

STUDY THE ABILITY STORAGE OF SIX OLIVE FRUIT CULTIVARS GROWN IN ZAKHO REGION

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ABSTRACT

Green mature olive fruit (*Olea europaea* L.) of six cvs. (Basheqi, Sorani, Khilkhali, Manzanillo, Chemlali, Frantoio) were harvested from trees grown in Zakho Nursery, Zakho District, Dohuk governorate, Kurdistan region/Iraq. Samples of each cultivar were placed in plastic bags and stored at 6°C and 85-90%RH for three different periods (2, 3 and 4) months to evaluate their postharvest physiology and quality changes. Estimated were made on parameters such as (weight loss, TSS, total sugar, pulp stone ratio, fruit peel color development, dry weight, fruit decay and oil content). The results showed that Basheqi cv. Superior other cvs. in weight loss and dry weight, while sorani cv. surpassed significantly in TSS, total sugars. Khilkhali cv. exceeded in pulp stone ratio and fruit peer color development. Chemlali cv. gave the highest value in oil content and fruit decay. After sweetening the fruit, Chemlali and Basheqi cv. recorded significantly maximum value of oil. Prolonged storage period to 3 and 4 months significantly increased weight loss, TSS, total sugar, pulp stone ratio, fruit peer color development, oil content and fruit decay, while decreased dry weight. The maximum dry weight was obtained when fruit stored for 2 months.

KEYWORDS: Olive fruit, cultivar, storage period

INTRODUCTION

Olive (*Olea europaea* L.) belongs to the family Oleaceae which is one of the oldest agricultural tree crops for remarkable cultural and it is one of the most important plants which have a great economic value. Also it represents a widely distributed fruit tree in the world (FAO, 2008). It can thrive and produce in new reclaimed areas where other crops can't grow; beside the nutritional olive fruits, use as a table or for oil extraction (Garcia *et al.*, 1999). Olive trees are grown in some areas of central and northern of Iraq, Nineveh province, the forefront of other Iraqi provinces in olive production, its cultivation in Nineveh spreading in an area including village of Baashiq, Bahzany, Fadiliya, Sheikh Uday, Dhecan, Sinjar and Aqrah, followed by Babylon, Diyala, Kirkuk, Baghdad, Arbil and Duhok (Central statistical organization, 2015). Hartmann and Opitz, (1977) reported that olive fruit growth is rapid during the first stage; slower during the second stage, in 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 and oil begins to accumulate in the fruit.

Oil production, quantity and quality are greatly affected by many factors i.e., cultivar, oil accumulation and harvesting stage etc. The fruit weight and fruit volume showed continuous increase from the beginning of fruit development till fruit reached its full weight when it was 26 weeks old. However, moisture content in development olive fruits remained constant during the first two weeks, this was followed by intermittent variations until fruit starting to color (reddish-green). At this stage, the moisture content remained constant until the blacking of the fruit (Ezzat and El-Azzouni, 1963).

The importance of olive fruit is due to heavy loading and dietetic value, as the fruit is a good source of vitamins (A, B, C, D, E, and K) and mineral like K, Ca, Mg and P (Ibrahim and Khlaef, 2007). In addition, olive oil is filled with mono-unsaturated fatty acids and has many anti-oxidative characteristic as phenolic acid (Trichopoulou, 1995). The greatest deterioration of olive oil is due to poor handling of the olives during the time between harvesting and processing. Storage of olive fruits is carried out

