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Research Article

Postharvest Application of *Aloe vera* Gel-Based Edible Coating to Improve the Quality and Storage Stability of Fresh-Cut Papaya

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Ready-to-eat products are damaged by various factors, including exposure to O_2 and CO_2, extreme temperatures, and rapid decay, due to trauma during processing. The use of natural antimicrobial agents and antioxidants might extend the shelf-life of the fruits. The aim of this work is to investigate the effects of four different antibrowning and gelling agents added into the *Aloe vera* gel-based edible coatings and applied to fresh-cut papaya. EC1 treatment consists of *Aloe vera* gel (30% v/v), EC2 contains $CaCl_2$ (5% v/v), EC3 contains K carrageenan (0.5% v/v), and EC4 contains sodium alginate (1.5% v/v) and K carrageenan (0.5% v/v). The fruits treated with EC2 showed the best results while maintaining high values in terms of firmness (that differ from the control of 42.5%), soluble solid content (that differ from the control of 14.6%), and titratable acidity (that differ from the control of 49%). Hence, the addition of $CaCl_2$ also reduces the ripening rate and loss of color without altering the product's sensory qualities. EC3 and EC4 treatments have provided an oxygen barrier and reduced respiratory rate, increasing the firmness retention and keeping a high C^* value thanks to K carrageenan and sodium alginate.

1. Introduction

During the last decade, there has been a marked change in both consumers' lifestyles and in the climate: the former has stimulated the demand by modern consumers for ready-to-eat fruits and vegetables that have been peeled, cut, washed, dried, and packaged in plastic trays and finally are marketed in refrigerated cases [1]; the second has allowed Mediterranean areas to cultivate tropical and subtropical crops [2]. During this last decade, the cultivation of papaya (*Carica papaya* L.) has also spread in these areas. It is originally from southern Mexico and Costa Rica and it was introduced as a plantation crop cultivated in protected environments throughout all tropical and subtropical regions; in fact, in the coastal areas of Sicily, papaya cultivation could represent a valid alternative to traditional crops in cold greenhouses.

Papaya is a climacteric fruit and is known for its high nutritional value: it contains low calories and is rich in vitamins and minerals such as vitamins C and A, riboflavin, folate calcium, thiamine, iron, pantothenic acid, niacin, potassium, and fibers [3]. Papayas have a very short postharvest shelf-life (7–14 days) under greenhouse conditions [4, 5]; for this reason, several researchers have developed postharvest storage procedures that help minimize quality deterioration [6] and help prolong shelf-life while maintaining high sensory and nutritional attributes. Several conservation techniques have been studied and developed to increase the shelf-life of fresh-cut fruit, such as pickling, drying, high-pressure processing, modified atmospheres, and edible coating. Some of these techniques use additives for increased effectiveness [7]. However, the organoleptic properties of these fresh-cut fruits are influenced by these preservation techniques. For example, the drying method will cause a loss of moisture, thus changing the appearance and taste of the fruit. Therefore, the edible coating could be the most favorable method for maintaining the condition of fresh-cut fruit. The edible coating (EC) is an odorless, colorless, and tasteless substance consisting of hydrocolloids, polysaccharides, proteins, lipids, and wax and forms an invisible barrier on the surface of the fruit that separates it from the surrounding atmosphere [8]. It also reduces water loss and controls microbial growth while preserving fruit quality and giving the product better mechanical resistance [9]. A layer of edible material is especially effective in preserving postharvest quality and reducing production costs for highly perishable fruits such as the papaya [10–12]. Although its effectiveness has been tested on different fruits, its application is not yet widespread [13], especially not on fresh-cut fruits. Tavassoli-Kafrani et al. [14] have studied the application of calcium chloride, K carrageenan, and sodium alginate as film-forming agents: calcium forms links between pectic substances within the cell wall [15] giving it the potential to increase the postharvest quality of fruits and vegetables [16, 17]. In addition, the colloidal properties of alginate, salt of alginic acid isolated from brown algae, results in the formation of resistant gels or insoluble polymers by reacting with Ca^+ after treatment with $CaCl_2$ [18]. Instead, K-carrageenan is derived from carrageenans, which are natural hydrophilic polymers [19] constituted by a linear chain of partially sulphated galactans. These biopolymer-based films extend food shelf-life by maintaining organoleptic and sensory characteristics [20] and inhibiting oxidation processes [21]. Another interesting aspect is that the products used in edible coating are totally natural and are considered safer for consumption, as they are nontoxic and economical.

