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# *Aloe vera* Gel Coating to Enhance Shelf life of Papaya (*Carica papaya* L.)

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## ABSTRACT

**Edible coating is a novel method which can be used to enhance shelf life of fruits. Therefore, this study was carried out to develop an edible coating from *Aloe vera* leaf gel to extend the shelf life of papaya (*Carica papaya* L.) fruits. Four different concentrations (0, 33, 66 and 100%) of *A. vera* gel solutions were evaluated. *Aloe vera* gel extracted from fresh leaves was used to prepare different treatments after pasteurization (70 °C at 45 min) and pH adjustment. Gel solutions were equally applied to fruits as two coats and they were stored under room temperature (32±2 °C) with 68% of relative humidity. Percentage weight loss (PWL), total soluble solids (TSS), titratable acidity (TA) and percentage disease incidence (PDI) were measured at three days intervals. A sensory evaluation was carried out for all the treatments at the end of the storage period to evaluate the sensory attributes using a Five Point Hedonic scale. Data were analyzed using Minitab statistical package (version 16). Based on the results, fruits treated with 100% *A. vera* gel recorded the longest shelf life of 12 days together with higher median ranks for taste (4), firmness (3), marketability (4) and overall quality (5). Therefore, 100% *Aloe vera* gel coatings could be promoted among locals to extend the shelf life of papaya.**

**KEYWORDS:** *Aloe vera*, *Carica papaya*, Edible coating, Gel, Shelf life

## INTRODUCTION

Tropical fruits are wasted due to rapid deterioration during handling, transportation and storage. On the other hand, demand for fresh fruits continues to increase. Therefore, it is essential to develop safe methods for extending the shelf life of fruits while preserving their internal quality. One method of extending shelf life is the use of edible coatings (Baldwin *et al.*, 1995). Edible coatings are thin films which cover the product and maintain product quality. These films can be safely eaten as part of the product and do not add undesirable properties to the food in contact with the film (Baldwin, 1994).

An edible coating can create a modified atmosphere around the fruit and act as a barrier to external elements. It, therefore, increases shelf life by minimizing gas exchange and the loss of water, flavour, aroma and solute migration through the cuticle during postharvest life (Baldwin, 1994). Further, edible coatings may contain active ingredients such as anti-browning agents, colourants, flavours, nutrients, spices and antimicrobial compounds which can suppress the growth of pathogens, thereby increasing the keeping quality of fruits (Pranoto *et al.*, 2005).

*Aloe vera* (Aloe/*Komarika;* Family Liliaceae) is a widely used medicinal plant (Dassanayake and Fosberg, 1996). The colorless, tasteless and odorless matrix (gel) of fleshy leaves is used to prepare fruit coatings. *Aloe vera* gel contains nearly 200 active compounds including polysaccharides, glycoproteins, phenolics, salicylic acid, lignin, phytohormones, amino acids, vitamins, saponins and enzymes (Dureja *et al.*, 2005). Nevertheless, the main components of the gel matrix are polysaccharides which can create a natural barrier to loss of moisture and gasses, thereby slowing down the deterioration of fruits (Misir *et al.*, 2014).

Papaya (*Carica papaya* L.; Family Caricaceae) is a popular and economically important fruit crop in Sri Lanka (Dassanayake and Fosberg, 1996). The extent and production of the papaya in 2014 were 6,943 ha and 93,672 mt, respectively (Anon, 2015). Papaya contains many nutrients including carbohydrates, vitamins A, B, C, and Proteolysis enzymes such as papain and chymopapain (Aravind *et al.*, 2013). It is used in treatment of all types of digestive and abdominal disorders, dyspepsia, hyperacidity, dysentery and constipation (Jayaweera *et al.*, 1981).

Papaya has a short shelf life and fruits begin to soft rapidly at room temperature after two to three days of harvesting (Archbold *et al.*, 2003). Due to its thin skin and the nutritious flesh with high amount of water, rough handling leads to heavy losses as high as 46% in Sri Lanka (Anon, 2006; Hewajulige and Wijeratnam, 2015). Limited studies have been done on the use of *A. vera* gel based coatings to increase the shelf life of fruits such as mango in Sri Lanka (Nivethika and Mikunthan, 2015). Therefore, this study was conducted to evaluate the potential for using *Aloe vera* gel coating to extend the shelf life of papaya.

