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Original Research

Effect of *Aloe vera* Gel, Chitosan and Sodium Alginate Based Edible Coatings on Postharvest Quality of Refrigerated Strawberry Fruits of cv. Chandler

Jahanzaib Qamar, Shaghef Ejaz*, Muhammad Akbar Anjum, Aamir Nawaz, Sajjad Hussain, Sajid Ali and Shahzad Saleem
Department of Horticulture, Faculty of Agricultural Sciences and Technology, Bahauddin Zakariya University, Multan (60800), Pakistan

ABSTRACT

Strawberry is a non-climacteric fruit but exhibits very limited postharvest life due to rapid softening and decay. Therefore, the current study was carried out to evaluate the effects of different types of edible coatings to extend the postharvest life of strawberry fruit. The strawberry fruits of cultivar Chandler, grown under agro-climatic conditions of Multan, were coated with *Aloe vera* gel, chitosan (2%) or sodium alginate (2%) and kept in refrigerated storage at 5-7 °C with 50-60% RH for 12 days. The fruits were evaluated for sensory and biochemical quality attributes after every 4 days of storage. The results showed that overall coated fruits had prolonged storage life (8 days) as compared to non-coated fruits (4 days). *Aloe vera* gel coating maintained various quality attributes of strawberry fruits such as firmness, appearance, TSS (6.8°Brix), titratable acidity (1.14%), pH (3.27), ascorbic acid content (76 mg 100 mL^{-1}), antioxidant activity (93%), anthocyanins (104 mg PE 100 g^{-1} FW) and total phenolic content (369.45 µg GE mL^{-1}). Generally, all coatings prohibited the decay incidence. The results showed that edible coatings based on *Aloe vera* gel can be used as an effective alternative for other costly and synthetic chemicals.

Keywords: *Biochemical quality, Fragaria ananassa, polysaccharide-based coating, storage life.*

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INTRODUCTION

Strawberry (*Fragaria ananassa* Duch.) is one of the most liked fruits in the world due to its pleasant color, shape and aroma (Hu et al., 2012). Strawberries are vital source of many health promoting nutritious compounds such as vitamins C and E, anthocyanins and *β*-carotene (Van De-Velde et al., 2013). The antioxidants and polyphenolic compounds in strawberries can be useful in curing various types of cancers, suppressing premature aging and improving immunity system in humans (Ahmed et al., 2013).

Total postharvest losses of fruits and vegetables range from 25 to 40% in various countries, rising up to 60% in perishable commodities in developing countries that cause a huge financial loss to farmers (Ahmed et al., 2013). Strawberry fruits are highly perishable and prone to postharvest losses mainly owing to a sharp increase in water loss, respiration rate and tissue softening after harvest. Moreover, loss in fruit quality exaggerates due to high cellular metabolic activities and sensitivity to fungus such as *Botrytis cinerea* that cause gray mold (Hernandez-Munoz et al., 2006). Therefore, for extending the postharvest life of strawberry fruits, many preservation techniques are being used that includes hot water treatment (Villa-Rojas et al., 2011), irradiation (Jouki and Khazaei, 2014), hypobaric storage (Hashmi et al., 2013), chemical treatments (Hu et al., 2012), bio-based packaging (Aday and Caner, 2013), ultrasound technique (Aday et al., 2013) and edible coating (Wang and Gao, 2013). Edible coatings could be used to preserve the quality attributes of fresh or slightly processed fruits and vegetables. The edible coating acts as a barrier to moisture and gases and restricts the respiration process and loss of moisture (Rojas-Graü et al., 2009).

The gel, extracted from *Aloe vera* leaves, is considered as biologically active as it comprises of various antioxidant and antibiotic properties (Vega-Gálvez et al., 2011). *Aloe vera* gel contains various antibiotic and antifungal properties which can restrict the growth of numerous microbes responsible for the diseases and spoilage of food commodities. Because of antifungal and antibacterial properties, *Aloe vera* gel is recently being used as an efficient ingredient in various food products. *Aloe vera* gel can also be used as edible coating to enhance the storage life of various fruits and vegetables (Lin and Zhao, 2007). *Aloe vera* gel has now achieved much importance to be used as an efficient ingredient in processed food commodities because it is non-toxic and environment friendly. It delays the ripening process and exerts beneficial effects on fruit quality of peaches and plums (Guillén et al., 2013). Alginate is derived from brown marine algae and is a natural polysaccharide. It is widely used as an edible coating due to its extraordinary colloidal possessions (Acevedo et al., 2012). Sodium alginate can be used to enhance the shelf life of pear fruits as it retards the weight loss and can conserve the total soluble solids (TSS)

