Shelf-life Assessment of Tomato (Solanum lycopersicum) Treated with Different Rates of Chitosan as Edible Coating

***Ailyn R. Hernando[1,2], Lorcel A. Sialongo[1,3], Salvador Jr. O. Masumbid[1,4], Sarah H. Ravelo[1]**

[1]Agusan del Sur State University, College of Agriculture

[2]Montevista Stand Alone Senior High School

[3]Crispin E. Rojas National High School

[4]Samal Island City College

***Corresponding Author**

DOI: https://doi.org/10.51244/IJRSI.2026.1307000247

Received: 24 July 2026; Accepted: 29 July 2026; Published: 09 August 2026

ABSTRACT

Tomato (Solanum lycopersicum) is one of the most important vegetable crops worldwide; however, its highly perishable nature results in considerable postharvest losses, particularly under ambient storage conditions. This study evaluated the effectiveness of different concentrations of chitosan as an edible coating in maintaining the postharvest quality and extending the shelf life of tomato fruits. The experiment was conducted using a Completely Randomized Design (CRD) consisting of five treatments: control (distilled water), 5 g/L, 10 g/L, 15 g/L, and 20 g/L chitosan, with four replications per treatment. Tomato fruits were evaluated based on physical quality parameters, including weight loss, visual quality rating, color development, shriveling, disease incidence, and hardness, as well as physicochemical characteristics such as total soluble solids (TSS), titratable acidity (TA), pH, and Vitamin C content. Results revealed that chitosan application contributed to the maintenance of visual quality and delayed color development, particularly at higher concentrations of 15–20 g/L. Among the treatments, 15 g/L chitosan significantly improved fruit hardness, indicating better firmness retention during storage. Meanwhile, 20 g/L chitosan recorded the highest titratable acidity, while 10 g/L chitosan provided the greatest retention of Vitamin C content. However, no significant differences were observed among treatments in terms of weight loss, shriveling, disease incidence, TSS, and pH. These findings demonstrate that chitosan coating has potential as a natural and biodegradable postharvest technology for improving tomato quality by delaying ripening, maintaining firmness, and preserving nutritional attributes. Among the tested concentrations, 15 g/L chitosan was identified as the most balanced treatment for maintaining tomato quality under room temperature storage conditions.

Keywords: Chitosan coating, Edible coating, Postharvest quality, Shelf-life extension, Tomato (Solanum lycopersicum)

INTRODUCTION

Tomato (Solanum lycopersicum) is one of the most widely cultivated and economically important vegetable crops worldwide (FAO, 2023). It is valued for its nutritional content, versatility in culinary applications, and significance in both local and commercial markets. In the Philippines, tomato production plays a vital role in supporting smallholder farmers and supplying fresh produce to urban and rural consumers. Despite its importance, tomato is highly perishable and susceptible to rapid postharvest deterioration. Significant losses occur due to physiological processes such as respiration and transpiration, microbial decay, mechanical injury, and improper handling, storage, and transportation. Postharvest losses of tomato can reach 20–40%, particularly under ambient tropical conditions where high temperature and humidity accelerate ripening and spoilage (Al-Dairi et al., 2023).

Edible coatings have emerged as an effective and environmentally friendly postharvest technology to reduce quality deterioration and extend shelf life of fresh produce (Shinga et al., 2025). Among natural polymers, chitosan has gained increasing attention due to its biodegradability, film-forming ability, antimicrobial activity, and capacity to modify internal gas exchange in fruits and vegetables (Rinaudo, 2006; Hossain & Iqbal, 2016). Chitosan coatings create a semi-permeable barrier that reduces moisture loss, delays ripening, and suppresses microbial growth.

While several studies have demonstrated the effectiveness of chitosan-based coatings on fruits such as banana, mango, and citrus, limited local studies focus on its application on tomato using varying concentrations under room temperature storage. Determining the optimum rate of chitosan for tomato preservation is essential to maximize its postharvest benefits without negatively affecting fruit quality.

Therefore, this study aims to evaluate the effects of different rates of chitosan as an edible coating on the postharvest quality and shelf life of tomato.

REVIEW OF RELATED LITERATURE

Tomato Production and Importance

Tomato is one of the leading vegetable crops in terms of production volume and consumption (FAO, 2023). It is rich in vitamins A and C, minerals, and antioxidants such as lycopene, which contributes to its health-promoting properties. However, tomatoes are climacteric fruits that continue to ripen after harvest, making them prone to rapid softening, color changes, and microbial spoilage.

Postharvest Problems of Tomato

Postharvest deterioration of tomato is primarily caused by high respiration rate, excessive moisture loss, mechanical damage, and microbial infection (Al-Dairi et al., 2023). Common postharvest diseases such as anthracnose, soft rot, and Alternaria rot significantly reduce marketability and shelf life. These problems are intensified under tropical storage conditions where refrigeration is often unavailable or costly.

Chitosan: Properties and Applications

Chitosan is a natural polysaccharide derived from the deacetylation of chitin, which is abundantly found in crustacean shells and fungal cell walls (Rinaudo, 2006). It is biodegradable, non-toxic, and exhibits antimicrobial and antifungal properties. Chitosan has been widely studied as an edible coating material due to its ability to form transparent, flexible films on fruit surfaces.

Effect of Chitosan on Postharvest Quality of Fruits and Vegetables

Numerous studies have shown that chitosan coatings delay ripening, reduce weight loss, maintain firmness, and suppress microbial growth in various horticultural commodities (Marydashti et al., 2020; Abdul Aziz et al., 2023). In tomatoes, chitosan coatings have been reported to slow down color development, reduce decay incidence, and extend shelf life by modifying internal atmosphere and reducing respiration rate (Hasan et al., 2020; Yuan et al., 2023). Higher concentrations of chitosan generally enhance barrier and antimicrobial effects, although excessively high levels may affect fruit appearance.

