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Original Article

Effect of Some Postharvest Treatment and Storage Conditions on Alfons Mango Fruit Quality

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Abstract

This search studied the effects of some treatments, such as polyethylene stretch, paraffin oil, and salicylic acid (3 mM/L), in an individual form, at cold storage at 10°C ± 1 and 85% RH to prolong the storage period of mango fruits (*Mangifera indica*, L.cv. Alphonse). This experiment was conducted during two successive seasons (2019 and 2020) and demonstrated the influence of these treatments on the physical and chemical characteristics of mango during cold storage. Data illustrated that all treatments extended the storage period of mango until a month with as good condition as possible compared with the control by reducing the respiration rate that induced all the problems that fruits face during the storage period, and saving protective factors for fruits against infection with microorganisms. And not only had that but the storage period of the mango fruits coated, forty days, whereas the control could not reach this period because most of its fruits were spoiled. All treatments achieved the prolonging of mango storage, but the best effect was found in mango wrapped with polyethylene stretch followed by paraffin oil, while salicylic acid did not have a good impact in some characters. This study illustrated that it is preferable for the storage period of mango Alphonse to not exceed one month at a low temperature of not less than 10°C ± 1with 85% RH to get fruit in the best condition by wrapping it with polyethylene stretch, coated with paraffin oil or salicylic acid. Moreover, the best treatment was in fruits wrapped in polyethylene stretch.

***Keywords**: Alphonse Mango, polyethylene stretch, paraffin oil, salicylic acid, cold storage.*

Introduction

The most economically important fruit in the Anacardiaceae family is mango (*Mangifera indica* L.). It is grown commercially in over 80 countries throughout the world because of its appealing color, exquisite taste, and nutritional value. It is a good source of fiber, and antioxidants like ascorbic acid,

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and is high in vitamins. One fruit can provide about half of the daily recommended vitamin C intake, minerals, and carotenoids like provitamin A compound, beta-carotene, lutein, and alpha-carotene, polyphenols like quercetin, kaempferol, gallic acid, caffeic acid, catechins, polyphenols, omega-3, and -6 polyunsaturated fatty acids, and polyphenols. The mango fruits play a major role in balancing a person's diet by supplying 64–86 calories of energy, and they aid in the prevention of many deficiency illnesses (Tharanathan *et al.,* 2006; Nunes *et al.,* 2007).

The mango is a climacteric fruit. Because of its rapid degradation, it has a limited shelf life. This period is defined by the time of harvest and the start of fruit rotting. It can reach the respiration peak of the ripening phase a few days after harvesting at an ambient temperature. (Narayana *et al.,* 1996). This short time severely restricts long-distance commercial transportation of this fruit (Gomez-Lim, 1997). Producers and traders are losing roughly 27% of their crops due to mismanagement, improper storage, or a lack of postharvest technical understanding (Hassan *et al.,* 2010). Ripening is a sequence of biochemical changes that increase the activity of cell wall disintegrating enzymes, such as the production of carotenoids, the degradation of chlorophyll, anthocyanins, essential oils, and flavor components (Narayana *et al.,* 1996).

Because there is a glut of fruits on the market after harvest, it is important to prolong the shelf life of the fruits for the best benefits of both farmers and consumers. Excessive water loss of fruit during the respiration process was frequently the primary cause of fruit quality degradation during transit, storage, and marketing by reducing glossiness, shrivelling, and increasing susceptibility to postharvest infections (Olivas *et al.,* 2008).

By minimizing moisture loss and respiration rate from the fruits in all these ways, the shelf life is prolonged. Skin coating is considered important for extending the storage life of fresh fruits in places where cold storage facilities are not available, by minimizing the range of both size and physiological weight (Baldwin, 1994).

Edible coatings are considered to form a barrier to gas exchange between fruits coated and the ambient atmosphere, so researchers have sparked a lot of interest recently in studying the effect of edible coatings on fruit life (Tripathi and Dubey, 2004). The development of films with selective permeability characteristics, particularly for O_2, CO_2, and ethylene, allows some control of fruit respiration rate and can minimize microbial growth (Cuq *et al.,* 1995).

