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Changes in Some Constituents of Kalamata and Picual Olive Fruits During Development

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Abstract : This work was carried out through 2011, 2012 and 2013 seasons on Kalamata and Picual olive cultivars. Trees were about 8 years old, grown in a sandy soil, planted at 5x5 meters apart under drip irrigation system. The investigation aimed to study the changes in some constituents in relation to fruit development stage. Results obtained provide that fruit development of both cultivars followed the double growth pattern in which a great increase in fresh fruit weight occurred during the first stage, (about 10 weeks) after fruit set, followed by a very limited change in fruit size for about (4-5 weeks) then a rapid increase in fresh fruit weight was followed. The change in fruit skin color shortly began during the early period of the third stage. 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.
Kew words: Olive (*Olea europaea*), Kalamata, Picual, growth pattern.

Introduction

Olive tree (*Olea europaea* L.) is considered among the major fruit trees grown in the south countries of the Mediterranean Sea. It is able to be grown in regions of low chilling winter, high summer temperature and dry weather, moreover, olive tree relatively resists drought and soil salinity comparing with many other fruit trees.

According to[1] the cultivated area of olive in the world reached about 4,268,415 feddans producing about 20,344,343 tons about 90% of which is channeled into oil production while the remaining 10% is for table olives.

Olives are considered among the major commercial fruit varieties grown in Egypt its ranks the fourth after citrus, mango and grapes.

As well know the main constituents of olive fruit are moisture, dry matter other than oil and oil content. Changes in these constituents affect the gross fruit fresh weight, the increase in fresh fruit weight is achieved through one or more of the following means; increase in moisture content , dry matter other than oil or flesh oil content. It is true that factors affecting the accumulation of any of these three components greatly affected fruit weight and volume. Fruit moisture content seemed to be the main factor affecting fresh fruit weight in considered. This can be proved through the positive correlation between the change in the pattern of fruit fresh weight and this of the fruit moisture content. As for oil full fruit coloration seemed to the essential to get sufficient oil content.

[2]reported that, the fruit weight and volume continuous in the increase from the beginning of fruit development until the fruit has reached it's full weight when it was about 26 weeks (180 days from fruit set) in Hamed cultivar and after about 28 weeks (195 days from fruit set) in Chemlali cultivar. This was followed by intermittent variations until fruit starting to color (reddish-green). At this stage, the fruit moisture content remained steady until the blacking of the fruit. On the other hand, [3] reported that in Chemlali olive cultivar, the oil began to accumulation in fruits after (60 days from fruit setting) and reached the maximum after (185 days) about (22%).. Also[4] noticed that, increase in fruit weight and volume of eight seedling olive cultivars during the season with a reduced in growth rate in the middle period of development. In addition to, [5]observed 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, as well as, [6]found that fruit oil content increases gradually during summer and fall and reaches its maximum when fruits were completely black. The average flesh weight of olive fruit increased from the age of 60 days until the end of the sampling with a slow rate of increase during the middle stages of growth. And also[7] stated that the fruit of the three cultivars (Arbequina, Bouteillan and Koroneiki) exhibited a cycle growth pattern: Growth was rapid during the first stage about (8-10 weeks), followed by a slow increase during the second stage for about (6-8 weeks), then a rapid increase in growth was followed. This stage coincides with the change in the skin color of the fruit. The accumulation of oil begins in the fruit and increases gradually during July, August and reaches its maximum when fruit was completely black.

Materials and Methods

The present study was conducted on twelve trees of each of the two olive cultivars (Kalamata and Picual). Trees were about eight years old and grown in a sandy soil at five meters apart under drip irrigation system and received the ordinary horticultural practices. Selected trees were visually free from any disease symptoms, similar as far as possible in their growth vigor and bearing phase and grown in a private orchard in Ismailia governorate near Cairo.

In each season a sample of one hundred fruits per each individual tree was randomly collected at two weeks intervals from early May, shortly after fruit set, until the beginning of August then sampling was done every week up to the harvesting date. Collected samples were immediately brought to the hort. laboratory at the N. R. C .to determine the following fruit characteristics:

Fruit weight: Using ordinary balance with 0.01 gm sensitivity and the average fresh fruit weight was calculated.