For this reason, recent studies have shown that the gel extracted from different parts of plants has an antifungal and antimicrobial effect on the whole fruit [22]. *Aloe vera* gel has been applied to grapes [23], cherries [24], strawberries [25], litchis [26], and plums [27] in film form, showing excellent results in terms of browning reduction and fungal alterations on the surfaces of treated fruits. *Aloe vera* gel has been used as an edible coating for raw produce such as nectarines [28], mangoes [29], apples [30], papayas [4], and table grapes [31, 32]. Furthermore, *Aloe vera* provides 20 of the 22 amino acids required in the human diet and 7 of the 8 essential amino acids. It is a good source of vitamins that act as antioxidants that neutralize free radicals [33, 34].

Therefore, the aim of this work was to evaluate the potential activity of *Aloe vera* gel in edible coating based on calcium chloride, K carrageenan, and sodium alginate, to assess the changes in the quality attributes of fresh-cut papaya.

2. Materials and Methods

2.1. Vegetal Material. Fifty papaya fruits were harvested at green-mature ripening stage (entire surface green, with traces of yellow on the flesh), with a regular shape and uniform size, from the "Orto di Nonno Nino" farm greenhouse in Sicily (38°08′ N, 13°10′ E).

2.2. Chemicals. Food-grade sodium alginate (Keltones LV, ISP, San Diego, CA, USA) and gellan gum (Kelcogels, CPKelco, Chicago, IL, USA) were used as carbohydrate biopolymers in the coating formulations. Glycerol (Merck, Whitehouse Station, NJ, USA) was added as a plasticizer. $CaCl_2$ (Sigma-Aldrich Chemic, Steinheim, Germany) was employed for cross-linking (0.75% v/v) per 2 min, and *Aloe vera* gel was added as an antimicrobial agent.

2.3. Preparation of Aloe vera Gel. Homogeneous leaves were selected according to size and harvested according to visual analysis. The epidermis was separated from the gel, which was manually cut into portions of 10 ± 1 mm in thickness and the sample was maintained at 4 ± 1°C in a refrigerator. The gelatinous parenchyma was triturated (Ultra-Turrax T25, Janke and Kunkle, IKa Labortechnik, Breisgau, Germany) for 5 minutes at 24.500 rpm, to form a homogeneous substance, and filtered to remove the fibrous portion. Then, a gelling agent (Gelzan™ CM Gelrite®, Sigma-Aldrich, 1% v/v) and glycerol (3% v/v) were added to improve the viscosity and plasticity of the film [4]. An additional homogenization, at 90°C for 40 minutes, was used as a microbiological stabilization of the solution.

2.4. Coating Composition. For the preparation of the edible coating, four treatments were tested in 500 ml of distilled water:

(i) CTR: control, untreated
(ii) EC1: gellan gum (1% v/v), Aloe v. gel (30% v/v), and glycerol (3% v/v)
(iii) EC2: gellan gum (1% v/v), Aloe v. gel (30% v/v), glycerol (3% v/v), and $CaCl_2$ (5% v/v)
(iv) EC3: gellan gum (1% v/v), Aloe v. gel (30% v/v), and K carrageenan (0.5% v/v)
(v) EC4: gellan gum (1% v/v), Aloe v. gel (30% v/v), sodium alginate (1.5% v/v), and K carrageenan (0.5% v/v)

All of the concentrations were selected on the basis of other studies conducted on other kinds of fruits and on papaya in which positive and statistically significant results were obtained [35–37].

The sample was homogenized with heat treatment (90°C for 45 min), and ascorbic acid (0.5% v/v) and citric acid (1% v/v) were added to prevent the browning of the solution and to maintain a pH value below 4.

The papaya fruits were washed with cold tap water to remove surface contamination and then were sanitized by immersion in sodium hypochlorite (2% v/v) in distilled water at 5°C for 2 min. After that, each papaya fruit was hand-peeled and cut into slices of 2 cm using a ceramic knife and at room temperature (9 ± 1°C). The knife and cutting board were rinsed in cool water at 8°C.

All of the treatments were applied by spraying with an airbrush (0.8 mm of nozzle diameter) powered by N_2. Finally, 100 g of fresh-cut fruits was packaged in a passive atmosphere and stored at a low temperature (5°C and 90% RH), in 90 PET trays for 12 days. Each tray (125 mm × 115 mm and 150 cc) was thermally sealed on the top with a 50 mm thick bioriented polypropylene (BOPP) film. The BOPP permeability was 2.004 mL O_2 m^{-2} d^{-1} atm^{-1}

and 3.824 mL CO_2 m^{-2} d^{-1} atm^{-1}. All of the analysis was carried out on an interval of three days up to twelve days.

