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# Effect of safe phytochemicals coating on postharvest loss and shelf-life of Starfruit (*Averrhoa carambola*) - A Fruits of Medicinal values.

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## Abstract

Fruits are important sources of vitamins and minerals and play an important role in improving nutritional status of human beings. This study was conducted to investigate the potential of phytochemical extracts on extending the shelf-life of harvested carambola fruits, and to determine which phytochemical extracts can best enhance its shelf-life. The freshly harvested Carambola(*Averrhoa carambola* L.) fruits were coated with two safe phytochemicals like *Aloe vera* and *Bryophyllum pinnatum* and stored at ambient condition. To evaluate the pretreatment with phytochemical coating on Carambola fruits the *Aloe vera* coating showed an encouraging result with respect to biological properties when compared with fruits coated wth *Bryophyllum pinnatum.*

**Keywords**: bio-preservatives, Carambola fruits, Shelf life, Storage.

## 1. Introduction

Post harvest losses of fruits and vegetables are a serious problem due to rapid deterioration of quality of the produce during handling, transport and storage. Though the fruits and vegetables have skins that provide natural protection against drying out, discoloration and other forms of spoilage, however cutting or other form of injury during handling, storage and transport may remove the natural protection and allowing deterioration and spoilage to begin. To protect the quality and nutritional value of the stored food the edible coatings were preferred due to their edibility and do not add unfavourable properties to the food stuff. Edible coatings are slim layer of edible material that applied to the product surface in addition to or as a replacement for natural shielding waxy coatings and also to provide a barrier to natural gases (e.g. oxygen, ethylene), moisture, and solute movement for the food (McHugh and Senesi, 2000, Adetunji *et al.*, 2012).Edible coatings on fruits and vegetables can improve the quality and increase their shelf-life.

Carambola (*Averrhoa carambola* L.) a soft skinned fruit belongs to the family Oxalidaceae and commonly known as 'Star fruit' grows in tropical and subtropical regions throughout the world. The fruit is believed to have originated in Southeast Asia, Indonesia or Malaysia, but it is now cultivated throughout the tropics and subtropics of the world. Starfruit, is a star shaped tropical fruit with sweet and sour flavour. The fruit is non-climacteric and rich in reducing sugars, ascorbic acid and minerals such as K, Ca, Mg and P (Bose *et al.*, 2002). Oxalic acid and tannins are believed to strongly influence the taste. Ripe fruits of sweet form of Carambola contain both oxalic acid (0.16%) and malic acid (0.06%), whereas, fruits of the sour form contain only oxalic acid ranging from 1.0 per cent in unripe fruits to 0.51 per cent in ripe. Sugars present in both types vary largely in glucose with moderate quantities of fructose and traces of sucrose (Raghav *et al.,* 2016).

The starfruit possesses high nutritional and medicinal values. It contains only 30 calories per fruit plus lots of fiber, it helps to lose weight. Starfruit is a good source of vitamin B9 (folic acid), which helps to reduce the risk of heart disease and stroke. Starfruit contain B-complex vitamin, which is essential for hair

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growth and help in keeping hair strong and healthy. Starfruit purifies the blood, helps in getting a glowing skin(Hitesh and Tejpal, 2016).

Carambola has many medicinal uses and also contains secondary metabolites which have various biological activities(Chopra *et al*, 1956). Traditionally Starfruit is used as home remedy for hangovers and sunburns. Starfruit also helps to cure cough, fever, ulcers and sore throats. The leaves of star fruit can be used to treat stomach ulcers and also improves digestion. The medicinal properties of Starfruit also include anti-inflammatory (Sripanidkulchai *et al.*, 2002), analgesic (Das and Ahmed, 2012), hypotensive (Soncini *et al.,* 2011), anthelmintic (Shah *et al.*, 2011), anti-oxidant, anti-ulcer (Goncalves *et al.*, 2006), hypocholesterolemic and hypolipidemic, antimicrobial (Mia Masum *et al.*, 2007), anti-tumor (Tadros and Sleem, 2004) activities. It is effectively used in diabetes and help to reduce the risk of heart disease and stroke. The ripe fruit usually administered to halt hemorrhages and to relieve bleeding hemorrhoids; and the dried fruit or the juice may be taken to counteract fevers.

