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Research Article

Evaluation of different plant extracts as a postharvest management strategy for enhancement of shelf life in Tomato fruit

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ABSTRACT

Tomatoes are the most commercialized vegetable due their high nutritional content and health-promoting properties. However, tomatoes have a short shelf life; edible coatings have evolved as an effective approach to enhance its shelf life. Edible coatings are thin layers applied onto the surface of fruits and vegetables to improve their physiochemical properties. Different natural extract such as neem leaf extract, lemongrass leaf extract, ginger extract, garlic extract, aloe vera gel and distilled water along with control were used as edible coating on shelf life and quality of tomatoes under room temperature. Data was collected on many traits i.e., tomato weight loss, fruit pH, fruit color, total soluble salts (TSS), firmness and total phenolics contents. The treated tomatoes showed significantly minimum weight loss, good appearance, color, firmness and high total phenolics contents. So, these natural and environmental friendly edible coating could be considered a potential postharvest treatment to delay ripening and to conserve the quality of harvested tomatoes. Data was analyzed using LSD test at 5% probability level.

Keywords: Tomato, postharvest management, shelf life, quality traits.



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INTRODUCTION

The Tomato is the world's most highly consumed summer vegetable it is most valuable component of many cooked, raw and processed foods (Babalola et al., 2010). In Pakistan, tomatoes are important crops, grown predominantly in Sindh, Punjab and Baluchistan (FAO, 2017). Tomato fruit are most vulnerable to bacterial and fungal degradation after harvest due to their increased activity of water, favourable pH, and rich in nutrition, all of which serves as a growth nutrient for microorganism's growth (Safari et al., 2021). Bacterial deterioration is indicated by appearance of sour rot and soft rot on tomato surface (Das et al., 2020; Spricigo et al., 2021). To cope this short shelf life, there are many postharvest approaches, i.e., hypobaric, modified atmospheric packaging, controlled atmospheric storage (CA), and coating with edible materials are widely used (Oliveira-Bouzas et al., 2021; Paulsen et al., 2019; Pristijono et al., 2017). Organic coating materials are increasingly being used in the post-harvest treatment of tomatoes to improve their shelf life and thus maintain quality. These coatings work by producing barriers that restricts moisture loss and gas exchange, thereby slowing respiration and delaying ripening (Elsabee and Abdou, 2013). Similarly, Aloe Vera Gel; known for its biocompatibility and biodegradability and creates a protective layer that retain moisture and delays the ripening process (Valverde et al., 2005).

Gum Arabic; natural gum forms a film on the tomatoes. This reduces transpiration and respiration, and hence tomatoes shelf life is improved (Ali et al., 2010). Natural coatings of neem, aloe vera, ginger, garlic and distilled water on tomatoes have remarkably affected shelf life as well as quality. Below are the results with enhanced effects of each coating are tabulated in details: (Kumar et al., 2008). Aloe vera gel is widely known for its hydrating and healing properties. Its biocompatibility and biodegradability also make it a very good coating material that can extend the shelf life of fresh produce. The aloe vera gel was helpful in maintaining tomatoes' low weight loss and texture and preserving sensory traits during storage (Valverde et al., 2005). Ginger extract is rich in bioactive compounds, including gingerol and shogaol, possessing huge antimicrobial and antioxidant activities. After coating the tomatoes with it, the ginger extract can heavily limit microbial contamination that causes spoilage. Being antimicrobial, it regulates the growth of the microorganisms that would have caused spoilage, whereas its antioxidant activity prevents the development of oxidative stress and prolongs the shelf life of the produce against premature senescence (Singh et al., 2014). Since the garlic extract consists of allicin, a compound which is strongly known to possess antimicrobial activity, garlic-extract coating on tomatoes may reduce microbial loads, which may include bacteria and fungi, which often cause spoilage (Yin and Cheng, 2003). No such study has been documented till date about the wholesome and minute study regarding the effect of natural extract on tomatoes in Pakistan. Hence, the objective of current investigation was exploring the impact of natural edible coating on the quality of tomato fruits under room temperature.

