



Effect of Packaging Type on Characteristics of Saidu Date Fruits During Refrigerated Storage

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ABSTRACT

A study was conducted during two consecutive seasons 2020/2021 and 2021/2022 to investigate the effect of some types of packaging on the storage capacity and quality of Saidu dates during the refrigerated storage period. Types of packing were packaged with cartons and plastic bags perforated or not perforated. The fruits were stored in cool conditions at 5 ± 10 °C and 85-90%RH. All transactions were randomly sampled every two months for a period of 10 months. The obtained data showed a significant increase in the percentage of loss of fruit decay %, fruit weight, sugar contents, as well as % of total soluble solids with the extension of the storage period. On the other hand, the advanced storage period led to a significant gradual decrease in the weight of the fruits. All packaging treatments with carton bags led to a significant decrease % of damaged fruits and the weight of fruits, as well as compared to the use of other types of packaging. The use of non-perforated plastic resulted in a loss of fruit weight and a lower % of damaged fruits compared to the use of other types of packaging. Packaging whole or seedless fruits in non-perforated plastic bags improved fruit quality during the refrigerated storage period compared to packing whole or seedless fruits in perforated

plastic or cans. It can be concluded that packing the whole fruits in non-perforated plastic bags maintains the freshness of the fruits without any negative effects on the quality of the fruits and it seems that it is the appropriate and ideal type of packaging to prolong the refrigerated storage of Saidu dates without a significant depletion in the quality of the fruits.

Keywords: Cartons, Plastic, packing types, Date palm, storage.

INTRODUCTION

The date palm (*Phoenix dactylifera L.*) is a major crop in arid and semi-arid regions of the world. The Arab Republic of Egypt is considered one of the most productive countries for dates in subtropical world

Date fruits are a high-energy food and a carbohydrate-rich fruit (60-70% sugar, mainly glucose and fructose) and serve as an important superfood (Wrigley, 1995). The total annual global production of dates has reached 8.5 million metric tons, and North Africa and the Middle East countries are the largest producers of dates. Among the top ten date producing countries is Egypt (FAO, 2018).

Date palm fruits play an important role in the dietary pattern of many people, in addition to being a strategic crop in food, chemical and biological production (Khayyat et al., 2007). In addition, date palm plays an important role in maintaining intercropping systems and ecosystem stability (Hasnawi et al., 2011).

Sewy dates in the Arab Republic of Egypt are considered one of the important semi-dry varieties suitable for packaging, storage and processing. In addition, it is considered one of the most important items for export and the local market. Refrigerated storage extends the shelf life of fruits by reducing ethylene production and respiration rate, decreasing the incidence of fruit decay and inhibiting the rate of biological degradation (Kader, 1992).

An important way to expand our exports and enrich our income is to improve the collection, packaging, storage, handling, transportation, marketing and export of dates to foreign markets (Azadi et al 2006).

The loss of date fruit quality resulting from physiological and pathological deterioration increases with increasing storage temperature and moisture content (Yahya 2004). At low temperatures, storing date fruits is one of the most important ways to preserve quality: because they reduce the loss of flavour, color and texture quality; It delays the development of sugar spotting, the spread of insects and

prevents the formation of acidity and syrup in excessively moist date fruits. Dates in the khalal stage should be stored at 0°C, 85°C and 95%RH to delay ripening, reduce water loss to the Routab stage and maintain the quality of their flavor and texture 10-20 minutes, depending on the initial temperature, this requires effective water disinfection and disposal from excess surface moisture of cooled date fruits prior to packing into shipping containers; Thus, forced air cooling is a better choice than water cooling (Kader and Hussain 2009).

The packaging of date fruits protects them from physical damage, moisture absorption or loss, and insect infestation during subsequent handling and storage steps. Dates packages of several types and sizes. Some dates are marketed in flats of wood or fiberboard weighing 15 pounds (approximately 6.8 kg), others in cartons weighing 5 or 10 pounds (approximately 2.3 and 4.5 kg, respectively). Large reinforced cartons are used for packing dry dates fruits, especially for export. Various consumer packages, sizes and shapes are widely used for dates. Storage and transportation at low temperatures is the most important way to preserve the quality of dates (Yahya et al. 2014).

