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POSTHARVESTING TECHNOLOGY | ORIGINAL ARTICLE

Improving quality and prolonging shelf life of guava (*Psidium guajava* L.) by organic and inorganic compounds and plant extracts

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ABSTRACT

Shelf life of a fruit is an important consideration for its storage and marketing. Post-harvest losses of guava represent a massive loss and decreased our guava production every year. The current study was carried out in the Baramoon Experimental Farm of the Horticulture Research Institute, Dakahlia Governorate, Egypt, to evaluate the effect of pre- and postharvest treatments to extend the marketability and shelf life of guava fruits. A total of 56 trees primarily selected and seven treatments such as T1 = Spray pre-harvest with water and dipping postharvest into water (control), T2 = Spray pre-harvest with $CaCl_2$ at 1% and dipping postharvest into $CaCl_2$ at 1%, T3 = Spray pre-harvest with citric acid at 1% and dipping postharvest into citric acid at 1%, T4 = Spray pre-harvest with rosemary oil 4.0% and dipping postharvest into rosemary oil 4.0%, T5 = Spray pre-harvest with moringa oil 4.0% and dipping postharvest into moringa oil 4%,T6 = Spray pre-harvest with coconut oil 4.0% and dipping postharvest into coconut oil 4% and T7 = Spray pre-harvest with extract of peppermint 4% and dipping postharvest into extract of peppermint 4%. From each group, random samples of 20 light yellow color stage fruits were taken and immersed in the same solution, separately each for 2 min, and stored at ambient conditions for 9 d. Quality attributes of fruits were analyzed before and after 9-day storage. The obtained results indicated that there were significant differences among the treatments. Medicinal and ornamental plant extracts or oils solutions resulted in extending the shelf life of guava for 9 d by minimized the loss in physical and chemical quality attributes. Among the treatments pre-harvest spraying with moringa oil 4% and postharvest dipping into the same solution performed best in terms of loss of fruit weight 14.0%, fruit firmness 1.30 kg cm^{-2}, increases of TSS content 0.10 °Brix, decrease ascorbic acid content 1.67 mg $100g^{-1}$ and increases of acidity 1.0%.

Keywords: Guava, plant extracts, organic compound, shelf life

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1 Introduction

Guava (*Psidium guajava* L.) is becoming a popular fruit all over the world. It is tasty at fresh and then fruit quality deteriorate drastically. The post-harvest losses of guava were about 23.1% in Ethiopia (Kasso and Bekele, 2018), 26.0% in Egypt (Sahar, 2014) and 18.05% in India (Nanda et al., 2012). Several pre- and postharvest applications have been tested on guavas and the results were efficient in extending the shelf life and preserving the fruit quality. However, some pre-and postharvest treatments interfere with the sensory characteristics of the fruit while others extend

the shelf life in an economically insignificant way, and leave chemical residues.

Natural plant-based products are generally used for extending the shelf life and maintaining the fruit quality. It's advantageous considering its edibility, non-toxic nature and cost effective as compared to other pre- and postharvest treatments (Gulhane et al., 2018). Several investigators reported that the positive effects of medicinal and ornamental plant extracts or oils solutions in extending the shelf life and maintaining the quality parameters of guava (Shaaban and Hussein, 2017; EL-Eryan et al., 2017; Malik et al., 2015; Sabah et al., 2020), on apple (Kazemi and Shirzadeh, 2012; Anushka et al., 2020), on avocado (Tesfay and Magwaza, 2017) and on lemon (Nasrin et al., 2020). Malik et al. (2015) and Sabah et al. (2020) found that application of Moringa oil and leaf extracts of Neem, Chinaberry and Marigold kept fruits more marketable and appealing by minimized the loss in physical and chemical quality attributes for 9 days after harvest at ambient storage. Hence the present study was aimed to evaluate the efficacy of medicinal and ornamental plant extracts or oils solutions to extend the marketable and shelf life of guava fruits.

2 Materials and Methods

The research was conducted at the Baramoon Experimental Farm of the Horticulture Research Institute located at Dakahlia Governorate, Egypt during the year 2015 and 2016. Twenty-two years old guava trees cv. Montakhab- Elsabaheya were selected. Trees were planted at 5 m *times* 5 m spacing and subjected to the same agricultural practices that recommended by MoALR (2001). Fifty-six trees uniform in growth, free from disease and pests were selected, divided in to 7 groups and each group was sprayed (10 days before harvest date) with one of the following solutions: Tap water (control), $CaCl_2$ at 1%, citric acid at 1%, rosemary oil (*Rosemarinus officinalis* L.) at 4.0%, moringa oil (*Moringao leifera* L.) at 4.0%, coconut oil (*Cocos nucifera* L.) at 4.0% and extract of peppermint (*Mentha piperita* L.) at 4.0%. Tween-20 (0.1 %) as surfactant was added to all spraying solutions and applied directly for the trees with a hand sprayer (type AGRICO 20L) until runoff in the early morning.

