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Effect of Chitosan and Aloe Vera Application on Oxidative Stability and Nutritional Value of Strawberry Fruit (*Fragaria ananassa*) cv. Camarosa

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ABSTRACT

Background: Nowadays biomaterial has been proposed as a suitable alternative for chemical substance. It has no odor and taste and its consumption is beneficial to human health. The present study aimed to investigate the effect of application of chitosan coating individuality and along with Aloe Vera gel on the nutritional level and quality of strawberry fruit (cv. Camarosa).

Methods: After application treatments Aloe Vera gel (0, 50 and 100%), Chitosan (0, 0.5 and 1%) and their combination, plates contain strawberry were kept in the refrigerator with a temperature of 4 ± 1 °C, at humidity of 85- 90%. Traits were evaluated in the first days zero, 4, 8 and 12.

Results: The results showed fresh weight of fruit, chlorophyll, vitamin C and anthocyanin significantly affect by Aloe Vera 100%+ Chitosan 0.5% application. Also, plants treated with Aloe Vera 50% + chitosan 0.5% produced higher taste index, phenol and antioxidant capacity. On the other hand, lower weight loss of fruit, malondialdehyde and total soluble solids was observed with Aloe Vera 100 % + Chitosan 0.5 %. Storage life significantly was enhanced with Aloe Vera 50% + Chitosan 0.5% up to 15.7 days which was the same level with Aloe Vera 100% + Chitosan 0.5%.

Conclusion: Overall, the application of Aloe Vera treatment 50% or 100% along with Chitosan 0.5%, would be a highly recommended practice in the maintaining the nutrition value and storage life of strawberry fruits.

1. Introduction

Fragaria ananassa is a genus of the Rosaceae family, commonly identified as strawberries which including about more than 20 species, cultivars and hybrids. These additional features included invisible and undepictable traits such as taste, smell, flavor, odor ad nutritional values, made attractive to consumer [1]. Strawberries provide a range of potential benefits and can support the body's defenses against a variety of diseases. Their fruits have been reported to be potent antioxidants and reduce cardiovascular risk factors, such as, elevated blood pressure, hyperglycemia, dyslipidemia and inflammation in limited studies. In subjects with cardiovascular risk factors, supplementation of strawberry puree, in combination with other berries has shown to increase HDL-cholesterol and decrease systolic blood pressure versus the control group [2]. Previous studies had assessed the antioxidants quercetin, kaempferol, and anthocyanin. Researcher looked at the link between antioxidants that were present in strawberries and stroke

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risk [3] It found that they moderately reduced the risk of stroke. The powerful antioxidants in fruits may work against free radicals. Strawberries are rich in vitamin C, potassium, folic acid, and fiber. These are all essential nutrients that support the body's daily functioning. The quality of fruit and their post-harvest life are greatly influenced by environmental factors during the growing season, pests, diseases and nutrition. The use of appropriate compounds in post-harvest fruit can play an effective role in maintaining quality, improving the post-harvest life and nutritional properties. Suitable compounds include edible films and coatings such as Aloe vera gel and chitosan [4].

Aloe vera is a genus Aloe belongs to the Liliaceae an evergreen herbaceous plant native to tropical and southern Africa. A clear gel is extracted from the inside of the aloe vera leaf which contains a yellow liquid that was produced juice. In recent years, aloe vera gel has been proposed as a protective coating for fruits and vegetables to maintain their storage quality. Because it has no odor and taste and its consumption is beneficial to human health so it has been proposed as a suitable alternative to increase the storage life of fresh fruit [5]. Chitosan is a non-toxic, biodegradable and biocompatible natural coatings that has been used successfully after harvesting fruits and vegetables. The antimicrobial properties of chitosan include a wide range of microorganisms such as bacteria and fungi [6]. This property is due to positively charged amino groups that reacts with the cell membrane of microorganisms and leads to the deposition of protein and other intracellular components of microorganisms [7].

Previous study on strawberry, the findings of [8] illustrated that application of aloe vera with 25, 50, 75 and 100% (v/v) on *Fragaria ananassa* cv. Kordestan improved morphological, physiological and biochemical characteristics of the plant such as fruit weight, total acidity, total soluble solid, chlorophyll, phenol, anthocyanin, firmness and vitamin C. Some researcher suggested chitosan at 1% and 2% as an agent for improving flavonoids, anthocyanin, weight loose, enzyme activity in three cultivars of Candonga, ،Jonica and Sabrina [9]. Furthermore, [10] it was found that application of 0.5 and 1% chitosan can increase taste index, ascorbic acid, total flavonoid, total phenol content and antioxidant activity in plant compared to control.

Strawberry fruit has a short shelf life due to rapid spoilage, softening and moldiness, which can be due to high metabolic activity and susceptibility to various fungal diseases. In addition, due to the thin surface of the fruit, it is very sensitive to mechanical damage. Criteria for marketing and determining the quality of fruit include physical and chemical indicators that changes in these factors can be effective during fruit storage. Therefore, in order to increase the post-harvest life, it is very important to know the effective methods. However, the effect of chitosan in combination with aloe vera on longevity and post-harvest life of strawberry has less been investigated.

