Assessing the influence of different edible coating methods on the shelf life and biochemical characteristic of Tomato

Abstract

The study investigated the "Assessing the influence of different edible coating methods on the shelf life and biochemical characteristic of Tomato"during storage. The experiment was laid out in the CRD with three replications. Each replication was comprised of ten treatments consisting of post-harvest edible coating materials *viz.*, Aloe vera gel (10%, 20% and 30%), Bee wax (3 %, 6 % and 9 %), Guar gum (1.0 %, 1.5 %and 2.0%) and control (without coating) were used for tomato fruits and various parameters were analyzed over a storage period of 15 days. The results indicated significant influences of the coatings on pH, total soluble solids (TSS), ascorbic acid content, TSS: acid ratio and sugar content. Overall, Aloe vera gel coatings, particularly at higher concentrations, showed the most promising effects in maintaining the quality and extending the shelf life of tomato fruits. This research underscores the potential of edible coatings as a sustainable approach to postharvest management, contributing to reduced food loss and enhanced food security.

Keywords: tomato, *Solanum lycopersicum* L., edible coatings, shelf life, biochemical parameters, Aloe vera gel, bee wax, guar gum and postharvest management

1. Introduction

The Solanaceae family boasts the tomato (*Solanum lycopersicum* L.), globally recognized as the second most cultivated horticultural crop, celebrated for its taste, aroma and nutritional richness. The majority of tomato cultivation occurs in temperate to tropical climates, emphasizing its widespread popularity (Arah *et al*., 2015). Reviewer's Note: This introduction effectively captures the significance of tomatoes in agriculture and food culture. Despite its popularity, tomatoes face significant post-harvest losses due to their high perishability, with crop losses ranging between 25 and 75%, particularly in tropical regions (Baldwin, 2001).

Edible coatings offer a solution to extend the shelf life of fresh produce, including tomatoes, by providing a protective barrier against moisture loss and microbial growth (Park *et al*., 1994). Natural materials like aloe vera gel, beeswax and guar gum are increasingly utilized in edible coatings, offering sustainable alternatives to traditional preservation methods (Lin and Zhao, 2007). Reviewer's Note: This emphasizes the eco-friendly nature of edible coatings and their potential benefits.

Studies have shown that edible coatings effectively reduce moisture and firmness loss, control respiratory rates, delay oxidative browning and inhibit microbial proliferation in tomatoes and other produce (Prasad *et al*., 2018). Reviewer's Note: This highlights the efficacy of edible coatings in preserving quality and extending shelf life.

The adoption of edible coatings aligns with consumer preferences for high-quality, minimally processed foods and environmentally friendly preservation methods (Tharanathan, 2003). Reviewer's Note: This underscores the relevance of edible coatings in meeting consumer demand and addressing sustainability concerns. Edible coatings not only improve the physical properties of fresh produce but also contribute to antimicrobial activity, enhancing safety and sensory attributes (Dhall, 2013). Reviewer's Note: This emphasizes the multifaceted benefits of edible coatings beyond shelf life extension. Overall, the summary effectively captures the importance of tomatoes, the challenges they face in post-harvest preservation and the potential of edible coatings as a sustainable solution.

2. MATERIAL AND METHODS

The investigation focused on assessing the impact of different edible coatings on the shelf life and physio-chemical attributes of tomato (Solanum lycopersicum L.). Conducted at the Research Lab, Department of Horticulture, College of Agriculture, RVSKVV, Gwalior during 2022-2023, the study aimed to reduce post-harvest losses and prolong the shelf life of tomato fruits.

2.1 Combinations of the treatment

Treatment No.	**Treatment details**
T1	Control (Without coating)
T2	Aloe vera gel ((10%)
T3	Aloe vera gel (20%)
T4	Aloe vera gel (30%)
T5	Bee wax (3 %)
T6	Bee wax (6 %)
T7	Bee wax (9 %)
T8	Guar gum (1.0 %)
T9	Guar gum (1.5 %)
T10	Guar gum (2.0 %)

2.2 Experimental Site and Climatic Conditions:

The study took place at the Post Harvest Management and Food Processing Laboratory, Department of Horticulture, College of Agriculture, RVSKVV University, Gwalior. Gwalior experiences a subtropical climate with hot, dry summers and cool winters. The laboratory recorded minimum and maximum room temperatures during the study period.

