A Simple Bio-preservation Technique to Increase Shelf Life of Ampalavi Mango Fruits Using *Aloe vera* Gel

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Abstract: *Aloe vera* is being identified as a potential medicinal plant for its application in industries as well as traditional usage. The gel obtained from the leaves of *A. vera* has numerous properties. In this study, using the gel to extend the shelf life of Ampalavi mango fruits was studied. Even sized, uniform coloured, matured Ampalavi cultivar mango fruits were surface cleaned and coated with 33%, 66% and 100% gel, respectively. Results revealed that the ripening was delayed due to the coating. The total soluble solid (TSS), pH and weight loss were high in uncoated fruits. The mean pH of the pulp from fruits kept as control was 4.94 at 4 d fruit preservation period (FPP) and was slightly increased to 5.43 within 12 d FPP, whereas the minimal pH (4.69 at 4 d FPP and 5.03 at 9 d FPP) was noticed in 100% gel coated fruits. The TSS (brix) was significantly in higher levels (13.67 °Bx within 4 d FPP and 20.77 °Bx within 12 d FPP) in control fruits, whereas the minimum TSS value was 9.27 °Bx and 18.03 °Bx within 4 d and 12 d FPP, respectively, recorded from the 100% gel coated fruits in storage. The weight loss percentage (WLP) was significantly ($P < 0.05$) higher in control fruits (8.46%), whereas the lower WLP (1.13%) was found in 100% gel coated fruits after 12 d of storage. This low-scale gel coating technique prolonged the fruits shelf life by delaying the fruit ripening. This effect has to be further investigated to commercialize the natural product for large scale ready-made application.

Key words: *Aloe vera* gel, total soluble solid, weight loss percentage, mango.

1. Introduction

The word aloe is derived from the word Arabic “Alloeh” or the Hebrew “Halal”, meaning “bitter, shiny substance”. At present, *Aloe vera* is widely distributed throughout the tropics and subtropics region of Sri Lanka. *A. vera* is a perennial plant with thick, thorn-edged leaves and gray to bright green in color. With the appearance of a cactus, but *A. vera* is in fact a member of the lily family (Liliaceae). A typical *A. vera* plant produces two or three yellow tubular flowers, shaped much like those of the Easter lily, and it flowers intermittently throughout the year. Its fleshy leaves help to survive long periods of drought, due to the fact that leaves of this plant can store water [1].

A. vera contains 75 potentially active constituents, such as vitamins, enzymes, minerals, sugars, lignin,

saponins, salicylic acids and amino acids [2].

These natural preservative products are available in bulk quantity, and the simple and easy process of extraction, purification and sterilization makes it a standard product within a short processing time and not use of chemicals in their manufacture. Edible coatings of gel over fruits are used to improve their quality and shelf life [3].

A. vera gel has been proven one of the best edible and biologically safe preservative coatings for different types of foods, because of its film-forming properties, antimicrobial actions, biodegradability and biochemical properties. It is composed mainly of polysaccharides and acts as a natural barrier to moisture and oxygen, which are the main agents of deterioration of fruits and vegetables. *A. vera* gel has the ability to prolong shelf life of the fruits and vegetables by minimizing the rate of respiration and maintaining quality attributes (color, flavor, etc.). It

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has antifungal and antibacterial property, which provides a defensive barrier against microbial contamination of fruits and vegetable [4].

It could provide a greener alternative to sulphur dioxide and other synthetic food preservatives. Researchers in Spain have developed an edible coating from the gel that can prolong the freshness and safety of produce without affecting taste and appearance [5].

Kumar and Bhatnagar [3] reported that *A. vera* gel based edible coating has exhibited to prevent loss of moisture and firmness, control respiratory rate and maturation development, delay oxidative browning and reduce microorganism proliferation in fruits.

A. vera is a bio-preservative of table grapes, cherries, mangos, oranges and nectarines, and for increasing demands for environmentally friendly postharvest handling procedures [6]. The gel is useful in extending the shelf life of grapes [7] and sweet cherries [8]. The untreated grapes deteriorated rapidly within about 7 d, whereas the gel-coated grapes were well-preserved for up to 35 d under the same conditions. Therefore the gel-treated grapes were firmer, had less weight loss and less color change than the untreated grapes [9]. Further, *A. vera* gel coating in oranges resulted in decrease in weight loss, increase in titrability of acids and higher total soluble solid (TSS) [3]. This *A. vera* gel coating technique prolonged the fruits shelf life by delaying the fruit ripening. So this study aimed to use *A. vera* gel to extend the shelf life of Ampalavi mango fruits.

2. Materials and Methods

2.1 Ampalavi Mango Fruits

Mango fruits of Ampalavi cultivar with even size, mature, uniform shaped, coloured, free from visual blemishes and diseases were obtained from a fruit stall supplied from a fruit orchard situated in Thirunelvely, Jaffna. These fruits were surface cleaned to remove all contaminants and fruit's gum to render a sound firm bonding. Soap water was used to wash the Ampalavi

mango fruits thoroughly and shade dried to ensure cleaned fruit surface.