Therefore, the one purpose of this study was to highlight the potential of chitosan and aloe vera gel as the active biomaterial coating for increasing nutritional value and storage life of Strawberry fruit (*Fragaria ananassa*) cv. Camarosa.

2. Materials and Methods

2.1. Experimental materials

The strawberry cultivar (Camarosa) was received from a greenhouse in Damavand city, Iran. Chitosan with low molecular weight (LMW; 1.03 ×105) and 91% deacetylation degree was also obtained from Sigma-Aldrich Company (St. Louis, MO, USA), Aloe vera gel was also prepared from the fresh leaves of the aloe vera plant which was grown in commercial farm, Pakdasht, Iran.

2.2. Preparation of the Chitosan and Aloe vera Coatings

The chitosan solution was prepared with 2% (w/v) in 1% (v/v) acetic acid. In this process, two grams of chitosan were blended with 100 milliliters of distilled water, and the solution was mixed by a hotplate magnetic stirrer at the temperature of 40 °C for 10 minutes in order to become transparent. Afterwards, glycerol was added to chitosan at the concentration of 0.75 ml/gr as a plasticizer and stirred for 10 minutes. After superficial disinfection Aloe vera leaves, their flesh, which is in the form of a gel between the upper and lower epidermis, was extracted. Then it was mixed (VWR International, 10860-662, Shanghai, China) and diluted with distilled water in a 50 and 100% ratio. This substance was dissolved in a solution containing 1% (v/v) of acetic acid and then its pH was adjusted with a normal NaOH.

2.3. Treatments

The experiment design was factorial based on a in triplicate completely randomized with three replications. Treatments included Aloe vera gel (0, 50 and 100%), Chitosan (0, 0.5 and 1%) and their interaction. After application treatments, plates contain strawberry were placed in the refrigerator with a temperature of 4 ± 1 °C, at humidity of 85-90%. Traits were sampled and evaluated in the first days zero, 4, 8 and 12 (Table 1).

2.4. Weight of fruits measurement

Total weight of fruits was measured using a digital scale of Electronic Compact Scale SF_400C (GKS1567, Guangdong, China). Percentage weight loss of samples was calculated based on differing weights for different samples before and after storage using [11].

Table 1: Different treatment on some characteristics of strawberry

Number	Treatment
0	Control
1	*Aloe vera* 50%
2	*Aloe vera* 100%
3	Chitosan 0.5%
4	Chitosan 1%
5	*Aloe vera* 50%+ Chitosan 0.5%
6	*Aloe vera* 50%+ Chitosan 1%
7	*Aloe vera* 100%+ Chitosan 0.5%
8	*Aloe vera* 100%+ Chitosan 1 %

2.5. Determination of total soluble solid

The soluble sugars content was read at a wavelength of 490 nm using a spectrophotometer (Jenway 7305 UV–vis spectrophotometer, Staffordshire, England) according to the phenol-sulfuric acid method, while glucose (Sigma-Aldrich, USA) was used as standard [12].

2.6. Determination of taste index, pH and acidity

TSS/acid ratio was applied to determination taste index. pH was displayed by pH meter model METROHM-632 (Brinkmann, Geneva, Switzerland) and refractometer device model (RA-620/RA-600, KEM, Kyoto, Japan). The acidity was measured by titration method with 0.1 normal NaOH, in and was stated in terms of percentage of citric acid [13].

2.7. Determination of vitamin C

Vitamin C was measured by two-step oxidation-reduction titration. The titration operation was repeated with a solution containing 10, 20, 40, 80, 160 mg/100 ml and then the standard curve was drawn [14].

2.8. Determination of total phenol

The phenol content of samples was determined according to Cicco *et al.* (2009) with some modifications. Briefly, 300 μL of appropriately diluted extract or standard solution was mixed and incubated with 300 μL of FC solution for 2 min before 2400 μL of a 50 g/L sodium carbonate solution was added. The solutions were mixed well and placed in the dark at room temperature for 2 h before the absorption was measured at 765 nm using a spectrophotometer [15].

2.9. Determination of enzyme activity

The absolute absorbance was taken around 760 nm, the assays, namely 2, 2-diphenil-1-picrylhydrazyl (DPPH) radicals scavenging tests, were used to investigate the antioxidant potential of pomegranate. In a DPPH test, a mixture of DPPH (0.25 mM) and samples (5–1000 g/mL) was prepared and was left for 30 min at room temperature. Then, the absorbance was read at 517 nm [16].

2.10. Determination of chlorophyll and anthocyanin content

To measure chlorophyll and anthocyanin indices, 250 mg of the samples stored in the -80 freezer were thoroughly powdered in a mortar with liquid nitrogen, then 15 ml of 80% acetone was added to each sample. The acetone extract was centrifuged at 6000 rpm for 10 minutes and upper centrifuge extract was transferred from the centrifuge to Falcon in a Lambda EZ 201; then it was read separately at 663.2 nm for chlorophyll a, and 646.8 nm for chlorophyll b and 470 for anthocyanins [17].

