Comparative Study of some Edible Coatings for Retarding the Postharvest Ripening and Extending the Shelf Life of Guavas

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ABSTRACT

A mature – green guava (Psidium guajava L.) fruit were coated with three type of coatings; cellulose, pectin and carnauba – based emulsions to compare the effect on fruit ripening and quality of ripened fruit. Coatings containing pectin significantly slowed softening an average of 48.5% on Sept. reaping samples and 49.4% on Dec. reaping samples compared to uncoated fruit and 30% more than the other type of coatings (a delay of 3.5 days in Sept. & 4.5 days in Dec.). Also, 17.5% of the guavas did not soft within 2-3 weeks. All type of used coatings did not affect the decay susceptibility of softened fruit, but pectin formulation was most effective at reducing weight loss, did not develop as much color, had a lower SSC, a smaller percentage of decay 2-2.8% and injury 12.7-13.5%, a large beneficial effect of firmness retention (32% in Dec. & 56% in Sep. reaping samples and had a larger degrees in recorded color values of chromometer (L,C,h), therefore pectin – based emulsion affect all aspects of ripeness at the same rate. About the percent of opacity, pectin film graduated in the second calss after cellulose film (3.25% for pectin & 2.65% for cellulose) and graduated in the third class in barrier capacity against moisture transfer while pectin beside cellulose had an excellent mechanical and structural properties (TS and E%). Also, the scanning electron microscopy evaluation of coated samples showed that the pectin film was the most even among all of the other coating materials during the repining period and after ripening begins.

Key words: Guavas, Edible coating, Pectin, Cellulose, Carnauba wax, Respiration rate.

Introduction

Guavas (Psidium guajava L.) is one of the most important fruit consumed by human beings since ancient times. The fruit is very fragrant, greenish yellow in color, of medium size, and with a characteristic flavour. It is harvest in a maturity stages from September to January. Its fruits contain five times more vitamin C than citrus fruits. This fruit are tropical, climacteric fruit that are typically harvested while still green and firm, then placed into cold storage between 7 and 12°C for shipment to markets. Fruit removed from cold storage to ≥ 20°C ripin 3-10 days (Vazquez – Ochoa and Colinas – Leon, 1990). Soon after ripening begins, the decay fungus Colletotrichum gloeosporioides, which can latent but undetectable in unripe fruit. (Jeffries et al., 1990) may make fruit unsalable.

In combination with temperature control, a mechanism that delays ripening of guavas would allow the shipper and retailer a greater window of opportunity for maintaining fruit quality.

Fruit decay can be slowed by delaying ripening and moisture loss. Both these processes hasten the senescence, making the commodity more prone to pathogenic infection as a result of loss of cellular integrity and the tissue's natural defense mechanism.

The envelope coating plays an important role on the conservation, distribution and marketing of food stuff. Some of its functions are to protect the product from mechanical damage, physical, chemical and microbiological activities.

Amarante and Banks (2001) found that edible coatings of fruit can also form a physical barrier against pathogenic infection, and reducing incidence of postharvest disease. They ca create modified atmosphere, similar to that of modified atmosphere storage or package, their effectiveness being a function of coating permeability and fruit respiration.

This preserving the quality parameters regarding different factors such as weight loss, firmness, surface color of the fruit, commercial acceptability and nutritional quality.

Recent years coating formulations have been developed to enhance these characteristics, especially, reduce weight loss, promote color, or retard decay, but to varying degrees, all coatings promote the selective exchange of gases between the storage atmosphere and fruit. (Mafroozad et al., 2007). They are specifically formulated to reduce O₂ diffusion into a fruit and stop CO₂ diffusion to the outside, thereby
delaying fruit ripening (Nisperos – Carriedo et al., 2015).

Postharvest diseases of fruits and vegetables are a major problem in produce storage and significantly affect the cost of food production and produce trade. Ready to sell fresh or processed food carries a higher value than the same crop in the field because of the cumulative cost of production, harvestings, storage, distribution, and sales (Artes – Hernández et al., 2004).

Postharvest diseases of fruits are normally suppressed by low-temperature storage, by creating modified atmospheres (lower oxygen and elevated carbon dioxide levels) and/or some treatments that delay the tissue senescence. Use of edible coating has become a topic of great interest because of their potential value in increasing the shelf-life of many food.

