

## **EFFECT OF SOME NATURAL ACIDS AND CALCIUM ON TASTE PRESERVATION AND QUALITY OF "WASHINGTON" NAVEL ORANGES AFTER COLD STORAGE.**

### **B: POSTHARVEST TREATMENTS OF MATURE YELLOW FRUITS.**

**KARIM M. FARAG<sup>1</sup>, NEVEN M. N. NAGY<sup>1</sup> AND AHMED S. EL-SABAGH<sup>1</sup>.**

<sup>1</sup> Department of Horticulture, (Pomology), Faculty of Agriculture, Damanhour Branch,  
University of Alexandria, P.O.Box 22516, Damanhour, Egypt.

### **ABSTRACT**

The present study was carried out during 2004 and 2005 seasons on mature "Washington" Navel orange fruits. This work aimed to study the effect of postharvest dipping of the fruits at mature – yellow stage in water; natural acids and calcium chloride alone or plus waxing on keeping physical and chemical qualities which could reflect on the taste (sweetness) after cold storage. A total of 1280 mature – yellow fruits were harvested on 22 and 15 December, respectively in the two seasons of study, where they were divided into two equal groups each contained 640 fruits. The treatments were: Water as the control, Citric acid at 1% (w / v), Malic acid at 1% (w / v), Oxalic acid at 1% (w / v), and Calcium chloride at 2% (w / v). Fruits were then processed at El-Wady Station for Exporting Agriculture Crops, where one half was exposed to commercial waxing by using Citrashine emulsion while the second half was not waxed. Fruits were packaged in perforated carton boxes then stored at 5° C and 85-90% relative humidity. The data revealed that soluble solids increased in the juice as the cold storage progressed, regardless the treatments, and such increase was significant even after month of the storage. Meanwhile, juice acidity decreased in a consistent manner after a month of cold storage then was raised again after 2 and 3 months. The SSC/acid ratio after 3 months remained higher than at the beginning of cold storage in Navel juice. Furthermore, SSC

of the albedo significantly dropped over time as compared with the initiation value. The general trend of results of the SSC values in the albedo was opposite to that found in the juice of stored Navel oranges. In a similar manner, acidity of the albedo took an opposite trend to that found with the juice acidity. The total sugars of juice continued to increase as the cold storage duration increased and in a pattern similar to that found with the SSC in the juice. With regard to the effect of fruit waxing, regardless the treatments, it was found that waxing resulted in a significant reduction in SSC and acidity of the juice while increased in the albedo. Waxing also resulted in reducing water loss, reducing vitamin C content and caused a significant increase in total sugars of the juice in both seasons. Postharvest treatments with used natural acids (oxalic, citric or malic) regardless the waxing and storage period, led to a significant increase in SSC of the juice as compared with the control or calcium chloride treatment in both seasons while calcium chloride alone did not cause a significant change in such character. Moreover, acidity of the juice was significantly increased with the used natural acids especially with malic and citric acids while  $\text{CaCl}_2$  led to a significant increase in juice acidity as compared with the control in both seasons. The SSC to acidity ratio of natural acid- treated oranges was significantly reduced when compared with the control in both seasons in the juice. The data provided evidence that there is a possibility that the reduction of SSC to acidity ratio as a result of applying natural acids or calcium chloride treatments could be ascribed to the increase in both the SSC and acidity values of the juice as compared with SSC to acidity ratio of the juice found in the control treatment where SSC increased while acidity decreased which led to increasing the ratio of SSC to acidity in the juice of the control. The study also provided more data on the changes in calcium content in the juice and albedo carotenes of the peel and total sugars and the interaction between used natural acid, waxing and cold storage duration in relation to important fruit characters related to the juice

taste. The highest taste score as judged by the panel, was obtained with non-waxed Navel oranges treated with either citric acid, oxalic acid or  $\text{CaCl}_2$  then stored for three months in the cold as compared with the control. However, there was no significant difference between the taste of waxed and non-waxed oranges treated with either citric or malic acid. It could be recommended to treat mature-yellow oranges with used natural acid, air dry them before processing them in the commercial station to preserve the taste and quality of juice after cold storage.

## INTRODUCTION

Navel oranges are very popular and demanded fruits. They have a desired flavor and taste. The fruit peels relatively easily and sectionized well. Fruits tend to be lower in acid content than most orange varieties (Tuckers *et al.*, 1995). Citrus export, especially Navel oranges, is one of the major sources of foreign currency in Egypt. Juicy and Tasty Egyptian Navel oranges are famous in many European and American markets. Thus, maintaining quality attributes of "Washington" Navel oranges after harvest is very important to keep foreign markets open to them. The balance between the total soluble solids and acidity is the critical factor for maintaining that balance. This balance, however, could be altered either due to some preharvest or postharvest conditions. In general, orange fruits can store well on the tree and many growers delay harvest to extend the harvest season. However, such delay accelerates fruit senescence and lead to undesired change in fruit taste. Some Egyptian consumers might desire the sweeter taste. Meanwhile, the foreign market dislike that relatively sweet taste of Navel oranges. Furthermore, postharvest storage at such oranges leads to a significant reduction in juice acidity which is faster than of sugars (Samson, 1986). This explains the increase in juice sweetness during storage. Citric acid accounts for most of the acidity in citrus fruit juice. The citrus fruit is a very important source of ascorbic acid that ranges in oranges between 44-59 mg/100g (Kefford and Chandler, 1970). There are other organic acids in the peel that differ from those in the juice such as oxalic.

malonic, succinic, and malic (Vandercook, 1977). Even within the peel, there are variations in organic acids in the flavedo and albedo tissues (Clements, 1964).

The decline in fruit acidity after harvest was mainly attributed to the occurrence of gluconeogenesis in the orange juice (Echeverria and Valich, 1989). On the other hand, the taste change in orange juice could be attributed to the increase in soluble solids. Sugars represent most of the soluble solids which could reach to 70-85% as reported by Salunke and Desai, (1986). There are also small amount of other material in the juice including lipids, nitrogen and phosphorus-containing compound and especially pectin ( McCready, 1977). Navel oranges are nonclimacteric which means that very limited changes occur after harvest. However, the hydrolysis of cell wall by some cell wall hydrolases such as galactosidases or glycosidases might cause considerable changes in juice soluble solids. Changes in the activity of such enzymes during cold storage was observed by Echeverria and Ismail (1990). The release of galactose, glucose, arabinose or other cell-wall total soluble solids and acidity which lead to a noticeable change in the juice taste. To the best of my knowledge, no attempts have been made to maintain this balance between total soluble solids and acidity during cold storage either through preharvest or postharvest treatments.

Thus, the objectives of this research were to preserve the taste of "Washington" Navel orange fruit during and by the end of cold storage by using some natural compounds, that already exist in the fruit juice which provides Navel oranges growers and producers with economic and safe treatments that are feasible and applicable to control juice sweetness.