* Corresponding author. Telephone: +92 335 6683409
E-mail: shaghef.ejaz@bzu.edu.pk (S. Ejaz)

and pH (Moraes et al., 2012). Alginate may be utilized to enhance the antioxidant activity of sweet cherries (Díaz-Mula et al., 2012). It is an extraordinary compound because of being inexpensive, biocompatible, biodegradable and non-toxic (Vu and Won, 2013). Chitosan is a natural carbohydrate polymer obtained by deacetylation of chitin. It has attained a great consideration as utilized in chemicals, food commodities and in medicine (Sudarshan et al., 1992). It can be utilized as edible coating to improve the shelf life of food commodities as it is transparent, biocompatible, film forming, non-toxic and biodegradable compound (Pillai et al., 2009).

Edible coatings are comprised of edible compounds such as lipids, proteins and polysaccharides and can be consumed as a part of food (Cagri et al., 2004; Fakhouri et al., 2015). These coatings enhance shelf life of food commodities by refining their internal atmosphere. These act as a semipermeable barrier and reduce respiration and transpiration rates and hence retards senescence (Gao et al., 2015). However, there is not much information available about the performance of different edible coatings for extending postharvest life of fruits of strawberry cultivars grown in sub-tropical climates. Therefore, this study was designed with the objective of comparing edible coating formulations comprised of *Aloe vera* gel, chitosan and alginate to improve postharvest life of fruits of strawberry cultivar Chandler grown in agro-climatic conditions of Multan.

MATERIALS AND METHODS

Plant Material

Fresh strawberry fruits were harvested from a local farm located near Chenab River, Multan during 2015-16. The fruits were picked using color maturity index of ≥75% skin red color. The selected fruits were uniform in size and shape and free from any sign of visible mechanical damage, blemishes, decay or disease. The harvested strawberries were disinfected by immersing in 250 mg L^{-1} NaOCl for 30 sec. and then rinsed with distilled water. The fruits were then dried at room temperature.

Experiment Design and Layout

The experiment was laid out rendering completely randomized design having two factors (edible coating and storage days) and three replications. The edible coatings used were *Aloe vera* gel, chitosan and sodium alginate; whereas, control treatment comprised of non-coated fruits. The treated fruits were evaluated for their quality attributes on day 0, 4, 8 and 12.

Preparation of Chitosan Coating

Chitosan coating solution (100 mL) was prepared by adding 0.5% acetic acid (500 µL) to 1g of chitosan (M.W. 100,000-300,000, and 70–85% deacetylation degree, Avonchem Ltd., UK,) in distilled water. The solution was stirred at 70 °C for 30 min and its pH was adjusted to 5.6 with 1 N NaOH. Afterwards, 2 g of glycerol was added as plasticizer.

Preparation of *Aloe vera* Gel Solution

Mature *Aloe vera* leaves were taken from the botanical garden located at Bahauddin Zakariya University, Multan. The leaves were washed with 2% NaOCl for surface disinfection and then rinsed with distilled water. Colorless gel was extracted by peeling the cortex of *Aloe vera* leaves (~1 kg) and then blended. The gel mixture was filtered through muslin cloth to remove the fibers. After that, this solution was pasteurized at 70 °C for 45 min. The gel was cooled immediately, and the pH was adjusted to 4 as suggested by Marpudi et al. (2011).

Preparation of Sodium Alginate Solution

Sodium alginate (food grade) based edible coating was prepared by dissolving 20 g sodium alginate in 1 L distilled water while constant stirring at 70 °C until the solution became clear (Moayednia et al., 2010). The solution was cooled at room temperature and then used for coating. Further, 2% calcium chloride solution was prepared to induce cross-linking reaction.

Coating Application and Storage

The strawberry fruits were distributed in 4 groups and each group of fruits was dipped in respective coating solution for 2 min. Control treated fruits were immersed only in distilled water. After coating application, the fruits were air dried for 2 h. Each group was subdivided into three replications. The fruits were packed in transparent plastic boxes and each box consisted of 20 fruits. The boxes were weighed and then stored at a temperature of 5-7 °C with 50-60% RH in refrigerator. Fresh fruits were analyzed for their quality on day 0.

Attributes Studied

Following physical, organoleptic and biochemical attributes were measured.

Weight loss

Fruits were weighed and the percent weight loss on the given days was observed till the end of experiment.

Sensory Evaluation

Sensory evaluation was carried out for color, firmness, glossiness, aroma, decay incidence and general appearance by using a 9-point hedonic scale and expressed in scores (Sivakumar and Korsten, 2010). Sensory evaluation was conducted by a panel consisting of 8-10 members.

Evaluation of Biochemical Properties

Following chemical properties were examined during experiment on each given day.