Several important parameters for the application of such films in order to replace the widely used polymers in the packaging industry such as water solubility, mechanical, barrier and thermal properties should be properly studied (Palumbo et al., 2015). Among the natural polymers able to form edible films, carbohydrates, proteins and lipids or composite. In some recent studies the production of edible coating by combining various polysaccharides, proteins and lipids is considered with the aim of taking advantage of the properties of each compound and the synergy between them (Rojas–Grau et al., 2009).

Bari and Veale (2012) observed that orange treated with a shellac-based coating had a lower decay and incidence of postharvest disease than uncoated fruits. A lower incidence of decay was reported in cucumbers coated with Nature Seal with or without the addition of carnauba wax micro-emulsion than control (Baldwin et al., 1997).

Pøjewijd et al., (1999) showed delay and reduction in the incidence of decay with a polyethylene-wax-based coating in banana.

Chitosan has been shown to be effective against decay by inhibiting fungal activity in strawberry (Ngcobo et al., 2013) and tomato (Wencai Xu et al., 2013). Vera gel observed significantly delayed the tissue senescence in peaches and plums (Guillen et al., 2014).

Respiration rate has been used as a tool in predicting internal quality and storability of fruits. Color and textures are two physical quality parameters that affect consumer acceptability, modeling of these parameters as affected by coating and incidence of disease enables to optimize the marketability and profitability of the product. (Guillen et al., 2014).

The optimization of edible films composition is one of the most important steps of the research in this field, since they must be formulated according to the properties of the fruit and vegetables to which they have to be applied (Rojas–Grau et al., 2009).

Thus, it is very important to characterize and test different coating solutions on fresh and minimally processed food, since each one of them has different quality attributes to be maintained and enhanced during the storage time (Henry, 2012).

Although there are several studies on the use of edible coatings on a variety of fruits and vegetables even in the context of the incidence and spread of disease, application of these to Guavas is scarce, therefore, coating cold- stored Guavas with any film must be advisable to alter the internal gas concentrations, to retard ripening, to extend shelf life and to reduce moisture loss in storage (Zehra et al., 2010), which good quality Guavas are firm, green-yellow and without any disease.

The objective of this work were:

1- To ascertain changes in the ripening rate of Guavas coated with different types of edible coatings from cellulose, pectin and lipid-based emulsion formulations which were systematically evaluated and optimized.
2- To demonstrate which of them were effective in controlling the incidence and spread of decay fungus in Guavas.
3- A subsequent objective is to model the quality changes associated with Guavas as affected by coating and spread of decay.

Material and Methods

Materials:

A commercial carnauba wax were obtained from American Machinery Corp., Orlando, Fla. High methoxy pectin & Hydroxy propyl cellulose obtained from sigma - Aldrich Co., St. Louis, Mo, U.S.A, Polyvinyl alcohol, citric acid, glycerol, thyme oil and glyceryl monoestearate were obtained from braskem (Brazil).
Preparation of lipid emulsion:

Five percent of carnauba wax were immersed in glyceryl monoestearate with a total solids content of 5% with 150ppm essential oil thyme (Thymus vulgaris) to produce the carnauba-based emulsion formula. (Ayoubi et al., 2015).

Preparation of pectin solution:

Five grams of high methoxy pectin were mixed with distilled water (100 ml), polyvinyl alcohol (1.25% w/v) and 2.5% glycerol w/v at room temperature (25°C) for 5 min then the suspension was transferred to a water bath at 90°C for 30 min, and agitated by magnetic stirrer (500 rpm), followed by cooling at 40°C. (Zehra et al., 2010).

Preparation of hydroxyl propyl cellulose solution:

Four percent of hydroxypropyl cellulose were mixed with distilled water (100 ml), polyvinyl alcohol (1.25 w/v) was added as crosslink and 2 ml. glycerol (40% w/v) also added as a plasticizer and 10% citric acid w/w at room temperature (as acidulant) for 30 min, and agitated by magnetic stirrer (500 rpm) followed by cooling at 40°C before uses (Zehra et al., 2010).

