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EFFECT OF SOME ESSENTIAL OILS, SALTS AND SALICYLIC ACID ON REDUCING DECAY, KEEPING QUALITY AND PROLONGING SHELF-LIFE OF CANINO APRICOT FRUITS

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ABSTRACT: ***The present study was conducted on fruits harvested from 12 years old Canino apricot trees grown in a private orchard situated at Dinoushr village, El-Mahalla El-Kubra, Al-Gharbia Governorate, Egypt during 2017and 2018 seasons to study the effect of essential oils and some salts on reducing decay, maintain quality and prolonging shelf-life of Canino apricot fruits. Canino apricot fruits were dipped inessential oil: Thyme oil at 100 ppm, Spearmint oil at 1000 ppm, Clove oil at 1000 ppm, Eucalyptus oil at 1000 ppm and Mustard oil at 1000 ppm, and salts: K_2CO_3 at 2%, $KHCO_3$ at 2%, $CaCl_2$ at 3% and Salicylic acid at 2%as well as distilled water (control) for 5 min. The treated fruits were stored at 0±1°C with 90 – 95 % RH. for 28 days. The data showed that the weight loss, decay and respiration rate of the Canino apricot fruits were decreased significantly by the use of Eucalyptus, Spearmint and Clove oils. Also, applications of Eucalyptus, Spearmint, Clove and K_2CO_3were effective in maintaining firmness, titratable acidity, ascorbic acid, soluble solids content and SSC/acid ratio of Canino apricot fruits during cold storage period. Accordingly, Eucalyptus oil, Spearmint oil and Cloves oil are more effective in reducing weight loss, decay and respiration rate as well as maintaining overall quality of Canino apricot fruits under cold storage conditions for 28 days, as compared to other treatments.***

Key words: ***Apricots, essential oils, potassium compounds, firmness, ascorbic acid, TSS%***

INTRODUCTION

Apricots (*Prunus armeniaca* L.) is one of the most important economic fruit amongst one fruits in the world, due to it consumed freshly, dried or manufactory and it's important for a healthy diet because of their high levels of fibers, vitamins, antioxidants and minerals such as calcium, magnesium, iron and potassium (Fatima *et al.,* 2018 & Moustafa and Cross, 2019). Apricot is a fragile and climacteric fruit that produces large amount of ethylene that make it ripens very quickly after harvest. So, it starts to loss physical and chemical qualities and fruits face several physiological disorders as like weight and dry matter losses; fruit decay through microbial attack and rots which have negative influences on fruit shelf life and marketability (Egea *et al.,* 2007 and Ezzat *et al.,* 2012). These losses can be minimized with cold storage of fruits and applications of some natural essential oil and salts for maintenance fruit quality and extension of shelf life (Sivakumar and Bautista-Banos, 2014).

The essential oils are natural antioxidants which are well known for their anti-microbial and biodegradable properties without any residual effect on fresh fruits (Mohammadifar *et al.,* 2012).They are also environmentally friendly and are known as "reduced risk" pesticides (Abd Alla and El-Shoraky, 2017). So, in order to produce healthy fruits, free from chemicals and safe on human health, there is tendency to use

essential oils as a biofumigant to control the postharvest diseases, fruit decay and maintain their quality during storage (Caccioni and Guizzardi, 1994, Valero *et al.,* 2006 and Zeng *et al.,* 2012). In this respect, Shaarawi *et al.,* (2017) cleared that plum fruits dipped in Clove oil 2%, Mint oil 2% and Lemongrass oil 0.5% showed high quality during cold storage in terms of decreasing fruit weight loss and decay percentages, slowing change in fruit color and the deterioration of physical and chemical properties compared to fruits dipped in Ozone at 0.5 or 1.0 ppm. Also, Shirzadeh and Kazemi (2012) revealed that, immersing apple fruits in Calcium (1%) or Thyme oil 300 ppm and Lavender oil 500 ppm led to decrease weight loss and ethylene production as well as increase fruit firmness during cold storage at 0±2°C for 140 days. Moreover, Abd El Wahab (2015) suggest that the use of essential oils such Lemongrass, Thyme, Rosemary, Lavender, Bergamot, Pepper mint, Dill and Coriander (2ml/l) resulted in the best maintenance of overall quality parameters of nectarines fruits during cold storage at 0 °C for 4 weeks, thus extending post- harvest life of nectarines.

Calcium chloride, Potassium carbonate, Potassium bicarbonate and Salicylic acid not only used as food preservatives but also used as alternative solution to postharvest fungicide applications and maintaining overall quality during storage period especially fruit weight loss, decay and firmness (Khamis *et al.,* 2012, Talibi *et al.,* 2014 and Abdel Gayed *et al.,* 2017). Potassium (K^+) is essential element for sugar production, transport and storage in fruits (Jifon and Lester 2009). The application of K optimizes calcium assimilation by making a balance with ammonium, nitrate and phosphate (Rees *et al.,* 2012). K effects fruit firmness in different ways increased fruit tissue pressure potentiality (Lester *et al.,* 2006). Also the plant growth, development, soluble sugar content and reactive oxygen species production, apple fruit firmness and size influenced by K mechanism (Zhang *et al.,* 2017). Fruit firmness, sugars, soluble solids and ascorbic acid content are increased with add K in nutrient solutions (Botella *et al.,* 2017).

In this respect, Calcium chloride has been used for delayed ripening, maintaining fruit firmness, reduced weight loss and respiration rate (Martin-Diana *et al.,* 2007). In this concern, Jan *et al.,* (2015) reported that application of $CaCl_2$ significantly reduced fruit weight loss, decay, total sugar and increased both fruit firmness and ascorbic acid of apple fruits. In this line, Akhtar *et al.,* (2010) stated that loquat fruits dipped in calcium chloride at 2 and 3% retain maximum firmness, TSS, ascorbic acid content, and reduced fruit weight loss up to 4-5 weeks. Calcium application has been reported to be effective in terms of membrane functionality and integrity maintenance with lower losses of phospholipids and proteins, and reduced ion leakage which could be responsible for lower weight loss in apricot fruit (Abdrabboh, 2012).

Salicylic acid is a natural growth regulator in vascular plants. Salicylic acid belongs to a group of phenolic compounds, and stimulating many physiological processes including ion uptake, membrane permeability, enzymes activity, growth and development as well as disease resistance mechanisms (Ennab *et al.,* 2020). Salicylic acid shows direct toxicity on fungi, and significantly inhibits fungal growth which reflected on reduction fruit decay (Barakat *et al.,* 2015). Salicylic acid can delay the ripening of fruit, probably through inhibition of ethylene biosynthesis (Srivastava and Dwivedi 2000) Salicylic acid treatment maintains greater firmness, reduces chilling injury indices,

and delays membrane lipid per oxidation in fruit during cold storage (Awad 2013). Thus, Salicylic acid has remarkable ability to maintain the fruits quality during storage life of fruits.

