RESEARCH PAPER — FOOD SCIENCE RESEARCH JOURNAL

e ISSN-2230-9403 ■ Visit us : *www.researchjournal.co.in*
Volume 8 | Issue 2 | October, 2017 | 132-137
DOI : 10.15740/HAS/FSRJ/8.2/132-137

Application of biodegradable *Aloe vera* gel for extending the shelf-life of tomato

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The search for biodegradable, safe, healthy and environmental friendly treatments for increasing storage period of fruits has lead to use of edible, biodegradable films or coatings. Biopreservations is a novel food preservation method defined for extension of shelf-life and enhanced safety of foods by the use of natural or controlled microbiota and/or antimicrobial compounds. *Aloe vera* gel is applied to fruits as an edible coating which has been widely used for most fruits and vegetables. The aim of this work was to analyze the effects of biodegradable *Aloe vera* gel (aloe alone,1:1,1:2) along with 1% pectin or CMC coating on tomato stored at room temperature. Matured leaves of *Aloe vera* plants were harvested and washed and gel was extracted. The viscosity of *Aloe vera* gel and its coating efficiency was improved by using 1% thickening agent such as CMC and pectin. *Aloe vera* gel (*Aloe vera* juice mixed with 1% CMC / 1 % pectin) was taken in three different concentrations *i.e.,* alone alone, 1:1(200 ml of *Aloe vera* gel: 200 ml of water), 1:2 (133.3 ml of *Aloe vera* gel: 266.6 ml of water). The matured tomatoes (80%) were dipped in the coating solutions at room temperature for 10 min. At regular intervals, the fruits were rotated to increase the coating efficiency. They were allowed to drain for 2 min and then dried at room temperature under fan, to increase drying rate. The treated samples were packed in 100 gauge polyethylene bags with 1 % vent and another set of samples were kept without packing. The control and treated samples were stored at room temperature. The results revealed aloe gel coating to be very beneficial in reducing the weight loss, minimizing changes in physico-chemical parameters (titrable acidity, total soluble solids, lycopene) of the fresh fruits. The overall result showed that the *Aloe vera* gel coatings along with CMC and pectin is effective in extending the shelf-life of tomato fruits when compared to untreated tomato in the following order: Aloe +pectin (without packing) > Aloe +CMC (without packing) > Control. In respect of combined effects, tomato treated with *Aloe vera* + 1% pectin(without packing) showed the longest shelf-life (20 days), followed by *Aloe vera* + 1% CMC (without packing) whereas the shortest shelf-life (8 days) was recorded in control condition.This work evaluates the use of *Aloe vera* as biopreservative, which is an economical and eco-friendly.

Key Words : C M C (Carboxy methyl cellulose), Pectin

How to cite this article : Kanmani, Meenakshi, V. and Sashidevi, G. (2017). Application of biodegradable *Aloe vera* gel for extending the shelf-life of tomato. *Food Sci. Res. J.,* **8**(2): 132-137, **DOI : 10.15740/HAS/FSRJ/8.2/132-137**.

INTRODUCTION

In Tamil Nadu, Tomato is an important vegetable for almost every culinary purposes. It is being grown in all over Tamil Nadu. Tomato being a third most cultivated crop (NHB, 2012), the post harvest losses is significant in terms of quantity and value.The total post harvest losses of improved and hybrid varieties of tomatoes were 32.8 and 25.3 per cent, respectively. Moreover marketing of fresh tomato is a great problem because of its short post-harvest life, which leads to high post-harvest losses

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.Tomato fruits soften rapidly at room temperature after harvest and a 6 days shelf-life is to be expected.

Tomato is an easy access to post harvest infection and leads to considerable losses, Fruit coating after harvesting is becoming popular in this aspects. However possible health risks associated with the residue is of consumer concern. Edible coatings have no residue associated with health risk are an alternative options.

Edible films and coatings play an important role in the quality, safety, transportation, storage, and display of a wide range of fresh and processed foods (Daniel and Yanyun, 2007). Edible coating prevents the passing of moisture and gases, and improves food preservation conditions, and is a strategy for improving the quality and shelf-life of food products. In addition, these materials are very good carriers for bioactive substances including antimicrobial agents, antioxidants, minerals and vitamins (Bonilla *et al.,* 2012).