2.5. Physicochemical Characterization

2.5.1. Weight Loss. The weight loss was measured every three days with a two-decimal precision digital scale (Gibertini, Italy). The value was expressed as a relative percentage and calculated as weight loss (%) = (Wi − Wt)/Wi ∗ 100 (where Wi is the initial weight and Wt is the weight measured during storage).

2.5.2. Firmness. The firmness of the pulp (*N*) was determined by a digital penetrometer (mod. 53205, Turoni, Forlì, Italia), in two opposite sides of the fruit.

2.5.3. Total Soluble Solid Content. The total soluble solid content (°Brix) was estimated by a digital optical refractometer ATAGO (Atago Co., Ltd, Tokyo, Japan).

2.5.4. Titratable Acidity and pH. The titratable acidity (gL^{-1} MA%) and the pH value were measured with a Crison Compact pH meter titrator (Crison Instruments, SA, Barcelona, Spain).

2.5.5. Flesh Color. A Minolta colorimeter (Chroma Meter CR-400, Konica Minolta Sensing Inc., Tokyo, Japan) was used to evaluate the color of the fresh-cut papaya. The color space is shown as follows: brightness (L^* value); the hue angle, which shows the change in color of the fruit flesh (a lower h° indicates a more intense browning); and the saturation, which represents the degree of color saturation (higher C^* values indicate a brighter color and consequently a higher market value). The instrument has been calibrated using a standard white plate.

2.5.6. O_2 and CO_2 Analysis. The respiration rate (RR) of each tray was regularly monitored using a gas analyzer (CheckMate II, PBI-Dansensor (Far East) Limited., Copenhagen, Denmark). Three independent replicates were conducted for each treatment.

2.5.7. Sensorial Analysis. The sensorial analysis was carried out by 8 trained panelists (4 males and 4 females, aged 24 to 33 years) who were recruited based on previous experience as an apple sensory panelist [38, 39]. Twenty different qualitative and quantitative descriptors were evaluated: flesh color (FC), presence of filaments (PF), firmness (F), sea smell (SS), peach smell (PS), exotic fruit smell (EFS), medicines smell (MS), cheese smell (CS), burnt oil smell (BOS), acid (A), sweet (S), bitter (B), juiciness (J), mealy (M), seafood flavor (SFF), peach flavor (PF), exotic fruit flavor (EFF), medicinal flavor (MF), cheese flavor (CF), and finally, burnt oil flavor (BF). The judges evaluated the intensity of each attribute on a discontinuous scale from 1 (absence of the descriptor) to 9 (maximum intensity of the descriptor). Water was provided for rinsing their mouths between the different papaya samples. The sensory profile of each genotype was reported in spider plots.

2.5.8. Statistical Analysis. Data were presented as mean ± standard deviation. Statistical analysis was performed using the XlStat® software version 9.0 (Addinsoft, Paris, France). Data were analyzed using one-way analysis of variance (ANOVA) and Tukey's posttest with $p < 0.05$ considered significant.

3. Results and Discussions

As shown in Figure 1, weight loss during the 12-day cold storage period was characterized by higher values for the CTR treatment from the third day of storage. In this case, there was a gradual weight loss from the first to the last day of storage. Similar values were observed for the EC1, EC3, and EC4 treatments, with the former slightly different and with a greater weight loss, while the EC2 treatment was the most effective of all of the treatments and it has created a thin layer on the fruit surface that has probably reduced the weight loss. Hence, the *Aloe vera* gel reduced evaporation from the fruit surface and retained more weight. Thanks to *Aloe vera* gel-based edible coating, Guillén et al. [27] has shown an effective reduction in weight loss in both peach and plum fruits, while Benítez et al. [40] reduce the pectin depolymerization processes in fresh-cut kiwi. An important role of this positive effect could be attributed to calcium chloride: Mahajan and Dhatt [41] have reported that calcium might have delayed senescence and reduced the respiration rate and transpiration. Nevertheless, different concentrations of calcium chloride introduced in loquat [35] and strawberries [42] showed positive values regarding weight loss. Also, Ahmed et al. [28] carried out the same study on nectarine, applying 2.5% *Aloe vera* gel and suggested that the coating material contributed to maintaining the weight of the fruit and increased its postharvest shelf-life. Therefore, our data highlight that both coating materials can help reduce fruit weight loss during storage through minimal respiration.