From each pre-harvest treatment, random samples of 20 light yellow color stage fruits according to Mercado-Silva et al. (1998) were taken and transported to the Laboratory of Mansoura Horticulture Research Station. The fruits were rinsed with distilled water, dried properly. Fruits of each group were immersed in the same solution, separately each for 2 min, dried outdoors. Seven treatments such as T1 = Spray pre-harvest with water and dipping postharvest into water (control), T2 = Spray pre-harvest with $CaCl_2$ at 1% and dipping postharvest into $CaCl_2$ at 1%, T3 = Spray pre-harvest with citric acid at 1% and dipping postharvest into citric acid at 1%, T4 = Spray pre-harvest with rosemary oil 4.0% and dipping postharvest into rosemary oil 4.0%, T5 = Spray pre-harvest with moringa oil 4.0% and dipping postharvest into moringa oil 4.0%,T6 = Spray pre-harvest with coconut oil 4.0% and dipping postharvest into coconut oil 4.0% and T7 = Spray pre-harvest with extract of peppermint 4.0% and dipping postharvest into extract of peppermint 4.0%.

The treated fruits were packed in open carton boxes, 10 fruits per box, and stored in room conditions at 25–30 °C and 65±5% RH. The initial fruit quality characteristics before storage were measured (zero time). After 9 days storage, fruit of each treatment were analyzed to evaluate the physical and chemical quality measurements.

2.1 Physical quality measurements

2.1.1 Fresh weight loss

Fresh weight loss of fruits (FWL %) was calculated according to the following equation:

$$FWL = \frac{W_i - W_s}{W_i} \times 100 \quad (1)$$

where, W_i = fruit weight at initial period, W_s = fruit weight at 9 days storage.

2.1.2 Firmness

Firmness of fruits was determined by using a hand-held fruit firmness tester ("Penetrometer" (Model FT 327, QA Supplies, Norfolk, VA, USA), and data were expressed as kg m^{-2} (Chawla et al., 2018).

2.2 Chemical quality measurements

2.2.1 Total soluble solid (TSS)

TSS (%) was determined by using a hand refractometer, 0-32 scale (ATAGO N-1E, Japan) and expressed in standard °Brix unit after making the temperature correction at 20 °C (Chawla et al., 2018).

2.2.2 Titratable acidity

Ten gram guava pulp was homogenized in 40 mL distilled water and filtered to extract the juice. Two to five drops of 2, 6-dichlorophenol endophenol blue dye was added in this juice. A 10 mL juice was taken in a titration flask and titrated against 0.1 N NaOH till permanent light pink color appeared (El-Sisy, 2013). Three consecutive readings were taken from each replication of a treatment and percent acidity as citric acid was calculated by using the following formula:

$$\text{Acidity (\%)} = \frac{V_a \times N_a \times EW_{ca}}{W_s \times V_j} \quad (2)$$

where, V_a = volume of NaOH used (mL), N_a = normality of NaOH, EW_{ca} = equivalent weight of citric acid, W_s = weight of sample (g), and V_j = volume of guava juice taken (mL)

2.2.3 Ascorbic acid content

Ascorbic acid content of fruit was determined with the help of the method of El-Sisy (2013), and expressed as mg ascorbic acid per 100 mL juice.

2.3 Organoleptic parameters

The sensory evaluation of organoleptic parameters (fruit appearance, colour, flavour, taste and overall acceptance) was carried out using a 5-point hedonic scale in which 1 = disliked extremely; 2 = disliked slightly; 3 = neutral; 4 = liked slightly; 5 = liked extremely hedonic (Arpaia et al., 2015). Data were expressed as the mean of all the scores.

2.4 Statistical analysis

The data were statistically treated by analysis of variance (ANOVA) and means for various treatments were compared using Duncans Multiple Range Test (Duncan, 1955).

3 Results and Discussion

Results showed significant difference (P<0.0001) between treated and untreated controls against various quality attributes (loss of fruit weight, loss of fruit firmness, increases of TSS content, loss of ascorbic acid content and increases of titratable acidity). The control had 100% decayed after 9 days of storage. The results are in agreement with those obtained by Malik et al. (2015) and Sabah et al. (2020). Fruits treated with medicinal and ornamental plant extracts or oils solutions [T4, T5, T6 and T7] were significantly superior to calcium chloride 1% and citric acid 1% (are nowadays the common postharvest treatment used to increase the shelf life of fruits) (Fig. 1 and Fig. 2).

