Influence of Storage Temperature on Quality and Storability of Murcott Tangor [*Citrus Reticulata* × *Citrus Sinensis* (L.) Osbeck] Fruits.

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Abstracat: Murcott tangor [*Citrus reticulata* × *Citrus sinensis* (L.) Osbeck] is a promising mandarin cultivar in Egypt due to its harvest season (from January to the end of March) which extend the Egyptian fresh-market mandarin season and coincide with the world demand. Mandarins are very prone to losing quality during storage, and as a result, have a short shelf life. Hence, more researches to improve fruit quality and storability are needed. The aim of this study is to investigate the effects of storage temperature on quality and storability of Murcott fruits during two successive seasons (2014/2015 and 2015/2016). Full colored Murcott fruits were harvested from a nine years-old trees budded on Volkamer lemon rootstock and stored in carton boxes under three different conditions which were: room temperature (15°C±2 and 54% relative humidity (RH)) and refrigerator (10°C±1 or 5°C±1 and 85-90% RH). Weight loss, fruit firmness, total soluble solids (TSS), total acidity (TA) and ascorbic acid were recorded every 10 days intervals. The results showed that weight loss and decayed fruits decreased by lowering the storage temperature. The TSS percentage was higher in fruits hold at low temperature (5°C and 10° C) than fruits hold at room temperature. No significant difference between the low temperature degrees 5° C and 10° C in both varieties while TA decreased as the storage period advanced at higher temperature and thus, TSS/acid ratio increased parallel to TA decreasing. Ascorbic acid contents decreased significantly till the end of the storage period but the decline was found to be faster at room temperature as compared to cold storage. The results suggested that Murcott fruits can store at ambient temperature (15°C±2) for 40 days but this period can be aggravate (120 days) if the fruit stored at 5°C±1). The results suggested also that the best temperature to store the Murcott tangor fruit was at 5°C till (100 days) with higher retention of fruit quality.

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1. Introduction

Mandarin is the second largest citrus crop grown in Egypt after orange, and mandarin planted represents area roughly 25 percent of total area planted with citrus. The cultivated mandarin area has increased during the last 5 years by 12 percent due to increased demand from the local and international markets. The increase in exports stems from rising demand especially for late harvest season cultivars (**Verdonk and Hamza, 2016**).

Murcott is known in the world fresh fruit trade as Honey Tangerine and is commonly considered a tangor, a natural hybrid of tangerine and sweet orange [*Citrus reticulata* × *Citrus sinensis* (L.) Osbeck]. 'Murcott' has high quality fruit, but has the undesirable characteristic of seediness and the trees tend to alternate bear, leading to inconsistent production and crop management problems **(Chien., et al 2007)** Murcott is a promising cultivar in Egypt due to its harvest season which extend from January to the end of March. The cultivar anchors the end of the Egyptian fresh-market mandarin season and coincide with the world demand. Mandarins are very prone to losing quality during storage, and as a result, have a short shelf life **(Obenland et al., 2011).**

It is well known that an efficient postharvest cold storage is essential to preserve the quality of fresh produce and to extend its shelf life in order to reduce postharvest losses of horticultural commodities (**Porat et al., 2004 and Defraeye et al., 2015).** Thereafter, the aim of this study is to investigate the effects of storage temperature on quality and storability of Murcott fruits.

2. Materials and Methods

2.1. Plant material

Full colored Murcott tangor [*Citrus reticulata* × *Citrus sinensis* (L.) Osbeck] fruits were harvested from a nine year-old trees in a private orchard located in the South Tahreir zone, Beheira Governorate, in the North West Egyptian delta. The trees were budded on Volkamer lemon (*Citrus volkameriana*, Ten & Pasq) rootstock and planted at 6×4 meters apart in sandy soil with drip irrigation system. The fruits were selected for uniform size and color and the absence of visual defects and transferred to the postharvest laboratory in the faculty of Agriculture Cairo University in Giza Governorate. Harvest indices were adjusted when the fruit age reached 320 days after full blooming with 12-13% total soluble solids and 0.9-1.0 % total acidity according to a preliminary experiment was conducted in this study.

2.2. Treatments

The transferred fruits were sorted again, washed with tap water contain 5% Clorox, air dried and packed one layer in carton boxes 25 fruits per each. The packed fruits were divided into three groups each one stored under three different conditions which were: room temperature (15°C±2 and 54% relative humidity (RH)) and refrigerator (10°C±1 or 5°C±1 and 85-90% RH) and each group considered as treatment. For each treatment, two boxes replicated three times (i.e., six boxes per treatment) were devoted to fruit weight loss% and decay% measurements, in the same time another nine boxes divided into three replicates (3 boxes per each) were devoted to fruit firmness and chemical measurements. All measurements were taken 10 days intervals and the treatment ended when the decayed fruits reached 50%.

