J. Agric. Sci. Mansoura Univ., 32 (3): 2173 - 2193, 2007

EFFECT OF USING SOME ESSENTIAL OILS INSTEAD OF FUNGICIDES IN WAX ON THE STORABILITY OF "VALENCIA" ORANGE FRUITS

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ABSTRACT

This study was performed during 2005 and 2006 seasons. "Valencia" orange fruits treated with various treatments [dipping for 10 sec in (1) wax; (2) wax + Eucalyptus oil 1%; (3) wax + Eucalyptus oil 2%; (4) wax + Peppermint oil 0.5%; (5) wax + Peppermint oil 1%; (6) wax +Cinnamon oil 0.5%; (7) wax + Cinnamon oil 1%; (8) wax + Thiabendazole (TBZ) 0.5% + Imazalil (IMZ) 0.25% and (9) tap water (control)]. Thereafter, fruits were stored for 6 weeks at room temperature (20-26°C and 80-90% RH).

As the storage period prolonged, the percentages of unmarketable fruits and weight loss were significantly increased. At the end of storage period, the initial percentages of titratable acidity (TA) and fruit juice and the values of ascorbic acid (V.C) decreased, while the percentages of total soluble solids (TSS) and the TSS/ TA ratios increased. However, the differences of TSS and V.C were insignificant, as an average for all treatments.

As an average for all storage periods, when wax was used alone or combined with either the essential oils (Eucalyptus, Peppermint or Cinnamon) or the fungicides (TBZ + IMZ), gave a great effect on reducing the percentage of unmarketable fruits (10-20% in first experimental season and 10-22.5% in the second) compared with unwaxed ones (45% in both seasons) and reducing the percentages of weight loss (5.401-7.037% in the first season and 5.601-6.354% in the second) compared with unwaxed fruits (11.096 and 11.863% in first and second season, respectively). However, the superiority of wax treatments on improving physical properties, was not greatly obvious on chemical ones (TSS; TA; fruit juice %; TSS/TA and V.C).

Generally, neither essential oils nor fungicides influenced the percentages of weight loss by themselves, when both of them were added to the wax.

The essential oils were more effective on reducing the percentages of unmarketable fruits than the fungicides (when both were combined with wax). Except, Eucalyptus oil 1% (in both experimental seasons) and Peppermint oil 1% (in first one), as their efficient were similarly to the fungicides, as an average for all storage periods.

The unmarketable fruits were noticed for the first time at only 2 weeks of storage, in unwaxed orange fruits. Using wax alone retarded their appearance two weeks later. The addition of fungicides to wax delay their appearing till the end of storage period (6 weeks). When essential oils were used instead of fungicides, the unmarketable fruits appeared after 4-6 weeks of storage. Despite, most of their percentages were significantly lower than those of wax + fungicides, as an average for all storage periods.

Keywords: Oranges; wax; fungicides; essential oils and storage.

INTRODUCTION

Citrus fruits are immensely popular worldwide for their flavour and nutrition they are ranking first in their contribution of vitamin C to human nutrition in many countries.

Citrus fruits are commonly exposed to unfavourable environmental conditions in addition to infection with many pests and diseases during the growing season and storage. Common diseases and disorders predominantly related to harvesting and handling include green mold rot (*Penicillium digitatum* Sacc.), blue mold rot (*P. Italicum* Wehmer), sour rot (*Geotrichum candidum* Link) and oleocellosis. Postharvest losses of citrus fruits caused by *P. digitatum* and *P. Italicum* can account for more than 90 % of all postharvest losses. For this reason, virtually all decay control strategies in Egyptian citrus packinghouses are aimed at controlling green and blue molds. Green and blue mold diseases in citrus are controlled primarily by applications of chemical fungicides in commercial handling. The most common fungicides used are sodium ortho phenyl-phenate (SOPP), Imazalil (IMZ) and Thiabendazole (TBZ), (Mahmoud, 1998).

