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Effect of Indigenous Storage Materials on Shelf Life of Selected Tomato Varieties

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ABSTRACT

The experiment was undertaken in Molecular Horticultural laboratory and germplasm centre of Khulna University, Khulna, Bangladesh, during the period March to May, 2019 with the aims to study the effects of postharvest treatments on shelf life of tomato by cost effective different indigenous storage materials. Ten treatments with 16 tomato varieties including eight improved varieties developed by Bangladesh Agricultural Research Institute and eight cultivars collected from farmers field of Khulna region were used. The experiment was laid out in a Completely Randomized Design (CRD) with three replications. BARI Tomato-19 followed by Paltola showed the maximum shelf life (40 days and 37 days, respectively) and fresh fruit (84% and 77%, respectively). T1 (AC room) gave the highest fresh fruit (76.4%), which was statistically identical to T4 (saw dust dry), T8 (neem leaf) and T9 (mahogany oil (5%)) containing the value 70.5%, 70.1% and 72.05%, respectively.

KEYWORDS: Indigenous materials; postharvest quality; shelf life and tomato.

ARTICLE DETAILS

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1. INTRODUCTION

Tomato (*Lycopersicon esculentum Miller*) is one of the most important and remunerative vegetable crop in worldwide (Wang et al., 2005). It ranks first in terms of world vegetable production (Statista, 2023). Tomato is a versatile climacteric fruit, consumed both in raw and processed form. Tomato changes continuously after harvesting depending on the humidity and temperature and become soft and inconsumable (Ullah, 2009). Sensory attributes of fresh tomatoes like color, flavor, texture and appearance are the most important quality parameters which valorize its market value (Liu et al., 2009). Post-harvest losses refer to the measurable quantitative and qualitative food loss in the postharvest system (Aramyan and van Gogh, 2014). Postharvest losses in tomatoes can be as high as 25–42% globally (Rehman et al. 2007).

In tropical and subtropical regions where temperature is high, climacteric fruits have relatively high respiration rate which results in faster ripening and deterioration of fruit quality that eventually shorten their postharvest life (Bailen et al., 2006). Significant postharvest losses of tomatoes are due to fungal infection, and physical injuries (Firdous, 2021). In the peak harvesting time, the tomato in a glut in the market in Bangladesh and the growers fail to avail expected return of the produce (Sinha et al., 2019). The estimated post-harvest loss of tomatoes in the supply chain of Bangladesh is 27.6 % (Hasan et al., 2021). Developments of new storage and preservation techniques to extend shelf life have significant value (Ochida et al., 2019). The freshness of tomatoes also influenced by some postharvest techniques, and shelf life extended up to 17 days compared to 7 days for control treatments (Firdous, 2021). Several methods are suggested by researchers to increasing shelf life such as application of edible coatings (Firdous, 2021), storage at 5℃ (Javanmardi and Kubota, 2006), controlled atmosphere (CA), cold storage and modified atmosphere packaging (MAP). These are not available for the farmers in Bangladesh. In this condition, an appropriate, cheap and simple method of postharvest storage or preservation is necessary.

Synthetic chemicals and preservatives are widely used extensively to prolong the shelf life of tomato fruits. Increasing concern of consumers about both human health and the environment are restricting the use of synthetic chemical preservatives. Therefore,

healthy, effective and environmentally friendly methods for maintaining quality and improving marketable tomato life at ambient temperature must be investigated during storage and transport (Mustari et al., 2020).
To extend the storage life of tomato it is necessary to undertake a study using indigenous materials. That helps to increase shelf life of the selected tomato varieties. So, the objectives of the present study were determined the shelf life of the tomato varieties and suitability of indigenous materials as storage materials to prolong the shelf life.