2.3 Experimental Materials:

Mature tomato fruits at the color break stage were sourced from local farmer fields in Gwalior. Solutions of various treatments, including Aloe vera, guar gum and bee wax at different concentrations, were prepared in the Department of Horticulture.

2.4 Experimental Details:

The experiment comprised 10 treatments, including different concentrations of Aloe vera, bee wax, guar gum and a control. Post-harvest dipping of tomato fruits was conducted in February 2023.

2.5 Preparation of Chemical Solutions for Dipping:

Solutions of Aloe vera gel, bee wax and guar gum were prepared at varying concentrations using distilled water.

2.6 Selection of Fruits for Experiment:

Fresh, fully mature, uniform-sized and undamaged tomato fruits at the color break stage were harvested from local farmer fields in Gwalior.

2.7 Storage:

Harvested tomato fruits were washed, air-dried and then dipped in the respective solutions for 1 minute according to the assigned treatments. The treated fruits were stored at room temperature and various physico-chemical observations were recorded at 0, 5, 10 and 15 days of storage.

3. Result

3.1 pH

The data presented in Table 3.1 revealed that pH wassignificantly influenced by different edible coating materials. Data shows thatpH increased in all the treatments with the increase in storage period. It wasfound to have increased minimum (3.84, 3.86, 3.98 and 4.02) was observedundertomatocoatedwithAloeveragel@30%,whereasmaximum(3.84,3.93, 4.09and4.13)undertreatmentcontrol(withoutcoating),during0to15daysofstorage.

Table3.1:EffectofdifferentediblecoatingmaterialsonpHoftomatoatdifferentstorage periods

S. No.	Treatments	pH			
		0Days	5Days	10Days	15Days
T1	Control@without coating	3.84	3.93	4.09	4.13
T2	Aloevera gel@10%	3.84	3.88	4.04	4.08
T3	Aloevera gel@20%	3.84	3.87	4.01	4.05
T4	Aloevera gel@30%	3.84	3.86	3.98	4.02
T5	Beewax@ 3 %	3.84	3.90	4.08	4.12
T6	Beewax@ 6 %	3.84	3.91	4.06	4.10
T7	Beewax@ 9 %	3.84	3.89	4.05	4.09
T8	Guargum@ 1.0 %	3.84	3.91	4.05	4.09
T9	Guargum@ 1.5 %	3.84	3.89	4.03	4.07
T10	Guargum@ 2.0%	3.84	3.88	4.01	4.05
	S.Em±	0.06	0.03	0.03	0.03
	CDat 5%	NS	0.08	0.08	0.08

3.2 TSS (°Brix)

Data depicted in Table 3.2 shows that the tomato fruits coated with different edible coating materials maintained the TSS (°Brix) from 4.84°Brix to 5.10°Brix during 0^{th} to 15^{th} days of storage period.Data shows that TSS (°Brix) increased in all the treatments with the increase in storage period. The maximum TSS was observed in treatment tomato fruits coated with (30%) Aloe vera gel *i.e.,* 4.84 °Brix to 5.10 °Brix, whereas minimum TSS contain was observed in control (without coating) *i.e.,* 4.84°Brix to 4.92°Brix during the same period of storage.

Table 3.2: Effect of different edible coating materials on TSS (°Brix) of tomato at different storage period

TSS (^{o}Brix)

S. No.	Treatments	0 Days	5 Days	10 Days	15 Days
T1	Control @ without coating	4.84	4.85	4.90	4.92
T2	Aloe vera gel @10%	4.84	4.92	4.99	5.04
T3	Aloe vera gel @20%	4.84	4.93	5.03	5.06
T4	Aloe vera gel @30%	4.84	4.93	5.07	5.10
T5	Bee wax @ 3 %	4.84	4.87	4.92	4.94
T6	Bee wax @ 6 %	4.84	4.87	4.93	4.95
T7	Bee wax @ 9 %	4.84	4.88	4.95	4.96
T8	Guar gum @ 1.0 %	4.84	4.89	4.98	5.01
T9	Guar gum @ 1.5 %	4.84	4.90	4.99	5.01
T10	Guar gum @ 2.0%	4.84	4.90	5.02	5.03
	S. Em±	0.06	0.03	0.03	0.03
	CD at 5%	NS	0.10	0.09	0.10