The application of wax or wax emulsion coatings to certain perishable fruits has been practices for many years. This practice probably started with the waxing of citrus fruits, (Subedi, 1998; Petracek *et al*., 1998 and Daqing & Petracek, 1999). Citrus fruits should be waxed to prevent moisture loss and desiccation, (Hardenburg *et al*., 1986). The main effect of wax on extending the storage life of citrus fruits was confirmed by those found by Lawes & Prasad (1999) on "Silverhill Satsuma" mandarins. Waxing reduced respiration activity and ethylene production and thus extending shelf life of "Kinnow" mandarins, (Farooqi *et al*., 1988). Besides, Fioravanco *et al*., (1995) found that untreated "Tahiti" limes shriveled after 30 to 39 days of storage, while waxed fruits showed lower weight losses and maintained good quality throughout storage period (80 days).

Wax formulations by themselves do not control decay, as is sometimes claimed. So, in order to reduce incidence of infection or to minimize spoilage in bruised fruits, fungicides allowed by food laws, are combined with wax in a single application, (Subedi *et al.*, 1998). The combination of wax with fungicides (TBZ and SOPP) could be valuable in retarding deterioration and thus represented a major advance in the storage and handling lemon fruits, (Predebon & Edwards, 1992). Likewise, Smilanick *et al.*, (1997) found that, the application of Imazalil in wax reduced the incidence of green mold on lemons from 94.4% among untreated fruits to 15.1%.

New methods of control are needed because pathogen resistance to the fungicides chemicals has developed. Besides, the potential impact on environment as well as human health, largely limits fungicides application, (Eckert *et al.*, 1994). In addition, because of pollution risks, some fungicides are prohibited from use in many developed countries, (He *et al.*, 2003).

In order to minimize such problems, many investigators in the postharvest field of fresh production are trying to develop non-chemical means to improve fruit postharvest shelf-life and to protect them form decay. Recently, plant extracts and essential oils have been developed as an alternative to synthetic fungicides and a considerable success has been achieved for controlling postharvest diseases. Many plant extracts and essential oils were shown to have high antifungal activity against a wide range of fungi, (Singh *et al.*, 1980; Kurita *et al.*, 1981 and Davidson & Parish,

1989). Hussein *et al.* (1996) reported that alleochemical (s) from some plant extracts may have a potential to develop natural products that may act as bactericides and fungicides. Successful control of *P. digitatum and P. italicum* was recorded by many authors using different antagonistic plant extracts, (Arora & Pandey, 1985; Qamar & Chaudhary, 1994; Jiratko, 1995 and Hanafi *et al.*, 2002). In addition, Mahmoud (1998) reported that complete control of green mold on orange fruits was obtained due to fruit pretreatment with Cinnamon extracts (3%), Peppermint extracts (5%) and Eucalyptus extract (10%).

Almost, no studies have been done on using essential oils instead of fungicides in a combination with wax in a single application. So, to gain the beneficial effects of wax and essential oils, this investigation was carried out on "Valencia" orange fruits to evaluate the use of essential oils (Eucalyptus, Peppermint or Cinnamon) in a combination with wax, comparing to fungicides TBZ and IMZ as the standard fungicides in citrus packinghouse, on reducing decay and keeping quality of "Valencia" fruits during storage at room temperature (20-26°C) and relative humidity 80-90%.

MATERIALS AND METHODS

The experiment was conducted during the two successive seasons 2005 and 2006 using "Valencia" oranges. Fruits were obtained from a private orchard in Kafr El Dawar, Behera Governorate. The trees were about fifteen years old, budded on sour orange rootstock, planted in clay soil at 5x5 meters apart and were nearly similar in growth and productivity. The trees were receiving the normal horticultural practices.

Plant materials

Three commercial oils from plant materials were used, Eucalyptus fresh young leaves *(Eucalyptus globulus)* (Myrtaceae); Peppermint fresh leaves *(Mentha piperita L.)* (lamiaceae) and Cinnamon bark *(Cinnamomum zeylanicum L.)* (Lauraceae).

