Plant Archives Vol. 19, Supplement 2, 2019 pp. 226-231 **e-ISSN:2581-6063 (online), ISSN:0972-5210**

EFFECT OF THE HARVEST DATE, STORAGE PERIOD AND PACKAGE ON THE STORABILITY OF DATE PALM (*PHOENIX DACTYLIFERA* L. CV. TABERZAL) FRUITS

Majid Abdulhameed Ibrahim* and Hamzah Abbas Hamzah
Department of Horticulture and Landscape Design, Faculty of Agriculture, University of Basrah, Basrah, Iraq
*For the corresponding author email: majid.abdulhameedl@uobasrah.edu.iq

Abstract

This research was conducted during the growing season of 2017 in the Postharvest Technology Laboratory in the Department of Horticulture and Landscape Design, Faculty of Agriculture, University of Basrah, in order to study the effect of three dates of harvesting (15/7, 1/8 and 15/8), three periods of cold storage (1, 2 and 3 months at 4 ° C temperature) and two methods of packing on the storability of date palm fruits cv. Tabezal that cultivated in Qasim district, Babel government in the middle of Iraq. The results of the study showed that the fruits were harvested at the third date and foiled with polyethylene foil recorded the lowest loss of weight was 0.23% after one month of storage. The fruits foiled with the polythene and that were harvested at the first date recorded the highest water content were 63.26% after one month of storage. The fruits that not covered with polyethylene foil and harvested at the third date recorded the highest total soluble solids and total titratable acidity was 53.73% and 0.413%, respectively after 3 months of storage.

***Keywords*:** Cold storage, Khalal stage, Rutab stage, ripening phase, total soluble solid.

Introduction

The date palm (*P. dactylifera* L.) trees belong to the family of Arecaceae, which includes various species, the most important of which is the date palm, which is spread in tropical, sub-tropical and subtropical regions of the world. Iraq has more than 600 cultivars of the date palm, many of which produce high-quality fruits, making it an important food and economic source in this country (Al-Baker, 1972, Shabana *et al*., 2006). The fruit of date palm is a berry resulting from a single ovarian development and contains one seed surrounded by a thin membrane called endocarp, which separates the pulp of the fruit from the seed (Wrigley, 1995). The results of the studies have shown that the fruits of date palm in the growth and development of the single-sigmoid growth curve, which consists of three stages. The first is the slow stage of growth, which is mainly due to the cell division, and then the fruit enters the second stage of rapid growth, which is mainly due to cell elongation, after which the fruit enters a stage where the growth rate stabilizes (Steady state of fruit growth), until the fruit reaches the third stage of physiological maturity. This third stage called Khalal in date palm fruits (Ibrahim, 1996). The fruits enter in the ripening stage which called Rutab in date palm after end these three stages of growth. The ripening is the changes in the physical and chemical properties of the fruits so that they become edible. The cool storage of date palm fruits is an important storage method currently which used to increase the life of fruits in the Rutab stage for as long as possible, which increases the length of time in local markets (Ibrahim, 1996). The cold storage decreases the bioactivity of fruits, especially respiration rate and ethylene production, and reduces the growth of pathogens (Desouki *et al*., 2001, Mortazavi *et al*., 2010). Fruits differ in their behaviour during storage. They are affected by cultivar type, environmental conditions and agricultural treatments before and after harvest. All these factors are reflected in their effect on the longevity of the fruit in the store (Benjamin *et al*., 1985; Hegazy *et al*., 2003; Hafez *et al*., 2012). The soft cultivars that are cultivated in the middle and south of Iraq are important commercial cultivars with ripening fruits with high nutritional and marketing value. Studies have begun in the field of cold storage of palm fruits in the Rutab stage (ripening phase) for more than 75 years (Yusuf and Abu Ali, 1993; Al-Essawi, 2004; Taain, 2005). The aim of this study is to improve the storability of date palm fruits of Taberzal cultivar by studying the effect of the harvest date, storage period, and package type of fruits.

Materials and Methods

The date palm (*P. dactylifera* L.) fruits took from the Taberzal cultivar palms cultured in the Qasim district of Babil government, middle of Iraq, to the Postharvest Technology Laboratory in the Department of Horticulture and Landscape Design, Faculty of Agriculture, University of Basra, Iraq.