Methods:

In this study, mature – green guavas (averaging 93 g) were obtained from Horticultural Research Institute orchard, in the beginning of September and December 2015 (from late summer and early winter). Forty fruit washed in tap water were randomly sorted in each of three treatments and a control group, then weighted individually. Surface coatings were applied by hand-wiping fruit with ≈ 6.5 μl.cm⁻² of surface. These coatings included (1) a commercial carnauba wax formulation, (2) Nature Seal formulation of hydroxyl propyl cellulose and (3) high methoxy pectin formulation. Fruit were allowed to air-dry for 90 min. Then, treated fruit and the uncoated controls were placed into storage at 12°C. After 7 days, all fruit were weighted individually a second time and removed to 20°C to ripen. Fruit taken from cold storage were examined daily after their removal to 20°C, and the data was noted when gentle finger pressure applied simultaneously from both sides could indent the fruit ≈ 0.5 cm. This subjective measurement of firmness corresponded to a resistance by the fruit of 10 to 20 N; at harvest, resistance averaged 96.8N. When 50% of the control fruit had softened and were subjectively estimated to be ripe, the quality of all fruit was evaluated. Fruit were weighted a third time, and the percentages of surface decay and injury were estimated with a 12-point visual acuity scale (Horsfall and Barratt, 1995).

Texture firmness:

Firmness of each fruit was measured with a universal testing instrument (model 1011; Instron Corp., Canton, Mass.) fitted with a compression anvil 12 mm in diameter. Resistance to pressure was recorded after a compression of 3 mm. (Garcia et al., 1998).

Surface color development:

The color at the equator of each fruit was determined with a chromameter (model CR-200; Minolta Corp., Ramsey, N.J.) recording in the L*, C*, and h* (lightness, chroma, and hue angle, respectively) color system that had been calibrated to a standard white reflective plate. Measurements were taken across an area of ≈ 50 mm² with diffuse illumination at a viewing angle of 0 under CIE illuminant C conditions (McGuire, 1992).

Soluble solids concentration (SSC) & pH value:

Twenty ripe control fruit and 10 randomly chosen treated fruit were peeled, and the pulp of individual fruit was forced through a 16- mesh sieve (pore size = 2.25 mm²) to remove seeds. Pulp (21g) was mixed with 5 ml of distilled water, and the pH was determined. One gram of this mixture was transferred to a
centrifuge tube and spun at 5000 x g for 15 min, and the refractive index (Abbe refractometer; Fisher Scientific Co., Pittsburgh) was determined on the supernatant for calculation of the SSC.

Titratable acidity:

The remaining pulp was titrated with 0.1 M NaOH to a pH of 8.1 for calculation of titratable acidity expressed as the percentage of citric acid (A.O.A.C, 2000).

Characterization of edible films:

Opacity:

By using a pane of transparent glass and coated it with the same thickness were used with fruit samples (≈ 6.4 µ – cm⁻¹). This procedure was carried out by hand wiping for each treatment. The opacity of each coated glass pane was determined using a Hunter lab colorimeter (coloquest 11, Fairfax, USA). The determinations were carried out in triplicate after calibration of the colorimeter with a standard white background and a standard black background.

The values for opacity were calculated according to the following equation: \[ \text{Op} = \left( \frac{\text{Op}_N}{\text{Op}_\beta} \right) \times 100 \]

Where:
- \( \text{Op} \) = opacity of the bioplastic (%).
- \( \text{Op}_N \) = opacity of the bioplastic against a black background;
- \( \text{Op}_\beta \) = opacity of the bioplastic against a white background

Water vapor permeability (WVP):

WVP was measured in the former films after doing opacity determination according to the method of Espinal Villacres et al., (2014). The film samples was fixed in aluminum cells containing solid calcium chloride (CaCl₂) and sealed with paraffin to ensure water migrating only through the exposed area of the film. The permeation cells were placed in desiccators kept at 25°C and 75% relative humidity. The amount of water vapor migrating through the film was determined indirectly by the gain in mass of the CaCl₂, which was evaluated every 24h.

Thickness of coats:

The thickness of coats could be evaluated by electronic microscope and chosen the best and more even coats on Guavas. It is important that the tri-dimensions structure of samples must be preserved with this respect.

Mechanical properties:

The tensile strength and elongation at break were determined using a TA-XT2 Texture Analyzer (SMS, Surrey, UK), which operated according to the ASTM standard method D882 with minor modifications (Jridi et al., 2013).

Statistical analysis:

The data were tested by analysis of variance, and means were separated (Ryan – Einot – Gabriel – Welsch multiple F test) using the SAS statistical package (2001). After analysis, Horsfall decayed or injured.