2.2 Preparation of *A. vera* Gel

The gel was prepared from matured leaves of *A. vera* plants. At first, leaves were washed with tap water, followed by 70% alcohol to sterilize the surface. Gel was then separated from the outer cortex of leaf, the colorless hydroparenchyma was grounded in a blender and resulting mixture was filtered to remove the fibers. According to Misir et al. [1], the gel was pasteurized at 70 °C for 45 min, cooled immediately at ambient temperature for stabilization and 1% gelatine was used as a gelling agent to facilitate coating the gel [6].

2.3 Experiment Design

The experiment was conducted using completely randomized design. Thirty six even size Ampalavi fruits were obtained from an orchard and kept into four groups. Each group had nine Ampalavi fruits and were coated with 33%, 66%, 100% gel, respectively, while another group of nine fruits were not coated and kept as control (0%). Gel dilutions were prepared using distilled water as 0%, 33%, 66% and 100%, then fruits were dipped for 20-30 s into the gel. Fruits were shade dried and stored in wooden racks and stored at room condition (31 °C, 85%-88% relative humidity). Some fruit quality parameters, such as weight loss, pH and TSS were measured.

The fruits were peeled, sliced and blended to prepare juice. The pH of fruit juice was measured by using digital pH meter (Hach model). TSS was determined using hand refractometer at room temperature. The extracted juice from each lot was shaken well, the representative samples were placed on dry refractometer prism and readings were taken directly. Weight loss was determined during storage. Fruits were weighed in each treatment at periodic weighing of 4, 9 and 12 d fruit preservation period (FPP) from beginning, using an electronic balance to

calculate weight loss during storage. The percent weight loss was calculated as:

$$\text{Weight loss (\%)} = \frac{W_t - W_p}{W_t} \times 100 \quad (1)$$

where, W_t = weight of fresh fruit after treatment (g) and W_p = weight of fruit after preservation (g).

Data were analyzed using SAS statistical package in Duncan's mean separation at 95% confidence interval.

3. Results and Discussion

A. vera gel having various effects on preservation of fruits, such as pH, TSS and weight loss percentage (WLP) are described below.

3.1 pH Value of Fruit Juice

pH values exhibited increasing trend in the control samples with storage period due to the ripening process and loss of organic acid through oxidation in uncoated fruits [10]. Gel acts as an antioxidant [11], so gel coating on fruit acts as a barrier for oxidation. There is a slight deviation in 9 d FPP and 12 d FPP with storage time for coated fruits.

Statistical analysis ($P < 0.05$) results in Table 1 showed that in 4 d FPP, T_4 retained the minimum pH level (4.697 ± 0.25), followed by $T_3 < T_2 < T_1$, and non-significant difference was recorded among treatments. In 9 d FPP and 12 d FPP, there was also the same pattern of result, the minimum pH level (5.0367 ± 0.76 and 4.570 ± 0.30 , respectively) was obtained in T_4 , followed by $T_3 < T_2 < T_1$. In 12 d FPP, there was a significant difference for pH between the coated fruits and the control fruits.

The possible reason for the variation may be due to the difference in the micro environment created by gel coatings in various percentages used, coupled with less oxidative reactions and lesser decline in degradation of acids, thus maintaining the integrity of cells. These results are in line with Raje et al. [12]. Organic acids are substrates for many enzyme mediated reactions during aerobic respiration in the

plant cells, and a reduction in the acidity may be expected as a result of such activity during the preservation period. The decrease in acidity was correlated with the advancement of maturity and ripening in the untreated fruits. The tendency of reduced acidity during storage might be due to that the fruit undergoing the ripening process diminished its malic acid and favored formation of sugars [13]. Another possibility for decrease in acidity is consumption of acid by micro-organisms as a source of carbon. High amount of acidity in treated fruits might be due to facts that carbon dioxide accumulated internally in the fruit tissues caused acidosis after dissolving and forming carbonic acids. These results are also in line with those of Carrillo et al. [14].

3.2 TSS

The results of TSS in Table 2 showed that TSS was the highest in control (T_1) as compared with other treatments (T_2 , T_3 and T_4). Samples treated with gel showed significantly ($P < 0.05$) lower amount of TSS than control (T_1) in 9 d FPP and 12 d FPP. TSS was decreased with increasing gel concentration in the order of $T_4 < T_3 < T_2 < T_1$. In 9 d FPP, TSS of T_1 , T_2 and T_4 were significantly ($P < 0.05$) different from each other. In 12 d FPP, TSS in control (T_1) was significantly ($P < 0.05$) higher than that from gel treatments (T_2 , T_3 and T_4).

Change in TSS in the present study might be due to the hydrolytic conversion of polysaccharides into soluble sugar, as is the case in mango fruits during the ripening process. In the control (T_1), rate of conversion of insoluble polysaccharide was faster than the rate of fermentation of mono and disaccharides into organic acids. Therefore, this resulted in an increase in TSS of the fruits. In the gel-coated mango fruits, the rate of conversion of soluble mono and disaccharides into organic acids is faster than the conversion of decreasing trend in TSS. This might be attributed to the microbial activity. The results are in line with the findings of Manzano et al. [15].