The fruits were harvested in the growing season of 2017 at three stages:

1. The maturation stage (Khalal) after 105 days of pollination for the 15 of July.
2. The stage of the beginning of ripening (Rutab), after 120 days of pollination for 1 of August.
3. The stage of ripening after 135 days of pollination for 15 of August.

The fruits of Taberzal cultivar were washed and cleaned from dust and dirt. The healthy and non-infected fruits were then divided into two parts. The first part of these fruits is placed in plastic containers without foil. The second part of the fruit was placed in plastic containers foiled with 40 microns of low-density polyethylene. The fruits packed in both foiled and non-foiled containers were placed in the cooled incubator at a temperature of 4 ± 2 °C for three months.

The studied characteristics of stored fruits:

(1) Weight loss of fruits (%)

This percentage is calculated from the following equation:

$$\text{Percentage of weight loss} = \frac{\text{WB - WE}}{\text{WB}} \times 100$$

WB: The weight of fruits at the beginning of storage.
WE: The weight of fruits at the end of storage.

(2) Water content (%)

The water content was estimated at the pulp of the ten fruits for every replicate of treatment by placing it in a vacuum oven at 70 ° C for 72 hours. At constant weight, the percentage of water content was calculated as follows:

$$\text{Water content (\%)} = \frac{\text{Fresh weight of pulp (g)} \;\; \text{Dry weight of pulp (g)}}{\text{Fresh weight of pulp (g)}} \times 100$$

(3) Total soluble solids (TSS) %

A total of 5 g of pulp fruits was cut and added 15 mL distilled water and crushed well using a ceramic mortar. The percentage of total soluble solid was estimated using a digital refractometer by taking a drop of juice and placing it on the lens. The readings were adjusted based on the optimum temperature (20 ° C) depending on the method described by Shirokov (1968).

(4) Total titratable acidity (%)

Total titratable acidity was estimated as a percentage according to the method described in A.O.A.C. (1970). The 5 grams of fresh fruit was crushed with 50 ml distilled water using Blender mixer for 5 minutes and then filtered using filter paper. Then, 10 mL of juice was taken and titrated to NaOH (0.1 normality) with phenolphthalein indicator to reach the breakpoint. The results were calculated using the following equation:

$$\text{Water content (\%)} = \frac{\text{T*}(\text{cm}^3) \times \text{Normality of NaOH} \times 0.064}{\text{The volume of juice}(\text{cm}^3)} \times 100$$

*T: The volume of NaOH a necessary for titration (cm^3).

Experimental design and statistical analysis

The experiment was designed using Randomized complete block design (RCBD). The type of experiments for the current study is factorial in three factors. Each treatment repeated ten times. The data were statistically analyzed using variance analysis. The mean of the treatments was compared with the revised-least significant difference, depending on Snedecor and Cochran (1980).

Results and Discussion

Weight loss of date fruit

The results of Table 1 show the effect of harvest date, storage period, package type and their interactions on the percentage of weight loss of the fruits of Taberzal cultivar that were stored at a temperature of 4 ± 2 °C. It is noticed that the date of harvest have a significant effect in reducing the percentage of weight loss, which was the lowest percentage of weight loss of 0.96% in the third date. While the fruits harvested at the first date was the highest weight loss which reached 1.62 %. Perhaps the reason for the decrease of weight loss at the time of the third harvest to the water content in the fruits harvested in the first and second dates was higher than the third date (Ramadan *et al*., 2016). The period of storage has a clear effect on the percentage of weight loss. It is noticed from Table (1) that the percentage of weight loss increased with the increase in storage period. These results were agreed with another study conducted by Zaki *et al*. (2017) on the cold storage of date palm fruits. The fruits recorded the lowest percentage of loss weight 1 was 0.48% after one month of storage period. The highest loss of weight was 2.54% in the fruits of the Taberzal cultivar after 3 months of storage period. The package type had a significant effect in reducing the percentage of weight loss. Fruits foiled with 40 microns of low-density opolyethylene recorded the lowest percentage of weight loss was 1.28%. The highest weight loss was 1.34% in non-covered fruits.

