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EXTENSION OF SHELF LIFE AND ASSURING QUALITY OF TOMATO BY USING POSTHARVEST TREATMENTS

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ABSTRACT

The experiment was carried out in the Postharvest laboratory at Sher-e-Bangla Agricultural University, Dhaka, Bangladesh. The single factor experiment was laid out in a Completely Randomized Design (CRD) with three replications. The present research was conducted to evaluate the effect of different postharvest treatment on shelf life and quality of tomato. The postharvest treatments were (viz: W_o = Tap water dips, W_H= Hot water dips, I = With ice, I_o= Without ice, P= Perforated Polybag, P_o = Non-Perforated Polybag, R_H= 80±5% Relative Humidity and R_o= Relative humidity at room condition 60-65%. Results revealed that the lowest disease incidence (43.54%) and weight loss (7.62 %) were recorded from T_{13} (Hot water dips + With ice + Perforated Polybag + 80±5% RH) treatment where highest disease incidence (100%) and weight loss (16.17 %) were found in T_{12} (Tap water dips + Without ice + Control + RH at room condition 60-65%) treatment. The highest shelf life (17 days) and quality of tomato were obtained from T_{13} (Hot water dips + With ice + Perforated Polybag + 80±5% RH) treatment. The better performance was observed in tomatoes when treated with hot water including ice and storage with perforated polybag and 80±5% relative humidity for longer shelf life and quality.

Key words: postharvest treatment, perforated polybag, relative humidity, shelf life, fruit quality.

INTRODUCTION

Bangladesh is one of the leading producers of different types of vegetables that are grown in its diverse agro-ecological zones. Among them, Tomato is one of the most important and popular vegetables ranking fourth in respect of production and third in respect of area in Bangladesh (BBS, 2020). It contains high fiber, Vitamin C, amino acids, carbohydrates, organic acids, anti-oxidant properties such as lycopene which can protect cells from free radical damage and also prevent cancers in humans (Li *et al*., 2021 and Puah *et al*., 2021). However, post-harvest losses remain a big threat to tomato cultivation that can be caused by a wide variety of factors, ranging from the initial harvest and distribution to the final consumer. During the process of distribution and marketing, substantial losses are incurred which range from a slight loss of quality to total spoilage. It is estimated that 20-30% losses in fruits and vegetables are due to post harvest diseases. It is not only a serious problem of tomato growers in Bangladesh, but also the improvement of the shelf life and reduction of the postharvest losses of tomatoes has become an international issue. Therefore, it is necessary to explore the ways and means to prolong the shelf life of the fruit while keeping the quality high. Hot water treatment (HWT) has been a safe and effective method in managing postharvest decay in a variety of fruits, including apple, pear, peach, strawberry, and melon (Bai *et al*. 2006; Jemric *et al.,* 2011; Villa-Rojas *et al*., 2011; Maxin *et al*., 2012; Spadoni *et al*., 2014 and Sui *et al*., 2014). It was observed that lemon fruit dipped in hot-water for 2 min at 52–53°C that prevents postharvest decay (Nafussi *et al*., 2001) and hot water brushing at 60°C for 30s or 65°C for 20s significantly reduced the decay incidence of natural infection in cactus pear (Dimitris *et al*., 2005). Besides, another safe treatment is using ice after harvesting of tomatoes to reduce postharvest losses such as microbial activity, water loss and decay, thus extending the storage time of the fruit (Gruyters *et al*., 2019 and Zhu *et al*., 2019). Furthermore, among the various techniques developed to extend the fruit postharvest life, packaging materials such as polythene is used to prevent degradation which can create a modified atmosphere which significantly reduce fruit weight loss (Shammi and Masud, 2009). The present study is undertaken to investigate the physiological changes in tomatoes during postharvest handling and storage, as well as to identify effective postharvest treatments for extending their shelf life and maintaining quality.