Data such as country of origin, expiry date, weight and quality must appear on package labels (Glasner et al. 2002). Nutritional labels, which are already required on retail packaging by many importing countries of dates, must be added to all retail packaging, including those intended for domestic markets. The use of a perforated plastic liner inside the box reduces water loss during transportation and marketing. The cooling speed and temperature affect physiological phenomena such as the occurrence of sugar crystallization resulting from the rupture of the skin or cell walls, which facilitates the movement of water outside or inside the fruit. This fact is related to the amount of moisture in the fruits. Accordingly, the risk increases when the

amount of humidity exceeds 20% (also at low temperatures) (Glassner et al. 2002).

Packaging plays an important role in maintaining the quality and ensuring the safety of dates. Packaging is an important part in selling products, which is always a major priority for consumers. Moreover, as the packaging communicates with the consumers. Packaging design including shapes and graphics as well as its own functionality for use and convenience can greatly increase sales. Packaging is closely linked with cost and profit. Optimization between cost and damage or loss is an important concept for packaging designs (Chonhenchob et al. 2014).

Major bulk packaging commonly used for fresh dates in most date-producing countries, which are located in North Africa and the Middle East (FAO 2012), including reusable plastic packaging (RPCs), single-use paper packaging (solid fiberboard) or corrugated boxes or trays), wooden packages (crates or crates), baskets made of paper (such as palm leaf) and plastic bags. For the high-end market or for export, the date fruit is usually packed in individual retail packages and sold in packages or as open stock, and placed in corrugated containers or placed directly into corrugated containers with plastic liners for domestic markets .

Cardboard packaging is commonly used for bulk and retail packaging of dates. Different types of packaging styles can also be custom made to meet product and market requirements such as folding carton is the common form commonly used for retail packaging of dates. Cardboard cartons have stacking capacity and attractive printing options. It also helps protect against mechanical forces resulting from pressure, vibration and shocks during storage and distribution. However, this mainly depends on the intended markets as well as the stages of the maturity dates.

Bleached Kraft paperboard can print with higher quality, better contamination/odor protection for food products, and better creasing/cutting properties compared to

unbleached strong Kraft paperboard, but it is more expensive. Cardboard is lower in strength than small flute board and more flexible than standard corrugated board, which is commonly used to make shipping containers. The most common methods are thermoformed trays with plastic lids, or individual wrapping paper for the dates. The complete telescope design container is a two-piece box made with two drawers as the body and lid. Cardboard containers sometimes have a "window" to view the packaged products. Printing and retail packaging design have a significant impact on purchasing decisions (Chunhenchob et al. 2014).

In the main date-producing countries, the refrigerated storage of date fruits has received more attention in recent years. Dates industries usually store dates at 3°C for up to a year. It has gained popularity because it allows dates to be consumed at any time of the year. Refrigerated storage is an essential practice for storing dates. Further research on date fruit quality parameters such as texture, organoleptic characteristics, and appearance is highly recommended (Ismail et al., 2008; Al-Yahya and Al-Kharousi, 2012; Al-Eid, 2013; Al-Eid et al., 2014).

Worldwide many storage technologies are available and are used to extend the preservation and market life of a high quality product and add value to dates in order to increase the economic value of edible products and market competitiveness (Din et al., 2011 and Al. - Yahya and Al-Kharousi, 2012) .

Thus, the main objective of this study was to find out the effect of packing types on the quality of the Saily date fruits and their portability during cold storage.

MATERIALS and METHOD

The present work was carried out on Saily date palm during 2020/2021 and 2021/2022 seasons. The fruits of date palms were collected in the Routab stage in the two experimental seasons. The fruits were immediately transferred to the laboratory of

the Horticulture Department, Faculty of Agriculture, New Valley University. The chosen fruits were of uniform size and color, free from any visible defects, and divided into nine groups, each containing three replicates of 1.0 kg of fruit/repeat in the two experimental seasons as follows:

The Six different treatments were as follows:

1-Packing the whole fruits in carton bags(T1).

2-Packing the whole fruits in non-perforated plastic bags (T2).

3-Packing the whole fruits in perforated plastic bags(T3).

4- Packing fruits without seeds in carton bags (T4).

5-Packaging the fruits without seeds in non-perforated plastic bags(T5).

6-Packaging the fruits without seeds in perforated plastic bags(T6).

The experiment starts on 1 September until 1st July under cold storage at 5°C+1°C with (85±90% R.H.) and the following measurements were determined during the two studied seasons.

Physical characteristics:

1- **Weight Loss %:** This percentage is calculated from the following equation:

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

WB: weight of fruits at the start of storage.

We: Weigh the fruits at the end of storage.

2- Fruit decay: It was determined by counting the number of rotten fruits (physiological or pathological disorders) throughout the ten months and expressed as a percentage of the initial number of fruits for each sample (repeated).