Therefore, the aim of this research is to study the effects of postharvest application of some essential oils: Thyme oil, Spearmint oil, Clove oil, Eucalyptus oil, Mustard oil and some salts i.e. Calcium chloride, Potassium carbonate, Potassium bicarbonate and Salicylic acid on reducing decay, maintain quality and prolonging shelf-life of Canino apricot fruits.

MATERIALS AND METHODS

The present study was carried out on fruits taken from 12 years old Canino apricot (*Prunus armeniaca* L) trees growing in a private orchard at Dinoushr village, El-Mahalla El-Kubra, Al-Gharbia Governorate, Egypt. The trees were planted at 5×5 m spacing in clay soil under flood irrigation system. Harvesting took place on July 14th and 11th in 2017 and 2018 seasons respectively, when the peel was fully colored and the SSC had reached 13.0 – 13.1% according to Dong *et al.,* (2002). Fruit samples were selected for uniform size (3.1 cm length and 3.05 cm width), color and free from physical injuries, insect attack and damages. Fruit samples were directly transported at ambient temperature (26°C) to laboratory of Sakha Horticulture Research Station, Kafr El-Sheikh Governorate, cleaned, washed with tap water, dipped in hypochlorite solution (0.02%) for 2 minutes (surface-sterilized) and air dried with an electrical fan. The fruit samples were divided into eleven groups; the first group was used for achieving the initial quality parameters at the picking date. The remaining groups from 2 to 11 each alone was dipped in one of the following aquatic solutions for 5 minutes: Control (distilled water); Thyme oil at 100 ppm, Spearmint oil at 1000 ppm, Clove oil at 1000 ppm, Eucalyptus oil at 1000 ppm, Mustard oil at 1000 ppm, K_2CO_3 at 2%, $KHCO_3$at 2%, $CaCl_2$ at 3% and Salicylic acid at 2%. Afterward, the treated fruits were packed in one layer into carton boxes; each box contained 2kg of apricot fruits. Each treatment replicated three times for each sample date, the treated fruits were stored at 0±1°C with 90 – 95 % RH for 28 days. The experiment was arranged in randomized complete block design. The variables were measured at 7 days intervals during storage period as follow:

Weight loss%:

Canino apricot fruits were weighed at zero time (before storage) and reweighted again at each ex-storage date during the storage period. Weight loss was calculated according to the following equation: Fruit weight loss % = (W_I – W_S) / W_I × 100, Where W_I = fruit weight before storage. Ws = fruit weight after each storage period.

Fruit decay%:

Fruit decay% was determined by counting the number of decayed fruits on the sampling date and expressed as a percentage of fruit decay according to the following equation: Fruit decay% = {NO. of decayed fruits ÷ Initial NO. of stored fruits} × 100.

Fruit firmness (Newton):

Fruit firmness was determined by using Effegi penetrometer (thump diameter = 1 mm) and expressed as Newton (N) according to A.O.A.C., (1990).

Fruit shelf life (days):

Fruit of each treatment and the control were examined at harvest day and weekly intervals during cold storage period, until the percentage of injured fruit (fruit in senescence stage, decay…etc.) reached ≥ 51%.

Respiration rate(mg CO_2/kg/h):

Respiration rate (mg/kg^{-1}/h^{-1}), the respiratory rate, expressed as mg of CO_2 produced by kg fruit during one hour (mg /kg/h) it was determined using one kg fruits which placed in desiccator and connected to a tube contains 25 ml of 1.0 N KOH; Air CO_2 free was drown into the desiccator throughout the KOH for one hour, then KOH titrated with 1.0 N HCl using thymolplue indicator, CO_2 production was calculated as mg CO_2/ kg/ h. (Demirdoven and Batu, 2004).

Soluble solids content (SSC %), Titratable acidity% and SSC/acid ratio:

Soluble solids content of the fruit was recorded with the help of hand refractometer, acidity was estimated by titrating against standard alkali solution (0.1N NaOH) using phenolphthalein indicator and expressed as percentage of malic acid per 100 ml of juice according to A.O.A.C.,(1990) and then SSC/acid ratio was estimated.

Ascorbic acid mg/100 ml juice:

Ascorbic acidwas determined by using 2, 6 dichlorophenol indophenol pigment according to Rangana, (1977).

Statistical analysis:

Data were statistically analyzed using SAS software Version 9.1 according to Snedecor and Cochran (1990). The differences among means were compared by using Duncan's multiple range tests (DMRT) at 0.05 levels according to Duncan (1955). Also, Pearson correlation coefficient was calculated

RESULTS AND DISCUSSION

Fruit weight loss (%):

Data in Table 1 show that, weight loss percentages of Canino apricot fruits were increased with the progress of storage period in both seasons. Table 1 show that, weight loss percentages of Canino apricot fruits increased with the progress of storage period for 28 days in both seasons. Also, it can be observed that fruit weight loss percentages significantly decreased by dipping in all treatments of essential oils, $CaCl_2$, potassium compounds and Salicylic acid during cold storage period as compared to control fruits. Canino apricot fruits dipped in Eucalyptus oil and Spearmint oil followed by Thyme oil and Salicylic acid recorded the lowest values of weight loss percentages during storage period without significant differences among them in most cases in both seasons. On cold contrast that fruits dipped in distilled water (control) had the highest values of weight loss during cold storage period. These results are agreed with those of Abd El Wahab (2015) and Saleh *et al.,* (2019). In this respect, Mahmoud *et al.,* (2019) reported that, post-harvest essential oils treatments decreased weight losses and incidence of decay during cold storage of Anna apple. Also, Salimi *et al.,* (2013) showed that, postharvest applications of essential oils significantly controlled the weight loss of grape compared to the control under cold storage. In their studies on cherries and grapes mentioned that using eugenol, thymol or menthol vapors reduced weight loss during cold storage. Solgi and Ghorbanpour (2014) detected that, moisture loss decreased significantly in fruits that treated with essential oil enriched coatings. The reduction in fruit weight loss as a result of essential oils application maybe due to reduce evaporation of water, respiration rate, degradive processes and ethylene production during cold storage which reflected on delay the fruit ripening and thereby delay the decline in fruit quality (Antunes *et al.,* 2007).