MATERIALS AND METHODS

Freshly harvested tomatoes were collected from farmer field of Raipura Upazilla of Narsinghdi District, Bangladesh. This research was conducted at Postharvest Laboratory, Department of Horticulture, Sher-e-Bangla Agricultural University, Dhaka. The fruits were sorted out, labeled and separated into experimental units for further analysis. Tomatoes were treated with 24 different treatment combinations using tap water dip, hot water dip, with ice, without ice, perforated polybag, non-perforated polybag, 80±5% Relative Humidity, 60-65% Relative Humidity at room condition. This experiment was laid out in the Completely Randomized Design (CRD) with three replications. Data on shelf life (days), weight loss (%), Vitamin C, TSS, TA, color change (days), disease incidence (%) were recorded at 3 days interval during the storage period. Where the shelf life was calculated by counting the days required to attain the beginning of rotting of fruits (Mondal, 2000). Weight loss (%) was determined by periodical weighing of fruits and expressed as percentage of original weight. Damaged (rotting or chilling injury) fruits were also included with it. The fruit quality attributes viz. total soluble solids, titratable acidity and vitamin c were determined by the distinct procedure in the postharvest laboratory of SAU. The peel color of fruit was recorded by visual observation. Thirteen days required of color during storage and ripening were measured by using numerical rating scale of 1-7, where 1 = green, 2 Greenish yellow, 3 = Yellowish (< 25%), 4 = Light red (<50%), 5 = Uniform red colour (<75%), 6 = Deep red (75-100%) and 7 = Mashy not edible. Disease incidence of the tomato fruits were critically examined one day later for the appearance of rot. The first count was made at the 3 days after storage. Disease incidence is measured by calculating the percentage of fruits infected in each replication of each treatment. The collected data on various parameters were analyzed statistically using MSTAT-C software. The significance of the difference between the pairs of means was assessed by the least significant difference (LSD) test at the 1% level of probability (Gomez and Gomez, 1984).

RESULTS AND DISCUSSION

Color change

The number of days required for color development after the harvest of tomatoes was significantly influenced (13 days) by different post-harvest treatments. It was found that the highest color score (7) was observed in T_{12}, T_2, T_6, T_7, T_{22}, and T_{24}, and the lowest treatment color score T_{13}, and T_{23}, was found in Uniform red color (Score <6) in hot water, perforated polythene, ice, and relative humidity (Fig. 1.). This might be due to the higher concentration of CO_2 and lower concentration of O_2 inside the sealed polythene bag. There was a significant variation due to the combined effect of different colors and types of polythene bag at relative humidity concerning the time required for color development or ripening of tomato. Thai *et al.* (1990) found a similar result in their work.

Goncalves *et al.* (2007) demonstrate that a chromatic function of hue is strongly connected with the assessment of color and anthocyanin concentrations throughout the storage of sweet cherries, which may also be influenced by cultivar.

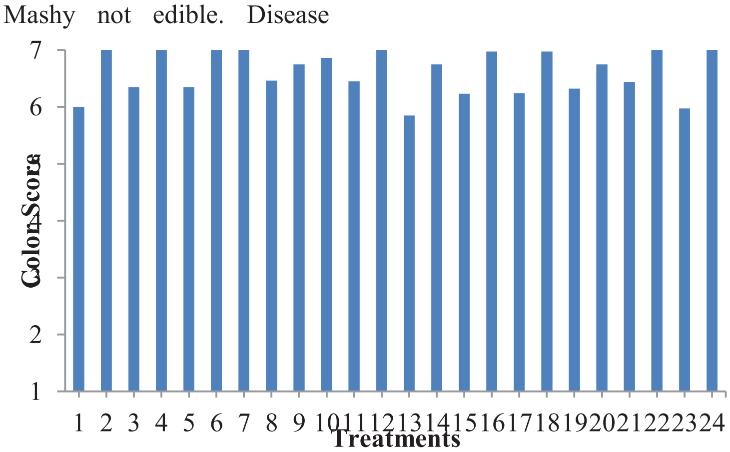

Fig. 1. Effect of postharvest treatments on the color of tomato at 13 days of storage

W_o = Tap water dips, W_H= Hot water dips, I = With ice, I_o= Without ice, P= Perforated Polybag, P_o = Non-Perforated Polybag, R_H= 80±5% Relative humidity (RH), R_o= Relative humidity (RH) at room condition 60-65%