3- Fifty fruits were randomly collected from each replicate and weighed to determine the percentage of fruit flesh, fruit weight and fruit dimensions .

Total Dissolved Solids (TSS%) :

The percentage of total dissolved solids from the edible pulp was estimated by hand refractometer. Three different readings were

recorded for each repeater and the average was calculated (A.O.A.C., 2000).

Total and Reducing Sugars:-

The percentages of total and reducing sugars were determined according to the volumetric method of Lane and Eynon described in A. (2000).

Statistical analyzes:

The least significant difference (L.S.D) test at the 5% level was used to differentiate between means following a completely random design with three replications and with the factor throughout the entire work according to Snedecor and Cochran (1980).

RESULTS

1-Percentage of fruit decay loss and fruit weight:

Figures (1, 2) showed the effect of packing with cartons and perforated and non-perforated plastic bags on the percentage of fruit rot and weight loss in Sady dates during the cold storage period in the seasons 2020/2021 and 2021/2022. The obtained results took a similar trend during the two study seasons.

The data presented in the present figures show that the percentage loss of fruit decay and fruit weight increased significantly with the increase in the cold storage period. At the beginning of cold storage until the fourth month these qualities were slightly increased, then rapidly increased until the eighth month.

The percentage of decomposition and weight loss increased during storage to reach (6.79 & 6.99%) and (10.32 & 9.98%) after ten months. Weight loss was significantly increased and reached (1.41, 2.48, 3.93, 4.77 and 6.79%) and (1.46, 2.57, 3.90 and 4.81 and 6.99%) due to storage for 2,4,6,8 and 10 months during the study period. seasons in a row. The values corresponding to the decay percentage were also obtained (1.82, 3.89, 5.63, 7.51, 10.32%) and (1.92, 3.76, 5.99, 7.52, 9.98), respectively.

In response to the types of packaging, that all fruit packing in cartons led to a significant increase in % of unwanted fruits and the percentage of losing weight of fruits during the

period of refrigerated storage compared to other treatments. The best results appeared in packing the fruits without seeds in non-perforated plastic bags, as it gave the least % of loss of fruit rot and weight of the fruits. In general, packing whole fruits in non-perforated plastic gave the least percentage of rotting fruits loss and fruit weight compared to using other treatments. The weight loss ratio was (60.78 and 59.71) and (56.86 and 46.10%) for using non-perforated bags (T2 & T5) compared to using cardboard bags (T1) during the two study seasons, respectively. The corresponding decrease in fruit decay values

was (58.39 and 75.46%) and (51.06 and 53.69%) during the two study seasons, respectively.

The difference in reducing fruit damage and fruit loss depends on the type of packaging used, as the use of non-perforated plastic bags gave the lowest percentage of spoiled fruits and the least percentage of losing weight of fruits compared to other treatments. The results indicated that packing whole Saidu date fruits in non-perforated plastic proved effective in reducing the percentage of fruit spoilage and weight loss, as well as preserving Saidu dates for a long time.

