

RESEARCH ARTICLE

Studies to enhance the shelf life of tomato using *aloe vera* and neem based herbal coating

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Received: 08.12.2017

Accepted: 09.03.2018

ABSTRACT

The present study was carried out to evaluate the ability of Aloe gel based herbal coatings to reduce the loss of post harvest quality in Tomato (*Solanum lycopersicum L.*). Unripe green to reddish Tomato fruits were coated with different formulations of *Aloe vera* gel, Neem extract, Salicylic acid and citric acid. The coated and uncoated fruits were stored under different physiological conditions to slow down the ripening process. Visual, Firmness and sensory characteristics and marketability were analyzed at regular intervals during the storage period. It was found that the coatings controlled the physiological loss in weight (PLW), ripening process and decay to a great extent and thus resulted in extended shelf life and better quality of Tomatoes. The effectiveness of *Aloe vera* gel coating was found to improve on incorporation of citric acid and neem extract.

Keywords: *Aloe vera*, edible coating, shelf life, tomato, neem extract.

Citation: Jaiswal, A.K., Kumar, S. and Bhatnagar, T. 2018. Studies to Enhance the Shelf Life of Tomato Using *Aloe Vera* and Neem Based Herbal Coating. *Journal of Postharvest Technology*, 6(2): 21-28.

INTRODUCTION

India incurs postharvest losses of fruits and vegetable worth Rs 2 lakh crore per year, due to lack of proper storage and processing facilities, according to a study in Economic times (2014). Tomato is a major vegetable crop that is used widely throughout the different strata's of the population over the last century. Tomato is grown in an area of 8.65 lakh hectares with an average production of 168.26 lakh tones in India (NHB, 2012). Tomatoes spend so much time on shelves and in refrigerators that an estimated 20 percent are lost to spoilage. From the moment produce is harvested the clock starts ticking and produce decay begins. The main factors that affect shelf life of produce include improper handling, inadequate humidity, temperature abuse and Ethylene exposure. (Mwajjande, 2017; Dang et al., 2008; Workneh et al., 2010) Many tomatoes which are grown for fresh consumption are picked when still firm and green, stored at low temperature, and exposed to exogenous ethylene to induce color and ripeness before reaching the supermarket shelf. Although this process is effective in limiting postharvest losses, these chemicals negatively affect tomato flavor, aroma, and texture (Ali et al., 2017; Baldwin et al., 2011). The common use of ethylene inhibitors affecting ripening has similar negative impacts on flavor. Thus, in the present study, in an attempt to prevent the use of chemicals for increasing the shelf life and decreasing post harvest losses as well as flavor loss in Tomato, *Aloe vera* herbal coatings have been used in different combinations of temperature, pH and plant extracts.

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Aloe vera is widely used as an antimicrobial agent. They protect the quality losses during ambient storage (Ergun and Satici, 2012). The quality is depended on the plant variety, stage of fruits, presents and past condition of the fruit. (Lin and Zhao, 2007; Saks and Barkai-Golan, 1995). *Aloe vera* is used in medicinal and therapeutic properties, because it is a tropical and subtropical plant (Eshun et al., 2004) *Aloe vera* helps in protection from microorganisms and is also a herbal remedy for regeneration and rejuvenation of human skin (Boudreau and Beland, 2006). *Aloe vera* gel is also used in the food industry such as, in drinks, beverages, and ice creams (Moore and MacAnalley, 1995).

MATERIALS AND METHODS

***Aleo vera* gel preparation**

Aloe vera gel [AG] matrix was separated from the outer layer of leave and this colorless hydroparenchyma was ground in homogenizer and the crude *Aloe vera* gel was prepared. This gel was diluted with distill water and filtered to remove the fibers. The liquid obtained constituted fresh *Aloe vera* gel. The gel matrix was pasteurized at 70°C for 45min. After pasteurized the gel was cooled down to ambient temperature. Salicylic acid (2.5g L⁻¹)(SA), citric acid (4.5 g L⁻¹)(CA) and Neem extract (10% - 20%) were added in 40% *Aloe vera* gel (AG) and the pH was maintained at 4. The coating efficiency was improved by using 0.1% commercial gelling agent for coating agent and the fruit and vegetable sample was coated with coating agent (Adetunji et al 2012). After coating, the fruit were weighed and stored under different condition.

