Effect of some anti- transpiration on the storage traits of two tomato cultivars

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Abstract

A storage experiment was conducted on the fruits of two (hybrid) cultivars of tomatoes grown inside plastic tunnels obtained from one of the private farms in Khan Bani Saad district during the spring agricultural season 2020-2021. The study included the use of two factors, namely the cultivar and the waxing of the fruits, to know the effect of these factors on the storage traits of the fruits of these two cultivars of tomatoes. The second cultivar is the Siemens cultivar, which is a hybrid. Its fruits are of medium size, with high specific weight, high hardness, and bright red color. As for the fruit waxing agent, two types of wax were chosen, the first is Waxes Dysper and the second is Paraffin Waxes. The fruits were stored in a refrigerator at a f 5°C for a month. The experiment was conducted as a factorial experiment with a completely randomized design (CRD), with three replications per treatment. The obtained data were collected and analyzed according to the used design using the LSD test at the probability level of 0.05., The waxing showed a significant effect on TSS, where the highest percentage when using dysper wax and the lowest percentage when using paraffin wax. Also, the waxing treatment showed significant differences between them, where the highest content of vitamin C was obtained using paraffin wax, and the lowest percentage when using dysper wax, which. The waxing treatment also gave significant differences in the acidity level characteristic of the fruits, where the highest acidity was 0.603% when using paraffin wax. In the aspect of respiration rate, there were significant differences between the waxing treatments. The fruits treated with dysper wax excelled in giving the lowest rate of respiration rate for fruits, which reached 2.973 mg CO_2/kg/hour. The highest average of respiration rate for fruits when using paraffin wax.

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Introduction

Tomato (*Solanum lycopersicum*) is a vegetable crop with high production and its production is still increasing all over the world continuously, It belongs to the Solanaceae family,. The global production of tomatoes in 2018 amounted to about 182 million tons of fresh fruits, according to the statistical database issued by the Food and Agriculture Organization of the United Nations.

The area planted with this crop in Iraq during 2018 was estimated at 69,686 dunams, with a total production rate of 467,579 tons, which constitutes 33.9% of the total vegetable production in Iraq (Central Statistics Organization 2018). Tomatoes are rich in minerals, vitamins, essential amino acids, sugars, and dietary fibers (Ayandiji et al. 2011) and tomatoes also contain ascorbic acid (Rashid and Shammari. 2014). The shape of the fruit varies according to the variety.

The color of the ripe fruits ranges from yellow to red (Akishin et al. 2021). In view of meeting the needs and requirements of the consumer, studies were directed to improve the quality of tomato fruits in terms of size, color, and firmness of the fruits and their content of soluble solids and antioxidants. This is done through the management of agricultural operations, such as choosing the appropriate variety, securing environmental conditions, and applying some modern agricultural operations (Morshid et al. 2013). Companies improve these varieties for the purpose of giving them the ability to adapt to different climatic conditions and to entice farmers to cultivate these varieties (Seifudin. 2016). These cultivars were produced in terms of their suitability to the prevailing environmental conditions in the region, their resistance to diseases, their productivity, and the quality of their fruits (Ahmed, et al. 2007).

The different tomato cultivars show clear differences in the acidity ratio after the end of the storage periods, as well as the reduction in the level of vitamin C for the studied cultivars (Younis and Abu Turabi. 2004). The amount of vitamin C decreases when the storage period for five tomato cultivars increases, and the cultivars did not differ significantly. Among them, in their vitamin C content at the end of the 30-day storage period (Gerry et al. 2007), Tomato fruits are cultivarified under moderately perishable crops due to their short endurance period for handling and shipping operations, does not exceed one to two months.