Paraffin oil is one of the most recommended edible coatings on the surfaces of food products because it is safe, biocompatible, non-toxic, and inexpensive, and thus becomes more advantageous than synthetic materials. The major objective of the paraffin function is to extend both the shelf life of fruit and marketing and also preserve the fruit quality as much as possible and impart a shiny appearance to fruits. Because it can modify the atmosphere around the surface of the fruit during storage by reducing the oxygen available and increasing the concentration of CO_2 to the appropriate limit, this leads to preventing fruit deterioration by reducing all of the water loss, respiration rates, decay, and keeping firmness and maintaining tissue quality, thus delaying senescence (Magashi and Bukar, 2006).

Salicylic acid plays many important roles, such as inhibiting ethylene biosynthesis and acting by blocking the conversion of ACC (1-aminocyclopropane-1-carboxylic acid) to ethylene and suppressing the activity of ACC oxides, causing fruit ripening to be delayed and fruit senescence to be delayed. It also plays a role in local and systemic pathogen resistance, reducing the fruit softening rate, increasing chilling injury resistance, and phenolic compound accumulation, extending the storage life of fruit (Srivastava and Dwivedi, 2000; Zheng and Zhang, 2004; Huang *et al.,* 2008).

Plastic bags or wrappings modify the inner atmosphere of the fruit during storage and provide important functions such as prolonging the shelf-life of fruit, delaying ethylene synthesis, impediment against volatile compounds, water vapor, and gases, allowing for a reduced degree of gas exchange (Arjona *et al.,* 1994; Saftner, 1999).

This research aimed to study the effect of some treatments on mango fruit storage to prolong the shelf life, improve fruit quality during storage, reduce the loss of productivity and decay percentage of fruit, find a solution to the postharvest problems and maintain the fruit quality during long-distance transport.

Materials and Methods

The experiment was conducted during two successive seasons, 2019 and 2020, on mature mango "Alphonse", cv, which was cultivated at Aswan Governorate. The fruits were carefully harvested in the physiological maturity stage, nearly 100 days after the fruit set as recommended by Baloch and Bibi, 2012. The fruits were harvested and transferred directly to the horticulture lab, of the faculty of agriculture, Aswan University.

Fruits that were uniform size, good quality, and free of injury or disease are chosen. Fruits were rinsed with distilled water and cleaned with a 1 percent sodium hypochlorite solution to remove all foreign matter such as dust, dirt, and other contaminants, before being air-dried before use.

The fruits were randomly divided into four groups, each one was treated with the following treatments:

1. Fruits were dipped in distilled water as a control (**T_1**).

2. Fruits were individually wrapped with stretch polyethylene (**T_2**).

3. Fruits were immersed in Paraffin oil for 5 minutes **(T_3).**

4. Fruits were immersed in 3 mM/L salicylic acid solutions mixed with 0.05 percent tween-20 as a surfactant for 5 minutes (**T_4**).

Fruits were air-dried again after treatment, put in plastic boxes, and stored for 40 days at 10°C ± 1 and 85 percent relative humidity. Mangoes were tested for various criteria at 10-day intervals till the storage period ended. Samples of fruits (3 replicates with 2 fruits of each) were taken every 10 days from cold storage until the end of storage to determine the following parameters:

Fruit weight loss %

The difference between each replication's initial and final weight was calculated. The following equation was used to convert it to a percent:

$$\text{Fruit weight loss \%} = \frac{\text{Wi(g)} - \text{Ws(g)}}{\text{Wi (g)}} \times 100$$

Where Wi = The initial weight of the fruit before cold storage, Ws = The weight of the fruit at a period of sampling. *Interval = 10 days for refrigerator

Fruit decay %

All damaged fruits produced by rots, fungus, bacteria, and pathogens were accounted for by the percentage of disordered fruits, and the defects were calculated in the following way:

$$\text{Fruit decay \%} = \frac{\text{Total number of decayed fruits}}{\text{Initial number of stored fruits}} \times 100$$

*Interval = 10 days for refrigerator

Total soluble solid

To estimate the refractive index, a hand refractometer was utilized (A.O.A.C, 1999).