2. MATERIALS AND METHODS

This experiment was conducted in Molecular Horticultural laboratory and germplasm centre of Khulna University, Khulna, Bangladesh, during the period March to May, 2019. The experiment was laid out in a Completely Randomized Design (CRD) with three replications. The fruits of 16 tomato varieties including eight improved varieties (Figure 1) developed by Bangladesh Agricultural Research Institute (BARI), namely BARI Tomato-2, BARI Tomato-8, BARI Tomato-14, BARI Tomato-15, BARI tomato-16, BARI tomato-17, BARI tomato-18, BARI tomato-19 and eight cultivars (Figure 2) collected from farmers field of Khulna region namely Bonkim Ruby, Pusa Ruby. Suraksa, Patharkuchi, Ruma VF, Ruma 19, Guli and Paltola were used. The freshly harvested mature green tomatoes were studied to determine their shelf life. The used indigenous materials (Table 1) are available for farmers and retailer and they have no toxic effect on human beings. Fresh tomatoes with individual indigenous materials were placed in gunny bag. About 10-12 fruits were consisted for each replication of the treatments. Data on weight loss (%), fresh fruit (%) or marketable fruit and shelf life recorded from fresh ripe tomato fruit at 5 days interval from the beginning to 40 Days of storage period.

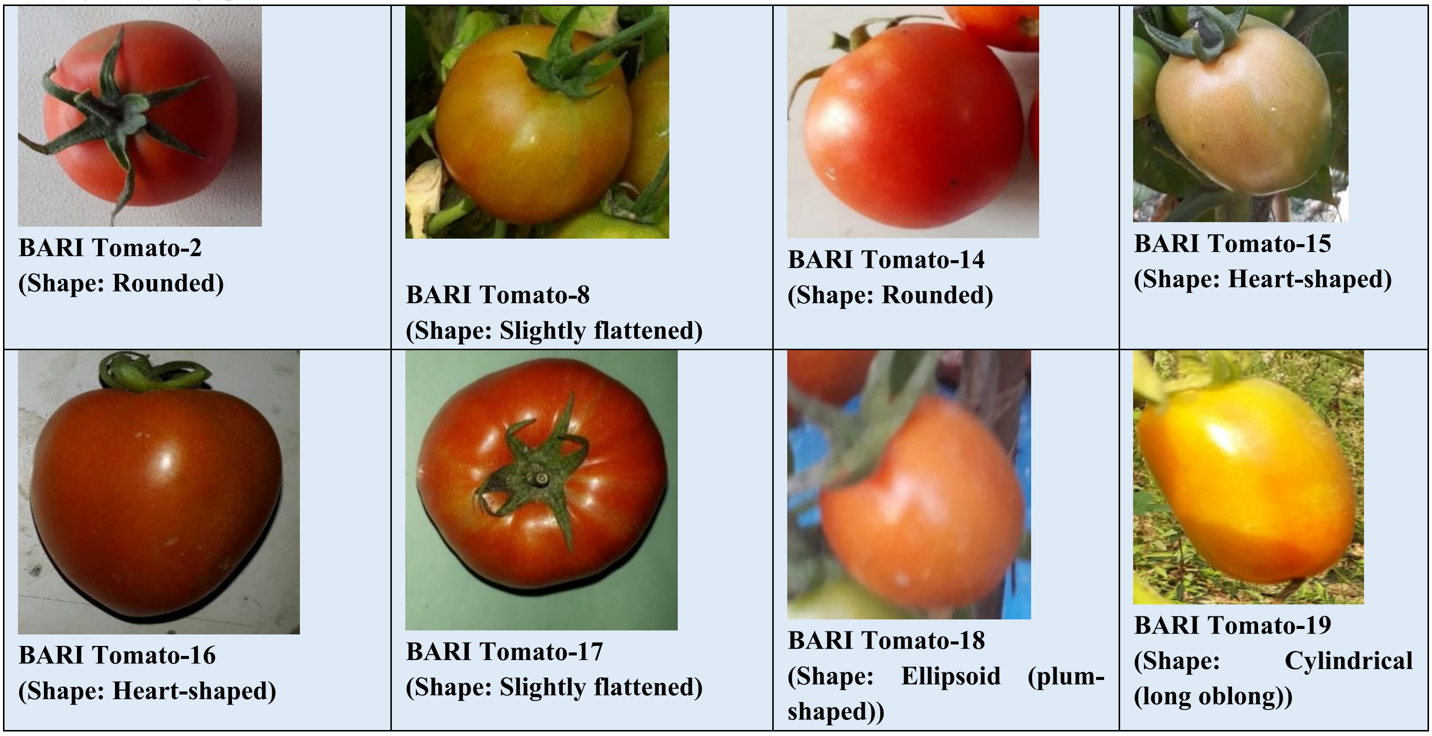
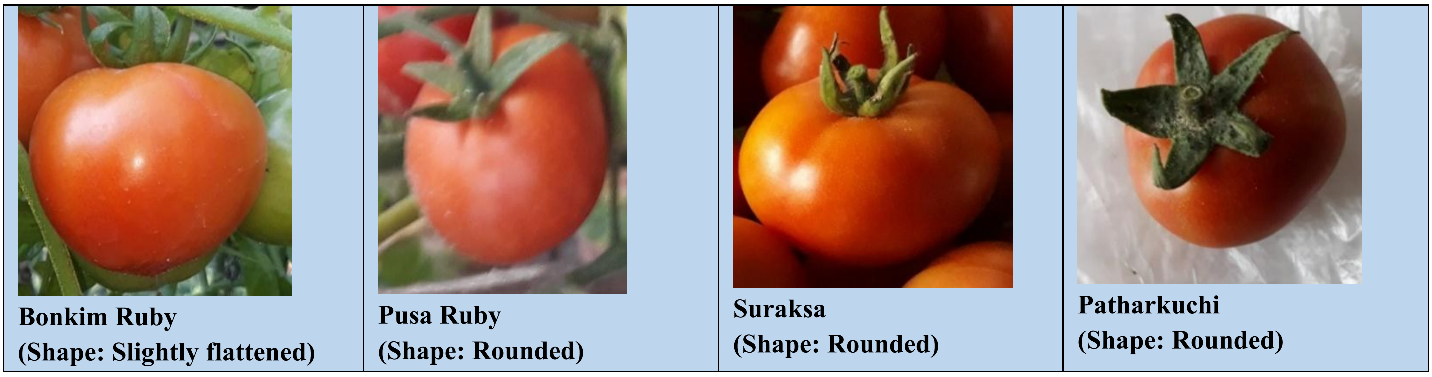
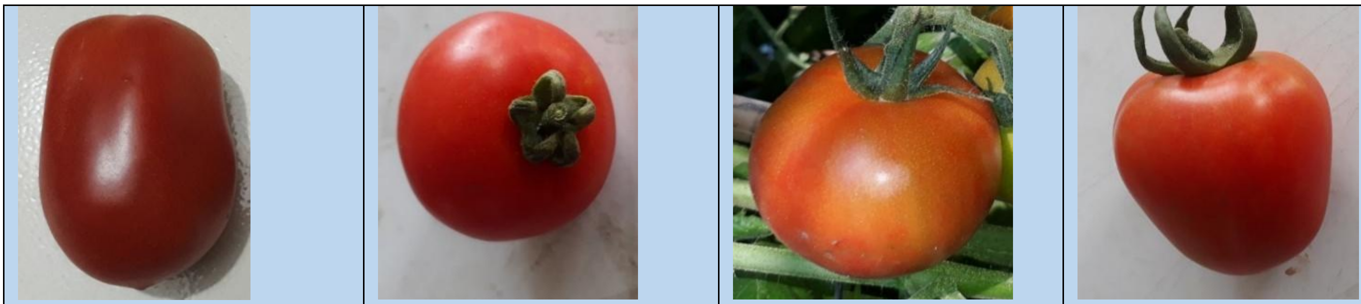