by simple heaping in fruit piles, waiting their processing. These fruits develop all kinds of degenerative processes in a short period of time (Garcia and Yousfi, 2006). The olive maturation develops for few months by many metabolic processes and transformations that affect phenolic and chemical composition of extracted olive oils (Giuffrè, 2014). Arnon Dag *et al.*, (2012) assessed the effects of olive storage temperature and duration on the resultant oil's quality in three cultivars. Oil acidity increased with storage temperature and time, most markedly in 'Barnea' and least in 'Koroneiki'. Tayfun Agar *et al.*, (1998) studied the evaluate of Black-ripe olives (*Olea europaea* cv. Ascolano, Manzanillo, Mission, and Sevillano), intended for oil extraction, were stored at 5°C for 6-8 weeks to evaluate their postharvest physiology and quality changes. fruit and oil quality of Ascolano and Manzanillo cultivars deteriorated more rapidly than that of Mission and Sevillano olives. Black-ripe Manzanillo and Ascolano olives could be stored with good air circulation at 5°C for 2 and 4 weeks, respectively, whereas Mission and Sevillano cultivars could be stored for 6-8 weeks at 5 °C with maintenance of good fruit and oil quality. Besides volatile compounds, principally associated with a decrease in olive oil sensory quality and other quality markers were affected as well by prolonged olive fruit storage (Vichi, *et al.*, 2009).

Storage is a very important step of any food, including olive oil. In fact, olive oil shelf life can be influenced by different factors, from olive quality to processing technologies, however, the selection of proper storage conditions, including packaging, can be of great importance. The consumer expresses its judgment on olive oil quality considering only some sensory characteristics, such as the more or less pungent taste, fruity and mild flavour and within this context a wide range of preferences can be found, because the sensory quality may match specific dishes, cultural aspects or simple dietary habits. Incorrect storage practices influence the sensory quality of the oil, as rancidity and off-flavours may develop (Piscopo and Poiana, 2012). The degree of excellence of virgin olive oil is directly related to the physiological stage of the fruit when processed, and this is the most important factor determining its level of quality (Canet and García 1999).

The aim of the study is to evaluate the storage ability and fruit quality in term (weight loss,

TSS, total sugar, pulp stone ratio, fruit peel color development, fruit decay, dry weight and oil content) under cold storage conditions of six olives cultivars (Basheqi, Sorani, Khilkhali, Manzanillo, Chemlali, Frantoio) grown in Zakho, Dohuk region.

MATERIALS AND METHODS

Healthy olive (*Olea europaea* L.) fruits from (Basheqi, Sorani, Khilkhali, Manzanillo, Chemlali, Frantoio cultivars) were randomly harvested at green mature stage on 27-10-2019 from tree in Zakho Nursery, Zakho District, Dohuk governorate, Kurdistan region/Iraq. Then harvested fruits were directly transferred to the central laboratory, College of Agricultural Engineering Sciences, University of Duhok. Kurdistan Region-Iraq.

Olives fruit of each cultivar were distributed according to storage period and 3 replicates. The olive fruits of each cultivar randomly placed in polyethylene bags with a capacity of 2 kg, (1kg/boxes for each replicate) and 3replicate for each storage period, in addition 6 replicates were placed for weight loss and physiological disorders, then all fruits stored in cold storage at 6°C with 85-90% RH for 4 months to study the storage fruit behavior of 6 olive cultivars (Basheqi, Sorani, Khilkhali, Manzanillo, Chemlali and Frantoio) in cold storage. Sampling for analysis was carried out with three replicates after each period (2, 3 and 4month storage period) of cold storage. On other hand 3 replicates for every cultivar were analyzed before storage. These physical and chemical measurement were analyzed;

1- Fruit weight loss (%); The weight was determined according to (El-Badawy, 2007).

2- Total soluble solids (TSS %); Total soluble solids were determined with a hand Refractometer.

3- Total sugar (%); was determined according to Lane and Eynon method, (Joslyn, 1970).

4- Pulp / stone ratio; was determined according to Mohsenin (1984)

5- fruit peer color development (%); the percentage of fruit coloration was calculated physically.

6- Dry weight; the dry weight was determined according to (Gobara, 1998).

7- Oil content; By using Soxhlet method according to (A.O.A.C., 1975).

8- Fruits decay (%); Fruit showed any sign of decay were counted. The percentages of fruit

decay were calculated on the bases of total fruit number (Abd-Elghany *et al.*, 2012).

The experiment was laid out as Factorial in Randomized Complete Block Design (RCBD) including 2 factors (6 cvs \times 3 storage period) with 3 replicates for each storage period (Al-Rawi and Khalafallah, (2000). All the data were tabulated and statistically analyzed with computer using (SAS system, 2000).