Total acidity

By diluting 10 g of pulp from each fruit with 50 ml of sterile distilled water, the fruit's titratable acidity was evaluated. The titration of 10 ml of the dilution with 0.1 N NaOH was carried out according to the procedure specified by the. The results were calculated using the proportion of citric acid in the samples (g citric acid/100 g fresh pulp weight) (A.O.A.C., 1999).

$$\text{Citric acid (\%)} = \frac{\text{Standard solution (N)} \times \text{base solution (ml)} \times 0.06404}{\text{Total juice volume (ml)}} \times 100$$

*The equivalent weight of citric acid =0.06404
*Juice volume =5 ml

Total sugars

The concentration was computed as g glucose per 100 g and was determined calorimetrically using phenol and sulphuric acid, according to Malik and Singh, 1980. Reducing sugar content according to Miller, 1972.

Statistical analysis

Data were statistically investigated by ANOVA being a factorial experiment in a Completely Randomized Design (CRD). Factor one as treatments and another as storage period, and the means of the treatments were compared using the LSD test based on Gomez and Gomez, 1984 in Statistics 8.1 to compare the means of the three treatments (Analytical Software, 2008).

Result and Discussion

Data demonstrated that mango fruits treated with salicylic acid, paraffin oil, and stretch polyethylene wrapping, stored in cold circumstances, extended their storage period to 40 days while maintaining their characteristics to the greatest extent feasible. While the control could not reach the end of the storage period, it stopped on the thirtieth day. The changes in physical and chemical mango features with storage were used to value the storage duration.

Weight loss %

In general, with a prolonged storage period, the percentage of weight loss was increased. The data in Fig. 1 showed that all treatments gave the lowest rate of weight loss compared with the control and there were significant differences among treatments and between treatments and control. After a month of the storage period, the highest percentage was found in the control (17.5, 19.4%) while T4 was recorded (9.1, 10.7%) followed by T3 (4.98, 5.7%) and then T2 (4.5, 4.79%) in both seasons, respectively. After 40 days, the highest percentage was found in T4 (14.5, 16.5%) followed by T3 (7.49, 7.7%) and then T2 (6.13, 6.6%) in the two seasons, respectively. So, fruits that were wrapped in stretch polythene had the best effect on reducing the weight loss%.

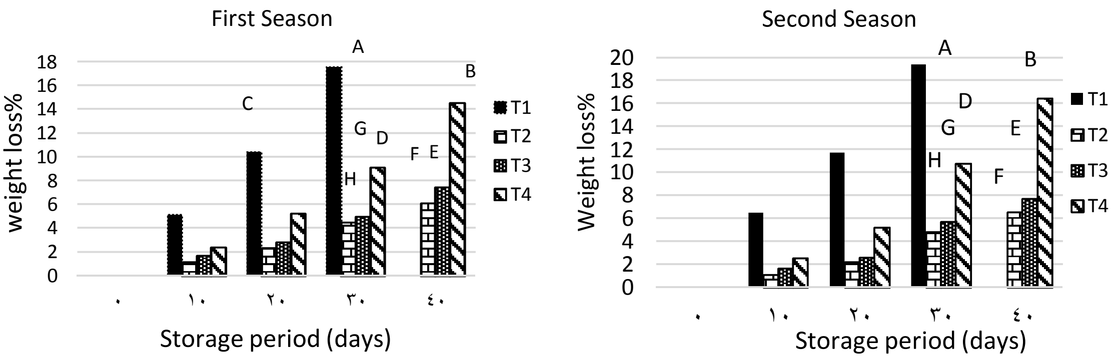

Fig. 1. The influence of salicylic acid at 3 mM/L, stretch polyethylene wrapping, and Paraffin oil on weight loss % during cold storage (10 ± 1°C and 85% RH.) on "Alphonse" mango fruits in 2019 and 2020 seasons. *Means separation by LSD tests at P ≤ 0.05. The same letters within columns are not significantly different. Ascending order starts from (A) means the lowest value until reaches the letter which has the highest value.

The fruit is considered an organism that continues the respiration process even after being harvested. At harvest, the fruit begins to lose moisture because of metabolic activity, respiration, and transpiration (evaporation of water). This results in a loss of both moisture content and weight of the fruit, which has a negative impact on the fruit quality, making it unfit for commercialization. The water loss begins firstly from the peel and then from the pulp. So, the peel is responsible for most of the water loss. Water loss or evaporation takes time depending on the thickness of the fruit skin, the temperature, and the length of storage. If the fruit has thick skin and is stored at low temperatures, it will take longer for the water to evaporate. Weight loss from fresh fruits and vegetables is mostly caused by vapor pressure at various sites, adding to that, respiration also contributes to weight loss (Yaman and Bayoindirli, 2002).