Moisture content was determined by drying the fresh fruit in an electric oven at 60-80°C until a constant weight according[8]

Weight of dry matter other than oil : It was estimated through the following equation: Dry matter other than oil = fruit fresh weight – (moisture content + oil content)

Oil percentage : Flesh fruit oil content was determined according[8] method by extracting the oil from the dried flesh fruit with soxhlet apparatus using petroleum ether 60-80 º C of boiling point and expressed in percentage on dry weight basis.

Statistical analyses:

The data were subjected to analysis of variances **(ANOVA)** according[9] using MSTAT program. Least significant ranges (LSR) were used to compare between means of treatments according[10] at the probability of 5%.

Results and Discussions

1- Fruit weight:

In Tables (1 and 2) and Figs. (1 and 2) concerning the Kalamata cultivar, it is clear that a very sharp increase in fresh fruit weight reached (about 98.21 and 44.14%) in the second half of May and the first half of

June, respectively, followed by continuous increase amounted (29.38 and 29.95%) during the second half of June and the first half of July, respectively. Slow fruit increase in average fruit weight prevailed during the second half of July and the first half of August, followed by a sharp increase during the second half of August rate was observed (17.31 and 15.78 %), respectively. Only about (8.35, 6.49, 5.14 and 1.81%) increase was observed through the fourth week of September.

As for Picual cultivar, somewhat similar pattern was detected in which the fruit development exhibited the double growth curve in some differences in the occurrence of the three development stages.

These findings are in line with those reported by[5, 7, 11, 12].

2- Moisture content:

Data concerning the changes in fruit moisture content and its rate of change are presented in Tables (1 and 2) and Figs. (1 and 2).

This study proved that the major factors affect olive fruits construction are ;moisture content, dry matter other than oil and pulp oil content. Concerning fruit weight and size moisture seemed to have the main factor in this respect, an adequate and sufficient supply of water and water conservation during the early season (flowering, fruit set, cell division and cell enlargement) seemed to have vital role in fruit formation .furthermore moisture has a great role in tree grow, vigor and carbohydrate metabolism and subsequent organic substances. Good horticultural practices i.e. adequate fertilization, pest and insect control--etc. played an important role in this respect. Final swelling of fruit occurs in the early period of the third stage and prior to skin coloration which consists about one-fifth to one-fourth of fruit weight depends on the available irrigation water also conserving tree water content through spraying any anti-transparent substances results in larger fruits. The cessation occurred in fruit weight increment during June and July (second stage) may be attributed to the competition between embryo and seed tissues against flesh tissues on endogenous auxin and at the end of this stage the stone becomes hard.

It could be noticed that this sharp increase in fresh fruit weight which occurs in the early stage of fruit development could be attributed to the moisture content and this because the change in fruit weight was a barrel to this of moisture content. For instance, for Kalamata, the moisture consisted about 68 and65 % of the total fresh fruit weight in the first and second of May respectively and it was about 62%in the first half of June corresponding value of Picual is 68, 65 and 63%.Therefore supplies adequate available water to the tree during this period seems to be important to improve fruit weight, also, it may prevent heavy small fruit drop which occurs in this period .e Kalamata and Picual cultivars respectively. In the second stage only about 8% increase in Kalamata fresh fruit weight (from the second half of July to the first half of August) corresponding value for Picual is about 7% (from the second half of July to the third week of August). At the beginning of the third stage (final swelling) a considerable share increase in fruit weight reached (about15 %) for the Kalamata during the second half of August and these increase reached (27%) for Picual cultivar during the period from the fourth week of Aug. till the first half of Sep. Fruit moisture content is the main source of this increase .Provide the adequate moisture and conserve moisture loss is in a great important for improving fruit weight and subsequent tree productivity.

It is interesting to note that the change in fruit moisture content is greatly connected with the fruit growth development in fresh weight. These findings are in harmony with those of [6, 13, 14] who mentioned that moisture content showed wide variation according to cultivars and seasons. Similar results were obtained by [2, 7, 11, 12].