Physicochemical Changes During Tomato Ripening

Tomato is a climacteric fruit that undergoes significant biochemical changes during ripening, including sugar accumulation, organic acid degradation, pigment synthesis, and vitamin degradation. These changes directly influence Total Soluble Solids (TSS), Titratable Acidity (TA), pH, and Vitamin C content (Kader, 2002). Monitoring these parameters is essential in evaluating postharvest quality and shelf-life extension strategies.

ISSN No. 2321-2705 | DOI: 10.51244/IJRSI |Volume XIII Issue VII July 2026

Total Soluble Solids (TSS)

Total Soluble Solids represent the concentration of soluble sugars and are commonly expressed in °Brix. TSS increases during ripening due to starch hydrolysis and sugar accumulation (Wills et al., 2007). In tomatoes, higher TSS is associated with improved flavor and sweetness. Studies have shown that edible coatings can slow the increase in TSS by reducing respiration rate and metabolic activity. Hasan et al. (2020) reported that chitosan-coated tomatoes exhibited a slower increase in TSS compared to untreated fruits, indicating delayed ripening. Similarly, Yuan et al. (2023) found that chitosan coatings helped maintain stable TSS levels during storage by modifying internal gas exchange and reducing respiration.

Titratable Acidity (TA) and pH

Titratable Acidity reflects the total concentration of organic acids, primarily citric acid in tomato. During ripening, organic acids are gradually metabolized for respiration, resulting in decreased acidity and increased pH (Kader, 2002). According to Hossain and Iqbal (2016), chitosan coatings help maintain higher titratable acidity in fruits by slowing metabolic processes. Hasan et al. (2020) also observed that tomatoes treated with chitosan retained significantly higher TA levels compared to control fruits during storage. As acidity decreases, pH tends to increase. Maintaining lower pH is important for microbial stability and flavor quality. Heydarian et al. (2021) reported that chitosan-coated fruits exhibited slower pH changes, suggesting reduced biochemical deterioration.

Vitamin C (Ascorbic Acid)

Vitamin C is one of the most important nutritional quality indicators in tomato. However, it is highly sensitive to oxidation and degradation during storage (Wills et al., 2007). Loss of Vitamin C is accelerated by high temperature, oxygen exposure, and increased respiration.

Edible coatings have been shown to reduce Vitamin C degradation by limiting oxygen permeability. According to Hasan et al. (2020), chitosan-treated tomatoes retained significantly higher ascorbic acid content compared to untreated fruits during ambient storage. Similarly, Kaur and Nikhil (2024) reported that chitosan coatings effectively reduced oxidative loss of Vitamin C in fresh produce by forming a protective semi-permeable barrier.

Marydashti et al. (2020) further emphasized that the effectiveness of chitosan in preserving Vitamin C depends on its concentration, molecular weight, and film-forming properties.

Relationship Between Chitosan Coating and Biochemical Stability

Chitosan functions as a semi-permeable membrane that regulates gas exchange (O_2 and CO_2), reduces respiration rate, and delays ethylene production (Rinaudo, 2006). By slowing these physiological processes, chitosan coatings contribute to: Slower increase in TSS, Delayed decrease in Titratable Acidity, Stabilized pH levels, Reduced degradation of Vitamin C Yuan et al. (2023) demonstrated that higher concentrations of chitosan provided stronger barrier effects and improved fungal inhibition in tomato, although excessively high concentrations may affect fruit appearance and texture.

MATERIALS AND METHODS

Experimental Design, Lay-out, and Treatments

The experiment was laid out using a Completely Randomized Design (CRD) with five (5) treatments replicated four (4) times. The selected chitosan concentrations of 5 g/L, 10 g/L, 15 g/L, and 20 g/L correspond to 0.5%, 1.0%, 1.5%, and 2.0% chitosan, respectively. These levels are within the concentration range commonly tested in postharvest tomato studies. Kibar and Sabir (2018) evaluated 0.5%, 1.0%, and 2.0% chitosan coatings on tomato and reported reduced weight loss, better firmness, less biochemical change, and improved visual quality compared with the control.

ISSN No. 2321-2705 | DOI: 10.51244/IJRSI |Volume XIII Issue VII July 2026

Each treatment per replication consisted of fifteen (15) tomato fruits. Treatments were as follow.

TREATMENTS	DESCRIPTION
T1	Control (Distilled water)
T2	5 g Chitosan/1L of Water
T3	10 g Chitosan/1L of Water
T4	15 g Chitosan/1L of Water
T5	20 g Chitosan/1L of Water

Collection and Preparation of Tomato Fruits

Freshly harvested tomatoes of the Jiwel variety were purchased on March 13, 2026, from a local farm in New Albay, Maragusan, Davao de Oro. The fruits were obtained at the mature green to breaker stage and were selected based on uniformity in size, color, and maturity, as well as the absence of visible defects, mechanical damage, or signs of disease. After selection, the tomatoes were washed thoroughly with running water to remove surface dirt and possible contaminants. The fruits were then air-dried at room temperature for 12 hours prior to the application of the treatments.

Figure 1. Collection and Preparation of Tomato Fruits Used in the Study

Preparation of Chitosan Solutions

Food-grade chitosan powder was weighed using digital scale. Different concentrations (5 g, 10 g, 15 g, and 20 g) were prepared by dissolving the required amount of chitosan in 1 liter of distilled water with continuous stirring using a stirrer rod until completely dissolved.

Figure 2. Weighing of Food Grade Chitosan per treatment.