The effect of the coating as a semi-permeable barrier against O_2, CO_2, moisture, and solute transport, reducing respiration, water loss, and oxidation reaction rates, was most likely responsible for the reduction in weight loss. Our findings corroborate those of others (Hafez *et al*., 2007; Sakhale and Kapse, 2012).

Salicylic acid inhibits ethylene production and/or activity and forms complexes with organic molecules in the cell wall of epidermal cells, conferring resistance to degrading enzymes. Salicylic acid extends storage life by decreasing ethylene biosynthesis, respiration, and transpiration, as well as water loss and decays infection through stomatal closure of the fruit surface, preserving firmness, and delaying the Senescence stage by preventing polyphenol oxidase activity (Srivastava and Dwivedi, 2000; Zheng and Zhang, 2004; Abdel Salam, 2016).

Paraffin makes a modified atmosphere inside the fruit by reducing the oxygen content and enhancing the carbon dioxide and therefore, decreases the fruit's respiration rate and improves the postharvest life which permits to prolong of the marketing and storage period for the fruits (Magashi and Bukar, 2006).

Polyethylene stretch can modify the atmosphere around the fruits by reducing oxygen and raising CO_2, resulting in a decrease in the rate of respiration and weight loss (Mangaraj *et al*., 2011 and Caleb *et al*., 2012).

Fruit decay %

There is a direct relationship between the increase in the storage period and the decay rate. Data in Fig. 2 showed that all treatments had a positive effect to reduce the percentage of decay compared with the control which gave the highest rate of decay during the storage period. All treatments gave significant differences among them and compared with the control in both seasons.

After 30 days, T2 did not record any value of decay while, T3 was recorded (9.6, 9.5%) followed by T4 (36.3, 27.6%) compared with the control gave the highest value (45.4, 36.3%). At the end of the storage period, T2 recorded the lowest value (12.6, 9.7%) followed by T3 (22.3, 18.4%) and T4 (54.1, 62.4%) whereas the control recorded the highest value (73, 83%) in two successive seasons.

Fruit degradation after harvest is primarily caused by fungi, due to the low acidity of the fruit, which provides weak resistance to bacterial invasion (Pitt and Hocking, 1999). The edible coating forms a thin layer on the fruit surface resistant to microbial effects and Polyethylene makes full coverage of fruit which isolated fruit from the atmosphere ambient and then protects the fruit from decay.

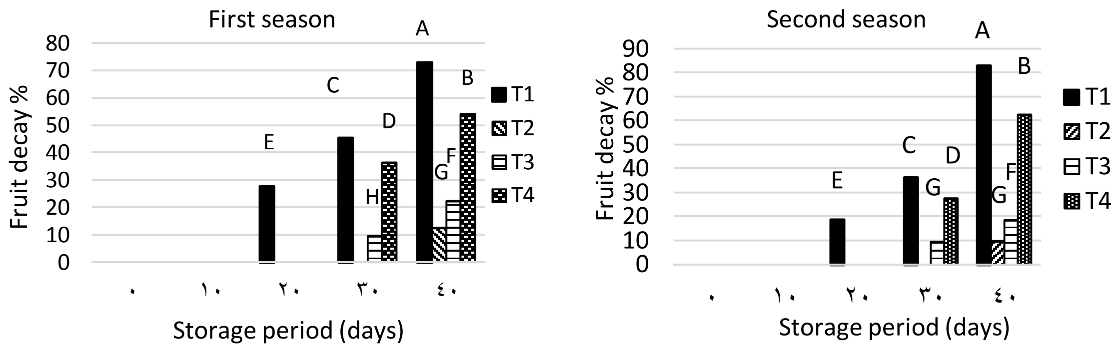

Fig. 2. The influence of salicylic acid at 3 mM/L, stretch polyethylene wrapping, and Paraffin oil on fruit decay % during cold storage (10 ± 1° C and 85% RH.) on "Alphonse" mango fruits in 2019 and 2020 seasons. *Means separation by LSD tests at P ≤ 0.05. The same letters within columns are not significantly different. Ascending order starts from (A) means the lowest value until reaches the letter which has the highest value.

