Plant Archives Vol. 20 Supplement 1, 2020 pp. 2607-2612 **e-ISSN:2581-6063 (online), ISSN:0972-5210**

EFFECT OF SODIUM METABISULFITE TREATMENT AND STORAGE PERIODS ON THE STORABILITY OF TWO PERSIMMON VARIETIES FUYU AND HACHIYA

Manar Ismail Alwan[1] and Sarah Abdul Hadi Hassan[2]

[1, 2]Department of Horticulture and Landscape Gardening, College of Agriculture, AL-Qasim Green University, Iraq

Abstract

This study was conducted at the Laboratory of Graduate Studies/Department of Horticulture and Landscape Gardening/ college of Agriculture, Al-Qasim Green University during 2018, to study the effect of Sodium metabisulfite at a concentration of 1.5, 3 g. Liters-1 by immersing the fruits for 2 minutes then comparing the treatment with a concentration of 0 dippings in distilled water only in the storing properties of two Fuyu and Hachiya varieties of persimmons under conditions of cold storage at a temperature of 1 + 5°C and relative humidity 90-85% for 20 and 40 days. The results showed that the Fuyu variety decreased the respiratory rate significantly than Hachiya variety, the Hachiya variety registered the lowest rate of weight loss. The Sodium metabisulfite treatment at 1.5% concentration resulted in a decrease in the respiration and the rate of decay. At the same time, the 3 % concentration led to a decrease in the weight loss rate and the percentage of total soluble solids. The period of storage 40 days led to an increase in the speed of respiration rate, as well as an increase in the rate of weight loss, the percentage of total soluble solids and decay to fruits. In contrast, a period of storage 20 days reduced the speed of respiratory rate, weight loss rate, TSS and no decay to fruits.

Key words: Persimmon, Sodium Metabisulfite, Storage.

Introduction

Persimmon (*Diospyros kaki*) belongs to the Ebenaceae family and falls under the genus Diospyros, which means in Greek the heavenly food. Persimmon genus includes 40 species, of which there are persistent and deciduous leaves, including trees and shrubs, there are four types that for produce fruits are used commercially, the essential commercial varieties named as eastern Kaki or Japanese Linn *Diospyros Kaki* (Fadel and Alrwai, 2011). It is native to the Far East, where it was cultivated naturally in China and Japan and is known as the East Apple (Fadel *et al*., 2013). Kaki is growing in many warm regions of the world, such as southern France and some Mediterranean countries such as Egypt, Italy and Palestine, in addition to Brazil, California, Australia and New Zealand, which have enough cold hours to break the rest phase requirements (Jackson and Looney, 1991). in Iraq, its cultivation widely, especially in Karbala Governorate, the number of trees is (4775) trees distributed over three regions (Al-Markaz, Al-Hussainiya and Aljadwal algharbi), the average production of one tree is 25 kg (Karbala Agriculture Directorate - Agricultural *Fruit weight at the beginning of storage* good source of ascorbic acid, minerals, carbohydrates, fiber and carotene (Oz *et al*., 2004) as well as they contain Isodiospyrin Diospyrin compounds that are effective to treating of cancer (Chun *et al*., 2003), also it contains antioxidants that are acting to aging delay, fruits are used for fresh consumption and in the food industry, as well as for tanning fabrics and leather because they contain tannins. The available period of Kaki fruits is limited in the market due to the sensitivity to bacterial and fungal infections (Derhab, 2003, Prusky *et al*., 2006). May be expose to the damaged due to inadequate of appropriate conditions during transportation and storage (Lou, 2007), which causes economic losses of yield, so, to reduce those losses, some transactions will reduce the causes of damage and extend the storage life of the fruits, including the use of Sodium metabisulfite($Na_2S_2O_5$) as it is considered a useful materials that used in preventing and