2.11. Determination of malondialdehydes

Malondialdehydes (MDA) level was considered after the end of treatment. For measurement of MDA content, 3ml of 20% trichloroacetic acid containing 0.5% nithiobarbituric acid was added to a 1ml aliquot of the supernatant. The mixture was heated at 95°C for 30 min and then quickly cooled in an ice bath. The tube was centrifuged at 10,000×g for 10min, and then absorbance of the supernatant was read at 532nm. The value for the nonspecific absorption at 600nm was subtracted from the 532nm reading. The concentration of MDA was calculated using MDA's extinction coefficient of $155 mM^{-1} cm^{-1}$ [18].

2.12. Determination of loose shape, dehydration and mold contamination

The strawberry was kept in the refrigerator at 4 ± 1 °C, at RH 80 ± 5 %, and their shelf life was noted in terms of symptoms such loose shape, dehydration and mold contamination by day. Different fruits were divided into 4 groups (types) according to the severity of infection: 0 without infection and healthy, 1 (low wrinkly and spotty), 2 (moderate wrinkly and spotty) and 3 (high wrinkly and spotty) [19].

2.13. Statistical Analysis

Analysis of data was done by software SPSS19. The analysis of variance (ANOVA) and Duncan multiple range tests were used to figure out significant differences in the means at 5%.

3. Results and Discussion

Variance analysis of generative properties and biochemical traits showed the effect of Treatments on *Malondialdehyde* (MDA) and Taste index and effect of Time on Total acidity, Taste index, vitamin C and Antioxidant capacity were significant at 5% level. In addition the interaction effect of Treatments × Time on pH, fruit anthocyanin, total chlorophyll and total phenol were significant at 5% level (Table 2).

Comparisons of treatment stated that the highest relative fresh weight of fruit, anthocyanin, total chlorophyll, vitamin

C, respectively were related to Aloe vera 100% + Chitosan 0.5% treatment (Table 3).

The concentration and composition of anthocyanin, which cause the strawberry red color, are important for the sensory quality and beneficial properties of strawberries. In this study, the amount of total anthocyanin increased after 8 days of storage. This enhancement can be the result of biosynthesis of anthocyanin in post-harvest or water loss conditions. At the end of the storage period, the amount of total anthocyanin decreased compared to the harvest time. Changes in anthocyanin levels with the use of Chitosan and Aloe vera gel are probably due to the delay in the aging process and the reduction of oxygen. Also, the reduction of anthocyanin is due to its degradation and the activity of polyphenol oxidase and peroxidase enzymes. Treatments performed by reducing the activity of the above enzymes significantly prevent the degradation of anthocyanin. This result agreed with the findings of [9] and [20] on chitosan on strawberry. The total chlorophyll content decreased in all treatments during storage. Chitosan is believed to slow down the rate of respiration. Chitosan has also been reported to increase the internal concentration of carbon dioxide, thereby reducing ethylene synthesis and delaying fruit ripening, result in reducing chlorophyll degradation. The use of aloe vera gel also decreased the rate of respiration and ethylene production by reducing the availability of oxygen, and as a result, like chitosan, delays fruit aging and chlorophyll degradation. Our results are consisting with [21] on chitosan and aloe vera gel on mango fruit during storage and [17] on Aloe vera gel for grape. Ascorbic acid is more sensitive to oxidation and decomposition than other nutrients during consumption and storage, and the possible reason for the decrease in ascorbic acid during auto-oxidation storage is that it occurs spontaneously in the presence of oxygen in the air. By coating the strawberries with Aloe vera and Chitosan gel, the penetration of oxygen into the fruit tissue is reduced, which in turn decrease the activity of ascorbic acid oxidizing enzymes and ultimately the rate of ascorbic acid destruction. Our results were consisting with [22] of Aloe vera on apple.

Also, the effects of treatment on factors illustrated that the minimum weight loss percentage (2.44%), amount of Malondialdehyde (16.46 µm/g F.W) was seen in Aloe vera 100% + 0.5% Chitosan treatment (Figure 1 and 2). Weight loss percentage and malondialdehyde content is mainly related to the removal of moisture from the surface of fruits. This amount of weight loss can vary depending on the type of product, cultivar and texture. The thin skin of the strawberry fruit makes it susceptible to rapid water loss, which results in drying of the fruit skin surface. The role of chitosan in fruit weight loss can be attributed to its polycationic properties. The polycation coating breaks down into polymer parts and re-forms the polymer chain to form a jelly-like surface coating film. This coating leads to the formation of hydrophilic layers around the fruit, which is a barrier to gas exchange, thus reducing respiration and preventing perspiration and surface moisture. Therefore, due to its antimicrobial properties, Chitosan prevents fruit weight loss by reducing post-harvest contamination. Aloe vera coatings also act as a protector to prevent the transfer and evaporation of water from the fruit skin, delaying water loss. Therefore, the results of the study were similar with the findings of [23] on the effect of application of Aloe vera gel on lychee fruits, using antimicrobial edible coatings on sliced papaya [24] and antibacterial impact of nano chitosan edible coatings [25].