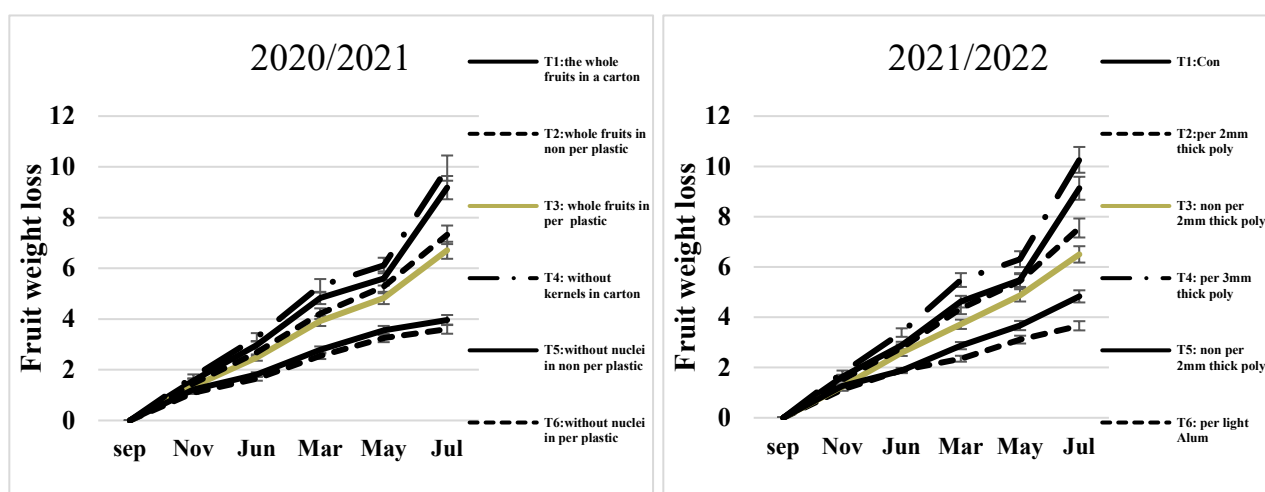


Figure (1): Effect of packing types on the percentage of weight loss of Saidu dates under refrigerated storage conditions for the seasons 2020/2021 and 2021/2022

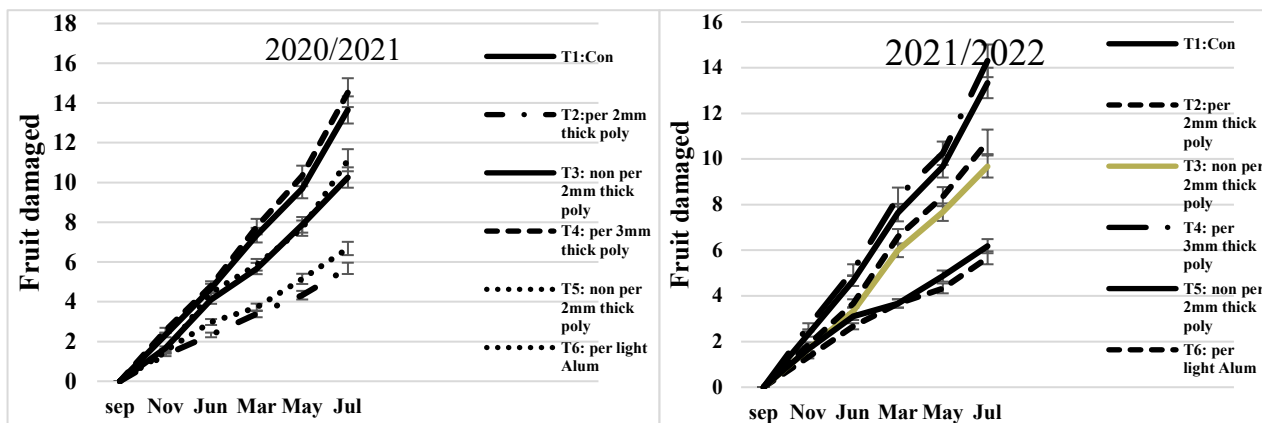


Figure (2): Effect of packaging types on the spoilage of Saidu dates under refrigerated storage conditions during the 2020/2021 and 2021/2022 seasons.

2- Date fruit weight:

The results related to the effect of different types of packaging on the weight of Saidu

fruits during the seasons 2020/2021 and 2021/2022 are listed in Table No. (1). It was clear from the data that results took a similar

trend over the two seasons of the study. Generally, the obtained readings showed a significant decrease in the weight of the fruits during the storage period up to the tenth month. Fruit weight decreased significantly with the advanced storage period, and the lowest value was recorded at 10 months. Fruit weight (9.62, 9.49, 9.38, 9.26, 9.18, 8.99 g) and (9.75, 9.62, 9.51, 9.41, 9.31, 9.13 g) were obtained due to storage for 2,4,6,8 and 10 months during the storage period two seasons of study in a row. Then the percentage of weight loss was (4.57 & 4.51) and (6.54 & 6.36) as a result of storage for eight or ten months compared to the weight of the fruits at the beginning of storage, respectively. According to the effects of packaging type, the data showed that all packaging materials used had a significant effect on the weight of the fruits. Packaging whole fruits in cartons as well as non-perforated or perforated plastic resulted in a significant decrease in fruit

weight compared to packing seedless fruits in non-perforated or perforated cartons and plastic bags. Moreover, packing whole fruits or fruits without seeds in non-perforated plastic bags has less drawbacks as compared to carton packing bags.

The weight of the fruits when packing the fruits with non-perforated plastic (T2) recorded the highest values at the end of the warping period compared to other treatments. On the other hand, as for the weight of the date fruits, the lowest values were recorded for packing the fruits without seeds in a cardboard box (T4) during the two study seasons.