T_1= Wo + I + P + R_H, T_2= Wo + I + P + R_o, T_3= Wo + I + P_o + R_H, T_4= Wo + I + P_o + R_o, T_5= Wo + I + Control + R_H, T_6= Wo + I + Control + R_o,T_7= Wo + I_o + P + R_H, T_8= Wo + I_o + P + R_o, T_9= Wo + I_o + P_o + R_H, T_{10}= Wo + I_o + P_o + R_o, T_{11}= Wo + I_o + Control + R_H, T_{12}= Wo + I_o + Control + R_o, T_{13}= W_H + I + P + R_H, T_{14}= W_H + I + P + R_o, T_{15}= W_H + I + P_o + R_H, T_{16}= W_H + I + P_o + R_o, T_{17}= W_H + I + Control + R_H, T_{18}= W_H + I + Control + R_o, T_{19}= W_H + I_o + P + R_H, T_{20}= W_H + I_o + P + R_o, T_{21}= W_H + I_o + P_o + R_H , T_{22}= W_H + I + P_o + R_o, T_{23}= W_H + I + Control + R_H ,T_{24}= W_H + I + Control+ R_o.

Özkaya. *et al.* (2015) showed that there had been a decrease in h° that was not significant statistically at the end of the shelf life. The low h° values relative to those measured in the beginning imply that there were condenses in color. Skin color is considered the most important index of cherry quality and maturity.

Shelf life (days)

A major problem with the storage and marketing of fresh tomatoes is their relatively fast deterioration in quality and short shelf life. Hence, different post-harvest technologies are employed to reduce losses and extend the shelf life. High temperature and relative humidity favor the growth of microorganisms which cause extensive damage to the produce. The fruits treated with hot water, packed in a perforated polyethylene bag, and kept in ice showed a comparatively longer shelf life (17 days). On the other hand, tomatoes treated with control without packaging showed a comparatively shorter shelf life (7 days) (Figure 2). Many reports have shown that the percentage of weight loss in postharvest fruit, such as dragon fruit (Lum and Azri, 2011), mango (Angasu *et al.,* 2014), and tomato (Boonkorn, 2016), increases with hot water temperature and storage period. Modified atmospheric packaging (MAP) has the advantage of delaying stem deterioration, color changes, softening, and weight loss. Consequently, cherries treated with MAP can retain their quality for extended durations of storage (Serrano *et al*., 2005).

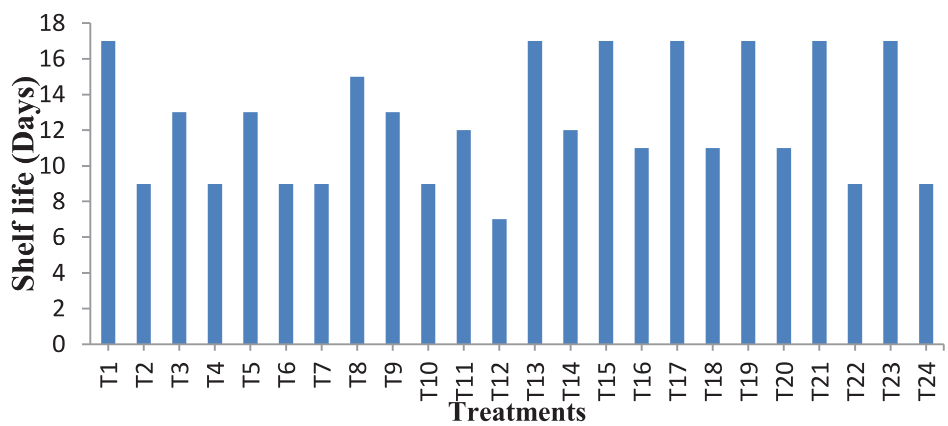

Fig. 2. Effect of postharvest treatments on the shelf life of tomato

W_o = Tap water dips, W_H= Hot water dips, I = With ice, I_o= Without ice, P= Perforated Polybag, P_o = Non-Perforated Polybag, R_H= 80±5% Relative Humidity (RH), R_o= Relative humidity (RH) at room condition 60-65%