The results showed that the interaction between the date of harvesting and storage period had a significant effect. The lowest percentage of weight loss was 0.21% in the fruits that were harvested on the third date after one month of storage. The highest percentage of weight loss was 3.09% in the fruits that were harvested on the first date after 3 months of storage period. The effect of the interaction between the harvest date and the packing type indicates that the fruits harvested on the third date and foiled with polyethylene were significantly superior in the reduction of weight loss by 0.99%. While the highest percentage of loss of weight was 1.75% in the fruits on the first date and that was not foiled with Polyethylene foil. The results showed that the interaction between the storage period and the packing type had a significant effect. The lowest percentage of weight loss was 0.48% in the fruits foiled with polyethylene foil after one month of storage period. The highest percentage of weight loss was 2.63% in fruits not foiled with polyethylene foil after 3 months of the storage period. The effect of triple interaction between harvest date, storage period and type of packing indicates that the lowest percentage loss of weight was 0.23% in the fruits that were harvested at the third date and foiled with polyethylene foil after one month of storage period. The highest percentage of weight loss was 3.36% in the fruits that were harvested at first date and not foiled with polyethylene foil after 3 months of storage period.

Fruit water content

The results of Table 2 show the effect of the date of harvest, the storage period, the packing type and their interactions on the percentage of water content of fruit pulp at 4 ± 2°C. It is noticed that the date of harvest was a significant effect in the percentage of water content in the fruit pulp. The highest percentage of water content is 49.85% in the pulp of fruits that were harvested on the first date. While the fruits harvested at the third date recorded the lowest percentage of water content was 46.37%. Perhaps the reason for the lack of water content at the pulp of the fruit harvested on the third date is that the water content in the pulp of fruits in the full ripening (Full-Rutab) is less than at the stage of Khalal and the beginning of ripening (Pre-Rutab). The storage period had a significant effect on the water content of the fruit pulp. It was noticed from Table 2 that the percentage of water content decreased with the increase in the length of the storage period. The lowest percentage of water content was 38.07% in the pulp of fruits after 3 months of storage period. This may be due to the fact that storage temperature and low storage humidity resulted in the loss of water content due to differences in vapour pressure of water between inside and outside the fruit (Taain, 1997). The results of this study agreed with the results found by Abbas *et al*. (2005) and Al-Barak (2009). The type of package had a significant effect in raising the percentage of water content. The highest percentage of water content in the fruits foiled with polyethylene foil was 48.58%. The lowest percentage of water content was 46.20% in the non-foiled fruits. This may be due to the fact that the fruits foiled with polyethylene foil do not allow for the loss of water content of the fruit compared to the non-foiled fruits (Taain, 2005). The results of this study agreed with the study of Jasim *et al*. (1999).

The results showed that the interaction between the harvest date and storage period had a significant effect on the water content of the fruit pulp. The fruits that were harvested at the first date recorded the highest percentage of water content was 63.17% after one month of storage period. While the fruits that were harvested at the third date recorded the lowest percentage of water content was 37.13% after 3 months of the storage period. The results of the study from Table 2 indicate that the effect of the interaction between the harvest date and the packing type was significant. The fruits that were foiled with polyethylene foil and harvested at the first date had significantly superior in the percentage of water content reached 49.78%. While the non-foiled fruits that were harvested on the third date recorded the lowest percentage of water content reached 44.06%. The results showed that the interaction between the type of packing and the storage period had a significant effect. The highest percentage of water content was 61.73% in fruits foiled with polyethylene foil after one month of storage. The lowest percentage of water content was 36.66% in the fruits that not foiled with polyethylene foil at 3 months of the storage period. The effect of the triple interaction between the date of harvest, the storage period and the type of packing was significant. The highest percentage of the water content was 63.26% in the fruits that were foiled with the polythene and harvested by the first date after one month of storage. The lowest percentage of water content was 34.26% in the non-foiled fruits with polyethylene and that were harvested at a third date after 3 months of storage period.

