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Recognition the changes in some physical and chemical fruit properties during fruit development stage of Kalamata and Sebhawy olive oil cultivars.

Laila Haggag F., M.F.M. Shahin, E.A.E. Genaidy and Fekria H. Khalil

Pomology Dept., National Research Centre, El-Tharir Str., Dokki, Egypt.

ABSTRACT

This work was carried out through 2011 and 2012 seasons on two olive oil cultivars, namely (Kalamata and Sebhawy). Trees were 10 years old, grown in sandy soil, planted at 5x5 meters apart under drip irrigation system. The investigation aimed to study the changes in some physical and chemical fruit properties in relation to fruit development stage. Results proved that fruit of the three cultivars exhibited a cycle growth pattern: Growth was rapid during the first fruit growth stage (6-10 weeks), slow during the second stage (4-5 weeks). The third stage is again one of rapid growth and coincides with the change in fruit skin color. The increment in fruit size prior to fruit coloration comes mainly from increased moisture content of the fruit. Oil begins to accumulate in the fruit and increases gradually through July, August and reaches the maximum as fruit become completely black. So, it is important for olive trees cultivars Kalamata and Sebhawy grown under Ismailia - Egypt have adequate water needs for about 16 to 19 weeks after fruit set tell just before harvest to obtain high fruit and oil quality.

Key words: Olive (*Olea europaea*), Kalamata, Sebhawy, Shemlaly, growth curve,

Introduction

The olive is native to the Mediterranean region, tropical and central Asia and various parts of Africa. The olive has a history almost as long as that of Western civilization, its development being one of civilized man's first accomplishments. At a site in Spain, carbon-dating has shown olive seed found there to be eight thousand years old. O. europaea may have been cultivated independently in two places, Crete and Syria. Archeological evidence suggests that olives were being grown in Crete as long ago as 2,500 B.C. From Crete and Syria olives spread to Greece, Rome and other parts of the Mediterranean area. Olives are also grown commercially in California, Australia and South Africa.

Olive tree (Olea europea L.) is grown for one of two purposes: olive oil extraction and green mature olives for processing. The olive fruit is a drupe and ripening period is determined by the time elapsing between the first purple spots and the peel turning black. By green maturation we mean the changes in fruit color and characteristics during the period the olive are green.

The olive fruit has, in general, the same growth pattern of the other stone fruits, such as the peach, plum, apricot, and cherry. Fruits of this type take a fairly rapid growth during the first period which occurs early in the season. Later, during the second period, which coincides with the hardening of the pit, very little increase in size is made. Finally there is a third period, the period of final swell, corning just before harvest in which there is a large increase in size.

Desouky, *et. al*. (2010) stated that, the fruit of olea species is a drupe, the term "stone fruit" expresses the fact that the seed is surrounded by a hard shell or stone, the endocarp. This stone develops from the inner part of the ovary wall and the soft flesh from the outer part. When the fruit is very young the stone is soft but after a few weeks it begins to harden. The seed of the mature fruit is the embryo and the large halves. Hartmann and. Opitiz (1977) reported that olive fruit exhibits a cyclic growth pattern. Growth is rapid during the first stage, slower during the second stage, in (July and August). The third stage, just before fruit starting to color, is again one of rapid growth and coincides with the color changes from green to straw to red to black. After few weeks from fruit set, oil begins to accumulate in the fruit. The amount of oil increases gradually through summer and fall, and reaches its maximum as fruits become completely black. Oil production, quantity and quality is greatly affected by many factors i.e., cultivar, oil accumulation and harvesting stage. AL-Maaitah et al (2009) reported that, better understanding of olive fruit growth curve can help us to improve the commercial and qualitative characteristic of fruit and identify the Optimal harvesting time which is the most important factor that determines the olive oil quality and quantity.

The fruit weight and fruit volume showed continuous increase from the beginning of fruit development till fruit reached it's full weight when it was 26 weeks old (180 days from fruit set) in Hamed variety and about 28 weeks old (195 days from fruit set) in Chemlali variety. However, moisture content in development olive fruits remained constant during the first two weeks. This was followed by intermittent variations until fruit starting to

Corresponding Author: Laila Haggag F, Pomology Dept., National Research Centre, El-Tharir Str., Dokki, Egypt.

color (reddish-green). At this stage, the moisture content remained constant until the blacking of the fruit Ezzat and El-Azzouni, (1963). Olive oil quality is known to show varietal differences and also to be influenced by environmental conditions from site to site and from year to year. However, the greatest differences occur during the maturation period, from young green olives to the final dark colored fruit. During this period the oil quality will gradually change and this change will be greater than the variation between cultivars, sites or environments. The variation during this period therefore can be influenced by grower management. The oil began to appear in Chemlali olive fruits after 60 days from fruit setting and reached its maximum (22%) after 185 days Boulis and Malaty, 1965. The fruit weight and fruit volume of eight seedling olive cultivars increased through the season with a reduced rate of growth in the middle period development Hegazi, (1970). The average flesh weight of olive fruit increased from the age of 60 days till the end of the sampling with a slow rate of increase during the middle stages of growth Hassan, (1980).