ISSN No. 2321-2705 | DOI: 10.51244/IJRSI |Volume XIII Issue VII July 2026

Application of Treatments

Tomato fruits were dipped in their assigned coating solutions for 30 minutes to allow the coating to cover the fruit surface evenly. The 30-minute dipping time was based on Donjio et al. (2023), who used 10–30 minutes of dipping for tomato fruits treated with edible coatings to help delay ripening and maintain quality. After dipping, the coating forms a thin layer on the fruit surface, which helps reduce moisture loss and slows respiration without fully blocking gas exchange. This supports the findings of El Ghaouth et al. (1992) and Paul et al. (2018), who reported that edible coatings such as chitosan can help extend the storage life of tomato fruits. Control fruits were dipped in distilled water only. After treatment, all fruits were air-dried and stored at room temperature. Postharvest observations were done every 3 days, and all physiological parameters were recorded on the same observation days for consistency.

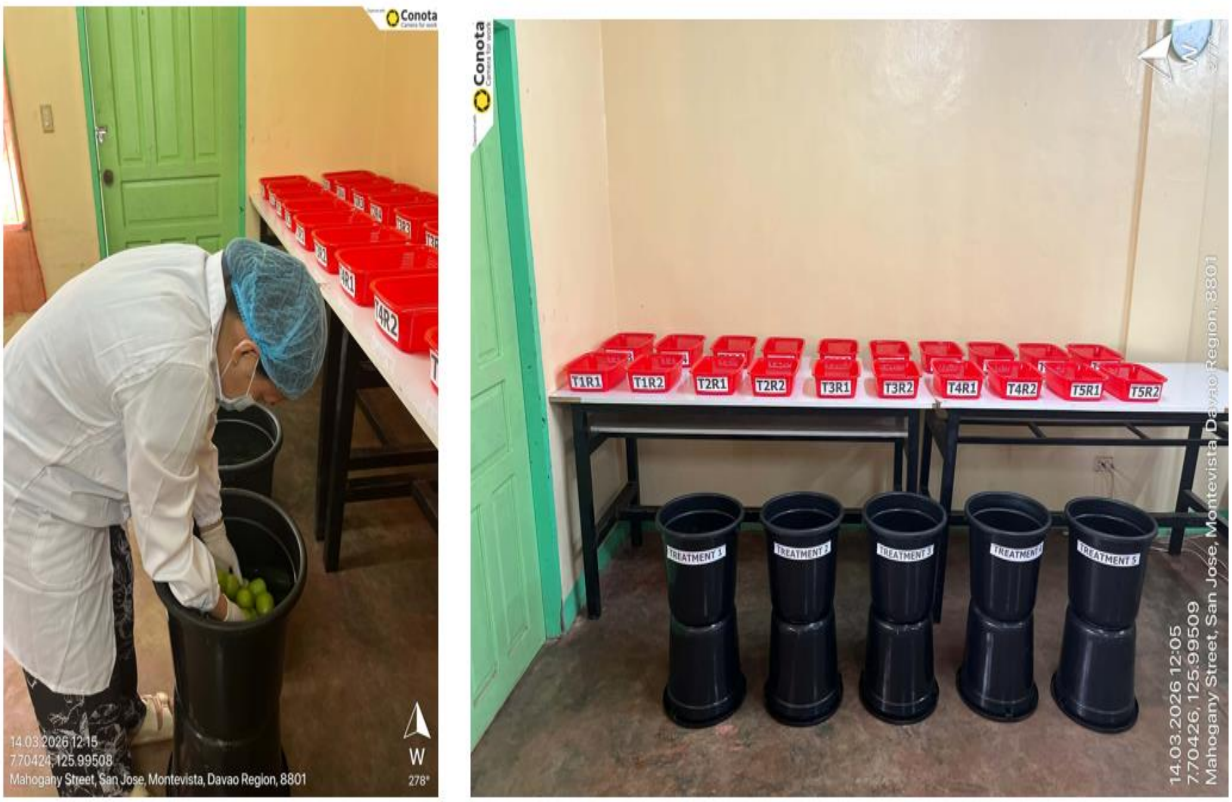

Figure 3. Application of Treatments using Food grade Chitosan.

RESULT AND DISCUSSION

Weight Loss (g)

The result of the study showed that the application of different rates of chitosan did not significantly affect the weight loss of tomato fruits during the storage period. Although the treatments showed numerical differences, these differences were not statistically significant. This indicates that the observed variation in weight loss among the control and chitosan-treated tomato fruits may have been due to natural fruit-to-fruit variation, differences in maturity, storage condition, or environmental factors rather than the direct effect of the chitosan coating. Based on the data, weight loss increased progressively in all treatments from March 16 to April 12. This trend was expected because tomato fruits continue to lose water after harvest due to transpiration and respiration. On the final observation date, T4 treated with 15 g chitosan/L of water recorded the highest mean weight loss of 175.75 g, followed by T5 with 20 g chitosan/L of water at 147.50 g. The control treatment, T1, recorded 125.25 g, while T3 with 10 g chitosan/L of water recorded 121.25 g. The lowest numerical weight loss was observed in T2 with 5 g chitosan/L of water at 120.25 g. Although T2 showed the lowest final weight loss, it cannot be considered statistically better than the other treatments because the differences were non-significant.

ISSN No. 2321-2705 | DOI: 10.51244/IJRSI |Volume XIII Issue VII July 2026

Treatment	Mean Weight Loss per Treatment (g)								
	16-Mar	19-Mar	22-Mar	25-Mar	28-Mar	31-Mar	3-Apr	6-Apr	12-Apr
T1 – Control (Distilled water)	0.00	11.25	21.75	30.75	40.75	54.25	65.75	76.50	125.25
T2 – 5 g Chitosan/1L of Water	0.00	22.00	31.50	39.00	54.50	64.75	76.75	87.25	120.25
T3 – 10 g Chitosan/1L of Water	0.00	12.50	23.75	33.25	47.00	67.50	78.75	89.75	121.25
T4 – 15 g Chitosan/1L of Water	0.00	14.00	24.75	34.25	55.75	70.25	89.00	110.25	175.75
T5 – 20 g Chitosan/1L of Water	0.00	17.25	28.75	38.25	54.25	70.25	84.00	103.75	147.50

Table 1. Weight loss result of the Tomato as applied with the different treatments.