Juice pH

Digital pH meter was used to evaluate the pH of strawberry fruit juice.

Total Soluble Solids

Total soluble solids (TSS) was measured by using hand refractometer and the values were noted in °Brix.

Titratable Acidity

Titratable acidity (TA) of the samples was measured as suggested by Hortwitz (1960). Fruit juice was titrated against 0.1N NaOH and TA was determined by using following formula.

$$\text{Titratable acidity (\%)} = \frac{0.1\text{ N NaOH used} \times 0.0064}{\text{mL of juice used}} \times 100$$

Ripening Index

The ratio of TSS to TA was taken as ripening index as suggested by Pešaković et al. (2013).

Ascorbic Acid Content

Fruit juice sample was added to 0.4% oxalic acid solution and the solution was then filtered. The 5 mL aliquot was titrated against 2, 6-dichlorophenolindophenol dye (Ruck, 1963).

Total Anthocyanins

Total anthocyanins were measured by using method of Nunes et al. (2005). Homogenized aliquot 2 g was mixed with 0.5% 18 mL HCl in methanol and kept for 1 h so that pigments could be extracted. The solution was filtered, and the filtrate was analyzed at an absorbance of 520 nm. Total anthocyanins were evaluated using the following formula and the results were articulated as mg pelargonidin equivalent (PE) 100 g^{-1} fruit fresh mass.

Total anthocyanins= A_{520} × Dilution Factor × M.W. of pelargonidin × Molar extinction coefficient

Where; molecular weight of pelargonidin = 433.2, extinction coefficient = 2.908×10^4

Total phenolic content

Phenolic content was analyzed using Folin-Ciocalteu's reagent method described by Gorinstein et al. (2001). Homogenized sample was centrifuged at 10,000 rpm at 4 °C for 15 min. The supernatant (0.2 mL) was separated and kept at -20 °C until analysis. Sample supernatant was added to the mixture of Folin-Ciocalteu reagent and 7.5% of 0.8 mL Na_2CO_3 solution. Distilled water was added to make the volume 10 mL and the absorbance was measured at 765 nm. Total phenolic content was expressed as µg gallic acid equivalent (µg GE/mL) fruit juice.

Antioxidant activity (%)

Antioxidant activity was evaluated according to the method advised by Shimada et al. (1992). Methanol was added to strawberry fruit juice and shaken in volumetric flask on a water bath for 120 min. Then the solution was concentrated up to the volume of 10 mL by rotary evaporator. Methanolic extract (1 mL) along with 1 mL 0.2 mM DPPH was taken in a test tube and mixed on a shaker. Absorbance of the reaction mixture was noted at wavelength of 571 nm using spectrophotometer (BMS, UK). Methanol was used as blank whereas DPPH with methanol was used as control. Antioxidant activity was evaluated using the following formula.

$$\text{Antioxidant activity (\%)} = \frac{A_0 - A_1}{A_0} \times 100$$

Where, A_0 = Absorbance of control, A_1 = Absorbance of sample

Statistical Analysis

Statistical software Statistix® version 8.1 (Tallahassee Florida, USA) was used to analyze the data. Means of the treatments were separated by the LSD (least significant difference) test at α=0.05.

RESULTS AND DISCUSSION

Weight Loss

Overall, there was loss of weight in all the fruits after storage (Fig. 1). At the end of the experiment, *Aloe vera* gel coated fruits showed significantly reduced weight loss (13%) compared to chitosan (CH) and sodium alginate (NaA) coated fruits (16 and 20%, respectively). However, the maximum loss was shown by non-coated fruits (27%). Edible coatings improve shelf life of strawberry by creating a physical barrier for water evaporation and restrict the dehydration and fruit senescence (Almenar et al., 2007). Moraes et al. (2012) observed that sodium alginate film acts as a water permeable membrane and less water evaporates from the surface ultimately leading to reduced weight loss of the treated fruits. Miguel et al. (2009) also noted that grapes coated with alginate conserved the weight of fruits.

Sensory Evaluation

Color

Fruit color is the most important factor which describes the fruit general quality. Edible coatings and storage days have significant effects on color of strawberry fruits (Table 1). By day 8, *Aloe vera* gel coating significantly retained color (11% loss) as compared to CH and NaA (22% loss), whereas non-coated fruits showed the maximum loss in color (44%). However, on day 12, all coatings were statistically similar to each other in color and significantly differed from control. Increased weight loss and enzymatic processes cause loss of fruit quality due to reduction in visual quality. *Aloe vera* gel coated strawberry fruits were more capable to preserve their various physico-chemical attributes mainly color and firmness (Sogvar et al. 2016). Similarly, *Aloe vera* gel coated sweet cherries showed higher hue values for longer time period at low temperature suggesting anti-browning functionality of *Aloe vera* gel coating (Martínez-Romero et al., 2006).

