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EFFECT OF STORAGE TEMPERATURE AND TREATMENT WITH BENZOIC ACID AND CALCIUM CHLORIDE ON THE STORAGE ABILITY OF OLIVE FRUITS (*OLEA EUROPEAE* L.) CV. KHASTAWI

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Abstract

This study was carried out on olive fruits (*Olea europeae* L.) cultivar Khastawi That were collected from 7-years old olive trees grown in a private orchard situated at Abu al-Khasib region, south of Basra, Iraq to investigate the effect of treatment with calcium chloride and benzoic acid (0.6% sodium benzoate + 2% calcium chloride, 0.12% sodium benzoate + 4% calcium chloride) in addition to control treatment on the storage ability of fruits. Fruits were soaked in the mentioned solutions, then packed in perforated polyethylene bags (16 holes with a diameter of 5 mm weighed 1 kg per bag) and stored at a temperature of 7°C ± 1 in a refrigerated incubator for 4 weeks and at room temperature for 12 days. The results of the study showed that the treatment of 0.12% sodium benzoate + 4% calcium chloride was superior to the rest treatments in reducing the percentage of weight loss of fruits and loss of total chlorophyll of fruits with significant difference from the rest treatments followed by the treatment with 0.6% sodium benzoate + 2% calcium chloride. Untreated fruits recorded the highest percentage of total soluble solids after four weeks of storage. The results indicated that the percentage of weight loss of fruits and total soluble solids increased with an increment of storage periods.

***Key words*:** olive fruits, sodium benzoate, calcium chloride, storage

Introduction

The olive *Olea europaea* L. belongs to the Oleaceae family, which is a perennial tree with a solid trunk. It's leaves are pale green and yields oil fruits with varied colors according to the maturity stage and the date of harvesting from green, yellow to purple red. Olive fruits have a high nutritional value. 19% Carbohydrate, 1.6% protein, 1.5% mineral salts, 5.8% cellulose, various vitamins in addition to their high content of oil 15-20%. The area of the Mediterranean basin and surrounding areas are the original home of the olive (Vossen, 2007).

Olive oil has a high quality and has great nutritional and therapeutic value. It helps to reduce the risk of heart diseases such as coronary heart disease, because of the high percentage of oleic acid, regulates cholesterol in the body and fights strokes and heart attacks, especially if the oil is virgin and with high polyphenols. Olive oil also softens the skin and strengthens the hair (Ismail, 1994; Lanza, 2011).

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Calcium salts are used to increase the hardness of fruits and to treat many of the physiological disorders to fruits and resistance to damage because calcium enters the building of middle lamella of the cell wall and plays an important role in the activation of many enzymes and thus, treatment with calcium salts plays a large role, especially in the postharvest fruits (Taain, 2011; Taain *et al*., 2017). Taain (2011) found that the treatment of jujube fruits with calcium reduced the percentage of weight loss of fruits stored at 5°C compared to the control treatment. The treatment with calcium also delayed ripening.

Due to the lack of studies on the storage of olive fruits that post-harvest treated with a combination of calcium chloride and benzoic acid solutions, the present study was conducted.

Materials and Methods

Olive fruits were obtained from one of the private orchards in Abu al-Khasib region, south of Basrah, from 7-years old olive trees during the growing season of 2018. After washing the fruit with water and leaving it to dry,

the fruits of the same volume were selected and treating with (0.6% sodium benzoate + 2% calcium chloride, 0.12% sodium benzoate + 4% calcium chloride) in addition to control (distilled water only) by immersing in these solutions for 5 minutes. After leaving the fruit to dry, fruits were packed in polyethylene bags weighed 1 kg and perforated (16 hole with a diameter of 6.2 mm per bag) and stored at temperature of 7°C ± 1 in a refrigerated incubator for 4 weeks and at room temperature for 12 days.

The following fruit tests were performed every 7 days at 7°C ± 1° and every 6 days at room temperature.

The weight loss was calculated as a percentage by observed the changes in weight during the storage period using weight balance (Polegaev, 1988).

Total chlorophyll in fruits (mg.100>$^{-1}$) determined according to the method of Zaehringer and his colleagues described in (Goodwin, 1976). Total soluble solids (T.S.S.) of fruit pulps were determined by using hand refractometer and the results were corrected to 20ºC (Shirokov, 1968).

Complete Randomized Design was used with three replicates. The results were analyzed by the analysis of variance and mean values were compared using the Revised Least Significant Difference Test at 0.05 probability (Al-Rawi and Khalaf Allah, 1980).