Treatments medicinal and ornamental plant extracts or oils solutions [T4, T5, T6 and T7] increased firmness, ascorbic acid (VC). Also, it decreased fruit weight loss percentage, total soluble solids (TSS) and titratable acidity (Figure 1). Similar findings are also reported by Shaaban and Hussein (2017); EL-Eryan et al. (2017) and Sabah et al. (2020) in guava fruits, Shirzadeh and Kazemi (2012) and Anushka et al.(2020) in apple, Tesfaya and Magwaza(2017) in avocado and Nasrin et al. (2020) in lemon.

Treatment 5 that is pre-harvest spray with 4.0% moringa oil and at post-harvest dipping into same solution, found the most effective for fruit quality (loss of fruit weight 14.00%, loss of fruit firmness 1.30 Kg/cm2, increases of TSS content 0.10 °Brix, loss of ascorbic acid content 1.67 mg/100g and increases of titratable acidity 1%) and shelf life during storage period at room conditions 25-30˚C and 65±5% RH. (Figure 1). These results are in agreement with those of Sabah et al. (2020).

Similarly, the organoleptic parameters (fruit appearance, colour, flavour, taste and overall acceptance) were found maximum with all the medicinal and ornamental plant extracts treatments [T4, T5, T6 and T7]. However, guava fruits treated with moringa oil 4.0% retained maximum scores for all organoleptic parameters and were rated as 5 = liked extremely hedonic (Figure 3). Previous reports of Kubheka et al. 2020 also found that the avocado fruits coated with moringa leaf extract had the highest scores in all organoleptic parameters after 28 days of storage, whereas those coated with control and gum arabic 15% developed poor taste.

4 Conclusion

Application of medicinal and ornamental plant extracts kept fruits more marketable and appealing by minimized the loss in physical and chemical quality attributes for 9 days of storage. Treatment 5 (Spray pre-harvest with moringa oil 4.0% and dipping into the same solution) are suggested to be a good recommendation for improving the fresh quality assessments of guava fruits during 9 days of storage at ambient storage 25-30˚C and 65±5% RH.

Conflict of Interest

The authors declare that there is no conflict of interests regarding the publication of this paper.