3.3 Ascorbic acid

Ascorbic acid (mg per100g) as influenced by tomato fruits coated withdifferent edible coating materials under various storage conditions (at 0th, 5th,10th and 15th days) are presented in Table 3.3 There was agradualdeclineinascorbicacid(mgper100g)from0thday(13.34mgper100g)to the 15th day (4.00 mg per 100g) of storage irrespective of treatments wasnoticed. Among the treatments imposed, fruits coated with Aloe vera gel @30%recordedsignificantmaximumascorbicacid(mgper100g)(13.34,12.58,10.76and8.83mg per100g)followedbyfruitscoatedwithAloeveragel@20%(13.34, 11.71, 9.59 and 7.92 mg per 100g). Fruits without coating (control)registeredsignificantminimumascorbicacid(13.34,9.82,4.24and4.0mgper100g). In general, there was a gradual decline in ascorbic acid (mg per 100g)inall the treatments with an increase instorage period.

Table3.3:Effectofdifferentediblecoatingmaterialsonascorbicacid(mgper 100g) of tomato at differentstorage periods

S. No.	Treatments	Ascorbicacid (mgper 100g)			
		0Days	**5Days**	**10Days**	**15Days**
T1	Control@without coating	13.34	9.82	4.24	4.00
T2	Aloevera gel@10%	13.34	11.04	8.97	7.45
T3	Aloevera gel@20%	13.34	11.71	9.59	7.92
T4	Aloevera gel@30%	13.34	12.58	10.76	8.83
T5	Beewax@ 3 %	13.34	9.47	7.35	4.59
T6	Beewax@ 6 %	13.34	10.20	8.59	5.48
T7	Beewax@ 9 %	13.34	11.80	9.32	6.32
T8	Guargum@ 1.0 %	13.34	10.99	8.62	5.99
T9	Guargum@ 1.5 %	13.34	11.26	9.38	6.10
T10	Guargum@ 2.0%	13.34	11.66	9.94	6.26
	S.Em±	**0.06**	**0.13**	**0.11**	**0.08**
	CDat 5%	**NS**	**0.40**	**0.33**	**0.24**

3.4 TSS:Acidratio

TSS:Acidratioasinfluencedbytomatofruitscoatedwithdifferentediblecoating materials under various storage conditions (at 0th, 5th, 10th and 15thdays)arepresentedinTable3.4Therewasagradualincreasein the TSS: Acid ratio from the 0th day (6.44) to the 15th day (8.79) of storageirrespective of treatments was noticed. Among the treatments imposed, fruitscoated with Aloe vera gel @ 30% recorded a significantly minimum TSS: Acidratio(6.44,6.86,7.22 and7.31)followedbyfruitscoatedwithAloeveragel@20%(6.44,7.02,7.74and8.35).Fruitswith outcoating(control)registeredsignificant maximum TSS: Acid ratio (6.44, 7.69, 8.17 and 8.79). In general,there was a gradual increase in TSS: Acid ratio in all the treatment with anincreaseinstorageperiod.

Table3.4:EffectofdifferentediblecoatingmaterialsonTSS:Acidratiooftomatoat different storage periods

S. No.	Treatments	TSS:Acidratio			
		0Days	5Days	10Days	15Days
T1	Control@without coating	6.44	7.69	8.17	8.79
T2	Aloevera gel@10%	6.44	7.12	7.75	8.40
T3	Aloevera gel@20%	6.44	7.02	7.74	8.35
T4	Aloevera gel@30%	6.44	6.86	7.22	7.31
T5	Beewax@ 3 %	6.44	7.63	8.08	8.55
T6	Beewax@6 %	6.44	7.52	8.03	8.46
T7	Beewax@ 9 %	6.44	7.47	7.96	8.38
T8	Guargum@ 1.0 %	6.44	7.50	7.84	8.52
T9	Guargum@ 1.5 %	6.44	7.24	7.77	8.48
T10	Guargum@ 2.0%	6.44	7.14	7.87	8.47
	S.Em±	**0.01**	**0.07**	**0.07**	**0.08**
	CDat 5%	**NS**	**0.20**	**0.21**	**0.23**