Table 1: Effect of postharvest application of some essential oils salicylic acid and some salts on weight loss% of Canino apricot fruits stored at 0 ±1°C with 90 – 95 % RH

Treatments	Storage period (days)					
	0	7	14	21	28	Mean
	2017 season					
Control	0.00 a	1.43 a	1.60 a	1.92 a	2.02 a	1.74a
Thyme oil at 100 ppm	0.00 a	0.27 de	0.44 de	0.46 e	0.65 f	0.46 f
Spearmint oil at 1000 ppm	0.00 a	0.23 de	0.40 ef	0.43 e	0.57 f	0.41fg
Clove oil at 1000 ppm	0.00 a	0.45 c	0.75 c	0.82 c	1.08 d	0.77 d
Eucalyptus oil at 1000 ppm	0.00 a	0.20 e	0.31 f	0.38 e	0.48 g	0.34 g
Mustard oil at 1000 ppm	000 a	0.35 cd	0.55 d	0.65 d	0.81 e	0.59 e
K_2CO_3 at 2%	0.00 a	0.66 b	0.89 b	1.01 b	1.38 b	0.99 b
$KHCO_3$ at 2%	0.00 a	0.45 c	0.84bc	1.00 b	1.23 c	0.88 c
$CaCl_2$ at 3%	0.00 a	0.46 c	0.54 d	0.65 d	0.78 e	0.61e
Salicylic acid at 2%.	0.00 a	0.34 cd	0.39 ef	0.46 e	0.74 e	0.48f
Mean	0.00e	0.49 d	0.67c	0.78b	0.97 a	
	2018 season					
Control	0.00 a	1.37 a	1.69 a	1.80 a	1.90 a	1.69 a
Thyme oil at 100 ppm	0.00 a	0.20 e	0.30 e	0.40 a	0.47 def	0.34 de
Spearmint oil at 1000 ppm	0.00 a	0.18 e	0.25 e	0.33 a	0.40 ef	0.29 e
Clove oil at 1000 ppm	0.00 a	0.32cde	0.38 de	0.52 a	0.63 de	0.46 d
Eucalyptus oil at 1000 ppm	0.00 a	0.18 e	0.23 e	0.28 a	0.34 f	0.26 e
Mustard oil at 1000 ppm	000 a	0.28 de	0.37 de	0.41 a	0.52 def	0.39 de
K_2CO_3 at 2%	0.00 a	0.59 b	0.77 b	0.96 a	1.12 b	0.86 b
$KHCO_3$ at 2%	0.00 a	0.37 cd	0.59 c	0.76 a	1.11 b	0.71 c
$CaCl_2$ at 3%	0.00 a	0.42 c	0.52 cd	0.83 a	0.90 bc	0.67 c
Salicylic acid at 2%.	0.00 a	0.30cde	0.39 de	0.48 a	0.67 cd	0.46 d
Mean	0.00e	0.42d	0.55c	0.68b	0.81a	

Means followed by different letter are significantly different within columns by Duncan's multiple range tests, P≤0.05.

Fruit decay (%):

The results in Table 2 showed that, decayed fruit was increased with the increasing of storage period for all treatments except Clove oil in both seasons. The highest decay% was observed in control treatment in both seasons. Clove oil treatment showed zero percent of decayed fruits during cold storage period in both seasons, on the other words Clove oil at concentration of 1000 ppm showed to be the superior one in reducing fruit decay percentage in both seasons. Moreover, Spearmint oil, Eucalyptus oil and $CaCl_2$ came the second for prevent fruit decay. These results are agree with the obtained of Baiea and El Badawy (2013) who indicated that, Clove oil-treated Washington navel orange fruits showed to be the most effective treatments in inducing the lowest fruit decay percentages. Also, Shaarawi *et al.,* (2017) found that plum fruits dipped in Clove oil recorded the lowest fruit decay percentage as compared with those dipped in Mint oil, Lemongrass oil and ozone application.

Table 2: Effect of postharvest application of some essential oils salicylic acid and some salts on decay% of Canino apricot fruits stored at 0 ±1°C with 90 – 95 % RH.

Treatments	Storage period (days)					
	0	7	14	21	28	Mean
	2017 season					
Control	0.00 a	9.00 a	13.00 a	18.00 a	23.00 a	12.60 a
Thyme oil at 100 ppm	0.00 a	1.00 d	3.43 b	3.43 c	6.50 b	2.87 b
Spearmint oil at 1000 ppm	0.00 a	0.00 e	0.00 g	0.00 f	4.05 e	0.81 f
Clove oil at 1000 ppm	0.00 a	0.00 e	0.00 g	0.00 f	0.00 g	0.00 g
Eucalyptus oil at 1000 ppm	0.00 a	0.00 e	0.60 f	0.92 e	4.25 de	1.15 f
Mustard oil at 1000 ppm	000 a	0.00 e	1.03 ef	4.50 b	5.40 c	2.19 cd
K_2CO_3 at 2%	0.00 a	1.20 c	1.80 d	2.20 d	3.50 ef	1.74 de
$KHCO_3$ at 2%	0.00 a	2.10b	2.50 c	3.18 c	3.70 ef	2.30 c
$CaCl_2$ at 3%	0.00 a	0.00 e	1.30 de	2.30 d	2.60 f	1.24 ef
Salicylic acid at 2%.	0.00 a	2.22 b	3.20 b	4.10 b	5.20 cd	2.94 b
Mean	0.00e	1.55d	2.69c	3.86b	5.82a	
	2018season					
Control	0.00 a	8.00 a	12.00 a	16.67 a	25.00 a	12.33a
Thyme oil at 100 ppm	0.00 a	0.00 d	0.00 e	3.00 bc	6.00 b	1.80bcd
Spearmint oil at 1000 ppm	0.00 a	0.00 d	0.00 e	0.00 d	4.00 cd	0.80de
Clove oil at 1000 ppm	0.00 a	0.00 d	0.00 e	0.00 d	0.00 f	0.00e
Eucalyptus oil at 1000 ppm	0.00 a	0.00 d	0.00 e	0.00 d	4.33 cd	0.87de
Mustard oil at 1000 ppm	000 a	0.00 d	0.00 e	4.00 b	5.00 bc	1.80bcd
K_2CO_3 at 2%	0.00 a	1.00 c	1.67 cd	2.00 c	3.00 de	1.53cd
$KHCO_3$ at 2%	0.00 a	2.00 b	2.33 bc	2.83 c	3.15 de	2.06bc
$CaCl_2$ at 3%	0.00 a	0.00 d	1.00 de	2.00 c	2.40 e	1.08cd
Salicylic acid at 2%.	0.00 a	2.00 b	3.00 b	4.00 b	5.00 bc	2.80b
Mean	0.00e	1.30d	2.00c	3.45b	5.79a	

Means followed by different letter are significantly different within columns by Duncan's multiple range tests, P≤0.05.