## MATERIALS AND METHODS

The present investigation was carried out during two successive seasons 2004 and 2005 using "Washington" Navel orange fruits. Twenty three years old orange trees, healthy, grown, in a clay soil, in a private orchard at kaffr El-Dawar region, El-Behira Governorate were used for this study. Trees were uniform, grafted on sour orange

rootstock, and under standard cultural practices. A Total number of 1312 of mature yellow orange fruits were harvested from the untreated trees. Samples of thirty two orange fruits were used to determine both physical and chemical properties of the untreated fruits as the initial. Before cold storage, samples of 128 fruits from each treatment were washed with tap water, then dipped for 20 minutes in one of the following solutions, citric, malic and oxalic acids each at 1% (W/V); calcium chloride (2% W/V) and distilled water (as the control). The non-ionic surfactant agent (Tween-60) at 0-1% (V/V) was used, with all treatments. Fruits were then translocated as soon as possible to El-Wady station for Exporting Agriculture crops, in Kaffr El-Dawar province, where they were exposed to the following: Washing (water mixed with 0.5% V/V of Freshgard fungicide at 38°C and pH ranged from 11.8-12 for 3 minutes), Rinsing in water, Drying with heated air then Packing in perforated cartons (16 orange fruits/carton). After that, all cartons were translocated to Lashin refrigerator for cold storage in cold chamber at 5°C and 85-90% relative humidity (according to Demirkol *et al.*, 2001), for 3 months. The second half of fruits (640 fruits) were waxed with (18%) Citrashine wax emulsion containing 7.5 gms TBZ (thiabendazole) and 2.5 mg/L IMZ (Imazalile), then, fruits were dried with heated air, packed in perforated cartons (16 fruits for each one) and stored at 5°C and 85-90% relative humidity for 3 months in Lashin refrigerator. Every month, orange fruits of each treatment (32 fruits) were subjected to the following determinations. Fruits, of each treatment, were weighed before storage to obtain the initial weight. Then, weighed every one month. During cold storage, changes in fruit weight were mentioned at each sampling date and fruit weight loss was calculated as a percentage from the initial weight (Ghoname,1992).

Taste panel was carried out after three months of cold storage by ten panelists per each treatment to compare the effect of each used treatment on color, flavor and taste of orange juice according to a hedonic scale as follows in a taste panel questionnaire (Kramer and Twigg, 1962). The percentage of soluble solid contents was measured at 20°C using hand Refractometer. The percentage of soluble solid contents of albedo was also determined by homogenizing

5 gms of albedo in 50 ml distilled water for 5 minutes and lasted to 15 minutes. The solution was filtered and the extract was used to determine the total soluble solids and acidity (Egan *et al.*, 1987). Titratable acidity for both juice and the aqueous extract of albedo were determined by titration against 0.1N and 0.01 N, respectively, sodium hydroxide in the presence of phenol phthaline indicator according to the method of Spayed and Morries (1981). Acidity was expressed as gms citric acid per 100 ml of fruit juice or per 100 gm of albedo.

The ratio between soluble solid contents and acidity was calculated by dividing the total soluble solids value on that of titratable acidity of juice. Vitamin C was determined as milligrams ascorbic acid/100 ml juice by titration against 2,6 dichlorophenol indophenol blue dye in the presence of oxalic/glycical acetic acid indicator according to the method of Egan *et al.*, (1987). Half-gram of fresh peel was extracted by 15 ml of 85% acetone with 0.5 gm calcium carbonate. The mixture was filtered through a glass funnel and the residue was washed with a small volume of acetone and completed to 25 ml. The extract was measured at wave length of 622,644 and 440 nm for chlorophyll A,B and carotene using spectrophotometer (20 D+, Milton Roy, England) (Wintermans and Mats, 1965).

Sugars were extracted from 10 ml of filtered juice of each sub-sample. The extraction was carried out by using distilled water according to Loomis and Shull (1937). Total sugars were determined colorimetrically by using 1 ml of the extract mixed with 1ml phenol 5% and 5ml sulphuric acid concentrated. The developing color intensity after 30 minutes was measured against blank at 480 nm using spectronic 20 D+, Milton Roy, England (Egan *et al.*, 1987).

Calcium content of orange juice was determined by aching 25 ml of orange juice on the Muffle at 550°C/6 hours and dissolving the precipitate by Hcl 6N and filtration by using filter paper. The extracted calcium was determined according to Egan *et al.*, (1987). One gm of albedo was ashed by using the Muffle at 550°C/6 hours and the percipitate was dissolved by 6N Hcl. The extraction of albedo was

used to determine calcium content by the method mentioned above according to Egan *et al.*, (1987)

The Experiment was laid as split split plot design leaving out the part of taste panel which was laid out as split plot design. All the data were subjected to the analysis of variance. The least significant difference to compare the means (LSD) was calculated as outlined by Steel and Torrie (1980).

## RESULTS & DISCUSSIONS

### 1. Storage duration and fruit characteristics:

The effect of storage period, regardless of the treatments, on weight loss and some chemical properties of mature yellow Navel oranges is shown in Tables 1 and 2.

The data revealed that as the storage duration increased soluble solid contents also increased. This trend was consistent in both seasons of study. Even after one month of cold storage, SSC were significantly increased as compared with zero time (the beginning of storage). The highest increase in SSC was obtained with the longest storage duration. There was no significant difference between the juice SSC values of two and three months storage duration in the first season. However, these values tended to increase in both seasons. Moreover, SSC of the juice after three-months of storage significantly varied from that of one month storage in both seasons.

With regard to acidity of the juice, the data in Tables 1 and 2 indicated that after one month of cold storage there was a significant reduction in juice acidity, when compared with that acidity at the beginning of the experiment. This decline in juice acidity after such period was consistent in both seasons. However, after two and three months of cold storage, juice acidity was raised again in a significant manner in both seasons. Furthermore, juice acidity at the last sample after 3 months of cold storage was significantly higher than of two months of cold storage.

The increase in juice acidity after two months was significant as compared with that of the one month storage duration. Thus, the

general trend of juice acidity in Navel oranges, regardless of the treatment, was characterized by a decline after one month of cold storage followed by restoring juice acidity that appeared significantly higher after two and three months of cold storage.

Changes in the ratio of soluble solid contents to acidity after various durations of cold storage were reported in Tables 1 and 2. The trend of this ratio was influenced by the indicated changes in SSC and acidity. As expected, SSC to acidity ratio of the juice increased significantly after one month of cold storage in both seasons due to the increase in SSC and the reduction in juice acidity. However, this ratio significantly declined again in the two and three-month samples of stored oranges but still the ratio of SSC to acidity after two months of cold storage was higher than that of the zero time of cold storage in both seasons. The SSC / acid ratio after three months of cold storage remained higher than that at the beginning of cold storage in Navel oranges juice.

Soluble solid contents in the albedo tended to decline as the storage duration increased as shown in Tables 1 and 2. This decline was slight after one month of cold storage in the first season but was significant in the second season when compared with SSC at zero time of storage. Moreover, as the storage period reached to two and three months, the SSC of the albedo significantly dropped as compared with the initial SSC value and the one month stored oranges. Even the SSC of the albedo after three months of cold storage were significantly lower than that of the two months stored oranges. The general trend of results of the SSC values in the albedo was opposite to that found in the juice of stored Navel oranges.

Acidity of the albedo took an opposite direction to that found with the acidity of the juice. After one month of cold storage, albedo acidity increased significantly as compared with the beginning of storage then this acidity declined significantly after two months of cold storage. Moreover, acidity of the albedo by the end of cold storage after 3 months was significantly lower than that of all storage periods and also the initial acidity. This trend of results was consistent in both seasons. Thus, the highest value of acidity in the albedo was obtained after one month of cold storage while the lowest value of



such acidity was obtained at the end of cold storage after three months.

Changes in vitamin C of juice due to cold storage shown in Table 1 and 2. The data indicated that there was a significant reduction in vitamin C after one month of cold storage as compared with the initial value of vitamin C content in the juice. Such content remained stable and leveled off after two and three months of cold storage in the first season. Similar trend of results was found in the second season. However the decline in vitamin C in the juice continued as the cold storage period was prolonged. By the end of cold storage after 3 months, vitamin C in the juice was significantly lower than that of the initial in both seasons of study.