2.3. Measurements

The weight loss was calculated as follows: weight loss (%) = [(w0 – w1)/w0] x100, where w0 is the initial weight and w1 is the weight measured at sampling date. Decay percentage was determined by calculating the number of decayed fruits on the sampling date and expressed as a percentage of initial fruit number (**El-Anany et al., 2009**).

A sample of three fruits were randomly chosen from each replicate and devoted to firmness and chemicals measurements. Fruit firmness was examined in two sides of the fruit using pressure tester (Digital force-Gouge Model FGV-0.5A to FGV – 100A. shimpo instruments) and expressed as kg/cm^2. After firmness measurements, the fruit pulp were juiced by hand juicer and filtered in order to estimate the chemical characteristics. Total soluble solids (TSS) were estimated by digital refractometer (ATAGO, mod. N-1E, Japan) and expressed as percentage (%) of fruit juice. Total acidity (TA) was determined by titration with Na OH 0.1N and expressed as citric acid % of fruit juice (**A.O.A.C. 2000**). Ascorbic acid (L-AA) was determined by titration with 2, 6-dichlorophenol indophenol dye and expressed as mg/100 mL juice (**A.O.A.C. 2000**).

2.4. Statistical analysis

This experiment was arranged as factorial completely randomized design with three replications. The treatments means were compared using least significant difference test (L.S.D.) at 5% level of significance in the two seasons. All data were subjected to statistical analysis according to **Snedecor and Cochran (1980)**.

3. Results and Discussion

3.1. Losses in fruit weight:

The weight loss of Murcott Tangor fruits, as measured in the two experimental seasons is shown in Fig (1). Postharvest storage temperatures had a main influence on weight loss. The rate of weight loss increased throughout storage period regardless of storage temperatures in both seasons but the weight loss of the fruits stored at 10 ° C and 5 °C were much lower than that of the fruits stored at 15 °C. The data showed the fruits stored at 15 °C.

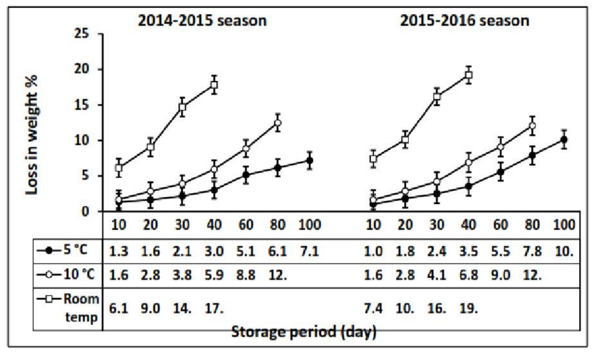

Fig (1): Effect of storage temperature on weight loss of Murcott Tangor fruits in 2014-2015 and 2015-2016 seasons.

The data showed also that at the end of the storage period, the loss in fruit weight was higher in fruits stored at 10°C compared to those stored at 5 °C.

It is known that during the postharvest period, weight loss mostly depends on the storage temperatures **(Jemriic and Pavicic, 2004)**, and our study confirmed that the weight loss is mainly affected by storage temperatures. Furthermore, the fruits stored at 5 °C and 10 °C showed less weight loss than those stored at 15 °C, which is likely because the higher storage temperature caused the loss of more moisture **(Tan-cha et al., 2015)**.

3.2. Decay %

Fig. (2) showed that, after 80 days of storage at 5°C, the decay percentage reached (16.67 and 15.83%) in the 1st and 2nd season respectively. While, it was (51.67 and 52.50%) after the same period of storage at 10°C in the 1st and 2nd season respectively.

On the other hand, the decay percentage reached (33.33 and 37.50 %) after 40 days only of storage at room temperature in the 1st and 2nd season respectively. A significant difference between all temperature degrees used was recorded in this respect during overall of storage periods. The principal cause of deterioration for fruit hold at room temperature was green mold, brown rot, drying damage of the skin, aging and shriveling. The results are in harmony with **Piga, et al., (2000)** who found that a more pronounced loss of 'Salustiana' orange due to rots was registered for 2°C-stored fruits compared with 8°C-stored fruits. Our data showed that arelatively low storage temperature (e.g., 10 or 5 °C) lead to inhibition of microorganisms growth and postharvest decay incidence on the other hand **Tripathi and Dubey (2004)** reported that the decay of citrus fruits may be due to low pH, high moisture content and many nutrients at fruit juice, so are very susceptible to attack by pathogenic fungi, which causes rotting, causes them to produce mycotoxins and thus makes them unfit for consumption.