On the third week of April in both experimental seasons, 840 mature, uniform "Valencia" orange fruits were hand picked and carefully brought, soon after picking, to the Postharvest Laboratory, Pomology Department Faculty of Agriculture, University of Alexandria. The fruits were free from obvious defects or mechanical damage. They were then rinsed in tap water and dried. Thirty fruits form the selected ones were used as an initial sample for physical and chemical analysis. The remaining fruits (810) were divided into 9 equal groups (treatments), each treatment contained 90 fruits. Each of these groups was treated with one of the following 9 treatments. (Fig 1 and 2)

1- Dipping the fruits for 10 seconds in Citrosol wax emulsion (22%). Dipping the fruits for 10 seconds in Citrosol wax emulsion (22%) mixed with:-
2- Eucalyptus oil at 1.0%.
3- Eucalyptus oil at 2.0%.

4- Peppermint oil at 0.5%
5- Peppermint oil at 1.0%
6- Cinnamon oil at 0.5%
7- Cinnamon oil at 1.0 %
8- TBZ and IMZ at 0.5% and 0.25%, respectively.
9- Dipping the fruits, for 10 seconds, in tap water (control).

To emulsify the essential oils, tween-40 at 0.03% was added to wax (treatments 1-8) and to tap water (treatment 9).

Fruits were dried by the aid of an electric fan. Fruits of each treatments (90 fruits) was divided into 3 groups, 30 fruits each (10 fruits for each replicate), i.e. 3 storage periods x 3 replicates x 10 fruits = 90 fruits.

Fruits of each replicate (10 fruits) were packed in plastic mesh bag. All bags were saved in 9 open plastic boxes (60 x 40 x 18 cms). Each box contained 1 bag (replicate) from each treatment, in other words, each treatment was represented by 1 bag (one replicate) in each box. Three boxes (contained one replicate from each treatment) were taken at every evaluating date. All boxes were stored at room temperature (20-26°C) with relative humidity of 80-90%. Fruits of each treatment were evaluated at a 14 day-interval throughout the storage period (6 weeks), to study the effect of different experimental treatments on:

I- Physical properties:

1- Unmarketable fruits, the number of unmarketable fruits due to shrinkage or decay was calculated as percentage from the total number of each sample.
2- Weight loss, as a percentage from the initial weight.

II- Chemical properties:

1- Total soluble solids (TSS), were determined using a hand refractometer.
2- Titratable acidity (TA), expressed as percent of citric acid, was determined by titration against 0.1N sodium hydroxide, according to the A.O.A.C. (1985).
3- TSS/ TA ratio.
4- Juice percentage, juice weight was calculated as a percentage from the fruit weight (w/w).
5- Ascorbic acid (V.C), was determined by titration against 2.6 dichlorophenol indophenol blue dye, according to the A.O.A.C. (1985).

All data were statistically analyzed according to Snedecor and Cochran (1971). The design was Randomized Complete Block Design, two factors experiment, treatments and storage periods (split in time). The L.S.D method at (0.05) was used to compare the average of treatments (T), storage periods (P) and their interaction (TxP).