With regard to weight loss, it was found that weight loss continued to increase as the storage duration progressed. This loss was significant even after one month of cold storage when compared with the initial weight of the fruit. Periodical sampling after two and three months also indicated to further significant loss as compared with the initial fruit weight. Even from one month to another of cold storage, weight loss was significant when compared with the previous one. This trend was consistent in both seasons.

Carotene content of the peel was also increased even after one month of cold storage when compared with the initial carotene value. Further increase in carotenes was found after 2 months of cold storage as compared with one month assessment of carotenes. The highest carotene content was obtained by the end of cold storage after 3 months. However, the increase in carotene content of the peel between two and three months of storage was significant only in the first season while remained unchanged in the second season. In general, carotene content of the peel continued to increase from one sample to another relatively to the initial carotene value (Tables 1 and 2).

Total sugars of the juice continued to increase as the cold storage duration increased. This pattern of results was similar to that obtained with the soluble solid contents in the juice. The increase in total sugars was significant even after one month of cold storage in both seasons. There was a further increase in total sugars of the juice when determined after two and three months of cold storage relative

to the initial value at zero time storage period. The increase in total sugars between the three-month sample and the two-month sample was not significant in the second season. However, in both seasons there was a general trend of increasing total sugars with the progress of cold storage.

Calcium content data of the juice in relation to storage duration is shown in tables 1 and 2. It was evident from the results that calcium tended to increase significantly as the storage period progressed. The amount of calcium in the juice did not remain stable during cold storage of Navel oranges. The lowest amount of calcium was found at the beginning of the cold storage while the highest amount was found after three months of cold storage indicating to an internal source of calcium that supplied the juice. This trend was consistent in both seasons. The difference in calcium content of the juice appeared in a significant manner even after one month only of cold storage and the increase in calcium continued from one month of storage to another in a significant way in both seasons.

On the other hand, calcium content of the albedo took an opposite direction to that found in the juice. The data in Tables 1 and 2 indicated to a continuous decline in calcium content of the albedo as the storage duration increased. The reduction in calcium content of the albedo started early with the first sample after one month of cold storage, there was a significant reduction in calcium content of the albedo. This trend of results suggested that calcium in the albedo could have been the source of calcium supply to the juice. Calcium ions might have migrated from the albedo tissue to the juice since there was no external source of such ions. The data also revealed that the amount of calcium retained by the albedo was much higher than that reached to the juice. There was no deviation from that in both seasons of study.

The effects of cold storage found in this study were in agreement with those found by Ezz, 1999 on "Washington" Navel oranges who reported that total soluble solids increased significantly as the storage period advanced. This trend may be due to the increase of total sugars in orange juice during storage (Tables 1 and 2) which presented 70 to 80% of soluble solids (Salunkhe and Desai, 1986 on

citrus), in addition, the increase in SSC could be due to the release of some polysaccharides to the juice as a result of metabolism of cell-wall (Biale, 1960) on citrus.

The increase in juice acidity of Navel oranges as the storage period progressed may be due to the migration of acids from the peel to the juice. Thus, there is a possibility that the decrease of soluble solid contents to acidity ratio as the storage period advanced could be ascribed to the increase in both SSC and acidity values. In addition, the decrease in soluble solid contents of albedo tissue was due to the migration of total sugars, sucrose and other soluble solids compounds from albedo to juice consequently the SSC of the juice increased. This explanation was supported by Nawar and Ezz, 1994 on "Washington" Navel oranges.

In this study, the recorded results were supported by Adisa, 1986 on oranges; Sharafat-Gul *et al.*, 1990 on Blood red oranges and Dundar *et al.*, 2001 on "Washington" Navel oranges who reported that ascorbic acid content decreased with the progress of storage period. It may be due to the oxidation of ascorbic acid (vitamin C) by ascorbic acid oxidase, thus ascorbic acid levels decreased while dehydro-ascorbic acid levels increased and this explanation was in line with that found by Hoare *et al.*, 1993 on oranges.

In addition, the above results agreed with those found by El-Nawam, 1991 on "Washington" Navel oranges and Nage, 2000 on Banzahir limes who reported that fruit weight loss increased significantly as the storage period advanced. This reduction of weight loss was due to water loss from pulp and peel, loss of carbon dioxide and fruits compound degradation as a result of respiration process.

In this matter, the presented results also were in line with those obtained by Murata, 1988 on citrus; El-Helaly, 1995 on Housseni and Banzahir limes and Ortuzar *et al.*, 2003 on Lanelate and Navelate oranges who found that carotenes content in the fruit peel increased with the progress of storage period. This trend of increase could be ascribed to the loss of green chlorophyll in the peel by chlorophyllase which turned this pigment from green colour to colourless thus its permanent yellow colour themselves (Jahn and Young, 1976) on Citrus fruits.

Aforementioned data in Tables 1 and 2 agreed with Goda, (1978) on Balady and Valencia oranges and Balady mandarins (El-Helaly, 1995) on Banzahir and Housseni limes and Ezz, (1999) on "Washington" Navel oranges who found that sugars increased as the storage period advanced. This increase in sugar content was due to the result of metabolism of cell-wall polysaccharides since some of cell-wall polysaccharides released from peel to juice to increase the content of sugar in orange juice (Biale, 1960). With regard to calcium content in the juice, the findings in this matter were in line with those found by Goda, 1978 on Balady and Valencia oranges and Balady mandarins who affirmed that calcium content of the fruit juice increased significantly by extending storage period. This direction of increase in calcium content of the juice suggested that calcium in the albedo could have been the source of calcium supply to the juice and calcium ions might have migrated from the albedo tissue (which were rich in calcium pectate and analysed enzymatically to release calcium ions) to the juice since there was no external supply source of such ions and the obtained results of calcium content of albedo supported this explanation where this content decreased during storage and took an opposite direction to that found in the juice.

## **2. Waxing and fruit characteristics:**

The data in Tables 3 and 4 indicated the effect of waxing on weight loss and some chemical properties of mature-yellow "Washington" Navel oranges during the two seasons of 2004 and 2005.

The data proved that waxing had a significant effect on soluble solid content of the juice where it was significantly reduced by waxing in both seasons. In a similar manner, acidity of the juice was significantly reduced as a result of waxing treatment in both seasons. The SSC to acid ratio was not significantly affected due to the waxing treatment in the first season while there was a significant increase in such ratio in the second season. The actual increase, however, in SSC / acid ratio in the second season was not that considerable.

Soluble solid contents in the albedo took an opposite direction to that found in the juice. SSC of the albedo increased significantly due to waxing treatment. Similarly, acidity of the albedo significantly

increased in waxed Navel oranges. Vitamin C (ascorbic acid) of the juice was significantly reduced in waxed orange which was in agreement with the reduction in juice acidity in both seasons (Tables 3 and 4). Waxing also cause a reduction in weight loss as compared with non-waxing as shown in the data. This reduction was significant in both seasons since wax creates a barrier to water loss.

Carotene content of the peel was significantly reduced as a result of waxing treatment in both seasons while total sugars of juice were significantly increased due to waxing consistently in both seasons. Calcium content of juice was significantly reduced in waxed oranges as compared with non-waxed oranges while in the albedo such calcium was increased in the albedo in both seasons of study.