The most amount of pH, taste value, total phenol, total soluble solid and antioxidant capacity was addressed in Aloe vera 50% + Chitosan 0.5% (Table 3 and Figure 3). As shown in the table 4, there is significant a negative/significant correlation between the amount of titratable acidity and taste index at the level of 1% and also, between the amounts of soluble solids and taste index, a positive and significant correlation was observed at level 5%. Over time, the acidity of fruits decreases, which is related to the rate of respiration of fruits and the existence of organic acid in the respiration enzymatic reactions. The amount of titratable acidity is also often negatively related to the pH of the juice. Taste index is also one of the most important quality parameters in the evaluation of strawberry fruit that determines its acceptability by consumers, which is the result of a significant difference in the amount of increase in soluble solids and decrease in titratable acidity. Our findings are accordance with the results of research on application of chitosan and Aloe vera gel on mango fruit during storage [21]. The predominant phenolic compounds in strawberry fruit are coumarin, quercetin and alginic acid. Decomposition of phenolic compounds is the result of the activity of polyphenol oxidase and peroxidase enzymes. Preservation of phenolic compounds in strawberry fruits coated with chitosan and aloe vera gel has been attributed to delays in the aging process and reduced activity of enzymes. Our researches lie in the study of chitosan coating on mango fruit [26]. Antioxidant capacity in all treatments decreased during the storage period until day 8. Oxidative stresses, including aging, increase free radicals, but endogenous active antioxidant systems can scavenge free radicals, thereby delaying aging. But Aloe vera gel and chitosan coating alone or in combination with each other by delaying the aging process maintained the antioxidant activity in the treated fruits compared to the control. This report confirms the findings of a study of aloe vera gel on tomato fruits [26].

Weight loss, thickening of the juice during storage, dissolution of the constituents of the cell wall during the ripening and aging process, as well as respiration of the fruit, which breaks down the polysaccharides into simpler compounds, may increase soluble solids. But the coating of chitosan and Aloe vera gel decline the metabolic activities and the aging process of the fruit by preventing gas exchange, leads to increasing soluble solids [28].

Table 2: Analysis of variance of application of different treatment on some characteristics of strawberry

	DF	Fresh weight	Loss weight	MDA	TSS	Total acidity	Taste index	pH	Vitamin C	Anthocyanin	chlorophyll	phenol	DPPH	Shelf life
Treatments	8	24.693**	12.601**	16.234*	2.130**	0.77**	15.903*	0.266**	14.454**	65.742**	0.197**	23.636*	6.383**	38.299**
Time	3	35.907**	34.388**	21488**	23.832**	0.824*	48.296*	2.407**	37.519*	86.611**	1.655**	38.807**	23.038*	-
Treatments time	24	9.801**	2.148**	4.098**	0.356**	0.1**	2.715**	0.43*	0.03**	9.296*	0.03*	9.73*	0.823**	-
CV (%)	---	11.71	10.85	6.18	10.35	11.57	8.57	11.76	11.54	10.12	11.54	10.88	0.013	9.22

*, ** and ns: Significant at $P< 0.05$, $P< 0.01$ and insignificant, respectively.

Table 3: Mean comparison of application of different treatment on some characteristics of strawberry