Inglese (2009) indicated that, the composition of olive oil results from a multivariate interaction in which genotype, environment, and agronomic-dependent factors are involved. The genotype controls genetic traits accounting for the rate pattern of fruit growth, oil accumulation in mesocarp cells and fruit ripening, while the genotype × environment interaction changes the rate of fruit growth, oil accumulation and fruit ripening pattern. The influence of genotype is linked to differences in the fruit growth and ripening patterns, though all those factors that may have an influence on fruit size, flesh/pit ratio and relative growth rate have a lower and more erratic influence on the olive oil composition. The genotype is the principal source of sensorial differences and this has been proved for most of the cultivars, giving them a specific role in gastronomy. The influence on olive oil composition of environmental factors, such as temperatures during fruit growth and ripening or water availability, may also be a function of changes in the fruit growth and ripening patterns and of the oil accumulation rate pattern.

The aim of this investigation is studding fruit development stages for Kalamata and Sebhawy olive cultivars grown under Ismailia – Egypt condition in order to be a guide for olive growers to improve the commercial and qualitative characteristic of fruit and identify the Optimal harvesting time which is the most important factor that determines the olive oil quality and quantity.

Materials And Methods

The present study was conducted on twelve olive trees of the two cultivars (Kalamata and Sebhawy). The trees were 10 years old, grown in a sandy soil under drip irrigation system depending on wills in irrigation (Table 1) in private orchard in Ismailia – Egypt. The trees spaced 5 x 5 meter apart (168 trees\ acre) in a sandy soil (Table 2). The trees were received the same cultural practices that are recommended. The trees were almost similar in vigor, free from any visible pathogenic symptoms and at the same bearing phase. Experimental trees were subjected to the ordinary horticultural practices and the work was conducted during 2011 and 2012 seasons.

For somewhat, similar trees of each olive cultivar were selected. Study the changes in some physical and chemical fruit properties during fruit development stages of the three olive cultivars has a great importance for olive growers to modify some horticultural practices during fruit development.

Fruit sample (100 fruit per tree) was randomly collected at two weeks intervals (from May 14, 2011 and May 23, 2012) until the early September of each season, thereafter fruit samples were collected as following:

- Collected at two weeks intervals (from May 14, 2011 and May 23, 2012) until early August of each season.
- Then collected Weekly intervals till early September (September 3, 2011 and 2012).
- Finally collected every three days till the harvest date (October 4, 2011 and September 20, 2012).

For each studied olive cultivar only healthy fruits, without any kind of infection or physical damage were subjected to the following physical and chemical fruit characteristics determination as follows:

1-Fruit weight:

It was determined by weighing the samples (100 fruits) by ordinary balance with 0.01 gm sensitivity and average weight per fruit was calculated.

2- Moisture content:

was determined by drying the flesh in an oven at 60-80°C until a constant weight [6]**.**

3- Weight of Dry Matter other than oil:

It was determined by the following equation (Dry Matter = fruit fresh weight – moisture content)

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Table 1: Chemical characteristics of sandy soil used for the present study.

parameters	Depth of simple (cm)		
	Surface sample	30 cm depth	60 cm depth
pH	8.02	8.70	8.11
EC(dSm-1)	3.80	0.80	1.70
	Soluble cations (meq\l)		
Ca++	6.00	2.50	3.00
Mg++	4.00	1.50	1.50
Na+	28.60	4.40	12.90
K+	0.12	0.14	0.78
	Soluble anions (meq\l)		
CO3=	-	-	-
HCO3-	4.40	2.40	2.00
Cl-	27.20	5.00	13.00
SO4=	7.12	1.14	3.18

Table 2: Chemical characteristics of water weal used for the present study.

parameters	values
pH	7.49
EC(dSm-1)	4.40
Soluble cations (meq\l)	
Ca++	7.50
Mg++	5.00
Na+	33.10
K+	0.16
Soluble anions (meq\l)	
CO3=	-
HCO3-	1.60
Cl-	40.00
SO4=	4.16

4-Oil percentage:

Fruit oil content was determined by means of the Soxhlett fat extraction apparatus using Hexan of 60-80°C boiling point as described by A.O.A.C., (1975).

Statistical analyses:

The data were subjected to analysis of variance and Duncan's multiple rang test was used to differentiate means at 5% Duncan, (1955).