T_1= Wo + I + P + R_H, T_2= Wo + I + P + R_o, T_3= Wo + I + P_o + R_H, T_4= Wo + I + P_o + R_o, T_5= Wo + I + Control + R_H, T_6= Wo + I + Control + R_o,T_7= Wo + I_o + P + R_H, T_8= Wo + I_o + P + R_o, T_9= Wo + I_o + P_o + R_H, T_{10}= Wo + I_o + P_o + R_o, T_{11}= Wo + I_o + Control + R_H, T_{12}= Wo + I_o + Control + R_o, T_{13}= W_H + I + P + R_H, T_{14}= W_H + I + P + R_o, T_{15}= W_H + I + P_o + R_H, T_{16}= W_H + I + P_o + R_o, T_{17}= W_H + I + Control + R_H, T_{18}= W_H + I + Control + R_o, T_{19}= W_H + I_o + P + R_H, T_{20}= W_H + I_o + P + R_o, T_{21}= W_H + I_o + P_o + R_H , T_{22}= W_H + I + P_o + R_o, T_{23}= W_H + I + Control + R_H ,T_{24}= W_H + I + Control+ R_o.

Weight loss (%)

Weight loss is one of the most important parameters that affect fruit quality during storage and shelf life. The treatments were found to have a significant effect on the weight loss of tomatoes. The highest weight loss (16.17 %) was found in the T_{12} treatment while the second highest (14.52%) was in the T_6 treatment and the lowest (7.62 %) in the treatment T_{13} (Table 1). This might be due to the rate of transpiration being lower in sealed polyethylene bags. There was also a significant variation due to the combined effect of different methods and hot water treatment at room temperature (28°C) concerning the percent weight loss of tomatoes. This means that the difference between the ambient and evaporative was highly significant and therefore the use of treatment for preserving and improving the shelf life of tomatoes cannot be avoided. FAO (1989) reported that water is an important constituent of most fruits and vegetables and it adds up to the total weight and losses of water will reduce the weight. Modified humidity/modified atmosphere (MA/MH) packing markedly decreased weight losses in comparison to the control group. The increased relative humidity within the MA/MH packaging could be the reason for the delaying of fruit weight losses in comparison to cherries kept in ambient air (Meheriuk et al., 1997; Kappel *et al.,* 2002). The difference was also because the fruits were stored for different storage durations. Znidarcic and Pozrl (2006) reported similar results that tomatoes stored for longer periods had greater weight loss. Tomatoes stored at room temperature recorded a maximum weight loss as compared to those packed in polyethylene bags due to a higher rate of transpiration and water loss (Lingaiah, 1982).

Vitamin C (mg/100 g)

Initially, tomatoes contained Vitamin C, but it was reduced significantly on the last day of the storage period. The maximum values were found to be T_{13} (6.61mg/100g) and minimum values T_{12} (4.38 mg/100) respectively (Table-1). Vitamin C was reduced in small amounts when fruits were packed in perforated polyethylene bags, hot water, and kept in ice. The vitamin C content of tomatoes for both maturity stages indicated significant ($p<0.05$) decreases as the storage time increased at 25^0 C (*Bapary et al.,* 2024). The vitamin C and titrable acidity content of tomato juice increased with maturity stages and reached the peak and thereafter started to decrease (Sinaga, 1986). The amount of ascorbic acid in the juice of tomatoes increased consistently until day 3, when the rate of rise was comparable across all samples; however, post day 3, the increase in ascorbic acid was significantly greater in the hydro-cooling with ice water and $CaCl_2$ (HIWC) samples. The best results were shown with hydro-cooling with ice water and $CaCl_2$ (HIWC) samples recording a rise of 32 % followed by HIW samples recording an increase of 41% in the value of ascorbic acid during 13 days of storage (Shahi. *et al.,* 2012).

Table 1. Effect of different postharvest treatments on weight loss (%) and vitamin c (mg/100g) of tomato at the end of shelf life

Treatments	Weight loss (%)	Vitamin C (mg/100g)
T_1	10.17 j	5.91 e
T_2	13.65 d	4.86 j
T_3	10.69 hi	5.57 f
T_4	14.52 c	4.56 kl
T_5	11.73 g	5.34 fg
T_6	14.95 b	4.56 kl
T_7	13.21 e	4.80 jk
T_8	10.56 i	5.94 de
T_9	10.95 h	5.55 f
T_{10}	14.60 c	4.55 kl
T_{11}	11.65 g	5.39 fg
T_{12}	16.17 a	4.38 l
T_{13}	7.63 n	6.61 a
T_{14}	12.95 ef	5.31 fgh
T_{15}	8.47 m	6.52 ab
T_{16}	13.76 d	5.05 hij
T_{17}	9.62 k	6.33 bc
T_{18}	12.85 f	6.16 cde
T_{19}	8.45 m	6.51 ab
T_{20}	12.99 ef	5.13 ghi
T_{21}	8.99 l	6.36 abc
T_{22}	13.92 d	5.13 ghi
T_{23}	9.70 k	6.21 cd
T_{24}	13.95 d	5.01 ij
LSD%	0.32	0.27
CV	1.62	2.92