RESULTS AND DISCUSSION

Weight loss (%)

The obtained results in table (1) revealed that Basheqi cultivar was significantly highest over other cultivars and followed by the Chemlali in

fruit weight loss %. However, the Frantoio cultivar recorded the lowest percentage of Weight loss.

Data appeared that fruit stored for 4 months induced significantly the highest weight loss (%) of fruit in comparison with both 2 and 3month storage period respectively.

As for the interactions between cvs. and storage period had a significant impact on fruit weight loss %, Basheqi cv. fruit stored for 4 month recorded significantly the maximum fruit weight loss % compared to other combination treatments. Frantoio fruit stored for 2 months recorded the lowest weight loss %.

Table (1): Effect of cultivars, storage period and their interactions on weight loss % of olive fruit.

Cultivars	Periods (month)			Effect of Cultivars
	2	3	4	
Basheqi	7.10 h	14.97 de	23.84 a	15.30 a
Sorani	5.93 hi	9.74 fg	16.02 d	10.56 d
Khilkhali	5.85 hi	11.43 f	17.10 c	11.76 c
Manzanillo	4.35 i	6.18 hi	10.94 f	7.16 f
Chemlali	6.65 h	13.56 e	21.83 b	14.02 b
Frantoio	4.23 i	7.96 gh	13.58 e	8.59 e
Effect of Periods	5.68 c	10.64 b	17.37 a	

Means of each factor and their interactions followed by the same letters are not significantly different from each other according to Duncan's multiple ranges test at 5% level.

Total Soluble Solid (TSS %)

The results of table (2) cleared significant differences in TSS (%) between olive cultivars. Sorani cv. showed significantly the maximum TSS (%) in fruit compared with other cultivars.

On the other hand, prolonging the storage period from 3 to 4 induced reduction in fruit TSS (%). Fruit stored for 3 month induced

significantly the highest TSS (%) in comparison with 2 and 4month storage period.

As for the interactions between cv. and storage period had a significant

impact on fruit TSS (%), Basheqi cv. fruit stored for 3 month recorded significantly the maximum fruit TSS (%) compared to most other combination treatments.

Table (2): Effect of cultivars, storage period and their interactions on TSS (%) of olive fruit.

Cultivar	Periods (month)			Effect of Cultivars
	2	3	4	
Basheqi	15.73 ab	16.13 a	13.17 ef	15.01 b
Sorani	14.93 bc	15.67 ab	16.43 a	15.68 a
Khilkhali	12.87 f	12.9 f	11.23 g	12.33 d
Manzanillo	11.4 g	11.57 g	10.07 h	11.01 e
Chemlali	13.87 de	14.57 cd	13.5 ef	13.98 c
Frantoio	13.07 ef	13.37 ef	11.77 g	12.73 d
Effect of Periods	13.64 b	14.03 a	12.69 c	

Means of each factor and their interactions followed by the same letters are not significantly different from each other according to Duncan's multiple ranges test at 5% level.

To that significant difference among the six cultivars on fruit total sugars (%). Sorani cv. predominant significantly in fruit total sugars (%) of other cvs. significantly increasing fruit total sugars %. But when storage period prolonged to 4month fruit total sugars % decreased significantly.

Table (3): Effect of cultivars, storage period and their interactions on Total sugar (%) of olive fruit.

Cultivar	Periods (month)			Effect of Cultivars
	2	3	4	
Basheqi	13.58 ab	13.95 a	11.19 ef	12.91 b
Sorani	12.83 bc	13.52 ab	14.24 a	13.53 a
Khilkhali	10.92 f	10.95 f	9.40 g	10.42 d
Manzanillo	9.56 g	9.71 g	8.31 h	9.19 e
Chemlali	11.85 de	12.50 cd	11.51 ef	11.95 c
Frantoio	11.11 ef	11.38 ef	9.91 g	10.80 d
Effect of Periods	11.64 b	12.00 a	10.76 c	

Means of each factor and their interactions followed by the same letters are not significantly different from each other according to Duncan's multiple ranges test at 5% level.