Carambola is mainly used in food preparation and has good medicinal properties. Carambola serves as an excellent garnish and unripe fruits can be used as vegetables. Ripe fruits of sweet form of Carambola contain both oxalic acid (0.16%) and malic acid (0.06%), whereas, fruits of the sour form contain only oxalic acid ranging from 1.0 per cent in unripe fruits to 0.51 per cent in ripe. Sugars present in both types vary largely in glucose with moderate quantities of fructose and traces of sucrose(Rathod *et al.*, 2011). So the main objective of the present paper is to assess the post harvest losses in starfruits and evaluate biodegradable phytochemical coatings to minimize the post harvest quality of the fruits. Dried Carambola makes delicious snacks and length wise slices of Carambola fruit are used for canning to export. It is required that fruits have to be preserved fresh and make available throughout the year to fulfill the human dietary requirements. As the fruits being living entities, their metabolic activities continue even after harvest with a sum total effect on their degrading quality and composition.

Improvement in fruit quality has economical implications in the value of the product, as well as in strengthening or expanding of consumer markets. The storage of fruits at low temperatures is one option to preserve their post-harvest quality and to increase the shelf life. However, formation of ice crystals inside the cells during the freezing process, leading to an increased loss of juice and, consequently, nutrients during thawing due to exudation, thus further reducing the content of soluble solids (Prado *et al.*, 2005). The post-harvest losses not only reduce the availability of fruits but also result in increase in per unit cost of transport and marketing (Subrahmanyam, 1986, Ghatge *et al.*, 2005). Post harvest losses ultimately affect both the producers and the consumers. Moreover, it is utmost important to protect the human body from the onset of degenerative diseases as well as from toxicants that are often used to handle and preserve different fruits and vegetable harvests. So there is necessity of development of proper measures to prevent or reduce such losses and to increase the availability of fruits for domestic consumption and for export purposes. Some phytochemical extracts and natural products have been reported potential commodity coatings that can promote safety, profitability and quality of harvested fruits and vegetables.

*Aloe vera* is a unique plant which is a rich source of many chemical compounds and plays an important role in the international market. *Aloe vera* reported to contains as many as 75 nutrients and 200 active compounds including sugar, anthraquinones, saponins, vitamins, enzymes, minerals, lignin, anthraquinones or phenolic compounds, lignin, sterols, amino acids and salicylic acid (Chauhan *et al*., 2014, Vogler and Ernst 1999). *Aloe vera* also contains many vitamins including A, B1, B2, B6, C, and E and F excluding vit. D (Chauhan *et al.,* 2014). *Aloe vera* extracts are utilized in the development of anti-bacterial and anti-fungal products (Farnsworth 1984). Aloe 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 has antifungal and antibacterial property which provides a defensive barrier against microbial contamination of fruits and vegetables. (Chauhan *et al*., 2014).

*Bryophyllum pinnatum* (lam.) Oken is commonly known as Parnabeeja in Ayurvedic science and growing naturally as an environmental weed from the family Crassulaceae. It is commonly used traditionally as a medicine in different regions of India mainly to treat urinary stones, as well as in other parts of world. The traditional practitioners in various parts of world use this plant in numerous conditions like hypertension, skin disorders, asthma, cold, insect stings, abscesses etc. bRecent research have proved many pharmacological activities of the plant known and unknown like Anti-Diabetic activity, Wound healing property, Antilithogenic activity, Hepato-protective

activity, Anticancer property etc. The species of these is thought to be poisonous to livestock, as it contains cardiac glycoside.

*Bryophyllum pinnatum* (lam.) Oken is an indigenous and exotic plant used widely by the traditional practitioners for treating various ailments like renal calculi, hypertension, asthma, cold, abscesses, bleeding disorders. It is a succulent herb, leaves are variable and leaflets are elliptic.(Vaidhya B. Some controversial drugs in Indian Medicine. Edn 3, Chaukhambha Orientalia, Varanasi, 2010). Keeping in view, the medicinal properties of these plant, an attempt has been made in this present study to know the effect of Aloe vera and B. pinnatum as biopreservative for enhancing the postharvest life and quality of carambola fruits.

## 2. Material and methods

### 2.1 Collection and surface preparation

Carambola fruits were harvested from a homestead garden of Guwahati, Assam at the well developed ripe or slightly under-ripe stage and brought to the laboratory during February, 2017. For surface preparation the freshly collected fruits were washed thoroughly with clean tap water, surface-disinfected with 2% salt solution for 10 min and then air dried.These fruits were subjected to different treatments on the day of harvest and taken for studies.