The waxing effects on fruit characteristics found in this research were in agreement with Cohen *et al.*, 1985 on Murcott mandarins; El-Helaly, 1995 on Banzahir and Housseni limes and Nage, 2000 on Banzahir limes who reported that waxing reduced total soluble solids and acidity contents of the juice in comparison with control treatment. Moreover, the obtained results in this study were in line with those found by El-Helaly, 1995 on Banzahir and Housseni limes who reported that waxed fruits had lower content of V.C than un-waxed fruits. In addition, the presented results agreed with those found by Cohen *et al.*, 1990 on Murcott mandarins. McDonald *et al.*, 1993 on Marsh grapefruits and Baldwin *et al.*, 1995 on Valencia oranges who pointed out that waxing reduced significantly physiological fruit weight loss.

The introduced results also agreed with those recorded by Wild, (1981) on "Washington" Navel oranges and Nage, 2000 on Banzahir limes who found that waxing declined carotenes content of the peel thus waxed fruits remained green longer than un-waxed fruits. In this matter, the presented results were in agreement with those obtained by Sharafat-Gul *et al.*, 1990 on Blood red oranges and El-Helaly, 1995 on Banzahir and Housseni limes who reported that waxing fruits maintained higher reducing, non-reducing and total sugars during storage.

These effects of waxing in reducing SSC, acidity, V.C and calcium values of the orange juice, carotenes content of the peel and

fruit weight loss could be due to the modified atmosphere, as a result of waxing treatment, which resulted in reducing the percentage of oxygen and increasing the percentage of carbon dioxide around the fruit ,consequently, these conditions led to reduce water loss from pulp and peel, and reduced respiratory rate, thus fruit had higher moisture content than non-waxed fruits and such moisture content led to more dilution of waxed-fruit juice than non-waxed fruit juice thus SSC, acidity, V.C and calcium values of the juice of waxed fruits were lower than that of juice of un-waxed fruit. Moreover, these conditions of modified atmosphere as a result of waxing treatment might reduce the activity of chlorophyllase enzyme which is responsible of degreening, thus waxing delayed the degreening and caused unsatisfactory colour, mainly because of poor carotenoid development (Jahn, 1976) on Hamlin oranges and Dancy tangerines.

On the contrary, waxed oranges had significantly higher values of SSC, acidity and calcium of the albedo tissue as compared with those non-waxed ones. The effects might be due to the modified atmosphere, which existed around the fruits (high CO<sub>2</sub> and low O<sub>2</sub>) as a result of using waxing treatment where it reduced the activity of Pectinestrace, Polygalacturanase (were an important factor in the pectic changes that occur in citrus, Rouse, 1977) and Cellulase consequently, retained high content of pectin thus amount of calcium ion which released and migrated from albedo to juice was lower consequently, calcium amounts of the albedo in waxed fruits were higher than that found in albedo of un-waxed fruits. The modified atmosphere as a result of using waxing treatment might have reduced the migration of some polysaccarides of cell-wall and acids from albedo tissue to the juice and the obtained results of SSC and acidity of the juice could be supported this explanation since these results took an opposite trend to that obtained in the albedo.

### **3. Natural acids treatments and fruit characteristics:**

Effects of some natural acids on weight loss and some chemical properties of mature-yellow "Washington" Navel oranges are shown in Tables 5 and 6. All used natural acids, namely oxalic, citric and malic caused a significant increase in SSC of the juice as compared with the control in both seasons. Furthermore, oxalic and citric acids

did not significantly differ from each other in terms of their effect on SSC of the juice in both seasons. Malic acid and a similar effect on SSC of the juice that obtained with oxalic and citric acids in the first season but led to a significant increase in SSC juice in the second season. Calcium chloride, on the other hand, did not cause a significant difference in SSC of the juice when compared to the control in both seasons. Natural acids, however, caused a significant increase in SSC of the juice when compared with calcium chloride in both seasons.

Acidity of the juice was significantly increased by using natural acids relative to the control. This increase was higher with the use of malic and citric than oxalic acid in both seasons. Calcium chloride treatment led to significantly higher juice acidity than the control in both seasons. Acid treatments with citric and malic caused a significant increase in juice acidity when compared with calcium chloride while oxalic acid had significantly lower effect on juice acidity than that of calcium chloride (Tables 5 and 6).

The ratio of SSC to acidity was also affected by acid treatments significantly. There was a significant reduction in SSC to acidity ratio when compared with the control in both seasons. The SSC / acidity ratio obtained with oxalic was significantly higher than that of citric and malic acid in both seasons. Moreover, SSC to acidity ratio was significantly reduced by calcium chloride when compared with the control and oxalic and citric acids in both seasons. All treatments, in general, significantly caused lower SSC / acidity ratio than the control and this trend was consistent in the two studied seasons.

The effect of various treatments on soluble solid contents of the albedo, regardless of the storage duration, is shown in Tables 5 and 6. Oxalic acid treatment caused a significant increase in SSC of the albedo relative to the control and the other two acids (citric and malic acids). In general, all acid treatments caused a significant increase in SSC of the albedo when compared with that effects obtained with the control and calcium chloride in both seasons. SSC of the albedo were not consistently influenced by calcium chloride treatment since this compared significantly reduced SSC of the albedo only in the second season. However, calcium chloride treatment led to lower SSC of

albedo than that obtained with natural acids treatments in both seasons.

With regard to acidity of the albedo tissue, it was found that all natural acids caused a significant increase in albedo acidity. Oxalic acid treatment did not result in significantly different acidity of the albedo from that obtained with citric and malic acids. Calcium chloride, on the other hand, did not result in different albedo acidity from that obtained with natural acids but led to an increase albedo acidity when compared with the control. This trend of results was found only in the first season while in the second season, natural acids and calcium chloride treatments also increased significantly acidity of the albedo when compared with that obtained with control treatment. But the differences among natural acids treatments and differences among natural acids treatments and calcium chloride were significant where the highest significant values of albedo acidity were obtained by oxalic acid treatment followed by malic acid, calcium chloride and citric acid treatments.

The influence of various treatments on vitamin C content in the juice is shown in Tables 5 and 6. The data revealed that all used natural acids led to a significant increase in vitamin C of the juice as compared with the control. Moreover, the highest increase in vitamin C of the juice occurred with malic acid treatment in both seasons. Calcium chloride treatment also led to higher vitamin C content than the control. However, citric and malic acids treatments resulted in significantly higher vitamin C than that occurred with oxalic acid or calcium chloride. The data were consistent in both studied seasons.

Weight loss of Navel oranges was also influenced by various treatments. It was found that all natural acids treatments were effective in increasing weight loss. However, more weight loss occurred with oxalic acid than with citric and malic acids. Calcium chloride treatment resulted in higher weight loss than that occurred with the control. Oxalic acid also caused higher weight loss than calcium chloride. Generally, various treatments increased weight loss as compared with the control in both seasons (Tables 5 and 6).

Carotene content of the peel was significantly increased by natural acids treatments in both seasons. Navel oranges treated with



malic acid achieved the highest amount of carotenes in the peel in the first season but had similar effect to that obtained by oxalic and citric acids treatments in the second season. The control fruits also had significantly less carotenes in the peel as compared with calcium chloride treated fruits. This trend was consistent in both seasons (Tables 5 and 6).