reducing fungal infection (Vota and Harvey, 1978). Sodium metabisulfite is a chemical compound that represents one of the forms of sulfur as a white crystalline powder that is not fixed and soluble in water due to the length of bond between the two sulfur atoms, it is considered a preservative that is used as an antioxidant within the food additives as preferred being of sterile materials and antiseptic (Winkler, 1974). Valero *et al*., (1992) pointed out that Sodium metabisulfite is an inhibitor of the enzyme production Polyphenol Oxidase. Al-Anbaki, (2002) mentioned that the treatment of grapes, confectionery cultivar with potassium metabisulfite, with different concentrations led to a decrease in the percentage of weight loss rates during the two seasons of study. High concentrations of sulfite decrease in the percentage of fungal infections to 0.38% while in the comparison treatment, it reached 10.89% at the same time, it caused a significant increase of the percentage of physiological disorders, which amounted to 5.91%. Koley *et al*., (2009) found that the use of 250ppm of potassium metabisulfite for rambutan fruit had preserved the quality of taste and color for 21 days. Breksa *et al*., (2010) found that the treatment of grapes with SO_2 reduced the brown enzymatic reactions and anaerobic by reserving sticky compounds that containing an active carbonyl group (Millard-non-enzymatic reaction) as well as inhibition of the enzyme Polyphenol Oxidase that causes enzymatic browning. Durrant *et al*., (2010) obtained an increase in the total titratable acidity percentage after storage termination in both apples and pears treated with Sodium metabisulfite concentration 2% Pear fruits treated with a concentration of 1% of sodium metabisulfide maintained the highest rate of ascorbic acid after 90 days refrigerated storage. Kasnazany *et al*., (2017) observed that when immersed the pear fruits in potassium metabisulfite, 2% concentration had a significant increase in TSS and acidity correctable. However, it caused a significant decrease in the moisture content of the fruits during storage. Kasnazany (2018) explained that the treatment of pomegranate fruits with potassium metabisulfite in different concentrations was effective in reducing the percentage of spoilage and had no significant effect on weight loss and total acidity and considered a concentration of 4%, the best is where it led to high total soluble solids and total sugars.

Due to the lack of studies in the country related to the use of this material for the treatment of Kaki fruits, this study conducted on the fruits of two varieties of persimmons, Fuyu and Hachiya, whose cultivation widely spread in Karbala Governorate, in order to find out the best concentration for prolonging storing the fruits and providing them to the consumer with good quality.

Materials and Methods

This study was conducted in the post-graduate laboratory of the Department of Horticulture and Landscape Gardening, College of Agriculture, Al-Qasim Green University, the fruits of two varieties of persimmons, Fuyu and Hachiya obtained from trees at the age of 15 years from one of the private orchards located in Al-Hussainiya, Karbala Governorate.

The fruits of the two varieties were harvested manually during physiological maturity in early November 2018. Homogeneous fruits in color and size were chosen, excluding infected and injured fruits, then were washed with water and dried at room temperature. The fruits are dipped with $Na_2S_2O_5$ solution with a concentration of 1.5, 3 g^{l}·liter for 2 minutes, symbolized by T1 and T2, in addition to the comparison treatment (distilled water only) symbolized with the symbol T0, the fruits were left to dry at room temperature, then placed in polyethylene bags of 1 kg capacity, perforated by eight holes and stored for 20 and 40 days at a degree temperature 5±1 and humidity 85-80%.

The experiment was carried out according to the Complete Randomized Design (C.R.D) as a factor experiment with three factors, the first factor represents the variety V and the second-factor Sodium metabisulfite T and the third factor S storage periods included three replicates, the data were analyzed using the Genstat statistical program and the differences were compared between the means according to the choice of the least significant difference (L.S.D) at p 0.05 (Sahuki and Waheeb, 1990).

Studied traits

The percentage of weight loss

Weight loss percentage = fruit weight at the beginning of storage - fruit weight after a specific time × 100/*Fruit weight at the beginning of storage*

Percentage of total dissolved solids (T.S.S)

The percentage of total dissolved solids in fruit juice was measured by used a Hand Refractometer according to (A.O.A.C, 1986).

Respiration rate

Estimated the respiration speed used the system closed method according to the method of (Al-Ani, 1985). Calculated the respiratory speed was according to the following equation:

$mgCO_2$ / Kg / hr. = $mgCO_2$ × 1 / Wt (kg) × 1 / hr.