### 2.2 Storage condition

The storage studies were conducted under ambient conditions in the laboratory and refrigerated conditions where temperature maintained at (25.0 - 30.0° C) and Relative humidity(86%).

### 2.3 Preparation of phytochemical extracts

#### 2.3.1 Preparation of aloe vera gel coating

Matured leaves of Aloe vera plant was harvested and washed with a salt solution of 25%. Aloe vera gel matrix was then separated from the outer cortex of leave and this colourless hydroparenchyma was messed and resulting mixture was filtered to remove the fibers, and fresh Aloe vera gel was obtained. The gel matrix was pasteurized at 70°C for 45min. The gel was cooled immediately for stabilization and ascorbic acid (1.9 - 2.0g L-1 ), citric acid was added to maintain the pH at 4. The viscosity of the stabilized Aloe vera gel and stored in brown Amber bottle to prevent oxidation of the gel (He *et al*., 2005 and Adetunji *et al*., 2012).

#### 2.3.2 Preparation of Bryophyllum Gel Coating

Leaves of Bryophyllum pinnatum harvested and washed with a mild chlorine solution of 25%. The washed leaves were allowed to air-dried. These were then cut into small pieces and blended in a blender followed by filtration with a thin white cloth. The final filtrate free from particles were concentrated and dried in an oven at 40ºc

### 2.4 Application of edible gel

Fruits were dipped in the following edible coating treatments for 5 min: a. 100% (w/v) *Aloe vera* gel solution b. 100% (w/v) *B. pinnatum* solution. All the treated fruit were allowed to dry at room temperature for 10 min to form a thin layer of edible coating on the surface of treated samples. Some fruits were kept untreated with any coating gel. All the control and treated fruit samples were stored at room temperature, (25 ± 5) °C and (65 ± 5) % RH, in an air tight packet which allowed them to ripen.

The following analyses were carried out at (7th, 14th, and 21st) days of storage to evaluate the effect of different concentrations of edible coating components on the postharvest shelf life and nutritional quality.

### 2.5 Weight loss percentage

Carambola fruit were weighed at the beginning of the experiment just after coating and air drying, and thereafter on every 7th day during the storage period. Weight loss was expressed as the percentage loss of the initial total weight calculated by considering the difference between the initial weight and final weight of the carambola fruit divided by their initial weight.

### 2.6 Determination of pH

Whole fruit were passed through an electric juicer and filtered through cheesecloth for the measurement of pH. pH was measured by digital pH meter (WTW 526, Germany) .

### 2.6 Shelf-Life Evaluation of Harvested Star fruit

The coated fruits were placed on plastic trays in triplicates arranged in a completely randomized design and stored at the laboratory of the Department of Biotechnology at room temperature (25± 5°C). The visual quality ratings (VQR) and weight loss (Acedo, 1999) were recorded daily. A replicate or a treatment is terminated once the vegetable fruits attained a VQR of 3 or a 50% weight loss. The treatments of the final

shelf-life evaluation were as follows:
T0 = untreated, T1 = *Aloe vera* coating , T2 = *Bryophyllum pinnatum* coating.

### 2.7 Biochemical analysis

#### 2.7.1 Test for ascorbic acid content

Volumetric analysis of ascorbic acid content using 2,6-dichloro indophenols dye was carried out. Working standard was prepared in which ascorbic acid was dissolved in 4% oxalic acid. The concentrated of working standard was 100µg/ml. 5g of the sample dissolved in 4% oxalic acid and centrifuged. 5ml supernatant in 10ml 4% oxalic acid was dissolved and titrated against the dye. By comparing volume consumed of working standard and sample, the amount of ascorbic acid content in sample was determined (Sadasivam and Manickam, 1992).