Results and Discussion

As the harvest progressed from late summer through early winter, the time required for uncoated, cold-stored, control fruit (fig 1) to ripen when moved to 20°C increased from 7 to 9 days (Table 1). This is reality to give evidence that the suitable date of harvest is very important for retards ripening and extending the shelf life of these fruits (Baldwin et al., 1992).

Coated fruit consistently softened at a slower rate than uncoated control fruit. Results was revealed
that applying 5% of high methoxy pectin delayed softening about 48.5% in September reaping samples (from 7.0 to 10.4 days) and about 49.5% in December reaping samples (from 9.1 to 13.6 days). The commercial 5% carnauba formulation and 4% hydroxyl propyl cellulose, also delayed softening, through generally not to the same extent as the high methoxy pectin coating.

Between 5 and 17% of the Guavas did not soften within 2 to 3 weeks (Table 1 & fig 2,3) this percentage increased with the high methoxy pectin coating (17.5%) but was not affected by the carnauba wax (5.2%).

### Table 1: Ripening in Guavas after postharvest application of three type of edible coatings and cold storage

<table>
<thead>
<tr>
<th>Coating</th>
<th>Days until softening at 20°C</th>
<th>Fruit not softening (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>September</td>
<td>December</td>
</tr>
<tr>
<td>None</td>
<td>7.0</td>
<td>9.1</td>
</tr>
<tr>
<td>H. Cellulose</td>
<td>8.0</td>
<td>10.5</td>
</tr>
<tr>
<td>Pectin</td>
<td>10.4</td>
<td>13.6</td>
</tr>
<tr>
<td>Carnauba wax</td>
<td>7.1</td>
<td>10.2</td>
</tr>
</tbody>
</table>

*: Means of 100 fruit per treatment. Mean separation at P≤0.05 according to the Ryan – Einot – Gabriel Welsh multiple F test in SAS.

Y*: Fruit were held at 12°C for 7 days then 20°C to ripen (as judged subjectively by resistance to gentle finger pressure).

*: Months represent; late summer and early winter.

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Results of weight loss after samples removal from cold storage and after ripening at 20°C indicated that the 5% carnauba wax consistently retarded weight loss in storage more effectively than either formulation of H. cellulose and H.M. pectin (Table 2). Values showed a significant differences (P < 0.05) in comparison with fruit in cellulose or pectin.

### Table 2: Weight loss during storage of Guavas after postharvest application of three type of coatings:

<table>
<thead>
<tr>
<th>coating</th>
<th>Weight loss (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>On removal from 7 days at 12°C</td>
</tr>
<tr>
<td>None</td>
<td>7.0 a</td>
</tr>
<tr>
<td>H. Cellulose</td>
<td>6.1 b</td>
</tr>
<tr>
<td>Pectin</td>
<td>5.2 b</td>
</tr>
<tr>
<td>Carnauba wax</td>
<td>3.5 c</td>
</tr>
</tbody>
</table>

*: Means of 100 fruit per treatment. Mean separation at P≤0.05 according to the Ryan – Einot – Gabriel – Welsh multiple F test in SAS.

When control fruit were ripe, coated fruit were firmer, their surface pigmentation was greener, more vivid than uncoated, generally less intense, and pulp SSC was lower, and for all coatings, decay and injury (a tendency for ridges on the peel to blacken) were below levels found the control (Table 3). Coated pectin samples had a smaller percentage of decay 2.0 and 2.8% and injury ones, 12.7 and 13.5% through late summer and early winter respectively and therefore, applying pectin coating fruit continued to be greener, and more vivid than the other type of coating and control.

Titratable acidity and pH values in the pulp of softened, coated fruit was similar to that in the uncoated controls, but the SSC of most coated fruit remained relatively lower in both September and December reaping samples that uncoated control samples.

Retention of firmness can be explained retarded degradation of insoluble proto-pectins to the more soluble pectic acid and pectin. During fruit ripening, depolymerization or shortening of chain length of
effect on water vapor permeability. Are less likely to affect the permeability of coated guavas, but have less effect on water vapor (Kester and Fennema, 1986). However, carnauba wax retards ripening and extends shelf life and may explain the delayed softening and color development of cellulose, retard the movement of these gases (O2, CO2, or C2H2), it alters the internal gas concentrations, retards ripening and extend shelf life and may explain the delayed softening and color development of coated guavas, but have less effect on water vapor (Kester and Fennema, 1986). However, carnauba waxes are less likely to affect the permeability of O2, CO2, or C2H2 (Hagenmaier and Shaw, 1992), but have large effect on water vapor permeability.