Fruit firmness (Newton):

Data presented in Table 3 indicate that, fruit firmness was enhanced with all essential oils and $CaCl_2$, potassium compounds and Salicylic acid applications compared to control in both seasons. Also, it can be noted that, fruit firmness was gradually decreased by increasing storage period for all treatments in both seasons. K_2CO_3, Spearmint oil and Clove oil treatments recorded the highest values of firmness in both seasons compared to other treatments, and no significant differences among treatments in most cases. The above-mentioned results of fruit characters were confirmed (Table 4) where, Pearson correlation coefficient data showed a highly positive correlation between weight loss % of fruits and fruit decay% (0.702**). However, it cleared a negative correlation with fruit firmness (-.481**). These results are in agreement with those of Togrul and Arslan (2004), Tzortzakis and Economakis (2007), Raybaudi-massilia *et al.* (2008), Abbasi *et al.* (2011) and Shaarawi *et al.* (2013).

Table 3: Effect of postharvest application of some essential oils salicylic acid and some salts on firmness (Newton) of Canino apricot fruits stored at 0 ±1°C with 90 – 95 % RH

Treatments	Storage period (days)					
	0	7	14	21	28	Mean
	2017season					
Control	6.92 a	3.81 f	2.54 e	2.34 e	2.28 e	3.58c
Thyme oil at 100 ppm	6.92 a	4.70 e	4.27 d	3.49 d	2.34 e	4.34bc
Spearmint oil at 1000 ppm	6.92 a	6.09 ab	5.55 a	4.65 a	3.99 ab	5.44ab
Clove oil at 1000 ppm	6.92 a	5.59 bc	5.39 ab	4.18 bc	3.61 c	5.14ab
Eucalyptus oil at 1000 ppm	6.92 a	5.54 cd	4.85 bc	4.43 ab	3.21 d	4.99ab
Mustard oil at 1000 ppm	6.92 a	5.74 bc	4.88 bc	3.68 d	2.97 d	4.84ab
K_2CO_3 at 2%	6.92 a	6.44 a	5.82 a	4.81 a	4.17 a	5.63a
$KHCO_3$ at 2%	6.92 a	5.03 de	4.27 d	3.76 cd	3.03 d	4.60abc
$CaCl_2$ at 3%	6.92 a	5.44 cd	4.93 bc	4.42 ab	3.67 bc	5.08ab
Salicylic acid at 2%.	6.92 a	5.41cd	4.59 cd	4.13 bc	3.80 bc	4.97ab
Mean	6.92a	5.38b	4.71c	3.99d	3.31e	
	2018 season					
Control	7.09 a	3.55 g	2.90 d	2.55 h	2.13 f	3.64c
Thyme oil at 100 ppm	7.09 a	4.98 f	3.97 c	3.43 g	2.95 e	4.48bc
Spearmint oil at 1000 ppm	7.09 a	6.13 b	5.46 a	4.70 ab	4.08 ab	5.49ab
Clove oil at 1000 ppm	7.09 a	5.45 de	5.40 a	4.33 de	3.99 b	5.25ab
Eucalyptus oil at 1000 ppm	7.09 a	5.15 ef	4.68 b	4.39 cd	3.52 cd	4.97ab
Mustard oil at 1000 ppm	7.09 a	5.62 cd	4.93 b	4.56 bc	3.46 d	5.13ab
K_2CO_3 at 2%	7.09 a	6.67 a	5.60 a	4.84 a	4.18 a	5.67a
$KHCO_3$ at 2%	7.09 a	5.38 de	4.51 b	4.12 f	3.66 c	4.95ab
$CaCl_2$ at 3%	7.09 a	5.46 de	4.80 b	4.57 bc	3.95 b	5.17ab
Salicylic acid at 2%.	7.09 a	5.83 bc	4.67 b	4.17 ef	4.13 ab	5.18ab
Mean	7.09a	5.42b	4.69c	4.17d	3.61e	

Means followed by different letter are significantly different within columns by Duncan's multiple range tests, P≤0.05.

Table 4: Pearson correlation coefficient relations among some chosen characters of Canino apricot fruits treated by some essential oils and some salts with storage at 0 ±1°C with 90 – 95 % RH

	Weight loss%	SSC%	Decay%	Shelf life (days)	Acidity %	SSC/acid ratio	PH	Firmness(Newton)	Respir-ation rate	V.C (mg/100 ml)
Weight loss%	1									
SSC%	-.019	1								
Decay%	0.702**	-.570**	1							
Shelf life*(days)*	-.562**	-.046	-.590**	1						
Acidity%	0.309	-.539**	0.718**	-.503**	1					
SSC/acid ratio	-.122	0.822**	-.685**	0.277	-.910**	1				
PH	0.661**	-.156	0.697**	-.630**	0.454*	-.335	1			
Firmness(Newton)	-.481**	0.537**	-.846**	0.422*	-.558**	0.581**	-.747**	1		
Respiration rate	0.565**	-.351	0.621**	-.403*	0.441*	-.380*	0.522**	-.549**	1	
V.C(mg/100 ml)	-.308	0.399*	-.508**	0.331	-.613**	0.552**	-.368*	0.375*	-.813**	1

Shelf life (days):

Data in Table 5 reveal that all tested postharvest treatments progressively increased shelf life of Canino apricot fruits with significant differences in most cases when compared with control in both seasons. However, Spearmint oil, Clove oil, Eucalyptus oil and Mustard oil applications showed to be the most effective treatments for prolonging fruits shelf life, in both seasons. The obtained results of essential oil treatments on extending the shelf life of Canino apricot fruits are in harmony with those of Serrano *et al.,* (2005) on sweet cherry, Valero *et al.,* (2006) on table grape and Baiea and El Badawy (2013) on Washington navel orange. They mentioned that application of essential oil constituents such as Thymol, Carvacrol, Eugenol and Menthol enhanced the shelf life of fruits.