3.3 Weight Loss Percentage

The general trend was an increase in weight loss with decreased concentration of gel. This was true for all preservation periods (4, 9 and 12 d FPP), which is showed in Table 3. In 4 d FPP, the highest weight loss percentage ($3.5430\% \pm 0.48\%$) was obtained in control (T_1) fruits, while the lowest weight loss percentage ($2.6210\% \pm 0.32\%$) was obtained in T_4 . There was a significant difference between means of control (T_1) and other treatments (T_2 , T_3 and T_4).

The loss of water from treated fruits was lesser than the control. This was due to the fact that *A. vera* coating served as semi permeable membrane around fruit surface. Statistical analysis ($P < 0.05$) revealed that in storage period, T_1 (control) showed the maximum weight loss, followed by $T_2 > T_3 > T_4$.

However, no significant difference was recorded between T_3 and T_4 in 4 d FPP and 12 d FPP. In T_1 (control), an increase in weight loss percentage was recorded with the increased days of preservation, while in fruit of T_4 , weight loss was decreased at 12 d. In treated fruits, the final decrease in weight loss might be due to the movement of water vapors from the saturated atmosphere into the fruits. These results are in agreement with those of Carrillo-Lopez et al. [16], who observed that coated or uncoated mango in Mexico had an increasing trend of weight loss with the passage of storage time.

Weight loss is an important index of shelf life in the fresh produce. It is mainly attributed to the loss of water during metabolic processes like respiration and transpiration. Moisture loss and gaseous exchange

Table 1 Response of Ampalavi mango fruit pH to various concentration of *A. vera* gel.

<i>A. vera</i> gel concentration	pH within fruit preservation period (FPP)		
	4 d	9 d	12 d
T_1 (0%)	4.943 ± 0.17^a	5.240 ± 0.36^a	5.430 ± 0.15^a
T_2 (33%)	4.823 ± 0.21^a	5.070 ± 0.71^a	4.860 ± 0.44^b
T_3 (66%)	4.780 ± 0.34^a	5.050 ± 0.78^a	4.630 ± 0.12^b
T_4 (100%)	4.697 ± 0.25^a	5.037 ± 0.76^a	4.570 ± 0.30^b

All the values with the means of three replicates. Means with the same letters in a column are not significantly different according to the Duncan's mean separation at $\alpha = 0.05$ and 95% confidence interval.

Table 2 Change of TSS for Ampalavi mango fruit as influenced by *A. vera* gel.

<i>A. vera</i> gel concentration	TSS ($^{\circ}\text{Bx}$) within fruits preservation period (FPP)		
	4 d	9 d	12 d
T_1 (0%)	13.667 ± 1.97^a	17.333 ± 0.45^a	20.767 ± 0.65^a
T_2 (33%)	12.733 ± 0.99^a	15.400 ± 0.76^b	18.967 ± 0.60^b
T_3 (66%)	11.333 ± 2.14^a	14.400 ± 0.63^{bc}	18.433 ± 0.55^b
T_4 (100%)	9.267 ± 6.30^a	13.967 ± 0.40^c	18.033 ± 0.38^b

All the values with the means of three replicates. Means with the same letters in a column are not significantly different according to the Duncan's mean separation at $\alpha = 0.05$ and 95% confidence interval.

Table 3 Effect of various concentration of *A. vera* gel on weight losses of Ampalavi mango fruits.

<i>A. vera</i> gel concentration	Weight losses (%) within fruit preservation period (FPP)		
	4 d	9 d	12 d
T_1 (0%)	3.5430 ± 0.48^a	7.7690 ± 2.24^a	8.4570 ± 4.19^a
T_2 (33%)	3.2232 ± 0.33^{ab}	6.1230 ± 1.37^{ab}	4.4570 ± 1.30^{ab}
T_3 (66%)	2.6718 ± 0.34^b	5.2259 ± 0.46^{ab}	3.2930 ± 0.42^b
T_4 (100%)	2.6210 ± 0.32^b	4.5390 ± 0.87^b	1.1360 ± 0.63^b

All the values with the means of three replicates. Means with the same letters in a column are not significantly different according to the Duncan's mean separation at $\alpha = 0.05$ and 95% confidence interval.

from the fruits are usually controlled by the epidermal layers provided with guard cells and stomata. The *A. vera* gel coating helps to reduce this further, because it forms a film on the top of the skin acting as an additional barrier to moisture loss [17]. These barrier properties also reduce the oxygen uptake by the fruit, which in turn slows down rate of respiration and associated weight loss from the fruit surface. Also it may be due to less availability of ethylene in the storage atmosphere, which in turn decreases the mitochondrial activity and respiration rate, eventually reducing moisture loss from the fruit.

4. Conclusions

A. vera gel coating technique prolonged the fruits' shelf life by delaying the ripening. This study proved that the bio-preservative potential of *A. vera* gel in Ampalavi mango fruits. The TSS, pH and weight loss were differed in coated and uncoated fruits, due to the chemical properties of gel. The mean weight loss, pH and TSS value of control fruits pulp were higher than that in gel treated fruits. Further studies should be carried out to compare the preservative properties of gel with synthetic preservatives, like benzoic acid.

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