Application of Herbal Coating

The fresh fruits were dipped in coating solution at room temperature for 15 min. They were allowed to dry at room temperature to allow a thin film layer to be formed on the fruits. Six tomatoes were used for each parameter testing. Fruits were then weighed and stored at 25°C or 4°C. Tomatoes without coating were stored under same conditions as those for coated fruits.

Parameters analyzed

Various parameters were analysed at fixed intervals. The parameters analyzed included (PLW) Physiological loss in fresh weight (Marpudi et al., 2011), Change in peel colour and sensory analysis of fruit quality. Visual Analysis of the fruit was done for the change in fruit weight and peel color rating.

Peel color rating

Peel colour rating is done on the basis of 6 point score scale as given in Figure 1.

Sensory Analysis

Sensory Analysis was carried out by 6 selected panelists. The fruits were randomly selected from each batch was evaluated visually in terms of peel color, texture, Flavor, Marketability. They rated each of the variant on the basis of 9-point Hedonic Score Scale (1=Dislike extremely, 2=Dislike very much, 3=Dislike moderately, 4=Dislike slightly, 5=neither like nor dislike, 6=like slightly, 7=like moderately, 8=like very much, 9=like extremely).

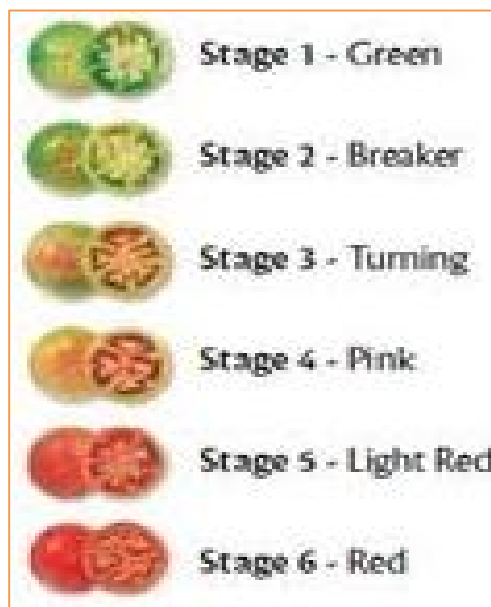


Figure 1. Peel colour rating

RESULTS AND DISCUSSION

The effect of different formulations of *Aloe vera* coating was observed for as long as 36-40 days. Physiological loss in weight during storage was found to be significantly different among the tomatoes treated with the different coatings and control at the end of 20 days storage.

Change in peel color rating is observed in Tomatoes during 36-40 days storage. It was observed that when Pure AG was coated on the tomatoes, the result was astonishing. Since the control tomatoes showed ripening on the 6th day and were red and showed 6 rating of peel color. They also became soft and unmarketable. In comparison the *Aloe* gel coated tomatoes showed ripening at 18 days when kept at 25^oC and ripening at 30 days when stored at 4^oC. Thus, it is observed that the *Aloe vera* gel coating not only prevents fungal growth on the tomatoes, it prevents ripening thus increasing the shelf life and marketability of the tomatoes by 20-24 days. The physiological loss weight was also less in pure AG coated as compared to the control tomatoes (Table 1).

The coating of AG+SA formulations (Table 2) at different concentrations did not give good results as compared to only pure AG coating. Formulations having different concentrations of *Aloe vera* gel, Citric acid, Salicylic acid and Neem extract were tried for the study. Neem extract when used at 20% along with *Aloe vera* gel and Citric acid gave enhanced results (Table. 3). An increase in shelf life and peel color rating was seen from 18 days in 4 °C of the control tomatoes to 36 days for the tomatoes coated with Neem extract +Citric acid +*Aloe vera* gel.