The data also showed that the higher chitosan concentrations did not consistently reduce weight loss. In fact, T4 and T5 showed greater numerical weight loss compared with the lower concentrations and the control treatment. This suggests that increasing the amount of chitosan does not automatically result in better moisture retention. Higher concentrations may have affected the uniformity of the coating or produced a thicker coating layer that did not provide additional protection against water loss. However, since the differences were not significant, this observation should be interpreted only as a numerical trend and not as a definite treatment effect.

The result does not necessarily contradict the known function of chitosan as an edible coating. Chitosan has been reported to form a thin semi-permeable film on the surface of fruits, which may reduce moisture loss, slow gas exchange, and delay respiration and transpiration processes (Rinaudo, 2006; Hossain & Iqbal, 2016). However, the effectiveness of chitosan coating may vary depending on several factors, including concentration, coating preparation, coating thickness, dipping time, fruit maturity, storage temperature, relative humidity, and length of storage. If these conditions are not strictly controlled, they may reduce or mask the possible effect of the coating.

Physiological Parameters

Visual Quality Rating (VQR)

The visual quality rating (VQR) of tomato fruits remained generally high across all treatments during the storage period, indicating that the fruits maintained acceptable to excellent marketable quality for most of the observation duration. From March 16 to April 3, all treatments consistently recorded a rating of 5, which corresponds to excellent quality. This suggests that during the initial storage phase, no visible signs of deterioration such as shriveling, decay, surface discoloration, or physical defects were observed in both the control and chitosan-coated fruits.

A noticeable divergence in quality began on April 6, where the control treatment (T1) declined from a rating of 5 to 4, indicating the onset of slight visual deterioration. In contrast, all chitosan-treated fruits (T2, T3, T4, and T5) maintained an excellent rating of 5 at this stage. This suggests that chitosan application helped delay the initial appearance of visible defects compared with the untreated fruits.

By April 12, further differences among treatments became evident. Both the control (T1) and the lowest concentration treatment (T2, 5 g chitosan/L) decreased to a rating of 4, indicating good but no longer excellent visual quality. On the other hand, T3 (10 g/L), T4 (15 g/L), and T5 (20 g/L) maintained a rating of 5, demonstrating that fruits in these treatments remained in excellent condition up to the end of the storage period. This indicates that higher chitosan concentrations (10–20 g/L) were more effective in preserving the external appearance of tomato fruits compared with the control and the lowest concentration treatment.

TREATMENTS	VISUAL QUALITY RATING (VQR)								
	16-Mar	19-Mar	22-Mar	25-Mar	28-Mar	31-Mar	3-Apr	6-Apr	12-Apr
T1 - Control (Distilled water)	5	5	5	5	5	5	4	4	4
T2 - 5 g Chitosan/1L of Water	5	5	5	5	5	5	5	4	4
T3 - 10 g Chitosan/1L of Water	5	5	5	5	5	5	5	5	5
T4 - 15 g Chitosan/1L of Water	5	5	5	5	5	5	5	5	5
T5 - 20 g Chitosan/1L of Water	5	5	5	5	5	5	5	5	5

Table 2. Visual Quality Rating result of the Tomato as applied with the different treatments.

The observed delay in quality deterioration among chitosan-coated fruits may be attributed to the film-forming properties of chitosan. Chitosan creates a semi-permeable coating on the fruit surface that can reduce moisture loss, regulate gas exchange, slow respiration rate, and act as a physical barrier against microbial contamination. These combined effects help maintain firmness and surface integrity, thereby preserving visual quality during storage.

Figure 4. Conducted Visual evaluation of Tomato Fruits

The results also suggest a concentration-dependent trend, where higher concentrations of chitosan (T3–T5) were more effective in maintaining visual quality than lower concentration (T2) and the control. This supports the concept that an adequately formed chitosan coating may enhance protective effectiveness by improving surface coverage and barrier strength. However, since all treated fruits still eventually showed minimal decline by the end of the storage period, the effect of chitosan should be interpreted as a delay in deterioration rather than complete prevention.

Color Development

Color development of tomato fruits increased progressively in all treatments from the entire duration of the study, indicating the normal advancement of ripening from the green stage toward the light-red to red stage. During the first six days of observation, the different concentrations of chitosan did not significantly affect color development, as shown in all treatments. On the Day 1 of the observation, all fruits remained at the green stage, with mean scores ranging from 1.01 to 1.08. By Day 3 and Day 4, the fruits began to show visible color change, with scores near the breaker to early turning stage. By Day 5 and Day 6, all treatments continued to ripen, reaching mean scores of approximately 2.71 to 4.20, indicating progression from turning to pink stage. Although numerical differences were observed during these periods, the treatments were statistically comparable, suggesting that chitosan coating did not immediately alter the early visible ripening pattern of the tomato fruits.

TREATMENTS	COLOR DEVELOPMENT							
DAY	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7	Day 8
T1 – Control (Distilled water)	1.05	1.36	1.96	2.03	2.71	4.07	5.15	5.80
T2 – 5 g Chitosan/1L of Water	1.08	1.33	1.71	2.01	3.08	3.81	4.35	5.78
T3 – 10 g Chitosan/1L of Water	1.01	1.13	2.09	2.12	3.15	4.20	4.72	5.74
T4 – 15 g Chitosan/1L of Water	1.03	1.17	1.72	1.76	2.93	4.03	4.56	5.74
T5 – 20 g Chitosan/1L of Water	1.03	1.15	1.68	1.71	2.74	3.97	4.45	5.36

Table 3. Color Development result of the Tomato as applied with the different treatments.