Wt = sample weight/kg, hr = the number of hours

The percentage of decay

It was calculated at the end of the storage period, as the fruits were considered decayed as soon as any fungal or physiological injury appeared and calculated as in the following equation: Percentage of decay = Weight of decayed Fruits / Total Treatment Weight × 100.

Results and Discussion

The percentage of weight loss

The results showed in table 1 that there was a significant difference for the two verities, the Hachiya variety recorded the lowest rate of weight loss of 1.25% compared to the Fuyu variety, which recorded the highest rate of weight loss of 1.44%. The treatment of fruits with Sodium metabisulfite 3% (T2) had a significant effect in reducing the weight loss rate from 1.79% for the comparison treatment (T0) to 1.03%. Regarding the storage period, a significant increase in the rate of weight loss of fruits was observed, a maximum of 1.90% after passed of 40 days, while the storage period 20 days recorded the lowest rate of 0.80%. The results of binary interaction between the variety and the coefficients showed that this trait was significantly affected when treating the interaction between the Fuyu class and the compared with non-treated (V1T0), it reached 1.83%. In contrast, the interaction treatment between the variety Hachiya and Sodium metabisulfite 3% (V2T2) caused a decrease to 0.95%. The interaction treatment between the Hachiya variety and the first storage period 20 days (V2S1) was significantly reducing this percentage to 0.64% compared to the interaction treatment between the Fuyu variety and the storage period 40 days (V1S2) that caused its rise to 1.93%, also the trait was significantly affected when the interaction treatment between the transactions and the storage period, the minimum rate was 0.61% in the interaction treatment between Sodium metabisulfite and the storage period 20 days (T2S1), while the interaction treatment between the non-treatment and the 40-day storage time (T0S2) caused a rise to 2.69%. The triple interaction between the study factors had a significant effect in reducing this percentage from 2.78% to the interaction treatment between the Fuyu variety, the non-treatment and the second storage period 40 days (V1T0S2) to 0.45% in the treatment of interaction between the Hachiya variety, the Sodium metabisulfite and storage period 20 days (V2T1S1).

Table 1: Effect of variety, Sodium metabisulfite, storage periods and their interactions on the % of weight loss of two varieties of persimmon Fuyu and Hachiya fruits.

Varieties V	Sodium metabisulfite T	Storage period (days) S		Interactions V*T
		20 S1	40 S2	
Fuyu V1	T0	2.61	2.78	1.83
	T1	0.72	1.05	1.38
	T2	0.74	1.07	1.12
Hachiya V2	T0	1.37	1.70	1.73
	T1	0.45	0.76	1.06
	T2	1.45	1.48	0.95
LSD		0.598		0.423
Effect S		0.80	1.90	Effect V
LSD		0.244		
Effect V*S		0.96	1.93	1.44
		0.64	1.86	1.25
LSD		0.345		0.244
				Effect T
Effect T*S		0.88	2.69	1.79
		0.91	1.53	1.22
		0.61	1.46	1.03
LSD		0.423		0.299

The exposure of gradual weight decrease of Kaki fruits in a continuous period of storage is attributed to the loss of the water content of the fruits by evaporation or as a result of the loss of food storage and the consumption by the respiration process or both (Shirikov, 1988). On the other hand, Sodium metabisulfite contributed to reducing weight loss from the modification of the atmosphere surrounding the fruits and the formation of a thin film of moisture around the fruits, which reduce the transpiration process and also preserved the ability of the cells to retain their moisture content (Kasnazzny, 2017). Regarding the length effect of the storage period on increasing the weight loss of the stored fruits 40 days resulted from continuing the effect metabolic activities inside the fruits, including transpiration and respiration (Al-Ani, 1985), this results agreed with the results of (Ansari, 2005 and al-Jubouri, 2019).