Firmness

The result showed that coatings and storage days had significant effect on fruit firmness. Fruit firmness decreased with increasing storage time. During the first 4 days, significant difference in firmness of fruits started to appear as *Aloe vera* gel coated and chitosan-treated fruits showed the firmest fruits followed by NaA treated and untreated (control) fruits (Table 1). Also, by day 8, *Aloe vera* gel coating maintained the maximum firmness (33% loss); whereas, non-coated fruits had the lowest firmness showing 60% loss in the firmness.

Strawberries lose their firmness during postharvest storage, which is the main cause of shorter shelf life. *Aloe vera* gel coating reduces rate of fruit softening by minimizing metabolic activity and ripening process as it acts as a barrier for O_2 uptake (Sogvar et al., 2016). Hernandez-Munoz et al. (2006) also observed that organic coatings such as chitosan keeps the strawberry fruits firmer as compared to no coating. This is because chitosan is a selective gas barrier to O_2 and CO_2 which modifies the internal atmosphere of fruits and thus reduces their respiration rate.

Glossiness

By day 8, the maximum loss in glossiness was shown by untreated (control) fruits (60%) as compared to coated ones (30±2%). On day 12, all coated fruits showed less but equal loss in glossiness (~27%) as compared to non-coated (80%) fruits (Table 1). Edible coatings based on alginate adheres to strawberry fruit skin that results in increase in glossiness and bright appearance (Moayednia et al., 2010). Martínez-Romero et al. (2006) applied different coatings on sweet cherries and cold stored the fruits for 16 days. They concluded that *Aloe vera* gel coated sweet cherries maintained their glossiness and were brighter at the end of experiment.

Aroma

By day 4, *Aloe vera* gel coated fruits showed no loss of aroma and significantly differed from all other treatments (Table 1).

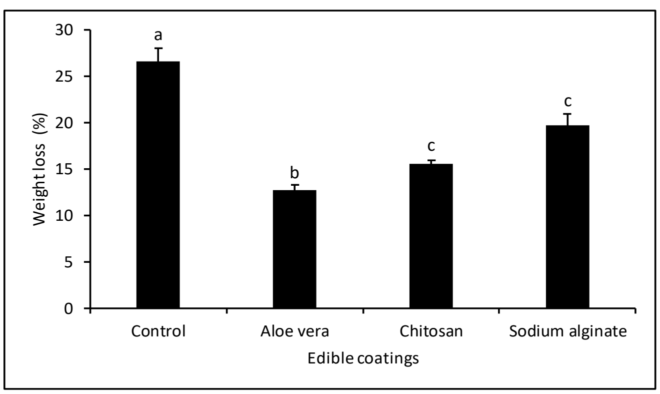

Figure 1: Effect of edible coating on weight loss of strawberries coated with *Aloe vera* gel, chitosan and alginate-based formulations after 12 days of refrigerated storage A vertical bar at the columns indicates standard error of different means, while columns sharing similar letter(s) are statistically similar at $p \leq 0.05$ (LSD test).

By day 8, *Aloe vera* gel coating and NaA treated fruits retained the maximum aroma followed by CH treated fruits, whereas non-coated fruits showed the maximum aroma loss. However, on day 12, all coatings were statistically similar to each other in preserving aroma but different to control which showed the greater aroma loss. Serrano et al. (2006) applied *Aloe vera* gel coating on table grapes to evaluate its effect on the sensory characters of fruits. They observed that, after 21 days of storage, non-coated fruits developed off-flavor along with unpleasant aroma; whereas, *Aloe vera* gel coated grapes were still marketable and aromatic.

Decay Incidence

On day 4, there was no sign of visible fungal infestation in *Aloe vera* gel coated and CH treated fruits which were significantly different from most infested NaA coated and non-coated fruits (Table 1). Similar trend continued till the end of the experiment, whereby all coated fruits showed statistically similar reduced decay incidence (30%) as compared to non-coated fruits (~47%) at the end the experiment. *Aloe vera* contains bioactive components such as phenol and quinones and these are responsible for its anti-fungal activity. Some other components present in *Aloe vera* are saponins, anthraquinones derivatives and acemannan, considered to be responsible for its anti-bacterial activity (Sarabia et al., 1999). Castillo et al. (2010) described that *Aloe vera* gel can restrict the growth of some pathogens such as *Penicillium digitatum* and *Botrytis cinerea*. Reynolds and Dweck (1999) described that *Aloe vera* gel can inhibit growth of numerous types of bacteria. El Ghaouth et al. (1992) investigated the effect of CH coating on pathogens infecting strawberry fruits; CH was lethal to mold cells, halted the polygalacturonases secretions and induced enzymes related to defense mechanism.