Reduced internal oxygen levels may have directly affected fungal metabolism, limiting the fungus' ability to infiltrate fruit tissues.

Based on the current research, indicates that treating mangoes with an edible coating may have the ability to lessen the severity of anthracnose losses and delay the Physico-chemical changes in mango fruit. Furthermore, the coating reduces O_2 exchange and increases CO_2, delaying metabolism by inhibiting ethylene, resulting in a delay in mango ripening, pathogen elimination of mango fruits, and prolonged shelf life (Bai *et al.*, 2003; Hagenmaier, 2005; Boonyakiat *et al.*, 2007).

Exogenous salicylic acid has been utilized to improve postharvest quality, lengthen shelf life, control infections, and alleviate physiological abnormalities during storage (Asghari and Aghdam, 2010). Silicon is a beneficial nutrient for plants, protecting them against a variety of illnesses. It confers resistance to certain diseases through the physical block created by the deposition of this element under the cuticle and on the epidermal cell wall or through the enhancement of defined mechanisms such as the production of phenolic compounds, which increases lignification and promotes cell wall strengthening to control many diseases in plants (Lopes *et al.*, 2014).

Salicylic acid has been found in recent research to be a potent alternative to those pesticides in delaying the ripening process and minimizing post-harvest losses. SA is a plant hormone that belongs to a group of phenolic chemicals that are prevalent in plants. It regulates a range of physiological processes in plants. Numerous studies have explored its impact on delaying fruit ripening, softening, reducing disease resistance, and reducing disease incidence (Raskin, 1992).

TSS

Data in Fig. 3 demonstrated that TSS increased in parallel with the prolonging of the storage period. Untreated fruit had a maximum level of TSS compared with treated fruit. After 30 days of the storage period, the control (18, 17%) had the highest rate followed by T4(15.5, 16.2%) while the lowest rates were found in T2 (14.3, 14.7%) and T3 (13.8, 14%) with a significant difference between them but there was an insignificant difference between T2 and T3. After 40 days of storage, the highest rate was found in T4 (18.3, 18.2%) and the lowest rates were found in T2 (15.5, 15.3%) and T3 (15, 15.2%) with a significant difference between them but there was an insignificant difference between T2 and T3. This data was in two successive seasons, respectively.

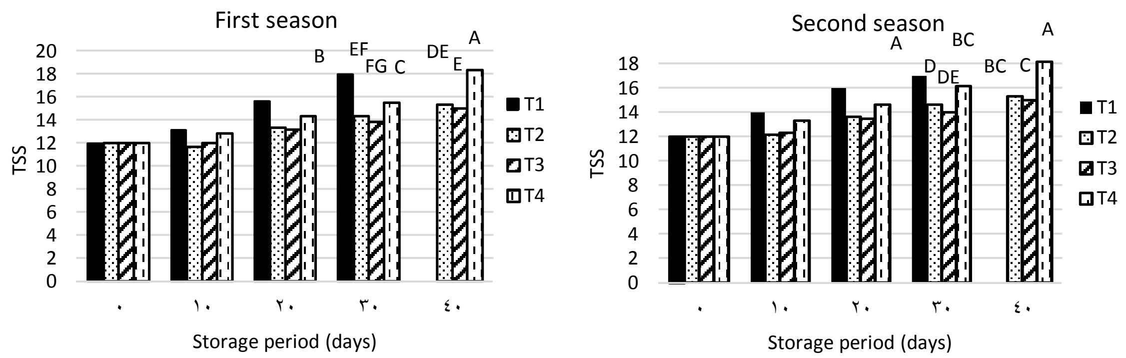

Fig. 3. The influence of salicylic acid at 3 mM/L, stretch polyethylene wrapping, and Paraffin oil on TSS % during cold storage(10 ± 1° C and 85% RH.) on “Alphonse” mango fruits in 2019 and 2020 seasons. *Means separation by LSD tests at P ≤ 0.05. The same letters within columns are not significantly different. Ascending order starts from (A) means the lowest value until reaches the letter which has the highest value.