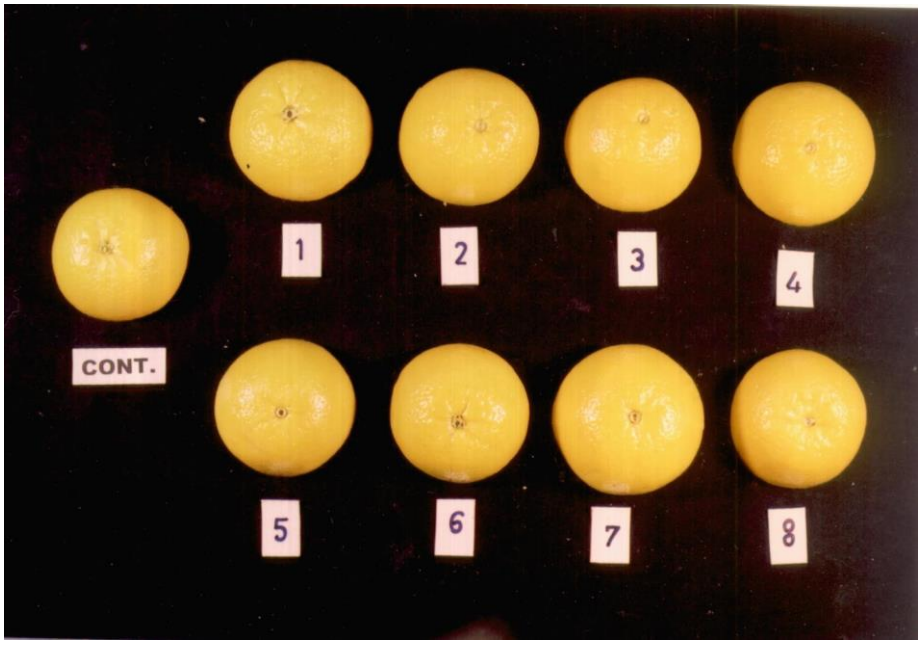

Fig. 1: The initial "Valencia" orange fruits treated with various treatments compared with control.

Treatments:

Control (Tap water)

1-	Wax		5-	Wax + Peppermint oil	1%
2-	Wax + Eucalyptus oil	1%	6-	Wax + Cinnamon oil	0.5%
3-	Wax + Eucalyptus oil	2%	7-	Wax + Cinnamon oil	1%
4-	Wax + Peppermint oil	0.5%	8-	Wax + TBZ + IMZ	

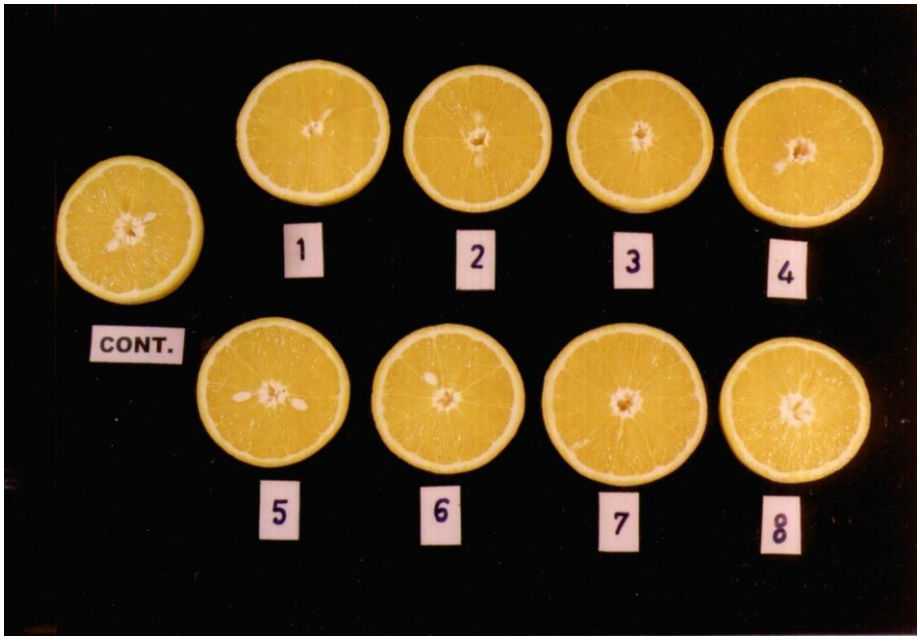

Fig. 2: Cross section in the initial "Valencia" orange fruits treated with various treatments compared with control.