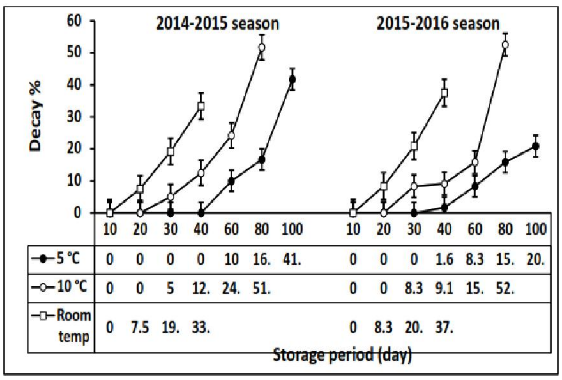

Fig (2): Effect of storage temperature on decay percentage of Murcott Tangor fruits in 2014-2015 and 2015-2016 seasons.

3.3. Fruit firmness:

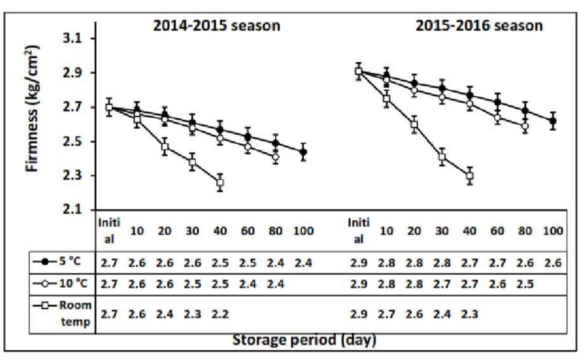

Fig (3): Effect of storage temperatures on Firmness (kg/cm2) of Murcott Tangor fruits in 2014-2015 and 2015-2016 seasons.

Fig. (3) showed that change in "Murcott Tangor" fruit firmness (kg/cm2) during storage at room temperature and under low temperature (5 and 10 °C) in 2014-2015 and 2015-2016 seasons. It was clear that the fruit firmness values in general decreased with the progress of storage period for all fruits hold at 5, 10°C and room temperature but at the end of the storage period, the firmness was higher in fruits stored at 5°C compared to those stored at 10 °C and room temperature.

This decrease in firmness, which may be due to the polygalacturonase activity on the pectin substances (**Matsuo and Kitagawa, 1989 and Turk, 1993**). A high degree of firmness at harvest plays a positive role in being able to preserve the quality of the fruit during the postharvest period (**Salvador et al., 2007**). Moreover, **Sánchez et al., (2013)** found that the firmness and maximum penetration force decreased during storage conditions.

2.1. TSS:

The TSS percentage were higher in fruits hold at low temperature (5°C and 10° C) than fruits hold at room temperature. Low temperatures maintain the fruit TSS content, where after 80 days of storage at 5°C, the TSS percentage was (12.40 and 12.40 %) in the 1st and 2nd season respectively. While it was (12.35 and 12.30 %) after the same period of storage at 10°C compared to (12.73 and 12.62 %) at the initial time of storage period in the 1st and 2nd season respectively. On the other hand, the TSS percentage was (12.05 and 11.50 %) after 40 days only of storage at room temperature in the 1st and 2nd season respectively.

No significant difference between the low temperature degrees 5° C and 10° C was observed in this respect during overall of storage periods as shown in Fig (4). These results are in agreement with **Kaur and Kumar (2014)** studied the influence of different post-harvest treatments and storage conditions on TSS. They reported that the rate of decrease in TSS was faster at room temperature than in cold storage on"Kinnow". While **Plaza et al., (2003)** who found that no effect was observed on total soluble solids in fruit during storage.

