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Shelf life of Tomato *(Solanum lycopersicum)* in different post-harvest treatments

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ABSTRACT

This study was carried out in order to evaluate the tomato's (*Solanum lycopersicum*) shelf life in different postharvest treatments in terms of color, firmness, percent weight loss, and percent weight of tomato. Study result would help farmers to adopt alternative techniques to protect and extend the shelf life of tomato. Four treatments were applied: t0- tap water treatment (control); t1- hot water treatment; t2- UV-C light treatment; and t3- seaweed treatment. Five (5) times each of these treatments were replicated in a completely randomized design (CRD). Data were collected, tabulated, and subjected to Analysis of Variance (ANOVA) using the Statistical Tool for Agricultural Research (STAR). Comparison among means made at a 5% level of significance using Tukey's Honest Significance Difference (HSD). Seaweed treatment at 3% concentration, hot water treatment for 20 minutes, and UV-C light treatment for 20 minutes had the same effect but significantly maximized the shelf life of tomatoes than tap water treatment during 30 days of storage, seaweed treatment at 3% concentration significantly delays the color of the shelf life of tomatoes among treatments during 30 days of storage, seaweed treatment is significantly firmer than the tap water treatment but is comparable to UV-C light treatment and hot water treatment. Thus, seaweed treatment, UV-C light treatment, and Hot water treatment have the same effect on the firmness of the shelf life of tomatoes in storing 30 days; seaweed treatment at 3% concentration is significantly lowest in percent weight loss than tap water and hot water treatment but is comparable to UV-C light treatment in storing 30 days. As a result, both UV-C light and seaweed treatments have the similar effects on tomato weight loss. Both may thereby lessen tomato weight loss during storage.

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INTRODUCTION

One of the crops with the largest production both globally and in our nation is the tomato (Colvine, 2021). Asia has by far the best productivity of any continent. However, because tomatoes are particularly perishable due to their climacteric pattern of respiration, vast quantities of harvested tomatoes are sold at throwaway prices, and poor microbial decomposition also contributes a lot to the post-harvest loss (Arah et al., 2015; Shahnawaz, 2012). The increased physiological and physicochemical changes in this fruit, such as weight loss, transpiration, respiration, and the softening of the pulp, sugar, and acid contents, are thought to be the cause of its perishability (Firmin, 1997). Increasing the shelf life and lowering post-harvest losses of tomatoes throughout the supply chain, domestic marketing, and export marketing are crucial (Sinha, S. et al., 2019; Mustefa A. et al., 1994).

Treating hot water reduces the metabolic process of cell walls, decomposing enzymes, and oddities in ethylene-producing enzymes, the disruption of ripening production can cease certain biochemical reactions that are necessary for ripening (Paul & Chen, 2000; Khan, 2009). Seaweeds are naturally present marine algae with a number of properties that provide organic preserving agents that extend the expected life expectancy of foods that are perishable without adversely impacting the quality and nutritional value or causing negative adverse effects (Banu, 2020). Currently, bacteria and post-harvest illnesses on the external surfaces of fruits are controlled by subjecting horticulture crops to UV-C radiation. Without reducing the fruit's quality, UV-C light helps slow down microbial growth and disinfect fresh produce (Idzwana et al., 2020).

OBJECTIVES OF THE STUDY

Generally, the study aims to determine the shelf life of tomatoes in different postharvest treatments. Specifically, the study aims to determine and compare the effect of different treatments on the shelf life of tomatoes in terms of; Color, Firmness, % Weight Loss, % Weight of Tomato.

MATERIALS AND METHODS

CRD was utilized in the study, with four treatments replicated five times and a total of twenty experimental units. Treatments were assigned following the randomization method by drawing of lots.

Experimental Set-up

The study was conducted in a room environment; the experimental area was disinfected and cleaned up**.** The materials used during the study were fresh, totally matured, yet unripened tomato fruits, Jewel F1 variety procured by the researcher at the farm situated at Brgy. Minapasuk, Calatrava, Negros Occidental. Plastic containers were used for the placement of the experimental organisms, each plastic container has eight (8) tomatoes which served as samples weighing 45 grams each, the pathogen-infected or mechanically injured tomatoes were discarded during sorting, samples were sorted at the same maturity level.