The total soluble solids in fruit pulp

The results from Table 3 show the effect of the harvest date, the storage period, the type of packing and their interactions on the percentage of total soluble solids in the pulp of dates palm fruits of Taberzal cultivar that were stored at a temperature of 4 ± 2° C. It is noticed that the date of harvest has a significant effect on the percentage of total soluble solids in the pulp of fruits. The highest percentage of total soluble solid was 41.62% in the pulp of fruits that were harvested on the third date. While the lowest percentage of total soluble solid was 38.14% in the pulp of fruits that were harvested on the first date. It may be due to the low percentage of total soluble solid in the pulp of date palm fruits on the first date was that the percentage of water content in the pulp of the fruit in the Rutab stage is less than in the Khalal and Pre-Rutab stages (Al-Essawi, 2004, Taain, 2005). The storage period had a significant effect on the increase in the percentage of total soluble solid in the pulp of the fruit. Table 3 shows that the total soluble solid content increases with the longest storage period. The date palm fruits of Taberzal cultivar had the highest soluble solids (49.84%) after 3 months of storage period. This may be due to the fact that the total soluble solids in the pulp of ripened fruits were increased at the end of this stage (Ibrahim, 1996). The ripening process is accompanied by numerous chemical changes, particularly those under the control of the enzymes that end with an increase in the dry matter and sugar content of the fruits, which is positively reflected on their soluble solid content. The increase in total soluble solid at the end of the ripening stage may be due to increased accumulation of dry matter and cellular sap concentration. These results had agreed with other studies (Shabana *et al*., 1988; Taain, 1997; 2005). The packing type had a significant effect on the percentage of total soluble solid in the pulp of the fruit. The highest percentage of total soluble solid in the pulp of fruits that were not foiled with polyethylene foil was 41.79%. While the pulp of the fruits covered with polyethylene foil recorded the lowest percentage of total soluble solid was 39.41%. This is due to the low loss of water content of fruits foiled with polyethylene foil compared to non-foiled ones. This change in total soluble solid at the pulp of the fruits is similar to the change in the water content at the fruit pulp (Table 2). As the high water content of the fruits reduced the concentration of the cellular sap, which in turn led to a decrease in the percentage of total soluble solid (Burton, 1982). The results of the study agreed with what found Jasim *et al*. (1999).

The results showed that the interaction between the date of harvest and the storage period had a significant effect on the percentage of total soluble solids. The highest percentage of total soluble solids was 50.86% in the pulp of fruits that were harvested at the third date and after 3 months of storage period. The lowest percentage of total soluble solids was 24.82% in the fruit pulps that were harvested on the first date and after one month of storage (Table 2). The effect of the interaction between the date of harvest and the type of packing indicates that the fruits were harvested on the third date and not foiled with polyethylene foil increased the percentage of total soluble solid at 43.93%. While the total soluble solid percentage of the pulp of fruits that were harvested on the first date and covered with polyethylene foil was 38.21%. The results showed that the interaction between the storage period and packing type had a significant effect. The highest percentage of total soluble solid (51.33%) was in the pulp of fruits that were not foiled with polyethylene foil after 3 months of storage period. The lowest percentage of total soluble solid was 26.26% in the pulp of the fruits that were foiled with polyethylene foil after one month of storage period. The effect of triple interaction between harvest date, storage period and type of packing showed that the pulp of fruits that were not foiled with polyethylene and harvested at the third date recorded the highest total soluble solid was 53.73% after 3 months of storage period. While the pulp of fruits covered with polyethylene foil, that were harvested at the first date recorded the lowest percentage of total soluble solid was 24.73% after one month of storage period.

Total titratable acidity

The results in Table 4 show the effect of the harvest date, the storage period, the type of packing and their interactions in the percentage of total titratable acidity of the date palm fruit pulp of Taberzal cultivar which stored at a temperature of 4 ± 2°C. The highest total titratable acidity was 0.377% in fruit pulp which harvested at the first date and had a significant difference comparison with the two other dates. While the lowest percentage total titratable acidity was 0.367% in fruit pulp which harvested on the third date. Because the titratable acidity of fruit pulp of date palm is high in the stage of Khalal and begin to decline with the entry of fruits in the ripening stage, because of the high rate of respiration in fruits and the consumption of organic acids (Ibrahim, 1996, Zahran *et al*., 2015). The storage period had a clear effect on total acidity in the pulp of the fruit. The results from Table 4 indicate that the total titratable acidity increased with increasing the length of the cold storage period. The highest percentage of total titratable acidity reached 0.382% at the end of the 3 months of storage period. The effect of the packing type showed no significant differences in the percentage of total titratable acidity of the

pulp of fruits between the foiled and non-foiled dates palm fruits by polyethylene foil.