Overall Acceptability

The edible coatings and storage days have significant effect on overall acceptability of strawberry fruit (Table 1). On day 8, overall acceptability was statistically similar in all coated fruits. However, non-coated fruits showed the maximum loss (up to 47%) and were not acceptable. Coatings can extend shelf life by conserving firmness of fruits. *Aloe vera* gel acts as a barrier to retard the uptake of O_2 and restricts the metabolic activity ultimately maintaining overall acceptability (Sogvar et al., 2016). *Aloe vera* gel coating can conserve the pleasant aroma and shiny appearance of table grapes (Serrano et al., 2006) and sweet cherry (Martínez-Romero et al., 2006). Vu et al. (2011) reported CH coated strawberry fruits maintained their red color and glossiness till 21 days during storage as compared to non-coated strawberries which lost their appearance due to molds infestation rather on 10^{th} day.

Juice pH

A significantly increasing trend was observed in juice pH of fruits during the experiment. During the first 4 days, no significant difference was observed among treatments (Fig. 2A). On day 8, *Aloe vera* gel coated fruits showed significantly least change (1%) as compared to other treatments (≥4%). By day 12, *Aloe vera* gel coated fruits showed the least change in

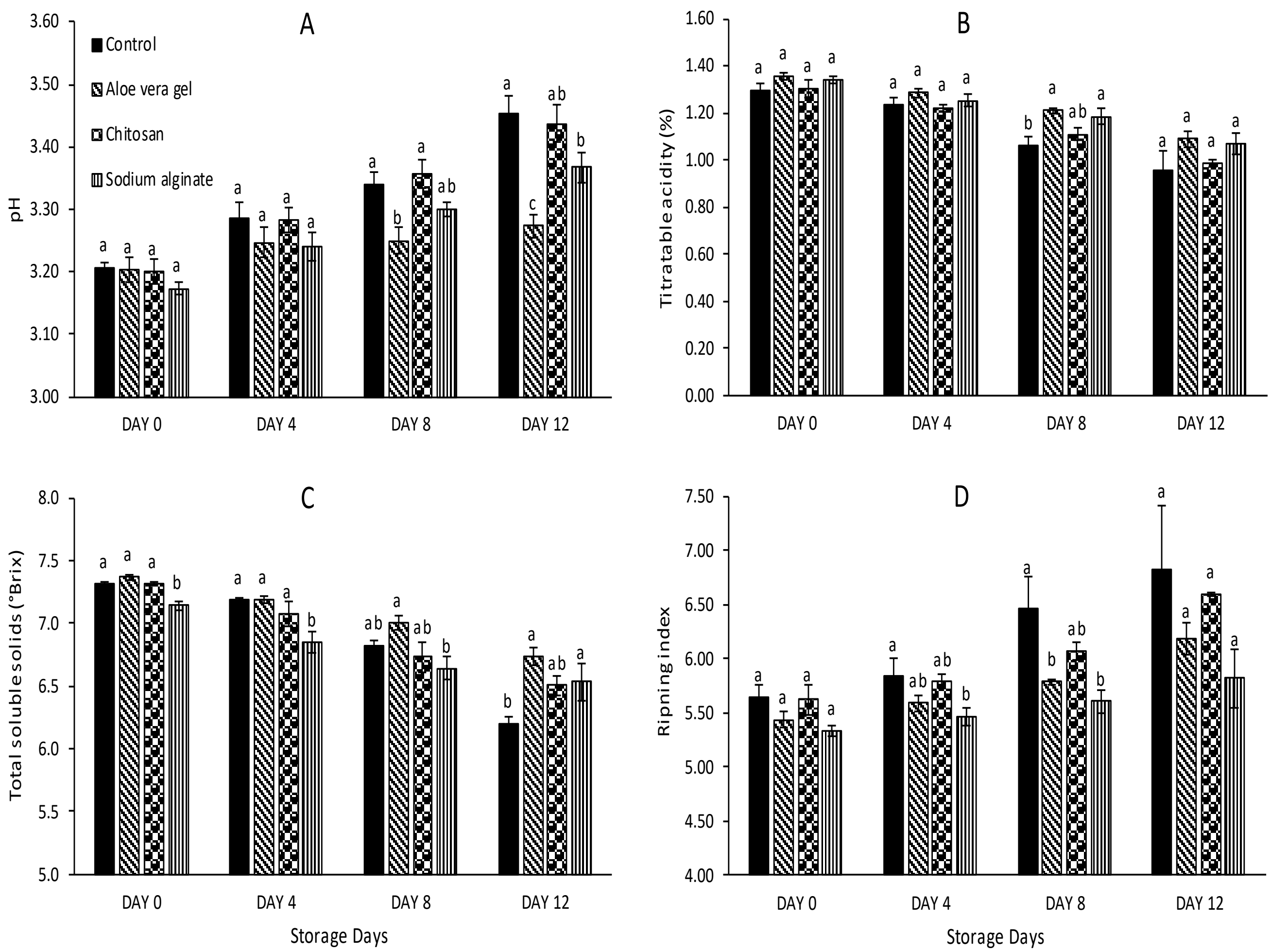

Figure 2: Effect of edible coating and storage days on (a) pH, (b) titratable acidity, (c) total soluble solids and (d) ripening index of fresh strawberries coated with *Aloe vera* gel, chitosan and alginate-based formulations. A vertical bar at the columns indicates standard error of different means, while columns sharing similar letter(s) separately for each storage day are statistically similar at $p \leq 0.05$ (LSD test).

pH (2%) followed by NaA (6%) as compared to CH coated and non-coated fruits (7 and 8%, respectively). Vieira et al. (2016) reported that blueberries when coated with *Aloe vera* gel conserved their pH in contradiction with non-coated ones. Moreover, Benítez et al. (2013) found that kiwi fruits coated with *Aloe vera* gel preserved their pH till 12th day of storage. Sophia et al. (2015) explained that *Aloe vera* gel coating create permeable surface on the fruit skin and can improve the internal atmosphere. Ahmed et al. (2013) observed that alginate coated strawberry fruits retained their pH during storage. However, non-coated fruits showed significant change in pH of fruit juice.