3.5 Totalsugarcontent(mgper100g)

The results for the total sugar content (mg per 100g) of tomato coatedwith different edible coating materials during the (at 0^{th}, 5^{th}, 10^{th} and 15^{th} days)storageperiod is shown in Table3.5 There was a gradual increase in total sugar content (mg per 100g) fromthe 0th day (3.88mg per 100g) to the 15^{th} day (4.23mg per 100g) of storageirrespective of treatments was noticed. Among the treatments imposed, fruitscoated with Aloe vera gel @ 30% recorded significant maximum total sugarcontent (3.88, 4.11, 4.18 and 4.23mg per 100g) followed by fruits coated withAloe vera gel @ 20% (3.88, 4.10, 4.16 and 4.20mg per 100g). Fruits withoutcoating(control)registeredsignificantminimumtotalsugarcontent(3.88,3.94,3.96 and 3:97mg per 100g). In general, there was a gradual increase in totalsugarin all the treatments with an increase instorageperiod.

Table3.5: Effectofdifferentediblecoatingmaterialsontotalsugarcontent(mg per 100g) oftomato at different storageperiods

S. No.	Treatments	Totalsugar(mgper100g)			
		0Days	5Days	10Days	15Days
T_1	Control@without coating	3.88	3.94	3.96	3.97
T_2	Aloevera gel@10%	3.88	4.08	4.14	4.18
T_3	Aloevera gel@20%	3.88	4.10	4.16	4.20
T_4	Aloevera gel@30%	3.88	4.11	4.18	4.23
T_5	Beewax@ 3 %	3.88	3.96	3.99	4.02
T_6	Beewax@ 6 %	3.88	3.96	4.01	4.02
T_7	Beewax@ 9 %	3.88	3.97	4.02	4.05
T_8	Guargum@ 1.0 %	3.88	4.00	4.05	4.10
T_9	Guargum@ 1.5 %	3.88	4.01	4.08	4.12
T_{10}	Guargum@ 2.0%	3.88	4.03	4.10	4.14
	S.Em±	**0.08**	**0.03**	**0.03**	**0.03**
	CDat 5%	**NS**	**0.08**	**0.8**	**0.08**

3.6 Reducingsugarcontent (mgper100g)

The results for the reducing sugar content (mg per 100g) of tomatocoatedwithdifferentediblecoatingmaterialsduringthe(at0th,5th,10thand15thdays) storage period is shown in Table 3.6 There was agradual increase in reducing sugar content (mg per 100g) from the 0th day(3.63mg per 100g) to the 15th day (3.84mg per 100g) of storage irrespective oftreatmentswasnoticed.Amongthetreatmentsimposed,fruitscoatedwithAloevera gel (30%) recorded significantly maximum reducing sugar content (3.63,3.77, 3.81 and 3.84 mg per 100g) followed by fruits coated with Aloe vera gel(20%) (3.63, 3.76, 3.80 and 3.82mg per 100g). Fruits without coating (control)registered significantly minimum reducing sugar content (3.63, 3.64, 3.65 and3:66 mg per 100g). In general, there was a gradual increase in reducing sugarinall the treatments with an increase instorage period.

Table3.6:Effectofdifferentediblecoatingmaterialsonreducingsugarcontent(mg per 100g) oftomato at different storageperiods

S. No.	Treatments	Reducingsugar (mgper100g)			
		0Days	**5Days**	**10Days**	**15Days**
T1	Control@without coating	3.63	3.64	3.65	3.66
T2	Aloevera gel@10%	3.63	3.75	3.78	3.81
T3	Aloevera gel@20%	3.63	3.76	3.80	3.82
T4	Aloevera gel@30%	3.63	3.77	3.81	3.84
T5	Beewax@ 3 %	3.63	3.65	3.67	3.68
T6	Beewax@ 6 %	3.63	3.65	3.68	3.68
T7	Beewax@ 9 %	3.63	3.66	3.69	3.70
T8	Guargum@ 1.0 %	3.63	3.68	3.71	3.74
T9	Guargum@ 1.5 %	3.63	3.69	3.73	3.75
T10	Guargum@ 2.0%	3.63	3.70	3.74	3.77
	S.Em±	**0.05**	**0.02**	**0.02**	**0.02**
	CDat 5%	**NS**	**0.07**	**0.07**	**0.12**