As shown in table (3) the pectin-based coating had a beneficial effect on firmness retention. It retarded the firmness of guava samples and reduced fruit softening significantly (P <0.01), which firmness values (N) of september & december reaping samples was bigger than uncoated control samples by 56% and 32% respectively.

**Table 4**: Quality aspects of guavas after postharvest application of three types of edible coatings and cold storage

<table>
<thead>
<tr>
<th>Maturity stages</th>
<th>Coating</th>
<th>Firmness (N)</th>
<th>Pulp</th>
<th>Surface</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>pH</td>
<td>TA (%)</td>
</tr>
<tr>
<td>September reaping</td>
<td>None</td>
<td>15.1 a</td>
<td>3.9 a</td>
<td>0.67 a</td>
</tr>
<tr>
<td></td>
<td>H. Cellulose</td>
<td>22.4 b</td>
<td>3.9 a</td>
<td>0.67 a</td>
</tr>
<tr>
<td></td>
<td>Pectin</td>
<td>24.0 c</td>
<td>3.8 a</td>
<td>0.69 a</td>
</tr>
<tr>
<td></td>
<td>Carnauba wax</td>
<td>23.6 b</td>
<td>3.9 a</td>
<td>0.67 a</td>
</tr>
<tr>
<td>December reaping</td>
<td>None</td>
<td>15.1 a</td>
<td>3.9 a</td>
<td>0.67 a</td>
</tr>
<tr>
<td></td>
<td>H. Cellulose</td>
<td>16.0 a</td>
<td>3.9 a</td>
<td>0.67 a</td>
</tr>
<tr>
<td></td>
<td>Pectin</td>
<td>19.9 c</td>
<td>3.8 a</td>
<td>0.69 a</td>
</tr>
<tr>
<td></td>
<td>Carnauba wax</td>
<td>17.7 b</td>
<td>3.9 a</td>
<td>0.67 a</td>
</tr>
</tbody>
</table>

zTA: Titratable acidity   SSC: Soluble solids concentration
* Means 100 fruit per treatment. Mean separation at P<0.05 according to the Ryan – Gabriel – welsh multiple F test in SAS.
Note: control and control fruit ripe at 20°C.

About surface color development; when coated fruit softened and were more directly comparable to the equally soft ripe controls, they continued to be somewhat greener and more vivid than uncoated fruit (Table 4).

Color changes after removing of cold storage and during ripening at 20°C were observed by an increase in the lightness (L), chroma values (C) and the degrees of hue angle (h) in control samples and coated fruit samples. But, as shown in table (4) pectin – based samples had larger degrees in the three recorded values L, C, h of the chromameter.

Control fruit with the smallest L, C and h values showed significant differences (P<0.05) in comparison with fruit in cellulose, carnauba wax and pectin. Thus, these coatings were effective to promote a small delay of surface color development compared with the control treatment, as documented by the smaller increase in L, C and h values.

**Table 4**: Color measurements of Guavas after postharvest application of three type of edible coatings and cold storage.

<table>
<thead>
<tr>
<th>Maturity stages</th>
<th>Coating</th>
<th>Color *</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>L</td>
</tr>
<tr>
<td>September reaping</td>
<td>None</td>
<td>58.2 b</td>
</tr>
<tr>
<td></td>
<td>H. Cellulose</td>
<td>61.0 b</td>
</tr>
<tr>
<td></td>
<td>Pectin</td>
<td>62.3 a</td>
</tr>
<tr>
<td></td>
<td>Carnauba wax</td>
<td>59.4</td>
</tr>
<tr>
<td>December reaping</td>
<td>None</td>
<td>57.4 b</td>
</tr>
<tr>
<td></td>
<td>H. Cellulose</td>
<td>60.2 b</td>
</tr>
<tr>
<td></td>
<td>Pectin</td>
<td>61.7 a</td>
</tr>
<tr>
<td></td>
<td>Carnauba wax</td>
<td>58.3 b</td>
</tr>
</tbody>
</table>

L= lightness (0 = Dark, 100 = light)
C = Chroma (0= Dull, 100 = vivid)
h= hue angle (0° = red-purple, 90° = yellow, 180° = bluish green)
* Means 50 fruit per treatment. Mean separation at P≤0.05 according to the Ryan – Einot – Gabriel – Welsh multiple F test in SAS.
Note: Coated and control fruit ripe at 20°C.