The response of total sugars in the juice to various treatments regardless the storage duration is also shown in Tables 5 and 6. The results indicated a significant increase in these sugars by oxalic acid treatment as compared with the control in both seasons. Citric and malic acids were equally effective in increasing total sugars of the juice in both seasons relative to the control and to oxalic acid treatment. This trend of results was similar to that obtained with SSC of the juice. Furthermore, calcium chloride treated oranges had significantly higher sugar content in the juice than the control fruits in both seasons. Meanwhile, natural acids treated fruits had significantly higher sugars in the juice than that treated with calcium chloride in both seasons.

With regard to calcium content of the juice, as influenced by natural acids and calcium chloride, it was evident that natural acids did not show a consistent trend in both seasons. There was a reduction in calcium content of the juice as a result of natural acids treatments in both seasons when compared with the control. Oxalic acid treated fruits, however, tended to have higher calcium in the juice than the other two acids treatments in the first season of study while in the second season, oxalic and malic acids treatments did not significantly differ in calcium content of the juice, however, these acids increased significantly calcium content of the juice when compared with malic acid treatment which resulted in the lowest content of calcium in orange juice. The highest calcium content in the juice was achieved with calcium chloride treatment in both seasons, where the juice had superior amount of calcium when compared with the control and natural acids (tables 5 and 6).

Navel oranges response in terms of their content of calcium in the albedo clearly showed a significant increase in natural acids-treated fruits in both seasons as compared with the control. Moreover,

malic acid treated fruits had significantly greater calcium in the albedo than oxalic and citric acids treated ones and this was consistent in both seasons. Calcium chloride, on the other hand, caused the highest content of calcium in the albedo of Navel oranges in both seasons. The albedo treated with calcium chloride had even much more calcium content than that treated with malic acid.

Aforementioned results shown in Tables 5 and 6 it could be concluded that the effect of natural acids and calcium chloride treatments on the increasing of soluble solid contents in both juice and albedo may be due to that these treatments increased the migration of soluble solid contents especially the polysaccharides from cell wall from flavedo to albedo and from albedo to juice or due to that these natural acids and calcium chloride treatments increased water loss from pulp and peel where fruit weight loss was increased as a result of using the mentioned treatments consequently, total solids of pulp and peel concentrated thus the values of SSC were higher than that of control treatment. In addition, natural acids and calcium chloride when applied on mature yellow oranges, they could be penetrated the peel of oranges thus it may be increased albedo acidity than control and may be increased the migration of acids from albedo to juice thus juice acidity increased.

For the above explanations there is a possibility that the decrease of soluble solid contents to acidity ratio as a result of applying natural acids and calcium chloride treatments could be ascribed to the increase of both the SSC and acidity values of the juice as compared with SSC to acidity ratio of juice found in control treatment where soluble solid contents increased while acidity decreased which led to the increase of the ratio between SSC and acidity in juice of un-treated oranges (control).

Gross (1987) discussed the factors affecting carotenoids biosynthesis in fruits. It was reported that ethylene, gibberellins, light, oxygen, temperature, nitrogen content in the fruit had various effects on the biosynthesis of carotenoids in different fruits. The positive effects of malic, citric and oxalic acids and calcium chloride treatments found in this study could be due to its effect on ethylene biosynthesis. Further studies are needed to elaborate on the effect of

natural acids and calcium chloride on carotenoids biosynthesis in fruits especially carotenes in the peel of "Washington" Navel oranges.

#### **The taste panel data:**

With regard to effect of waxing on juice color, flavor and taste, the data in Table 7 showed that juice color of non-waxed fruits was rated to be better than that of waxed fruits while the panel had a preference to the flavor of waxed oranges as compared with non-waxed one. Moreover, the taste of juice extracted from waxed oranges was rated as less favorable than non-waxed ones.

On the other hand, the data in Table 8 indicated to the effect of various treatments on the juice color, flavor and taste. It was evident from the data that oxalic and malic acids were able to maintain the juice color since they had similar score to that obtained with the control after three months of cold storage. Meanwhile, those oranges treated with either citric acid or calcium chloride had less favorable juice color than the control. The least color score was gained with oranges previously treated with  $\text{CaCl}_2$ .

Flavor data, however, did not take the same trend as color data. The highest flavor score was given by the panel to the juice extracted from oranges previously treated with citric acid or  $\text{CaCl}_2$  while oxalic or malic treatments resulted in less favorable flavor than the control. The taste was also influenced by various treatments where oxalic or citric acid – treated fruits resulted in the most favourable taste as compared with the control while malic acid – treated fruits had similar taste to that found with the control.

The taste of  $\text{CaCl}_2$  – treated fruits was significantly better than that of the control and more favourable than the taste of malic acid – treated fruits (Table 8), thus natural acids and  $\text{CaCl}_2$  either maintained the desired taste or improved it as indicated by the taste panel judge.

With regard to the interaction between waxing and the treatments in relation to juice color, flavor and taste (Table 9). The panel judged that waxed fruits of the control and non – waxed fruits of malic acid treatment ranked the best as compared with other treatments in terms of juice color. Moreover, the consumer did not

favor the color of juice extracted non-waxed control or waxed- $\text{CaCl}_2$  treated fruits. The interaction between waxing and the treatments by the end of cold storage revealed that the most favourable juice flavor was obtained waxed fruits treated with either citric acid or calcium chloride as compared with the control and other treatments while in non-waxed fruits, the panel favored the juice flavor of the control fruits and the treatments and did not differentiate between the flavor of the control fruits and the treatments .

Juice taste data by the end of cold storage as influenced by the interaction between waxing and treatments indicate that non-waxed fruits treated with either oxalic acid, citric acid or calcium chloride had more favored taste than those of the control and malic acid – treated fruits. Furthermore, waxed oranges treated with either oxalic or citric acid had more favourable taste than these of the control and malic acid – treated ones. The highest taste score was obtained with non-waxed oranges treated with either  $\text{CaCl}_2$ , oxalic acid or citric acid then stored for three months as compared with most treatments and the control. The panel favored non-waxed oranges treated with either oxalic acid or  $\text{CaCl}_2$  as compared with waxed fruits of the same treatments. However, there was no significant difference between waxed and non – waxed oranges treated with either citric or malic acid (Table 9).

Table (1): Effect of storage period on weight loss and some chemical properties of mature-yellow "Washington" Navel oranges during 2004.

Properties St. Months	SSC of juice (%)	Acidity of juice (%)	SSC/AC of juice	SSC of albedo (%)	Acidity of albedo (%)	V.C of juice (mgs/100ml)	Fruit weight loss (%)	Carotene content of peel (mgs/L)	Total Sugars of juice (%)	Ca content of juice (mgs/100ml)	Ca content of albedo (mgs/100gm)
0*	11.75** c	0.690 c	17.03 c	13.50 a	0.106 b	37.67 a	0.00 d	4.00 d	7.82 d	7.29 d	77.50 a
1	12.55 b	0.658 d	19.07 a	13.25 a	0.164 a	27.61 b	1.59 c	5.69 c	9.05 c	8.19 c	74.22 b
2	12.92 ab	0.722 b	17.89 b	11.33 b	0.091 c	27.33 b	3.01 b	6.94 b	9.29 b	8.80 b	64.60 c
3	13.33 a	0.777 a	17.16 bc	9.60 c	0.087 d	26.96 b	4.15 a	7.11 a	9.41 a	9.24 a	51.59 d

Where \*: The initiation of cold storage (Zero time of storage).

\*\* : Values, within a column, with similar letters are not significantly different when compared by using the LSD values at 0.05 levels.

Table (2): Effect of storage period on weight loss and some chemical properties of mature-yellow "Washington" Navel oranges during 2005.