#### 2.7.2 Test for organic acid content

Titratable acidity was determined by titration of 5ml of juice diluted with 25ml distilled water to pH 8.2 with 0.1 NaOH and expressed as percentage. (Chauhan *et al.,* 2014). Coated and uncoated fruits were analysed by volumetric method taking 2,6-dichlorophenol indophenols dye and oxalic acid is used as titrating medium. The result was obtained using ascorbic acid solution as standard.(Sadasivam and Manickam,1992). Determination of organic acid content of coated and uncoated fruits was done on 7th, 14th and 21st days of storage. Titratable acid was determined by titration of 5 ml juice diluted with 25 ml distilled water to pH 8.2 with 0.1 N NaOH. (Chauhan *et al.*, 2007)

#### 2.7.3 Test for total phenolic content

Total Phenolic contant was determined by Folin-Ciocalteau method. A standard curve was obtained by using standard galic acid solution. Polyphenol extraction was carried out with 80% ethanol added to 1 gm of sample, centrifuged at 10,000rpm for 20 minutes. Next, the supernatant evaporated and diluted with 5ml of distilled water, the aliquots pipetted out in different test tubes (0.2ml-1ml) to this 3ml of water added and then 0.5 ml of Folin Ciocalteu reagent and 2 ml of 20% sodium carbonate were added to the mixture. The tubes were kept in boiling water bath for exactly one mimute and cooled. The absorbance of the samples was measured at 765 nm with a UV spectrophotometer. Gallic acid was used as a standard for obtaining the calibration curve.

#### 2.7.4 Test for total sugar content

The sugar content of the fruits at the begening (0 days) of the storage was determined. Determination of carbohydrate content of coated and uncoated fruits was done on 7$^{th}$, 14$^{th}$ and 21$^{st}$ days of storage. Carbohydrate content was estimated by anthrone method. The absorbance of the samples was measured at 630nm.

A standard curve was prepared by using standard glucose solution and concentration of sample was determined by plotting absorbance along y-axis and concentration along x-axis.

## 3. Results and discussion

The collected uniformly matured carambola fruits were subjected to different treatments from the day of collection and taken for the studies. The storage studies were conducted under ambient condition in the laboratory on the floor of a well ventilated room maintaining the temperature in the range of 25.0 to 30.0°C and also in refrigerated condition (2-4°C). It was observed that in all the treatments refrigerated storage (2-4 °C) had resulted in lesser weight loss when compared to ambient storage conditions. The present findings are in conformity with the findings of other workers (Bhatnagar *et al.,* 1990 and Midon and Lam, 1986). Low temperature is the best storage treatment for retarding all physiological and pathological deterioration. Low temperature reduces respiration and other metabolic activities (Faragher *et al.*, 1984, Reid and Kofrauck, 1980) transpiration (Faragher *et al*., 1984).

**Table 1:** Comparative changes in pH and weight loss of coated Carambola during storage

| Storage days | Changes in Weight loss during storage | | | Changes in pH during storage | | |
|---|---|---|---|---|---|---|
| | *Aloe vera* coated (g) | *Bryophyllum pinnatum* coated (g) | Uncoated-Control (g) | *Aloe vera* coated | *Bryophyllum pinnatum* coated | Uncoated-Control |
| 7 days | 128 | 128 | 128.00 | 4.72±0.17 | 4.95±0.17 | 4.35±0.17 |
| 14 days | 128 | 127.70 | 126.40 | 4.84±0.69 | 5.00±0.69 | 5.09±0.69 |
| 21 days | 127.35 | 127.16 | 125.34 | 5.81±3.10 | 5.95±3.10 | 6.20±3.10 |

On the 7th and 14th days storage there was no significant loss in weight and changes in pH of the carambola fruit was observed(Table 1). The pH of the coated carambola on 14th days was 4.45±0.69 and pH of the uncoated fruit was 4.49±0.69. In another study the pH of the grape juice was reported to be gradually increasing during the course of storage(Chauhan *et al*, 2014). The plant based coated fruits had higher values at the end of storage period which might be due to the semi permeability created by *Aloe vera* coatings on the surface of fruits. It might have modified the internal atmosphere i.e. endogenous $O_2$ and $CO_2$ concentrations in the fruits and retarding the ripening process(Lowings and Cutts, 1982, Bai *et al*, 1988).

| | | |
|---|---|---|
|  *B. pinnatum* coated carambola fruit- (0 day storage condition) |  *Aloe vera* coated carambola fruit (0 day storage condition) |  Un- coated carambola fruit (0 day storage condition) |
|  *B. pinnatum* coated carambola fruit- (14th day of storage) |  *Aloe vera* coated carambola fruit (14th day of storage) |  Un- coated carambola fruit (14th day of storage) |
|  *B. pinnatum* coated carambola fruit- (21st day of storage) |  *Aloe vera* coated carambola fruit (21st day of storage) |  Un- coated carambola fruit (21st day of storage) |

The appearance of the *Aloe vera* , *B. pinnatum* coated and uncoated carambola fruit are shown in Figure-1(a,b,c) on the 0 day, 14thday and 21st day of the storage treatment respectively. Significant changes in the appearance of the plant based coated and uncoated fruits were recorded. Similar findings also reported by Chauhan et al,( 2014) where wax coating reported to be reduces the shrivelling of oranges than the control.