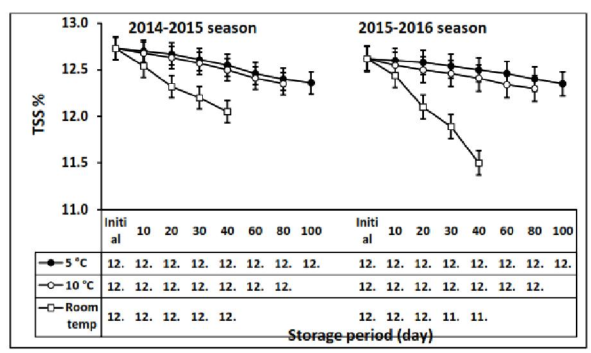

Fig (4): Effect of storage temperature on total soluble solids (TSS) percentage of Murcott Tangor fruit in 2014-2015 and 2015-2016 seasons.

2.2. TA:

Fig (5) indicates that acidity of Murcott tangor decreased significantly till the end of the storage period (at room temperature in both seasons. The same trend appeared when fruits were stored at 5°C and 10°C in spite of some fluctuations.

Comparing the various temperatures used, there were significant between the low temperature degrees (5 or 10°C) and room temperature. These results coincide with the findings of Results are consistent with the results of **Kaur and Kumar (2014)** who reported that the decline in acidity was found to be faster at room temperature as compared to cold storage. Many authors are the view that juice acidity decreased as the storage period advanced and at higher storage temperature **(Rapisarda, et al., 2001 and Ali, 2002).** The decline in acidity during storage may be attributed to the use of acids as substrates for respiration **(Tan-cha et al., 2015).**

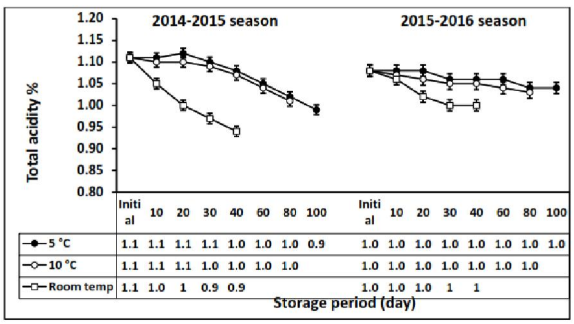

Fig (5): Effect of storage temperature on total acidity (TA) percentage of Murcott Tangor fruit in 2014-2015 and 2015-2016 seasons.

2.3. Ascorbic acid:

Ascorbic acid is widely regarded as one of the most important antioxidants in citrus fruits. As shown fig (6), ascorbic acid contents decreased significantly till the end of the storage period.

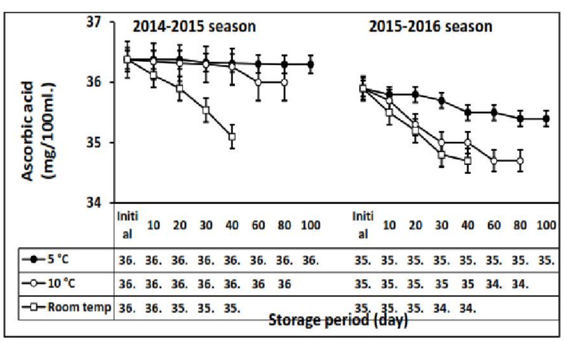

Fig (6): Effect of storage temperature on total acidity (TA) percentage of Murcott Tangor fruit in 2014-2015 and 2015-2016 seasons.

But the decline was found to be faster at room temperature as compared to cold storage. This might be attributed to the enhancement of fruit respiration and other metabolic processes in room conditions (higher in their storage temperature) than the low temperatures. These findings are agree with that obtained (Kaur and Kumar 2014, Shah et al., 2015 and Rab et al. (2012) they demonstrated that better vitamin C retention in 'Blood Red' sweet oranges stored at 10◦C than those stored at 20◦C.

Conclusion

The results of this study showed that postharvest storage temperatures had an impact on tangor Murcott fruits inregard to decay incidence, weight loss and storability. Murcott fruits can store at ambient temperature for 40 days but this period can be aggravate (100 days) if the fruit stored at 5°C±1). 5°C degree is more suitable for Murcott fruit storage compared to room temperature or 10°C degrees.