Titratable Acidity (TA)

Until day 4, there was no significant effect of treatments on TA (Fig. 2B). However, on day 8, non-coated fruits showed the least TA. The minimum reduction in TA, at the end of experiment, was noted in *Aloe vera* gel and NaA treated fruits (20%) as compared to non-treated and CH treated fruits (26 and 24%, respectively). Sogvar et al. (2016) stated that decrease in TA of fruits during storage might be due to metabolic activities within the tissue. Whereas, *Aloe vera* gel modifies the internal atmosphere. The results are in line with the findings of Benítez et al. (2013), Vieira et al. (2016) and Guillén et al. (2013) who observed that *Aloe vera* gel coating conserved the concentration of TA in kiwifruit, blueberries, peach and plum fruits, respectively.

Total Soluble Solids (TSS)

The results revealed that TSS decreased with the increase in the number of storage days. Regarding the coatings, there was no significant difference among coatings at the end of experiment (Fig. 2C). However, non-coated fruits showed the significantly least TSS on day 12 as compared to coated fruits. Athmaselvi et al. (2013) proposed that TSS retention in coated fruits always remain higher as compared to non-coated fruits,

Table 1: Effect of edible coatings on the strawberry fruit under refrigerated storage.

Attributes	Storage period (days)	Control	*Aloe vera* gel	CH	NaA
Color	4	33.3 a	0.0 c	11.1 b	11.1 b
	8	44.4 a	11.1 c	22.2 b	22.2 b
	12	66.6 a	44.4 b	44.4 b	44.4 b
Firmness	4	20.00 a	6.7 c	20.0 a	13.3 b
	8	60.00 a	33.3 b	40.0 b	40.0 b
	12	73.3 a	46.7 b	53.3 ab	46.7 b
Glossiness	4	33.3 a	11.1 b	15.0 b	0.0 c
	8	60.0 a	30.0 b	33.3 b	28.0 b
	12	80.0 a	53.3 b	53.3 b	53.3 b
Aroma	4	6.7 a	0.0 b	6.7 a	6.7 a
	8	42.0 a	20.0 c	33.3 b	22.7 c
	12	66.7 a	40.0 b	46.7 b	46.7 b
Decay incidence	4	6.7 b	0.0 c	0.0 c	13.3 a
	8	33.3 a	13.3 b	13.3 b	20.0 ab
	12	46.7 a	26.7 b	26.7 b	33.3 b
Overall acceptability	4	13.3 a	6.7 b	13.3 a	6.7 b
	8	46.7 a	18.0 b	18.0 b	12.0 b
	12	66.7 a	46.7 b	46.7 b	53.3 ab

* Means sharing similar letter(s) within a row are statistically similar at $p \leq 0.05$ (LSD test).

possibly, due to breakdown of carbohydrates and pectin and partial protein hydrolysis. Sophia et al. (2015) concluded that when mangoes were coated with *Aloe vera* gel, their TSS was preserved possibly due to delayed ripening.