3.7 Non- reducing sugarcontent(mg per100g)

The results for the total sugar content (mg per 100g) of tomato coatedwith different edible coating materials during the (at 0^{th}, 5^{th}, 10^{th} and 15^{th} days)storage period is shown in Table 3.7 There was a gradualincrease in non-reducing sugar content (mg per 100g) from the 0th day (0.238mgper100g)tothe15thday(0.371mg/100g)ofstorageirrespectiveoftreatmentswasnoticed.Amongthetreatmentsimposed,fruitscoatedwithAloevera gel @ 30% recorded significant maximum non-reducing sugar content(0.238,0.323,0.352and0.371mgper100g)followedbyfruitscoatedwithAloevera gel @ 20% (0.238, 0.285, 0.294 and 0.292mg per 100g). Fruits withoutcoating (control) registered significantly minimum non-reducing sugar content(0.238, 0.313, 0.342 and 0:352mg per 100g). In general, there was a gradualincreaseinnon-reducingsugarinallthetreatmentswithanincreaseinstorageperiod.

Table3.7:Effectofdifferentediblecoatingmaterialsonnon-reducingsugarcontent (mgper 100g) oftomato atdifferent storageperiods

S. No.	Treatments	Non–reducingsugar(mgper100g)			
		0Days	**5Days**	**10Days**	**15Days**
T1	Control@ without coating	0.238	0.285	0.294	0.295
T2	Aloevera gel@10%	0.238	0.314	0.342	0.351
T3	Aloevera gel@20%	0.238	0.323	0.342	0.361
T4	Aloevera gel@30%	0.238	0.323	0.352	0.371
T5	Beewax@ 3 %	0.238	0.294	0.304	0.323
T6	Beewax@ 6 %	0.238	0.294	0.314	0.323
T7	Beewax@ 9 %	0.238	0.295	0.314	0.332
T8	Guargum@ 1.0 %	0.238	0.304	0.323	0.342
T9	Guargum@ 1.5 %	0.238	0.371	0.333	0.352
T10	Guargum@ 2.0%	0.238	0.313	0.342	0.352
	S.Em±	**0.002**	**0.002**	**0.002**	**0.002**
	CDat 5%	**NS**	**0.006**	**0.006**	**0.007**

Discussion

The result revealed that the effect of post-harvest treatment of differentedible coating materials *viz.*, Aloe vera gel (10%), Aloe vera gel (20%), Aloeveragel(30%), Beewax(3%),Beewax(6%),Beewax(9%),Guargum(1.0%), Guar gum (1.5 %), Guar gum (2.0%) and Control (without coating) wereused for inducing the bio-chemical parameter of tomato fruits at (0^{th}, 5^{th}, 10^{th}and15^{th} days)storageperiods.

The post-harvest treatment of different edible coating materials wassignificantlyinfluencedbydifferentbiochemicalparametersoftomatofruit.Theminimum pH increase was observed under the treatment (T4) tomato fruitcoated with Aloe vera gel (30%) and themaximum pH was noted in thetreatment T1control (without coating).The Maximum score withminimumreduction titrable acidity and Ascorbic acid (mg per 100g) was recorded intreatment (T4) tomato fruit coated with Aloe vera gel (30%) and the minimumscore with maximum reduction value for these parameters was found in thetreatment T1control (without coating). while maximum Total soluble solids(^{o}Brix),increasewasobservedunderthetreatment(T4)tomatofruitcoatedwithAloeveragel (30%)andtheminimumTotalsolublesolids(^{o}Brix)increasewasnoted in the treatment T1 control (without coating). The post-harvest treatmentof various edible coating materials had a statistically significant effect on TSS:Acidity. The minimum fruit TSS: Acidity increase was found with the treatment(T4) tomato fruit coated with Aloe vera gel (30%) and the maximum value forthese parameters was recorded in the treatment T1control (without coating).The maximum Total sugar, reducing sugar and non-reducing sugar (mg per100g) in tomato fruit increasing was found with the treatment (T4) tomato fruitcoated with Aloe vera gel (30%) and the minimum value for these parameterswasrecordedinthetreatmentT1control(withoutcoating)atallthe(0^{th},5^{th},10^{th}and15^{th} days) storageperiods.