References

1. A.O.A.C.,) 2000(.Association of Official Agricultural Chemists Official Methods of Analysis. 12 Ed. Washington, D.C. USA.
2. Ali, G. (2002). Effect of four citrus root-stock on fruit quality and storability of "Fremont" tangerine. Hort. Sci., 28:312-326. '
3. Chien, P. J., Sheu, F., and Lin, H. R. (2007). Coating citrus (Murcott tangor) fruit with low molecular weight chitosan increases postharvest quality and shelf life. Food Chemistry, 100(3), 1160-1164.
4. Defraeye T., Verboven P., Opara U.L., Nicolai B., Cronjé P. (2015). Feasibility of ambient loading of citrus fruit into refrigerated containers for cooling during marine transport, Biosystems Engineering, 134: 20-30.
5. El-Anany, A.M., Hassan, G.F.A. and Rehab Ali, F.M. (2009). Effects of edible coatings on the shelf-life and quality of Anna apple (*Malusdomestica* Borkh) during cold storage. J. Food Technol. 7:5-11.
6. Jemriic, T., Pavicic, N., (2004). Postharvest treatments of Satsuma mandarin (*Citrus unshiu* Marc.) for the improvement of storage life and quality. Postharvest Biol. Technol. 4, 213-227.
7. Kaur, N., and Kumar, A. (2014). Impact of post-harvest treatments on shelf life of Kinnow mandarin. International Journalof Advanced Research, 2:290-295.
8. Matsuo, T. and Kitagawa, H., 1989. Effects of ethylene absorbent on polygalacturonase activity of persimmon fruit. Journal of the JPN Society for Horticulture Science, 57(4): 697 - 701.
9. Tan-Cha Lee, Pei-Juan Zhong, Pai-Tsang Chang (2015). The effects of preharvest shading and postharvest storage temperatures on the quality of 'Ponkan' (*Citrus reticulata* Blanco) mandarin fruits. Scientia Horticulturae 188: 57–65.

10. Obenland, D., Collin, S., Mackey, B., Sievert, J., and Arpaia, M. L. (2011). Storage temperature and time influences sensory quality of mandarins by altering soluble solids, acidity and aroma volatile composition. Postharvest biology and technology, 59:187-193.
11. Piga, A., D'Aquino, S. and Agabbio, M. (2000). Influence of cold storage and shelf-life on quality of 'Salustiana' orange fruits. Post-harvest News and information 11 (4): 214.
12. Plaza, Usall, J.; Torres, R.; Lamarca, N.; Asensio, A. and Vinas, l. (2003). Control of green and blue mould by curing on oranges during ambient and cold storage. Postharvest Biology Technology, 28 (1): 195-198.
13. Porat, R., Weiss, B., Cohen, L., Daus, A., Aharoni, N., (2004). Reduction of postharvest rind disorders in citrus fruit by modified atmosphere packaging. Postharvest Biol. Technol. 33, 35–43.
14. Rab, A., Sajid, M., Khan, N.U., Nawab, K., Arif, M., Khattak, M.K., (2012). Influence of storage temperature on fungal prevalence and quality of citrus fruit (cv. Blood Red). Pak. J. Bot. 44, 831–836.
15. Rapisarda, P.; Bellomo, S.E. and lntelisano, S. (2001). Storage temperature effects on Blood orange fruit quality. Journal of Agricultural and Food Chemistry 49 (7): 3230-3235.
16. Shah, S. W. A., Jahangir, M., Qaisar, M., Khan, S. A., Mahmood, T., Saeed, M., and Liaquat, M. (2015). Storage Stability of Kinnow Fruit (*Citrusreticulata*) as Affected by CMC and Guar Gum-Based Silver Nanoparticle Coatings. Molecules, 20(12), 22645-22661.
17. Salvador, A.; Arnal, L.; Besada, C.; Larrea, V.; Quiles, A. and P´erez-Munuera, I., 2007. Physiological and structural changes during ripening and deastringency treatment of persimmon fruit cv. 'Rojo Brillante'. Postharvest Biology and Technology, 46: 181 – 188.
18. Sánchez, M. T.; De la Haba, M. J. and Pérez-Marín, D. 2013. Internal and external quality assessment of mandarin's on-tree and at harvest using a portable NIR spectrophotometer. Computers and Electronics in Agriculture, 92: 66 - 74.
19. Snedecor, G.W. and Cochran, W.G. (1980). Statistical Methods oxford and J.B.H. Publishing Com.7 Th edition.
20. Tripathi, P. and Dubey, N. K. 2004. Exploitation of natural products as an alternative strategy to control postharvest fungal rotting of fruit and vegetables. Postharvest Biology and Technology, 32: 235 – 245.
21. Turk, P., 1993. The cold storage of persimmons harvested at different maturities and the effect of different CO_2 applications on fruit ripening. Acta Horticulture, 343: 190 - 194.
22. Verdonk, R., and Hamza, M., (2016). Egyptian pound's devaluation to boost orange exports. USDA Foreign Agriculture Service.

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