Concerning the firmness of the papaya slices (also shown in Figure 1), the EC2 treatment showed the best results (decreases by 35.8% compared to the CTR on the 12th day). The EC1 and EC3 show similar values (24.3% and 22.3% respectively), while the CTR showed a greater decrease in firmness (78.3%) during 12 days of cold storage. These results show the beneficial effects of the *Aloe vera* coating on the shelf-life of papaya fruits, in agreement with Batisse et al. [43] and Vidrih et al. [44] as they assumed that the softening and consistency of the fruits change during fruit storage. According to many research studies carried out on fresh fruit, postharvest $CaCl_2$-based preparations have been observed to maintain food quality and fruit firmness of loquat [45] and fresh-cut papaya [46]. White and Broadley [47] demonstrate that the preservation of firmness in calcium-treated fruits may be due to its accumulation in cell walls, which facilitates the crossing of pectic polymers that increases the strength of the walls and cell cohesion [48]. The

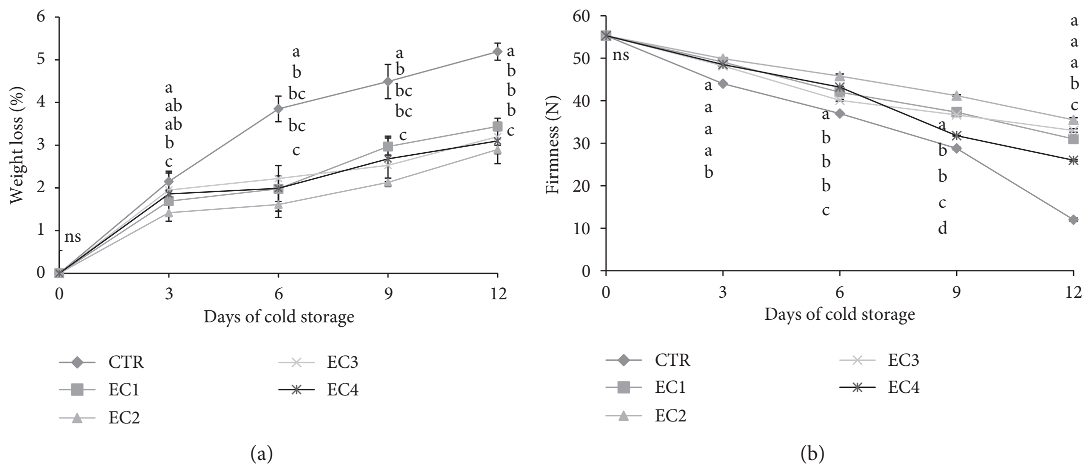


Figure 1: Trend of weight loss (%) and firmness (*N*) of fresh-cut papaya fruit cold stored and treated with edible coating. Values were recorded at 0, 3, 6, 9, and 12 days at 5°C and RH 90%. Significant values are indicated with equal letters in each step.

softening process in the fruit is dependent on the increase in polygalacturonase, activity of β-galactosidase, and pectinmethylesterase [49], as they are responsible for the loss of fruit quality. Narsaiah et al. [36] in their study on minimally processed papaya have demonstrated that an increase in alginate concentration increases the firmness retention. Lerdthanangkul and Krochta [50] also obtained similar results and concluded that coatings and/or films based on *Aloe vera* gel have a significant effect on the firmness of the preserved fruits.

From day 0 to day 12, the soluble solid content increased significantly between uncoated papaya fruits and coated fruits (Figure 2), starting from the same value (6.85°Brix) and reaching (in CTR) values close to 10°Brix. This increase in soluble solid content occurs due to the ripening and senescence of the fruit. In uncoated papaya fruits, the increase in soluble solid content may be due to increased degradation or biosynthesis of polysaccharides into simple sugars. It also increases moisture loss due to the accumulation of sugars in the tissues. This phenomenon probably leads to a decrease in the acid content of the fruits (TA), since acids are important substrates for respiratory metabolism. However, the coated sample showed a minimal increase in the values of the total soluble solid content, compared to the control sample. The lowest SSC at the end of the storage period was registered in fruits coated with an EC2 treatment (7.90°Brix) that provided an excellent semipermeable film modifying the internal atmosphere by reducing the ethylene production. Decreased respiration rates also slow down the metabolite use and the fruit ripening [51]. Biale [52] asserted that an increase in SSC in the flesh and the peel was observed when the fruits reach their climacteric respiration peak. In particular, the EC2 treatment showed almost gradual linearity with the lowest maximum values compared to the other treatments, on the 12th day of storage. Similar results have been reported from Li et al. [53] on the edible coating for fresh-cut kiwis and from Cortez-Vega et al. [54] on fresh-cut papaya.