3-Dry matter content other than oil:

Data in Tables (1 and 2) and Figs. (1 and 2) concerning the changes in the dry matter content other than oil during the fruit development. As for Kalamata cultivar, it could be observed that the early phase was marked by a sharp increase in the dry matter content. The rate of increase in the fruit dry matter content reached 100, 55.56 and 37.50 % for the first three sampling data, respectively. After that, the increase in the dry matter turned into a slow rate till the fruit reached the harvesting stage. The rate of increase exhibited 2.27, 1.48 and 0% in the latest of the three sampling dates, respectively**.** Concerning the Picual cultivar, the same pattern was found**.** The high rate of the increment in the dry matter content other than the oil may be due to accumulation of carbohydrate during the early stage of development. Therefore, a sizable amount of metabolic compounds turned to the fatty acids and oil.

The obtained results are in line with the findings of [7, 11, 12] they found that the rate of increase in dry matter reached its highest value during the early fruit development stage after which the rate of increase was marked by a slow rate.

4-Oil content:

According to Tables (1 and 2) and Figs. (1 and 2). For the Kalamata cultivar, it could be seen that the period from May till the first half of August, the fruit oil content was rather low. Oil begins to accumulate in the fruit in the second half of August. The increment in fruit oil content from 0.44 to 0.72 g/fruit occurred during the period from the third week of August till the first week of September. This marked increase in the fruit oil content occurred through fruit coloration and reached its maximum at the end of September (1.01 gm), when fruits were completely colored. With regarded to Picual cultivar, the data observed that the period from May until the third week of August, the fruit oil content was low. Oil begins to accumulate in the fruit in late August and the first half of September. The increment in fruit oil content from 0.36 to 0.70 gm/fruit occurred during the period from the fourth week of August till the second week of September. This significant increase in the fruit oil content occurred during the fruit coloration and reached its maximum at the end of October, when fruits were completely colored.

Results obtained in this work are in conformity with those of [5]who reported that the fruit oil content increases gradually during fall and winter, and reaches its maximum in late December and January, when fruits were completely black. Similar observations were recorded by[15] who found that Arbequina cultivar fruits in the period between (165 and 195 days after fruit set) seem to be the optimum period for harvesting, where the oil content is high enough. Also, the results are in line with the findings by [2, 4].

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(Table 1): Changes in fruit constituents of "Kalamata" olives during development.