Here, W_o = Tap water dips, W_H= Hot water dips, I = With ice, I_o= Without ice, P= Perforated Polybag, P_o = Non-Perforated Polybag, R_H= 80±5% Relative Humidity (RH), R_o= Relative humidity (RH) at room condition 60-65%,
T_1= Wo + I + P + R_H, T_2= Wo + I + P + R_o, T_3= Wo + I + P_o + R_H, T_4= Wo + I + P_o + R_o, T_5= Wo + I + Control + R_H, T_6= Wo + I + Control + R_o,T_7= Wo + I_o + P + R_H, T_8= Wo + I_o + P + R_o, T_9= Wo + I_o + P_o + R_H, T_{10}= Wo + I_o + P_o + R_o, T_{11}= Wo + I_o + Control + R_H, T_{12}= Wo + I_o + Control + R_o, T_{13}= W_H + I + P + R_H, T_{14}= W_H + I + P + R_o, T_{15}= W_H + I + P_o + R_H, T_{16}= W_H + I + P_o + R_o, T_{17}= W_H + I + Control + R_H, T_{18}= W_H + I + Control + R_o, T_{19}= W_H + I_o + P + R_H, T_{20}= W_H + I_o + P + R_o, T_{21}= W_H + I_o + P_o + R_H , T_{22}= W_H + I + P_o + R_o, T_{23}= W_H + I + Control + R_H ,T_{24}= W_H + I + Control+ R_o.

Total Soluble Solids (%)

There was a significant difference in TSS for all the tomatoes from the different treatments on the day of purchase. Total TSS ranged from 3.13– 4.16% and was highest for tomatoes from T_{19} (4.16%) followed by T_{13} (4.15 %) and lowest from T_{12} (3.13%) (Table 2). The hot water tank would have had a sweeter flavor at the full ripe stage than other treatments and after storage, it was reduced which was also lower in fruits packed in perforated polyethylene bags than others. There was a gradual decrease in TSS for produce over time. This phenomenon can probably be attributed to the normal senescing causing carbohydrate respiratory losses (Nunes, 2008). Changes in tomato TSS were also significantly different between the storage conditions. Ripening contributes to the breakdown of pectin substances into more simple sugars thereby increasing the total TSS (Wills & Ku, 2002). The total soluble solids increased during the ripening due to degradation of polysaccharides to simple sugars thereby causing a rise in TSS (Naik *et al.*, 1993). For instance, the TSS of heat-treated tomatoes was unaffected when tomatoes ripened at ambient temperatures (McDonald *et al.,* 1999*)* or when they ripened in a modified atmosphere storage system (Suparlan and Itoh, 2003).

Titratable Acidity (%)

There was a significant reduction in tomato acidity with storage time. The TA ranged from 0.244– 0.595% and was significantly higher for tomatoes from T_{13} (0.594) compared to T_{19} (0.560) and T_{15} (0.522) which was statistically similar. Tomatoes kept in ambient condition had lower values from T_{12} (0.244%) compared to that T_{10} (0.334) and T_4 (0.333%) respectively, (Table 2). Increased storage temperature has been reported to enhance fruit ripening which is inversely related to the acidity of fresh produce, as organic acids decline with continued ripening (Kader, 2002). The major acid constituents of tomatoes are malic and citric acid. Malic acid decreases quickly as produce starts to turn red while citric acid is rather stable throughout the ripening period. Shahi. *et al.,* (2012) showed that the decrease in titratable acidity after 5 days was almost linear in all cases although the rate of decline was slightly higher in the controlled samples, at the end of the storage period there were no significant differences among acidity at different treatments. The controlled sample was found to be the most acidic and the samples of HRW treatment were least acidic till 9 days. These results agreed with those from (Castro *et al.,* 2005) presenting an acidity decrease with maturity. (Will *et al.,* 1982) showed, that the amount of organic acid usually decreases during maturity, because of the substrate of respiration.