The titratable acidity (TA) decreases both in the fruits subjected to coating treatments and in the untreated fruits (CTR), starting from the same value (1 g citric acid/L) (Figure 2). At 5°C and 90% RH, the fruits show a similar tendency with the TA parameter decreasing linearly over the storage period. The EC1 treatment differs from the others in that it shows a constant trend in the range of time from 0 to 6 days; from day 6 to day 12, a decreasing trend begins. The EC2, EC3, and EC4 treatments show more or less the same values during the whole storage period; the CTR is characterized by rather lower values in the storage period (0–12 days), with much lower values than the treated fruits on the 12th day. Here, the TA value did not seem to be influenced by treatment. Manganaris et al. [55] reported that calcium chloride dips did not produce any effects in TA% in fruit of peaches, but titratable acidity is directly related to the concentration of organic acids present in the fruits, which are substrates for enzymatic respiration reactions [56]. Ahmed et al. [28] and Marpudi et al. [4] reported that the TA decreases and the SSC increases in nectarines and papaya coated with *Aloe vera* gel, during storage time. This difference in the TA and SSC values is most likely due to the difference in the types of fruit and whether they were cut or whole.

During the 12 days of storage, the application of the EC helped to preserve the color attributes (Figure 3) of the analyzed fresh-cut papaya. Concerning lightness (L^*), throughout the time, the coated samples showed higher values than the controls. Regarding chroma (C), the measured parameters indicate that the saturation decreases during the storage period, so the samples tend to become darker and tending to grey (55%). A more marked decrease in saturation values is found in the papaya slices of the EC3 treatment, probably due to the presence of K carrageenan which provides an oxygen barrier and manages to reduce the respiratory rate and maturation leading to the delay of activities that cause the reduction of chroma values [57]. In addition, Martínez-Romero et al. [24] show that the color values are better in fruits treated with *Aloe vera* gel than in untreated fruits. During the storage period, a color change from warmer to colder tones was observed, which was more

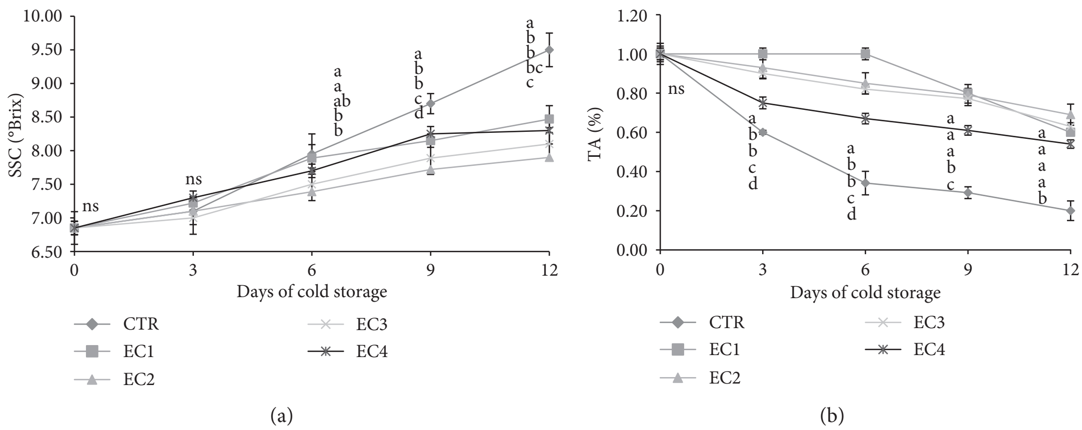


Figure 2: Trend in the soluble solid content (°Brix) and titratable acidity (%) of fresh-cut stored papaya. Values were recorded at 0, 3, 6, 9, and 12 days at 5°C and RH 90%. Significant values are indicated with equal letters in each step.