The harvesting of tomato fruits depends on the degree of ripening and is determined by the nature of the use of the fruits, the method of transportation and the duration of storage. Tomato fruits suffer from many problems during the storage process, including increased weight loss due to increased ripening and the

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consequent increase in respiration and increased loss resulting from fungal infections, (Rashid and Al-Shammari 2014),Therefore, many studies have been conducted in different parts of the world to reduce the spoilage of the fruits of this crop after harvesting (Melkamu et al. 2008) for the purpose of avoiding losses resulting from spoilage of fruits and to increase the period of displaying them in their fresh condition, of high quality and fit for consumption, this requires conducting additional and basic transactions to prolong the period of presentation of fruits in the market. Where studies have proven that the process of waxing maintains the length of the display of fruits in the market by preserving them from spoilage, reducing weight loss, and maintaining the integrity of their nutritional components. Transpiration inhibitors are edible substances that treat fruits after harvest and reduce the loss of water, oxygen and other soluble nutrients (Bourtoom 2008). They have a great importance in improving the appearance of fruits by preserving the flavor, color, acids and sugars, and they act as barriers to moisture and oxygen during transportation and storage. These barriers delay the deterioration of food and fruits and enhance their safety due to their nature (Cha et al. 2004).(Muthuselvi et al., 2020) indicated that the waxing process leads to an increase in the shelf life of fruits after harvest by reducing respiration and delaying senescence, and indicated (Singh et al. 2010).Also, the process of waxing fruits with wax materials reduces the respiration process of fruits and thus slows down the ripening process and helps to close the stomata, thus reducing the process of transpiration and water evaporation from the fruits, thus slowing down the rapid ripening and senescence process (Muthuselvi et al. 2020) indicated that the percentage of physiological and biological damage to fruits treated with anti-transpiration reduces damage due to cold damage and the change in the color of the fruits, as well as reducing the loss of water content of fruits, which in turn delays fruit wilt during storage, as well as preserves the fruits from micro biological infection (Al-Shammari, 2017)This is what was agreed upon. (Tharanathan 2003) mentioned that there are different types of transpiration inhibitors in fruits, including Lipid Based Coatings, which are good barriers to moisture loss in addition to preventing water loss, and to reduce respiration, and thus extend the age of the fruit and improving the appearance and that the effect of edible oil-based transpiration inhibitors is used on fruits and vegetables, and it consists of oils, waxes and waxes that are naturally present on the surfaces of fruits and vegetables, as waxes help prevent moisture loss, (Al-Shammari.b 2017). In a study on *Citrus aurantium* fruits, to know the response of these fruits to some substances to reduce deterioration and improve the quality

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characteristics during storage, it was found that the fruits treated with anti-transpiration material gave the lowest value of weight loss, which amounted to 1.18%, while the untreated fruits gave 4.51%. At the end of the 28-day storage period, Also (Sridevi et al. 2018) found that aloe vera gel as an anti-transpiration substance during storage of pomegranate fruits, the fruits treated with this anti-transpiration substance in total sugar content outperformed the fruits not treated with this substance. As for the ascorbic acid content of fruits treated with an anti-transpiration agent, it was higher than that of fruits not treated with this substance. The study aims to find the best way to preserve the characteristics of Tomato fruits.

Materials and Methods

The tomato fruits of Two cultivars grown in greenhouses in Khan Bani Saad in the spring agricultural season of 2021. These cultivars are the newton tomato hybrid, a hybrid of unlimited growth, produced by the Dutch company (Holland-S&G/Syngenta Seeds B.V/ Enkhuizen), It is suitable for cultivation in greenhouses and plastic, and the Siemens tomato cultivar. Two types of wax were used, where each of the mentioned types of fruits was dipped in wax before the storage process.The types of wax used are Waxes DYSPER. Where the dysper wax was used at a concentration of 2 g. liters of wax in a liter of water in a suitable container. The fruits were immersed in the solution for 5 minutes and then they were taken out and placed on a cloth for the purpose of drying, forming a thin layer on the surface of the fruit. And Paraffin Waxes, where an unspecified amount of paraffin wax was placed to dissolve in proportion to the quantity of fruits to be immersed in a metal container and exposed to a suitable heat source for the purpose of dissolving it, and then the fruits were entered into the resulting wax bath and take it out directly. Where a thin waxy layer forms on the surface of the fruit immediately after exposure to the wax and the fruits were stored at a temperature of 5 °C for 30 days (Al-Shammari and Fadel, 2021)

Treatments and experimental design

The tomatoes harvested directly from the field were coded with the symbol A and for the two varieties (Newton) A1 and the variety (Siemens (A2) with two degrees of maturity (M1 50%) and (M2100%), and the above transactions were waxed with wax (T), where the symbol for (Disper T1) and for wax (paraffin T2), The comparison treatment was maintained for all cultivar (T0) without being treated with wax for the purpose of control with the results of other treatments. The experiment was conducted as a factorial experiment, with a Completely randomized design C.R.D, with three replications per

treatments, and treatments were randomly distributed where the obtained data were collected. They were analyzed according to the used design, and the differences between the treatments were tested according to the LSD method at the 0.05 . probability level according to the statistical program Genstat using an electronic computer to test the significance of differences and the averages of different treatment(Al-Mohammadi and Mosleh, 2012).