Color, firmness, taste and marketability the major sensory attributes were scored by selected panel members. On 30th day, overall score of 8.7 and 8.0 was obtained for Pure AG and AG+CA+Neem, respectively and Control was already diseased and not eatable on 18 day. AG+CA+Neem gave an overall score of 8.7 even on 36th day after treatment (Table 4).

Table 1. Physiological loss in weight (gm) and Peel color rating with coating of *Aloe vera* gel

Days after treatment	Pure AG coated tomato kept at 4°C		Control tomato kept at 4°C		Pure AG coated tomato kept at 25°C		Control tomato kept at 25°C	
	PLW (gm)	Peel color	PLW	Peel color	PLW	Peel color	PLW	Peel color
0	88.38±3.3	1	84.34±2.3	1	83.12±3.2	1	81.65±2.4	1
6	85.94±2.4	2	72.56±3.3	3	80.75±3.8	3	72.38±2.7	6
12	83.51±2.1	3	65.31±2.9	6	78.38±2.6	5		
18	82.29±1.6	4			73.65±2.1	6		
24	81.08±1.5	5						
30	80.65±2.5	6						

Table 2. Physiological loss in weight (gm) and Peel color rating with coating of Salicylic acid + 40% *Aloe vera* (4°C) and (25 °C).

Days after treatment	AG + 10% Neem extract	Peel color	AG + 20% Neem extract	Peel color	Control	Peel color
	PLW		PLW		PLW	
0	65.21±1.5	1	66.24±2.3	1	63.94±2.1	1
6	60.18 ±1.2	2	61.12 ±3.2	2	55.25 ±2.5	3
12	57.21 ±2.2	3	56.22 ±1.5	3	49.15 ±2.7	5
18	52.12 ±1.8	4	51.14 ±2.4	4		
24	45.36 ±1.6	5	46.52 ±2.4	5		

Table 3. Physiological loss in weight (gm) and Peel color rating with coating of Neem extract + 40% *Aloe vera* (4°C)

Days after treatment	AG+ CA +10% Neem extract	Peel color	AG+ CA + 20% Neem extract	Peel color	Control	Peel color
	PLW (gm)		PLW (gm)		PLW (gm)	
0	63.65±4.1	1	64.48±2.4	1	63.94±2.5	1
6	61.17 ±1.5	2	62.82 ±1.6	2	60.25 ±2.4	3
12	56.58 ±1.6	3	60.04 ±1.3	3	55.15 ±1.8	5
18	51.45 ±2.8	4	58.12 ±2.5	3	51.23 ±2.1	6
24	50.32 ±3.5	5	56.33 ±3.2	4		
30	48.65 ±3.2	5	54.24 ±3.4	5		
36	46.25 ±1.4	6	52.15 ±2.8	6		

Table 4. Sensory and Visual Analysis of tomatoes on basis of 1-9 scale

Days after treatment	Pure AG coated tomato kept at 4°C	AG+S.A (4°C)	AG+20% Neem	AG+ CA + 20% Neem extract	Control
0	3	3	3	3	3
6	3.6	3.4	3.2	2	4.8
12	4	3	4	3	6
18	4.8	8	6	3	7
24	6		8.3	7.5	
30	8.7			8	
36				8.7	

Mean Physiological weight loss, Peel color and sensory and visual analysis of all samples was calculated after calculation of Standard deviation. Using one-way ANOVA, p values of Physiological weight loss ($0.025 < 0.05$) and Peel color change ($0.001 < 0.05$) indicated that there was a significant difference between the shelf life of tomatoes when *Aloe vera* gel was used as an edible coating at 4°C. Standard deviation in above parameters is shown in tables for PLW. The peel color,

sensory and visual analysis is the mean of replicates for every test.