MATERIALS AND METHODS

The experiment was conducted at the Post harvest lab of the Department of Horticulture Sciences, University of the Punjab, Lahore, following all relevant guidelines. The aim of this study was to investigate the effects of various edible coatings, including Distill water, Garlic extract, Ginger extract, Aloe vera gerl, Neem leaf extract and Lemon-grass leaf extract applied to tomatoes after harvest to evaluate their potential in extending shelf life. After sorting, grading and washing uniform tomatos were selected for this study. The dipping technique was used to apply the painstakingly prepared treatments. This method made it possible to apply the extract evenly and completely on every tomato, the tomatoes were dipped into the solutions, making sure that the treatment covered every fruit completely for reliable and efficient outcomes. The temperature kept between 32 ± 2 degrees Celsius. Throughout the experiment, the tomatoes were kept this condition. Study was comprised with following treatments, T0= Control, T1= Distilled water, T2=lemon grass leaf extract, T3=Neem leaf extract, T4= Ginger extract, T5= Garlic extract, T6= Alovera gel and each treatment was replicated four time to overcome the study error. The study was evaluated on the basis of following parameters.



Figure 1: Process of Neem Leaf extraction

Fresh weight loss (%)

Used an extremely accurate weighing scale to precisely count the weight, which is a crucial potential in assessing commodities quality. Maintaining the accuracy of our data required this degree of precision and calculated with the following formula.

$$\text{Fresh weight loss (\%)} = \frac{\text{Initial weight} - \text{Final weight}}{\text{Initial weight}} \times 100$$

Fruit firmness

Firmness of the fruit was measured by a portable digital penetrometer (FR-5120 PENETOMETER, Tokyo, Japan). To reduce variability in such measurements, firmness was measured on both sides of the equatorial axis of each individual tomato, and the average of two such measurements made on any individual was used. Resultant averages based upon standard procedures were reported in SI units, that is, newtons (Hasan et al., 2019).

Organoleptic Parameters

Fruits of each replicate were divided into portions and randomly allotted for sensory evaluation by a panel of three experts for determination of the organoleptic parameters. The critical sensory attributes assessed by the panel were taste, flavor, aroma, color, and overall acceptability. The descriptive scale used was that of 1 to 9 as recommended by Peryam and Pilgrim (1957). A score of 1 on this scale meant quality was bad and not acceptable, while a score of 3 meant quality was only moderately acceptable yet constrained. Though the appraisal scored a 5, this did not necessarily mean that quality was simply adequate to meet market needs, but a score of 7 was an indication that quality was excellent. Lastly, a score of 9 meant the quality was excellent. The assessment tool was pre-service standardized, allowing the evaluators to record impressions regarding the organoleptic characteristics through this tool.

Total soluble solids (TSS) measurement

Total soluble solids (TSS) was determined by the use of a refractometer as specialized equipment for TSS measurement, where TSS is the indicator of the concentration of dissolved solids in the liquid phase of the fruit. Samples of tomatoes were taken from each treatment and replication for the determination of TSS content. The refractive index of juice obtained from fruits was measured by a refractometer; such an index has a direct relationship with the concentration of TSS.

pH measurement

Firstly, juice was extracted from tomato samples using a mortar and pestle, after which the clear liquid was obtained by filtering. Then, it was weighed and the pH of this juice was measured, which gave significant information about what is inside the fruit. Then, after careful processing, it was measured on the third, fourth, fifth, tenth, and fifteenth days.

Ash contents measurement

The residual mineral after drying the tomato specimens and incinerating them at high temperatures was measured to calculate the ash content. This methodological approach permitted a systematic analysis of how storage conditions under environmental conditions affect the ash content in tomatoes treated with sustainable, edible coatings.

Total phenolics contents

Total phenolic contents were estimated by the described technique of Ozgen et al. (2008). The extraction solution comprised of 28% anhydrous ethanol, 2% formic acid (v/v) and 70% methanol. A 0.2 g tomato sample was taken and ground with liquid nitrogen and after that sample was placed in a centrifuge tube. Then, 5 mL extraction solution was added, followed by 30 min of ultrasonic extraction. Then it was shaking at 250 rpm at 30°C for 2 hours, the extract was centrifuged at 8000 rpm for 10 minutes at 4°C. Filter paper was used to filter supernatant now through a 0.45 mm needle tube filter for analysis of phenolic contents and procedures were completed in the dark.