Time	Treatments	Fresh weight (%)	TSS (°Brix)	Acidity (mg/100 g FW)	Taste index	pH	Anthocyanin (mg/g FW)	Chlorophyll (mg/g FW)	Phenol (mg/g DW)	Vitamin C (mg/ 100g FW)
1	Control	100. 00^{a}	7.58^{l}	0.84^{a}	9.02^{k}	3.85^{a}	6.71^{l}	0.653^{a}	51.83^{a}	5.85^{a}
4	Control	65.74^{j}	8.25^{gh}	0.81^{d}	10.19^{i}	3.54^{g}	9.22^{jk}	0.294^{i}	37.19^{g}	3.28^{i}
4	Aloe 50%	76.90^{g}	8.00^{i}	0.76^{de}	10.53^{hi}	3.67^{e}	10.51^{j}	0.402^{g}	41.39^{f}	4.04^{gh}
4	Aloe 100%	86.47^{e}	7.82^{ij}	0.72^{c}	10.86^{h}	3.81^{b}	12.56^{h}	0.484^{ef}	46.35^{cd}	4.82^{e}
4	Chit 0.5%	75.54^{h}	7.85^{ij}	0.79^{de}	9.94^{j}	3.57^{fg}	9.78^{jk}	0.374^{hi}	40.02^{fg}	3.91^{gh}
4	Chit 1%	82.99^{f}	8.02^{i}	0.71^{e}	11.3^{gh}	3.62^{ef}	11.72^{i}	0.434^{f}	44.08^{e}	4.55^{f}
4	Aloe50%+Chit 0.5%	89.81^{d}	7.79^{j}	0.65^{ef}	11.98^{g}	3.69^{de}	13.80^{ef}	0.621^{bc}	49.83^{b}	5.43^{bc}
4	Aloe100%+Chit 1%	92.57^{bc}	7.68^{k}	0.70^{ef}	10.97^{h}	3.79^{c}	13.57^{fg}	0.595^{cd}	48.04^{c}	5.15^{d}
4	Aloe50%+Chit 1%	91.25^{c}	7.64^{k}	0.67^{d}	11.4^{gh}	3.72^{d}	13.14^{gh}	0.605^{c}	47.56^{c}	5.36^{cd}
4	Aleo100%+Chit 0.5%	94.03^{b}	7.72^{j}	0.65^{e}	11.88^{g}	3.80^{bc}	14.26^{de}	0.640^{b}	48.79^{bc}	5.64^{b}
8	Control	44.28^{mn}	9.03^{d}	0.75^{e}	12.04^{g}	3.28^{j}	10.98^{ij}	0.265^{ij}	28.63^{ij}	2.39^{j}
8	Aloe 50%	60.97^{k}	8.89^{de}	0.69^{e}	12.88^{f}	3.54^{g}	12.82^{gh}	0.365^{h}	37.22^{g}	3.41^{i}
8	Aloe 100%	65.43^{j}	8.45^{f}	0.68^{f}	12.43f^{g}	3.61^{f}	13.70^{f}	0.422^{fg}	43.26^{ef}	4.14^{g}
8	Chit 0.5%	54.97^{l}	8.63^{ef}	0.67^{g}	12.88^{f}	3.44^{hi}	12.57^{h}	0.315^{hi}	35.14^{gh}	2.89^{ij}
8	Chit 1%	62.00^{jk}	8.75^{e}	0.63^{gh}	13.89^{de}	3.48^{gh}	13.61^{fg}	0.405^{g}	40.5^{fg}	3.75^{h}
8	Aloe50%+Chit 0.5%	74.62^{h}	8.29^{g}	0.57^{g}	14.54^{c}	3.59^{fg}	16.89^{b}	0.548^{de}	47.59^{c}	4.63^{ef}
8	Aloe100%+Chit 1%	79.35^{g}	8.18^{h}	0.61^{fg}	13.41^{ef}	3.63^{ef}	16.03^{c}	0.451^{ef}	45.63^{d}	4.31^{fg}
8	Aloe50%+Chit 1%	70.25^{i}	8.03^{i}	0.59^{ef}	13.61^{e}	3.60^{f}	15.33^{d}	0.523^{e}	44.12^{de}	4.83^{e}
8	Aleo100%+Chit 0.5%	84.29^{ef}	8.22^{gh}	0.59^{f}	13.93^{de}	3.66^{e}	17.03^{a}	0.571^{d}	46.12^{cd}	4.95^{de}
12	Control	33.36^{o}	9.59^{a}	0.72d^{e}	13.32^{ef}	3.17^{k}	8.54^{k}	0.202^{k}	25.41^{j}	1.72^{k}
12	Aloe 50%	45.74^{mn}	9.19^{b}	0.67^{g}	13.72^{e}	3.47^{gh}	11.28^{ij}	0.268^{ij}	31.74^{hi}	2.73^{ij}
12	Aloe 100%	51.27l^{m}	8.83^{d}	0.63^{g}	14.02^{d}	3.67^{de}	12.43^{hi}	0.325^{hi}	35.62^{gh}	3.54^{hi}
12	Chit 0.5%	43.74^{n}	9.00^{c}	0.70^{gh}	12.86^{f}	3.46^{gh}	10.98^{ij}	0.242^{j}	29.34^{i}	2.48^{j}
12	Chit 1%	49.08^{m}	9.43^{ab}	0.60^{h}	15.72^{b}	3.39^{i}	11.72^{i}	0.297^{i}	33.78^{h}	3.17^{i}
12	Aloe50%+Chit 0.5%	53.61^{l}	8.78^{e}	0.51^{f}	16.57^{a}	3.44^{h}	14.16^{e}	0.361^{h}	44.63^{de}	3.97^{gh}
12	Aloe100%+Chit 1%	65.23^{j}	8.43^{fg}	0.58^{bc}	14.53^{c}	3.54^{bc}	13.86^{ef}	0.345^{hi}	40.03^{fg}	3.76^{h}
12	Aloe50%+Chit 1%	56.61k^{l}	8.32^{g}	0.58^{bc}	14.6^{c}	3.45^{h}	13.31^{g}	0.348^{hi}	34.65^{h}	4.16^{g}
12	Aleo100%+Chit 0.5%	70.95^{i}	8.51^{f}	0.57^{b}	15.76^{b}	3.58^{fg}	14.61^{de}	0.407^{f}	44.65^{de}	4.21^{g}

Means within each column followed by the same letter are not different according to the Duncan test.