## MATERIALS AND METHODS

### *Location*

The study was carried out at the Department of Horticulture and Landscape Gardening, Faculty of Agriculture and Plantation Management, Wayamba University of Sri Lanka, Makandura, Gonawila from January to May 2016.

### *Sample Collection*

Papaya var. *Rathna* fruits were harvested at green mature stage from a cultivation at Pannala area (Low Country Intermediate Zone), which was maintained according to the recommendations of the Department of Agriculture, Sri Lanka. Visually blemish disease and damage free papaya fruits were transported to the laboratory. Fully extended fresh *A. vera* leaves were harvested and transported to the laboratory on the same day.

### *Preparation of Coating Solution*

*Aloe vera* gel was extracted from fresh leaves. Matrix was separated from outer coat carefully and ground using a blender (Model: IS 4250, Japan). Then, the resulting mixture was filtered using a muslin cloth to remove fibre. Afterwards, the gel was pasteurized at 70 °C for 45 min. For stabilizing, it was cooled immediately at ambient temperature and 4.5 g/L of ascorbic acid was added followed by 4.5 g/L of citric acid to adjust the pH to 4.0 (Sophia *et al.*, 2015).

### *Treatment Combination and Experimental Design*

Four gel concentrations (treatments) 0, 33, 66 and 100% were prepared by changing *Aloe vera* gel composition and distilled water (w/v). Papaya fruits were washed in clean water and dried at room temperature. Then, *A. vera* gel was equally applied on each fruit surface as two coats using a brush (Brishti *et al.*, 2013) and allowed to dry at room temperature to form a thin film on the fruit surface. The treated fruits were stored at room temperature (32±2 °C) at 68% relative humidity. The experiment was arranged as factorial design embedded in a Completely Randomized Design (CRD) with three replicates.

### *Percentage Weight Loss*

Percentage weight loss was calculated at three day intervals after treatment by using the following equation.

$$\%\ Weight\ Loss = \frac{W_1 - W_2}{W_1} X\ 100$$

$W_1$- Initial weight
$W_2$- Final weight

### *Change of Peel Colour*

Peel colour was measured using RHS (Royal Horticultural Society, 2001) Colour Chart at three day intervals.

### *Determination of Physico-chemical Parameters*

Titratable acidity (TA) and total soluble solids (TSS) content of the fruits were determined according to Ranganna (1986) and AOAC procedures (1994) at three days intervals until the overall acceptability became unsatisfactory for each lot of samples in four different treatments. Briefly, samples from individual fruits were ground using a blender (Model: IS 4250, Japan) and filtered through a muslin cloth to separate the juice from the pulp. Titratable acidity was measured by titrating with 0.01 N NaOH and TSS was determined using a hand-held refractometer (Model: 040334, Japan).

### *Percentage Disease Incidence (PDI)*

Percentage Disease Incidence was measured at three day intervals by visual estimation of the extent of symptoms on each fruit. It was expressed as a percentage of the total surface area.

### *Sensory Evaluation*

A panel of ten semi-trained tasters (Age between 20 to 30 years) carried out the acceptance tests for fruits in all the treatments at the end of the storage period ($T_4$ at 12 days and all other treatments at nine days). The panelists were asked to indicate their observations using a Five Point Hedonic scale for firmness, taste, marketability and overall quality (Ranganna, 1986).

### *Scale of Acceptance (Five Point Hedonic Scale)*

Fruit firmness: 5- Very Firm, 4- Firm, 3- Moderately Firm, 2- Soft, 1- Very Soft.
Fruit taste: 5- Very Sweet, 4- Sweet, 3- Moderate, 2- Bland, 1- Very Bland.
Marketability: 5- Excellent, 4- Good with Slight Defects, 3- Fair and Moderate Defects, 2- Marketability Limited, 1- Not Marketable.
Overall quality: 5- Excellent, 4- Good, 3- Fair, 2- Bad, 1- Worst.

### *Statistical Analysis*

Quantitative data were subjected to Analysis of Variance (ANOVA) procedure. Data of sensory evaluation were analyzed by non-parametric analysis method (Kruskal Wallis test) and mean separation was done with Turkey's test using Minitab statistical package (Version 16).

