

# Effects of chitosan and *Aloe Vera* gel coating on quality characters of pistachio

## Abstract

Iran is one of the largest pistachio producer and exporter in the world. Under unfavorable conditions during storage, pistachio quality will be reduced due to undesirable reactions. The objective of the present study was to evaluate the ability of *Aloe vera* gel to reduce/control the loss of post harvest fresh pistachio quality, compare with a natural polysaccharide-chitosan, as an established coating material with antifungal activity. Freshly harvested pistachio fruits were coated with *A. vera* gel (100% and 50%), chitosan (0.05% and 0.5%) and control (water). The coated and uncoated pistachio was stored at 4° RH for 1 month. The parameters analyzed included physiological water conservation (PWC), sensory analysis for pistachio quality (colour and marketability), degree of spoilage, and Peroxide value of oil extracted from them. Results indicate that chitosan and *A. vera* gel are potential candidates to preserve post-harvest quality of pistachio; either showed that for coating of pistachio, chitosan 0.05% is better than other coating; that followed by *A. vera* gel 50% and Chitosan 0.5% coating, and *A. vera* gel 100% is undesirable for coating of pistachio.

**Keywords:** *Aloe vera* gel, chitosan, coating, marketability, pistachio

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Mehdi Kaviani,<sup>1</sup> Mohammad Ali Shariati,<sup>2</sup> Elena Joshevska,<sup>3</sup> Julijana Tomovska,<sup>3</sup> Maryam Vanaei<sup>4</sup>

<sup>1</sup>Department of Food Science and Technology, Ferdowsi University of Mashhad, Iran

<sup>2</sup>Department of Food Science and Technology, Islamic Azad University, Iran

<sup>3</sup>Faculty of Biotechnological sciences, Sofia University, Macedonia

<sup>4</sup>Department of Biology, science and Research Branch, Islamic Azad University, Iran

**Correspondence:** Maryam Vanaei, Department of Biology, science and Research Branch, Islamic Azad University, Damghan, Iran, Email shariatymohammadali@gmail.com

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**Abbreviations:** PWC, physiological water conservation; FDI, fruit disease index; PV, peroxide value

## Introduction

The traditional concept of a packaging is to preserve the quality of the product with a minimal product/package interaction, however, in recent years, a wide variety of packages have been employed for interaction with products to provide desirable or beneficial effects.<sup>1</sup> Active packaging technology is a relatively novel concept beneficial for extending the product shelf-life, maintaining its nutritional and sensory quality, as well as contributing to the microbial safety.<sup>2</sup> The ability of edible film or coating as a type of active packaging to carry some products additives such as antioxidants, antimicrobials, colorants, flavors, fortified nutrients and spices are being studied.<sup>3</sup>

Chitosan, a natural carbohydrate copolymer [-(1-4)-2-acetamido-d-glucose and -(1-4)-2-amino-d-glucose units], which is yielded from deacetylation of chitin [poly-(1-4)-N acetyl-2-d-glucosamine], is harmless to humans, animals and, and the environment; and has been studied for efficacy in inhibiting decay and extending shelf life of fruits. Chitosan and its derivatives have been shown to inhibit the growth of a wide range of fungus,<sup>4,5</sup> so one of interest application of this biopolymer is products preservation because of its ability to be used as coating materials to extend the shelf life of different products.<sup>6,7</sup> Recently, the use of *A. vera* gel as an edible coating has been reported to prolong the shelf life and to delay the changes in the parameters related to deterioration of quality of products.<sup>8,9</sup>