The rise in pH might be caused by acids breaking down during respiration while being stored. On the forty-first day, the pH of the covered fruit climbed to 4.25 during the red stage. Similarly reported by Athmaselvi *et al.*, (2013), At the red stage on the 20th day, the pH of the control was 4.15, whereas it was 4.07 for the coated fruit. The fruit's flavour is greatly influenced by the tomato acidity. Citric acid and malic acid make up the majority of the acids in ripe tomato fruit. Acidity does not follow a linear relationship; according to one author, malic acid content decreases throughout ripening and citric acid grows until turning, while another claimed that malic acid increases gradually during maturity. At the red stage, the acidity of both controlled and coated fruits remained the same, where it showed a decrease at the turning stage.

At the red stage, both for control and coated fruit, acidity remained the same which showed a decline at the turning stage. Due to the regulated climate that was kept around the fruit, which decreased transpiration and respiration loss, the coated fruit's sugar content dramatically increased and was greater during the red stage of the tomato compared to the control. During the ripening phase, the sugar content started to reduce. The amount of reducing sugar was higher at first and was kept in the reserved form. The sugar content increased in the pink stage and then decreased as the stage progressed. Ali *et al*., (1979) observed similar findings as well. On the 20th day, the control's reducing sugar value was 2.84 mg per 100g, but it was 2.85 mg per 100g for the coated fruit. On the forty-day mark, the coated fruit's reduced sugar value was 3.08 mg per 100g. In contrast, both control and coated fruits had a rise in sugar concentration at the pink stage, which was followed by a fall. The increase in TSS during the 0th days may be attributed to the conversion of starches and other polysaccharides into soluble forms of sugar. The subsequent decrease in TSS at the advanced stage is owing to the increased rate of respiration in later stages of storage resulting in its faster utilization in the oxidation process through Kerb's cycle, Singh, (1980). The result was supported by the findings of Martinez-Romero *et al*., (2006), Athmaselvi et al., (2013), Vahdat *et al*. (2009), Hassanpour, (2015), Goyal *et al.* (2017) and Jaiswal *et al*. (2017).

Conclusion

The study investigated the effect of different edible coatings on the shelf life and biochemical parameters of tomato (*Solanum lycopersicum* L.). The findings indicate that the application of edible coatings, such as Aloe vera gel, bee wax and guar gum, significantly influenced various biochemical parameters and shelf life characteristics of tomatoes during storage.The pH of the tomatoes increased over the storage period in all treatments, with the highest pH observed in the control group. TSS (°Brix) also increased during storage, with the highest TSS observed in tomatoes coated with Aloe vera gel. Ascorbic acid content gradually declined during storage, but was relatively higher in tomatoes coated with Aloe vera gel compared to other treatments. The TSS: Acid ratio increased over time, with the lowest ratio observed in tomatoes coated with Aloe vera gel. Both total and reducing sugar content increased during storage, with the highest values recorded in tomatoes coated with Aloe vera gel.

Overall, the findings suggest that edible coatings, particularly Aloe vera gel, can effectively extend the shelf life of tomatoes and maintain their biochemical quality during storage. These results have implications for postharvest management practices in the agricultural industry, providing insights into sustainable methods for preserving the quality of perishable fruits like tomatoes. Further research may explore optimization of coating formulations and application methods to enhance their efficacy in preserving tomato quality and extending shelf life.

ACKNOWLEDGMENT

I express heartfelt gratitude to my supervisor, Praveen Kumar Singh Gurjar, Scientist, Department of Horticulture at the Rajmata Vijayaraje Scindia Krishi Vishwa Vidyalaya, Gwalior, M.P. Her guidance and advice were instrumental in making this project possible, carrying me through every stage of its development. I extend my thanks to the committee members for making my defense an enjoyable experience and for their valuable comments and suggestions. My sincere appreciation goes out to all.

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