Treatments:

Control (Tap water)

1-	Wax		5-	Wax + Peppermint oil	1%
2-	Wax + Eucalyptus oil	1%	6-	Wax + Cinnamon oil	0.5%
3-	Wax + Eucalyptus oil	2%	7-	Wax + Cinnamon oil	1%
4-	Wax + Peppermint oil	0.5%	8-	Wax + TBZ + IMZ	

RESULTS AND DISCUSSION

I-Physical Properties

1- Unmarketable fruits

The data presented in Table (1) clearly pointed out that, in both years of study, there was a significant increase in the percentage of unmarketable fruits with the progress of storage period, as an average for all experimental treatments.

Unwaxed fruits (tap water treatment) gave the highest significant percentage of unmarketable fruits (45% in both experimental seasons) compared with waxed ones (10-20% in first season and 10-22.5% in the second). The results were in agreement with those obtained by Attia (1995), as an average for all storage periods on "Balady" oranges and Baladwin *et al.* (1995) on "Valencia" oranges.

The data also declared that, fruits treated with wax only, showed significantly higher percentage of unmarketable fruits comparing with those treated with wax in combinations with each of the three essential oils (Eucalyptus; Peppermint or Cinnamon) or the fungicides (TBZ and IMZ). This may be explained by the accumulation effects of wax either with essential oils or fungicides on maintaining fruit quality.

The above mentioned data were supported by those previously found by Arras & Picci (1985); Grang & Ahmed (1988); Peretz *et al.* (1998) and EL-Gamal & El-Mougy (2002).

It was also clearly noticed that, all used essential oils (Eucalyptus; Peppermint or Cinnamon), when combined with wax emulsion, were more effective on reducing the percentage of unmarketable fruits than fungicides (TBZ and IMZ). However, the efficiency of Eucalyptus at 1.0% (in both seasons) and Peppermint at 1.0% (in first one), were similarly to the fungicides on reducing the percentage of unmarketable fruits. Obtained results were in line with those reported by Soltan & El-Shazly (2003) on navel oranges. They noticed that Cinnamon oil or Carnation oil at 1% were very comparable to Tecto (a recommended fungicide) on controlling Penicillum blue and green molds and kept fruit quality properly up to 60 days at 5°C and 90-95% RH.

Concerning the effect of essential plant oils, the data also showed that the least significant percentage of unmarketable fruits existed in fruits treated with wax + Cinnamon oil at both concentrations (0.5 and 1.0%) in first season, compared with those of other treatments. In the second one, they were found in fruits treated with wax +Eucalyptus oil at 2%; wax + Peppermint oil at both concentrations (0.5 and 1.0%) and wax + Cinnamon oil at 0.5%. These results were supported by those found by Mahmoud (1998) on navel orange, lime and lemon fruits.

It was worth noting that, the unmarketable fruits were have been noticed after 2 weeks of storage, in unwaxed fruits. Using wax emulsion alone retarded the appearance of unmarketable fruits 2 weeks later. The combination of wax with the fungicides (TBZ and IMZ) retarded the unmarketable fruits to the end of storage period (6 weeks).

T1

When essential plant oils (Eucalyptus; Peppermint or Cinnamon) were used instead of fungicides, the unmarketable fruits appeared at 4-6 weeks of storage, but most of their percentages were significantly lower than those of wax +fungicides, as an average for all storage periods.

2- Weight loss

The data illustrated in Table (2) disclosed that, in both years of study, as an average for all treatments, the percentage of weight loss significantly increased gradually as the storage period advanced. These findings agreed with those found by Rana & Kartar (1992) on sweet oranges.

The highest significant percentage of weight loss was found in unwaxed fruits (tap water treatment)(11.096 and 11.863% in the first and second season, respectively) compared with all waxed ones (5.401-7.037% in the first season and 5.601-6.354% in the second one), as an average for all storage periods. The data was supported by those found by Aworh *et al* (1991) on oranges and grapefruits and Farooqi (1994) on "Kinnow" mandarin fruits. Sun & Petracek (1999) reported that, the application of wax could minimize shrivelling through loss of water during storage "Marsh" grapefruits.