The results in Table 4 showed that the interaction between the date of harvest and storage period had a significant effect. The highest percentage of total titratable acidity was 0.400% in the pulp of fruits which harvested at the third date after 3 months of the storage period. The lowest percentage of total titratable acidity was 0.324% in the fruits that were harvested on the third date after one month of storage period. The effect of the interaction between the harvest date and the type of packing indicates that the fruits that harvested at the first date and not covered with polyethylene foil had an increase in the percentage of total titratable acidity to 0.383%. While the lowest percentage of total titratable acidity was 0.367% in the pulp of fruits that were harvested at the third date and covered with polyethylene foil. The results showed that the interaction between the storage period and packing type had a significant effect. The highest percentage of total titratable acidity was 0.392% in non-covered fruits at 3 months of storage period. The lowest percentage of total titratable acidity was 0.361% in the fruits that were covered with polyethylene foil after one month of storage period. The effect of triple interaction between the harvest date, storage period and type of packing indicated that the highest percentage of total titratable acidity was 0.413% in the pulp of fruits that were harvested at the third date and not covered with polyethylene foil after 3 months of storage period. While the lowest percentage of total titratable acidity was 0.326% in the pulp of fruits that were harvested at the third date and covered with polyethylene foil after one month of storage period.

Conclusion

The fruits of the date palm of Taberzal cultivar, which was harvested on 15 August (after 135 days of pollination, can be stored for three months at a temperature of 4 ± 2 °C when compared to the 15 July and 1 August dates.

Table 1: The effect of harvest date, storage period, packing type and their interactions on the percentage of weight loss in the fruits of Taberzal cultivar at 4 ± 2 °C.

Harvest date	Packing type	Storage period (months)			Harvest date × packing type interaction		
		1	2	3			
15th July	Not covered	0.75	1.13	3.36	1.75		
	Covered	0.73	1.05	3.20	1.66		
1st August	Not covered	0.52	0.95	2.35	1.27		
	Covered	0.48	0.90	2.22	1.20		
15th August	Not covered	0.24	0.63	2.18	1.02		
	Covered	0.23	0.59	2.16	0.99		
					The main effect of harvest date		
Harvest date × storage period interaction	15th July	0.70	1.07	3.09	1.62		
	1st August	0.46	0.88	2.19	1.18		
	15th August	0.21	0.58	2.09	0.96		
					The main effect of packing type		
Packing type × storage period interaction	Not covered	0.50	0.90	2.63	1.34		
	Covered	0.48	0.85	2.52	1.28		
The main effect of the storage period		0.48	0.86	2.54			
R-LSD P≥0.05	Harvest date	Storage period	Packing type	Harvest date × storage period	Harvest date × packing type	Packing type × storage period	Harvest date × storage period × packing type
	0.01	0.02	0.22	0.03	0.80	0.06	0.11

Table 2: The effect of harvest date, storage period, packing type and their interactions on the percentage of water content in the fruits of Taberzal cultivar at 4 ± 2 ° C.

Harvest date	Packing type	Storage period (months)			Harvest date × packing type interaction		
		1	2	3			
15th July	Not covered	61.26	44.36	38.36	48.00		
	Covered	63.26	45.80	40.30	49.78		
1st August	Not covered	59.73	42.56	37.36	46.55		
	Covered	62.36	44.36	38.36	48.00		
15th August	Not covered	57.30	40.63	34.26	44.06		
	Covered	59.56	43.23	38.40	47.06		
					The main effect of harvest date		
Harvest date × storage period interaction	15th July	63.17	46.72	39.67	49.85		
	1st August	62.23	44.54	39.00	48.59		
	15th August	59.09	42.90	37.13	46.37		
					The main effect of packing type		
Packing type × storage period interaction	Not covered	59.43	42.52	36.66	46.20		
	Covered	61.73	44.70	39.31	48.58		
The main effect of the storage period		58.37	45.60	38.07			
R-LSD P≥0.05	Harvest date	Storage period	Packing type	Harvest date × storage period	Harvest date × packing type	Packing type × storage period	Harvest date × storage period × packing type
	0.05	0.08	0.10	0.14	0.17	0.25	0.43

Table 3: The effect of harvest date, storage period, packing type and their interactions on the percentage of total soluble solid in the fruits of Taberzal cultivar at 4 ± 2 ° C.