According to the previous results, it can be concluded that packing whole fruits in non-perforated or perforated plastic bags that preserve the weight of the fruits appears to be the appropriate and ideal treatment to prolong the refrigerated storage of Saidy dates without significantly reducing the weight of the fruit.

Table (1): Effect of packing types on fruit weight (gm.) in Saidy dates in cold storage during the seasons 2020/2021 and 2021/2022.

Seasons		2020/2021						2021/2022							
Month(A)	Sep.	Nov.	Jun.	Mar.	May	Jul	Mean	Sep.	Nov.	Jun.	Mar.	May	Jul	Mean	
Treat(B)															
T1	10.18	10.01	9.88	9.69	9.61	9.24	9.77	10.40	10.23	10.10	9.92	9.83	9.45	9.99	
T2	10.35	10.24	10.17	10.10	10.02	9.97	10.14	10.60	10.48	10.40	10.35	10.27	10.21	10.39	
T3	10.58	10.44	10.31	10.17	10.07	9.87	10.24	10.47	10.34	10.20	10.08	9.96	9.79	10.14	
T4	8.62	8.45	8.35	8.21	8.13	7.82	8.27	8.86	8.71	8.61	8.46	8.38	8.06	8.51	
T5	8.93	8.83	8.77	8.70	8.62	8.59	8.74	9.18	9.07	8.99	8.95	8.89	8.84	8.99	
T6	9.05	8.93	8.81	8.70	8.60	8.44	8.76	9.00	8.89	8.77	8.67	8.57	8.43	8.72	
Mean	9.62	9.49	9.38	9.26	9.18	8.99	9.75	9.62	9.51	9.41	9.31	9.13			
NEW	A= 0.26		B= 0.19			AB= 0.49			A= 0.29		B= 0.22			AB= 0.53	
LSD %															

T₁: Packing the whole fruits in a carton

T₃: Packing the whole fruits in perforated plastic

T₅: Packaging the fruits Without seeds in non-perforated plastic

T₂: Packing the whole fruits in non-perforated plastic

T₄: Packing fruits without seeds in carton

T₆: Packaging the fruits Without seeds in perforated plastic

3-Chemical results of the fruits of the dates:

Data were included on the effect of different types of packaging on the chemical components of Saidy date fruit juice during the seasons 2020/2021 and 2021/2022. It was evident from the data in Tables (2, 3, 4) the results took a similar trend during the two seasons of the study.

Remarkably, the obtained data showed that the quality of the chemical fruit juice extract in terms of the content of total sugars and soluble solids increased significantly during the

storage period up to the tenth month. There was a gradual increase with the increase in the storage period, where the highest value of the juice properties was recorded after ten months.

According to the effects of filling types, the obtained data showed that all types of filling significantly increase the properties of chemical juice. Fruit packaging in cardboard bags resulted in a significant increase in the properties of chemical juice compared to fruit packaging in non-perforated or perforated plastic bags.

Moreover, packing seedless fruits in cartons resulted in a significant increase in sugar and total soluble solids contents compared to packing whole fruits in non-perforated plastic bags.

The highest values of sugars and total soluble solids contents were recorded when packing seedless fruits in carton boxes (T4) at the end of the storage period compared to other treatments.

On the other hand, the lowest values for the contents of sugars and total soluble solids were

recorded on the fruits that packed the whole fruits in non-perforated plastic (T2) during the two study seasons. This means that packaging in plastic bags had less of an effect on increasing juice contents.

Based on the foregoing, and according to the results obtained, it can be clarified that packing the fruits with seeds in non-perforated plastic bags maintains the freshness of the fruits.

Table (2): Effect of packing types on TSS% of Saidu dates under cold storage during 2020/2021 and 2021/2022 seasons.

Seasons Month(A) Treat(B)	2020/2021							2021/2022						
	Sep.	Nov.	Jun.	Mar.	May	Jul	Mean	Sep.	Nov.	Jun.	Mar.	May	Jul	Mean
T1	65.76	68.18	69.63	72.88	74.21	76.15	71.14	66.38	69.41	70.89	74.25	75.45	77.68	72.34
T2	65.40	65.96	66.35	68.87	69.76	71.80	68.02	66.73	76.38	67.81	70.28	71.17	73.24	69.44
T3	65.51	66.13	67.33	70.36	71.81	73.55	69.12	67.45	67.53	68.75	71.83	73.46	75.10	70.69
T4	66.10	69.38	70.83	74.11	75.43	77.40	72.21	66.83	70.76	72.14	75.22	76.85	78.63	73.41
T5	65.80	67.15	67.50	70.18	71.11	73.10	69.14	66.58	68.63	69.10	71.53	72.53	74.63	70.50
T6	66.18	67.38	68.55	71.63	73.10	74.85	70.28	66.88	68.89	70.13	73.28	74.57	76.26	71.67
Mean	65.79	67.36	68.37	71.34	72.57	74.48		66.81	68.77	69.80	72.73	74.01	75.92	
NEW LSD %	A=1.31		B=1.29		AB= 3.16			A= 1.45		B= 1.37		AB=3.34		

Table (3): Effect of packing types on Total sugar of Saidu dates under cold storage during 2020/2021 and 2021/2022 seasons.