Data also showed that the differences were insignificant between weight loss percentage of fruits treated with wax + fungicides (TBZ + IMZ) on one side, and those treated with wax + each of the three essential oils (Eucalyptus; Peppermint or Cinnamon) on the other. Except ones treated with wax + Cinnamon oil at 1.0% (in first season only) where the differences were significant, as an average for all storage period.

3- Total soluble solids (TSS)

The data concerning the effect of various treatments on the percentages of TSS in the juice of oranges are presented in Table (3). As an average for all used treatments, the initial percentages of TSS slightly increased (from 10.266 to 10.414% in first experimental season and from 10.466 to 10.555% in the second, after 6 weeks of storage), the differences were not big enough to be significant. These findings are in line with those found by Singh *et al.* (1988) on "Kinnow" mandarins. In addition, Mansour & Smilanick (1997) reported that TSS of "Washington Navel" oranges showed slight increases due to storage period, compared with that at harvest time.

It has generally been found that, TSS percentage was not greatly affected by using wax emulsion either containing each of the three plant oils (Eucalyptus; Peppermint or Cinnamon) or the fungicides (TBZ + IMZ). The obtained results were in agreement with those found by Burns & Echeverria (1991) on "Valencia" oranges; Mansour & Smilanick (1997); Farag (2001); Hanafi *et al.* (2002) and Soltan & El-Shazly (2003) on navel oranges.

4- Titratable acidity (TA)

The effect of various treatments on the titratable acidity (expressed as percent of citric acid) in the juice of "Valencia" fruits, are presented in Table (4). The data declared that, in both experimental seasons, as an average for all applied treatments, the initial citric acid percentage significantly decreased, from 0.810 to 0.671% in the first experimental season and from 0.853 to 0.670% in the second one, at the end of storage period (6 weeks).

T2

t3

T4

The reduction of percent citric acid, at the end of storage, was previously recorded by El-Nawam (1991) on oranges; Cohen *et al.* (1991); Angadi & Krishnamurthy (1992) on mandarins; El-Zayat *et al.* (1998) on limes and El-Wahab (2000) on "Washington Navel" oranges. However, Artes *et al.* (1993) noticed that titratable acidity of "Primofiori" lemons was not changed relatively during storage.

Generally, essential oils (Eucalyptus; Peppermint or Cinnamon) such as fungicides (TBZ+IMZ), when combined with wax emulsion, did not greatly influence citric acid percentages, in both years of study. The inefficiency of wax with or without either essential oils or fungicides, on the values of TA, during storage, was previously noticed by Singh *et al.* (1988) on "Kinnow" mandarins and Sharafat *et al.* (1990) on "Blood red" oranges. In addition, Mansour & Smilanick (1997) found that physical and chemical properties of "Washington Navel" oranges were not or slightly affected by IMZ treatment during the storage period of 3 weeks at 10°C, Compared with untreated fruits.

5- TSS/ TA ratio

The data demonstrated in Table (5) showed that, in both years of study, as an average for all used treatments, the initial TSS/ TA ratios significantly increased from 12.680 to 15.727 in the first experimental season and from 12.463 to 15.921 in the second one, at the end of storage period. It could be mentioned that, TSS/ TA ratios, followed the changes of both TSS which was slightly increased, and acidity which significantly decreased, with the progress of storage period, so those ratios increased as a result.

Generally, the influence of the combinations of wax emulsion with each of the three plant oils (Eucalyptus; Peppermint or Cinnamon) likewise with the fungicides (TBZ+IMZ), were not greatly obvious on TSS/ TA ratios. The previous results were in harmony with those found by Mansour & Smilanick (1997) on "Washington Navel" orange.

6- Juice percentage

The data introduced in Table (6) recorded that, in both years of study, as an average for all experimental treatments, the initial juice percentages were significantly decreased from 60.690 to 42.318% in first season and from 58.353 to 43.043% in the second one, at the end of storage period.