Table 2. Effect of different postharvest treatments on total soluble solids (%) and titratable acidity (%) of tomato

Treatments	Total soluble solids (%)	Titratable acidity (%)
T_1	4.09 abc	0.452 defgh
T_2	3.74 ghi	0.357 kl
T_3	4.01 abcdef	0.467 defg
T_4	3.79 fgh	0.333 l
T_5	3.94 abcdefg	0.392 ijk
T_6	3.52 I	0.271 m
T_7	3.75 ghi	0.348 kl
T_8	4.05 abcde	0.439 efghi
T_9	3.93 abcdefg	0.430 ghi
T_{10}	3.84 defgh	0.334 l
T_{11}	3.17 J	0.445 defgh
T_{12}	3.13 J	0.244 m
T_{13}	4.15 A	0.595 a
T_{14}	3.88 bcdefg	0.415 hij
T_{15}	4.12 ab	0.522 bc
T_{16}	3.86 cdefg	0.434 fghi
T_{17}	4.07 abcde	0.488 cde
T_{18}	3.93 abcdefg	0.425 ghi
T_{19}	4.16 A	0.560 ab
T_{20}	3.85 cdefg	0.393 ijk
T_{21}	4.07 abcde	0.494 cd
T_{22}	4.08 abcd	0.373 jkl
T_{23}	3.61 hi	0.485 cdef
T_{24}	3.83 efgh	0.369 jkl
LSD%	0.24	0.052
CV	3.86	4.640

Here, W_o = Tap water dips, W_H= Hot water dips, I = With ice, I_o= Without ice, P= Perforated Polybag, P_o = Non-Perforated Polybag, R_H= 80±5% Relative Humidity (RH), R_o= Relative humidity (RH) at room condition 60-65%,
T_1= Wo + I + P + R_H, T_2= Wo + I + P + R_o, T_3= Wo + I + P_o + R_H, T_4= Wo + I + P_o + R_o, T_5= Wo + I + Control + R_H, T_6= Wo + I + Control + R_o,T_7= Wo + I_o + P + R_H, T_8= Wo + I_o + P + R_o, T_9= Wo + I_o + P_o + R_H, T_{10}= Wo + I_o + P_o + R_o, T_{11}= Wo + I_o + Control + R_H, T_{12}= Wo + I_o + Control + R_o, T_{13}= W_H + I + P + R_H, T_{14}= W_H + I + P + R_o, T_{15}= W_H + I + P_o + R_H, T_{16}= W_H + I + P_o + R_o, T_{17}= W_H + I + Control + R_H, T_{18}= W_H + I + Control + R_o, T_{19}= W_H + I_o + P + R_H, T_{20}= W_H + I_o + P + R_o, T_{21}= W_H + I_o + P_o + R_H , T_{22}= W_H + I + P_o + R_o, T_{23}= W_H + I + Control + R_H ,T_{24}= W_H + I + Control+ $R_{o.}$

Disease incidence (%)

Significant variation was observed concerning disease incidence among postharvest treatments. It was observed that the disease incidence tended to increase with the advancement of storage period in both control and hot water treatment. The present investigation showed that the postharvest treatments of tomato harvest had significant effects on disease incidence. A gradual increase in disease incidence was also observed here with the advancement of storage duration. Disease incidence was found to be the highest (15.59% 42.47% 67.62 and 100% at the 7th, 10th and 13th, and 16th days of harvest respectively) at all stages in the case of control (T_{12}) where the hot water, ice, perforated polybag, and relative humidity (T_{13}) represented the lowest disease incidence (0.0%, 2.76% 19.68% and 43.54% at 7th, 10th and 13th and 16th days of harvest respectively) (Table 3). Similar findings shown that fungus components that might develop in the environment during storage are eliminated by modified atmosphere–modified humidity packing (MA/MH). Furthermore, compared to the samples that were air-cooled, MA/MH packing stops these pathogens from developing over the period of the tomatoes. After nine days, the controlled and air-cooled samples both displayed skin rupture and surface fungal growth. When it came to their shelf life, the tomatoes that were hydro-cooled with ice water and $CaCl_2$ treatment performed better than those that were hydro-cooled with ice water treatment (Shahi *et al.,* 2012).