The increment of TSS of fruit during the storage period was due to losses in water through respiration and evaporation; hydrolysis of starch into sugar because of the behavior of sucrose phosphate synthase (SPS), a crucial enzyme in sucrose production, and this enzyme is stimulated by ethylene, and the conversion of soluble pectic acid from insoluble protopectin during the senescence process (Asghari and Aghdam, 2010; Abd El-Motty-Elham & El-Faham-Sawsan 2013).

Data explained that the fruits treated with paraffin and wrapped with polyethylene had a low percentage of soluble solids compared with fruits treated with salicylic acid. This is due to that paraffin formed a layer on the fruit surface and thus reduced the respiration rate, evaporation rate, and water loss compared to other treatments. As for polyethylene, it covers the entire fruits and reduces the percentage of oxygen around the fruits, and increases the carbon dioxide inside the fruits to the permissible limit, thus reducing the rate of respiration, weight loss, and transpiration (Kader *et al.*, 1989; Cuq *et al.*, 1995; Nakasone and Paull,1998; Saftner, 1999; Magashi and Bukar, 2006).

Acidity%

Basically, with an increasing storage period, acidity decreased gradually. In the first season after 30 days, the highest rate of acidity was found in T2 and T3 (1.65, 1.67%) without significant differences and the lowest rate was found in the control (0.69 %).

On the fortieth day, control did not reach the end of storage; the acidity gave the highest rate in T2 (0.81%) and then, T3 (0.71%) with significant differences, and the lowest rate was found in T4 (0.49%). In the second season, there was a significant difference between T2 and T3 (1.32, 1.26%) on the thirtieth day then T4 (0.95%) compared with control (0.44%). At the end of storage, there was an insignificant difference between T2 and T3 (0.75, 0.71% but T4 (0.59%) gave the lowest rate.

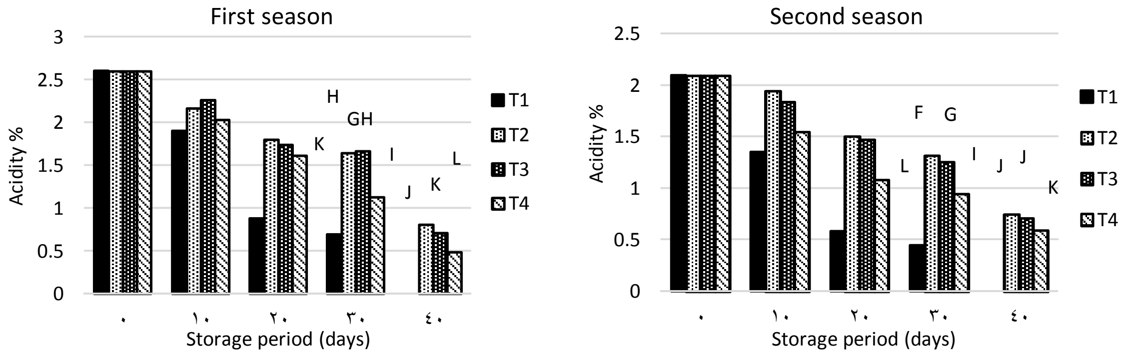

Fig. 4. The influence of salicylic acid at 3 mM/L, stretch polyethylene wrapping, and Paraffin oil on acidity% during cold storage (10 ± 1°C and 85% RH.) on “Alphonse” mango fruits in 2019 and 2020 seasons. *Means separation by LSD tests at P ≤ 0.05. The same letters within columns are not significantly different. Ascending order starts from (A) means the lowest value until reaches the letter which has the highest value.

The fruit's acidity is the main factor in determining its quality and acceptability. Extremely high or low rates of acidity, are not among the conditions for the quality of the fruits. Citric acid is the primary acid found in mango fruit. The main reason for the reduction of acidity in fruits during storage; is respiration. Whereas, organic acids were considered the essential factor in the enzymatic reactions of respiration, and therefore the acidity rate within the fruits decreases (Yaman and Bayoindirli, 2002).