A clearer treatment effect was observed on Day 7. The control treatment recorded the highest color development score of 5.15, corresponding to the light-red stage. In contrast, T2 and T5 recorded significantly lower scores of 4.35 and 4.45, respectively, indicating slower progression toward full red coloration. T3 and T4, with scores of 4.72 and 4.56, were intermediate and statistically comparable with both the control and the lower-scoring treatments. This result suggests that chitosan coating began to delay visible ripening during the later storage period, particularly when the fruits approached the advanced color stages. On Day 8 of the inspection, most treatments reached the light-red stage, with the control, T2, T3, and T4 recording statistically similar scores ranging from 5.74 to 5.80. However, T5, treated with 20 g chitosan/L of water, recorded the lowest score of 5.36 and was significantly different from the other treatments. Although T5 fruits were also within the light-red stage, their lower score indicates that they were less advanced in red color development compared with the control and lower chitosan rates. Therefore, among the treatments, T5 showed the most evident delay in color development at the end of the observation period. The slower color development observed in chitosan-coated fruits may be attributed to the semi-permeable film formed by chitosan on the tomato surface. This coating can modify the internal atmosphere of the fruit by reducing oxygen availability and increasing carbon dioxide concentration, thereby slowing respiration and ethylene production. In tomato, a climacteric fruit, ethylene is a major regulator of ripening, and color change from green to red is associated with chlorophyll degradation, conversion of chloroplasts into chromoplasts, and accumulation of carotenoids, particularly lycopene. Previous work on chitosan-coated tomatoes found that chitosan reduced respiration rate and ethylene production and resulted in less red pigmentation compared with uncoated control fruits at the end of storage.

The findings of the present result agree with studies reporting that edible coatings, including chitosan, can delay ripening-related quality changes in tomato fruits. Abebe et al. reported that chitosan coating significantly delayed changes in quality attributes and extended tomato shelf life during ambient storage compared with uncoated fruits. Similarly, Venkatachalam et al. found that chitosan-based coatings helped maintain tomato quality, including color-related parameters and pigment stability, during storage. Thus, the lower color scores in chitosan-coated fruits, especially T5, may indicate delayed ripening rather than poor color development.

Shriveling

Shriveling was not significantly affected by the different chitosan treatments. Most ratings were close to 1.00, indicating absent to very slight shriveling. T2 showed a numerically higher value on the start, but this did not translate into a statistically significant treatment effect.

TREATMENTS	SHRIVELING		
	April 3	April 6	April 12
T1 – Control (Distilled water)	1.00	1.00	1.00
T2 – 5 g Chitosan/1L of Water	3.77	1.12	1.05

ISSN No. 2321-2705 | DOI: 10.51244/IJRSI |Volume XIII Issue VII July 2026

T3 – 10 g Chitosan/1L of Water	1.02	1.02	1.02
T4 – 15 g Chitosan/1L of Water	1.12	1.12	1.07
T5 – 20 g Chitosan/1L of Water	1.20	1.12	1.10

Table 4. Shriveling result of the Tomato as applied with the different treatments.

The low shriveling ratings suggest that tomato fruits generally maintained acceptable surface quality during the observation period. Chitosan coatings are expected to reduce shriveling by minimizing water loss and maintaining tissue hydration. However, since no significant differences were observed, the results suggest that the storage duration or environmental conditions may not have been severe enough to cause measurable shriveling differences among treatments. Similar findings may occur when fruits are observed over a short period or when initial fruit quality is uniform.

Disease Incidence

Disease incidence was not significantly affected by chitosan treatments from entire inspection date. The rating values were generally close to 1.00, suggesting that disease symptoms were absent or very minimal during the observation period.

TREATMENTS	DISEASE INCIDENCE		
	April 3	April 6	April 12
T1 – Control (Distilled water)	1.05	1.05	1.05
T2 – 5 g Chitosan/1L of Water	1.05	1.00	1.00
T3 – 10 g Chitosan/1L of Water	1.00	1.07	1.07
T4 – 15 g Chitosan/1L of Water	1.00	1.05	1.05
T5 – 20 g Chitosan/1L of Water	1.15	1.07	1.15

Table 5. Disease Incidence result of the Tomato as applied with the different treatments.

Although chitosan is known for antimicrobial and antifungal properties, the absence of significant differences may be due to the low disease pressure during storage. If fruits were initially healthy and disease incidence remained low, statistical separation among treatments would be difficult to detect. Chitosan has been reported to suppress microbial growth and reduce decay incidence in horticultural commodities due to its antimicrobial activity and film-forming ability (Rinaudo, 2006; Hasan et al., 2020; Yuan et al., 2023). In this study, however, the result only indicates that all treatments maintained low disease incidence during the short storage period.

Hardness

Hardness was significantly affected by the different chitosan treatments. Treatment 4 at 15 g chitosan/L of water obtained the highest hardness value of 5.775 while Treatment 3 at 10 g chitosan/L of water recorded the lowest value of 3.825. This indicates that T4 was significantly firmer than T3. The control, T2, and T5 were not significantly.

TREATMENTS	HARDNESS
T1 – Control (Distilled water)	5.050
T2 – 5 g Chitosan/1L of Water	4.500
T3 – 10 g Chitosan/1L of Water	3.825
T4 – 15 g Chitosan/1L of Water	5.775
T5 – 20 g Chitosan/1L of Water	4.500

Table 6. Hardness result of the Tomato as applied with the different treatments.