The percentage of total dissolved solids (TSS)

The results of table 2 did not showed any significant effect between the two varieties in the percentage of total soluble solids (TSS). While the treatments had a significant effect, the Sodium metabisulfite treatment 3% (T2) achieved the lowest rate of 20.82% and the compared with non-treatment (T0), which gave the highest rate for this trait was 22.42%. Regarding the storage period, a significant increase in the rate of TSS was observed, a maximum of 22.28% after the passage of 40 days (S2), while the storage period recorded 20 days (S1), the lowest rate reached 20.67%. The values of binary interaction between the variety and the coefficients indicated that this trait was significantly affected when treating the interaction between the Fuyu variety and the

Table 2: Effect of variety, Sodium metabisulfite, storage periods and their interactions on the % of total soluble solids of two varieties of persimmon Fuyu and Hachiya fruits.

Varieties V	Sodium metabisulfite T	Storage period (days) S		Interactions V*T
		20 S1	40 S2	
Fuyu V1	T0	20.67	21.67	22.67
	T1	22.67	23.67	21.17
	T2	20.67	21.00	21.17
Hachiya V2	T0	21.33	21.67	22.17
	T1	19.65	20.33	21.17
	T2	21.33	22.00	20.50
LSD		1.317		0.932
Effect S		20.67	22.28	Effect V
LSD		0.538		
Effect V*S		21.00	22.33	21.67
		20.33	22.22	21.28
LSD		0.761		N.S.
				Effect T
Interactions T*S		21.17	23.67	22.42
		20.83	21.50	21.17
		20.00	21.67	20.83
LSD		0.932		0.659

comparison coefficient (V1T0) 22.67%. At the same time, the interaction treatment between the Hachiya variety and the Sodium metabisulfite3% (V2T2) caused a decrease to 20.50%.

Moreover, the interference treatment between Fuyu variety and the 40-day storage period (V1S2) increased by raising that percentage to 22.33% compared to the interaction treatment between Fuyu variety and the 20-day storage period (V1S1) that caused decrease to 20.00%. Also, the trait was significantly affected when treating (T0S2), as the highest rate was 23.67% in the comparison treatment and the storage period is 40 days. In contrast, the interaction treatment between Sodium metabisulfite 3% and the storage period 20 days (T2S1) caused a decrease to 20.00%. The triple interference between the study factors had a significant effect on raising that percentage from 19.65% to the treatment between the Hachiya variety and the Sodium metabisulfite and the storage period 20 days (V2T1S1) to 23.67% in the treatment between the Fuyu variety and the comparison treatment and the storage period 40 days (V2T0S2).

Total soluble solids (TSS) are the most important factors affecting the fruit's taste and nutritional value. In general, the behavior of these substances during storage is due to the changes that happen to carbohydrates, nitrogenous and pectin compounds and mineral salts inside the fruits (Jacobs, 1951). The fruits retaining the highest percentage of TSS at the end of the storage period that lasted 40 days compared to the period of 20 days, it may be due to the continuation of metabolic activities and the fruits were exposed to the loss of their moisture content table 1. Al-Juburi, (2019) indicated the sweet lemon fruits stored for 60 days, or may be due to the change in the components of the cell wall, so that the breakdown or destruction of complex carbohydrates increases turns into simple sugars that reflect on increasing the fruit content of TSS and acids may turn to sugars (Kasnazany, 2017).

Respiratory rate mgCo_2 / kg / hr

The results in table 3, showed that there were significant differences between the two varieties in the respiration rate, the Fuyu variety recorded the lowest respiration rate of 9.40 mgCo_2/ Kg/hr compared to the Hachiya variety, which recorded the highest respiration rate of 10.13 mgCo_2/kg/hr The treatment of Sodium metabisulfite exceeded 1.5% (T1) by registering the lowest respiratory rate of 9.27 mgCo_2/ Kg/hr while the respiration rate in the fruits of the non- treatment (T0) increased to 10.52 mg Co_2 /kg/hr. Regarding the storage period, the rate of this trait in the fruits have stored for 40 days (S2) decreased to 9.52 mg Co_2/ Kg /hr compared to the fruits that have stored for 20 days (S1) in which it rose to 10.03 mg Co_2/ kg/hrr. The mutual interaction, a significant difference was observed between the Fuyu

Table 3: Effect of variety and Sodium metabisulfite and storage periods and their interactions on the respiration rates of two varieties of persimmon Fuyu and Hachiya fruits.