Properties St. Months	SSC of juice (%)	Acidity of juice (%)	SSC/AC of juice	SSC of albedo (%)	Acidity of albedo (%)	V.C of juice (mgs/100ml)	Fruit weight loss (%)	Carotene content of peel (mgs/L)	Total Sugars of juice (%)	Ca content of juice (mgs/100ml)	Ca content of albedo (mgs/100gm)
0*	11.41** d	0.711 c	16.05 c	14.40 a	0.096 b	39.55 a	0.00 d	3.33 c	7.00 c	7.51 d	80.12 a
1	12.47 c	0.660 d	18.89 a	14.06 b	0.161 a	29.19 b	1.23 c	5.41 b	8.68 b	8.42 c	74.58 b
2	13.07 b	0.723 b	18.08 b	11.93 c	0.070 c	28.48 c	2.20 b	6.43 a	9.14 a	9.09 b	62.19 c
3	13.63 a	0.778 a	17.52 b	9.59 d	0.064 d	22.23 d	3.98 a	6.81 a	9.31 a	9.57 a	47.25 d

Where \*: The initiation of cold storage (Zero time of storage).

\*\* : Values, within a column, with similar letters are not significantly different when compared by using the LSD values at 0.05 levels.

Table (3): Effect of Waxing treatment on weight loss and some chemical properties of mature-yellow "Washington" Navel oranges during 2004.

Properties Waxing Treatment	SSC of juice (%)	Acidity of juice (%)	SSC/AC of juice	SSC of albedo (%)	Acidity of albedo (%)	V.C of juice (mgs/100ml)	Fruit weight loss (%)	Carotene content of peel (mgs/L)	Total Sugars of juice (%)	Ca content of juice (mgs/100ml)	Ca content of albedo (mgs/100gm)
Without Waxing	12.73* a	0.718 a	17.73 a	11.42 b	0.109 b	31.48 a	2.50 a	6.45 a	8.85 b	8.66 a	65.63 b
With Waxing	12.53 b	0.706 b	17.76 a	12.42 a	0.115 a	28.30 b	1.88 b	5.42 b	8.94 a	8.10 b	68.32 a

\* Values, within a column, with similar letters are not significantly different when compared by using the LSD values at 0.05 levels.

Table (4): Effect of Waxing treatment on weight loss and some chemical properties of mature-yellow "Washington" Navel oranges during 2005.

Properties Acide- Treatments	SSC of juice (%)	Acidity of juice (%)	SSC/AC of juice	SSC of albedo (%)	Acidity of albedo (%)	V.C of juice (mgs/100ml)	Fruit weight loss (%)	Carotene content of peel (mgs/L)	Total Sugars of juice (%)	Ca content of juice (mgs/100ml)	Ca content of albedo (mgs/100gm)
Without Waxing	12.76* a	0.727 a	17.55 b	11.93 b	0.093 b	31.66 a	2.25 a	6.12 a	8.47 b	8.96 a	65.80 b
With Waxing	12.53 b	0.709 b	17.67 a	13.06 a	0.103 a	28.07 b	1.46 b	4.87 b	8.60 a	8.33 b	66.27 a

\*: Values, within a column, with similar letters are not significantly different when compared by using the LSD values at 0.05 levels.



Table (5): Effect of Some natural acids on weight loss and some chemical properties of mature-yellow "Washington" Navel oranges during 2004.

Properties Acids Treatments	SSC of juice (%)	Acidity of juice (%)	SSC/AC of juice	SSC of albedo (%)	Acidity of albedo (%)	V.C of juice (mgs/100ml)	Fruit weight loss (%)	Carotene content of peel (mgs/L)	Total Sugars of juice (%)	Ca content of juice (mgs/100ml)	Ca content of albedo (mgs/100gm)
Control	12.40* b	0.644 d	19.25 a	11.54 c	0.095 c	28.79 d	1.91 d	4.55 e	8.66 d	8.70 b	60.48 e
Oxalic acid	12.79 a	0.709 c	18.04 b	12.54 a	0.116 ab	29.36 c	2.68 a	5.97 d	8.92 b	7.89 c	63.35 d
Citric acid	12.69 a	0.747 a	16.99 d	12.00 b	0.115 b	30.70 b	2.29 b	6.40 b	9.03 a	7.78 d	65.51 c
Malic acid	12.84 a	0.739 a	17.37 c	11.92 b	0.118 a	31.06 a	1.95 d	6.52 a	9.06 a	7.41 e	69.63 b
Calcium Chloride	12.46 b	0.720 b	17.31 c	11.60 c	0.116 ab	29.55 c	2.11 c	6.24 c	8.79 c	10.12 a	75.91 a

\*: Values, within a column, with similar letters are not significantly different when compared by using the LSD values at 0.05 levels.

Table (6): Effect of Some natural acids on weight loss and some chemical properties of mature-yellow "Washington" Navel oranges during 2005.

Properties Acids Treatments	SSC of juice (%)	Acidity of juice (%)	SSC/AC of Juice	SSC of albedo (%)	Acidity of albedo (%)	V.C of juice (mgs/100ml)	Fruit weight loss (%)	Carotene content of peel (mgs/L)	Total Sugars of juice (%)	Ca content of juice (mgs/100ml)	Ca content of albedo (mgs/100gm)
Control	12.35* c	0.640 e	19.30 a	12.12 d	0.074 c	28.60 d	1.61 e	3.80 c	8.20 d	8.97 b	57.56 e
Oxalic acid	12.72 b	0.711 d	17.89 b	13.26 a	0.107 a	29.28 c	2.11 a	5.69 b	8.53 b	8.12 c	60.92 d
Citric acid	12.81 b	0.759 a	16.88 d	12.61 b	0.102 d	30.82 b	1.97 b	6.13 a	8.75 a	8.04 c	63.81 c
Malic acid	12.92 a	0.749 b	17.25 c	12.49 c	0.105 b	31.18 a	1.73 d	5.92 ab	8.78 a	7.71 d	70.34 b
Calcium Chloride	12.43 c	0.732 c	16.98 d	12.00 e	0.103 c	29.42 c	1.86 c	5.93 ab	8.39 c	10.40 a	77.55 a

\*: Values, within a column, with similar letters are not significantly different when compared by using the LSD values at 0.05 levels.

Table (7): Effect of waxing treatment on color, flavor and taste of juice of "Washington" Navel oranges as determined by the taste panel after storage for three months during 2005 season.

Characteristics Waxing	Color	Flavor	Taste
Without waxing	5.46 a *	4.77 b	7.10 a
With waxing	4.88 b	8.27 a	5.90 b

\* Values, within a column, with similar letters are not significantly different when compared by using the LSD values at 0.05 levels.

Table (8): Effect of natural acids and calcium chloride treatments on color, flavor and taste of juice of "Washington" Navel oranges as determined by the taste panel after storage for three months during 2005 season.

Characteristics Treatments	Color	Flavor	Taste
Control	6.05 a *	6.03 b	5.41 c
Oxalic acid	6.05 a	4.37 c	7.59 a
Citric acid	4.73 b	8.29 a	7.73 a
Malic acid	6.50 a	5.27 b	5.15 c
Calcium chloride	2.96 c	8.58 a	6.79 b

\* Values, within a column, with similar letters are not significantly different when compared by using the LSD values at 0.05 levels.

Table (9): The interaction between waxing and various treatments in relation to color, flavor and taste of juice of "Washington" Navel oranges after three months of cold storage during 2005 season.