ISSN No. 2321-2705 | DOI: 10.51244/IJRSI |Volume XIII Issue VII July 2026

The higher hardness observed in T4 indicates that 15 g chitosan/L may have been the most effective concentration in maintaining tomato firmness. This agrees with the expected function of chitosan as an edible coating that slows ripening and softening by reducing respiration, limiting moisture loss, and modifying internal gas exchange. Previous studies have reported that chitosan coatings can maintain firmness and delay softening in fruits and vegetables by slowing metabolic processes associated with ripening (Marydashti et al., 2020; Abdul Aziz et al., 2023). The low hardness in T3 may indicate that 10 g/L was not sufficient or not optimal under the conditions of this experiment.

Physicochemical Parameters

Total Soluble Solids (TSS)

Total soluble solids were not significantly affected by chitosan treatments. Numerically, the control treatment had the highest TSS value of 4.125, while T4 recorded the lowest value of 3.775. However, these differences were not statistically significant.

TREATMENTS	TOTAL SOLUBLE SOLIDS (TSS)
T1 – Control (Distilled water)	4.125
T2 – 5 g Chitosan/1L of Water	3.875
T3 – 10 g Chitosan/1L of Water	3.850
T4 – 15 g Chitosan/1L of Water	3.775
T5 – 20 g Chitosan/1L of Water	3.950

Table 7. Total Soluble Solids (TSS) result of the Tomato as applied with the different treatments.

TSS is associated with soluble sugars and ripening progression. A slower increase in TSS may indicate delayed ripening because starch conversion and sugar accumulation are reduced. Chitosan coatings have been reported to slow changes in TSS by reducing respiration and metabolic activity (Hasan et al., 2020; Yuan et al., 2023). In the present study, the non-significant result suggests that chitosan did not produce a measurable effect on soluble solids during the storage period. The slightly lower TSS in coated fruits may still indicate a tendency toward delayed ripening, but this trend should be interpreted cautiously because it was not statistically significant.

Figure 5. Actual Total Soluble Solids collection using hand-held refractometer.

Titratable Acidity (TA)

Titratable acidity was significantly influenced by chitosan treatment. Treatment 5 at 20 g chitosan/L of water recorded the highest titratable acidity value of 9.20 while Treatment 2 at 5 g chitosan/L of water recorded the lowest value of 7.45. Treatment 4 at 15 g chitosan/L of water was statistically comparable to Treatment 5 at 20 g chitosan/L of water but also overlapped with the intermediate group.

TREATMENTS	TITRATABLE ACIDITY (%)
T1 – Control (Distilled water)	0.051
T2 – 5 g Chitosan/1L of Water	0.032
T3 – 10 g Chitosan/1L of Water	0.070
T4 – 15 g Chitosan/1L of Water	0.032
T5 – 20 g Chitosan/1L of Water	0.051

Table 8. Titratable Acidity result of the Tomato as applied with the different treatments.

The higher titratable acidity in T5 suggests that the highest chitosan concentration was more effective in retaining organic acids in tomato fruits. Organic acids normally decline during ripening because they are used as substrates in respiration. Chitosan coatings can slow respiration and delay acid degradation by forming a barrier that regulates gas exchange (Hossain & Iqbal, 2016; Hasan et al., 2020). Therefore, the higher acidity in T5 may indicate delayed ripening and better biochemical stability. The result supports the role of chitosan in maintaining fruit quality, although very high concentrations should still be evaluated carefully because excessive coating thickness may affect fruit appearance or texture.

Figure 6. Actual Set-up of Titratable Acidity (TA)

pH

The pH values of tomato fruits were not significantly affected by chitosan treatments. The pH values ranged only from 4.272 in Treatment 5 to 4.387 in Treatment 2, showing that acidity level remained relatively stable across all treatments.

TREATMENTS	pH
T1 – Control (Distilled water)	4.325
T2 – 5 g Chitosan/1L of Water	4.387
T3 – 10 g Chitosan/1L of Water	4.362
T4 – 15 g Chitosan/1L of Water	4.340
T5 – 20 g Chitosan/1L of Water	4.272

Table 9. pH result of the Tomato as applied with the different treatments.

ISSN No. 2321-2705 | DOI: 10.51244/IJRSI |Volume XIII Issue VII July 2026

This result implies that chitosan coating did not cause a strong change in tomato juice pH during the storage period. Since tomato is naturally acidic, small pH differences may not become statistically significant over short storage intervals. During ripening, organic acids are metabolized, which may gradually increase pH; however, edible coatings such as chitosan may slow this biochemical change by reducing respiration and metabolic activity (Kader, 2002; Heydarian et al., 2021). In this study, the stable pH suggests that all treatments maintained comparable acidity conditions.

Figure 7. Actual pH reading using a calibrated digital pH meter

Vitamin C (Ascorbic Acid Content)

Vitamin C content was significantly affected by chitosan treatments. Treatment 3 at 10 g chitosan/L of water recorded the highest Vitamin C content of 9.50. Treatment 4 at 15 g chitosan/L followed with 8.95, while the control treatment recorded the lowest value of 8.25. This indicates that T3 significantly improved Vitamin C retention compared with the control.

TREATMENTS	VITAMIN C
T1 – Control (Distilled water)	8.25
T2 – 5 g Chitosan/1L of Water	8.85
T3 – 10 g Chitosan/1L of Water	9.50
T4 – 15 g Chitosan/1L of Water	8.95
T5 – 20 g Chitosan/1L of Water	8.50

Table 10. Vitamin C result of the Tomato as applied with the different treatments.

The higher Vitamin C content in T3 suggests that 10 g chitosan/L may have been the most effective concentration for preserving ascorbic acid under the conditions of the study. Vitamin C is sensitive to oxidation, oxygen exposure, and high respiration rate during storage. Chitosan coatings may reduce Vitamin C degradation by limiting oxygen permeability and slowing oxidative reactions (Hasan et al., 2020; Kaur & Nikhil, 2024). The result indicates that a moderate chitosan concentration may provide sufficient protective barrier effects without causing possible stress or coating-related limitations associated with higher concentrations.