Traditionally, fruit coatings have been applied to improve appearance and reduce moisture loss in storage. All films also offer some resistance to gas exchange, the hydrophilic films such as pectin and cellulose, retard the movement of these gases (O2, CO2, or C2H2), it alters the internal gas concentrations, retards ripening and extend shelf life and may explain the delayed softening and color development of coated guavas, but have less effect on water vapor (Kester and Fennema, 1986). However, carnauba waxes are less likely to affect the permeability of O2, CO2, or C2H2 (Hagenmaier and Shaw, 1992), but have large effect on water vapor permeability.
Therefore our results revealed that pectin–based emulsions affect all aspects of ripeness at the same rate; allow softening to proceed, full color development, while these aspects in H. cellulose or carnauba wax coatings does not affect at the same rate (Table 2, 3, 4).

Results in Table (5) revealed that H. cellulose and pectin films which presented opacity of 2.65% and 3.25% respectively had a deeper penetration of light into the biopolymer and thus reduce its opacity, but carnauba wax of 24.3% opacity had a less transparency due to its hydrophobic properties which may hinder the passage of light.

WVP is a measure of the ease with which a material can penetrated by water vapor. The mechanical and barrier properties of any film not only depend on the compounds used in the biopolymer matrix, but also on their compatibility (Palumbo et al., 2015). While pectin and polysaccharides had an excellent mechanical and structural properties; TS and E% (Table 5). At the same time, they have a poor barrier capacity against moisture transfer due to a bundant hydrosphilic compounds.

Table 5: Opacity, water vapor permeability (WVP), tensile strength (TS) and percent elongation (%E) of three different edible coatings:

<table>
<thead>
<tr>
<th>Coating</th>
<th>Opacity (%)</th>
<th>WVP (kg m⁻¹ S⁻¹ Pa⁻¹)</th>
<th>TS (MPa)</th>
<th>E (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>H. Cellulose</td>
<td>2.65</td>
<td>6.72</td>
<td>4.90</td>
<td>55.47</td>
</tr>
<tr>
<td>Pectin</td>
<td>3.25</td>
<td>9.69</td>
<td>5.80</td>
<td>73.55</td>
</tr>
<tr>
<td>Carnauba wax</td>
<td>24.30</td>
<td>3.02</td>
<td>2.24</td>
<td>6.33</td>
</tr>
</tbody>
</table>

A significant difference was observed from the results obtained which WVP are 6.72 and 9.69 kg m⁻¹ S⁻¹ Pa⁻¹ for cellulose and pectin films respectively while WVP was 3.02 kg m⁻¹ S⁻¹ Pa⁻¹ in carnauba wax film (Table 5), therefore, lipid–based edible films have a good barrier capacity against moisture transfer due to its high melting point and their hydrophobic properties (Morillon et al., 2002). In this way, it has been found that fatty acids can form stable layers depend on their chain length: the lower the chain length, the greater the layers (Jimenez et al., 2010).

The scanning electron microscopy evaluation of coated samples showed that the pectin film was the most even among all of the other coating materials.

Conclusion:

Regarding the use of coatings in refrigerated Guavas, its use was effective as natural a postharvest treatment with aim to extend the shelf-life of Guavas and maintain fruit quality. Between 5% and 17% of the Guavas did not soften within 2 to 3 weeks, this percentage increased with the pectin formulation but not affected by the carnauba wax.

Guavas coated showed strong life extension of 7.0 to 13.5 days. Significant changes were observed in pectin-based emulsion coated fruits compared with non-treated controls with respect to surface colour development, weight loss, firmness, percentage of opacity, and had an excellent mechanical and structural properties (TS&E%) but had a middle barrier capacity against moisture transfer. Microscopic evaluation pectin film was the most even among all of the other coating materials.

Coating cold-stored Guavas with any film may be advisable if quality is to be maintained. Given that the selected film components present low cost and high biocompatibility, the industry and wholesalers could apply optimized film for commercial purposes.

References