Table 4: Correlation of between characteristics of strawberry

Correlation	Fresh weigh	Weight loose	MDH	TSS	TA	Taste index	pH	Anthocyanin	chlorophyll	Vitamin C	Phenol	DPPH	Shelf life
Fresh weight	1												
Weight loose	-0.953^{++}	1											
MDH	-0.979^{++}	+0.952^{++}	1										
TSS	+0.865^{++}	-0.761^{++}	+0.816^{++}	1									
TA	-0.601^{+}	+0.901^{++}	+0.73^{++}	-0.786^{++}	1								
Taste index	+0.726^{++}	-0.729^{++}	-0.589^{+}	+0.592^{+}	-0.923^{++}	1							
pH	+0.862^{++}	-0.521^{+}	-0.820^{++}	-0.784^{++}	-0.667^{+}	-0.514^{+}	1						
Anthocyanin	+0.969^{++}	-0.957^{++}	-0.956^{++}	+0.861^{++}	-0.963^{++}	+0.826^{+}	+801^{++}	1					
Chlorophyll	+0.549^{+}	-0.944^{++}	-0.858^{++}	+0.758^{++}	-0.859^{++}	+0.735^{++}	+0.744^{++}	+0.586^{+}	1				
Vitamin C	+0.947^{++}	-0.950^{++}	-0.765^{++}	+0.876^{++}	-0.914^{++}	+0.802^{++}	+0.820^{++}	+0.973^{++}	+0.918^{++}	1			
Phenol	+0.943^{++}	-0.744^{++}	-0.632^{+}	+0.807^{++}	-0.852^{++}	+0.841^{++}	+0.816^{++}	+0.788^{++}	+0.766^{++}	+0.559^{+}	1		
DPPH	+0.802^{++}	+0.875^{++}	-0.874^{++}	+0.744^{++}	-0.734^{++}	+0.828^{++}	+0.853^{+}	+0.742^{++}	+0.968^{++}	+0.946^{++}	+0.915^{+}	1	
Shelf life	+0.952^{++}	-0.938^{++}	-0.926^{++}	+0.826^{++}	-0.944^{++}	+0.789^{++}	+0.830^{++}	+0.891^{++}	+0.869^{++}	+0.875^{++}	+0.928^{++}	+0.975^{++}	1

*, ** and ns: Significant at $P< 0.05$, $P< 0.01$ and insignificant, respectively.

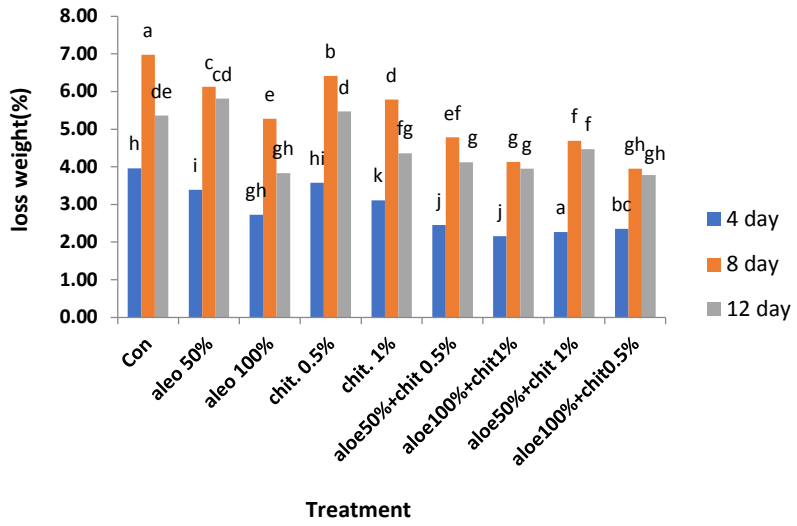

Figure 1: Effect of treatments on strawberry loss weight

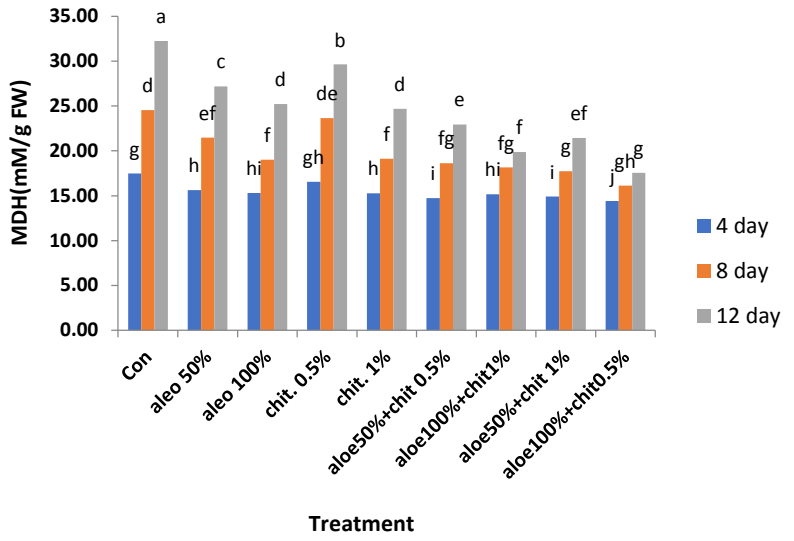

Figure 2: Effect of treatments on strawberry malondialdehyde (MDA)

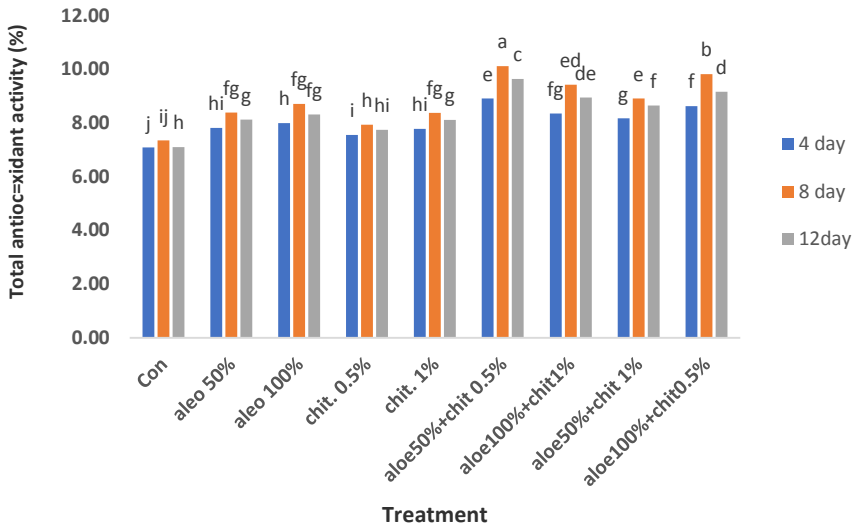

Figure 3: Effect of treatment on strawberry total antioxidant activity (DPPH)