Data in Fig. 4 implied that the coating might limit changes in the amount of TA and reduce its decomposition in the fruit; because it preserves the fruit in a state of adaptation, resulting in an increase in CO_2 to the appropriate extent, which inhibits the activity of ethylene and delays ripening. (Bai *et al*., 2003; Nabigol and Asghari, 2013). In addition, storage at low temperatures reduced the destruction of acidity in the fruits (Medlicott *et al*., 1987).

Total sugars

Data in Fig. 5 showed that total sugar content increased whenever; the storage period increased. Total sugar content was continued increasing during all storage periods of all treatments compared with the control which gave trivially increased and then was decreased at 30 days of storage. On the thirtieth day, the highest value was recorded in T2 (15.4, 15.3%) and the lowest value was recorded in the control (14.6, 14.7%) while there was an insignificant difference between T3 (15, 15.1%) and T4 (14.9, 14.8%). On the fortieth day, the biggest value was found in T2 (15.5, 15.32%) followed by T3 (15.1, 15%) and T4 (15, 14.9%) and there were trivial differences between them in two successive seasons, respectively.

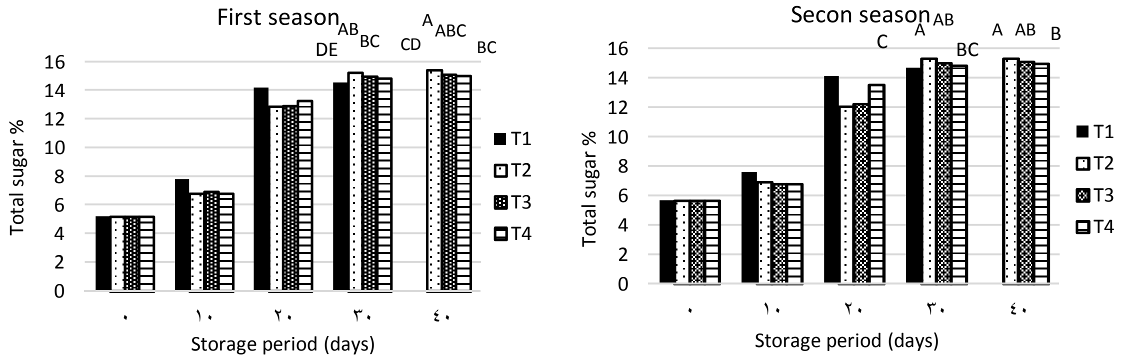

Fig. 5. The influence of salicylic acid at 3 mM/L, stretch polyethylene wrapping, and Paraffin oil on total sugar % during cold storage (10 ± 1° C and 85% RH.) on "Alphonse" mango fruits in 2019 and 2020 seasons. *Means separation by LSD tests at P ≤ 0.05. The same letters within columns are not significantly different. Ascending order starts from (A) means the lowest value until reaches the letter which has the highest value.

One of the most basic factors for evaluating the maturity of fruit is its total sugar content. Total sugars increased significantly in all treatments except control during storage, as treatments during storage delayed the rate of respiration, transpiration, and other metabolic processes (Gul *et al.*, 1990). All treatments had insignificant differences in the total sugar content of the fruits. The starch is converted to sugar throughout the storage period accounts for the increase in total sugar content. The multiplication of enzyme activity responsible for starch hydrolysis and sugar breakdown due to respiration is credited with the notable increase in total sugar concentration during storage. The decline of total sugar parallels with decreased other organic acids during storage because they are the primary substrate for respiration (Wongmetha *et al*, 2015).

Reducing sugar

Data in Fig. 6 proved that reducing sugar increased with the increment of the storage period and it began to decrease after a certain period. All treatments had a positive effect on increasing reducing sugar compared with the control which gave the lowest effect. After thirty days of storage, the highest rate was found in T2 (5.2, 5.3%) and T3 (5.0, 5.2%) there was a trivial difference between them followed by T4 (4.91, 4.92%) while the lowest rate was found in the control (4.82, 4.6%) in two successive seasons, respectively. On the fortieth day, the control could not reach the end of the storage; whereas, the biggest value was found in T2 (5.46, 5.56%) then T3 (5.2, 5.4%) after that T4 (5.1, 5.2%), and there were significant differences among them in two successive seasons, respectively.