Varieties V	Sodium metabisulfite T	Storage period (days) S		Interactions V*T
		20 S1	40 S2	
Fuyu V1	T0	11.01	10.89	10.44
	T1	10.19	9.99	8.59
	T2	10.11	8.86	9.17
Hachiya V2	T0	9.77	9.36	10.60
	T1	9.93	8.32	9.94
	T2	9.78	8.98	9.85
LSD		0.670		0.473
Effect S		10.03	9.85	Effect V
LSD		0.273		
Interactions V*S		9.71	9.10	9.40
		10.35	9.91	10.13
LSD		0.387		0.273
				Effect T
Interactions T*S		10.95	10.09	10.52
		9.49	9.04	9.27
		9.65	9.38	9.52
LSD		0.473		0.335

variety interaction treatment and the Sodium metabisulfite treatment of 1.5% (V1T1), it gave the lowest rate 8.59 mg Co_2 /kg/hr (V2T0) amounted to 10.60 mg Co_2/ Kg/ hr. The interaction of the variety and the storage period, we noticed the superiority of the interfaction treatment between the Fuyu variety and the storage period 40 days (V1S2), it gives the lowest rate for this trait was 9.10 mg Co_2/ Kg/hr compared to the highest rate that recorded when the treatment of overlap between the variety Hachiya and the storage period 20 days (V2S1) 10.35 mg Co_2/Kg/hr.

Also, the interaction treatment between the Sodium metabisulfite 1.5% with the storage period 40 days (T1S2) were increased significantly by giving it the lowest rate of 9.04 mg Co_2/ Kg/hr while the highest rate for that trait was the interaction treatment between treatment and the storage period 20 days (T0S1) reached 10.95 mg Co_2 /kg/hr The triple interaction between the study factors had a significant effect on reducing this percentage from 11.00 mg Co_2/kg/hr for the interaction treatment between Fuyu variety and the comparison coefficient and storage period 20 days (V1T0S1) to 8.32 mg Co_2/kg/hr In the treatment of interaction between the Hachiya variety and the Sodium metabisulfite 1.5%, with storage period 40 days (V2T1S2). The role of Sodium metabisulfite to decreasing the respiration rate through the contribution of Sodium metabisulfite to reducing weight loss by altering the atmosphere surrounding the fruits and producing a thin moisture film around the fruits, thereby reducing the transpiration process and also preserving the ability of cells to retain their moisture content (Kasnazzny, 2017). The storage period of S2 to decreasing the respiration rate may be due to the passage of fruits in the climacteric phase, after which the respiration rate begins to decrease gradually until entering the senescence stage (Al-Ani, 1985).

Percentage of fruit decay

The results in table 4, showed that the fruits of the Hachyia variety were decayed at the end of the storage period 40 days, Hachyia recorded non-significance higher rate than the Fuyu variety. However, the treatment of Sodium metabisulfite 1.5% (T1) was decrease significantly the percentage of decay to 4.86% compared to the non- treatment (T0), which recorded a maximum rate 10.50%, as well as the interaction between the Fuyu variety and the treatment of Sodium metabisulfite 1.5% (T1) was significant decrease the percentage of decay 4.79%. In contrast, the highest percentage was recorded for Hachiya at 10.14%.

Table 4: Effect of classes, Sodium metabisulfite and their interaction on the percentage of spoilage of Fuyu and Hachiya fruits.

Class V	Sodium metabisulfite T			Class effected rate
	T0	T1	T3	
FuyuV1	9.87	4.79	5.22	6.63
HachiyaV2	10.14	4.92	5.01	7.02
Treatment affected rate	10.50	4.86	5.11	V=N.S.
value L.S.D 0.05	T=1.255 T*V=1.775			

The decrease in the percentage of decay in the fruits treated with Sodium metabisulfite may be due to the disinfectant and resistant to pathological injuries (Winkler *et al*., 1974). The decay of the fruits at the end of the 40-day storage period may be due to the result of continuing activities processes inside the fruits, including the respiration process, losing weight, consuming its food storage and entering the senescence stage, which reduced its ability to resist infection with microorganisms.

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