Studied traits:

1- T.S.S Total Soluble Solids

It was use a hand refractometer.

2- Total Acidity

It was calculated by titrating a certain volume of fruit juice with the base NaOH (0.1N) and using phenolphthalein as an indicator, given that citric acid is the predominant acid, and then the total acid percentage was calculated according to the method (Ranganna, 1977).

3- Vitamin C content of fruits

Calculated by titrating a certain volume of fruit juice with a dye (.2-6-Dichloro Phenol Indo Phenol) and on the basis of a mg unit of vitamin C per 100 ml of juice, according to the method (Ranganna, 1977).

4- Average of respiration

The respiration average in fruits was measured using the Closed System method and at room temperature, and the results were calculated according to what was mentioned (Al-Ani. 1985) and according to the following equation:

$$\textbf{mg CO2/kg/hr}=\frac{The\ number\ of\ equivalent\ weights\ of\ the\ reactant\ base \times 22}{kg \times hr}$$

$$\textbf{mg CO2/kg/hr}=\frac{Hcl\ acid * standard - base\ (used\ NaOH * standard)}{kg \times hr}$$

Results and discussion

Total soluble Solids T.S.S (%)

It is noticed from Table 1 the effect of cultivar and wax on the character of total soluble solids (TSS), as no significant differences were found between the two cultivars of tomato Newton and Siemens in the percentage of total soluble solids, Waxing showed a significant effect on the total soluble solids, where the highest percentage of soluble solids was in fruits that were waxed with paraffin wax, where the percentage was 1.750%, and the lowest percentage of soluble solids when using dysper wax was 1.434%. As for the bi-interactions between the treatments, Where the interaction treatment between the cultivar Siemens with the use of paraffin wax was excelled and giving the highest percentage of soluble solids, which amounted

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to 2.150%.While the lowest percentage was recorded when using Newton's cultivar with dysper and paraffin wax, which amounted to 1.217% and 1.350%, respectively. respectively.

The Respiration rate

the amount of what is consumed is less than the amount of water lost by the fruits during storage,and this was evident in the rest of the experiment treatments that were treated with wax as the waxy substance closes the stomata and pores and leads to a reduction in the fruits' respiration process and water loss, and thus leads to a decrease in the percentage of total soluble solids inside the fruit, this was in agreement with what was reached by Abu-Goukh (2008), who stated that the waxed fruits were lower than the unwaxed fruits in the percentage of soluble solids.this was explained by him on the basis that the fruits that were not treated with wax had the highest loss of water and this leads to an increase in the concentration of total soluble solids, as the decrease in the decrease in soluble solids of the waxed fruits may be due to delayed ripening and senescence (

Table (1) Effect of cultivar and wax and the interaction between them on the character of total soluble solids (TSS)

waxing effect		Cultivar effect	A×T	waxing	Cultivar
1.434	Dysper	1.285	1.217	Dysper	Newton
			1.350	paraffin	
1.750	paraffin	1.900	1.650	Dysper	Siemens
			2.150	paraffin	
		A x T	T	A	LSD 5%
		0.171	0.121	NS	

Total Acidity

The results presented in Table 2 indicate the effect of the cultivar and the waxing of the fruits on the overall acidity of the experimental fruits. The results showed that there were significant differences between the waxing treatments used in the experiment, where the acidity was higher when waxing with Dysper wax 0.551% and the lowest acidity when waxing with paraffin wax