SUMMARY, CONCLUSION AND RECOMMENDATION

Summary

This study evaluated the effectiveness of different rates of chitosan as an edible coating in maintaining the postharvest quality and shelf life of tomato (Solanum lycopersicum) under room temperature conditions. The experiment used five treatments: T1 – control or distilled water, T2 – 5 g chitosan/L of water, T3 – 10 g chitosan/L of water, T4 – 15 g chitosan/L of water, and T5 – 20 g chitosan/L of water. The study assessed physical and physicochemical parameters such as weight loss, visual quality rating, color development, shriveling, disease incidence, hardness, total soluble solids, titratable acidity, pH, and Vitamin C content. The study was conducted using a Completely Randomized Design with five treatments and four replications. The results showed that weight loss was not significantly affected by the different chitosan treatments. Although numerical differences were observed, no treatment was statistically superior in reducing weight loss. Visual quality rating remained high in all treatments during the early storage period; however, by Day 8, tomatoes treated with 10 g, 15 g, and 20 g chitosan/L maintained excellent visual quality, while the control and 5 g chitosan/L treatment declined slightly. This indicates that chitosan, particularly at moderate to higher concentrations, helped preserve the external appearance and marketability of tomato fruits. For color development, all fruits showed normal ripening progression from green to red stages. However, significant differences appeared during the later part of storage. T5, or 20 g chitosan/L, showed the most evident delay in color development, indicating that the highest chitosan concentration slowed ripening more effectively than the other treatments. Shriveling and disease incidence were not significantly affected by the treatments, as the fruits generally showed absent to very slight shriveling and very minimal disease symptoms throughout the observation period.

Hardness was significantly affected by chitosan treatment. T4, or 15 g chitosan/L, recorded the highest hardness value of 5.775, indicating better firmness retention compared with the other treatments. In contrast, T3, or 10 g chitosan/L, recorded the lowest hardness value of 3.825. For physicochemical parameters, total soluble solids and pH were not significantly affected by chitosan treatments. However, titratable acidity and Vitamin C content were significantly influenced. T5 recorded the highest titratable acidity value of 9.20, suggesting better retention of organic acids, while T3 recorded the highest Vitamin C content of 9.50, indicating better preservation of ascorbic acid.

CONCLUSION

Based on the findings of the study, the application of chitosan as an edible coating showed potential in maintaining selected postharvest quality attributes of tomato. However, its effect was not uniform across all parameters. Chitosan treatments did not significantly reduce weight loss, shriveling, disease incidence, total soluble solids, and pH under the conditions of the study. This suggests that the storage duration, initial fruit quality, and ambient storage conditions may have limited the observable effects of the coating on these parameters.
Among the treatments, T4, or 15 g chitosan/L of water, may be considered the most balanced treatment because it maintained excellent visual quality and produced the highest hardness value, indicating better firmness retention. T5, or 20 g chitosan/L, was most effective in delaying color development and retaining titratable acidity, while T3, or 10 g chitosan/L, was most effective in preserving Vitamin C content. Therefore, no single chitosan concentration was superior in all quality parameters, but 15 g chitosan/L showed the most practical overall performance in maintaining tomato firmness and marketable appearance. Overall, the study supports the use of chitosan as a natural and biodegradable edible coating for tomato postharvest management. Its benefits were most evident in maintaining visual quality, delaying ripening-related color changes, preserving firmness, retaining acidity, and improving Vitamin C retention.

Recommendation

Based on the results of the study, the use of 15 g chitosan/L of water is recommended for maintaining tomato firmness and visual quality under room temperature storage. This concentration may be useful for farmers, traders, and postharvest handlers who need a simple, low-cost, and environmentally friendly method to help preserve the marketability of tomato fruits.

For future studies, it is recommended to venture another commodity such as Papaya, Banana and other perishable fruits and vegetable crops to better determine the effect of chitosan on shelf life, shriveling, disease incidence, and weight loss. Future researchers should also control storage temperature and relative humidity more strictly, since these factors strongly influence tomato deterioration and may affect the performance of edible coatings.

It is also recommended to test additional chitosan concentrations between 10 g and 20 g/L, particularly around 12.5 g and 15 g/L, to identify a more precise optimum rate. Further studies may also evaluate the effect of chitosan on sensory quality, consumer acceptability, microbial load, lycopene content, and economic feasibility. Finally, the study may be repeated using other tomato varieties and different maturity stages to determine whether the effectiveness of chitosan coating varies depending on fruit type and harvest maturity.