Results and Discussion

Percentage of weight loss

The results of table 1 showed the effect of fruits immersing into calcium chloride, benzoic acid, storage period and their interaction on the percentage of weight loss of stored olive fruits (7°C). The results showed that these treatments significantly affected on the percentage of weight loss. The highest percentage of weight loss was at control treatment which reached to (1.4%) with significant difference from the rest of the treatments, while the treatment of 0.12% sodium benzoate + 4% calcium chloride gave the lowest percentage of weight loss (0.06%) with a significant difference from the rest of the treatments. As for the effect of the storage period, the percentage of weight loss increased with the increment of storage period reached the highest percentage after four weeks of storage (1.78%). The results indicated to the significance of the interaction between the treatments and the storage period in the effect on the percentage of weight loss of olive fruits, The highest weight loss in fruits was in untreated fruits after four weeks of storage, which amounted to 3.55%.

Regarding to the storage of fruits at room temperature, the results were identical with the previous results. It was noted that the lowest percentage of weight loss was in fruits treated with 0.12% sodium benzoate + 4% calcium chloride which amounted to 2.26% and significantly different from the rest of the treatments, while the highest percentage of weight loss was in control fruits which amounted to 7.13. Results indicated to an increment of weight loss percentage with increasing of the duration of storage reached to 5.30% after 12 days of storage. As for the interaction between the treatments and the storage periods, the highest percentage of weight loss was in untreated fruits after 12 days of storage, which amounted to 7.13%.

Weight loss occurs as a result of water loss by evaporation from the surface of the fruit or as a result of the consumption of food stored due to respiration process or both (Taain, 2005, Taain, 2014). The water content of fruits plays an important role in the postharvest physiology of fruits because the loss of water leads to low turgor

Table 1: Effect of treatment with sodium benzoate and calcium chloride solutions in the percentage of weight loss of olive fruits strored at 7^{0}C ± 1.

Treatments	Storage periods (week)				weeks of treatments
	1	2	3	4	
Control	0	0.26	1.77	3.55	1.4
0.6% sodium benzoate + 2% calcium chloride	0	0	0.12	1.56	0.42
0.12% sodium benzoate + 4% calcium chloride	0	0	0	0.22	0.06
Means of storage periods	0	0.13	0.63	1.78	
LSD 0.05	Treatments = 0.27, storage periods = 1.06, interaction = 1.21				

Table 2: Effect of treatment with sodium benzoate and calcium chloride solutions in the percentage of weight loss of olive fruits strored at 7^{0}C ± 1.

Treatments	Storage periods (day)		Means of treatments
	1	12	
Control	3.33	7.13	5.23
0.6% sodium benzoate + 2% calcium chloride	1.76	5.12	3.44
0.12% sodium benzoate + 4% calcium chloride	0.86	3.66	2.26
Means of storage periods	1.98	5.30	
LSD 0.05	Treatments = 1.15, storage periods = 3.13, interaction = 3.41		

Table 3: Effect of treatment with sodium benzoate and calcium chloride solutions in the percentage of total suluble solids of olive fruits strored at $7^0C \pm 1$.

Treatments	Storage periods				Means of treatments
	1	2	3	4	
Control	14.2	14.6	15	15.3	14.78
0.6% sodium benzoate + 2% calcium chloride	12.4	12.6	12.8	14.4	13.05
0.12% sodium benzoate + 4% calcium chloride	10.7	11	11.2	11.5	11.1
Means of storage periods	12.43	12.73	13.73	14.07	
LSD 0.05	Treatments = 1.89, storage periods = 1.58, interaction = 4.31				

pressure and then withering of fruits, Shirokov (1988) suggests that if fresh fruit cells lose their turgor, their water content can be reduced to 5-7% of their fresh weight.

Percentage of total soluble solids

The results of table 3 indicated that untreated fruits recorded Significant increase in the percentage of total soluble solids reached to 14.78%, while the lowest percentage was in fruits immersed into gave 0.12% sodium benzoate + 4% Calcium chloride which was 11.1%. The results indicate that the percentage of total soluble solids of olive fruits increased with an increment in the storage period until it reached 14.07% after four months of storage. This may be due to the decrease in moisture content as the storage period progresses.

The results showed significant differences between treatment with sodium benzoate + Calcium chloride and storage period in their effect on the percentage of total soluble solids of olive fruits. The control treatment (dipping with distilled water only) showed the highest percentage of total soluble solids after four weeks of storage which was 15.3%, while the lowest percentage of total soluble solids was in Fruits treated with 12% sodium benzoate + 4% calcium chloride after a week of storage which was 10.7%.

When comparing with storage at room temperature (Table, 4), the results showed that the fruits that were treated with water only (control) had the highest percentage of total soluble solids which amounted to 16%, while the treatment of 0.12% sodium benzoate + 4% calcium chloride recorded the lowest percentage of total soluble solids, which was 12%. It is noted that the percentage of total soluble solids of fruits increased with an increment of storage period reached to 14.57% after

Table 4: Effect of treatment with sodium benzoate and calcium chloride solutions on the percentage of total solulble solids of olive fruits strored at room storage temperature.