Aloe vera is a stem less and very short- stemmed succulent plant belongs to family Liliaceae (Surjushe *et al.*, 2008 and Ni *et al.*, 2004). It has been used for centuries for its medicinal and therapeutic properties (Eshun and He, 2004). The two major liquid sources of *A. vera* are a yellow latex (exudates) and a clear gel (mucilage), which proceeds from the large leaf parenchymatic cells. The predominant medical uses of the orally ingested gel juice are against ulcerous, gastrointestinal, kidney and cardiovascular problems and also reduces the cholesterol and triglyceride levels in blood. Moreover, other properties such as anti-inflammatory and antibiotic activities against some diseases.

Currently, there is an increasing interest in the use of *Aloe vera* gel in the food industry, being used as a source of functional foods in drinks, beverages and ice creams. Several studies reported the antifungal and anti microbial properties of *Aloe vera* in extending the shelf-life of fruits. Bourtoom (2008) reported that *Aloe vera* gel is a new edible coating. This is a polysaccharide coating and has features such as a protective layer on the product, reducing the loss of fruit juice, and reducing the flow rate of the gases of the skin.

Therefore this study was conducted with the objective of evaluating the effects of the different *Aloe vera* gel on post harvest life of tomato and and quality attributes of tomato such as weight loss, total soluble solids (TSS), titrable acidity, Lycopene and colour changes.

METHODOLOGY

Raw materials:

The local variety of tomato fruits were purchased from Alanganallur village @ 80 % maturity level.Uniform sized, defect-free fruits were selected.

Preparation of edible coatings of *Aloe vera* :

Matured leaves of *Aloe vera* plants were harvested and washed. The viscosity of *Aloe vera* and its coating efficiency was improved by using 1% thickening agent such as CMC /pectin which was used as coating agent.

Aloe vera gel was extracted from *Aloe vera* leaves. Each aloe leaf is made up of four layers. The first layer is the rind. This is the hard greenish gray outer protective layer of the leaf. The second layer consists of a bitter liquid called sap. This is located under the rind and surrounds the gel. The third layer contains mucilage gel which is known as the inner leaf area. And finally, the fourth layer is where the *Aloe vera* is located.

Extraction procedure of *Aloe vera* gel from the leaves follows six steps: Cutting the leaves from plant, standing them upright for 15 min to drain the sap, slicing off the top skin layer of the leaf, cutting away the two side pieces of the leaf, slicing away the gel from the bottom layer of the skin and to prevent spoilage**.**

Application of the edible coating solutions :

The fresh tomato fruits were dipped in the coating solutions at room temperature for 10 min. At regular intervals, the fruits were rotated to increase the coating efficiency. They were allowed to drain for 2 min and then dried at room temperature under fan, to increase drying rate.

Treatments :

Tomatoes were given *Aloe vera* coating with the CMC in three different concentrations *i.e.*, aloe gel+ 1% CMC, 1:1 (200 ml of *Aloe vera* gel: 200 ml of Water) + 1% CMC, 1:2 (133.3 ml of *Aloe vera* gel: 266.6 ml of water). Similarly tomatoes were given *Aloe vera* gel with the pectin was taken in three different concentrations *i.e.*, aloe gel + 1% pectin, 1:1+ 1% pectin, 1:2+ 1% pectin. The treated samples and control samples were packed with 1 % vent and and one set without packing and kept at room temperature. Physio-chemical analysis was carried out 3 rd days of after coating.

Control- without any treatment with out packing

Tc1 – Tomatoes coated with aloe + 1% CMC with packing

Tc2 – Tomatoes coated with 1: 1 + 1% CMC with packing

Tc3 – Tomatoes coated with 1: 2 + 1% CMC with packing

Tc4 – Tomatoes coated with aloe + 1% CMC with out packing

Tc5 – Tomatoes coated with 1: 1 + 1% CMC with out packing

Tc6 – Tomatoes coated with 1: 2 + 1% CMC with out packing

Tp1- Tomatoes coated with aloe + 1% pectin with packing

Tp2- Tomatoes coated with 1: 1 + 1% pectin with packing

Tp3- Tomatoes coated with 1: 2 + 1% pectin with packing

Tp4- Tomatoes coated with aloe + 1% pectin with out packing

Tp5- Tomatoes coated with 1: 1 + 1% pectin with out packing

Tp6- Tomatoes coated with 1: 2 + 1% pectin with out packing

Physiological weight loss:

To evaluate weight loss, separate samples of each treatment were used. The same samples were evaluated for weight loss each time at regular intervals until the end of experiment. Weight loss was determined by the following formula: Physiological weight loss (%) = [(A–B)/A] x 100.Where A indicates the fruit weight on the first day and B indicates the weight on the final day.