Seasons Month(A) Treat(B)	2020/2021							2021/2022						
	Sep.	Nov.	Jun.	Mar.	May	Jul	Mean	Sep.	Nov.	Jun.	Mar.	May	Jul	Mean
T1	56.78	58.80	60.11	62.70	64.10	65.48	61.33	57.11	59.68	61.23	63.60	65.56	66.82	62.33
T2	56.45	56.92	57.28	59.48	60.21	61.93	58.71	56.83	57.98	58.45	60.58	61.35	63.11	59.72
T3	56.54	57.10	58.11	60.73	61.93	63.35	59.63	57.18	58.15	59.21	61.82	63.10	64.52	60.66
T4	57.11	59.75	61.13	63.90	65.18	66.81	62.31	57.63	60.73	62.28	65.10	66.25	68.00	63.33
T5	56.88	57.90	58.50	60.55	61.36	63.10	59.72	57.40	58.69	59.53	61.67	62.53	64.28	60.68
T6	56.80	58.15	59.16	61.83	63.10	64.50	60.59	57.28	59.26	60.28	62.81	64.18	65.61	61.57
Mean	56.76	58.10	59.05	61.53	62.65	64.20		57.24	59.08	60.16	62.60	63.83	65.39	
NEW LSD %	A= 1.18		B= 1.10		AB= 2.69			A=1.25		B= 1.18		AB= 2.88		

Table (4): Effect of packing types on Reducing sugar of Saidu dates under cold storage during 2020/2021 and 2021/2022 season.

Seasons Month(A) Treat(B)	2020/2021							2021/2022						
	Sep.	Nov.	Jun.	Mar.	May	Jul	Mean	Sep.	Nov.	Jun.	Mar.	May	Jul	Mean
T1	47.18	48.80	49.90	52.11	53.21	54.18	50.90	47.48	49.10	50.20	52.43	53.50	54.51	51.20
T2	46.86	47.25	47.50	49.38	49.85	51.40	48.71	47.15	47.81	48.22	49.71	50.15	51.73	49.13
T3	46.93	47.41	48.25	50.45	51.40	52.61	49.51	47.22	47.75	48.54	50.83	51.78	52.96	49.85
T4	47.41	49.60	50.78	53.18	54.10	55.46	51.76	47.86	49.95	51.11	53.35	54.43	55.80	52.08
T5	47.21	48.11	48.61	50.25	50.88	52.36	49.57	47.51	48.41	48.96	50.58	51.22	52.86	49.92
T6	47.15	48.30	49.10	51.36	52.35	53.51	50.30	47.45	48.98	49.62	51.68	52.66	53.88	50.71
Mean	47.12	48.25	49.02	51.12	51.97	53.25		47.45	48.67	49.44	51.43	52.29	53.62	
NEW LSD %	A= 1.05		B=0.95		AB= 2.31			A= 0.96		B= 0.98		AB= 2.39		

Discussion

To produce fruits and their quality, there are two vital methods: operation and storage. The

percentage of fruit decomposition was increased and the fresh weight was reduced by extending the storage period. During storage, a

basic problem occurs, which is the loss of water from the fruits due to weight loss and shrinkage, and thus the fruits are damaged and lose their quality (**Ben-Yehoshua, 2005**). The weight of the fruits is lost due to some processes of moisture evaporation inside the fruits, moisture transfer and the respiration process (**Hassan et al., 2014**).

Refrigerated storage and packing type can greatly affect the chemical and physical quality of the date fruit. There were clear statistically significant differences in the weight of the fruits. The physical characteristics such as width, length and weight of the fruit decreased significantly due to the storage period. Packaging type had a significant effect on water activity in dates and soluble solids. The total sugars and soluble solids content in date fruits increased gradually with increasing the length of storage period. It was found that the decomposition of insoluble compounds present in date fruits could have led to a significant increase in the sugar and soluble solids content (**Al-Qahtani et al., 1998; Azlamat et al., 2005**).