*A. vera*, a cactus-like plant, is a perennial succulent belonging to the Liliaceae family which grows in hot and dry climates.<sup>10</sup> The plant has triangular, fleshy leaves with serrated edges, yellow tubular flowers and fruits containing countless seeds. For centuries, the yellow latex (exudate) and clear gel (mucilage), exuded from the large

leaf parenchymatic cells of *A. vera*, has been employed for medical and pharmaceutical purposes such as anti-inflammatory effects, treatment of skin burns, protection of the skin against UV and gamma radiation damage, treatment of frostbite and psoriasis, supporting and enhancing the immune system, antiviral and antitumor activity, laxative effects, and, last but not least, wound healing.<sup>11</sup> However, the main use of *A. vera* gel is mainly in the cosmetology and medication; More recently, it has found its application in the food industry as a source of functional foods in ice-cream, drinks and beverages,<sup>12</sup> and, due to antifungal activity of *A. vera* gel, as an unique edible coating (plain or in combination with other components) to extend the post-harvest storage of arctic snow,<sup>4</sup> apple slices,<sup>13</sup> sweet cherry,<sup>8</sup> papaya fruits<sup>14</sup> and table grapes.<sup>1,9,15</sup>

*A. vera* gel based edible coatings have been shown to prevent loss of moisture and firmness, control respiratory rate and maturation development, delay oxidative browning, and reduce microorganism proliferation in fruits such as sweet cherry, table grapes and nectarines.<sup>6,8,12</sup> There are no reports presently on the post-harvest application of Aloe gel and chitosan coating on pistachio; therefore, the objective of this research was to elucidate the role of *A. vera* gel edible coating on the storage life of pistachio in comparison to chitosan coating.

## Materials and methods

### Preparation of coating solutions

Chitosan and *A. vera* gel coatings were prepared according to the method of Marpudi et al.<sup>3</sup> *A. vera* gel was ground in blender. After pasteurization at 70°C for 45min, gel was cooled to an ambient temperature and ascorbic acid (1.9-2.0g L<sup>-1</sup>) was added to gel for stabilizing it; citric acid (4.5-4.6g L<sup>-1</sup>) was then added to maintain the pH at 4.

## Sample preparation and coating application

Fresh pistachios were purchased from a local producer in Iran, and then randomly distributed into five groups with three replicates. First group immersed in water as the control (F0), four other groups immersed in solutions of chitosan 0.5% (F1), chitosan 0.05% (F2), *A. vera* gel 100% (F3) and *A. vera* gel 50% (F4) for 5 min. After 5 min; pistachios were dried at 25 °C until their coatings became non-sticky to touch. Each of Fifteen groups were placed into sterile plastic bag and were stored at 4 °C for one month.

## Physiological water conservation (PWC)

After one month, the samples were dried in an oven. Then water conservation was calculated in terms of PWC by the following equation:

$$100 - \frac{(A - B)}{A} \times 100,$$

Where, A is the initial weight of Fresh pistachios after the storage period and B is oven dried pistachios .

## Sensory evaluation

Sensory analysis was applied to determine quality of the differently coated pistachios stored for one month. A taste panel of 8 random panelists participated in the sensory evaluation of pistachios. The sensory quality of each batch of coating was evaluated visually in terms of pistachio bark color (5- ≥75% bright, 4- ≥50% to ≥75% bright, 3- 50% bright, 2- ≤50% to ≥25% bright, 1- ≥75% dark) and Marketability (5-Excellent, 4-Good with slight defects, 3-Fair and moderate defects, 2- Marketability limited, 1-Not marketable).

## Fruit disease index (FDI)

The differently coated pistachios were visually observed for fungal spoilage. The number of pistachios infected was recorded to assess the effect of the different coating on retarding fruit spoilage. Degree and Rate of Fruit Spoilage was reported as percentage disease index and calculated as follows:

$$\% \text{Disease index} = \frac{(0xa)(1xb)(2xc)(3xd)(4xe)}{a + b + c + d + e} \times \frac{100}{x}$$

Disease index- Where 0,1,2,3,4,5 are infection categories(0- no lesions, 1- 5 to ≤15%, 2- ≥15% to ≤5%, 3- ≥25% to ≤50%, 4-≥50% to ≥75%, 5-≥75%); a, b, c, d, e are number of pistachios that fall into the infection categories and X-maximum number of infection categories.<sup>14</sup>

## Oil extraction

Each sample of coated pistachio was ground in a mill, and then oil extraction was carried out using a Soxhlet extraction system with hexane as solvent. An extraction time of 8 hours was chosen. After extraction, the extracts were evaporated on a rotary evaporator, and the samples were stored with the exclusion of light.