DISCUSSION

There is a high production of tomato fruits during the harvest time, but post-harvest processing and preservation techniques are inefficient. Therefore, fruits spoil very early because of lack of appropriate systems of preservation and processing (Ameyapoh et al., 2008). Edible coatings can provide an additional protective coating for fresh products and can also give the same effect as modified atmosphere storage (Park et al., 1994). (Tharanathan, 2003). *Aloe vera* is a tropical or subtropical plant containing two major liquid sources, yellow latex (exudates) and clear gel (mucilage). Yellow latex is mainly composed of aloin, alo-emodin and phenols. The mucilaginous jelly from the parenchymal cells of the plant is the *aloe vera* gel.

In the present work *Aloe vera* gel with Citric acid and neem extract was used to study their effect on increasing the shelf life by spraying the above mixture on the tomatoes. Control showed complete ripening red in colour, soft and marketable at 12- 18 days at different temperatures, AG+SA coated showed similar to control. AG+CA+Neem showed ripening and firmness and good taste on 36th day also. Pure AG coated tomatoes were intermediate between the control and Neem and Citric acid coated. They gave a marketability range of 24 days.

Pure *Aloe vera* gel and *aloe vera* gel with citric acid coated tomatoes when maintained at pH-4, at 25 °C showed delayed ripening and extended the shelf life upto 16- 18 days whereas control got deteriorated within 5 days.

The results have proved the ability of different formulations of *Aloe vera* in extending the shelf life of tomatoes. Tomatoes stored with *Aloe vera* formulation having both Neem extract and Citric acid showed the maximum control on ripening in Tomatoes. Pure *Aloe vera* gel has extended the shelf life up to 30 days. Different concentrations of pure *Aloe vera* has shown appreciating results. 40% *Aloe vera* gel with citric acid gave the best results in comparison to 20% ,40%,60%,80% *Aloe vera* gel coated tomatoes.

Composed of polysaccharides, the *Aloe vera* gel appears to act as a natural barrier to moisture and oxygen which can speed up food deterioration. It can also enhance food safety. *Aloe vera* gel appears to contain various antibiotic and antifungal compounds that can potentially delay or inhibit microorganisms that are responsible for food borne illness in humans as well as food spoilage (Athmaselvi et al., 2013).

In a similar study by Chrysargyris et al. (2016), tomato fruit were coated with 0%, 5%, 10%, 15% and 20% *Aloe vera* gel and fruit quality maintenance was examined up to 14 days at 11 °C and 90% relative humidity. Results showed that 10% and 15% *A. vera* coating reduced fruit ethylene production. Chauhan et al, 2015 gave experimental results showing tomato fruits showed a shelf life of 9 and 12 days respectively for shellac alone and shellac with AG coated fruits against the shelf life of 6 days for uncoated fruits at ambient temperature (26–32 °C). The coating made up of shellac alone gave lesser shelf life due to excessive ethanol formation caused by anaerobiosis.

Aloe 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. (Kumar and Bhatnagar, 2014; Dandago et al., 2017)

Mean fresh weight, firmness and PG activity of all three samples are 26.43g, 3.78 kg/cm² and 67.69 mg glucose

equivalent/g fresh weight/hr respectively. Using one-way ANOVA, p values of fresh weight remains ($0.029 < 0.05$), firmness ($0.001 < 0.05$) and PG activity ($0.13 < 0.05$) indicated that there was a significant difference between PG activity of all treatments applied to tomato fruits. (Borah et al., 2014)

Aloe vera with citric acid and neem extract can thus play significant role in extension of shelf life of tomatoes as less microbial infection is observed comparative to other formulation of *Aloe vera*. *Aloe vera* with citric acid and neem extract improved the quality, firmness, color, marketability & sensory characteristics of tomato. Application of an edible coating can thus become a technique that can be used to increase vegetable and fruit storability/shelf life.

ACKNOWLEDGEMENTS

All the present research work has been done in the laboratories of Codon Biotech Pvt. Ltd., Noida.

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