Date fruits that were stored at a lower temperature had higher total carbohydrate and soluble solids values compared to dates stored at room temperature by canning (**Wahid et al., 2005 and Aleid et al., 2014**).

Non-perforated or perforated plastic bags are the best medium for good storage of fruits, as they recorded the lowest decay %, highest fruit texture, weight loss % and T.S%. It is also characterized by good appearance, acceptable fruit color and good taste. (**Kafrawy et al., 2018**)

Quality physical features:

The physical attributes of fruit quality are determined by instrumental analysis, texture, which includes texture profile analysis (TPA) measuring hardness, elasticity, chewiness, adhesion, and cohesion. Hardness, chewiness, and elasticity usually increase significantly with a decrease in moisture content, while moisture content decreases and significantly

increases cohesive strength, toughness, and adhesion (**Rahman and Al-Farsi 2005**).

The results also showed that packing the fruits without seeds leads to an increase in weight loss and the percentage of spoilage, with an increase in the fruits content of solids and total sugars, in addition to a decrease in the weight of the fruit. Then reduce the quality and reduce the storage period of the fruits.

This may be due to an increase in the wounds of the fruits due to the extraction of the seeds, and thus an increase in moisture loss, spoilage rate, weight loss, and an increase in the soluble solids content of the fruits and sugars.

Therefore, it is recommended to store the fruits completely and before processing needs to increase the quality of the fruits and prolong the supply period.

Conclusion

It was observed, from the results that were listed above, it can be speculated that the most effective treatment in preserving the quality of the Egyptian date fruits after ten months was packing the whole fruits in non-perforated plastic bags that preserve the freshness of the fruits and extend the refrigerated storage of the fruits. The fruits of Saily dates without the core are of low quality.

References

- A.O.A.C. 2000:** Association of Official Agriculture Chemist. Official method of analysis. 17 Ed., Washington, D.C. U.S.A., 490-520
- Aleid, S. M. (2013).** Date fruit processing and processed products. *Dates: postharvest science, processing technology and health benefits*, 171-202.
- Aleid, S. M., Elansari, A. M., Zhen-Xing, T., & Sallam, A. A. (2014).** Effect of cold storage and packing type on Khalas and Sukkary dates quality. *Advance Journal of Food Science and Technology*, 6(5), 603-608.
- Al-Kahtani, H. A., Abu-Tarboush, H. M., Al-Dryhim, Y. N., Ahmed, M. A., Bajaber, A. S., Adam, E. S. E., & El-**

