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Application of Polysaccharide Based Composite Film Wax Coating for Shelf Life Extension of Guava (var. Bangkok Giant)

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Abstract

The application of wax coating helps to extend the shelf life of picked guava by minimizing the weight loss due to natural migration process of moisture and gases. The present investigation relates to find out the applicability of different concentrations of edible coating (wax) for shelf life extension of guava, which include palm oil (3%), glycerol (30%), Sorbitan monooleate (tween 80) (2%) and guar gum (2%). The medium size fruits were harvested at correct maturity (green to yellow) and only disease and damage fruits were selected. The treatment solution was prepared by mixing wax formula with distilled water in 1:1 (T1) and 1:2 (T2) ratios and (T3) kept as control without any treatment. The fruits were analysed for physiological weight loss, fruit firmness, titratable acidity, pectin content, pH, total soluble solid content and rate of respiration for 09 days storage. The consumer acceptability was evaluated by 30-panellist using 5 point hedonic scale. Among the treatments tested, wax solution mixed with water in 1:1 ratio (T1) showed significantly higher performances ($p < 0.05$) compared to the other treatments tested. The selected treatment appeared to extend the shelf life of guava up to 09 days under ambient condition (29-32°C and 65%- 70% RH) with appreciable retention of all quality parameters tested.

INTRODUCTION

Guava is one of popular fruit crops grown in most of the agro ecological zones in Sri Lanka. It is most common and popular among the rich and the poor alike due to its comparative low price than other fruits, nourishing value and good taste. It is rich in vitamin C (260mg /100g) and a fair source of calcium, phosphorus, iron and vitamin A (Nag et al., 2011). The fruits are highly perishable and every year large quantities of fruits are lost due to spoilage. The major deteriorative changes are wilting, shriveling, and loss in texture of fresh fruits, weight and their appearance. Mechanical or physical injuries can occur at almost any point in the post harvest system resulted from poor handling and packaging, inadequate transportation and storage conditions, and damage in the market places.

Edible coating is a transparent film that covers the food item and acts as a barrier to humidity and oxygen. There are several types of edible coatings such as carbohydrate, protein, lipid and combination of all these type of materials. Edible coatings and films can provide an alternative for extending shelf life of fresh fruits and vegetables and result in the same effects as modified atmospheric storage where the internal gas composition is adjusted. Traditionally films and coatings have been used to reduce water loss but film materials and edible coatings formulated with wider range of permeability characteristics facilitate achieving a modified atmosphere effect in the fresh fruits (Smith et al., 1987). The main components are generally recognized as safe substances (GRAS); different extracts such as lipids, proteins, cellulose derivatives, starch and other polysaccharides (Guilbert, 1986, Kester and

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Fennema, 1986). Use of edible coating is a common issue that is beneficial to protect nutrients of food specially fruits and vegetables and provide a long durability. These are a thin layer of edible material, which restricts water loss, oxygen and other soluble materials of food (Baldwin, 1995).

Coating formulations have been developed to enhance appealing characteristics of many fruits. These materials may reduce weight loss; promote colour, or relative decay. To varying degrees, all coating promotes the selective exchange of gasses between the storage atmosphere and fruit.
The Present investigation relates to find out the applicability of different concentrations of lipid based edible coating (wax) for shelf life extension of guava.

Material and methods

Application of coating material

Fresh guava (variety Bangkok Giant) fruits were harvested at commercial maturity stage (based on peel color break stage, when skin color changes from dark green to light green) from a commercial farm at Anuradhapura (North Central part of the country) and transported under ambient conditions to the laboratory at Institute of Postharvest Technology (IPHT) within 15 minutes. Diseased, damaged and extremely large or small fruits were discarded to minimize biological variability.

The fruits washed with 200 ppm chlorine solution and dry at 30°C to remove surface water. Palm oil, glycerol, Sorbitan monooleate (tween 80) and guar gum were purchased from the market and coating solution was prepared on the percentage weight basis with distilled water and the formula contain palm oil (3%), glycerol (30%), Sorbitan monooleate (tween 80) (2%) and guar gum (2%). The treatment solution was prepared by mixing wax formula with distilled water in 1:1(T1) and 1:2 (T2) ratios and allowed to air dry for fixing it with fruit peel properly.