The increase of the reducing sugars in fruits during storage might be due to the rapid transformation of starch into less complex sugars such as sucrose, glucose, and fructose, "which are considered the main sugars in mango fruit" because of a reduction in both moisture and acidity by physiological changes during fruit storage. Water loss, starch dissolution, and sugar accumulation are all slowed by the edible coating (Duan *et al.*, 2011; Silva *et al.*, 2017).

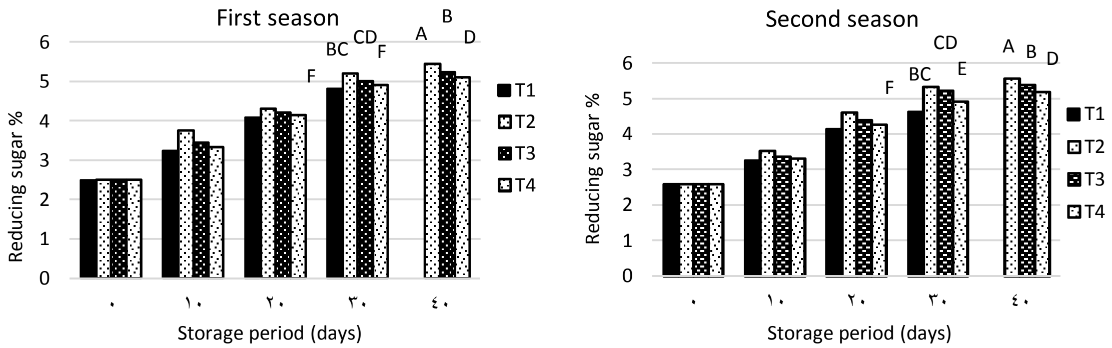

Fig. 6. The influence of salicylic acid at 3 mM/L, stretch polyethylene wrapping, and Paraffin oil on reducing sugar % during cold storage (10 ± 1° C and 85% RH.) on "Alphonse" mango fruits in 2019 and 2020 seasons. *Means separation by LSD tests at P ≤ 0.05. The same letters within columns are not significantly different. Ascending order starts from (A) means the lowest value until reaches the letter which has the highest value.

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تأثير بعض معاملات ما بعد الحصاد وظروف التخزين على جودة ثمار المانجو الفونس

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الملخص

في هذا البحث تم دراسة تأثير بعض المعاملات مثل البولي إيثيلين استرتش وزيت البرافين وحمض الساليسيليك على ثمار المانجو صنف الفونس

مع التخزين في درجات الحرارة المنخفضة عند 10 درجات مئوية ± 1 و85٪ رطوبة نسبية لإطالة فترة تخزينها. أجريت هذه التجربة خلال موسمين متتاليين (2019، 2020) وأظهرت تأثير هذه المعاملات على الخصائص الفيزيائية والكيميائية للمانجو أثناء التخزين. أوضحت البيانات أن جميع المعاملات أطالت فترة تخزين ثمار المانجو حتى شهر في حاله جيدة بقدر الإمكان مقارنة مع التحكم عن طريق تقليل معدل التنفس الذي يتسبب في جميع المشاكل التي تواجهها الثمار خلال فترة التخزين وتوفير الحماية للفاكهة من الإصابة بالكائنات الحية الدقيقة. وليس هذا فقط ولكن فترة تخزين ثمار المانجو المعاملة وصلت الي أربعين يومًا بينما لم تستطع الثمار الغير معامله الوصول الي هذه الفترة حيث حدث تدهور في الثمار. حققت جميع المعالجات زيادة في إطالة تخزين المانجو ولكن أفضل تأثير وجد في المانجو المغلف بستيك البولي إيثيلين متبوعًا بزيت البرافين بينما؛ حمض الساليسيليك لم يعطي تأثيراً جيداً في بعض الصفات. أوضحت هذه الدراسة أنه يفضل ألا تزيد مدة تخزين مانجو ألفونس على شهر في درجات حرارة منخفضة لا تقل عن 10 درجات مئوية ± 1 مع 85٪ رطوبة نسبية للحصول على ثمار بأفضل حالة اما مغلفة بمادة البولي إيثيلين او بزيت البرافين أو حمض الساليسيليك. لكن أفضل معاملة كان في الثمار الملفوفة في مادة البولي إيثيلين.