Pulp stone ratio

The obtained results in table (4) exposed that Khilkhali cultivar was

significantly superior over all other cultivars (Manzanillo, Frantoio, Basheqi, Chemlali and Sorani) in fruit Pulp stone ratio.

The highest total (%) sugar in fruits was recorded in Basheqi cv. fruits and 3 months, and it's significantly higher than the most other interactions, the minimum total sugars (%) showed at the interaction between Manzanillo cv. and 4months storage period.

fruit stored for 3 and 2 month induced significantly the highest fruit Pulp stone ratio respectively in comparison with 4month storage period.

Concerning the interaction between cultivars and storage period, it was appeared that the interaction treatment between Khilkhali cv. and 2month storage was significantly the most promising treatment for fruit Pulp stone ratio. On reverse, the lowest pulp stone ratio was recorded by the combination between Chemlali cv. and 4month storage.

Table (4): Effect of cultivars, storage period and their interactions on Pulp stone ratio of olive fruit.

Cultivar	Periods (month)			Effect of Cultivars
	2	3	4	
Basheqi	4.59 f	4.56 f	3.60 g	4.25 c
Sorani	2.94 h	3.18 gh	3.04 gh	3.05 e
Khilkhali	8.08 a	7.72 ab	7.31 bc	7.70 a
Manzanillo	6.39 de	6.86 cd	6.70 d	6.65 b
Chemlali	3.49 gh	3.51gh	3.25 gh	3.41 d
Frantoio	6.76 cd	6.75 cd	6.08 e	6.53 b
Effect of Periods	5.37 a	5.43 a	5.00 b	

Means of each factor and their interactions followed by the same letters are not significantly different from each other according to Duncan's multiple ranges test at 5% level.

Dry Weight (g)

Table (5) noticed that dry weight (g) were differ among the (Basheqi, Sorani, Khilkhali, Manzanillo, Chemlali and Frantoio) olive cultivars. Basheqi significantly give the maximum dry weight (g) compared to all other cultivars.

On the other hand, the data displayed that prolonged storage period from 2 to 3 and 4 month decreased dry weight (g) significantly.

The highest fruit dry weight (g) was recorded in Basheqi cv. fruit and 2month storage period, which was had a significant higher dry weight (g) than the all other interaction among cultivars and storage period. It was also clear from the results that the lowest fruits dry weight was recorded from the interaction between Chemlali and 4 month storage.

Table (5): Effect of cultivars, storage period and their interactions on dry weight of olive fruit.

Cultivar	Periods (month)			Effect of Cultivars
	2	3	4	
Basheqi	1.10 a	0.86 c	0.73 de	0.90 a
Sorani	0.94 bc	0.77 d	0.69 d-f	0.80 bc
Khilkhali	0.87 c	0.72 de	0.67 ef	0.75 c
Manzanillo	0.61 gf	0.55 g	0.55 g	0.57 d
Chemlali	0.53 gh	0.45 hi	0.44 i	0.48 e
Frantoio	0.97 b	0.78 d	0.70 d-f	0.82 b
Effect of period	0.84 a	0.69 b	0.63 c	

Means of each factor and their interactions followed by the same letters are not significantly different from each other according to Duncan's multiple ranges test at 5% level.

Fruit peel color development from green to red (%)

Table (6) revealed that there was a clear difference among the fruits of the olive cultivars in this study in color development of the fruit peel. Where the highest percentage of color development was observed in

the Khilkhali cultivar. But the lowest fruit peel color % appeared in cultivar Chemlali.

The data of storage period demonstrated that when storage

prolonged from 3 to 4 months recorded significantly increase in fruit peel color. It is worth mentioning that there was no development in the fruit peel color of the all olive cultivars (from green to red color) at the end of the first storage period (2month).