REFERENCES

1. Abebe, Z., Tola, Y. B., & Mohammed, A. (2017). Effects of edible coating materials and stages of maturity at harvest on storage life and quality of tomato (Lycopersicon esculentum Mill.) fruits. Journal of Food Science and Technology.
2. Abdul Aziz, A., Hussein, H. K., & Al-Qubaisi, Q. A. (2023). The application of chitosan as a preservative for fruits and vegetables and control of postharvest diseases: A review. European Journal of Agricultural and Rural Education, 4(2), 45–60.
3. Al-Dairi, M., Pathare, P. B., Al-Yahyai, R., Jayasuriya, H., & Al-Attabi, Z. (2023). Postharvest quality, technologies, and strategies to reduce losses along the supply chain of fresh produce. Trends in Food Science & Technology, 134, 77–91. https://doi.org/10.1016/j.tifs.2023.02.007
4. Alexander, L., & Grierson, D. (2002). Ethylene biosynthesis and action in tomato: A model for climacteric fruit ripening. Journal of Experimental Botany, 53(377), 2039–2055. https://doi.org/10.1093/jxb/erf072
5. Barros, A. C., Sousa, C., Ferreira, I. C. F. R., & Baptista, P. (2010). Vitamin C determination in plant foods: Comparison of methods for extraction and quantification. Food Chemistry, 121(4), 1084–1090. https://doi.org/10.1016/j.foodchem.2010.01.040
6. Conover, W. J. (1999). Practical nonparametric statistics (3rd ed.). John Wiley & Sons.
7. Donjio, R. T., Aghofack Nguemezi, J., Anoumaa, M., Tafre Phounzong, E., Kenfack, J. O., & Fonkou, T. (2023). Using response surface methodology to optimize edible coating formulations to delay ripening and preserve postharvest quality of tomatoes. Journal of Food Quality, 2023, Article 1019310. https://doi.org/10.1155/2023/1019310
8. Duguma, H. T. (2022). Potential applications and limitations of edible coatings for maintaining tomato quality: A review. International Journal of Food Science & Technology, 57(3), 1353–1366. https://doi.org/10.1111/ijfs.15525
9. El Ghaouth, A., Arul, J., Ponnampalam, R., & Boulet, M. (1992). Chitosan coating to extend the storage life of tomatoes. HortScience, 27(9), 1016–1018. https://doi.org/10.21273/HORTSCI.27.9.1016
10. Food and Agriculture Organization of the United Nations. (2023). Post-harvest losses and food waste in horticultural crops. FAO.
11. Hasan, M. M., Bashir, T., Ghosh, R., & Rahman, M. S. (2020). Effect of chitosan-based edible coating on quality and shelf life of tomato fruits. Journal of Food Processing and Preservation, 44(8), Article e14635. https://doi.org/10.1111/jfpp.14635
12. Heydarian, A., Ahmadi, E., & Dastjerdi, A. M. (2021). Chitosan coating effects on qualitative characteristics and shelf life of fresh fruits. Journal of Food Measurement and Characterization, 15, 311–320. https://doi.org/10.1007/s11694-020-00646-7
13. Holcroft, D. (2015). Water relations in harvested fresh produce. Postharvest Education Foundation White Paper No. 15-01.
14. Hoffmann, J. P. (2002). Official methods of analysis of AOAC International (17th ed.). Association of Official Analytical Chemists.
15. Hossain, M. S., & Iqbal, A. (2016). Effect of shrimp chitosan coating on postharvest quality of fruits and vegetables. International Food Research Journal, 23(1), 277–283.
16. Kader, A. A. (2002). Postharvest technology of horticultural crops (3rd ed.). University of California, Agriculture and Natural Resources.
17. Kaur, N., & Nikhil, P. (2024). Investigating potential of edible coatings for microbial safety, quality, and shelf-life extension of fresh produce. Journal of Stored Products Research, 108, Article 102393. https://doi.org/10.1016/j.jspr.2024.102393

18. Kibar, H. F., & Sabir, F. K. (2018). Chitosan coating for extending postharvest quality of tomatoes (Lycopersicon esculentum Mill.) maintained at different storage temperatures. AIMS Agriculture and Food, 3(2), 97–108. https://doi.org/10.3934/agrfood.2018.2.97
19. Marydashti, L. M., Ayatollahi, S. A., Salehi, B., Sharifi-Rad, J., & Maggi, F. (2020). Optimization of edible chitosan-based coatings to improve postharvest storage potential and quality of horticultural crops. Journal of Food Safety, 40(2), Article e12715. https://doi.org/10.1111/jfs.12715
20. Paul, S. K., Sarkar, S., Sethi, L. N., & Ghosh, S. K. (2018). Development of chitosan-based optimized edible coating for tomato (Solanum lycopersicum) and its characterization. Journal of Food Science and Technology, 55(7), 2446–2456. https://doi.org/10.1007/s13197-018-3162-6
21. Pillai, A. R. S., et al. (2024). Polysaccharide-based edible biopolymer-based coatings for fruit preservation: A review. Foods, 13(10), Article 1529. https://doi.org/10.3390/foods13101529
22. Rinaudo, M. (2006). Chitin and chitosan: Properties and applications. Progress in Polymer Science, 31(7), 603–632. https://doi.org/10.1016/j.progpolymsci.2006.06.001
23. Shapiro, S. S., & Wilk, M. B. (1965). An analysis of variance test for normality (complete samples). Biometrika, 52(3–4), 591–611. https://doi.org/10.1093/biomet/52.3-4.591
24. Shinga, M., Silue, Y., & Fawole, O. A. (2025). Recent advancements and trends in postharvest application of edible coatings on fruits and vegetables: A review. Plants, 14(4), Article 581. https://doi.org/10.3390/plants14040581
25. United States Department of Agriculture, Agricultural Marketing Service. (1997). United States standards for grades of fresh tomatoes. U.S. Department of Agriculture.
26. Venkatachalam, K., Lekjing, S., Noonim, P., & Charoenphun, N. (2024). Extension of quality and shelf life of tomatoes using chitosan coating incorporated with cinnamon oil. Foods, 13(7), Article 1000. https://doi.org/10.3390/foods13071000
27. Vicente, A. R., Martínez, G. A., Chaves, A. R., & Civello, P. M. (2007). Effect of calcium on cell wall composition and postharvest softening of strawberry fruit. Journal of Agricultural and Food Chemistry, 55(9), 3414–3419. https://doi.org/10.1021/jf0630279
28. Wills, R. B. H., McGlasson, B., Graham, D., & Joyce, D. (2007). Postharvest: An introduction to the physiology and handling of fruit, vegetables and ornamentals (5th ed.). UNSW Press.
29. Yuan, G., Wang, S., Gao, W., & Chen, X. (2023). Effects of chitosan with different molecular weights on storage quality and fungal inhibition of tomato and cucumber. Food Control, 153, Article 109909. https://doi.org/10.1016/j.foodcont.2023.109909