Results And Discussions

1- Fruit weight:

In Tables (3 to 6) and Figs (1 to 4), a considerable rapid increase in fresh fruit weight of Kalamata cultivar was noticed during the first stage of fruit development (from May 14 until July 23). This increase in fresh fruit weight was mainly due to cell division and cell enlargement prevailing in this early stage. Therefore, vigor of tree, adequate nutrients, availability of soil moisture, crop density and fruit leaf ratio has been shown to influence fruit weight. At the end of this stage fruit weight attained (2.48 and 2.60 gm) in the two seasons, respectively. The period between July 23 until September 3 was characterized by slow increase in fruit weight. After this rapid stage, slower increase was noticed (from Sep. 6 to Oct. 4), it could be a result of the decrease in auxin level in the fruit or the competition on the auxin between embryo and fruit flesh tissue. As a result of this competition the enlargement of the flesh is slow. After this time a sharp expand in the fleshy part was occurred (from 3.98 to 4.23 gm) and (from 3.34 to 4.32 gm) from Sep. 10 to Sep 24 and from Aug. 20 to Sept. 6, in the two season, respectively. However, the marked increase in fruit fresh weight in the third stage could be a result of the increase in moisture content in the fruit. Consequently, the exogenous factors such as non available moisture, high temperature or sever evaporation conditions may decrease the growth rate of the fruits. This rapid increase in fruit weight was coincided with the change in fruit color. The increment in flesh weight seems to be connected with the fruit moisture content, the higher the fresh fruit weight the higher the fruit content. As for the Kalamata cultivar results obtained were similar to Sebhawy cultivar. Fruit size increase in the third stage comes mainly from increased moisture content of the fruit, if the tree lacks soil moisture during this period, or if strong desiccating winds occur, the expected increase in fruit size can not take place. The Kalamata cultivar fruit exhibited similar cyclic growth curve as did the other two cultivars. Water represent 70% of the olive fruit weight. However, this percentage depends on various factors such as stage of fruit growth, cultivar and water

stress. These findings are in line with those reported by Desouky, *et. al.* (2010) and Hartmann and Opitiz. (1977).

Table 3: Fruit weight, moisture, oil and dry matter contents of "Kalamata" olive during 2011 season.

Day	Fruit weight (gm)	Increase (%)	Moisture content (gm)	Increase (%)	Dry matter content (gm)	Increase (%)	Oil content (gm)	Increase (%)
14/5	0.37 r	-	0.26 k	-	0.11 m	-	0.00 m	-
28/5	0.80 q	116.22	0.58 j	123.08	0.22 l	100.00	0.00 m	-
11/6	1.26 p	57.50	0.89 i	53.45	0.35 k	59.09	0.02 m	-
25/6	1.64 o	30.16	1.15 h	29.21	0.48 j	37.14	0.0 5lm	150.00
7/7	2.11 n	28.66	1.26 g	9.57	0.76 i	58.33	0.09 kl	80.00
23/7	2.48 m	17.54	1.50 f	19.05	0.84 h	10.53	0.14 jk	55.56
6/8	2.62 l	5.65	1.52 e f	1.33	0.91 g	8.33	0.19 j	35.71
13/8	2.81 k	7.25	1.62 e	6.58	0.94 fg	3.30	0.25 i	31.58
20/8	3.04 j	8.19	1.76 d	8.64	0.95 fg	1.06	0.33 h	32.00
27/8	3.50 i	15.13	2.14 c	21.59	0.96 efg	1.05	0.40 g	21.21
3/9	3.85 h	20.00	2.4 b	12.15	0.98 def	2.08	0.47 f	17.50
6/9	3.91 g	1.56	2.41b	0.42	1.01 cde	3.06	0.49 ef	4.26
10/9	3.98 fg	1.79	2.43 ab	0.83	1.02 bcd	0.99	0.53 e	8.16
13/9	4.05 ef	1.76	2.43 ab	0.00	1.02 bcd	0.00	0.60 d	13.21
17/9	4.12 de	1.73	2.45 ab	0.82	1.03 bcd	0.98	0.60 cd	6.67
20/9	4.17 cd	1.21	2.46 ab	0.41	1.05 abc	1.94	0.66 c	3.13
24/9	4.23 bc	1.44	2.48 ab	0.81	1.06 abc	0.95	0.69 bc	4.54
27/9	4.29 ab	1.42	2.50 a	0.81	1.08 ab	1.87	0.71 abc	2.90
1/10	4.33 a	0.93	2.50 a	0.00	1.09 a	0.93	0.74 ab	4.23
4/10	4.35 a	0.46	2.51 a	0.40	1.09 a	0.00	0.75 a	1.35

Means having the same letters within a column are not significantly different at 5% level

Table 4: Fruit weight, moisture, oil and dry matter contents of "Kalamata" olive during 2012season.