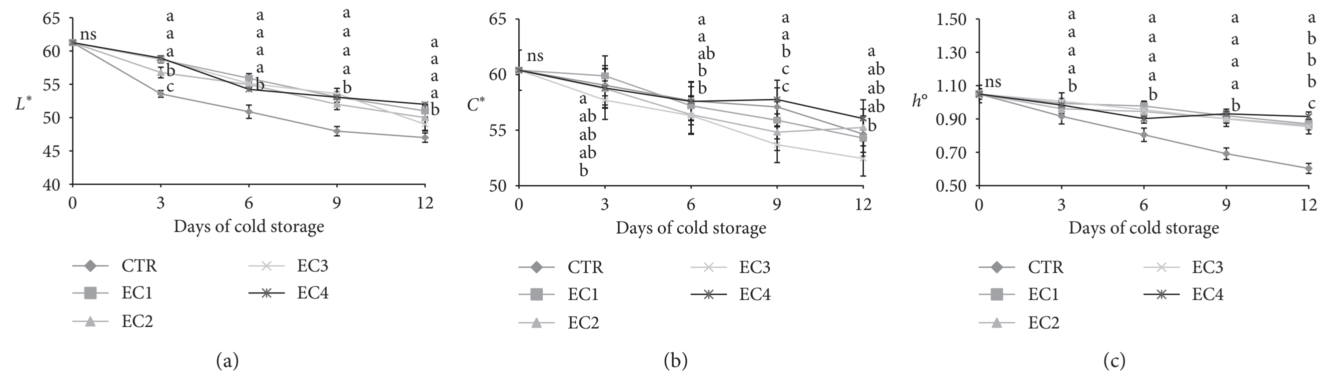


Figure 3: Brightness (*L*), chroma (*C*), and hue angle (*h*°) trends of papaya fresh-cut fruits during storage at 5°C and 90% RH. Significant values are indicated with equal letters in each step.

evident in the untreated papaya slices. In fact, as can be seen in the figure, CTR fruits suffer a greater decrease in hue angle (*h*°) values than fruits treated with EC, which instead have an almost similar and constant trend throughout the storage period. This behavior could be attributed to the presence of ascorbic acid and citric acid added in the coating formulations. These acids act as antibrowning agents. González-Aguilar et al. [58] studied color changes of fresh-cut pineapple treated with antibrowning agents for 16 days at 10°C and they reported that isoascorbic acid, ascorbic acid, or acetylcysteine significantly reduced ($p < 0.05$) the changes in the values of L^* and h° compared with the control. Moline et al. [59] found that the combination of citric acid and ascorbic acid was effective in reducing the browning of fresh-cut bananas. These results, in fact, show that the treatment with EC reduces the loss of color of the fruit and preserves it longer during cold storage.

Furthermore, the O_2 and CO_2 contents (Figure 4) were determined in the trays: concerning the evolution of oxygen, during the 12 days of storage at 5°C and RH 90%, it decreased both in the treated fruits and in the CTR. As shown in the figure, the initial values of O_2 are similar for both CTR and treated fruits, while on the 12th day of storage the values decreased by 3-4% for the fruits that have benefited from the various treatments. In particular, EC2 is the most effective treatment. This behavior can once again be attributed to the presence of Ca^+ ions which are involved in the reduction of the respiration rate and metabolic processes of the fruits [60]. In the CTR, on the other hand, there is a rather rapid decrease, in fact on the 12th day, and halved values are recorded, due to the normal ripening process of the fruits. This shows that the fruit, at the end of the storage period, has a minimum respiratory activity because the oxygen has almost completely been consumed. Considering that O_2 levels are complementary to CO_2 levels, fruits have a lower respiration rate due to the high presence of CO_2.

Concerning the evolution of carbon dioxide in the fresh-cut papaya fruits, it increases both in the four treatments and in the CTR, starting from initial values of CO_2 close to 0%, the same for all. The best final CO_2 values were recorded in the fruits treated with EC2, according to Ferguson [60], Maftoonazad, and Ramaswamy [61] and Alonso and Alique [62]. Narsaiah et al. [36] confirm that the alginate associated with the edible coating forms a barrier to gas exchange. The other treatments have similar values. The CTR, on the other hand, shows a higher production of CO_2 on the 12th day.

Finally, concerning sensory analysis (Figure 5) carried out by panelists, immediately after the transformation of