The ascorbic acid of fruit is one of the most important nutrient quality parameters. Various physical parameters such as cell wall damage, water loss, oxygen level, temperature and humidity have been reported to affect the stability or breakdown of the ascorbic acid structure of fruits during their post harvest storage.

Initially at day 7th the value of ascorbic acid was (150 ±0.04)mg/100mg of sample for *Aloe vera* coated fruit and for *B. pinnatum* coated fruit the value was (100 ±0.04)mg/100mg of sample. However this value decreases significantly in all the treated as well as untreated fruits. The fruits treated with *Aloe vera* coating showed the highest ascorbic acid content (100 ±0.13)mg /100mg of sample) on 21st day of storage period(Table-2). It was followed by *B. pinnatum* coated fruits (75 ±0.13)mg/100mg of sample) and untreated showed lowest content of ascorbic acid(32 ±0.13 )mg/100mg of sample). This is in conformity with the findings of other workers (Baraiya *et al*, 2012) where 12th day of storage period of fruits treated with green tea extract showed the highest ascorbic acid content(82.22 mg g-1) whereas the lowest amount (62.89 mg.g-1) occurred in untreated fruits. Thus the coating could help in improving the antioxidant properties in terms of ascorbic acid enhancement. The coating serve as a protective layer and control the permeability of O2 and $CO_2$, thus decreasing the auto oxidation potential of fruits (Togrul *et al*, 2004).

The effect of coating on organic acid showed a significant response during storage. The highest value was observed in case of *Aloe vera* coated fruit on the 7th day(0.088±0.08) equivalent per litre as well as on 21st day (0.069±0.23) equivalent per litre of storage followed by *B. pinnatum* coated fruit on the 7th day(0.078±0.08) equivalent per litre and 21st day (0.061±0.23) equivalent per litre of storage(Table-2). Lowest value was recorded in case of untreated fruit on 7th day(0.062±0.08) equivalent per litre and 21st day(0.05±0.23N) of storage. Similar results also reported by other workers (Chauhan *et al* 2014). The decreasing acidity with the storage duration might be due to metabolic changes in fruits resulting from the use of organic acids in respiratory process which is in agreement with the findings of other workers (Echeverria and Valich, 1989).

**Table 2:** Determination of Ascorbic acid and Organic acid content

| Storage days | Changes in Ascorbic acid during storage (mg/100mg sample) | | | Changes in Organic acid content during storage(in mg/ml) | | |
|---|---|---|---|---|---|---|
| | *Aloe vera* coated (g) | *Bryophyllum pinnatum* coated (g) | Uncoated-Control (g) | *Aloe vera* coated | *Bryophyllum pinnatum* coated | Uncoated-Control |
| 7 days | 150±0.04 | 125±0.04 | 100±0.04 | 0.088±0.08 | 0.084±0.08 | 0.072±0.08 |
| 14 days | 125±0.09 | 100±0.09 | 50±0.09 | 0.075±0.19 | 0.065±0.19 | 0.058±0.19 |
| 21 days | 100±0.04 | 75±0.13 | 32±0.13 | 0.069±0.23 | 0.061±0.23 | 0.050±0.23 |

The values of the total sugar content increase progressively with theadvancement of storage period. Total carbohydrate was determined by Anthrone method where 100gm of sample was hydrolysed keeping in a boiling water bath for 3 hours with 5ml 2.5N HCl and cooled to room temperature then neutralised with sodium carbonate and volume made upto 100ml. 0.5 and 1ml of aliquot collected from supernatant. The standard was prepared taking 0, 0.2, 0.4, 0.6, 0.8 and 1ml of working standard (glucose-100mg in 100ml then 10ml to 100ml D.W). 4ml of anthrone reagent added to the mixture in each tube.