Statistical Analysis

The study was carried out under completely randomized design. The data were analyzed with analysis of variance and means were differentiated with the least significant difference (LSD) test. The differences statistically significant at 5% probability level were considered

RESULTS**Fresh weight loss (%)**

For the estimation of fresh weight loss of coated and non-coated tomato fruits considerably ($P \leq 0.05$) enhanced as the storage period from 2th to 8th day (Figure 1). The fresh weight loss of un-coated tomato fruits was increased as the days under storage especially from 4th day to 8th day. On the last day, control showed maximum 40.09%

decrease in fresh weight and lowest weight reduction on the 8th days was seen in T3= Neem leaf extract 20.69% fresh weight loss. Overall edible coating reduced the weight loss in tomato fresh weight in comparison with control (Figure 1). The commercial and cooking value of the tomatoes is assessed over time based on their weight, color, look, and aroma. In comparison to the control group or non-coated fruits, study found that tomatoes coated with neem, garlic, ginger, and aloe vera gel extracts performed better on all sensory evaluations.

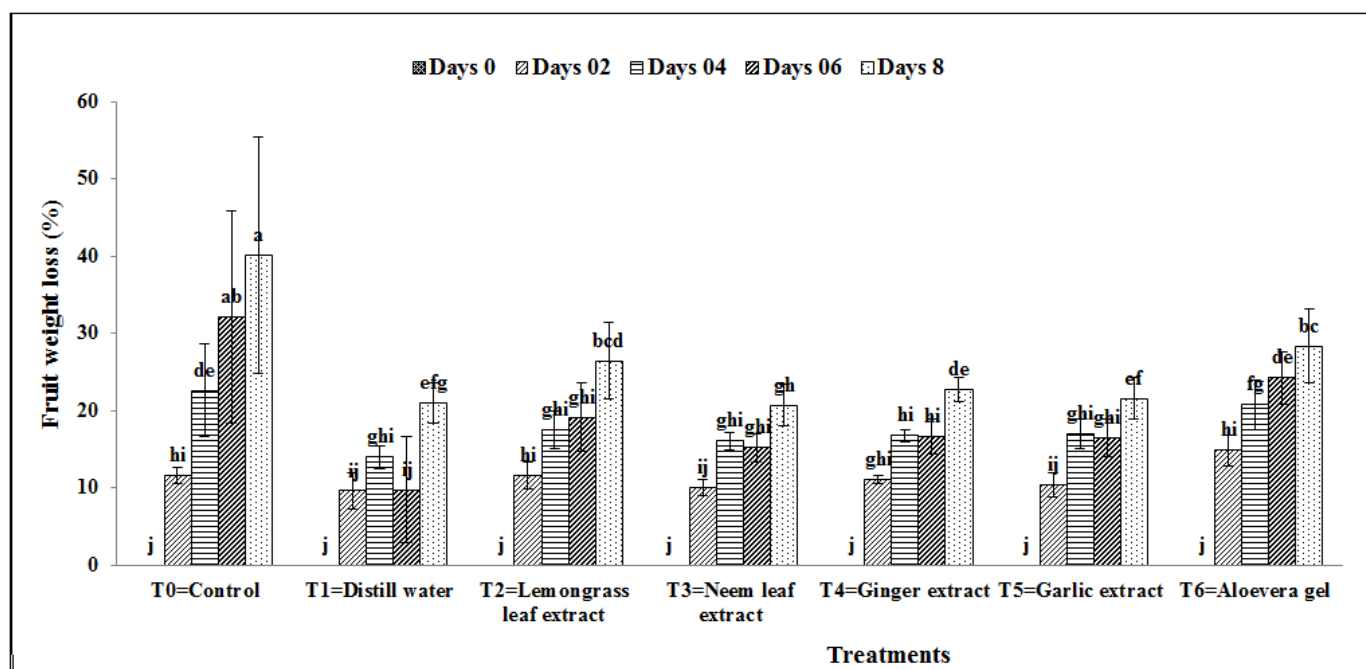


Figure 3.1. Effect of different edible coating on tomato fruit weight loss (%) under room temperature

Fruit Firmness

Randomly chosen tomatoes were used to gather data on their firmness, statistical analysis showed a significant ($P \leq 0.05$) differences between the all treatments (Table 1) T6= Aloe vera gel coated, had the maximum firmness (26.56). The control treatment T0 recorded the lowest tomato fruit firmness (18.23) as shown in Table 4.1.2 that the use of all other edible coatings was improved tomato firmness.