Storage quality evaluation

The fruits were analysed for physicochemical and physiological characteristics such as physiological weight loss percentage, fruit firmness, titratable acidity, pectin content, pH, total soluble solid content and rate of respiration during storage. Percentage weight loss was taken after each storage interval and loss in weight during storage was expressed as % of initial weight. Pre-weigh fruit samples weighed on top lording balance (OHAUS, model ARA 520, New Jersey, 07058, USA) after each storage interval. The loss in weight on each sample date was observed. Fruit firmness was measured with digital firmness tester (model TR 53205) which recorded the pressure required to force a plunger of 11mm diameter into flesh of fruit. The content of total soluble solids (TSS) has been determined by direct reading on a refractometer [ATAGO, Model: HR-5 (9-90%), Japan] and expressed as °Brix. Titratable acidity was determined by the following volumetric method. The juice was neutralized by a NaOH solution (0.1 mol L^{-1}) added by some drops of phenolphthalein as indicator solution. Indeed, under neutral conditions, the NaOH solution turns the juice pink. A known sample of fruits were measured and crushed, taken in 250 ml volumetric flask and the volume was made up after filtration, 10 ml of filtration were titrated with 0.1 N NaOH by using phenolphthalein as indicator to the end point of faint pink color (Horwitz, 1980). The pH of a known amount of fresh fruit juice in a 100ml beaker was recorded with a digital pH meter (Thermoorin, Model, $230A^{+}$). Pectin content was determined by Carre and Hayne’s method as described by Ranganna (1986) and expressed as percentage of Calcium pectate. Respiration rate was measured by the closed method described by Kader et al. (1989), where gas tight glass box of 1L volume were filled with approximately 1 kg of fruits per box. The accumulation of CO_2 and O_2 inside the box was measured after a period of 30 min. One mL of head space gas was taken from each box with a calibrated syringe and CO_2 and O_2 production monitored in gas analyser (Varian cp-3800, PO box 8033,43330 EA, MIDDELBURG, The Netherlands). The sensory evaluation was done to evaluate the appearance (peel), appearance (flesh), firmness, taste and overall acceptability by using a sensory evaluation panel consisting of 30 panellists using five point hedonic scale (1- extremely dislike, 5- extremely like).

Statistical analysis

Three replicates were used in each treatment and the results were assessed by completely randomized design. Each replicate consists of 20 fruits and mean separation was done by using Least Significant Difference (LSD) at α= 0.05. The nonparametric data were analysed using Friedman test with Minitab statistical package.

Results and discussion

A gradual decrease in firmness of guava fruits was observed during storage (Table 1). Wax solution mixed with water in 1:1 ratio (T1) showed higher fruit firmness (121.64N) and control sample was exhibited higher reduction of fruit firmness from 71.10N to 88.52N. The present findings confirmed the studies of Wijewardana and Guleria (2013) who have reported that coating of apple fruits slowed down the decrease in fruit firmness. The retention of relatively higher fruit firmness under this treatment could be due to slower metabolic activities leading delayed ripening changes and senescence. Ruzania et al. (2013) reported that coatings excreted a beneficial effect on fruit firmness for 14 days at 20° C and 21 days at 10^0 C storage.

The general trend was an increase in weight loss and this was true for all the treatments including control, however variable pattern of weight loss was observed in different set of treatments. This was because the coating consisting edible oil, guar gum and glycerol served as semi permeable membrane around fruit surface and however, the fruits treated with (T1) showed the minimum changes of weight loss than other treatments. Dorria (2007) reported that the use of jojoba oil as a coating significantly affects the reduction of percentage weight loss with its concentration increased.

Table 1 Effect of application of edible wax coatings on firmness (N) and weight loss (%) of Guava

Fruit firmness (N)			
Storage Intervals days			
Treatments	3	6	9
T_1	111.51^b	104.10^b	101.64^a
T_2	106.39^b	102.20^b	84.36^c
T_3	71.10^d	67.98^d	88.52^c
Weight loss (%)			
T_1	2.22^a	2.49^b	2.18^a
T_2	3.52^c	3.59^c	2.25^a
T_3	4.22^e	3.79^d	2.41^b

Initial value (Firmness): 112N

Figures with same superscripts are not significantly different (∝ = 0.05) along same column and row. (n=3). T1 – 1:1 ratio, T2- 1:2 ratio T3 - Control

Variation of acidity in guava fruits under different coating treatments at storage showed a gradual decrease in titratable acidity (TA) during storage (Table 2). At the end of storage, minimum level of TA content (0.20%) was shown by control and minimum changes in acidity (0.27% to 0.26%) was shown by treatment 1. The decrease in acidity and increase in pH during storage may be due to the use of organic acid as respiratory substrates during storage and conversion of acid into sugars because of ripening process (Keditsu et al., 2003).

Table 2 Effect of application of edible wax coatings on titratable acidity (citric acid %) and pH of Guava

Titratable acidity (% citric acid)			
	Storage Intervals days		
Treatments	**3**	**6**	**9**
T1	0.27a	0.26a	0.26a
T2	0.25b	0.24b	0.22c
T3	0.21c	0.21c	0.20d
pH			
T1	4.33ab	4.79 d	4.81b
T2	4.41a	4.52e	4.63ab
T3	4.31b	4.36c	4.37

Initial value (TA): 0.27%
Initial value (pH): 4.2

Figures with same superscripts are not significantly different (∝ = 0.05) along same column and row. (n=3). T1 – 1:1 ratio, T2- 1:2 ratio T3 - Control

Table 3 Effect of application of edible wax coatings on Total Soluble Solids (TSS 0B) and Pectin content (% calcium pectate)