A significant increase in the content of total sugars of carambola fruits was recorded for both the treated and control set during storage period. The sugar content of 7 days stored *Aloe vera* coated samples was recorded as (0.702±0.04) mg/ml which was followed by the *B. pinnatum* coated sample with the sugar content value (0.441±0.04)mg/ml. However the sugar content was found to be maximum with the value

(1.19±0.04)mg/ml in the control. The sugar concentration increases gradually and reached the value (1.11 ±0.13) mg/ml on the 21st day(Table-3). The findings of increase in the total reducing sugar content along with storage are also reported by other workers (Ingle *et al*., 1981).

The increase in the total sugar during storage observed due to the hydrolysis of polysaccharides. Total sugar content increases from harvest till ripening and declines as senescence approaches once the fruit ripens, the sugars undergo metabolic transformation, both quantitatively and qualitatively (Pantastico, 1975). These findings on the total sugar are in line with the report of Sanjay (1996), who noticed an increasing trends with respect to reducing, non-reducing and total sugar content with advancement of storage period. According to Maqbool *et al* (2012) an increase in reducing sugar was correlated with the enzymatic conversion of starch to reducing sugar and also the conversion of some non reducing sugars to reducing sugars through inversion process.

**Table 3**: Determination of Carbohydrate and Phenolic content

| Storage days | Changes in Ascorbic acid during storage (mg/100mg sample) | | | Changes in Organic acid content during storage(in mg/ml) | | |
|---|---|---|---|---|---|---|
| | *Aloe vera* coated (g) | *Bryophyllum pinnatum* coated (g) | Uncoated-Control (g) | *Aloe vera* coated | *Bryophyllum pinnatum* coated | Uncoated-Control |
| 7 days | 150±0.04 | 125±0.04 | 100±0.04 | 0.088±0.08 | 0.084±0.08 | 0.072±0.08 |
| 14 days | 125±0.09 | 100±0.09 | 50±0.09 | 0.075±0.19 | 0.065±0.19 | 0.058±0.19 |
| 21 days | 100±0.04 | 75±0.13 | 32±0.13 | 0.069±0.23 | 0.061±0.23 | 0.050±0.23 |

The phenolic compounds are closely associated with the sensory, nutritional quality, aroma and taste of foods. Phenolic compounds are thus good antioxidants and substrates for oxidative browning (Imeh *et al,* 2002). The phenolic content of carambola fruits decreased significantly during postharvest storage for both treated and untreated fruits. On the 7th day of storage the value for *Aloe vera* coated sample was 0.00237±0.15 mg/gm gallic acid equivalent and *B pinnatum* 0.00227±0.15 mg/gm gallic acid equivalent and for the untreated sample 0.00138±0.15mg/gm gallic acid equivalent. On the 21st day of storage the value for *Aloe vera* coated sample was 0.00136±0.54 mg/gm gallic acid equivalent and *B. pinnatum* 0.00125±0.15 mg/gm gallic acid equivalent and for untreated sample 0.00052±0.15 mg/gm gallic acid equivalent(Table-3). The present findings are in contrast to the findings of Barajya *et al*, (2012) where on the 8th day of storage period the phenolic content values were reported to have decreased. Ali et al, (2013) reported a low amount of total phenolic content or a sharp decline of it in untreated control tomato fruit as compared with that treated with Arabic gum.

## 1. Conclusion

The fruits Storage potential mainly dependent on variety, pre-harvest condition, culture practice, maturity at harvest and the storage environment. Enhancement of storage life of fruits makes them suitable for maintenance of quality and long distance export. The present findings suggested that the application of composite edible coating of *Aloe vera* and *Bryophyllum pinnatum* was found to be effective in retarding the ripening behaviour of carambola fruit without its excessive deterioration. The addition of these coatings formed a strengthened film on the cover of fruit and helped to overcome setbacks such as fragility and brightness of the film. Moreover, these bio-coating was able to retard the rate of respiration and the metabolism, which results in delaying the ripening and senescence process of fruit. The application of Aloe vera and Bryophyllum pinnatum was found to be effective in improving the level of phenolic compounds and ascorbic acid. Thus the application of using Aloe vera and Bryophyllum pinnatum edible coating on carambola fruit may be useful and promising eco-friendly postharvest technique for enhancement of postharvest shelf life and quality maintenance of perishable fruits and vegetables.

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