## Peroxide value (PV)

PV was determined according to the thiocyanate method. The sample (0.01-0.30 g, depending on the extent of peroxidation) was

mixed in a disposable glass tube with 9.8mL chloroform-methanol (7:3 v/v) in a vortex mixer for 2-4seconds. Ammonium thiocyanate solution (50μL, 30% w/v) was added and the sample was then mixed in a vortex mixer for 2-4seconds. Then, 50μL of iron (II) chloride solution ([0.4 g barium chloride dihydrate dissolved in 50 mL H<sub>2</sub>O] + [0.5 g FeSO<sub>4</sub>·7H<sub>2</sub>O dissolved in 50 mL H<sub>2</sub>O] + 2 mL 10M HCl, with the precipitate, barium sulfate, filtered off to produce a clear solution) was added, and the sample was mixed in a vortex mixer for 2-4seconds. After a 5minutes incubation at room temperature, the absorbance of the sample was read at 500 nm against a blank that contained all the reagents except the sample using a spectrophotometer (Jenway 6105 UVVIS). The entire procedure was conducted in subdued light and completed within 10minutes. All PV analysis results were expressed as meq O<sub>2</sub> kg<sup>-1</sup> oil.<sup>16</sup>

## Statistical analysis

Data were analyzed by one-way analysis of variance (ANOVA) using Excel and SPSS version 13 software. Duncan test was used to determine the difference at 5 percent significance level. All tests were done in three replicates.

## Results and discussion

### Physiological water conservation (PWC)

The effect of selected edible coatings on PWC can be seen in Figure 1. PWC was found to be significantly (P<0.05) different among five different coatings. PWC was observed to be 85.43%, 86.68%, 90.26%, 85.93% and 88.08% for F0, F1, F2, F3 and F4, respectively. Among the coated groups, F2 had significantly highest water preservation, and then PWC of F4 was higher than other groups, followed by F1, F3 and F0. Effects of F1 and F3 on water preservation approximately were similar and the difference was to a lesser extent in these two coating groups compared to control (F0). *A. vera* gel based edible coating have been shown to prevent loss of moisture and firmness.<sup>1,4,14</sup>

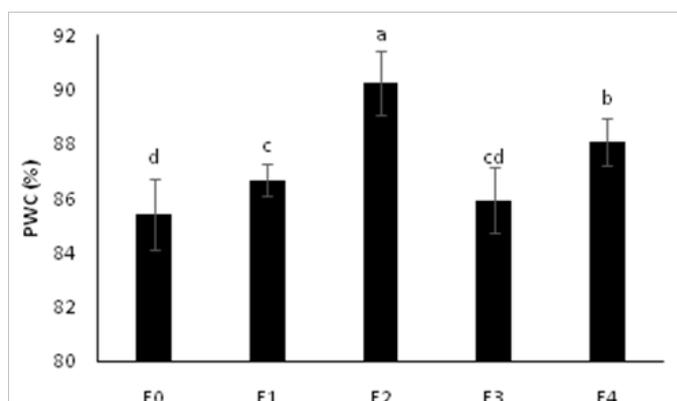


Figure 1 Effect of selected edible coatings on PWC.