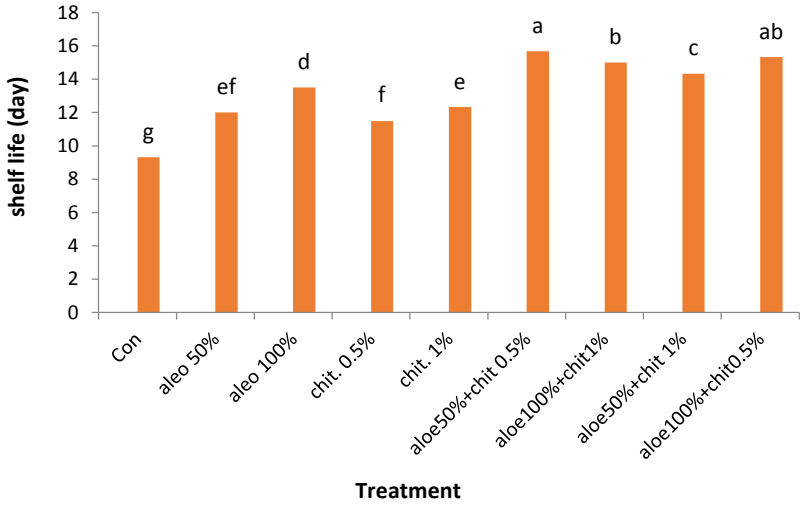

Figure 4: Effect of treatment on strawberry shelf life

Maximum of shelf life equivalent to 15.7 days was Aloe vera 100% or 50% + Chitosan 0.5% treatment that caused increase of 6 days in comparison with control (Figure 4). Strawberry fruit has a short shelf life base on rapid rot, softening and mold, which can be due to high metabolic activity and susceptibility to various fungal diseases. Nutritional value and the quality of fruit in strawberries include physical and chemical indicators that changes in these indicators can sometimes be effective during fruit storage. Therefore, in order to increase the post-harvest life, it is very important to know the effective factors in these criteria. The results of the present study showed that the use of oral coatings such as chitosan and Aloe Vera gel can increase the shelf life and maintain the quality of strawberries, which is similar research on the same issue on strawberry [20].

4. Conclusion

According to the results, use of the edible coatings such as Chitosan and Aloe vera gel had potential effects on the shelf life and maintaining the quality of strawberries. Moreover, this effect could be improved by using the concentration of the Aloe vera 50% or 100%+Chitosan 0.5 %. In the control

group, the all traits were also observed to decrease, which could be due to the non-application of biomaterial.

Authors' Contributions

Saharnaz Noorbakhesh: Data curation; Writing original drafts; Methodology. **Elham Danaee:** Conceptualization; Data curation; Formal analysis; Methodology; Project administrator; Supervision; Visualization; Writing original drafts; Writing -review editing.

Conflicts of Interest

The Authors declare that there is no conflict of interest.

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References

1. Barooah A, Shekhar Datta H. Response of Nutrient Management on Growth, Yield and Quality of Strawberry: A Review. *J Pharmacog Phytochem*. 2020; 9: 3222-8.

2. Erlund I, Koli R, Alfthan G, Marniemi J, Puukka P, Mustonen P, *et al*. Favorable Effects of Berry Consumption on Platelet Function, Blood Pressure, and HDL Cholesterol. *Am J Clin Nutr*. 2008; 87: 323–31.

3. Basu A, Rhone M, Lyons TJ. Berries: Emerging Impact on Cardiovascular Health. Nutr Rev. 2010;68(3):168-177.

4. Kristo AS, Klimis Zacas D, Sikalidis AK. Protective Role of Dietary Berries in Cancer. *Antioxidants (Basel)*. 2016; 5(4): 37.

5. Navarro D, Diaz Mula HM, Guillen F, Zapata PJ, Castillo S, Serrano M, *et al.* Reduction of Nectarine Decay Caused by Rhizopus Stolonifer, Botrytis Cinerea and Penicillium digitatum with Aloe Vera Gel alone or with the Addition of Thymol, *Int J Food Microbiol*. 2010; 57: 183-8.

6. Goy RC, Moraisb STB, Assisb OBG. Evaluation of the Antimicrobial Activity of Chitosan and Its Quaternized Derivative on *E. coli* and *S. aureus* Growth. *Rev Brasileira de Farmacognosia*. 2016; 26: 122–7.

7. Giatrakou V, Ntzimani A, Savvaidis IN. Effect of Chitosan and Thyme Oil on a Ready to Cook Chicken Product. *Food Microbiol*. 2010; 26: 501-4.