Traits	Color					Flavor					Taste				
	Control	Oxalic acid	Citric acid	Malic acid	Calcium chloride	Control	Oxalic acid	Citric acid	Malic acid	Calcium chloride	Control	Oxalic acid	Citric acid	Malic acid	Calcium chloride
Without waxing	3.92 e *	5.86 cd	5.57 cd	7.29 b	4.93 d	4.37 b *	1.54 d	8.41 a	3.24 c	8.35 a	6.15 d *	8.12 ab	8.07 ab	5.11 c	8.35 a
With waxing	8.64 a	6.25 bc	3.96 c	5.76 cd	1.49 f	7.95 a	8.64 a	8.18 a	7.78 a	8.82 a	4.71 a	7.08 c	7.40 bc	5.20 c	5.38 dc

\* Values, within each trait, with similar letters are not significantly different when compared by using the LSD values at 0.05 levels.

## REFERENCES

- Biale, J. B. (1960).** Adv. Fd Res. 10: 293-354. Cited after Hulme, A. C. (1970).
- Clements, R. L. (1964).** Organic acids in citrus fruits. I. Varietal differences. Journal of Food Science. 29, 276-280.
- Cohen, E.; S. Lurie; B. Shapiro; S. Ben-Yehoshua; Y. Shalom and I. Rosenbrger (1990-a).** Prolonged storage of lemons using individual seal-packaging. Journal of the American Society for Horticultural Science. 115: 2, 251-255.
- Cohen, E.; Y. Shalom and I. Rosenberger (1985).** The effects of growing area, root-stock, harvest time, waxing and storage temperatures on postharvest quality of Murcott mandarin fruit. Hassadeh. 66: 1. 70-74.
- Cohen, E.; Y. Shalom and I. Rosenberger (1990-b).** Postharvest ethanol buildup and Off – flavor in ‘Murcott’ tangerine fruits. Journal of the American Society for Horticultural Science. 115: 5, 775-778.
- Dermikol, A.; M. Pekmezci; M. Erkan; H. Gubbuk and N. Cakiroglu (2001).** Investigations on the cold storage of “Washington” Navel oranges grown in Antalya ecological conditions. Ziraat – Fakultesi – Dergisi, - Akdeniz – universitesi. 14: 2, 29-38.
- Dundar, O.; S. Gocer; R. Ben – Arie and S. Philosoph – Iiadas (2001).** Control of storage rates of “Washington” Navel oranges and Minneola by a combination of yeast antagonist and thiabendazole. Proceedings of the Fourth International conference on Postharvest Science, Jerusalem, Israel, 26-31 March 2001, 2 Acta – Horticultureae. 2: 553, 339-401.
- Echeverria, E. and J. Valich (1989).** Enzymes of sugar and acid metabolism in stored “Valencia” oranges. Journal of the American Society For Horticultural Science. 114, 445-449.
- Echeverria, E. and M. Ismail (1990).** Sugar unrelated to Brix changes in stored citrus fruits. HortScience. 25. 710.

- Egan, H.; R. S. Kird and R. Sawyer (1987).** Pearson's Chemical Analysis of Foods. Eight Edition – Longman Scientific and Technical. Essex CM20. 2TE, England.
- El-Helaly, A. A. (1995).** Effect of some Postharvest Treatments on Keeping Quality and Storage Period of Banzahir and Housseni Lime Fruits during Cold Storage. Ph. D. Thesis. Alexandria Univ., Alexandria, Egypt.
- El-Nawam, S. A. (1991).** Rind Creasing and Quality of "Washington" Navel Orange Fruits in Relation to Application with Some Growth Substances. M. Sci. Thesis. Alexandria Univ., Alexandria, Egypt.
- Ezz, TM. (1999).** Eliminating chilling injury of citrus fruits by preharvest proline foliar spray. Alexandria Journal of Agricultural Research. 44: 1. 213-225.
- Ghoname, M. I. (1992).** Effect of nitrogen, potasium and their interactions on quantitative, qualitative characteristics and keeping quality of some strawberry cultivars. ph. D. Thesis. Faculty. of Agric. Alexandria Univ., Egypt.
- Goda, M. A. M. (1978).** A Study on Physical and Chemical Changes in Fruits of some Varieties of Citrus during Storing. Ph. D. Thesis. Assiut Univ., Assiut, Egypt.
- Gross, J. (1987).** Pigments in fruits: Carotenoids, Pages 87 – 187. Academic Press, New York. Pp. 303.
- Hoare, M.; S. Jones and J. Lindsay (1993).** Total vitamin C analysis of orange juice. Food – Australia. 45: 7, 341-345.
- Jahn, O. L. and R. Young (1976).** Changes in chlorophyll a, b and the a / b ratio during color development in citrus fruit. Journal of the American Society for Horticultural Science. (101): 4, 416-418.
- Kefford, J. F. and B. V. Chandler (1970).** General composition of citrus fruits. In The Chemical Constituents of Citrus Fruits, (eds C. O. Chichester, E. M. Mark and G. F. Stewart), Academic Press, New York, pp. 5-22.

- Kramer, A. and Twigg, B. A. (1962).** Fundamentals of Quality Control for the Food Industry. Pp. 512. The AVI Publishing Co., Inc, Westport, Connecticut, U.S.A.
- McCready, R. M. (1977).** Carbohydrates Composition, distribution, Significance. In Citrus Science and Technology, (eds S. Nagy, P. E. Shaw and M. K. Veldhuis), Vol. L. AVI Publishing, Inc., Westport, CT, pp. 74-109.
- McDonald, R. E.; G. T., Mc collum and H. E. Nordby, (1993).** Temperature conditioning and surface treatments of grapefruit affect expression of chilling injury and gas diffusion. J. Amer. Soc. Hort. Sci. 118: 4, 490-496.
- Nage, N. M. N. S. E. D. (2000).** Storage Life, Physical and Chemical Properties of Banzahir Lime Fruits During Cold Storage as Affected by Some Postharvest Treatments. M. Sci. Thesis. Alexandria Univ., Alexandria, Egypt.
- Nawar, A. and T. Ezz (1994).** Surface pitting, proline, free amino acids and soluble sugars in grapefruit and orange fruit peel, in relation to chilling injury. Alexandria – Journal – of – Agricultural – research. 39: 1, 357-371.
- Rouse, A. H. (1977).** Pectin: Distribution, Significance. Cited after Nagy, S.; P. E. Shaw and M. K. Veldhuis (1977). Citrus Science and Technology. Vol. I AVI Publ. Co., West post. CT. pp. 110-207.
- Salunkhe, D. K. and B. B. Desai (1986).** Citrus. In Postharvest Biotechnology of Fruits, Vol. 1, CRC Press, Inc, Boca Raton, FL, pp. 59-75.
- Samson, J. A. (1986).** Citrus. In Tropical Fruits, Second edition, Longman Group UK. Ltd., Essex, UK pp. 73-138.
- Sasson, A. and S. P. Monselise (1977).** Organic acid composition of "Shamouti" oranges at harvest and during prolonged postharvest stage. Journal of the American Society of Horticultural Science. 102, 331-336.