Data reported in the same table illustrate that the highest (100%) development in the fruit peel color recorded in the fruit of Khilkhali at both storage period (3 and 4 month) which was

significant from some interaction treatment. On the contrary, the lowest development in the color of peel fruits was recorded from the Khilkhali cultivar during the same storage periods.

Table (6): Effect of cultivars, storage period and their interactions on peel color development of olive fruit.

Cultivar	Periods (month)		Effect of Cultivars
	3	4	
Basheqi	97.00 ab	94.50 b	95.75 a
Sorani	70.00 d	88.00 c	79.00 c
Khilkhali	100.00 a	100.00 a	100.00 a
Manzanillo	95.00 b	94.50 b	94.75 b
Chemlali	5.00 f	32.00 e	18.75 d
Frantoio	95.00 b	98.00 ab	96.50 b
Effect of Periods	77.00 b	84.58 a	

Means of each factor and their interactions followed by the same letters are not significantly different from each other according to Duncan's multiple ranges test at 5% level.

F

Chemlali cultivar significantly surpasses than Sorani, Manzanillo, Frantoio, Khilkhali and Basheqi cultivars respectively in fruit oil content and gave the highest fruit oil content. While the fruit of Basheqi cv. appeared the lowest Fruit oil content.

It was explained from the data that fruit oil content was significantly increased as the storage period prolonged from 2, to 3 and 4. Fruit stored for 2 months significantly maintained the highest fruit oil content in comparison with other storage periods.

when compared to the fruit oil content at some interaction treatment, it also shows that the interaction between

Basheqi cv. and 2 month storage period gave the lowest oil content in the fruits.

As for the effect of storing fruits for 4 months on the fruits oil content of 6 olive cultivars after sweetening or after pickling, table (8) cleared that Chemlali and Basheqi cultivars fruits recorded significantly maximum value of oil. While, cultivar Manzanillo gave the lowest fruit oil content among other cultivars.

Table (7): Effect of cultivars, storage period and their interactions on oil content of olive fruit.

Cultivar	Periods (month)			Effect of Cultivars
	2	3	4	
Basheqi	36.67 i	38.67 hi	48.83 ab	41.39 d
Sorani	43.33 de	45.17 cd	49.83 ab	46.11 b
Khilkhali	39.20 g-i	40.67 f-h	47.33 bc	42.40 cd
Manzanillo	39.83 gh	42.50 ef	47.67 a-c	43.33 c
Chemlali	50.17 a	48.83 ab	50.17 a	49.72 a
Frantoio	38.17 i	41.67 e-g	50.00 ab	43.28 c
Effect of Periods	41.23 c	42.92 b	48.97 a	

Means of each factor and their interactions followed by the same letters are not significantly different from each other according to Duncan's multiple ranges test at 5% level.

Table (8): Fruit oil content of olive cultivars after stored for 4 months under cold storage and sweetening.

cultivars	Basheqi	Sorani	Khilkhali	Manzanillo	Chemlali	Frantoio
Oil	66.83 a	59.00 b	59.83 b	53.00 c	68.83 a	58.83 b

Means of each factor followed by the same letters are not significantly different from each other according to Duncan's multiple ranges test at 5% level.

Fruit Decay (%)

The result of six (Basheqi, Sorani, Khilkhali, Manzanillo, Chemlali, Frantoio) olive cultivars in table (9) showed different behavior in cold storage in their resistance to deterioration, as it was found that some cultivars endured storage for 4 months without any deterioration on the fruits. Where the highest rate of deterioration in fruits appeared in the cultivar Chemlali.

Fruit decay (%) increased with prolonging the storage period, in which storage of fruit for 2month storage induced a significant reduction in fruit decay compared

to the highest decay in fruit stored for 3 and 4month.

The combinations between cultivars and storage period had significantly impact on fruit decay (%). The interaction between Chemlali and 4month storage period gave significantly the

highest fruit decay compared to other interactions.