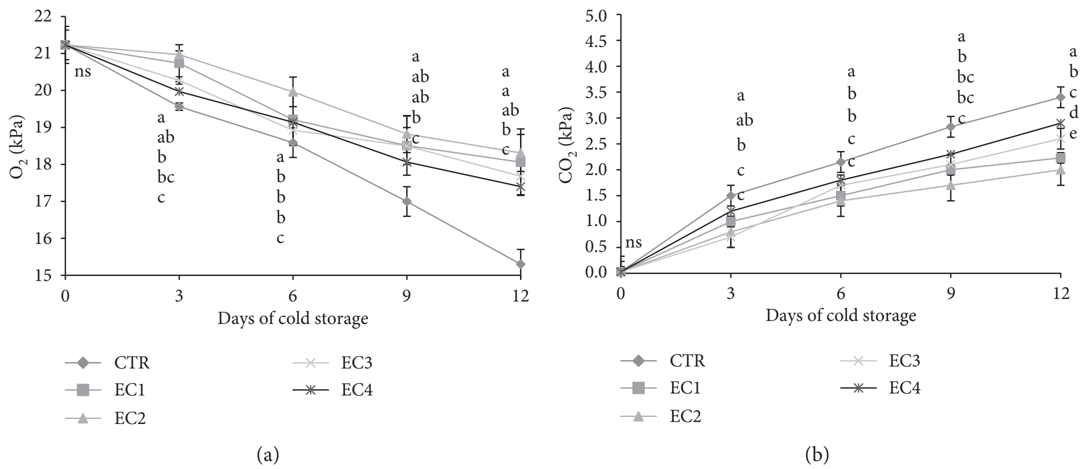


Figure 4: O_2 (kPa) and CO_2(kPa) trend of papaya fresh-cut fruits during storage at 5°C and 90% RH. Significant values are indicated with equal letters in each step.

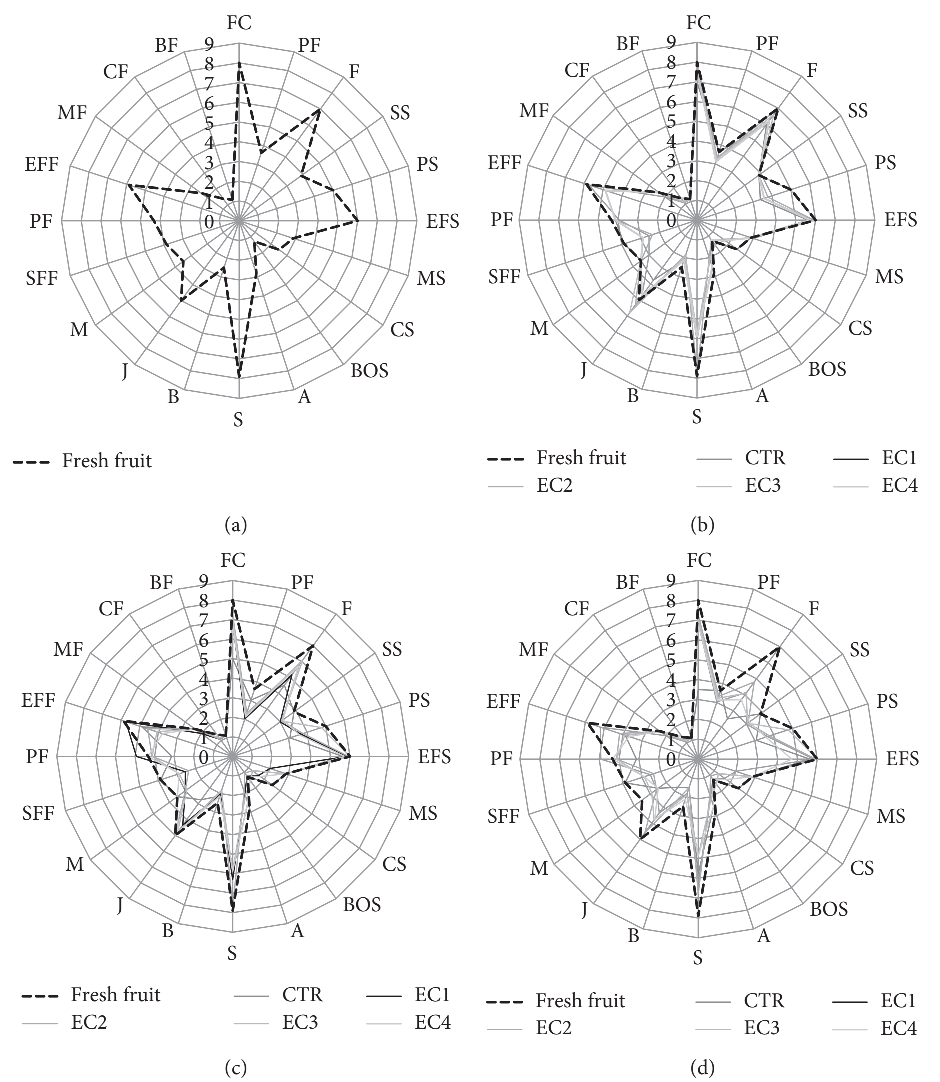
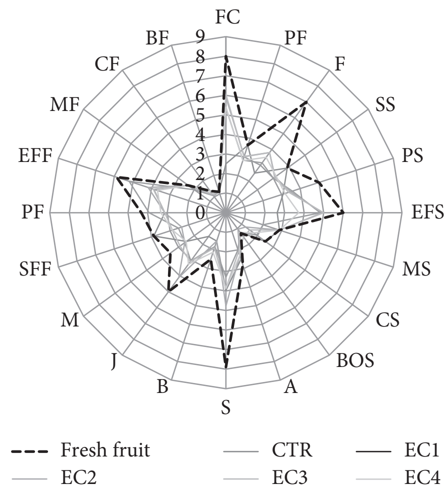


Figure 5: Continued.