Treatment Process and Application

For Treatment 0, tomatoes were soaked to tap water for 20 minutes, after soaking, tap water was drained, and tomatoes were dried with a paper towel and placed in different assigned plastic ware. For treatment 1, the water was heated in using hot water bath with the temperature set at 50°C, the tomatoes were soaked for 20 minutes, after soaking the tomatoes, the hot water was drained, and tomatoes were dried with a paper towel and placed in different assigned plastic ware. In treatment 2, the tomatoes were exposed to UV-C lamp in a container for 20 minutes, after exposing them for 20 minutes, tomatoes were placed in different assigned plastic ware. In treatment 3, *K. alvarezii* was subjected to boiling to extract the gel, the seaweeds were used in an amount of 200 grams, and they were simmered at 100 °C for 15 minutes in 500 ml of water. It was then filtered and allowed to cool, 3% concentrations of seaweed extract were applied to tomatoes as an outer covering layer to increase their shelf life, each treatment was put in the cleaned and sanitized storage room.

Data Gathering Procedures

Shelf life: determined by adding up the days that pass between the start and the end of the study (within 30 days). When too much loss of weight, changes of color, firmness reduction, and browning are observed in tomatoes, they are recorded daily, and the day before the deterioration of the quality is thought to indicate the fruit's shelf life (Mama et al., 2016).

Color: The changes in tomato color were assessed using a number grading system from 1 to 7, where 1 represents green, 2 is breaker, 3 is turning, 4 is pink, 5 is pale red, 6 is red, and 7 is ripe red (Sinha et al., 2019).

Data was taken carefully at an interval of two days for color within 30 Days of Storage.

Firmness: The firmness of tomato fruit was measured by a hand feel using a number rating scale of 1-6, with 1 indicating hard, 2 indicating sprung, 3 indicating between sprung and eating ripe, 4 indicating eating ripe, 5 indicating overripe, and 6 indicating rotten (Zhang et al., 2014; Sinha et al., 2019).

Data was taken carefully at an interval of two days for firmness within 30 Days of Storage.

Percent Weight Loss: The tomatoes were weighed before treatment to figure out the percentage of weight loss; the starting weight was obtained on the first day of storage; and the final weight was obtained after 30 days of storage (Sinha et al., 2019).

% Weight Loss determined as

$$Weight\ Loss\ (\%) = \frac{(IW - FW)}{\mathrm{IW(g)}} x100$$

Where IW is the initial weight of fruits (g) and FW is the final weight of fruits at every weight (g).

Percent Weight of Tomato: the percent weight of tomato fruit was estimated from the data obtained during % weight loss estimation using the formula:

% Weight of Tomato = (100–Percent weight loss)

Statistical Tool

Data was consolidated, tabulated, and analyzed based on the ANOVA of the experiment in CRD using STAR. Comparison among means made at a 5% level of significance using HSD.

RESULTS AND DISCUSSION

Shelf life

Table 1 below shows the average number of days of the shelf life of tomatoes in different postharvest treatments. This parameter is one of the critical quality parameters of tomatoes

Table 1. Average number of days of the shelf life of tomato in different postharvest treatments.

Treatments	Shelf life (Mean days)
Tap Water	19.60[b]
Hot Water Treatment	24.40[a]
UV-C Light Treatment	25.00[a]
Sea Weed Treatment	28.00[a]
CV (%)	8.27

**There is no significant difference between the means of the similar letters.*

Table 1 show that the application of seaweed at 3% concentration obtained the highest mean of 28.00, followed by the application of UV-C light for 20 minutes with a mean of 25.00 and then the application of hot water treatment for 20 minutes with a mean of 24.40, while the application of tap water got the lowest mean of 19.60. Results revealed that the application of seaweed treatment at 3% concentration with a mean of 28.00 days has significantly maximized the shelf life of tomatoes than tap water treatment however; application of seaweed, UV-C light, and hot water had the same effect in prolonging the shelf life of tomatoes. This means that any application of the treatments (except for tap water treatment) could extend the shelf life of tomatoes thus, this relates to the related literature stating that seaweed treatment at 3% concentration, UV-C treatment for 20 minutes, and hot water treatment for 20 minutes extend the shelf life of tomato due to the fact that hot water and UV-C spectrum kill cell wall-degrading enzymes, which reduces their activity in cell wall disintegration, reducing the production of ethelyn, and preventing ripening (Safdar, 2009; Mama et al., 2016; Barka et al., 2000; Idzwana et al., 2019). Additionally, seaweed provides natural preservatives that can increase the shelf life of tomatoes. Sea plant extracts, like seaweed, contain benzoic acid, nitrite, and sulfur oxide, which are utilized in additives and synthetic preservatives (Nabti et al., 2017; Banu et al., 2020).

Color

Table 2 displays the means for the various postharvest tomato treatments in terms of the color of the tomato's shelf life. This characteristic is essential to determining which postharvest treatment alters the tomato's color throughout storage.

Table 2. Means of the shelf life of tomato in different postharvest treatments in terms of color.