Table 5: Effect of postharvest application of some essential oils salicylic acid and some salts on shelf life (days) of Canino apricot fruits stored at 0 ±1◦C with 90 – 95 % RH

Treatments	Storage period (days)					
	0	7	14	21	28	Mean
	2017 season					
Control	8.62 f	5.67 e	5.00 c	3.67 d	3.00 d	5.19e
Thyme oil at 100 ppm	13.28 b	11.00 ab	7.00 b	4.67 cd	3.33 cd	7.86cd
Spearmint oil at 1000 ppm	14.28 a	12.33 a	9.00 a	8.33 a	7.33 a	10.26a
Clove oil at 1000 ppm	14.39 a	12.67 a	9.00 a	7.00 ab	6.00 ab	9.81ab
Eucalyptus oil at 1000 ppm	11.95 c	10.67 abc	8.00 ab	7.00 ab	6.00 ab	8.72bc
Mustard oil at 1000 ppm	11.98 c	10.67 abc	8.00 ab	7.33 ab	6.00 ab	8.80abc
K_2CO_3 at 2%	10.10 e	9.10 bcd	7.00 b	5.00 cd	4.00 cd	7.04d
$KHCO_3$ at 2%	8.94 f	7.40 de	7.00 b	4.91 cd	4.00 cd	6.45de
$CaCl_2$ at 3%	11.02 d	9.92 bc	8.00 ab	5.98 bc	5.00 bc	7.98cd
Salicylic acid at 2%.	9.83 e	8.63 cd	7.00 b	3.92 d	3.20 d	6.52de
Mean	11.44a	9.81b	7.50c	5.78d	4.79e	
	2018 season					
Control	8.11 f	6.02 e	4.35 c	3.03 d	2.03 d	4.71c
Thyme oil at 100 ppm	15.11 a	9.02 cd	7.03 b	4.02 cd	3.02 c	7.64ab
Spearmint oil at 1000 ppm	11.11 d	13.07 a	9.20 a	6.69 a	5.01 a	9.02a
Clove oil at 1000 ppm	11.15 d	9.03 cd	8.60 a	7.02 a	5.69 a	8.30ab
Eucalyptus oil at 1000 ppm	12.15 c	10.02 bc	8.52 a	7.02 a	5.68 a	8.68a
Mustard oil at 1000 ppm	13.11 b	11.03 b	8.01 ab	6.02 ab	5.34 a	8.70a
K_2CO_3 at 2%	11.50 cd	10.01 bc	8.00 ab	5.00 bc	4.00 b	7.70ab
$KHCO_3$ at 2%	10.03 e	8.03 d	8.00 ab	4.00 cd	4.00 b	6.81b
$CaCl_2$ at 3%	12.05 c	10.00 bc	8.01 ab	5.00 bc	4.00 b	7.81ab
Salicylic acid at 2%.	10.96 d	9.00 d	8.01ab	3.63 cd	2.33 cd	6.79b
Mean	11.53a	9.52b	7.77c	5.14d	4.11e	

Means followed by different letter are significantly different within columns by Duncan's multiple range tests, P≤0.05

Respiration rate (mg CO_2/kg/h):

Data presented in Table 6 show that, generally fruit respiration rate was decreased after 7 days of storage at 0 ± 1°C with 90 ± 95% relative humidity as compared with harvesting date, afterward respiration rate was increased with increasing storage period for all dates. This trend was true in both seasons. Fruit dipped in K_2CO_3, $KHCO_3$, Mustard oil had lower respiration rate than those found in the other treatments during the all determination times of cold storage. The significant highest respiration rate was recorded with control fruits. These results are agreed with those of Abd El Wahab (2015) who revealed that Lemongrass, Thyme, Rosemary, Lavender, Bergamot, Pepper mint, Dill and Coriander essential oils treatments tended to have the effective role in reducing the rate of respiration of nectarine fruits under cold storage. Moreover, the results of Table 4 clear a negative correlation between weight loss% of fruits vas shelf life (-.562) and positive correlation with fruit respiration rate (0.565**). The slower respiration rate in essential oils treated fruits may be explained according to fruit respiration is considered as the major factor contributing to postharvest losses, it increasing the converts of stored sugars or starch into energy in the presence of the O_2 and advances ripening (Day, 1990). Reduced fruit respiration retards softening and slows down ripening (Kader, 1986) and slowing ripening through decreases respiration rate in fruits which may reduce ethylene production. This result agrees with that of Abdolahi *et al.,* (2010) and Abd El Wahab *et al.,* (2014).**

Table 6: Effect of postharvest application of some essential oils salicylic acid and some salts on respiration rate (mg CO_2/kg/h) of Canino apricot fruits stored at 0 ±1◦C with 90 – 95 % RH

Treatments	Storage period (days)					
	0	7	14	21	28	Mean
	2017season					
Control	13.40 a	6.10 a	9.34 a	10.85 a	12.42 a	10.42a
Thyme oil at 100 ppm	13.40 a	5.93 a	8.22 b	8.26 bc	9.43 bc	9.05b
Spearmint oil at 1000 ppm	13.40 a	3.20 de	5.67 cd	7.06 d	7.66 d	7.40ef
Clove oil at 1000 ppm	13.40 a	4.54 b	6.33 c	8.43 bc	8.84 c	8.31cd
Eucalyptus oil at 1000 ppm	13.40 a	4.04 bc	8.55 b	8.96 b	9.18 c	8.83bc
Mustard oil at 1000 ppm	13.40 a	2.95 e	3.30 ef	7.03 d	7.54 d	6.84f
K_2CO_3 at 2%	13.40 a	1.04 f	1.83 g	4.62 e	6.10 e	5.40g
$KHCO_3$ at 2%	13.40 a	2.58 e	2.68 f	3.69 f	5.91e	5.65g
$CaCl_2$ at 3%	13.40 a	3.80 cd	3.92 e	7.78 cd	10.20 b	7.82de
Salicylic acid at 2%.	13.40 a	2.92 e	5.21 d	8.40 bc	8.98 c	7.78de
Mean	13.40a	3.71e	5.51d	7.51c	8.63b	
	2018 season					
Control	12.96 a	7.22 a	9.71 a	10.51 a	12.35 a	10.55a
Thyme oil at 100 ppm	12.96 a	5.43 bc	8.57 b	8.57 bc	8.79 de	8.87b
Spearmint oil at 1000 ppm	12.96 a	3.78 d	4.28 f	6.78 e	8.13 ef	7.18c
Clove oil at 1000 ppm	12.96 a	5.87 b	6.58 d	7.96 cd	10.14 b	8.70b
Eucalyptus oil at 1000 ppm	12.96 a	5.21 c	7.95 c	8.97 b	9.06 cd	8.83b
Mustard oil at 1000 ppm	12.96 a	3.35 d	4.25 f	4.45 f	6.54 g	6.31d
K_2CO_3 at 2%	12.96 a	0.85 g	2.47 g	6.27 e	7.36 fg	5.98d
$KHCO_3$ at 2%	12.96 a	1.83 f	3.90 f	4.33 f	8.24 de	6.25d
$CaCl_2$ at 3%	12.96 a	1.96 f	6.48 d	6.41 e	9.76 bc	7.51c
Salicylic acid at 2%.	12.96 a	2.71 e	5.66 e	7.55 d	8.75 de	7.53c
Mean	12.96a	3.82e	5.98d	7.18c	8.91b	