Table 1. Effect of different edible coating on tomato fruit firmness, fruit color, fruit firmness and fruit total soluble solids under room temperature

Treatment	Fruit firmness	Fruit color	Fruit appearance	TSS
T0= Control	18.23±3.99	7.70±0.30	7.60±0.26	4.42±0.54
T1= Distill water	25.90±0.98	7.37±0.54	8.52±0.26	5.22±0.55
T2= Lemongrass leaf extract	18.78±5.46	7.52±0.29	7.40±0.20	5.52±0.23
T3= Neem leaf extract	23.35±4.28	7.70±0.31	7.70±0.33	5.52±0.31
T4= Ginger extract	23.47±4.08	7.20±0.31	7.42±0.50	4.87±0.47
T5= Garlic extract	25.02±2.43	7.67±0.32	6.90±0.42	5.42±0.39
T6= Aloe vera gel	26.56±1.60	6.77±0.17	7.07±0.36	5.00±0.36

Tomato fruit color

Statistical analysis regarding tomato fruit color showed a non-significant difference between treatments. The data was computed to LSD test to compare the means of treatments at the level of 5% probability (Table 1). The tomato fruit coated with T6= Aloe vera gel presented minimum rating in term of color (6.7750). Whereas, control treatment

get high rated in term of color. Over time, the fruit loses its sensory properties due to a natural loss of water and compounds.

Tomato fruit appearance

The collected data on tomato fruit appearance was subjected to statistical analysis, findings showed difference between treatments and non-coated treatments (Table 1) T1= Distilled showed a highest fruit look (8.52) whereas, T5= Garlic extract presented lowest tomato appearance i.e., 6.90. Therefore, all other treatments have little bit difference in term of appearance.

Total soluble solids (TSS)

Statistical analysis on fruit TSS showed the significant difference, the results showed significant differences between all the studied treatments (Table 1). The LSD test was used to compare the means of all treatment at the 5% probability level. T2= Neem leaf extract exhibited a maximum tomato fruit TSS (5.52) followed by 4.4 in T0 control treatment. Therefore, it is concluded that after comparison of all the treatments, all the edible coatings were provided the similar results in term of TSS. Tomato sweetness and flavor are significantly influenced by total soluble salts (TSS), which are mostly composed of sugars, acids, and some soluble proteins. When comparing coated fruits to the control, the study discovered a steady increase in TSS. The control group T0 had the lowest TSS value (4.4250), while treatment T2, which included coating, had the highest TSS value (5.5250). By preventing moisture loss, coatings help concentrate the fruit's soluble ingredients. Additionally, coatings may have changed the inside atmosphere through increasing CO₂ concentrations and decreasing oxygen levels, which delayed the breakdown of organic acids and sugars. The variation in TSS values between the treatments indicates that the combination of edible coverings preserved the fruit's overall flavor and sweetness better.

pH of tomato fruit

The findings of the statistical analysis of the data recorded on the pH of tomatoes showed a non-significant difference between all treatments (Table 3.2) The LSD test was used to compare the treatment means at the level of 5% probability and presented a similar group for all the studied treatment. By maintaining a constant pH, the edible coatings has may extended the shelf life. According to the study, treatment which has coatings made of garlic extract, had a higher pH than the treatment without any coatings. The coatings are most likely to control the internal environment of the fruit by lowering ethylene production and respiration, which in turn lowers the buildup of organic acids.