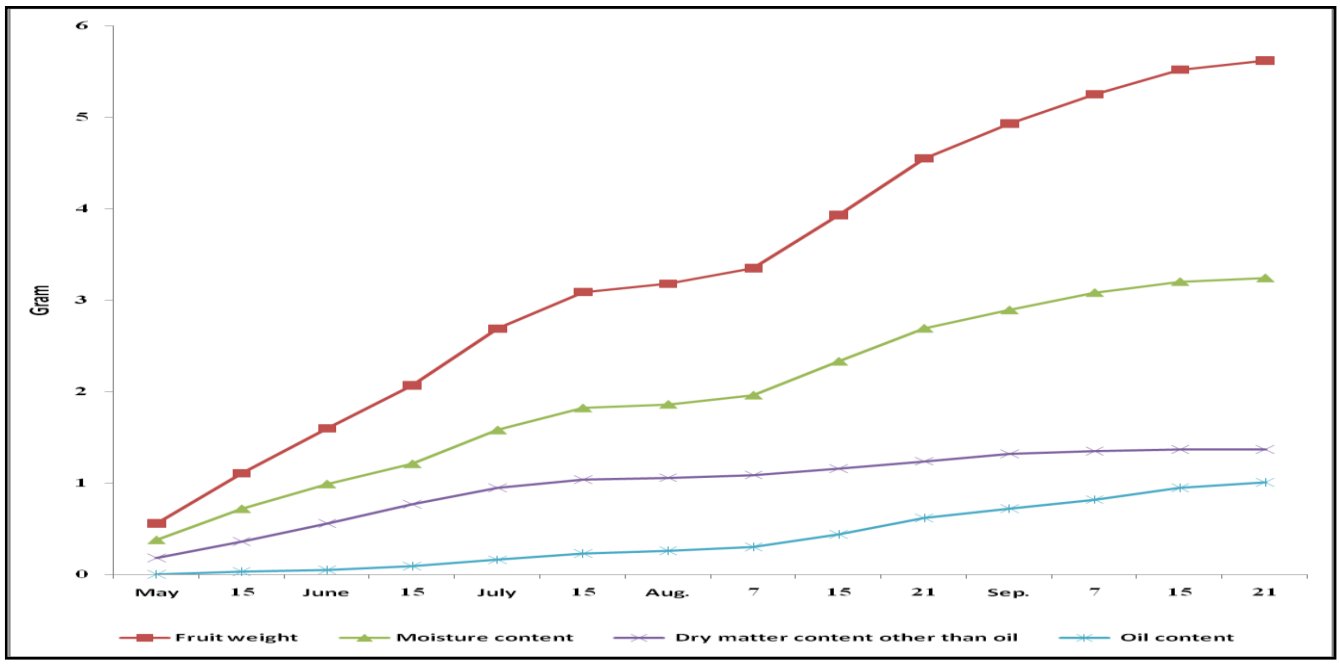
Month	Fruit weight (g)	Increase (%)	Moisture content (g)	Increase (%)	Dry matter content other oil (g)	Increase (%)	Oil content (g)	Increase (%)
May	0.56 j	-	0.38 h	-	0.18 g	-	0.00 h	-
	1.11 i	98.21	0.72 g	89.47	0.36 g	100.00	0.03 h	-
June	1.60 h	44.14	0.99 fg	37.50	0.56 f	55.56	0.05 gh	66.67
	2.07 g	29.38	1.21 f	22.22	0.77 e	37.50	0.09 gh	80.00
July	2.69 f	29.95	1.58 e	30.58	0.95 e	23.38	0.16 fg	77.78
	3.09 ef	14.87	1.82 de	15.19	1.04 cd	9.47	0.23 ef	43.75
Aug.	3.18 e	2.91	1.86 de	2.20	1.06 cd	1.92	0.26 ef	13.04
	3.35 e	5.35	1.96 d	5.38	1.09 cd	2.83	0.30 e	15.38
	3.93 d	17.31	2.33 c	18.88	1.16 bc	6.42	0.44 d	46.67
	4.55 c	15.78	2.69 b	15.45	1.24 ab	6.90	0.62 c	40.91
Sep.	4.93 bc	8.35	2.89 ab	7.43	1.32 ab	6.45	0.72 bc	32.26
	5.25 ab	6.49	3.08 a	6.57	1.35 a	2.27	0.82 b	13.89
	5.52 a	5.14	3.20 a	3.90	1.37 a	1.48	0.95 a	15.85
	5.62 a	1.81	3.24 a	1.25	1.37 a	-	1.01 a	6.32