Means followed by different letter are significantly different within columns by Duncan's multiple range tests, P≤0.05

Soluble solids content (SSC %):

The results in Table 7 show that, the soluble solids content percentage increased significantly during cold storage period in all treatments. The highest soluble solids content was recorded in fruits dipped in K_2CO_3, $KHCO_3$, $CaCl_2$ and Thyme oil without significant among them as compared with control and other treatments in both seasons. Spearmint oil, Clove oil, Eucalyptus oil and Mustard oil treatments slightly decreased soluble solids content percentage compared toK_2CO_3, $KHCO_3$, $CaCl_2$ treatments, but the lowest value was recorded in fruit dipped in distilled water (Control). These results were in agreement with those of Saleh *et al*., (2019) they reported that essential oil maintained the TSS compared to control by retarding the ripening process on the Le Conte pear. The positive effect on total soluble solids by essential oil may be due to the delaying in metabolic activity and reduced respiration rate and vital process, this reflected to reducing the loss of TSS during storage, degradation of fruits and over senescence results were in accordance with the findings of Abdolahi *et al.,* (2010) and Salimi *et al.,* (2013).

Table 7: Effect of postharvest application of some essential oils salicylic acid and some salts on SSC% of Canino apricot fruits stored at 0 ±1◦C with 90 – 95 % RH

Treatments	Storage period (days)					
	0	7	14	21	28	Mean
	2017season					
Control	13.13 a	13.67 f	14.80 f	15.15 c	16.00 d	14.55f
Thyme oil at 100 ppm	13.13 a	15.53 abc	16.67 b	17.07 a	18.40 a	16.16ab
Spearmint oil at 1000 ppm	13.13 a	14.47 e	14.47 f	15.13 c	16.00 d	14.64f
Clove oil at 1000 ppm	13.13 a	15.07 cd	15.87 de	16.00 b	16.00 d	15.21de
Eucalyptus oil at 1000 ppm	13.13 a	15.40 bc	15.93 cde	16.27 b	17.00 c	15.55cd
Mustard oil at 1000 ppm	13.13 a	14.67 cd	15.53 de	15.00 c	16.20 d	14.91ef
K_2CO_3 at 2%	13.13 a	16.00 a	17.27a	17.37 a	18.53 a	16.46a
$KHCO_3$ at 2%	13.13 a	15.87ab	17.33 a	17.40 a	18.0 ab	16.35a
$CaCl_2$ at 3%	13.13 a	15.93 a	16.40 bc	17.33 a	18.33 a	16.23ab
Salicylic acid at 2%.	13.13 a	15.27 c	16.33 bcd	17.00 a	17.53 b	15.85bc
Mean	13.13d	15.19c	16.06b	16.37b	17.20a	
	2018 season					
Control	13.67 a	13.80 e	14.80 f	15.13 g	16.00 f	14.68 e
Thyme oil at 100 ppm	13.67 a	16.00 a	18.07 b	18.00 cd	19.00 c	16.95 ab
Spearmint oil at 1000 ppm	13.67 a	14.67 d	14.97 f	16.33 f	17.00 e	15.33 de
Clove oil at 1000 ppm	13.67 a	15.67 ab	16.33 e	18.00 cd	18.27 d	16.39 bc
Eucalyptus oil at 1000 ppm	13.67 a	14.73 d	16.80 d	17.20 de	18.00 d	16.08 bcd
Mustard oil at 1000 ppm	13.67 a	15.07 cd	16.40 de	16.73 ef	17.13 e	15.80 cd
K_2CO_3 at 2%	13.67 a	16.00 a	18.73 a	20.00 a	21.40 a	17.96 a
$KHCO_3$ at 2%	13.67 a	15.93 a	18.60 a	19.37 ab	20.00 b	17.51 a
$CaCl_2$ at 3%	13.67 a	15.87 a	17.27 c	18.73 bc	19.93 b	17.09 ab
Salicylic acid at 2%.	13.67 a	15.33 bc	16.73 de	17.53 de	18.80 c	16.41 bc
Mean	13.67e	15.31d	16.87c	17.70b	18.55a	

Means followed by different letter are significantly different within columns by Duncan's multiple range tests, P≤0.05

Titratable acidity (%):

Data presented in Table 8 show Titratable acidity values were significantly decreased with the incidence of storage period in both seasons. Although, essential oils, calcium compounds and Salicylic acid treatments had a significantly influence on the titratable acidity content compared to control, there was no consistent trend for behavior of titratable acidity content with treatments in both seasons. These results came true with those of Barakat *et al.,* (2015). This result could be due to the delaying of alteration in metabolism and slowing down the respiration rate caused by coating with essential oils (Abd El Wahab *et al*., 2014).

Table 8: Effect of postharvest application of some essential oils salicylic acid and some salts on titratable acidity % of Canino apricot fruits stored at 0 ±1◦C with 90 – 95 % RH