Table 2. Effect of different edible coating on tomato fruit pH, fruit ash contents and fruit total phenolics under room temperature

Treatment	Fruit pH	Fruit ash contents	Fruit total phenolics
T0= Control	4.29±0.33	19.82±0.99	45.57±1.78
T1= Distill water	4.14±0.16	21.80±1.49	51.80±3.063
T2= Lemongrass leaf extract	4.36±0.28	27.50±3.94	49.90±3.55
T3= Neem leaf extract	4.17±0.08	22.20±1.96	58.45±3.84
T4= Ginger extract	4.44±0.37	28.40±2.48	59.17±6.40
T5= Garlic extract	4.42±0.32	24.99±2.27	60.19±4.35
T6= Aloevera gel	4.27±0.10	27.81±2.08	62.76±3.64

Tomato fruit ash contents

The data regarding tomato fruit ash contents was analyzed by statistical analysis; findings presented a significant difference ($P \leq 0.05$) among the treatments as seen in Table 3.2. T4= Ginger extract revealed the maximum ash contents of tomato fruit (27.81) followed by T6= Alovera gel coating (27.81) whereas, neem leaf extract coating presented (27.50) ash contents (Table 3.2). The lowest tomato fruit ash contents was (19.82) recorded in T0= Control treatment.

Tomato fruit total phenolic contents

The data regarding tomato fruit total phenolic contents were subjected to statistical analysis presented a significant ($P \leq 0.05$) distinction among the treatments (Table 3.2). Data were comparing by using LSD test at the 5% probability level. T6= Aloevera gel presented a maximum tomato fruit total phenolic contents (62.76) and the lowest contents

was noted in T0 control treatment (45.570). Whereas, T1, T2, T3, T4, T5 presented 51.80, 49.90, 58.45, 59.17, 60.10, respectively.

DISCUSSION

The study demonstrated that edible coatings effectively reduced the fresh weight loss of tomatoes, with neem leaf extract showing the lowest weight reduction (20.69%) compared to the control (40.09%). These coatings formed a protective barrier, minimizing moisture evaporation and respiration. Similar benefits of coatings have been reported in studies on fresh-cut fruits like pears (Oms-Oliu et al., 2008).

Tomato firmness was significantly preserved by coatings, with aloe vera gel achieving the highest firmness (26.56) compared to the control (18.23). The coatings slowed moisture loss and ethylene generation, preserving cell wall integrity and reducing enzymatic activity that causes softening. These findings align with results for strawberries treated with edible coatings (Tahir et al., 2018).

Although the coatings had no significant impact on color, the control group showed better retention of visual appeal compared to aloe vera gel-coated fruits. Over time, natural pigment degradation is inevitable, and coatings may have limited impact on preserving color (Porat et al., 2018). However, distilled water-coated tomatoes displayed the best appearance scores (8.52), while garlic extract-coated fruits scored lowest (6.90), suggesting coating type affects visual properties.

Neem leaf extract coatings led to the highest TSS (5.52), enhancing sweetness and flavor by reducing moisture loss and modifying the internal fruit environment. Coatings delayed organic acid and sugar degradation, aligning with findings in coated cherries (Alonso and Alique, 2004).

Coatings also stabilized pH levels, reducing organic acid buildup and microbial spoilage risk (Pasquariello et al., 2015). Additionally, ginger extract and aloe vera gel coatings preserved ash (27.81) and phenolic contents (62.76), which enhance nutritional and antioxidant properties (Ali et al., 2011; Marcelino et al., 2023). Overall, edible coatings effectively prolonged the shelf life and quality of tomatoes.

CONCLUSION

Edible coating on tomato was effective to delay the rotting and to maintain quality for eight days under room temperature during summer. Edible coating reduced weight loss, inhibited disease occurrence and increased the phenolic contents. The coating little bit delayed color and appearance changes. In addition, edible coating resulted in higher phenolics contents that eventually mitigated oxidative damage during postharvest storage. The coating application helped to improve shelf life of tomato so, these natural and environmental friendly edible coating could be considered a potential postharvest treatment to delay ripening and to conserve the quality of harvested tomatoes.

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Not applicable.

AUTHOR CONTRIBUTIONS

Sumreen Anjum and Zoya Naveed: Conducted the research trial and writing original draft. **Muhammad Rizwan Tariq:** Conceptualization and supervised the trial. **Moazzam Anees:** Finalization, writing– review and editing. **Zain Mustaq:** Co-supervised the trial. **Mubeen Sarwar and Ch. Zain Gulraiz:** Software, writing– review and editing. **M. Irfan Ashraf:** Helped in field work and technical assistance for lab analysis.

COMPETING OF INTEREST

The authors declare that the research was carried without any commercial or financial relationships that could be construed as a potential conflict of interest.

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