Treatments	Color
Tap Water	5.10[a]
Hot Water Treatment	4.97[a]
UV-C Light Treatment	4.41[b]
Sea Weed Treatment	3.27[c]
CV (%)	5.19

* *There is no significant difference between the means of the similar letters.*

Table 2 describes that the application of tap water for 20 minutes obtained the highest mean of 5.10, followed by the application of hot water treatment for 20 minutes with a mean of 4.97 and then the treatment with UV-C light for 20 minutes with a mean of 4.41 while the application of seaweed treatment at 3% concentration got the lowest mean of 3.27.

Based on the numerical rating scale of the color of tomato fruit, from one (1) to seven (7), the rate of one (1) means green, the rate of two (2) still break in color, the rate of three (3) means turning in color, the rate of four (4) means pink, the rate of five (5) means light red, the rate of six (6) means red, while the rate of seven (7) means ripe red. This means that the lower the rate of the color of tomato fruit, the better and fresher (Wills et al., 2004;

Sinha et al., 2019; Camelo, 2004). Thus, the result shows that seaweed treatment with a mean of 3.27 remained turning. UV-C light treatment with a mean of 4.41 showed pink, while hot water treatment and tap water treatment with a mean of 4.97, and 5.10 changed the light in color.

Moreover, results revealed that among the treatments, application of seaweed treatment at 3% concentration with a mean of 3.27 is significantly lower and delayed the color of the shelf life of tomato among treatments during 30 days of storage. The inhibitory effect of lycopene by synthesis of its precursor, such as phytoene levels and phytofluene, is the cause of the delay in color development. Seaweed from K. Alvarezzi contains phytonutrients (Yakir et al., 1984; Khan, 2009; Mama et al., 2016 Banu T. et al., 2020).

Firmness

The means for the shelf life of tomatoes under various postharvest treatments are shown in Table 3 in terms of firmness. This parameter is crucial for determining which post-harvest treatments alter the firmness of tomatoes during storage.

Table 3. Means of the shelf life of tomato in different postharvest treatments in terms of firmness.

Treatments	Firmness
Tap Water	4.36[a]
Hot Water Treatment	3.30[b]
UV-C Light Treatment	3.23[b]
Sea Weed Treatment	2.81[b]
CV (%)	10.68

** There is no significant difference between the means of the similar letters.*

Table 3 shows that the application of tap water for 20 minutes got the highest mean of 4.36, followed by the application of hot water treatment for 20 minutes with a mean of 3.30 and then the application of UV-C light treatment for 20 minutes with a mean of 3.23 while the application of seaweed treatment at 3% concentration got the lowest mean of 2.81.

Based on the numerical rating scale of the firmness of tomato fruit, from one (1) to six (6), the rate of one (1) means hard, the rate of two (2) sprung, the rate of three (3) means between sprung and eating ripe, the rate of four (4) means eating ripe, the rate of five (5) means overripe, while the rate of six (6) means rotten, this means that the lower the rate of the firmness of tomato fruit, the harder, and fresher (Zhang et al., 2014; Sinha et al., 2019). Thus, the result shows that seaweed treatment with a mean of 2.81, UV-C light treatment with a mean of 3.23, and hot water treatment with a mean of 3.30 remained sprung and eating ripe, while tap water treatment with a mean of 4.36 are eating ripe. Furthermore, among the treatments, it is evident that the firmness of tomatoes treated with seaweed is significantly harder than the tap water treatment however; UV-C light treatment and hot water treatment are comparable to seaweed treatment. They had the same effect on the firmness of the shelf life of tomatoes, this means that seaweed treatment at 3% concentration, 20 minutes of UV-C light, and hot water treatment for 20 minutes could still prolong the hardness of tomato thus, according to the relevant literature, the 3% concentration of *K. alvarezzi* seaweed maintains the firmness and extends the shelf life of tomatoes since *K. alvarezzi* has fair antibacterial and antifungal activity (Banu T. et al., 2020), hot water treatment delays the firmness of tomatoes. In addition, UV-C light remains the firmness and protein synthesis of perishable fruits because UV-C light slows down cell membrane deterioration by targeting the enzymes that do so (Barka et al., 2000; Idzwana et al., 2020; Mama et al., 2016).

% Weight Loss

The means of the various post-harvest treatments are shown in Table 4 in terms of weight loss percentage. This parameter is essential to evaluate which postharvest treatments weighed less on the tomato's shelf life during its storage.

Table 4. Means of the tomato's shelf life in different postharvest treatments in terms of % Weight Loss.

Treatments	% Weight Loss
Tap Water	17.80[a]
Hot Water Treatment	13.60[b]
UV-C Light Treatment	10.00[c]
Sea Weed Treatment	8.20[c]
CV (%)	12.56

** There is no significant difference between the means of the similar letters.*

Table 4 showed that the application of tap water for 20 minutes got the highest mean of 17.80, followed by the application of hot water treatment for 20 minutes with a mean of 13.60 and then the treatment with 20 minutes of UV-C light exposure with a mean of 10.00 while the application of seaweed treatment at 3% concentration got the lowest mean of 8.20.