Figure 1. Fruit shapes of collected BARI (Bangladesh Agricultural Research Institute) tomato varieties





Ruma VF (Shape: Pyriform)	Ruma-19 (Shape: Rounded)	Guli (Shape: Slightly flattened)	Paltola (Shape: Heart-shaped)

Figure 2. Fruit shapes of collected local tomato varieties tomato varieties of South-western region of Bangladesh

Table 1. Different treatments used in evaluation of shelf life

Treatment	Treatment materials	Condition
T0	Control (without treatment)	Room temperature (30ºC to 35ºC)
T1	AC room	Air cooling room temperature (25ºC)
T2	Coir dust dry	Coir dust dried in open sun for 4 days
T3	Coir dust wet	Added water to dry coir dust to make 10% moisture level (weight basis)
T4	Saw dust dry	Saw dust dried in open sun for 4 days
T5	Saw dust wet	Added water to saw dust to make 10% moisture level (weight basis)
T6	Sand dry	Sand dried in open sun for 4 days
T7	Sand wet	Added water to dry sand to make 10% moisture level (weight basis)
T8	Neem fresh leaf	Fresh green neem leaf
T9	Mahogany oil	5% Mahogany oil solution

2.1 Fresh fruit (%)

Fresh fruit were counted, omitting those showing symptomatic shriveled or sunken lesions and injuries by the pests and diseases. The numbers of fresh fruits were used as a measure to calculate the percentage of fresh fruits during storage. After individually assessing the fruits, it was calculated using the following formula.

$$\text{Fresh fruit (\%)} = \frac{\text{Number of fresh tomato fruit}}{\text{Total number of tomato fruit}} \times 100$$

2.2 Weight loss (%)

It was determined by using the methods described by Workneh et al. (2011). To calculate successive weight loss expressed as percentage for the respective treatments.

$$\text{Weight loss (\%)} = \frac{\text{Initial fruit weight - weight at data collection time}}{\text{Initial fruit weight}} \times 100$$

2.3 Shelf life (days)

Shelf life of the fruits is calculated from the period of harvest up to rotting, it is the basic quality of fruit as well as it is the most important parameter in loss of reduction of biochemical reaction of fruit. Shelf life of sampled fruits was determined when more than 50% of fruits symptomatically displayed shrinkage or sunken lesion (Islam et al., 2011).

2.4 Statistical analysis

Collected data were statistically analyzed by Software R. The significance of the difference between pairs of mean values was compared by the least significance difference (LSD) test at 5% level of probability. The dates of soil salinity data during different growth stages of mentioned entitled were recorded.

3. RESULTS

The physical characteristics of different tomato varieties were significantly differed from each other. And effects of different indigenous materials also significantly varied in storage of tomato.

3.1 Total number of fresh fruit

3.1.1 Fresh fruit (%) at different days after storage (DAS)

The number of fresh fruit (%) was significantly decreased with the passing of days after storage. Days after storage were an important factor for shelf life as well as fresh fruit (%). The number became 25.9% at 40 days after storage (Figure 3A).

3.1.2 Varietal performance in fresh fruit (%)

The sixteen selected varieties was significantly different from each other in respect of fresh fruit (%) (Figure 4B). The variety BARI Tomato-19 gave the highest fresh fruit (%) followed by Paltola. The variety Guli showed the lowest fresh fruit (%) that was statistically similar to Ruma-19 and BARI Tomato-15. The variety BARI Tomato-19 gave 35% more fresh fruit than the Guli.

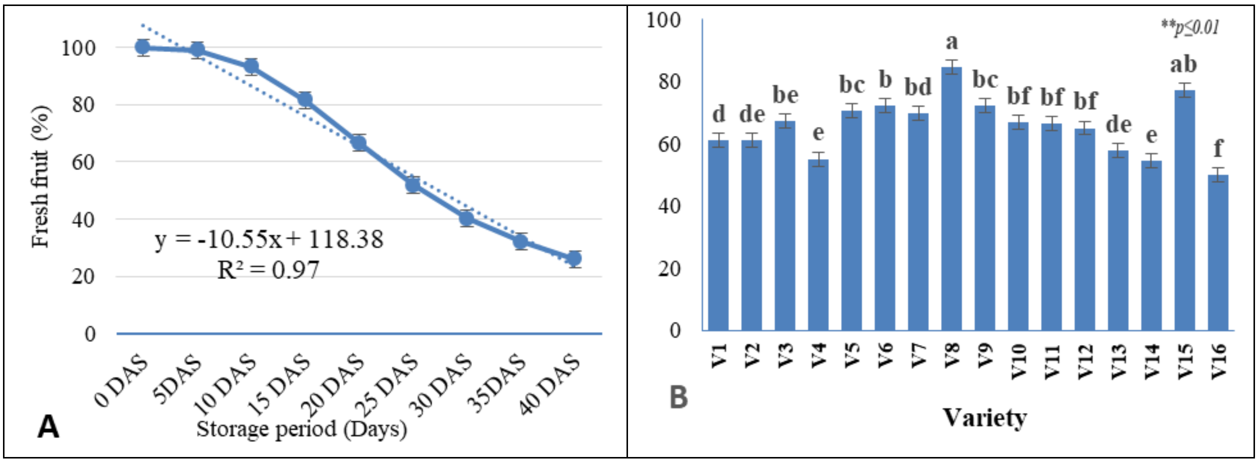


Figure 3: Change in fresh fruit (%). A. In respect of days after storage (DAS). B. Average performance of selected variety