The data also showed that, wax emulsion either containing plant oils (Eucalyptus; Peppermint or Cinnamon) of fungicides (TBZ +IMZ), almost had no effect on juice percentage.

7- Ascorbic acid (V.C)

The data in Table (7) clearly indicated that, in both years of study, as an average for all experimental treatments, the initial values of V.C slightly decreased at the end of storage period, although insignificant. The reduction of V.C content at the end of storage period, was previously reported by Al-Doori *et al.* (1990) on "Mahaley" orange and Rana & Kartar (1992) on sweet oranges. However, Artes *et al.* (1993) reported that the concentration of ascorbic acid in "Primofiori" lemons increased in relation to harvest values during storage.

T5

T6

T7

It seems quiet clear that, using wax emulsion either alone or combined with each of the three essential oils (Eucalyptus; Peppermint or Cinnamon) at both concentrations or with fungicides (TBZ + IMZ), did not greatly influence V.C values of "Valencia" orange fruits during storage.

Recommendation

Considering human health and because of the effectiveness of the essential oils on reducing decay, besides they were safe; physical and most of them easily available in our Egyptian environment, the author confirms on the importance of using essential oils (Eucalyptus, Peppermint or Cinnamon) as an alternative to the common fungicides (TBZ and IMZ), at citrus packinghouse, in waxing oranges.

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تأثير استخدام الزيون الطيارة بدلا من المبيدات الفطرية فى الشمع على المقدرة التخزينية لثمار برتقال "فالنشيا"

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أجريت هذه الدراسة خلال موسمى ٢٠٠٥، ٢٠٠٦ بهدف معرفة تأثير استخدام الزيوت النباتية الطيارة بدلا من المبيدات الفطرية فى الشمع المغطى لثمار برتقال "فالنشيا" على المقدرة التخزينية للثمار.

وكانت المعاملات كالآتى:

1- غمس الثمار لمدة ١٠ ثوان فى شمع مائى (Citrosol).
غمس الثمار لمدة ١٠ ثوان فى شمع مائى (Citrosol) مخلوطا بـ
2- زيت الكافور بتركيز ١%.
3- زيت الكافور بتركيز ٢%.
4- زيت النعناع بتركيز ٠,٥%.
5- زيت النعناع بتركيز ١%.
6- زيت القرفة بتركيز ٠,٥%.
7- زيت القرفة بتركيز ١%.
8- ثيوبيندازول وإمازليل بتركيز ٠,٥% ، ٠,٢٥% على الترتيب.
9- غمس الثمار لمدة ١٠ ثوان فى الماء (مقارنة)

وتم تخزين الثمار على درجة حرارة الغرفة (٢٠-٢٦ °م) ورطوبة نسبية (٨٠-٩٠%) لمدة ٦ أسابيع.

وقد أظهرت النتائج ما يلى:

أولاً: التغيرات الطبيعية والكيميائية أثناء التخزين

فى كلا موسمى الدراسة بتقدم فترة التخزين حدث زيادة معنوية فى النسبة المئوية للثمار الغير قابلة للتسويق وكذلك فقد الوزن. و عند نهاية فترة التخزين زادت نسبة المواد الصلبة الذائبة ونسبة المواد الصلبة الذائبة / الحموضة و حدث انخفاض فى النسبة المئوية للحموضة، و كذلك النسبة المئوية للعصير وقيم V.C وعموماً كانت التغيرات طفيفة فى نسبة المواد الصلبة الذائبة وV.C.

ثانياً: تأثير استخدام الشمع

ظهر تأثير استخدام الشمع واضحا عند استخدامه منفردا أو مخلوطا سواء بالزيوت الطيارة أو المبيدات الفطرية على

1- خفض النسبة المئوية للثمار الغير قابلة للتسويق معنوياً (١٠-٢٠% فى الموسم الأول للدراسة ، ١٠-٢٢,٥% فى الموسم الثانى) بالمقارنة بالثمار الغير مشمعه (٤٥% فى كلا موسمى الدراسة).
2- خفض النسبة المئوية للفقد الوزن معنويا (٥,٤٠١ – ٠٣٧.٧% فى الموسم الأول للبحث و٥,٦٠١ – ٦,٣٥٤% فى الموسم الثانى) بالمقارنة بالثمار الغير مشمعه (١١,٠٩٦ ، ١١,٨٦٣ فى الموسم الأول والثانى على الترتيب).