Day	Fruit weight (gm)	Increase (%)	Moisture content (gm)	Increase (%)	Dry matter content (gm)	Increase (%)	Oil content (gm)	Increase (%)
23/5	0.56 l	-	0.37 k	-	0.19 h	-	0.00 l	-
7/6	1.20 k	114.29	0.78 j	110.81	0.38 g	100.00	0.032 kl	-
22/6	1.75 j	45.83	1.04 i	33.33	0.654 f	72.11	0.056 jk	75.00
7/7	2.36 i	34.86	1.39 h	33.65	0.88 e	34.56	0.09 ij	60.72
22/7	2.60 h	10.17	1.53 g	10.07	0.94 d	6.82	0.13 i	44.44
8/6	2.79 g	7.31	1.59 g	3.92	0.95 d	1.06	0.25 h	92.31
13/8	2.91 gh	4.30	1.67 f	5.03	0.95 d	0.00	0.29 gh	16.00
20/8	3.34 f	14.78	1.96 e	17.37	1.04 c	9.47	0.34 g	17.24
27/8	3.64 e	8.98	2.20 d	12.24	1.05 c	0.96	0.39 f	14.71
3/9	4.05 d	11.26	2.45 c	11.36	1.09 c	3.81	0.51 e	30.77
6/9	4.32 c	6.67	2.52 bc	2.86	1.22 b	11.93	0.58 d	13.73
10/9	4.42 bc	2.31	2.53 b	0.40	1.24ab	1.64	0.65 c	12.07
13/9	4.54 ab	2.71	2.58 ab	1.98	1.25 ab	0.81	0.71 b	9.23
17/9	4.65 a	2.42	2.64 a	2.33	1.25 ab	0.00	0.76 ab	7.04
20/9	4.69 a	0.86	2.64 a	0.00	1.26 a	0.01	0.79 a	3.95

Means having the same letters within a column are not significantly different at 5% level

2- Moisture content:

Data concerning the changes in fruit moisture content and its rate of change Kalamata and Sebhawy cultivars are presented in Tables (3 to 6) and Figs (1 to 4). For the Kalamata cultivar in the first season, it could be seen that fruit moisture content markedly increased in the early stage of fruit development from May 14 to July 23, 20011, moisture content value raised from 0.26 to 1.50 gm (more than four folds increase). Fruit moisture content turned to very slow rate for about 20 days from July 23 to August 13, 2011 (only about 8% increase), after which the rate of moisture sharply increased for about 14 days from 1.76 gm/fruit at Aug. 20 to 2.40 gm/fruit at Sep. 3, 2011 (about 98 % increase). Fruit moisture content tended to fluctuate towards the end of the season. Data of the second season show that fruit moisture content increased markedly during the early fruit development stage, followed by a very slow increase from July 7 till Aug. 6, then a sharp increase was occurred between Aug. 13 till September 3 (about 47% increase). Fruit moisture content showed a steady increase value towards the ripening stage. Data of the other two cultivars showed somewhat similar growth pattern. Generally, it can be mentioned that the timing of each phase and its duration differed according to the cultivar and season. It is interesting to note that Water represent 70% of the olive fruit weight. However, this percentage depends on various factors such as stage of fruit growth development, cultivar and water stress. These findings are in harmony with those of Hassan, (1980), Fouad, *et. al.* (1992) and Kaynas, *et. al.* (1992)

who mentioned that moisture content showed wide variation according to cultivars and seasons. Similar results were obtained by Ezzat and Azzouni, (1963) and Desouky, *et. al.* (2010).

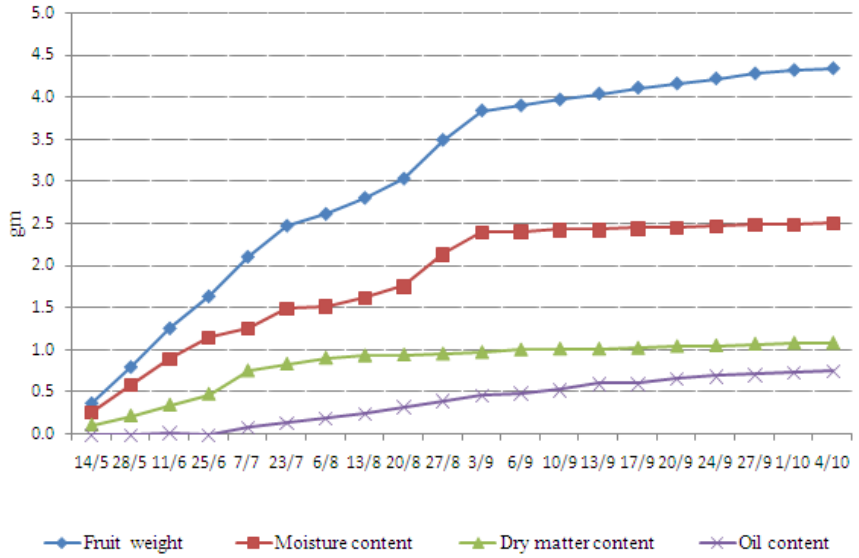

Fig. 1: Fruit weight, moisture, oil and dry matter contents of "Kalamata" olive during 2011 season.