## RESULTS AND DISCUSSION

### *Percentage Weight Loss*

There was no significant difference ($p<0.05$) of percentage weight loss among treatments at any three days intervals (Table 1). At each three days intervals, the highest percentage weight loss was recorded by the uncoated fruits (0%) while the lowest value was recorded by fruits coated with 100% *A. vera* gel. The percentage weight loss gradually increased when the storage period increased in all the treatments. There was a decrease of percentage weight loss with the increase of *A. vera* gel percentage in coating solution. This may be due to the hygroscopic properties of *A. vera* gel creating a barrier between the fruit and the surrounding environment to prevent its external transmissions (Morrilton *et al.*, 2002).

### *Change of Peel Colour*

Peel colour is one of the most important visual attributes of fruits which determine its marketability and acceptability. All the fruits turned from green to yellow orange during the storage period. Fruits in treatments one and two obtained complete yellowness after nine days whereas fruits in treatment three turned to yellow orange after nine days (Table 1). The 100% *A. vera* gel coated fruits turned to yellow orange colour after 12 days of storage. When fruits are coated with *A. vera* gel, the modified atmosphere condition retards ethylene production rate which could delay ripening, chlorophyll degradation and carotenoid synthesis thus, delaying the color change of fruits (Hoa *et al.*, 2002).

### *Total Soluble Solids (TSS)*

There was a significant difference ($p<0.05$) in TSS among treatments within each three day intervals (Table 1). Total soluble solids increased with the increase of storage time in all treatments. The highest TSS was recorded in the control fruits whereas the lowest TSS was recorded by the 100% *A. vera* gel coated fruits in all the three day intervals. There was a significant increase of TSS content in control fruits compared to $T_3$ (66% gel) and $T_4$ (100% gel) on day three of storage period. However, TSS in both $T_1$ (control) and $T_2$ were significantly high compared to $T_4$ after six days. The increase of TSS in control fruits may be due to the rapid production of free sugars in fruits during storage periods (Cheour *et al.*, 1990). Coated fruits retarded the TSS development because the coat decreases the respiration and eventually the catabolism of carbohydrates.

### *Titratable Acidity (TA %)*

During the storage period, there was a significant change ($p<0.05$) in TA% among different treatments (Table 1). Control fruits recorded the lowest TA% while the highest value was found in 100% gel coated fruits. The retention of acids by coated fruits was due to the protective effect of gel coating as a barrier to transfer $O_2$ from the surrounding atmosphere (Valverde *et al.*, 2005).

### *Percentage Disease Incidence (PDI)*

The effectiveness of *A. vera* gel on retarding fruit diseases was tested using PDI. In all the treatments less than 5% of PDI was observed until day three.

**Table 1. Variation in physico-chemical parameters of papaya fruits during the storage period**

| Treatment | Storage Period (days) | PWL (%) | TSS (%) | TA (%) | Colour | PDI (%) |
|---|---|---|---|---|---|---|
| $T_1$ | 0 | - | 7.4±0.00$^a$ | 0.167±0.00$^a$ | G 137 A | 0 |
| | 3 | 2.5±0.35$^a$ | 8.4±0.49$^a$ | 0.115±0.00$^a$ | YG 153 D | 5 |
| | 6 | 3.7±0.94$^a$ | 10.1±0.28$^a$ | 0.134±0.00$^a$ | YO 137 B | 53 |
| | 9 | 5.7±0.30$^a$ | 10.7±0.05$^a$ | 0.115±0.13$^a$ | YO 21 A | 74 |
| | 12 | * | * | * | * | * |
| $T_2$ | 0 | - | 7.4±0.00$^a$ | 0.167±0.00$^a$ | G 137 A | 0 |
| | 3 | 2.4±0.24$^a$ | 8.3±0.93$^{ab}$ | 0.116±0.01$^a$ | YG 152 C | 3 |
| | 6 | 3.6±0.79$^a$ | 10.1±0.10$^a$ | 0.136±0.00$^{ab}$ | YO 15 A | 23 |
| | 9 | 5.2±5.82$^a$ | 10.6±0.61$^a$ | 0.121±0.00$^a$ | YO 21 A | 55 |
| | 12 | * | * | * | * | * |
| $T_3$ | 0 | - | 7.4±0.00$^a$ | 0.167±0.00$^a$ | G 137 A | 0 |
| | 3 | 2.2±0.2$^a$ | 7.5±0.11$^{bc}$ | 0.124±0.02$^a$ | YG 146 A | 0.5 |
| | 6 | 2.8±0.34$^a$ | 9.2±0.27$^b$ | 0.144±0.00$^b$ | YG 153 C | 5 |
| | 9 | 4.8±1.36$^a$ | 9.9±0.98$^{ab}$ | 0.128±0.01$^b$ | YO 17 B | 16 |
| | 12 | 13.9±3.69$^a$ | * | * | YO 17 A | 61 |
| $T_4$ | 0 | - | 7.4±0.00$^a$ | 0.167±0.00$^a$ | G 137 A | 0 |
| | 3 | 2.2±0.93$^a$ | 7.4±0.16$^c$ | 0.145±0.02$^a$ | G 137 A | 0 |
| | 6 | 2.6±0.33$^a$ | 7.6±0.44$^c$ | 0.149±0.00$^b$ | G 143 A | 3 |
| | 9 | 4.1±1.59$^a$ | 8.7±1.2$^b$ | 0.143±0.00$^b$ | YG 144 A | 8 |
| | 12 | 16.2±11.65$^a$ | 11±0.45$^a$ | 0.118±0.10$^a$ | YO 14 A | 32 |