TSS (°B)			
	Storage Intervals days		
Treatments	3	6	9
T1	12.17b	12.33b	13. 23a
T2	11.33c	12.27b	12. 17b
T3	13.10a	12.30b	11. 30c
Pectin content (% Calcium pectate)			
T1	0.48a	0.38b	0.36b
T2	0.47a	0.32c	0.27d
T3	0.38b	0.17e	0.08f

Initial value (TSS): 11.2^{0}B%
Initial value (Pectine): 0.50%

Figures with same superscripts are not significantly different (∝ = 0.05) along same column and row. (n=3). T_1 – 1:1 ratio, T_2- 1:2 ratio T_3 - Control

Continuous increase of TSS was observed in the fruits treated with the coating solution mixed with water in 1: 1 ratio (Table 3). In all other treatments increase of TSS was observed at initial storage period and decreased thereafter. This increase in TSS is due to the hydrolysis of starch to simple (soluble) sugars, which is higher during fruit ripening. When conversion is lower than the utilization, a decrease of TSS can be seen (Gupta and Metha, 1987). Rate of increase in TSS under coating treatment may be due to delaying of ripening however, the interaction between treatments and storage intervals was significant at ∝ = 0.05 level.

Pectin content of guava fruits decreased with the storage (Table 3) and highest pectin content was reported by treatment one (0.36 %) at the end of storage. Interaction between treatment and storage intervals was significant at ∝ = 0.05 level. During fruit ripening, pectin compounds are reduced and disassembled and fruit softening takes place (Gross and Sams, 1984). The gradual decline in pectin content with the advancement of storage period might be the results of pectin enzymes activity on natural pectin in the fruits (Nara and Motomura, 2001). Polygalacturonase (PG) enzyme involve solubilization of pectin resulting softening of fruits and act on deesterified pectin molecule by breaking the linkage between galacturonic acid group in the poly galacturonides as reported by Colvin and Lepard, (1973). Significantly, lowest level of pectin content (0.08) was recorded by control and that may be due to decreased rate of pectin degradation and therefore, enabled the fruit to retain higher pectin content during storage (Wijewardane and Gularia, 2009).

Generally, O_2 declined when CO_2 increased during ripening at ambient storage as shown in Table 4. O2 and CO2 gases are related to the respiration of fruit during ripening. The higher rate of respiration is due to high temperature that increased the burning assimilates for fruit maintenance of guava. The treated fruits were tested for appearance (peel), appearance (flesh), firmness, taste and overall acceptability. The estimated median for appearance (peel), appearance (flesh), firmness, taste and overall acceptability were evaluated and treatment one was above the point 'like very much' which correspond to number 4 of the 5 point hedonic scale followed by treatment two (Fig. 1).

Table 4 Effect of application of edible wax coatings on Oxygen and Carbon dioxide concentrations

Oxygen concentration of guava (ml/kg/hr)			
	Storage Intervals days		
Treatments	3	6	9
T_1	12.79[d]	14.67[b]	14.63[b]
T_2	13.23[c]	15.48[a]	14.57[b]
T_3	12.68[d]	15.54[a]	14.57[b]
Carbon dioxide concentration of guava (ml/kg/hr)			
T_1	2.18[c]	2.06[ce]	1.98[e]
T_2	2.32[c]	2.17[ce]	4.91[a]
T_3	1.85[e]	3.04[b]	3.03[b]

Initial value (O_2 concentration): 12.6(ml/kg/hr) Initial value (CO_2 concentration):1.54(ml/kg/hr)
Figures with same superscripts are not significantly different (∝ = 0.05) along same column and row. (n=3). T1 – 1:1 ratio, T2- 1:2 ratios T3 - Control

Conclusion

The physicochemical and physiological characters of fruits were evaluated for 9-day storage and the fruits treated with T1: mixing of wax formula with water in 1:1 ratio exhibited better performances significantly (P<0.05) than other treatment tested. It extends storage life up to 9 days at 29-32°C and 65%- 70% RH with appreciable retention of all quality parameters.

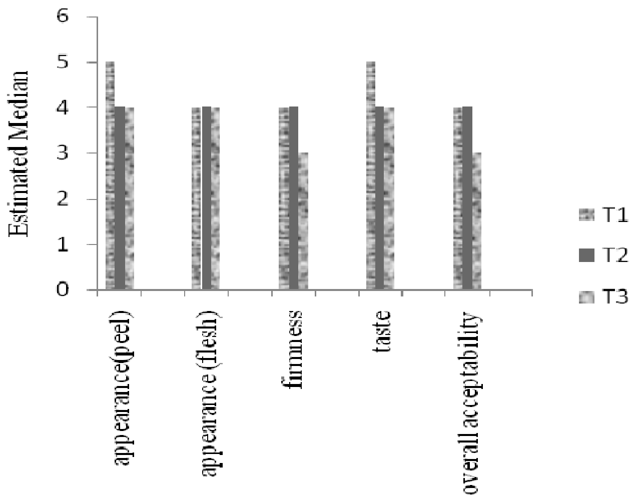

Fig.1. Estimated median for sensory quality attributes of guava at the end of storage
T1 – 1:1 ratio, T2- 1:2 ratios T3 – Control

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