Treatments	Storage periods (day)		Means of treatments
	6	12	
Control	15	17	16
0.6% sodium benzoate + 2% calcium chloride	12.8	14	13.4
0.12% sodium benzoate + 4% calcium chloride	11.3	12.7	12
Means of storage periods	13.03	14.57	
LSD 0.05	Treatments = 1.36, storage periods = 1.44, interaction = 4.22		

12 days of storage. The highest percentage of total soluble solids was in untreated fruits after four weeks of storage which reached to 17%, while the lowest percentage of total soluble solids was in fruits treated with 0.12% sodium benzoate + 4% % Calcium chloride after six days of storage which was 11.3%.

The increase of the percentage of total soluble solids with the increment of storage period may be due to the decrease of water content of fruits as the storage period progresses. There is an inverse relationship between the content of the fruits of the total soluble solids and the amount of water (Burton, 1982). It is also noticed from the results that the total soluble solids content of the fruits treated with sodium benzoate and calcium chloride was lower compared to untreated fruits. This is probably due to the role of calcium in delaying the maturity of fruits. It is well known that the percentage of total soluble solids increases as fruits make progress towards ripening (Desouki *et al*., 2001).

Total chlorophyll

As shown in table 5 fruit treated with 0.12% sodium benzoate + 4% calcium chloride gave the highest amount of chlorophyll reached to 3.08 mg. $100>^{-1}$, while untreated fruits gave the lowest amount of Chlorophyll 2.62 mg.$100>^{-1}$. The treatment of 6% sodium benzoate + 2% calcium chloride has exceeded the treatment of control. The amount of chlorophyll decreased with the increment of storage period reached to the lowest amount 2.28 mg.$100>^{-1}$ after four months of storage.

The results showed significant differences between the treatments and storage time in the effect of chlorophyll concentration in olive fruits. The highest value was in fruits treated with 0.12% sodium benzoate + 4% calcium

Table 5: Effect of treatment with sodium benzoate and calcium chloride solutions on total chlorophyll (mg.100^{-1}) of olive fruits strored at 7^{0}C ± 1.

Treatments	Storage periods				Means of treatments
	1	2	3	4	
Control	3.22	2.88	2.35	2.03	2.62
0.6% sodium benzoate + 2% calcium chloride	3.33	3.09	2.89	2.26	2.89
0.12% sodium benzoate + 4% calcium chloride	3.45	3.22	3.11	2.55	3.08
Means of storage periods	3.33	3.06	2.78	2.28	
LSD 0.05	Treatments = 0.15, storage periods = 0.87, interaction = 1.33				

Table 6: Effect of treatment with sodium benzoate and calcium chloride solutions on total chlorophyll (mg.100^{-1} dry weight) of olive fruits strored at room storage temperature.

Treatments	Storage periods (day)		Means of treatments
	6	12	
Control	3.07	2.12	2.60
0.6% sodium benzoate + 2% calcium chloride	3.13	2.67	2.90
0.12% sodium benzoate + 4% calcium chloride	3.22	2.78	3.00
Means of storage periods	3.14	2.52	
LSD 0.05	Treatments = 0.35, storage periods = 0.57, interaction = 0.98		

chloride after 1 month of storage which was 3.45 mg/100g.

Results appeared in table 6 showed that the highest concentration of chlorophyll was in fruits treated with 0.12% sodium benzoate + 4% calcium chloride which was 3.00 mg/100g and significantly different from the rest treatments, while the lowest concentration of chlorophyll was in untreated fruits which was 2.62 mg/100g and the results indicated that the concentration of chlorophyll decreased with the continuation of storage period reached to 2.52 mg/100g after 12 days of storage.

The table also showed the significant interaction between the treatments and storage period. The highest value was in fruits treated with 0.12% sodium benzoate + 4% calcium chloride after 1 month of storage that amounted to 3.22 mg/100g.

The retention of stored fruits in a greater quantity of chlorophyll when treated with sodium and calcium chloride may be due to the role of calcium in increasing the hardness of cell walls and thus delay maturation and reduce the effectiveness of chlorophyllase, which worked to decomposition of chlorophyll pigment. This is in agreement with what mentioned by Taain *et al.,* (2016) Calcium chloride has delayed the maturation of jujube fruits and retained the highest concentration of chlorophyll compared with the untreated fruits. The chlorophyll deficiency in fruits with an increment of storage period may be due to the activity of chlorophyllase which destroyed these pigments. This is in constant with Isabel *et al*., (1990) who reported that the amount of chlorophyll gradually decreased as a result of pigments destroy.

Conclusion

It is concluded from the study that immersing of olive fruits cv. Khastawi in solutions of 0.6% sodium benzoate + 2% calcium chloride, 0.12% sodium benzoate + 4% calcium chloride for 5 minutes improved the storage ability of fruits by reducing the loss in fresh weight and retaining the chlorophyll pigments compared to untreated fruits.

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