- Mojaddidi, M. A. (1998).** Irradiation of dates: insect disinfection, microbial and chemical assessments, and use of thermoluminescence technique. *Radiation Physics and Chemistry*, 53(2), 181-187.
- Al-Yahyai, R., & Al-Kharusi, L. (2012).** Physical and chemical quality attributes of freeze-stored dates. *International Journal of Agriculture and Biology*, 14(1).
- Azelmat, K., Sayah, F., Mouhib, M., Ghailani, N., & Elgarrouj, D. (2005).** Effects of gamma irradiation on fourth-instar *Plodia interpunctella* (Hübner)(Lepidoptera: Pyralidae). *Journal of Stored Products Research*, 41(4), 423-431.
- Benjamin, N. D., Al-Khalidi, M. S., Shabana, H. R., & 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.
- Ben-Yehoshua, S. (1985).** Individual seal-packaging of fruit and vegetables in plastic film—a new postharvest technique. *Hort. Science*, 20(1), 32-37.
- Dessouki, I. M., Algizawi, A. M., Abdel Azim, M. M., & Ahmed, S. (2001).** Technology of storage and export of horticultural crops. *College of Agriculture, Ain Shams University, Egypt*.
- Din, Z.U.; Shah, H.U.; Ihsanullah, Zubari, A. and Khan, S.A. (2011).** ESTIMATION OF PHYSICO-CHEMICALS AND MICROBIOLOGICAL LEVELS DURING STORAGE OF IRRADIATED FRESH DATE SAMPLE. *Int. J. Sci. Nat.*, 2: 16-21.
- El-Kafrawy, T. M., Ghazzawy, H., Ahmed, N., & Hikal, D. M. (2018).** Evaluation of quality and storability of “Sewy” date palm cv. in different production areas in Egypt. *Am Eurasian J Sustain Agric*, 12, 30-9.
- FAO, F. (2018).** Food and agriculture organization of the United Nations. *Rome*, URL: <http://faostat.fao.org>.
- Glasner B, Botes A, Zaid A, Emmens J. 2002.** Date harvesting, packinghouse management and marketing aspects. In: Zaid A, editor. Date palm cultivation. FAO Plant Production and Protection Paper No 156. pp 237–67.
- Hasnaoui, A., Elhoumaizi, A., Hakkou, A., Wathelet, B., & Sindic, M. (2011).** Physico-chemical characterization, classification and quality evaluation of date palm fruits of some Moroccan cultivars. *Journal of Scientific Research*, 3(1).
- Hassan, Z. H., Lesmayati, S., Qomariah, R., & Hasbianto, A. (2014).** Effects of wax coating applications and storage temperatures on the quality of tangerine citrus (*Citrus reticulata*) var. Siam Banjar. *International food research journal*, 21(2).
- Hayat, I., Masud, T., & Rathore, H. A. (2005).** Effect of coating and wrapping materials on the shelf life of apple (*Malus domestica* cv. Borkh). *Int. J. food safety*, 5, 24-34.
- Higazy, M., Fahmy, M. A., Sobeih, M. E., & El-Samad, M. A. (2002).** THE EFFECT OF SOME POSTHARVEST TREATMENTS ON ZAGHLOUL DATE FRUITS DURING STORAGE. *Journal of Plant Production*, 27(12), 8579-8590.
- Ibrahim, A. M., & Hajaj, M. N. (1993).** Tamr palm, cultivation and production. Maaref, Alexandria, Egypt.
- Ismail, B., Haffar, I., Baalbaki, R., & Henry, J. (2008).** Physico-chemical characteristics and sensory quality of two date varieties under commercial and industrial storage conditions. *LWT-Food Science and Technology*, 41(5), 896-904.
- Kader, A. A. (1992).** Modified atmosphere during transport and storage. *Postharvest technology of horticultural crops*. (Ed.) A.A. Kader, Univ. Calif. Div. Agr. Nat. Res. Publ. 3311. Oakland, CA pp. 135-144.

- Kader, A. A., & Hussein, A. M. (2009).** Harvesting and postharvest handling of dates. *ICARDA, Aleppo, Syria*, 4, 15.
- Khayyat, M., Tafazoli, E., Eshghi, S., & Rajaei, S. (2007).** Effect of nitrogen, boron, potassium and zinc sprays on yield and fruit quality of date palm. *Am Eurasian J Agric Environ Sci*, 2, 289-296.
- Lamberti, M., & Escher, F. (2007).** Aluminium foil as a food packaging material in comparison with other materials. *Food Reviews International*, 23(4), 407-433.
- Mortazavi, S. M. H., Arzani, K., & Arujalian, A. A. (2010, March).** MODIFIED ATMOSPHERE PACKAGING OF DATE FRUIT (PHOENIX DACTYLIFERA L.) CULTIVAR 'BARHEE' IN KHALAL STAGE. In *IV International Date Palm Conference* 882 (pp. 1063-1069).
- Omama, M. H., Malaka, A. S., & Naguib, 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.
- Rodov, V., Fishman, S., De la Asuncion, R., Peretz, J., & Ben-Yehoshua, S. (1996, September).** MODIFIED ATMOSPHERE PACKAGING (MAP) OF 'TOMMY ATKINS' MANGO IN PERFORATED FILM. In *V International Mango Symposium* 455 (pp. 654-661).
- Snedecor GW, Cochran WG. (1980).** *Statistical Methods* 7th ed. Iowa State Univ. Press. Ames.
- Waheed, A., Gasim, A., & Abbas, K. (2005).** Effect of storage temperature and packing method in storability and some characteristics of date palme c. vdayri. *Basrah Journal For Date Palm Research*, 4(1-2).
- Wrigley, G. 1995.** Date palm (*Phoenix dactylifera L.*) . In: Smartt J, Simmonds NW (eds) *The evolution of crop plants*, 2nd eds. Longman, Essex, 399-403.
- Yahia EM. 2004.** Date. In: Gross KC, Wang CY, Saltveit M, editors. *The Commercial Storage of Fruits Vegetables and Florist and Nursery Stocks*. Agriculture Handbook # 66. Beltsville, Maryland: USDA. 672p.
- Yahia, E. M., Lobo, M. G., & Kader, A. A. (2013).** Harvesting and postharvest technology of dates. *Dates: postharvest science, processing technology and health benefits*, 105-135.