Treatments	Storage period (days)					
	0	7	14	21	28	Mean
	2017season					
Control	0.89 a	0.86 a	0.79 a	0.70 a	0.66 a	0.78 a
Thyme oil at 100 ppm	0.79 a	0.83 ab	0.69 d	0.62 c	0.56 c	0.70 ab
Spearmint oil at 1000 ppm	0.89 a	0.82 b	0.71 cd	0.66 b	0.54 c	0.72ab
Clove oil at 1000 ppm	0.89 a	0.75 de	0.64 f	0.58 d	0.51 d	0.67b
Eucalyptus oil at 1000 ppm	0.89 a	0.81 b	0.72 bc	0.69 a	0.60 b	0.74ab
Mustard oil at 1000 ppm	0.89 a	0.79 bc	0.73 bc	0.63 c	0.56 c	0.72ab
K_2CO_3 at 2%	0.89 a	0.76 cde	0.74 b	0.61 c	0.54 c	0.71ab
$KHCO_3$ at 2%	0.89 a	0.72 ef	0.64 f	0.63 c	0.58 b	0.69b
$CaCl_2$ at 3%	0.89 a	0.71 f	0.67 e	0.57 d	0.49 e	0.66b
Salicylic acid at 2%.	0.89 a	0.76 cd	0.75 b	0.63 c	0.59 b	0.72ab
Mean	0.88a	0.78b	0.71bc	0.63c	0.56d	
	2018 season					
Control	0.85 a	0.78 a	0.69 a	0.65 ab	0.59 a	0.71a
Thyme oil at 100 ppm	0.85 a	0.64 d	0.60 c	0.54 cd	0.45 de	0.61ab
Spearmint oil at 1000 ppm	0.85 a	0.66 c	0.64 b	0.69 a	0.43 ef	0.65ab
Clove oil at 1000 ppm	0.85 a	0.60 ef	0.58 d	0.49 de	0.40 f	0.58ab
Eucalyptus oil at 1000 ppm	0.85 a	0.62 e	0.59 c	0.59 bc	0.52 c	0.64ab
Mustard oil at 1000 ppm	0.85 a	0.70 b	0.60 c	0.54 cd	0.46 d	0.63ab
K_2CO_3 at 2%	0.85 a	0.61 ef	0.54 e	0.46 e	0.41 f	0.57ab
$KHCO_3$ at 2%	0.85 a	0.60 f	0.47 f	0.47e	0.42 ef	0.56b
$CaCl_2$ at 3%	0.85 a	0.50 g	0.45 f	0.43 e	0.40 f	0.53b
Salicylic acid at 2%.	0.85 a	0.61 ef	0.57 d	0.56 c	0.56 b	0.63ab
Mean	0.85a	0.63b	0.57c	0.54c	0.46d	

Means followed by different letter are significantly different within columns by Duncan's multiple range tests, P≤0.05

SSC/acid ratio:

The results in Table 9 reveal that as cold storage period progressed, the SSC/acid ratio significantly increased. Also, the values of SSC/acid ratio was significantly affected by essential oils and calcium compounds treatments, since treated fruits with $CaCl_2$, $KHCO_3$ and K_2CO_3 had the highest SSC/acid ratio values during cold storage, while the lowest was in control fruits. Whereas, treated fruits with Thyme oil, Spearmint, Clove oil, Eucalyptus oil and Mustard oil had SSC/acid ratio values were in between lower values in control and were higher values in calcium compounds in both seasons. The obtained results go in the same line with those reported by Gameel, (2012) who observed that, the used concentrations of essential oils had no significant on TSS/acidity ratio of Eureka lemon fruits during the cold storage period.

Table 9: Effect of postharvest application of some essential oils salicylic acid and some salts on SSC/acid ratio of Canino apricot fruits stored at 0 ±1◦C with 90 – 95 % RH

Treatments	Storage period (days)					
	0	7	14	21	28	Mean
	2017season					
Control	14.83 a	15.90 g	18.79 f	21.57e	24.35 g	19.09 f
Thyme oil at 100 ppm	17.27 a	18.73 ef	24.05 bc	27.50 bc	33.12 c	24.13b
Spearmint oil at 1000 ppm	14.83 a	17.71 f	20.41 e	22.86 d	29.66 e	21.09e
Clove oil at 1000 ppm	14.83 a	20.17 cd	24.91 b	27.57 bc	31.23 d	23.74bc
Eucalyptus oil at 1000 ppm	14.83 a	19.10 de	22.06 d	23.43 d	28.49 f	21.58de
Mustard oil at 1000 ppm	14.83 a	18.55 ef	21.18 de	23.85 d	29.16 ef	21.51de
K_2CO_3 at 2%	14.83 a	21.20 bc	23.35 c	28.63 b	34.33 b	24.47b
$KHCO_3$ at 2%	14.83 a	22.14 ab	27.26 a	27.66 bc	30.81 d	24.54b
$CaCl_2$ at 3%	14.83 a	22.55 a	24.63 b	30.35 a	37.40 a	25.95a
Salicylic acid at 2%.	14.83 a	20.03 d	21.86 d	27.02 c	29.64 e	22.68cd
Mean	15.07e	19.61d	22.85c	26.04b	30.82a	
	2018 season					
Control	16.07 a	17.75 g	21.34 h	23.40 e	27.15 g	21.14f
Thyme oil at 100 ppm	16.07 a	25.13 c	30.17 d	33.63 c	42.28 d	29.46c
Spearmint oil at 1000 ppm	16.07 a	22.35 e	23.51 g	24.14 e	40.00 d	25.21e
Clove oil at 1000 ppm	16.07 a	25.97 b	28.32 ef	36.71 b	45.63 c	30.54c
Eucalyptus oil at 1000 ppm	16.07 a	23.77 d	28.31 ef	29.29 d	34.42 f	26.37d
Mustard oil at 1000 ppm	16.07 a	21.45 f	27.38 f	31.26 cd	37.44 e	26.72d
K_2CO_3 at 2%	16.07 a	26.28 b	34.69 c	43.53 a	52.66 a	34.64b
$KHCO_3$ at 2%	16.07 a	26.60 b	39.83 a	41.57 a	47.52 c	34.32b
$CaCl_2$ at 3%	16.07 a	31.98 a	38.25 b	43.11 a	49.98 b	35.88a
Salicylic acid at 2%.	16.07 a	24.99 c	29.35 de	31.21 cd	33.87 f	27.10d
Mean	16.07e	24.63d	30.11c	33.78b	41.10a	

Means followed by different letter are significantly different within columns by Duncan's multiple range test, P≤0.05

Ascorbic acid (mg/100 ml juice):

The levels of ascorbic acid in Canino apricot fruits followed a declining trend commensurate with advancement of storage period (Table 10) and that the mount of ascorbic acid at the initial of the storage period was higher than the end ones. These results came true with those of Ishaq *et al.,* (2009) who reported that the ascorbic acid content in apricot fruit was reduced during storage. With regards to the observations, significant differences were found in relation to the ascorbic acid level. Canino apricot fruits soaked in aqueous solution of Mustard oil had higher ascorbic acid levels than that of control and other treatments during cold storage. On the contrast, fruits dipped in distilled water (control) had the lowest values of ascorbic acid content in Canino apricot fruits storage duration. According to Ishaq *et al.,* (2009) the decrease of ascorbic acid during storage could be due to the conversion of dehydroascobic to diketogulonic acid by oxidation. The above-mentioned results of fruit characters (SSC%, acidity, SSC/acid ratio and ascorbic acid) were confirmed (Table 4) where, Pearson correlation coefficient data showed positive correlation between fruit SSC% vas SSC/acid ratio (0.822**), firmness (0.537**) and v.c (0.399*).However SSC% cleared negative correlation with fruit decay (-.570**), acidity (-.539**) and respiration rate (-.351).