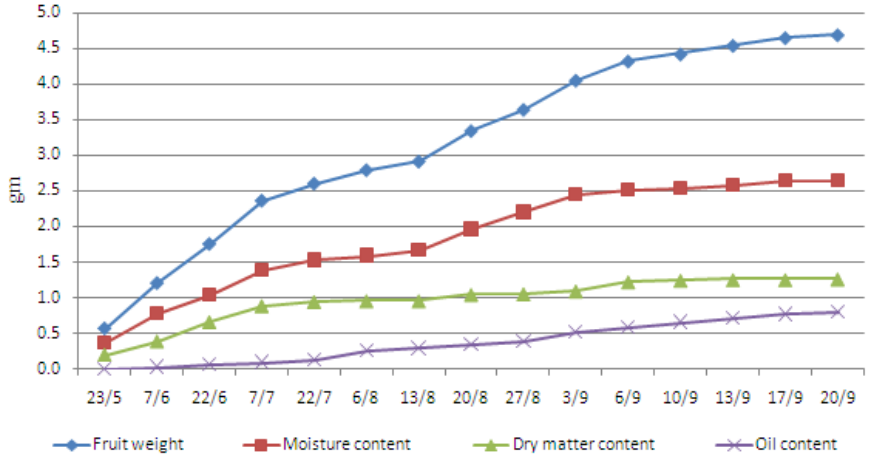

Fig. 2: Fruit weight, moisture, oil and dry matter contents of "Kalamata" olive during 2012 season.

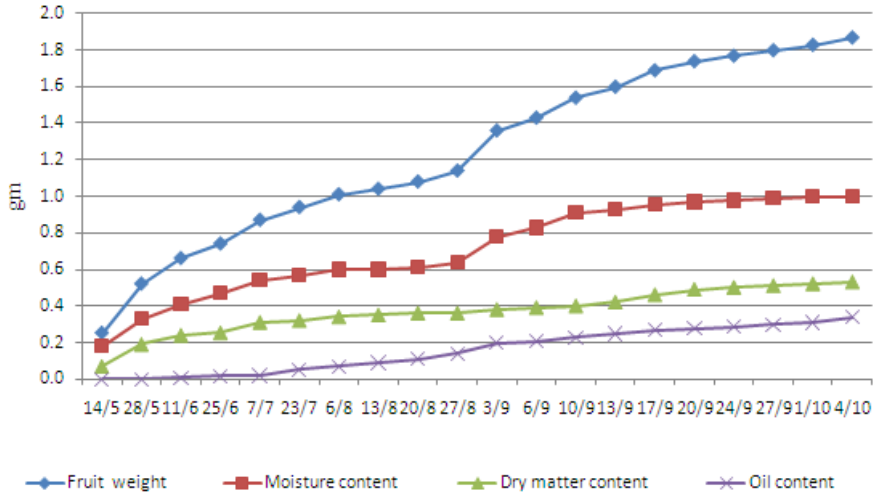

Fig. 3: Fruit weight, moisture, oil and dry matter contents of "Sebhawy" olive during 2011 season.

Table 5: Fruit weight, moisture, oil and dry matter contents of "Sebhawy" olive during 2011 season.