عموما لم تظهر تأثيرات واضحة لاستخدام الشمع على القياسات الكيميائية للجودة الثمار (النسبة المئوية للمواد الصلبة الذائبة – الحموضة والعصير ونسبة المواد الصلبة الذائبة إلى الحموضة وكذلك قيم فيتامين ج).

ثالثاً: المقارنة بين تأثيرات الزيوت الطيارة و المبيدات الفطرية

١- النسبة المئوية للثمار الغير قابلة للتسويق.

أظهر مخلوط الشمع مع الزيوت النباتية (كافور ، نعناع أو قرفة) تفوقا معنويا فى خفض النسبة المئوية للثمار الغير قابلة للتسويق بالمقارنة مع مخلوط الشمع مع المبيدات الفطرية (ثيابندازول وإمازليل) باستثناء زيت الكافور بتركيز ١% (فى كلا موسمى الدراسة) وزيت النعناع بتركيز ١% (فى الموسم الأول) حيث تعادل تأثيرهما مع المبيدات الفطرية.

٢- فقد الوزن

بصفة عامة لم توجد فروق واضحة بين تأثير الشمع مع الزيوت الطيارة (كافور، نعناع أو قرفة) وتأثير الشمع مع المبيدات الفطرية (ثيابندازول وإمازليل) على النسبة المئوية للفقد فى الوزن.

رابعاً: مواعيد ظهور الثمار الغير قابلة للتسويق

ظهرت الثمار الغير قابلة للتسويق لأول مرة بعد أسبوعين فقط من التخزين فى الثمار الغير مشمعة وأدى استخدام الشمع منفردا إلى تأخير ظهورها حتى ٤ أسابيع. و أدى استخدام الشمع مختلطا مع المبيدات الفطرية (ثيوبندازول ، إمازليل) إلى تأخر ظهور الثمار الغير قابلة للتسويق حتى ٦ أسابيع. وعندما استخدمت الزيوت النباتية الطيارة (كافور ، نعناع أو قرفة) بدلا من المبيدات الفطرية السابقة اختلف ظهور الثمار الغير قابلة للتسويق من ٤ إلى ٦ أسابيع على الرغم من أن النسبة المئوية لهذه الثمار الغير قابلة للتسويق عموما كانت أقل معنويا من مثيلتها للثمار المعاملة بالشمع مع المبيدات الفطرية (كمتوسط لكل فترات التخزين).

النتائج التى تم التوصل إليها تشير إلى:

- حيث أن الثمار الغير قابلة للتسويق يظهر معظمها بسبب الكرمشة نتيجة فقد الماء وبسبب الأمراض الفطرية وحيث أظهرت النتائج أن تأثير الزيوت الطيارة غير واضح على خفض % للفقد الوزن على ذلك يمكن ارجاع تفوق هذه الزيوت فى خفض % للثمار الغير قابلة للتسويق لقدرتها على خفض نسبة الإصابة بالفطريات.

توصية:

- نظرا لتفوق الزيوت الطيارة (كافور ، نعناع أو قرفة) بصفة عامة على المبيدات الفطرية فى قدرتها على خفض% الإصابة بالفطريات وحيث أنها أكثر أمنا وطبيعية ومعظمها متوافر فى البيئة المصرية ، لذا يمكن التوصية على أهمية استخدام هذه الزيوت النباتية (كافور ، نعناع أو قرفة) بدلا من المبيدات الفطرية (ثيوبندازول ، إمازليل) المعتاد إضافتها للشمع فى محطات تعبئة الموالح.