Table 10: Effect of postharvest application of some essential oils salicylic acid and some salts on vitamin C (mg/100ml juice of Canino apricot fruits stored at 0 ±1◦C with 90 – 95 % RH

Treatments	Storage period (days)					
	0	7	14	21	28	Mean
	2017season					
Control	17.61 a	13.06 e	10.88 f	10.23 e	7.98 c	11.95f
Thyme oil at 100 ppm	17.61 a	15.93 a-d	15.15 bc	13.85 b	9.81 b	14.47cd
Spearmint oil at 1000 ppm	17.61 a	17.23 ab	16.16 ab	14.50 ab	10.76 b	15.25abc
Clove oil at 1000 ppm	17.61 a	14.35 de	13.80 cde	13.80 b	10.46 b	14.00de
Eucalyptus oil at 1000 ppm	17.61 a	16.49 abc	14.60 cd	14.15 ab	10.96 b	14.76bcd
Mustard oil at 1000 ppm	17.61 a	17.75 a	17.46 a	15.06 a	13.29 a	16.24a
K_2CO_3 at 2%	17.61 a	16.28 abc	14.39 cd	13.91 b	10.97 b	14.63cd
$KHCO_3$ at 2%	17.61 a	17.11 ab	15.07 bc	14.68 ab	14.36 a	15.76ab
$CaCl_2$ at 3%	17.61 a	15.79 bcd	13.53 de	12.54 c	10.32 b	13.96de
Salicylic acid at 2%.	17.61 a	14.60 cde	12.88 e	11.53 d	8.52 c	13.03e
Mean	17.61a	15.86b	14.39c	13.43d	10.74e	
	2018 season					
Control	17.20 a	12.01 d	10.39 e	9.11 e	8.09 g	11.36g
Thyme oil at 100 ppm	17.20 a	15.20 b	12.30 cd	10.77 d	10.77 de	13.25de
Spearmint oil at 1000 ppm	17.20 a	16.14 a	13.80 b	12.66 c	11.45 bcd	14.25bcd
Clove oil at 1000 ppm	17.20 a	13.65 c	11.60 d	10.69 d	9.26 f	12.48ef
Eucalyptus oil at 1000 ppm	17.20 a	15.02 b	13.60 b	12.07 c	9.88 ef	13.55cd
Mustard oil at 1000 ppm	17.20 a	16.69 a	14.86 a	14.79 a	13.00 a	15.31a
K_2CO_3 at 2%	17.20 a	15.08 b	14.25 ab	13.57 b	11.99 abc	14.42abc
$KHCO_3$ at 2%	17.20 a	16.44 a	14.31 ab	13.78 b	12.39 ab	14.82ab
$CaCl_2$ at 3%	17.20 a	13.15 c	12.71 c	12.47 c	10.98 cd	13.30de
Salicylic acid at 2%.	17.20 a	11.94 d	11.83 d	9.50 e	9.53 f	12.00fg
Mean	17.20a	14.53b	12.97c	11.94d	10.73e	

Means followed by different letter are significantly different within columns by Duncan's multiple range tests, P≤0.05

CONCLUSION

It can be concluded from the above results that, fruit weight loss, decay and respiration rate were significantly decreased by using of Eucalyptus, and Clove oils. Also, soaking the fruits in the solution of Eucalyptus, Clove oils and potassium carbonate resulted in increase in fruit firmness, acidity, ascorbic acid, soluble solids and SSC/acid ratio during the cold storage period. Accordingly, Eucalyptus oil, and Cloves oil are more effective in reducing weight loss, decay and respiration rate and maintaining overall quality of Canino apricot fruits under cold storage conditions for 28 days, as compared to other treatments.

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تأثير بعض المستخلصات المائية لبعض الزيوت العطرية والأملاح وحمض الساليسيليك على تقليل التلف وحفظ الجودة وإطالة فترة عرض ثمار المشمش صنف كانينو

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الملخص العربى

أجريت هذه الدراسة على ثمار تم جمعها من أشجار المشمش صنف كانينو، عمر الأشجار ١٢ عامًا وتنمو في مزرعة خاصة بقرية دنوشر، مركز المحلة الكبرى، محافظة الغربية، مصر خلال مواسم ٢٠١٧ و ٢٠١٨ وذلك لدراسة تأثير بعض الزيوت العطرية وبعض الأملاح وحمض الساليسيليك على تقليل التدهور والحفاظ على جودة وإطالة عمر ثمار المشمش صنف كانينو. تم جمع الثمار في مرحلة التلوين الكامل. تم نقل الثمار مباشرة إلى معمل محطة بحوث البساتين بسخا محافظة كفر الشيخ، تم تنظيف الثمار وتعقيمها وتجفيفها هوائي، تم إجراء المعاملات على الثمار وذلك بنقعها في احد المحاليل المائية الآتية: زيت الزعتر بتركيز ١٠٠ جزء في المليون وزيت النعناع بتركيز ١٠٠٠ جزء في المليون وزيت القرنفل بتركيز ١٠٠٠ جزء في المليون وزيت الكافور بتركيز ١٠٠٠ جزء في المليون وزيت الخردل بتركيز ١٠٠٠ جزء في المليون وكربونات البوتاسيوم ٢% وبكربونات البوتاسيوم ٢% وكلوريد الكالسيوم ٣% وحمض الساليسيليك ٢٪ وكذلك الماء المقطر (الكنترول) لمدة ٥ دقائق. خزنت الثمار المعاملة في الثلاجة على درجة حرارة صفر ± ١ و رطوبة نسبية ٩٠ – ٩٥ ٪ لمدة ٢٨ يوما. أظهرت النتائج أن الفقد في الوزن وتدهور ثمار المشمش صنف كانينو انخفض بشكل كبير عن طريق استخدام زيوت الكافور والنعناع والقرنفل. أيضا، نقع الثمار في محلول زيوت الكافور، والنعناع والقرنفل وكربونات البوتاسيوم أدى إلى زيادة صلابة الثمار وزيادة الحموضة، حمض الأسكوربيك، المواد الصلبة القابلة للذوبان ونسبة المواد الصلبة القابلة للذوبان / الحموضة خلال فترة التخزين.

وعلية، يعتبر زيت الكافور والنعناع والقرنفل أكثر فعالية في الحد من الفقد في الوزن والتدهور والحفاظ على جودة ثمار المشمش صنف كانينو تحت ظروف التخزين البارد لمدة ٢٨ يوم وذلك عند المقارنة مع المعاملات الأخرى.

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