(e)

Figure 5: Sensory profile of papaya fruits after (a) 0 (T0), (b) 3 (T3), (c) 6 (T6), (d) 9 (T9), and (e) 12 (T12) days of cold storage at 5°C and 90% RH. Flesh color (FC), presence of filaments (PF), firmness (F), smell of sea (SS), smell of peach (PS), smell of exotic fruit (EFS), smell of medicines (MS), smell of cheese (CS), smell of burnt oil (BOS), acid (A), sweet (S), bitter (B), juiciness (J), mealy (M), seafood flavor (SFF), peach flavor (PF), exotic fruit flavor (EFF), medicinal flavor (MF), cheese flavor (CF), and burnt oil flavor (BF).

fresh untreated fruits (CTR) into a fresh-cut (T0) product: the judges found an excellent flesh color, pleasant sweetness, good consistency when cut, medium juiciness, and smell and flavor of exotic fruits; they did not perceive the presence of filaments, bitter taste, smell and flavor of medicine, or smell of burnt oil.

On day 3, the sensory profile of the fruits treated according to the four treatments was compared with the CTR in order to analyze the differences. As shown in the figure, the EC2 treatment was the most effective in maintaining high values of sweetness and flesh consistency, good consistency when cut, good smell of exotic fruit, and high juiciness. All treatments showed similar results. The EC1 treatment gave the best results for exotic fruit flavor, whereas the EC3 treatment was the one that maintained the highest juiciness compared to the others. In the CTR, the results were similar, the difference was found in the consistency of the pulp and the juiciness decreases, and the fruits showed a slight off-flavor and cheese smell. After six days of storage, the coated fruit still had no defects, unlike the CTR, which is characterized by a slight odor and flavor of cheese and flouriness. Flesh firmness was maintained at optimal levels for all treatments, especially for the EC2 treatment, but decreased significantly in the CTR. The sweetness remains at the same value for all treatments, but the juiciness decreases, especially, once again, in the CTR. In the EC1 treatment, compared to other treatments, there is a greater flavor of peach and of exotic fruit. Even on day 9, the pulp firmness is maintained in optimal conditions, unlike CTR, where it decreases significantly, demonstrating the success of treatments based on edible coating. The EC2 treatment was the most suitable in terms of pulp firmness, juiciness, and sweetness. EC1 treatment continues to maintain an average peach and exotic fruit flavor value. The CTR shows the least encouraging results, as it has a slight medicinal odor, a cheese odor, and a low firmness when cut. On day 12, the firmness of the pulp is minimally reduced in the four treatments, continuing to maintain a good quality, unlike the CTR in which this parameter is limited, having suffered a reduction. The cut firmness decreased for all treatments, showing slightly better results in the EC3 treatment. Juiciness also decreases, maintaining the best results in EC2 treatment and the lowest in the CTR.

4. Conclusions

Our results demonstrated the ability of the natural *Aloe vera* gel-based edible coatings to maintain the quality characteristics of fresh-cut papaya. It is certain that the fresh-cut fruits have benefited from the effects of *Aloe vera* gel, but in particular, the presence of $CaCl_2$ (in EC2 treatment) has kept the highest values in terms of weight loss, firmness, SSC, TA, and respiration rate. On the other hand, K carrageenan and sodium alginate (in EC3 and EC4 treatments) have provided an oxygen barrier and reduced respiratory rate, increasing the firmness retention and keeping a high C^* value. Finally, sensorial analysis confirms these results and claims that the *Aloe vera* gel-based edible coating and the other added agents did not affect the natural taste of papaya.

Data Availability

The data used to support the findings of the study are available from the corresponding author upon request.

Additional Points

Highlights. (i) Four edible coatings based on *Aloe vera* gel were used in fresh-cut papaya. (ii) EC2 treatment (gellan gum 1% v/v, Aloe v. gel 30% v/v, glycerol 3% v/v, and $CaCl_2$ 5% v/v) evidenced the best results. (iii) The edible coatings form an excellent semipermeable barrier, delay senescence, and reduce the respiration rate. (iv) The natural taste of the papaya was not affected by edible coatings.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

Acknowledgments

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