### Marketability

Marketability values were found to be 2.5, 3, 4.5, 1.25 and 3.25 for F0, F1, F2, F3 and F4, respectively (Figure 2). At the end of one month marketability was found to be better for F2 coated samples, followed by F4, F1, F0 and F3 coating. It is thought that bark firmness maintenance related to higher PWC. These results are in agreement with other studies.<sup>4,17</sup>

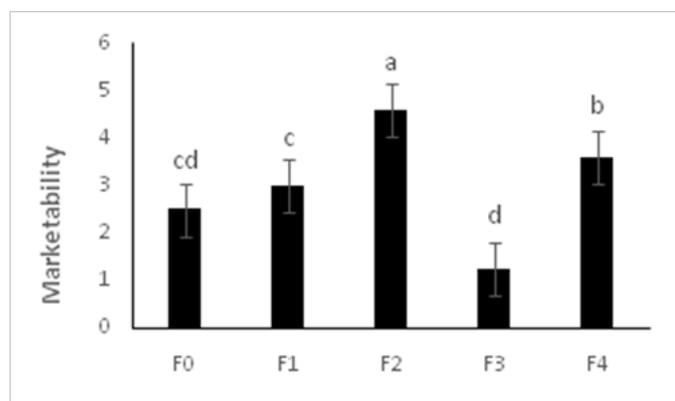


Figure 2 Effect of selected edible coatings on marketability.

### Sensory analysis

Color and firmness, the major sensory attributes, were scored by panel members (Figure 3) Color was evaluated based on the bark color with 5 as a score for bright to a score of 1 for complete dark. Bright color of bark changed to dark during storage in both control and coated fruits, but degree of darkening was varying in samples. The F3 had shown a greater degree of darkness. Color values were given as 1.25, 1.75, 2.75, 3.5 and 4.25 for F3, F0, F1, F4 and F2, respectively. Slow changes in physicochemical changes of coated samples revealed the more effective of maintaining ability.<sup>14</sup>

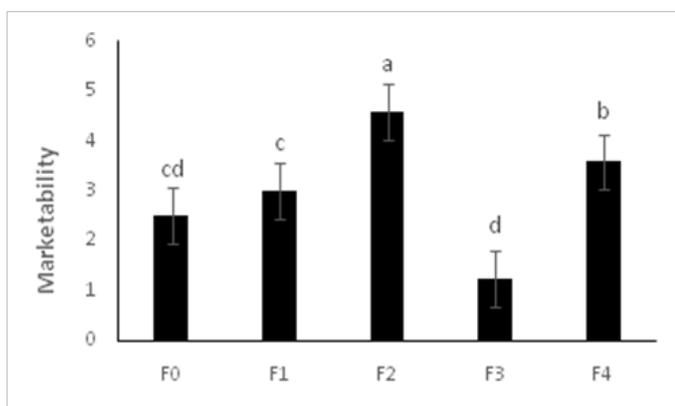


Figure 3 Effect of selected edible coatings on bark color.

### Fruit disease index (FDI)

FDI was used as a measure to indicate the effect of selected coatings on the microbial quality of product. FDI was observed to be 6.125, 4.125, 0.92, 1.135 and 1.565 for F0, F1, F2, F3 and F4, respectively (Figure 4). Coated groups had lesser extent FDI compared to control (F0), but among them, F1 had higher FDI than other coating groups, followed by F4, F3 and F2. Thus effect of F2 for retarding pistachio spoilage is greater than other coatings. In the present study, .05% chitosan and *A. vera* gel coatings showed the low disease index. Antimicrobial activity of *A. vera* gel against bacteria has been reported previously.<sup>18,19</sup> These results are in agreement with reported results of vena gel based coating in reduction of microorganism proliferation in Sweet cherries. *A. vera* gel based coatings have been reported earlier to reduce microorganism proliferation in sweet cherries and table grapes.<sup>15</sup>

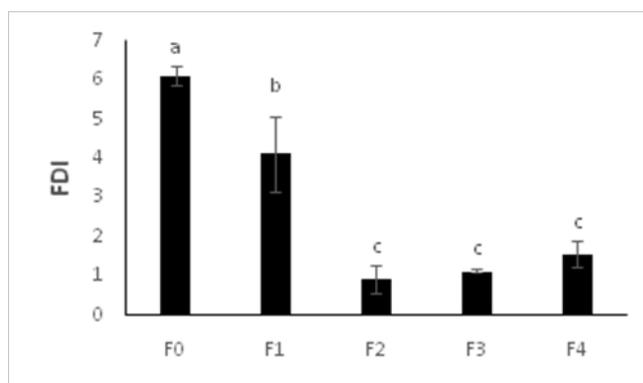


Figure 4 Effect of selected edible coatings on FDI.