Harvest date	Packing type	Storage period (months)			Harvest date × packing type interaction		
		1	2	3			
15th July	Not covered	26.73	43.63	49.63	40.00		
	Covered	24.73	42.20	47.70	38.21		
1st August	Not covered	28.26	45.43	50.63	41.44		
	Covered	25.63	42.93	48.76	39.11		
15th August	Not covered	30.70	47.36	53.73	43.93		
	Covered	28.43	44.76	49.60	40.93		
					The main effect of harvest date		
Harvest date × storage period interaction	15th July	24.82	41.27	48.32	38.14		
	1st August	25.76	43.45	48.99	39.40		
	15th August	28.90	45.09	50.86	41.62		
					The main effect of packing type		
Packing type × storage period interaction	Not covered	28.56	45.47	51.33	41.79		
	Covered	26.26	43.30	48.68	39.41		
The main effect of the storage period		27.16	44.08	49.84			
R-LSD P≥0.05	Harvest date	Storage period	Packing type	Harvest date × storage period	Harvest date × packing type	Packing type × storage period	Harvest date × storage period × packing type
	0.05	0.08	0.10	0.14	0.17	0.25	0.434

Table 4: The effect of harvest date, storage period, packing type and their interactions on the percentage of total titratable acidity in the fruits of Taberzal cultivar at 4 ± 2 ° C.

Harvest date	Packing type	Storage period (months)			Harvest date × packing type interaction		
		1	2	3			
15th July	Not covered	0.387	0.390	0.373	0.383		
	Covered	0.383	0.386	0.336	0.377		
1st August	Not covered	0.373	0.377	0.390	0.380		
	Covered	0.373	0.377	0.373	0.374		
15th August	Not covered	0.330	0.360	0.413	0.367		
	Covered	0.326	0.386	0.393	0.368		
					The main effect of harvest date		
Harvest date × storage period interaction	15th July	0.377	0.384	0.371	0.377		
	1st August	0.372	0.373	0.381	0.375		
	15th August	0.324	0.376	0.400	0.367		
					The main effect of packing type		
Packing type × storage period interaction	Not covered	0.363	0.375	0.392	0.377		
	Covered	0.361	0.383	0.376	0.373		
The main effect of the storage period		0.361	0.378	0.382			
R-LSD P≥0.05	Harvest date	Storage period	Packing type	Harvest date × storage period	Harvest date × packing type	Packing type × storage period	Harvest date × storage period × packing type
	0.005	0.008	N.S*	0.013	0.017	0.024	0.041

References

Abbas, K.I.; Jasim, A.M. and Waheed, A.M. (2005). Effect of storage temperature and packing method on the storability and some characteristics of date palm fruits of Deri cultivar. Basrah Journal of Date Palm Research, 4(1-2): 72-87.

Al-Baker, A. (1972). Palm Dates Past and Present and New in Cultivation, Industry and Trade. Al-Ani Press, Baghdad, Iraq, 1085 pp.

Al-Barak, S.H.T. (2009). Effect of storage temperature and calcium in the storability and quality of date palm fruits of Barhee and Hilali cultivars at the Khalal stage. M.Sc. Thesis, College of Agriculture, University of Basrah, Iraq.

Al-Essawi, S.A.A.S. (2004). Effect of gibberellin, liquorice extract and storage temperature on yield and fruits characteristics of Date Palm *Phoenix dactylifera* L. cv.

Zahdi. Master thesis, College of Agriculture, University of Baghdad, Republic of Iraq.

A.O.A.C. (1970). Official Methods of Analysis of The Association of Official Analytical Chemists, Washington, D.C.

Benjamin, N.D.; Al-Khalidi, M.S.; Shabana, H.R. and Marouki, A.S. (1985). Effect of cold storage on the quality characteristics of date palm fruits of six cultivars at the Rutab stage. Journal of Date Palm, 4(1): 1-17.

Burton, W.G. (1982). Post-harvest Physiology of Food Crops. Longman, New York, 310 pp.

