit weight, and the subsequent year will be "off" year with low number of fruits leading to high fruit weight due to the absence of competition for water and food. Also, the early rainfall in autumn positively affects the fruit weight and also agricultural practices such as fertilization and pruning have positive effects on fruit weight [8].

2) ***Stone Weight (g):***

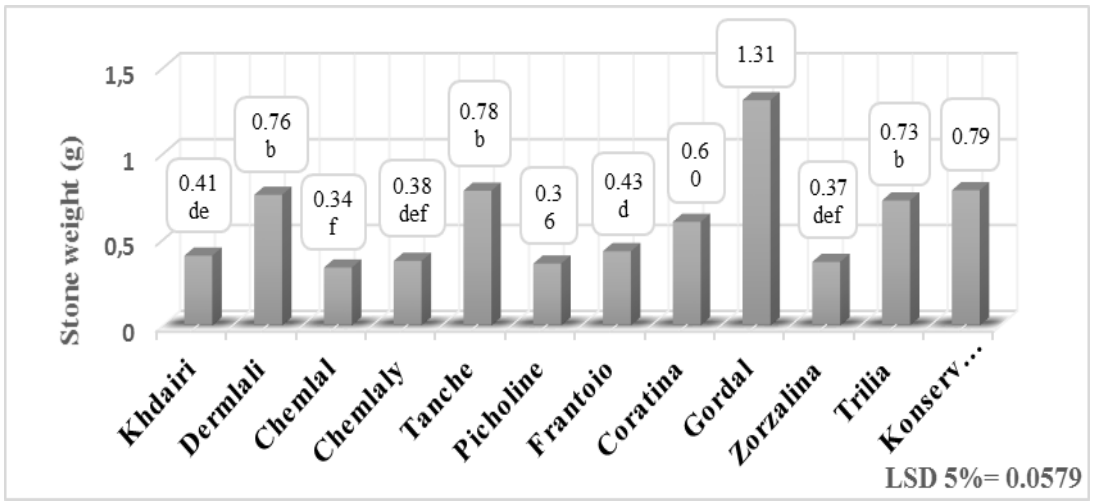
The weight of stone samples were estimated and the average for the two year was presented in figure 2. A difference in stone weight was detected between the different cultivars. The stone weight varied between medium (Khdairi, Chemlal, Chemlaly, Picholine, Frantoio, and Zorzalina), high (Coratina), and to very high weight (Dermlali, Gordal, Tanche, Trilia, and Konservolia)

It's known that stone characters are not affected by environmental conditions [16], and this is proved in our results. No difference was detected between the average of stone weight between the two years and for all studied cultivars. That means, the stone weight was not affected by alternate bearing, or by early rainfall in autumn because the stone hardens and takes its final size and weight before this period of the year.



*Cultivars with different letters are significantly different

Figure 1. Average Fruit Weight of the 12 Olive Cultivars

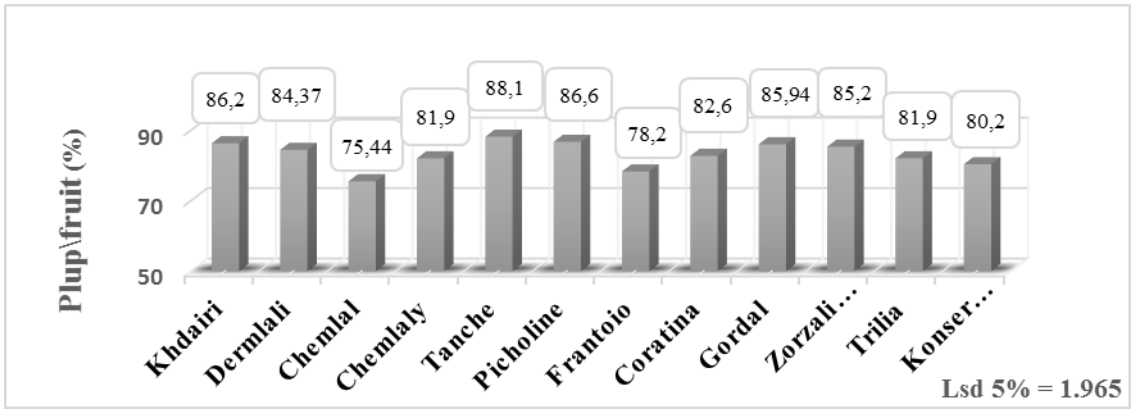


*Cultivars with different letters are significantly different

Figure 2. Average Stone Weight of the 12 Olive Cultivars

*3) **Percentage of pulp/fruit (flesh % or reflux %):***

Flesh percentage, is one of the most important criteria for the classification of olive cultivars according to their use, either for oil or for table. Cultivars with more than (80%) flesh are considered as table olive, while cultivars with less than (80%) flesh are classified as oil olive. Most of the studied cultivars was characterized by high percentage of flesh in their fruits. The highest percentage of flesh (88.1%) was revealed in Tanche cultivar, followed by Picholine and Khdairi with significant differences compared to the rest of cultivars. Low flesh% (less than 80%) was observed in Frantoio and Chemlal cultivars, which are



*Cultivars with different letters are significantly different.

Figure 3. Percentage of Pulp/Fruit for the 12 olive cultivars.

considered as oil cultivars because of their small fruits and low flesh% (Figure 3).