Legend: The bars with same letters are not significantly different from each other at 1% level of significance. V1, BARI Tomato-2; V2, BARI Tomato-8; V3, BARI tomato-14; V4, BARI Tomato-15; V5, BARI tomato-16; V6, BARI tomato-17; V7, BARI tomato-18; V8, BARI Tomato-19; V9, Bonkim Ruby; V10, Pusa Ruby; V11, Suraksa; V12, Patharkuchi; V13, Ruma VF; V14, Ruma 19; V15, Paltola and V16, Guli.

3.2 Combined effect of varieties and days after storage (DAS)

From 10 DAS to 40 DAS all tomato variety were significantly different from each other in case of fresh fruits (%). It was showed that the variety BARI Tomato-19 gave the maximum number of fruits up to 40 DAS and opposite result was found in Guli. The difference of fresh fruit (%) between varieties gradually increases up to 40 DAS. Significantly, best perfumed variety BARI Tomato-19 gave about 1.5 times (at 15 DAS), 2.2 times (at 20 DAS), 3.5 times (at 25 DAS), 5.7 times (at 30 DAS), 7.3 times (at 35 DAS) and 10 times (at 40 DAS) more fresh fruits then the lowest performer variety (Figure 4).

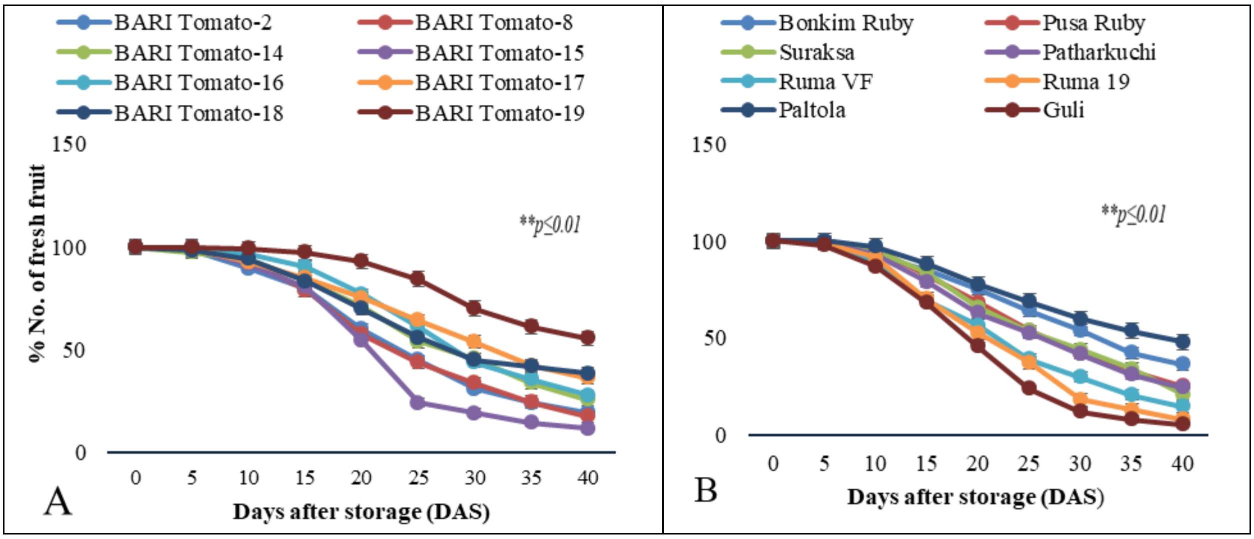


Figure 4. Number of fresh fruits (%) of different variety up to 40 days of storage; 4A. BARI released variety and 4B. local variety

3.3 Effect of treatments on fresh fruit (%)

The treatments were used in this experiment showed significant difference in case of fresh fruit (%). The treatments T1 (AC room) gave the highest fresh fruit (76.4%), which was statistically identical to T4 (saw dust dry), T8 (neem leaf) and T9 (mahogany oil (5%)) containing the value 70.5%, 70.1% and 72.05%, respectively. The treatment T7 (sand wet) Gave the lowest number of fresh fruit (44.56%) that was statistically equal to T3 (coir dust wet) having 46.0% fresh fruit (Figure 5A).