Desouki, I.M.; Al-Gezawi, A.M.; Abdul-Adhim, M. and Muntasar, A.S. (2001). The technology of storage and export of horticultural crops. College of Agriculture, University of Ain Al-Shams, Egypt.

Hafez, O.M.; Saleh, M.A. and Nagiub, M.M. (2012). Quality improvement and storability of some date palm cultivars by safe postharvest treatments. Australian Journal of Basic and Applied Sciences, 6(3): 542-550.

Hegazy, M.K.; Fahmy, M.A.; Sobaih, M.A. and Abdul-Samad, M.A. (2003). Effect of some postharvest treatments on Zaghloul date fruits during storage. Proceedings of International Conference on Date Palm. King Saud University, Qassim, Kingdom of Saudia Arabia: 353-362.

Ibrahim, M.A. (1996). The effect of source of pollen of the physiology of ripening of the fruit of the date palm (*Phoenix dactylifera* L.) cv. Hillawi. M. Sc. Thesis. College of Agriculture, University of Basrah, Iraq, 72 pp.

Jasim, A.M.; Taain, D.A.; Obeed, N.A. and Mahdi, A. (1999). Study of the storability of three grape cultivars in the Basrah region. Basrah Journal of Agricultural Science, 12(2): 121-129.

Motazavi, S.M.H.; Arzani, K. and Arujalian, A.A. (2010). Modified Atmosphere Packaging of Date Fruit (*Phoenix dactylifera* L.) Cultivar 'Barhee' in Khalal Stage. Acta Horticulturae, 882: 1063-1070.

Ramadan, B.R.; EL-Rify, M.N.A.; Abd El-Hamid, A.A. and Abd El-Majeed, M.H. (2016). Effect of some Treatments on Chemical Composition and Quality Properties of Saidy Date Fruit (*Phoenix dactylifera L.)* During Storage. Assiut Journal of Agricultural Science, 47(5): 107-124.

Shabana, H.R.; Benjamin, N.D. and Al-Khalidi, M.S. (1988). Effect of harvest date and freezing on the quality of date palm fruits of Zahdi cultivar at the Rutab stage under cold storage conditions. Journal of Research and Water Resources, 2(1): 169-181.

Shabana H.A., Zaid A., Khalil A.A. (2006). Date Palm Fruits Physiology, Harvesting and Handling. FAO, Rome, Italy.

Shirokov, E.P. (1968). Partial Course in Storage and Processing of Fruit and Vegetable USDA/NSF. Washington. D.C, USA. PP: 161.

Snedecor, G.W. and Cochron, W.G. (1980). Statistical Methods. 7th ed. Iowa State University Press, U.S.A., 507 pp.

Taain, D.A. (1997). Effect of thermal treatments and the packing method on the storability of date palm (*Phoenix dacdylifera* L.) fruits of Brim cultivar. M. Sc. Thesis, College of Agriculture, University of Basrah, Iraq.

Taain, D.A. (2005). Effect of packing type and storage temperature on the qualitative characteristics and storage behaviour of date palm fruits of Barhee cultivar. Basrah Journal of Date Palm Research, 4(1-2): 55-71.

Wrigley, G. (1995). Date Palm. In: J. Smart & N.W. Simonds (Eds.) Evolution of Crop plants, 2nd ed. Longman, London. pp. 399-403.

Yusuf, A.K. and Abu Ali, M. (1993). The possibility of Rutab fruits of some date cultivars of Saudi Arabia for conservation using cold and freezing techniques. Palm Research Center. King Faisal University, Hofuf and the Saudi Arabia Kingdom. Publications of the Third Date Palm Symposium, The second volume.

Zahran, A.A.; Hassanein, R.A. and Shaban, A.S. (2015). Quality Characteristics of 'Zaghloul' Date Fruits During Cold Storage as Affected by Postharvest Irradiated Chitosan Treatments. Journal of Horticultural Science and Ornamental Plants 7(2): 71-79.

Zaki, Z.A.; Yousef, A.R.M.; Abd El-Moneim, E.A.A. and Emam, H.E. (2017). Effect of some Natural Extracts on Maintaining Quality of Zaghloul Date Palm Fruits during Cold Storage. Middle East Journal of Agriculture Research, 6(2): 464-473.