Acidity:

Ten ml of squeezed fruit juice was diluted to 50ml with distilled water and titrated against 0.1N NaOH by using phenolpthalein as indicator. The results were expressed as % total acids (titrable acidity).

TSS:

Individual tomato fruit from each of the treatment will be ground manually using pestle and mortar for freshly prepared juice. Soluble solids content was measured using T/C hand refractometer in Brix per cent .

Lycopene:

Lycopene was determined by extracting 5 g of sample with acetone and transferred to separating funnel containing 20 ml of petroleum ether. Upper phase petroleum ether ex- tract containing lycopene in made upto 100 ml with petroleum ether and absorbance was measured at 503 nm using petroleum ether as blank (Ranganna, 2004).

Colour :

Colour value is measured by using hunter lab colour meter and “L”, “a , “b” values are noted.

OBSERVATIONS AND ASSESSMENT

The results obtained from the present investigation as well as relevant discussion have been summarized under following heads :

Physiological weight loss in % :

Weight loss is an important index of Postharvest activities. It is mainly attributed to the loss of water during metabolic processes like respiration and transpiration. The physiological weight loss was high in control and followed by those treated with aloe + 1 % pectin without packed samples with pack,tomatoes treated with aloe + 1 % CMC without packed samples than with pack at the end of storage period.The application of *Aloe vera* and pectin/ CMC coating retarded the weight loss of the tomato. The slower rate of moisture loss from the pectin coated fruits may be attributed to the additional barrier against diffusion through stomata (Table 1).

Mohebbi *et al*. (2012) examined the physico-chemical properties of mushrooms coated with *Aloe vera*, gum, tragacanth, and a combination of the two coatings, and observed that the coated samples compared to the control had lower weight loss and discoloration. They conclude that mixed coating was the best covered. This quality parameter is crucial since every loss in weight can be translated into an economic loss.

Table 1 : Effect of Aloe treatments on Physiological weight loss of tomatoes during storage

Control	CMC						Pectin					
	Tc1	Tc2	Tc3	Tc4	Tc5	Tc6	Tp1	Tp2	Tp3	Tp4	Tp5	Tp6
80.2 %	20.34	26.62	25.26	16.36	13.39	19.38	14.28	24.62	41.87	12.28	8.6	15.87

Colour changes :

Tomatoes, both control and coated, registered some changes in L*, a* and b* values during the storage period. L* means lightness. There was a decrease in L* value in aloe CMC / pectin coated samples in without packing samples from initial to 20th days of storage (Table 2). When red colour pigments started to synthesise, there was a decline in L* value.There was a increase in L* value in aloe CMC / pectin coated samples in with packing samples and control from initial to 20th days of storage. Similar results was reported by Ergun and Satici (2012).

*a** values change from negative (green colour) to positive (red colour) . *a** value of controlon the 20th day was 22.50, whereas for the coated fruit on the same day ranges between 6.20(TC_1) to 13.20 (TP4). Chromatic a* value also increased over time irrespective of the treatments.The increase in *a** value was, however, slower for the tomatoes treated with *Aloe vera* gel compared to control. Nazamin Sepheri *et al.* (2015) reported that coating of chitosan along with aloe increased a* factor which is consistent with our results. Athmaselvi *et al.* (2013) examined the colour value (a* value) of tomato coated with *Aloe vera* gel showed the significant increase from negative to positive value.

The initial b* (blue to yellow) values for control was 21.98 and 21.60, afterwards the values gradually decreased to 12.43 on 20th day. b* value of 100 % aloe + 1 % CMC coated samples in with pack and without pack was 17.45 and 12.89, the values gradually decreased to 12.29 and 9.0 on 20th day of storage. Similar trend was observed in tomatoes coated with CMC 1:1,1:2 and tomatoes coated with pectin 1:1,1:2 both in packed and without packed samples.