Day	Fruit weight (gm)	Increase (%)	Moisture content (gm)	Increase (%)	Dry matter content (gm)	Increase (%)	Oil content (gm)	Increase (%)
14/5	0.25 r	-	0.18 k	-	0.07 j	-	0.00 j	-
28/5	0.52 q	108.00	0.33 j	83.33	0.19 i	171.43	0.00 j	-
11/6	0.66 p	26.92	0.41 i	24.24	0.24 hi	26.32	0.01 j	-
25/6	0.74 o	12.12	0.47 h	14.63	0.253 h	5.42	0.017 j	70.00
7/7	0.87 n	17.57	0.54 g	14.89	0.31 g	22.53	0.02 j	17.64
23/7	0.94 m	8.00	0.57 fg	5.55	0.32 g	3.23	0.05 ij	150.00
6/8	1.01 l	7.45	0.60 ef	5.26	0.34 fg	6.25	0.07 hi	40.00
13/8	1.04 kl	2.97	0.60 ef	0.00	0.35 efg	2.94	0.09 ghi	28.57
20/8	1.08 k	3.84	0.61 ef	1.67	0.36 efg	2.86	0.11 gh	22.22
27/8	1.14 j	5.56	0.64 e	4.92	0.36 efg	0.00	0.14 g	27.27
3/9	1.36 i	19.3	0.78 d	21.88	0.38 def	5.56	0.20 f	42.85
6/9	1.43 h	5.14	0.83 d	6.40	0.39 def	2.63	0.21 ef	5.00
10/9	1.54 g	7.69	0.91 c	9.64	0.4 de	2.56	0.23 def	9.52
13/9	1.6 f	3.89	0.93bc	2.20	0.42 cd	5.00	0.25 cde	8.70
17/9	1.69 e	5.63	0.96 abc	3.23	0.46 bc	9.52	0.27 bcd	8.00
20/9	1.74 de	2.96	0.97 ab	1.04	0.49 ab	6.52	0.28 bcd	3.70
24/9	1.77 cd	1.72	0.98 ab	1.03	0.5 ab	2.04	0.29 abc	3.57
27/9	1.8 bc	1.69	0.99 a	1.02	0.51 ab	2.00	0.30 abc	3.45
1/10	1.83 ab	1.66	1.00 a	1.01	0.52 a	1.96	0.31 ab	3.33
4/10	1.87 a	2.19	1.00 a	0.00	0.53 a	1.92	0.34 a	9.67

Means having the same letters within a column are not significantly different at 5% level

Table 6: Fruit weight, moisture, oil and dry matter contents of "Sebhawy" olive during 2012 season.

Day	Fruit weight (gm)	Increase (%)	Moisture content (gm)	Increase (%)	Dry matter content (gm)	Increase (%)	Oil content (gm)	Increase (%)
23/5	0.60 p	-	0.41 l	-	0.19 k	-	0.00 m	-
7/6	1.02 o	70.00	0.65 k	58.54	0.37 j	94.72	0.00 m	-
22/6	1.59 n	55.88	0.95 j	46.15	0.63 i	70.27	0.02 m	-
7/7	2.00 m	25.79	1.17 i	23.16	0.78 h	23.81	0.04 lm	100.00
22/7	2.20 l	10.00	1.29 h	10.26	0.82 gh	5.13	0.09 l	125.00
6/8	2.44 k	10.91	1.42 g	10.08	0.85 fg	3.66	0.17 k	88.89
13/8	2.61 j	6.97	1.50 fg	5.60	0.86 fg	1.18	0.25 j	47.05
20/8	2.80 i	7.28	1.59 f	6.00	0.90 ef	4.65	0.33 i	32.00
27/8	3.32 h	18.57	1.97 e	23.90	0.94 e	4.44	0.41 h	24.24
3/9	3.69 g	11.14	2.20 d	11.68	1.00 d	6.38	0.49 g	19.51
6/9	3.88 f	5.15	2.29 cd	4.09	1.06 c	6.00	0.53 fg	8.16
10/9	3.99 e	2.84	2.35 bc	2.62	1.09 bc	2.83	0.55 ef	4.08
13/9	4.15 d	4.00	2.46 ab	4.68	1.1 abc	0.92	0.59 de	7.55
17/9	4.22 cd	1.69	2.49 a	1.22	1.11 abc	0.91	0.62 cd	5.08
20/9	4.29 bc	1.66	2.50 a	0.40	1.12 ab	0.90	0.67 bc	8.06
24/9	4.36 ab	1.63	2.53 a	1.20	1.14 ab	1.79	0.69 ab	2.99
27/9	4.39 ab	0.69	2.53 a	0.00	1.14 ab	0.00	0.72 ab	4.35
31/9	4.43 a	0.91	2.54 a	0.40	1.15 a	0.88	0.74 a	2.78

Means having the same letters within a column are not significantly different at 5% level

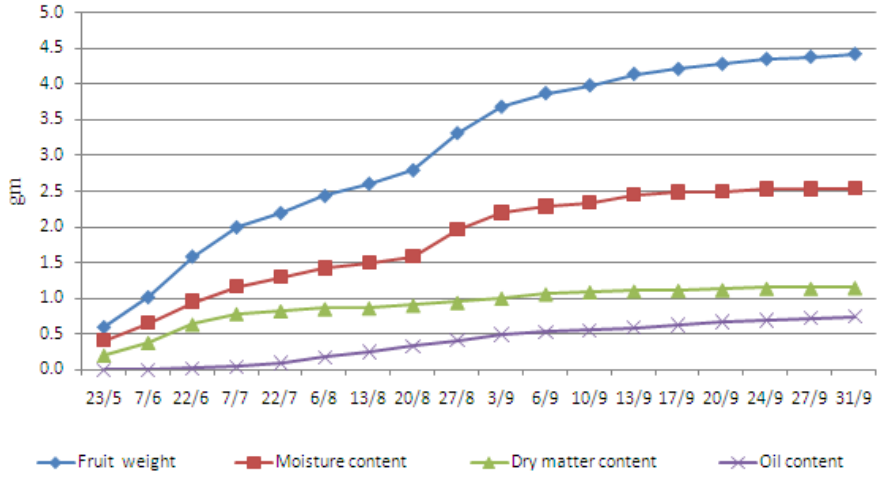

Fig. 4: Fruit weight, moisture, oil and dry matter contents of "Sebhawy" olive during 2012 season.