All olive cultivars which used in this study were planted in the same location in Zakho Nursery, Zakho District, Dohuk governorate, Kurdistan region/Iraq and subjected to the similar agricultural operations, also harvested at the same stage of fruit maturity, so the differences in fruit quality among fruit of olive cultivars as response to cooled storage appeared that the cultivars showed genetic heterogeneity, as well as cultivars type is one of the most factors which plays an important role in the behavior of fruit during storage (Tehraniifar *et al.*, 2010). Therefore, the variance in fruit parameter among cultivars of olive fruits might be depending on the presence or expression of genes which regulate the enzyme activity and formation (Johnston *et al.*, 2002).

Table (9): Effect of cultivars, storage period and their interactions on decay of olive fruit.

Cultivar	Periods (month)			Effect of Cultivars
	2	3	4	
Basheqi	1.00 c	25.00 b	30.00 b	18.33 a
Sorani	0.00 c	0.00 c	3.00 c	1.00 b
Khilkhali	0.00 c	0.00 c	0.00 c	0.00 b
Manzanillo	0.00 c	0.00 c	0.00 c	0.00 b
Chemlali	0.00 c	25.00 b	60.00 a	28.33 a
Frantoio	0.00 c	0.00 c	0.00 c	0.00 b
Effect of Periods	0.176 b	8.33 a	15.50 a	

Means of each factor and their interactions followed by the same letters are not significantly different from each other according to Duncan's multiple ranges test at 5% level.

CONCLUSIONS

It may be concluded from the results of this study that measured characteristic of all olive cultivars appeared deference behavior as a response to storage period, prolonged storage period to 3 and 4 months increased weight loss, TSS, total sugar, fruit peer color development, oil content,

fruit decay, while decreased dry weight.

The maximum dry weight was obtained when fruit stored for 2 months. It was also noted that the Khilkhali, Manzanillo and Frantoio cultivars were the best in their storage tolerance, as they were stored for 6 months with good quality compared to other varieties.

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دراسة القابليه الخزنیه لسته أصناف من ثمار الزيتون المزروعة في منطقة زاخو

الخلاصة

ثمار الزيتون الخضراء المكتملة النمو (*Olea europaea* L.) لسته اصناف من الزيتون (بعشيقى، صورانى، خلخالى، منزىلو، شملاى، فرانتوىو) تم حصادها من الأشجار الفتيه المزروعة في مشتل زاخو التابعة لدائرة الزراعة / محافظة دهوك إقليم كوردستان/ العراق ، تم وضع العينات من ثمار كل صنف في أكياس بلاستيكية وخزنت على درجة حرارة 6 °م و 85-90٪ رطوبة نسبية لثلاث فترات مختلفة (2 ، 3 و 4) أشهر لدراسة التغيرات الفسيولوجية والنوعية بعد الحصاد. قيمت نوعية الثمار من خلال (نسبة فقدان الوزن للثمار، المواد الصلبة الذائبة الكلية، السكريات الكلية، نسبة اللحم الى البذرة، تطور لون قشرة الثمرة، الوزن الجاف لحم الثمرة، تدهور الثمار ومحتوى الزيت). وأظهرت النتائج الى أن الصنف بعشيقى تفوق على بقية الاصناف في فقدان الوزن والوزن الجاف، بينما الصنف صورانى تفوق معنويا في نسبة المواد الصلبة الذائبة والسكريات الكلية اما الصنف خلخالى فتفوق في نسبة اللحم الى البذرة وتطور لون قشرة الثمار. الصنف شملاى أعطت أعلى محتوى للزيت والتدهور في الثمار. بعد تحلية الثمار الصنف شملاى وبعشيقى سجلت اعلى نسبة للزيت. أدت إطالة مدة التخزين (3 و 4 أشهر إلى زيادة معنوية في فقدان الوزن، والمواد الصلبة الذائبة الكلية، والسكريات الكلية، ونسبة اللحم الى البذرة، وتطور لون قشرة الثمار، ومحتوى الزيت، وتدهور الثمار، بينما انخفض الوزن الجاف لحوم الثمار واعلى وزن جاف للثمار سجل عند تخزين ثمار الزيتون لمدة شهرين.

الكلمات المفتاحية: ثمرة الزيتون، الأصناف، مدة التخزين