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

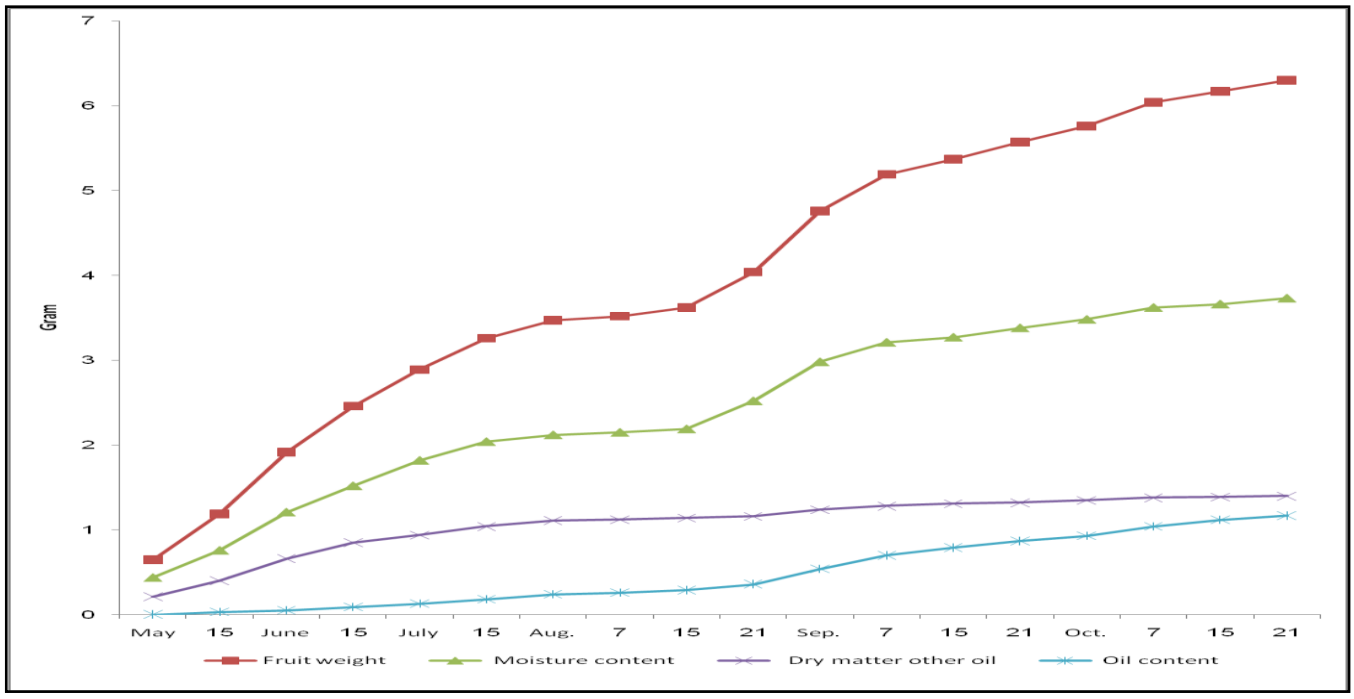
(Table 2): Changes in fruit constituents of "Picual" olives during development.

Month	Fruit weight (g)	Increase (%)	Moisture content (g)	Increase (%)	Dry matter content other oil (g)	Increase (%)	Oil content (g)	Increase (%)
May	0.65 n	-	0.44 l	-	0.21 i	-	0.00 k	-
	1.19 m	83.08	0.76 k	72.73	0.40 h	90.48	0.03 jk	0.00
June	1.92 l	61.34	1.21 j	59.21	0.66 g	65.00	0.05 jk	66.67
	2.46 k	28.13	1.52 i	25.62	0.85 f	28.79	0.09 ijk	80.00
July	2.89 j	17.48	1.82 h	19.74	0.94 ef	10.59	0.13 ijk	44.44
	3.26 i	12.80	2.04 gh	12.09	1.04 de	10.64	0.18 hij	38.46
Aug.	3.47 hi	6.44	2.12 g	3.92	1.11 cd	6.73	0.24 ghi	33.33
	3.52 hi	1.44	2.15 g	1.42	1.12 cd	0.90	0.26 ghi	8.33
	3.62 h	2.84	2.19 g	1.86	1.14 cd	1.79	0.29 gh	11.54
	4.04 g	11.60	2.52 f	15.07	1.16 bcd	1.75	0.36 g	24.14
Sep.	4.76 f	17.82	2.98 e	18.25	1.24 abc	6.90	0.54 f	50.00
	5.19 e	9.03	3.21 de	7.72	1.28 abc	3.23	0.70 e	29.63
	5.37 de	3.47	3.27 cd	1.87	1.31 ab	2.34	0.79 de	12.86
	5.57 cd	3.72	3.38 bcd	3.36	1.32 ab	0.76	0.87 cd	10.13
Oct.	5.76 bc	3.41	3.48 abc	2.96	1.35 a	2.27	0.93 bc	6.90
	6.04 ab	4.86	3.62 ab	4.02	1.38 a	2.22	1.04 ab	11.83
	6.17 a	2.15	3.66 a	1.10	1.39 a	0.72	1.12 a	7.69
	6.30 a	2.11	3.73 a	1.91	1.40 a	0.72	1.17 a	4.46

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



(Fig. 1): Changes in fruit constituents of "Kalamata" olives during development.



(Fig. 2): Changes in fruit constituents of "Picual" olives during development.

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