- Sharafat-Gul; I. Muhammed and S. H. Shah (1990).** Studies on the effect of storage on the quality of sweet orange. *Sarhad Journal of Agriculture*. 6: 5, 433-436.
- Steel, R. G. D. and T. H. Torrie (1980).** Principles and Procedures of statistics. (McGrow-Hill, Co., USA.).
- Tuckers, D. P. H.; C. J. Hearn and C. O. Youtsey (1995).** Florida citrus varieties. University of Florida, Institute of Food and Agricultural Sciences. Florida Cooperative Extension Service. SP102. pp. 57.
- Vandercook, C. E. (1977).** Organic acids. In *Citrus Science and Technology*. (eds. S. Nagy, P. E. Shaw and M. K. Veldhuis), Vol. 1. AVI Publishing Co., Inc., Westport CT, pp. 208-228.
- Wild, B. L. (1981).** The effects if waxing citrus fruit. *Rural Newsletter*. 79, 14-19.
- Wintermans, J. F. G. M. and D. E. Mats (1965).** Spectrophotometric characteristics of chlorophylls and their pheophytins in ethanol. *Biochem. Biophys. Acta*, 448-453.

### الملخص العربي

تأثير بعض الاحماض الطبيعية و الكالسيوم على حفظ مذاق و جودة ثمار البرتقال ابوسرة صنف " واشنجطن " بعد التخزين المبرد.  
B: معاملات ما بعد الجمع للثمار مكتملة النمو و التلوين.

كريم محمد فرج<sup>1</sup> ، نيفين محمد نبيه ناجي<sup>1</sup> ، أحمد سعيد الصباغ<sup>1</sup>  
<sup>1</sup> قسم البساتين (فاكهة)، كلية الزراعة بدمهور، جامعة الاسكندرية ص ب 22516 ، دمنهور.

اجريت هذه الدراسة خلال موسمين 2004، 2005 باستخدام البرتقال ابوسرة صنف " واشنجطن " حيث جمعت الثمار من اشجار عمرها 23 سنه منزرعة فى منطقة كفر الدوار محافظة البحيرة، بتاريخ 22 ، 15 ديسمبر على الترتيب لكلا الموسمين ، و قسمت الى مجموعتين متساويتين حيث احتوت كل مجموعة على 640 ثمرة و كانت المعاملات كالآتى: حامض الستريك 1%، حامض المالك 1% ، حامض الأوكساليك 1% ، بكلوريد الكالسيوم 2% ، بالإضافة للكنترول (الماء)، و قد عوملت هذه الثمار بالنقع لمدة



20 دقيقة و تركت لتجف فى الهواء ثم نقلت الى محطة الوداى لتصدير الحاصلات الزراعية حيث عرضت لعملية التشميع بواسطة مركب ستراشاين ثم تم تعبئتها فى صناديق كرتون و تم تخزينها على درجة 5 م و رطوبة نسبية 85 - 90 %، و قد تعرض نصف عدد الثمار للمعاملات السابقة الخمس و لنفس العمليات بمحطة الوداى و لكن دون اجراء تشميع. اخذت العينات دورية كل شهر من الثمار المخزنة لاجراء التقديرات للصفات الطبيعية و الكيماوية للثمار. اوضحت النتائج زيادة نسبة المواد الصلبة الذائبة فى عصير الثمار مع تقدم فترة التخزين المبرد، بغض النظر عن المعاملات، و كانت هذه الزيادة معنوية حتى بعد شهر واحد من التخزين، بينما انخفضت حموضة العصير و بطريقة ثابتة بعد شهر من التخزين المبرد، ثم ارتفعت مرة اخرى فى العينات التى اخذت بعد 2، 3 شهور من التخزين المبرد و مع ذلك فقد وجد ان نسبة المواد الصلبة الذائبة الى الحموضة بعد 3 شهور من التخزين قد بقيت اعلى مما تحصل عليه فى بداية تخزين الثمار. اما بالنسبة للاليبدو، فقد انخفضت نسبة المواد الصلبة الذائبة فى الاليبدو عكس اتجاه ما وجد فى عصير البرتقال ابوسرة المخزن تحت هذه الظروف، و بطريقة مشابهة وجد ان حموضة الاليبدو قد اتخذت اتجاها عكس ما وجد بالنسبة لنتائج حموضة عصير الثمار. بالنسبة لسكريات الكلية فى عصير الثمار فقد استمرت فى الزيادة مع تقدم عملية التخزين و بطريقة مشابهة لما وجد فى حالة المواد الصلبة الذائبة بالعصير. اما بالنسبة لتاثير عملية التشميع على صفات الثمار، بغض النظر عن المعاملات، فقد وجد ان التشميع قد ادى الى حدوث نقص معنوى فى المواد الصلبة الذائبة و الحموضة بالعصير، بينما ادى لزيادة تلك القيم فى الاليبدو، كذلك ادى تشميع الثمار الى خفض نسبة فقد الوزن، و خفض محتوى العصير من فيتامين ج، و الى حدوث زيادة معنوية فى السكريات الكلية بالعصير فى كلا الموسمين. اما بالنسبة لتاثير المعاملات على صفات الثمار، بغض النظر عن تاثير التشميع او التخزين المبرد، فقد ادت معاملات احماض الطبيعية الى حدوث زيادة معنوية فى نسبة المواد الصلبة الذائبة بالعصير و ذلك بالنسبة للكنترول او معاملة كلوريد الكالسيوم فى كلا الموسمين، بينما لم يسبب كلوريد الكالسيوم اى تغير معنوي فى هذه الصفة، كما زادت حموضة العصير مع معاملات الاحماض الطبيعية خاصة معاملة حمض المالك و الستريك بينما ادت المعاملة بكلوريد الكالسيوم الى حدوث زيادة معنوية فى حموضة العصير بالمقارنة بالكنترول فى كلا الموسمين. و قد انخفضت نسبة المواد الصلبة الذائبة للحموضة معنويا فى الثمار التى عوملت بالاحماض الطبيعية و ذلك بالنسبة لثمار الكنترول فى العصير فى كلا الموسمين، و قد برهنت الدراسة على امكانية حدوث خفض لنسبة المواد الصلبة الذائبة الى الحموضة فى عصير الثمار نتيجة معاملات الاحماض الطبيعية او كلوريد الكالسيوم، و يمكن ان يعزى ذلك لحدوث زيادة فى العصير من كل من المواد الصلبة الذائبة و الحموضة ايضا، و ذلك بالمقارنة بثمار الكنترول التى حدث بها زيادة فى نسبة المواد الصلبة الذائبة بينما انخفضت الحموضة مما ادى لزيادة تلك النسبة فى عصير ثمار الكنترول. تم تقدير تغيرات صفات اخرى مثل محتوى الكالسيوم فى العصير و الاليبدو، و محتوى الكاربونيات فى القشرة، و محتوى السكريات الكلية، و التفاعل بين معاملات الاحماض

الطبيعية المستخدمة و عملية التسميع، و اثر عملية التخزين المبرد على صفات الثمار المختلفة، اما بالنسبة لاختبار مذاق الثمار فقد وجد ان اعلى درجة مذاق فى الثمار غير المشبعة و التى عوملت باى من حمض الستريك او حمض الاوكساليك او كلوريد الكالسيوم ثم خزنت لمدة ثلاثة شهور بالتخزين المبرد و ذلك بالمقارنة بثمار الكنترول، و مع ذلك لم يكن هناك فرق معنوى بين مذاق عصير البرتقال سواء مع التسميع او بدونه فى حالة تلك الثمار التى تمت معاملتها بـحمض الستريك او المالك. و يمكن التوصية بمعاملات الاحماض الطبيعية للثمار المكتملة النمو و التلوين ثم جفافها بالهواء قبل اجراء العمليات المختلفة بمحطة التعبئة التجارية و ذلك للمحافظة على مذاق العصير و جودته بعد فترة التخزين المبرد.