Table 3. Effect of postharvest treatments on disease incidence (%) of tomato at different days of storage

Treatments	Disease incidence (%)			
	7th day	10th day	13th day	16th day
T_1	0.00 e	6.92 q	26.53 p	45.80 p
T_2	10.50 bc	33.82 e	54.76 f	100.00 a
T_3	0.00 e	14.85 l	28.54 no	80.72 g
T_4	11.07 b	38.55 c	60.71 d	95.52 b
T_5	0.00 e	13.87 m	22.62 r	60.60 j
T_6	11.68 b	40.30 b	63.50 c	100.00 a
T_7	0.00 e	7.85 pq	25.96 pq	46.66 o
T_8	10.52 bc	35.42 d	58.55 e	94.58 c
T_9	0.00 e	19.73 j	29.00 n	65.51 i
T_{10}	14.05 a	41.78 a	64.49 b	100.00 a
T_{11}	0.00 e	16.57 k	25.64 q	58.80 k
T_{12}	15.59 a	42.47 a	67.62 a	100.00 a
T_{13}	0.00 e	2.76 t	19.68 t	43.54 q
T_{14}	0.00 e	22.53 i	35.46 k	72.52 h
T_{15}	0.00 e	9.58 o	29.87 m	50.64 m
T_{16}	4.41 d	25.59 h	49.61 i	87.66 f
T_{17}	0.00 e	5.72 r	27.98 o	49.76 n
T_{18}	5.36 d	26.68 g	50.44 h	90.65 e
T_{19}	0.00 e	3.95 s	20.49 s	45.50 p
T_{20}	0.00 e	16.72 k	44.71 j	80.81 g
T_{21}	0.00 e	10.65 n	30.89 l	55.82 l
T_{22}	5.27 d	20.65 j	52.50 g	92.73 d
T_{23}	0.00 e	8.78 op	29.94 m	45.74 p
T_{24}	8.81 c	30.94 f	53.18 g	93.44 d
LSD%	1.85	0.95	0.73	0.84
CV	2.72	2.78	1.09	0.69

Here, W_o = Tap water dips, W_H= Hot water dips, I = With ice, I_o= Without ice, P= Perforated Polybag, P_o = Non-Perforated Polybag, R_H= 80±5% Relative Humidity (RH), R_o= Relative humidity (RH) at room condition 60-65%,
(T_1= Wo + I + P + R_H, T_2= Wo + I + P + R_o, T_3= Wo + I + P_o + R_H, T_4= Wo + I + P_o + R_o, T_5= Wo + I + Control + R_H, T_6= Wo + I + Control + R_o,T_7= Wo + I_o + P + R_H, T_8= Wo + I_o + P + R_o, T_9= Wo + I_o + P_o + R_H, T_{10}= Wo + I_o + P_o + R_o, T_{11}= Wo + I_o + Control + R_H, T_{12}= Wo + I_o + Control + R_o, T_{13}= W_H + I + P + R_H, T_{14}= W_H + I + P + R_o, T_{15}= W_H + I + P_o + R_H, T_{16}= W_H + I + P_o + R_o, T_{17}= W_H + I + Control + R_H, T_{18}= W_H + I + Control + R_o, T_{19}= W_H + I_o + P + R_H, T_{20}= W_H + I_o + P + R_o, T_{21}= W_H + I_o + P_o + R_H , T_{22}= W_H + I + P_o + R_o, T_{23}= W_H + I + Control + R_H ,T_{24}= W_H + I + Control+ R_o.)

CONCLUSION

Postharvest treatments play a crucial role in minimizing postharvest losses while maintaining the quality of tomatoes during storage. Without proper postharvest treatment, tomatoes are prone to microbial attacks and color deterioration, resulting in shorter shelf life and reduced quality. In this study, the T_{13} (W_H = Hot water dips + I= with ice+ P=Perforated Polybag + R_H=80±5% Relative Humidity) treatment showed superior performance by reducing weight loss (%), disease incidence (%), and controlling color development, while maintaining higher levels of vitamin C, TSS, and TA (%). It has been revealed that treating tomatoes with hot water and ice, combined with storage in perforated polybags at 80±5% relative humidity, significantly enhances their shelf life and overall quality.

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