Changes in chemical characters during storage :

Acidity :

The acidity of tomato plays a major role and imparts taste to the fruit. The predominant acids in ripened tomato fruit are citric acid and malic acid. The acidity of fresh tomatoes can be closely associated with their degree of ripeness. The more mature and ripe, the lower the acidity.

Titrable acidity increased in aloe coated samples with CMC in without packed /pectin in all the samples and control during storage then a decrease was observed. The reduction was low in coated samples than control. Greater TA content (Titrable acidity) retention of coated samples, which indicated that control (uncoated fruits) fruits presented a more pronounced maturation development than coated samples during storage periods. Aloe coating must have modified internal atmosphere thus reducing ripening and maintenance of the titrable acidity.

Tomatoes treated with CMC,1:1,1:2 treated samples in with pack condition showed a decreasing trend. Reduction in TA is due to conversion of acid to sugars

Table 2 : Effect of Aloe treatments on color changes of tomatoes during storage

Storage days	Control	CMC						Pectin					
		Tc1	Tc2	Tc3	Tc4	Tc5	Tc6	Tp1	Tp2	Tp3	Tp4	Tp5	Tp6
Initial	33.5	42.28	44.32	39.98	45.53	39.98	36.62	36.63	39.42	36.64	12.28	24.62	41.87
8th day	35.01	41.38	40.51	38.84	44.54	35.64	35.52	34.81	36.00	36.60	15.28	27.72	42.67
15th day	37.69	40.60	42.25	38.87	47.81	36.64	38.87	34.70	35.60	35.50	16.63	30.60	45.28
20th day	38.61	39.36	41.00	35.63	40.64	39.92	30.64	33.39	33.22	34.46	17.28	33.39	44.67
Colour value (a* value)													
Storage days	Control	CMC						Pectin					
		Tc1	Tc2	Tc3	Tc4	Tc5	Tc6	Tp1	Tp2	Tp3	Tp4	Tp5	Tp6
Initial	-7.74	-7.79	-6.50	-7.78	0.91	2.34	4.40	0.82	-0.78	-1.23	0.5	2.20	-1.42
8th day	-4.48	-5.20	0.21	1.10	3.30	5.40	7.20	-0.3	0.5	0.86	3.5	4.50	2.20
15th day	17.48	3.39	4.25	6.50	7.76	9.27	9.25	2.57	3.8	2.54	7.25	7.20	5.40
20th day	22.50	6.20	7.56	8.80	9.50	11.20	12.25	5.80	12.24	10.45	13.20	11.20	8.50
Colour value (b* value)	Control	CMC						Pectin					
		Tc1	Tc2	Tc3	Tc4	Tc5	Tc6	Tp1	Tp2	Tp3	Tp4	Tp5	Tp6
Initial	21.98	17.45	19.50	22.27	20.50	24.54	23.25	12.89	17.09	13.3	15.0	20.40	16.64
8th day	21.72	15.56	17.26	20.40	19.56	20.50	21.42	12.4	15.59	12.39	14.28	17.40	15.50
15th day	22.00	14.42	17.0	19.94	17.24	19.65	19.56	11.10	14.49	11.40	12.20	15.54	13.39
Final	12.43	12.29	15.24	18.50	15.40	17.36	18.32	9.0	12.20	9.5	10.24	14.20	12.56

and their further utilization of fruits in the metabolic process (Table 3).

TSS :

TSS concentration slightly increased initially and latter decreased in tomatoes coated with CMC /pectin samples in without packing condition .The total soluble solids increases as the fruit ripens there complex carbohydrates were converted to simple sugars. The coating with *Aloe vera* led to a lower increase in TSS, which indicated less maturation development. The decrease may be due to the break-up of carbohydrates and pectin, partial hydrolysis of protein, and decomposition of glycosides into subunits during respiration causing a decrease of total soluble solids; similar results were also reported by Athmaselvi *et al.* (2013). TSS of control and CMC /pectin coated tomatoes in packed samples showed a decreasing trend (Table 4).

Lycopene:

During ripening the chlorophyll content decreases, and there is a rapid synthesis of the red pigment lycopene. The lycopene content of control increased from 0.40 to 2.71 mg %. Similarly, lycopene of CMC / pectin coated tomatoes samples in with out packing condition showed a gradual increase till 10th day of storage and then a decreasing trend till 16th days of storage. There was a steady increase in the lycopene content of both the control and coated tomatoes that are not packed. A decreasing trend in lycopene content was observed in CMC /pectin coated tomatoes packed in LDPE bags (Table 5).