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3-Dry matter content:

Data concerning the changes in dry matter other than oil during fruit development of Kalamata and Sebhawy cultivars are presented in Tables (3 to 4) and Figs (1 to 4). According to the obtained data in the first season in Kalamata, it could be seen that, the early phase was characterized by a rapid rate of increase. The rate of increment in fruit dry matter content was 100.0, 59.01and 37.14% for the three sampling data, respectively. Thereafter the increment in dry matter turned to the slow rate till the fruit attained the harvesting stage. The rate of increase was 1.87, 0.93 and 0 % in the latest three sampling dates respectively. Data of the second season, take the same trained, the rate of increase reached its highest value during the early fruit development stage after which the rate of increase was characterized by a slow rate of increase. Regarding the Sebhawy cultivar, the same pattern was found whereas timing of each phase and its duration differed according to cultivar and season. The high rate of increase in the dry matter other than the oil probably due to carbohydrate accumulation during the early development stage. Therefore, a sizable amount of metabolic compounds goes into fatty acids and oil. Results obtained in this work are in conformity with those of Desouky, *et. al.* (2010) reported that, the early phase was characterized by a rapid rate of increase. Thereafter the increment in dry matter turned to the slow rate till the fruit attained the harvesting stage. The high rate of increase in the dry matter other than the oil probably due to carbohydrate accumulation during the early development stage. Therefore, a sizable amount of metabolic compounds goes into fatty acids and oil. On the other hand, Rapoport *et. al.* (1990) reported that, the dry matter of the endocarp increases by the end of August and afterwards it remains constant. Endocarp grows faster than mesocarp until the end of August, and afterwards its rate slows.

4-Oil content:

According to Tables (3 to 6) and Figs (1 to 4), for the Kalamata in the first season, it could be seen that the period from May 14 till August 13, the fruit oil content was rather low. It never exceeded 0.25 gm/fruit. Oil begins to accumulate in the fruit in early September and a sizable increase in fruit oil content was observed in the second half of September. Fruit oil content increased from 0.33 to 0.66 gm/fruit from Aug. 20th till September 20th. This marked increase in fruit oil content occurred during fruit coloration and reached its maximum at the end of October 4, as fruits become completely colored. Data of the second season and the two other olive cultivars showed similar pattern where the rate of oil accumulation was rather slight that no significant increment in fruit oil content was observed till about the second half of September. The coloration phase which occurred at the second half of September till early October yielded the increase in fruit oil content. Rate of oil accumulation differed according to tested cultivar and season of study. During the period of fruit growth and development, fruit composition varies (Nergiz and Engez, 2000), and a small quantity of olive oil is produced while the maximum quantity is produced during ripening. The maximum quantity of olive oil is produced in the mesocarp (96 – 98 %) with remainder in the endocarp. According to Cimato (1988) harvesting must be done, when the oils is of the best quality and the highest level. There have been numerous studies on this subject in an effort to find parameters that make it possible to easily define this period. Olive oil quality and quality are influenced by a great number of factors including the cultivar and the fruit maturity stage (Garcla *et al.*, 1996; Kiritsakis, 1998; Zamora *et al.*, 2001; Rotondi *et al*., 2004).

Numerous studies in the Mediterranean region have shown that the oil percentage increases dramatically during early fruit ripening (Salvador, 2001). Results obtained in this work are in conformity with those of Desouky, *et al* (2010) who reported that the Fruit oil content of three olive oil cultivars, namely Arbequina, Bouteillan and Koroneiki increased from September 5th till September 25th. This marked increase in fruit oil content occurred during fruit coloration and reached its maximum at the end of October, as fruits become completely colored. Also, Hartmann (1977) reported that the amount of oil increases gradually through fall and winter, and reaches its maximum in late December and January, as fruits becomes completely black. Similar observations were recorded by Tous *et. al* (1997) who found that oil accumulation in Arbequina cultivar fruits ranged between (165 and 195 days after fruit set) seems to be an optimum harvesting period, where oil content is high enough. Also, the obtained results are in line with the findings of Ezzat and Azzouni, (1963), Hegazi, 1970 and Desouky, *et. al.* (2010).