Data reveals that seaweed treatment at 3% concentration significantly obtained the lowest mean and percent weight loss of 8.20 than tap water and hot water treatment storing 30 days. Therefore, tomatoes treated with seaweed treatment had lower weight loss however, the treatment with UV-C light is comparable to the application of seaweed. Thus, they have the same effects on the percentage of weight loss of tomato, and little weight loss occurs to both treatments. At a 3% concentration of K. Alvarezii, seaweed maintains the weight of tomato fruit while the coatings act as barricade to the fruit's transpiration (Banu T. et al., 2020; Lin D., 2007). Treatment with UV-C has been proven to preserve the general quality and increase the ability to store freshly collected food. Additionally, it delays ripening and softening, maintains nutritional and sensory qualities while decreasing the rate of respiration and preventing weight loss (Baka et al., 1999; Marquenie et al., 2002; Idzwana et al., 2019).

% Weight of Tomato

Table 5 shows the means in terms of % weight of the tomato's shelf life in different postharvest treatments. This parameter is essential to evaluate which postharvest treatments maintain the % weight on the shelf life of tomatoes throughout the storage period.

Table 5. Means of tomato's shelf life in different postharvest treatments in terms of % weight of tomato.

Treatments	% Weight Loss	% Weight of Tomato
Tap Water	17.80[a]	82.20[c]
Hot Water Treatment	13.60[b]	86.40[b]
UV-C Light Treatment	10.00[c]	90.00[a]
Sea Weed Treatment	8.20[c]	91.80[a]
CV (%)	12.56	1.78

** There is no significant difference between the means of the similar letters.*

As seen in table 5, it shows that the % weight of tomato in seaweed treatment got the highest mean of 91.80, followed by UV-C treatment with a mean of 90%, and hot water treatment with the mean of 86%, while tap water treatment got the lowest mean of % weight of 82.20.

Results revealed that seaweed treatment at 3% concentration was significantly higher % weight on tomato's shelf life than the tap water also to hot water treatments however, UV-C light treatment is comparable to seaweed treatment. Thus, they have the same effects on the % weight of tomato, and both treatments could maintain the percent weight on tomato's shelf life. At 3% coating of *K. alvarezii*, seaweed creates the desired obstruction to the transmission of oxygen, carbon dioxide, and water vapor. To this, it helps maintain the weight of tomato fruit and lessen its problem of weight loss (Banu T. et al., 2020; Lin D., 2007). Perishable fruits and vegetables exposed to UV-C light for 20 minutes reduced microbial degradation, reduced respiration rate, and maintained weight (Erkan et al., 2001; Idzwana et al., 2019).

CONCLUSION AND RECOMMENDATION

Tomato's shelf life was greatly prolonged by using seaweed treatment at a concentration of 3%, 20 minutes of hot water treatment, and UV-C light treatment for 20 minutes during the period of 30 days of storage. When compared to other treatments, seaweed treatment at 3% concentration significantly shortens the 30-day color-shelf life of tomatoes. Compared to treatments using hot water and UV-C light, seaweed treatment is significantly firmer than tap water treatment. Therefore, the firmness of the tomato's 30-day shelf life is not affected by using seaweed, UV-C spectrum, or hot water treatments. At 3% concentration, seaweed treatment results in a significantly lower weight loss than hot water and tap water treatment, whereas it is comparable to UV-C light treatment for storing goods for 30 days. Thus, the effects of seaweed treatment and UV-C treatment on tomato weight loss are same. Therefore, both could reduce the weight loss of tomatoes throughout its shelf life. In comparison to hot water and tap water treatments, seaweed treatment at 3% concentration significantly increased tomato shelf life while being comparable to UV-C light treatment. Since both seaweed treatment and UV-C light treatment have the same effects on tomato weight in percentage, both treatments potentially keep tomato's weight in percentage for a prolonged period of time.

Since seaweed treatment performs best in terms of delaying the color, preserving the firmness, maintaining weight, and lowering weight loss on tomato's shelf life for 30 days, it is recommended to apply it at a concentration of 3% to be able to extend and prolong the tomato's shelf life. Since UV-C light treatment has the similar effect on extending shelf life, firmness, lowering weight loss, and maintaining% weight of tomato, it is likewise recommended in the absence of seaweed treatment. Additionally, treatment with hot water extends the shelf life and firmness of tomato fruit and has the same result. To truly validate the results, further research and study using hot water, UV-C light, and seaweed treatments to extend the shelf life of other perishable fruits, crops, and vegetables is advised.

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