Table 3 : Effect of Aloe treatments on acidity (%) of tomatoes during storage

No. of days	Control	CMC						Pectin					
		Tc1	Tc2	Tc3	Tc4	Tc5	Tc6	Tp1	Tp2	Tp3	Tp4	Tp5	Tp6
Initial	1.02	2.56	2.68	3.01	1.02	2.17	0.64	0.89	0.12	1.1	1.6	0.12	1.1
6th day	1.42	2.1	2.5	2.90	1.66	2.53	1.02	1.40	0.89	1.40	1.89	0.76	1.53
8th day	1.40	1.92	2.4	2.12	1.79	2.04	2.17	1.5	1.40	1.40	1.89	1.79	2.89
10th day	-	1.78	2.6	2.5	5.8	6.78	6.91	-	-	-	2.50	3.42	5.0
14th day	-	-	-	-	1.7	1.2	4.4	-	-	-	7.42	6.52	7.42
16th day	-	-	-	-	4.48	5.12	3.84	-	-	-	4.48	3.07	2.04
20th day	-	-	-	-	-	-	-	-	-	-	1.28	3.2	1.28

Table 4 : Effect of Aloe treatments on TSS (^{o}Bx)content of tomatoes during storage

No. of days	Control	CMC						Pectin					
		Tc1	Tc2	Tc3	Tc4	Tc5	Tc6	Tp1	Tp2	Tp3	Tp4	Tp5	Tp6
Initial	3.0	4.0	4.5	5.0	4.5	5.0	5.0	7.0	5.0	7.0	5.0	5.0	5.0
6th day	2.0	4.0	4.5	4.5	5.0	5.0	5.5	5.5	5.0	6.0	5.5	5.5	5.5
8th day	-	3.5	4.0	4.0	5.0	5.5	6.0	4.8	5.0	5.7	4.5	5.0	5.0
10th day	-	-	-	-	4.0	6.0	5.5	4.0	4.0	3.0	3.3	5.0	4.0
14th day	-	-	-	-	4.0	4.5	4.5	-	-	-	5.0	5.0	5.0
16th day	-	-	-	-	4.0	4.5	4.5	-	-	-	4.5	4.5	4.5
20th day	-	-	-	-	-	-	-	-	-	-	4.5	4.5	4.5

Table 5 : Effect of Aloe treatments on lycopene content (mg/100g) of tomatoes during storage

No. of days	Control	CMC						Pectin					
		Tc1	Tc2	Tc3	Tc4	Tc5	Tc6	Tp1	Tp2	Tp3	Tp4	Tp5	Tp6
Initial	0.40	2.56	2.68	3.01	2.17	0.64	0.12	0.59	0.42	1.17	0.02	0.46	0.34
6th day	1.70	2.1	2.5	2.9	2.66	1.53	1.02	0.59	0.48	0.95	0.18	0.76	0.85
8th day	2.71	1.92	2.0	0.12	2.79	2.04	2.17	0.62	0.51	0.84	0.37	2.39	1.14
10th day	-	-	-	-	5.8	6.78	6.91	1.54	1.71	0.84	1.68	4.24	2.73
14th day	-	-	-	-	2.7	1.2	4.4	-	-	-	3.04	3.05	3.58
16th day	-	-	-	-	1.48	0.12	3.84	-	-	-	6.33	2.27	4.96
20th day	-	-	-	-				-	-	-	3.02	2.19	1.02

Conclusion:

Coating with natural compounds is a minimal process which is more accepted by consumers compared to other shelf-life extension methods. The results revealed aloe gel coating to be very beneficial in reducing the weight loss, minimizing changes in physico-chemical parameters (titrable acidity, total soluble solids, lycopene) of the fresh fruits. The overall result showed that the *Aloe vera* gel coatings along with CMC and pectin is effective in extending the shelf-life of tomato fruits when compared to untreated tomato in the following order: Aloe +pectin (without packing) > Aloe +CMC (without packing) > Control. This work evaluates the use of *Aloe vera* as biopreservative, which is an economical and eco-friendly. In fact it can be considered as a green alternative to synthetic coatings and other postharvest chemical treatments.

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Received : *25.06.2017;* **Revised:** *15.07.2017;* **Accepted :** *01.08.2017*