There are many factors influence on olive oil composition, such as environmental factors (temperature) during fruit growth and ripening or water availability may also be a function of changes in the fruit growth and ripening patterns and of the oil accumulation rate pattern Inglese et al (2009). So, it is important for olive growers to supply adequate water for several weeks just before harvest (about 22 to 26 weeks) after fruit set to obtain high fruit and oil quality.

So, it is important for olive trees cultivars Kalamata and zaraier grown under Ismailia - Egypt have adequate water needs for about 16 to 19 weeks after fruit set tell just before harvest to obtain high fruit and oil quality.

References

A.O.A.C., 1975. Association of Official Agricultural Chemists. Official Methods of Analysis, 12th ed., P. O. Box 450, Benjamin Franklin station, Washington, D.C., pp: 832.

AL-Maaitah, M.I., K.M. AL-Absi and A. AL-Rawashdeh, 2009. Oil Quality and Quantity of Three Olive Cultivars as Influenced by Harvesting Date in the Middleand Southern Parts of Jordan. J. Agric. Biol., 11(3): 266-272.

Boulis, S.T. and B.R. Malaty, 1965. Fruit growth and development of Chemlali olive and co. agulation of oil in arid zones. The Egyptian Society of Horticulture in fifty years, pp: 1615-1965.

Cimato, A., 1988. Variazioni di parametric durante la maturazione delle olive. Influenza Delle Tecniche Colturali., 28: 12-18.

Desouky I.M., F. Laila Haggag, 2. M.M.M. Abd El-Migeed and E.S. El-Hady, 2010. Changes in some physical and chemical fruit properties during fruit development stage of some olive oil cultivars.American-Evrasian J.Agric.&Environ.sci.,7(1): 12-17.

Duncan, D.B., 1955. Multiple range and multiple "F" tests. Biometrics, 11: 1-42.

Ezzat, A.H. and M.M. El-Azzouni, 1963. Studies on the determination of fruit maturity of some olive varieties. Agric. Rev. Cairo, 43(1): 20-60.

Fouad, M.M., O.A. Kilany and M.E. El-Said, 1992. Comparative studies on fruit characters of some olive cultivars under Giza condition. Egypt. J. Appl. Sci., 7(5): 645-656.

Garcla, J.N., S. Seller and M.C. Perez-camino, 1996. Influence of fruit ripening on olive oil quality. Agric. Food Chem., 44: 3516-3520.

Hartmann, H.T. and K.W. Opitiz, 1977. Olive production in California. Calif. Agr. Expt. Sta. Bul., pp: 2474.

Hassan, L.H., 1980. Evaluation of some olive varieties in middle Egypt. M. Sc. Thesis, Fac. of Agric.,Al. Azhar Univ., Egypt.

Hegazi, E.S., 1970. Studies on growth, flowering and fruiting in some new olive seedling strains under Giza conditions. M. Sc. Thesis, Fac. of Agric. Cairo Univ., Egypt.

Inglese, P., F. Famiani and M. Servili, 2009. Factors affecting of olive oil composition during fruit growth and ripening. Italus Hortus., 16(4): 67-81.

Kaynas, N., A.E. Sutcu and A.E. Fidan, 1992. Studies on pomological characteristics of olive cultivars grown in the Marmara region. Bachce., 21(1-2): 38 (Hort. Abst. 16:9925, 1994).

Kiritsakis, A.K., 1998. Composition of olive oil. In: Trumbull, C.T. (ed.), Olive Oil from the Tree to the Table, Food and Nutrition, pp: 113-154.

Nergiz, C., Y. Engez, 2000. Compositional variation of olive fruit during ripening. Food Chem., 69: 55-59.

Rapoport, S.M., T. Schewe and B.J. Thiele, 1990. Maturational breakdown of mitochondria and other organelles in reticulocytes. Blood Cell Biochem., 1: 151-194.

Rotondi, A., A. Bendini, L. Cerretani, M. Mari, G. Lercker and T.G. Toschi, 2004. Effect of olive ripening degree on the oxidative stability and organoleptic properties of cv. Nostrana di Brisighella extra virgin olive oil. J. Agric. Food Chem., 52: 3649-3654.

Salvador, M., 2001. Simple and hydrolysable compound in virgin olive oil. Food Chem., 248: 95-112.

Tous, J., A. Romero, J. Plana, L. Guerrero, I. Diaz, and F. Hermoso, 1997. Caracteristicas quimico-sensoriales de los aceites de oliva Arbequina obtenidos en distintas zonas de Espana. Grasas y Aceites., 48(6): 415-424.

Zamora, R., M. Alaiz and F.J. Hidalgo, 2001. Influence of cultivar and fruit ripening on olive (Olea europaea) fruit protein content, composition and antioxidant activity. J. Agric. Food Chem., 49: 4267-4270.