*Mean with the same letters within each time interval are not significantly different at 0.05 level; *Indicates completely damaged fruits; PWL- Percentage weight loss; TSS- Total soluble solids; TA- Titratable acidity; PDI- Percentage disease incidence; $T_1$- 0% A.Vera, $T_2$-25% A.vera, $T_3$- 50% A.vera, $T_4$- 100% A.vera*

After 12 days, fruits in $T_1$ and $T_2$ were totally damaged and the lowest PDI was recorded by $T_4$ (100%) followed by $T_3$ (Table 1). This could be due to the bioactive agents in *A. vera* gel which prevents post-harvest fruit diseases (Habeeb *et al.*, 2007).

***Sensory Attributes***

There were significant differences ($p<0.05$) in taste, firmness, marketability and overall quality among treatments at the end of the storage period of each treatment (Figure 1). The fruits treated with 100% *A. vera* received the highest median ranks for firmness (3), marketability (4) and overall quality (5) compared to other treatments. Even though uncoated fruits recorded the highest median rank (5) for taste, it obtained lowest median ranks for all other sensory attributes namely, firmness (2), marketability (2) and overall quality (1). These results revealed that *A. vera* gel coating can be used to extend the shelf life of papaya. The 100% gel coated fruits could be kept 12 days under room temperature while the quality of uncoated fruits decreased along with over 50% of disease incidence even after six days. Edible coating is a simple, environmental friendly and relatively inexpensive method that can be used to extend the shelf life of tropical fruits. Further, *A. vera* is a naturally grown common medicinal plant that can be cultivated with less management in dry areas. Therefore, this could be introduced to papaya farmers in dry areas to improve the keeping quality and marketability of fruits. Further research is recommended with storing gel treated fruits under cool conditions and with incorporation of recommended preservatives to the gel.

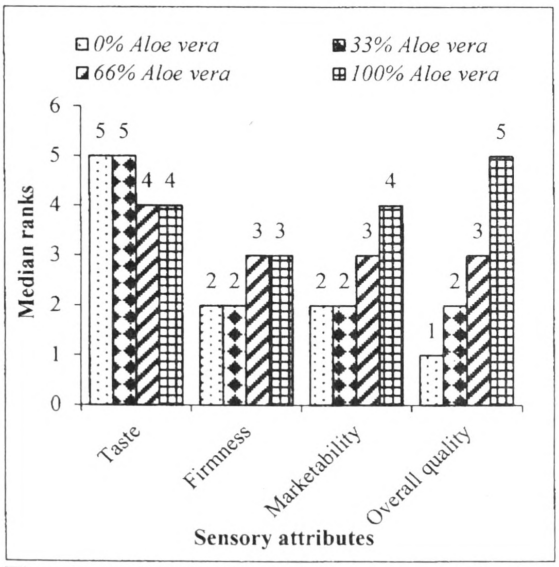


**Figure 1. Variation of sensory attributes among treatments**

## CONCLUSIONS

Hundred percent *Aloe vera* gel can be effectively used in extending the shelf life of papaya up to 12 days under room temperature. Further, it has no adverse effects on fruits, environment and consumers' health. Because both *A. vera* and papaya are grown in the dry zone of Sri Lanka, there is a potential to use the *A. vera* gel coating to minimize post-harvest losses of papaya.

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