### Peroxide value (PV)

The PV shows the degree of oxidation in the substance and measures the amount of total peroxides as a primary product of oil oxidation. As be seen in Figure 5, samples of F3 had Highest PV (even more than F0), followed by F0, F1, F4 and F2. These samples of F2 had least PV.

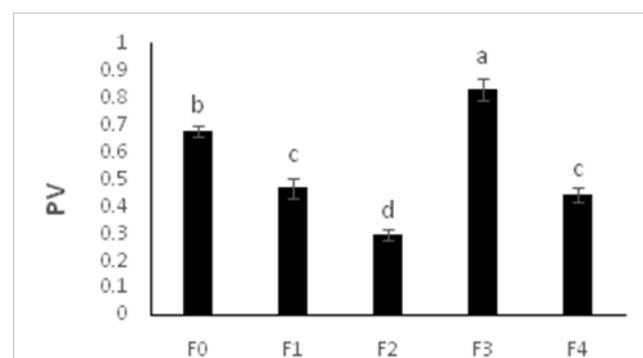


Figure 5 Effect of selected edible coatings on PV.

Investigation of both primary and secondary oxidations along with peroxide value (PV)<sup>11</sup> is requested on study of oxidative stability of vegetable oil as one of the key factors.<sup>20</sup> Peroxide value (PV) is an index exhibiting the amount of primary oxidation.<sup>21</sup> Figure 5 depicts that least oil oxidation of coated pistachios is related to 0.05% chitosan, followed by 50% *A. vera* gel, 0.5% chitosan, control and 100% *A. vera* respectively. PV of 100% *A. vera* gel coated pistachio was even rather than control. Since surface coating causes to a reduction in oxidation, gas permeability and modifies international atmosphere as well, it can be thought that this kind of coating method being more practically affects on shelf life of coated food,<sup>22</sup> which has been considered together with the peroxide value, as a classical index of primary oxidation products.<sup>11</sup>

Peroxide value (PV) is one of the most frequently determined quality parameters during oil production, storage, and marketing. The PV shows the degree of oxidation in the substance and measures the amount of total peroxides as a primary product of oil oxidation.<sup>21</sup> As be seen in Figures least oil oxidation of coated pistachios is related to 0.05% chitosan, followed by 50% *A. vera* gel, 0.5% chitosan, control and 100% *A. vera* respectively. These results showed that since surface coating increase resistance of fruit skin to gas permeability,

creating modified internal atmosphere<sup>22–24</sup> and reducing the respiration rate; maybe can said that each coating that reduced oil oxidation is more suitable for coating, rather than other coatings.

## Conclusion

The results have proved the ability of chitosan and *A. vera* gel coatings used in the present study to extent the post-harvest quality preservation of pistachio. At the end of storage time, results showed that 0.05% chitosan coating had the maximum effect in retarding the change in quality of pistachio (bark Color darkening, lessen of marketability, decay and oil oxidation), to a greater extent than 50% *A. vera* gel, 0.5% chitosan and 100% *A. vera* coatings respectively. Since 100% *A. vera* reduced quality of pistachio is not suitable for coating of pistachio; maybe due to its high concentration that can't penetrate in bark of pistachio. At the other hand, .05% chitosan and 50% *A. vera* since had greatly delayed the physiological changes, are suitable for coating and can be used for transport of fresh pistachio for long distance.

## Acknowledgements

None.

## Conflict of interest

Author declares that there is no conflict of interest.

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