8. Vahdat SH, Ghasemnejad M, Fotouhighazvini R, Shiri MA, Khodaparat SA. The Effect of Different Concentrations of Aloe Vera Gel on Maintaining Post-Harvest Quality of Strawberry Fruit. *J Food Indust Res.* 2012; 3: 271-85. [In Persian].

9. Petriccione M, Mastrobuoni F, Pasquariello MS, Zampella L, Nobis E, Capriolo G, *et al.* Effect of Chitosan Coating on the Postharvest Quality and Antioxidant Enzyme System Response of Strawberry Fruit during Cold Storage. *Foods*. 2015; 4: 501-23.

10. Mighani H, Boroumand N, Moghbeli A. The Effect of Chitosan and Calcium Chloride on Post-Harvest Quality and Antioxidant Compounds of Strawberry Fruit. *Food Sci Indust*. 2016; 5: 77-81. [In Persian].

11. Celicel FG, Reid MS, Postharvest Handling of Stock (Matthiola incana). *Hortic Sci.* 2002; 37: 144-7.

12. Dubois M, Gilles KA, Hamilton JK, Rebers PAT, Smith F. Colorimetric Method for Determination of Sugars and Related Substances. *Anal Chem.* 1965; 28: 350-6.

13. George DS, Patricia AM. PH and Titratable Acidity. *Food Analysis*. 2010. p.345.

14. Shafiee M, Taghavi TS, Babalar M. Addition of Salicylic Acid to Nutrient Solution Combined with Postharvest Treatments (Hot Water, Salicylic Acid, and Calcium Dipping) Improved Postharvest Fruit Quality of Strawberry. *Sci Hortic*. 2010; 124: 40-5.

15. Cicco N, Lanorte MT, Paraggio M, Viggiano M, Lattanzio V. A Reproducible, Rapid and Inexpensive Folin-Ciocalteu Micro-Method in Determining Phenolics of Plant Methanol Extracts. *Microchem J.* 2009; 91: 107–10.

16. Pokorny J, Yanishlieva N, Gordon M. Antioxidants in Food. Practical Pomegranates Grown in Turkey. *J Food Composi Analys*.2001; 15: 567-75.

17. Valverde JM, Valero D, Martinez Romero D, Guillen F, Castillo S, Serrano M. Novel Edible Coating Based on Aloe Vera Gel to Maintain Table Grape Quality and Safety. *Agric Food Chem.* 2005; 53: 7807-13.

18. Valentovic P, Luxova M, Kolarovic L, Gasparikova O. Effect of Osmotic Stress on Compatible Solutes Content, Membrane Stability and Water Relations in Two Maize Cultivars. *Plant Soil Environ*. 2006; 52(4): 186-91.

19. Bayer WF, Fridovich I. Assaying for Superoxide Dismutase Activity: Some Large Consequences of Minor Changes in Condition. *Ann Biochem*. 1987; 161:559–66.

20. Hernandez Munoz PA, Almenar B, Del Vallea V, Velez D. Effect of Chitosan Coating Combined with Postharvest Calcium Treatment on Strawberry (*Fragaria ananassa*) Quality During Refrigerated Storage. *J Food Chem*. 2008; 110: 428-35.

21. Shah S, Hashmi SM. Chitosan–Aloe vera gel Coating Delays Postharvest Decay of Mango Fruit, *Horticulture Environ Biotechnol*. 2020; 61: 279–89.

22. Ergun M, Satici F. Use of Aloe Vera Gel as Biopreservative for 'Granny Smith' and 'Red Chief' Apples. *J Animal Plant Sci.* 2012; 22: 363-8.

23. Ali S, SattarKhan A, Nawaz A, AkbarAnjum M, Naz S, Ejaz Sh, *et al.* Aloe Vera Gel Coating Delays Postharvest Browning and Maintains Quality of Harvested Litchi Fruit. *Postharvest Biol Technol*. 2019; 157-62.

24. Farina V, Passafiume R, Tinebra I, Scuderi D, Saletta F, Gugliuzza G, *et al.* Postharvest Application of Aloe Vera Gel-Based Edible Coating to Improve the Quality and Storage Stability of Fresh-Cut Papaya. *J Food Qual*. 2020: 1-10.

25. Raji F, Khanzadi S, Hashemi M, Azizzadeh M. Effect of Chitosan Coating Nano-emulsion Containing Zataria multiflora and Bunium persicum Essential Oils on Escherichia Coli O157:H7 in Vacuum-packed Rainbow Trout Fillet. *J Human Environ Health Promo*. 2019; 5(1): 21-5.

26. Zhu X, Wang Q, Cao J, Jiand W. Effect of Chitosan Coating on Postharvest Quality of Mango (Mangifera indica L. cv. Tainong). *Fruits*. 2008; 32: 770-84.

27. Garcia MA, Ventosa M, Diaz R, Falco S, Casariego A. Effects of Aloe vera Coating on Postharvest Quality of Tomato. *Fruits*. 2015; 69: 117-25.

28. Eyalati K. Danaee E. Evaluation of the Effect of Application of Ascorbic Acid and Chitosan on Quality, Nutrition Value and Storage of Agaricus bisporus. *J Food & Health*. 2021; 4(3): 7-12.