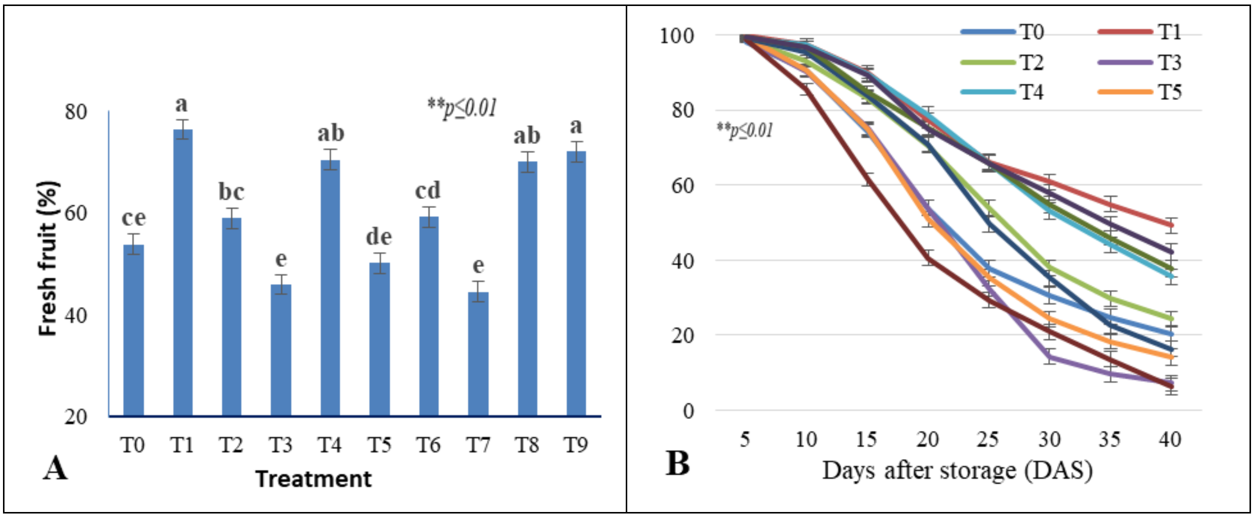


Figure 5. Fresh fruits (%) of different treatment up to 40 days after storage (DAS); 5A. Mean value and 5B. In different days after storage (DAS).

Legend: T0, Control; T1, AC Room; T2, Coir dry; T3, Coir wet; T4, Saw dust dry; T5, Saw dust wet; T6, Sand dry; T7, Sand wet; T8, Neem leaf and T9, Mahogany oil (5%). The bar with same letters are not significantly different from each other at 1% level of significance

3.4 Combined effect of treatments and days after storage (DAS)

The treatments were significantly different in respect of fresh fruit (%) in different days after storage (DAS) (Figure 5B). At 10 DAS, T1(AC room) gave the maximum fresh fruit (%) and T4 (saw dust dry), T8 (neem leaf) and T9 (mahogany oil (5%)) were statistically identical to T1(AC room) and they gave about 5% higher fresh fruit (%) than the T0 (control). At 15 DAS, the treatment T1 (AC room), T4 (Saw dust dry), and T9 (mahogany oil (5%)) were statistically same for maximum number of fresh fruit those were about 15% higher than the T0 (control). In the treatment T1 (AC room), T4 (saw dust dry), T9 (mahogany oil (5%)), and T8 (neem leaf) represent about 25% (at 20 DAS) and 27% (at 25 DAS) higher number of fresh fruit than the T0 (control). The treatment T1 (AC Room) and T9 (mahogany oil (5%)), gave higher number of fresh fruit 30% and 28% respectively at 30 DAS than the T0 (control). The treatment T7 (sand wet) gave minimum number of fresh fruit (%) from 15 DAS to 40 DAS. The differences of fresh fruit (%) among treatments gradually increase up to 40 DAS.