It's obvious that the pulp/fruit ratio is affected by fruit weight more than stone weight, because stone weight is more stable and not affected by environmental conditions and agricultural practices as fruit weights [16].

B. B. Productive Characters

1) ***Oil Content %:Based on Oil Content, the Cultivars Can be Divided Into Three Groups (Table 3)***

High oil content (Frantoio and Khdairi), medium oil content (Coratina, Tanche, Chemlaly, Picholine, and Dermlali), and low oil content (Trilia, Zorzalina, Konservolia, Chemlal, and Gordal). Frantoio cultivar, produced the highest fruit oil percentage (26.62%), followed by Khdairi. The differences between these two cultivars in oil content were not significant, but they showed together significant differences compared to all other cultivars. Menwhile the two cultivars Chemlal and Gordal recorded the lowest oil content %14.24 and 13.43% respectively.

Table 3. Oil Content % (of fruit wet weight) of the 12 Olive Cultivars (mean of two years).

Cultivar	Oil content %	classification	Cultivar	Oil content %	classification
Khdairi	26.26 a	High	Frantoio	26.62 a	High
Dermlali	20.01 d	Medium	Coratina	24.99 b	Medium
Chemlal	14.24 g	Medium	Gordal	13.43 g	Low
Chemlaly	22.64 c	Medium	Zorzalina	16.78 f	Low
Tanche	24.61 b	Medium	Trilia	17.83 e	Low
Picholine	20.49 d	Medium	Konservolia	16.30 f	Low
				LSD 5% =	1.010

*Cultivars with different letters are significantly different

Oil quality and quantity in olive fruits are affected by several factors, especially genetic componence (Genotype) of the cultivar, climatic conditions and soil type, agricultural practices, and harvesting date ([14], [17]).

In general, the total oil contents of olive cultivars in our study were closely matched the results of the previous studies on international imported cultivars ([8], [18]), and the result on local cultivars (Khdiri and Dermlali) [13].

2) ***Yield (Kg/tree)***

As shown in (Table 4), high differences in fruit yield/ tree were found between the cultivars and in the two years. The highest yield (Kg/tree) in the two years was recorded in Tanche cultivar (36.67 kg/tree), followed by 4 cultivars (Frantoio, Picholine, Coratina and Khdairi), without significant differences between them, while the lowest yield was recorded in Trilia cultivar (1.67 kg/tree).

Alternate bearing, also called biennial bearing, is a widespread phenomenon in olive tree.It affects all cultivars but with different levels according to the cultivar genotypes. The mean yield produced by all cultivars was (26.25 kg/tree) in the heavy yielded year "on year", followed by a mean fruit yield of (16.17 kg/tree) in the next year "off year" (Table 4).

Some cultivars (Picholine, Coratina, Frantoio and Khdairi) were characterized by good and stable yield during the two years, while the yield of other cultivars decreased greatly from the first year to the second one. It should be noted that the cultivar (Trilia) was characterized by the absence of fruits in the second year (2016).

The behavior of Dermlali in the second year was different from all other cultivars, where its yield in the second year (2016) increased (11.67 Kg/tree) and was more than the first year 2015 (5Kg/tree) , and in opposite side to all other cultivars. This may be due to the high sensitivity of Dermlali cultivar to olive peacock spot disease which prevailed considerably in the year (2015) and harmed olive trees, especially sensitive cultivars.

All olive cultivars are genetically highly alternating in fruit production, the alternate bearing phenomena affected by several factors, especially environmental conditions during bloom or fruit set. Horticultural practices such as pruning, water application,

fertilization can reduce the effect of alternate bearing on several olive cultivars [17].

IV. CONCLUSION

- Difference between the 12 cultivars in fruit weight was revealed and ranged from low to very high weight.
- All cultivars were characterized by high reflux percentage except Frantoio and Chemlal, which they are classified as oil cultivars.
- Frantoio cultivar possess the highest content of oil (26.62 %).
- Tanche cultivar produced the maximum of yield (36.67 kg fruits\tree).
- Picholine, Coratina, Frantoio and Khdairi cultivars were characterized by good and stable yield, while the other cultivars were sensitive to alternate bearing.

Table 4. Yield (Kg /tree) of the 12 Cultivars During 2015 and 2016 Years.

Yield / Cultivar	Yield 2015	Yield 2016	Mean yield 2015 & 2016
Khdairi	36.67 b	25 ab	30.83 ab
Dermlali	5.00 de	11.67 cd	8.33 de
Chemlal	35.00 b	16.67 bc	25.83 ab
Chemlaly	18.33 c	10.67 cd	14.50 cd
Tanche	48.33 a	25.00 ab	36.67 a
Picholine	35.00 b	30.00 a	32.50 a
Frantoio	40.00 b	26.67 a	33.33 a
Coratina	35.00 b	26.67 ab	30.83 ab
Gordal	11.67 cd	5.00 de	8.33 de
Zorzalina	31.67 b	11.67 cd	21.67 bc
Trilia	3.33 e	0.00 e	1.67 e
Konservolia	15.00 c	5.00 de	10.00 de
Average	26.25	16.167	21.208
LSD 5%	7.692	9.395	9.625

*Cultivars with different letters are significantly different.

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