Ripening Index

Coated fruits maintained the ripening index until day 8as compared to non-coated fruits. On day 8, a significant increment was found in non-coated fruits (14%) as compared to the *Aloe vera* gel and NaA coated fruits (Fig. 2D). Overall, between day 0 to 12, the minimum increment in ripening index was found in NaA coated fruits (9%) as Guillen_2013compared to the maximum in non-coated fruits (21%). Guillén et al. (2013) also observed that peach and plum fruits coated with *Aloe vera* gel revealed less increase in ripening index as compared to non-coated ones. *Aloe vera* coating could produce a modification of the internal atmosphere in coated fruits as compared to the non-coated fruits (Martínez-Romero et al., 2006). Moreover, edible coatings were found to be useful for maintaining ripening index in starch-coated strawberry (Mali and Grossmann, 2003) and chitosan coated strawberry (Petriccione et al., 2015).

Ascorbic Acid Content

Edible coatings significantly retained ascorbic acid content throughout the experiment. All coatings were statistically similar in retaining ascorbic acid content (Fig. 2A). On 8th and 12th day, non-coated fruits showed significantly lesser ascorbic acid contents (71 and 61 mg/100 mL, respectively) as compared to coated fruits (76 and 73 mg/100 mL, respectively). The reason for the loss of ascorbic acid content could be autoxidation, a spontaneous oxidation of ascorbic acid in the presence of oxygen (Owusu-Yaw et al., 1988). *Aloe vera* conserved the ascorbic acid contents effectively in comparison with non-coated fruits and other treatments due to reduction in its oxidation. Sogvar et al. (2016) demonstrated that *Aloe vera* gel coating can conserve the ascorbic acid content as it works as a permeable surface and restricts the gases exchange. Similarly, edible coatings based on chitosan have found to be retarding vitamin C content in strawberry fruits as compared to the non-coated fruits (Wang and Gao, 2013). Ahmed et al. (2013) found that when strawberry fruits were coated with alginate-based coating, it resulted in reduced rate of decrease in ascorbic acid content. However, comparatively, a quick decline in ascorbic acid content was observed in non-coated fruits.

Total Phenolic Content

Until day 4, all treatments showed no significant effect on total phenolics content. By day 8, non-coated fruits showed significant loss (21%) of phenolics as compared to coated fruits (13 %) as shown in Figure 3B. Likewise, on day 12, non-coated fruits showed the lowest phenolics content (315 µg GE/mL) as compared to *Aloe vera* geland NaA coated fruits (365 and 357 µg GE/mL, respectively) that was followed by CH coated fruits (344 µg GE/mL). Sogvar et al. (2016) demonstrated that phenolic content decreased with the passage of storage days but this reduction in phenolic content was lesser in *Aloe vera* coated fruits as compared to non-coated ones. Serrano et al. (2006) also observed that grapes coated with *Aloe vera* gel preserved their phenolic content and other quality attributes during post-harvest storage.

Total Anthocyanins

With the passage of storage time, anthocyanins content in non-coated fruits significantly increased compared to coated fruits. By day 8, fruits coated with *Aloe vera* gel showed the least change in total anthocyanins compared to fruits coated with CH and NaA (Fig. 3C). However, the differences among the coatings for anthocyanins content were statistically non-significant. Mullen et al. (2002) argued that anthocyanins are responsible for the red and blue color in horticultural products. Sogvar et al.