0.345%As for the cultivars, the Siemens cultivar was significantly excelled and gave 0.518 compared to the cultivar that gave 0.378%.As for the interactions between the treatments, the table above indicates that there are significant differences as a result of an interaction between the treatments of the cultivar (A) with the waxing (T), where the treatments of the Siemens cultivar excelled on the treatments of the wax Dysper with the highest acidity that reached 0.617%Whereas, treatment of Newton's cultivar with paraffin wax gave the lowest acidity of 0.325%. The reason for the increase in the total acidity of the fruits treated with waxy materials and its decrease in the control treatment is that the fruits in the comparison treatment have reached the senescence stage before the waxing treatments in which the fruits are in the final ripening stage, because the waxy substance reduces the breathing process of the fruits and thus slows down the process of respiration. Rapid maturation and aging process . As the waxing process helps to close the stomata and thus reduce the process of transpiration and water evaporation from the fruits and thus slow down the process of rapid ripening and aging (Singh, 2010),This reasoning was in agreement with what was stated by Islam et al. 1996, where they all affirmed that the total acidity of the fruits increases with the progression in the stages of ripening..

Vitamin C content of fruits (mg.100mL^{-1} juice)

The results in Table 3 show the effect of cultivar and wax on the vitamin C content of tomato fruits where there were no significant differences between the two cultivars of tomato, Newton and Siemens, in the content of vitamin C in the fruits, while these results showed the two waxing treatments significantly excelled used in the experiment, where paraffin wax was excelled to giving the highest content of vitamin C, which amounted to 11.645 mg.100 mL-1 juice while the lowest percentage when Dysper Wax 10,495 mg.100 mL-1juice. As for the effect of the interaction between the treatments, there was a significant effect between the interaction of each of the cultivar and the wax, where the highest percentage of the fruits content of vitamin C was recorded at Newton's cultivar with paraffin wax 11.90 mg.100 mL^{-1} while the bi-interaction treatment (Siemens cultivar+ Diaper wax) gave the lowest content of vitamin C 10.08mg.100ml-1 juice This may be due to the fact that the process of waxing the fruits before storage reduces the rate of respiration of the fruits and thus the decrease in the consumption of amino acids. (Muthuselvi et al., 2020)

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Table 2 Cultivar effect ,waxing and the interaction between them in the percentage of total acidity

waxing effect		Cultivar effect	A×T	waxing	Cultivar
0.551	Dysper	0.378	0.430	Dysper	Newton
			0.325	paraffin	
0.345	paraffin	0.518	0.671	Dysper	Siemens
			0.365	paraffin	
		A x T	T	A	LSD 5%
		0.046	0.032	NS	

Table 3. Effect of cultivar and wax and their interaction on the content of vitamin C in tomato juice

waxing effect		Cultivar effect	A×T	waxing	Cultivar
10.495	Dysper	11.405	10.91	Dysper	Newton
			11.90	paraffin	
11.645	paraffin	10.735	10.08	Dysper	Siemens
			11.39	paraffin	
		A x T	T	A	LSD 5%
		0.135	0.023	NS	

Effect on the average of respiration of fruits mg CO_2/kg/hour

Table 4 shows the effect of cultivar and wax on the average of respiration rate of tomato fruits, as there were no significant differences between the two tomato cultivars Newton and Siemens in the average of respiration rate of the fruits. Waxing showed a significant effect on the rate of respiration of fruits, where the lowest rate of respiration was when using Dysper wax, which reached 2.973 mg CO_2 / kg / h. The highest average of respiration speed of fruits when treating fruits with paraffin wax reached (3.118 mg

CO_2/kg/hour). As for the interactions between treatments, no significant differences were identified as a result of the cultivar interaction with the waxing.

Table (4) Effect of cultivar and wax and the interaction between them on respiration rate of tomato fruits

waxing effect		Cultivar effect	A×T	waxing	Cultivar
2.973	Dysper	3.053	2.980	Dysper	Newton
			3.125	paraffin	
3.118	paraffin	3.039	2.965	Dysper	Siemens
			3.112	paraffin	
		A x T	T	A	LSD 5%
		NS	0.033	NS	

From the foregoing, it is clear to us that the rate of respiration in the fruits decreased significantly and for both types of experiment for all fruits that were waxed with wax and for both types used by waxing. The reason for the high rate of respiration in tomato fruits after storage is due to the fact that the beginning of the increase in respiration rate in climacteric fruits begins immediately after harvesting and in the first days of storage. This is what was indicated by (Kopeliovitch et al. 1980), and here it should be noted that tomato fruits reach the best edibility shortly after they reach the peak of respiration (Al-Ani, 1985).

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