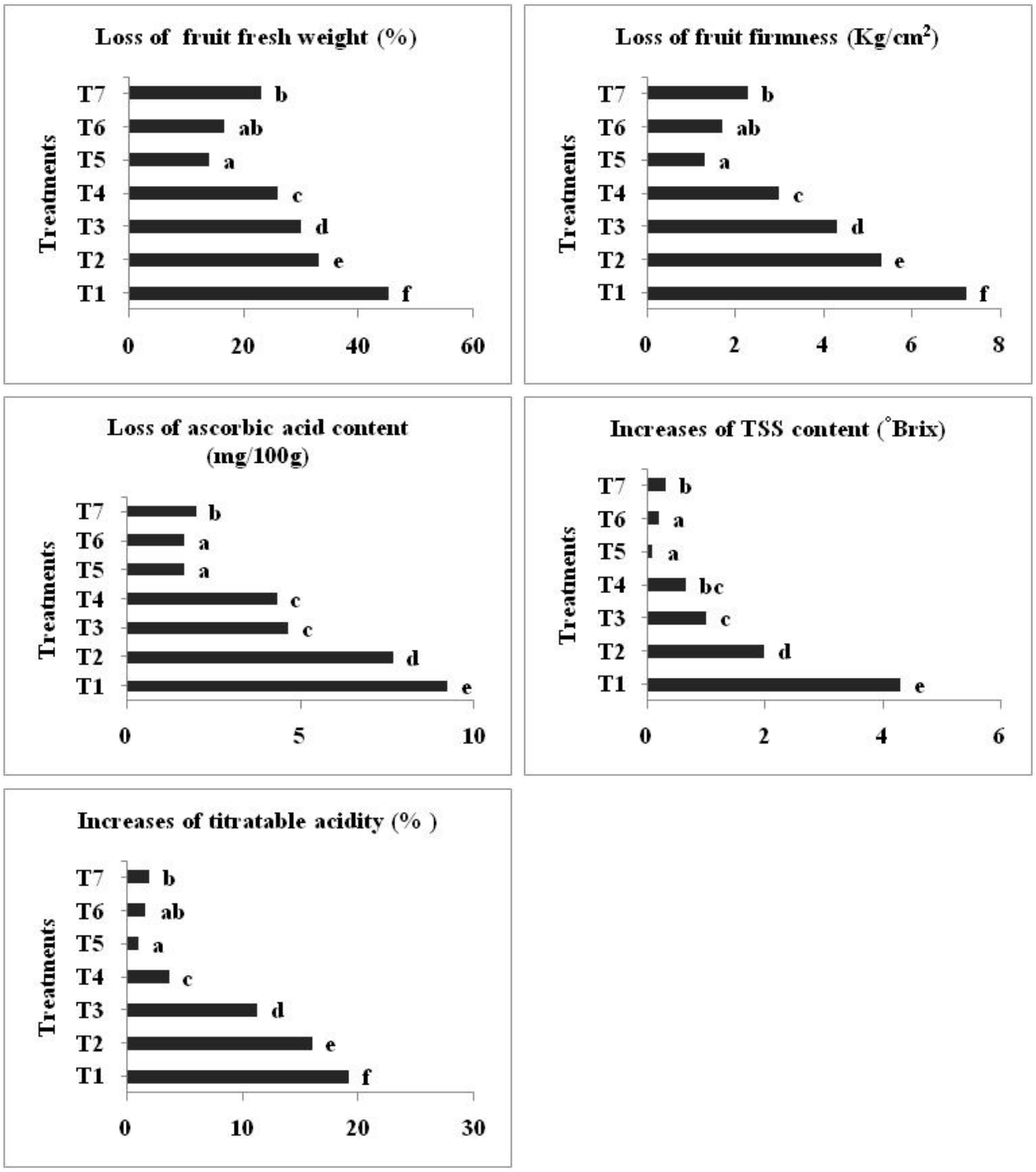

Figure 1. Physical and chemical quality measurements of fruits T1 = Spray pre-harvest with water and dipping postharvest into water (Control), T2 = Spray pre-harvest with $CaCl_2$ at 1% and dipping postharvest into $CaCl_2$ at 1%, T3 = Spray pre-harvest with citric acid at 1% and dipping postharvest into citric acid at 1%, T4 = Spray pre-harvest with rosemary oil 4% and dipping postharvest into rosemary oil 4%, T5 = Spray pre-harvest with moringa oil 4% and dipping postharvest into moringa oil 4%, T6 = Spray pre-harvest with coconut oil 4% and dipping postharvest into coconut oil 4%, T7 = Spray pre-harvest with extract of peppermint 4% and dipping postharvest into extract of peppermint 4%. Values in the bar followed by the same letter(s) are not significantly ($p \geq 0.05$) different.

Figure 2. Fruits of treatment 5(Spray pre-harvest with moringa oil 4% and dipping postharvest into moringa oil 4%) after (A) one day and (B) 9 days of storage at ambient storage 25–30 °C and 65±5% RH

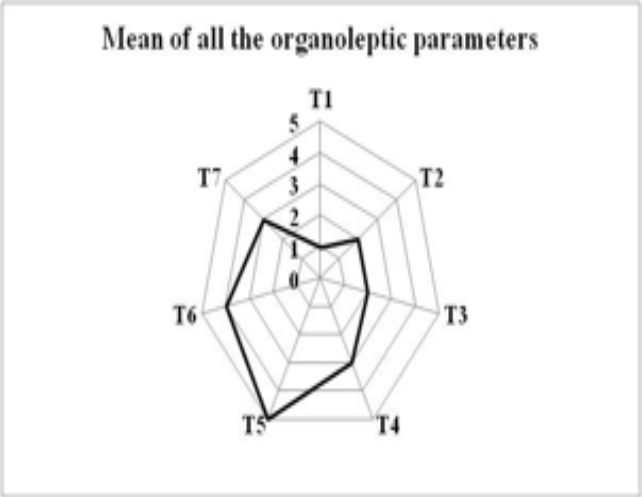

Figure 3. Sensory evaluation scores of organoleptic parameters (fruit appearance, colour, flavour, taste and overall acceptance) of guava fruits stored in room conditions at 25–30 °C and 65±5% RH, T1 = Spray pre-harvest with water and dipping postharvest into water (Control), T2 = Spray pre-harvest with $CaCl_2$ at 1% and dipping postharvest into $CaCl_2$ at 1%, T3 = Spray pre-harvest with citric acid at 1% and dipping postharvest into citric acid at 1%, T4 = Spray pre-harvest with rosemary oil 4% and dipping postharvest into rosemary oil 4%, T5 = Spray pre-harvest with moringa oil 4% and dipping postharvest into moringa oil 4%, T6 = Spray pre-harvest with coconut oil 4% and dipping postharvest into coconut oil 4%, T7 = Spray pre-harvest with extract of peppermint 4% and dipping postharvest into extract of peppermint 4%. Mean of all the organoleptic parameters used the following hedonic scale: 1 = disliked extremely; 2 = disliked slightly; 3 = neutral; 4 = liked slightly; 5 = liked extremely hedonic

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