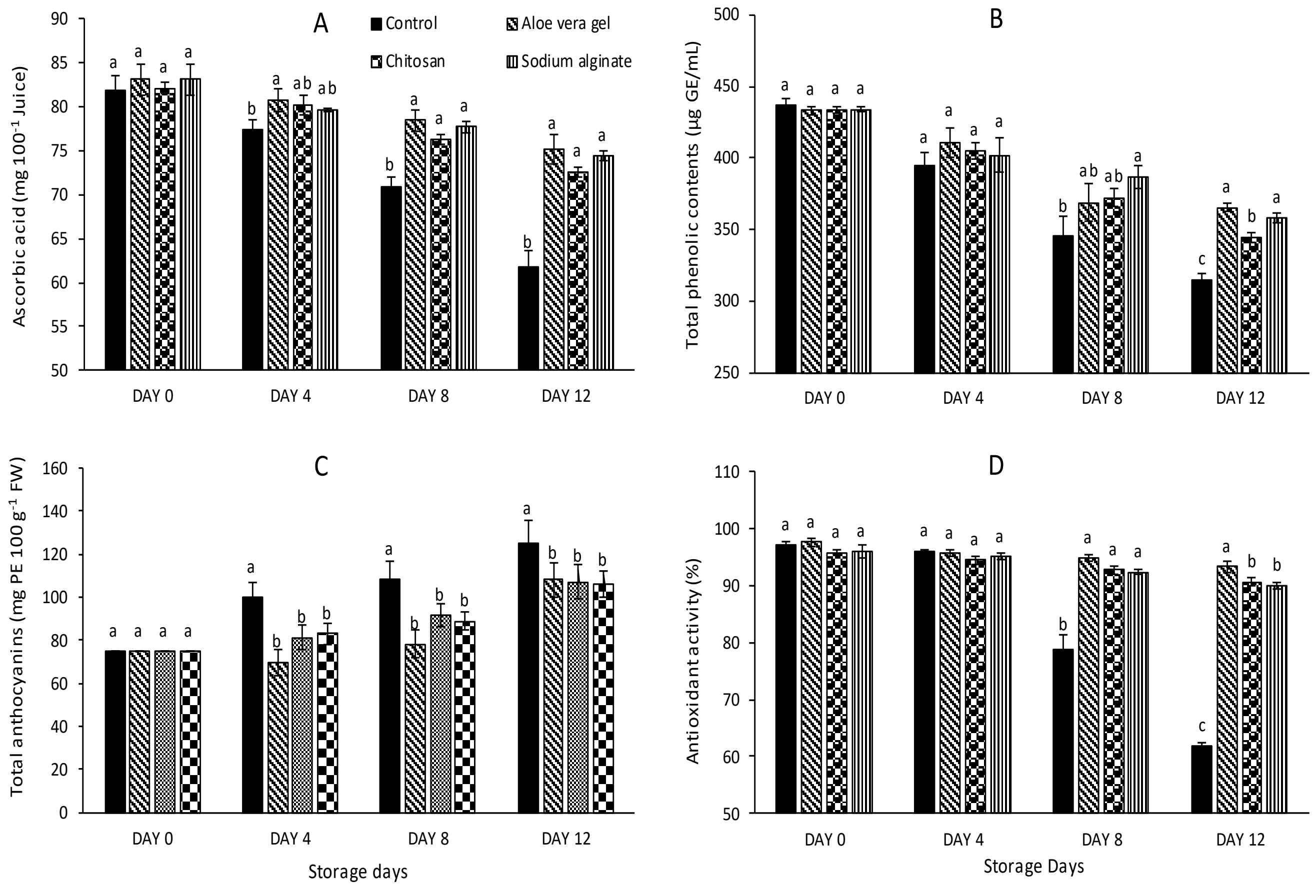

Figure 3: Effect of edible coating and storage days on (a) ascorbic acid, (b) total phenolics and (c) total anthocyanins and (d) antioxidant activity of fresh strawberries coated with *Aloe vera* gel, chitosan and alginate-based formulations. A vertical bar at the columns indicates standard error of different means, while columns sharing similar letter(s) separately for each storage day are statistically similar at $p \leq 0.05$ (LSD test)

(2016) observed that the increase in anthocyanin content with the number of storage days might be due to continuous biosynthesis of these compounds during postharvest storage. Hassanpour (2015) and Serrano et al. (2006) have reported less change in anthocyanin content in fruits of raspberry and table grapes coated with *Aloe vera* gel.

Antioxidant Activity

By day 4, there was no difference in antioxidant activity across all the treatments. But on day 8, non-coated fruits showed significant loss in antioxidant activity (19%) as compared to the coated fruits (3%) (Fig. 3D). This trend continued till the end of the experiment, whereby non-coated fruits had the minimum antioxidant activity (62%) compared to coated fruits (91%). *Aloe vera* gel coating was effective to preserve the antioxidant activity in strawberry fruits as compared to other treatments. Hu et al. (2005) described that *Aloe vera* gel coating can improve antioxidant system which may enhance the immunity of tissue from deterioration. Same results were obtained by Sogvar et al. (2016), they observed that *Aloe vera* gel and ascorbic acid coated fruits showed less decrease in antioxidant activity. *Aloe vera* gel coating application has also been found to be good for maintaining antioxidant activity in grapes (Serrano et al., 2006) and raspberry (Hassanpour, 2015).

CONCLUSION

In conclusion, *Aloe vera* gel based edible coating can be used to enhance the post-harvest life of strawberry fruits by conserving various quality attributes such as firmness, appearance, TSS, TA, pH, ascorbic acid content, antioxidant activity, anthocyanins and total phenolic content. The coating also exhibited antifungal and antibiotic properties and hence prohibited the disease occurrence. So, being indigenous and eco-friendly, *Aloe vera* gel coating is recommended for quality preservation and shelf life extension of strawberry fruits.

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