3.5 Weight loss (%) of tomato

3.5.1 Weight loss (%) at different days after storage (DAS)

The weight loss (%) was significantly increased with the passage of storage time of tomato. The weight losses (%) in 5 days interval were significantly different from each other. After 10, 20, 30 and 40 days of storage weight loss were recorded 11.96%, 40.9%, 65.7% and 78.9% respectively (Figure 6A).

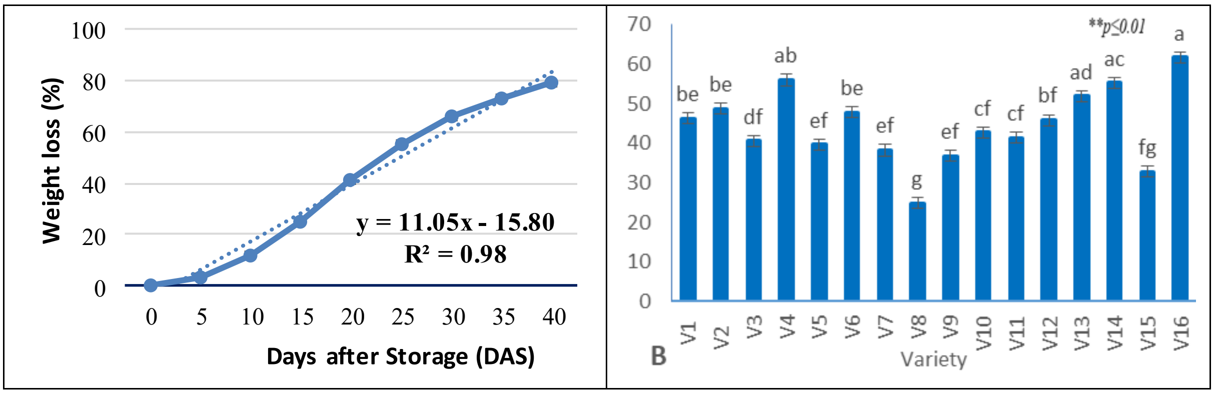


Figure 6: Change in Weight loss (%), 6A. In respect of days after storage (DAS). 6B. Average performance of selected variety

Legend: The bars with same letters are not significantly different from each other at 1% level of significance. V1, BARI Tomato-2; V2, BARI Tomato-8; V3, BARI tomato-14; V4, BARI Tomato-15; V5, BARI tomato-16; V6, BARI tomato-17; V7, BARI tomato-18; V8, BARI Tomato-19; V9, Bonkim Ruby; V10, Pusa Ruby; V11, Suraksa; V12, Patharkuchi; V13, Ruma VF; V14, Ruma 19; V15, Paltola and V16, Guli.

3.5.2 Varietal performance on weight loss (%)

The varieties were significantly different for average weight loss (%). The variety BARI Tomato-19 gave the minimum weight loss (%) followed by Paltola and Guli gave the maximum followed by BARI Tomato-15 and Ruma 19. The top scorer variety Guli showed about 2.4 times higher percent weight loss (%) than the best variety BARI Tomato-19 (Figure 4B). The variety showed different levels of weight loss (%).

3.6 Combined effect of treatments and days after storage (DAS)

3.6.1 Weight loss (%) of varieties at different days after storage (DAS)

The weight loss (%) is an important indicator for shelf life of fruit. Tomato varieties were significantly different from each other in case of weight loss (%) of fruits (Figure 7). The weight loss (%) among the varieties range was from 14.7% to 65.6% and 54.5% to 96.1% at 20 DAS and 40 DAS respectively. The maximum percent (%) weight loss was found in Guli followed by Ruma VF, BARI Tomato15, BARI Tomato-2 and Ruma 19. From 15 DAS to 40 DAS, the maximum weight loss (%) was found in Guli and BARI Tomato-15 and the minimum in BARI Tomato-19 which was statistically same to Paltola. The difference of weight loss (%) between varieties gradually increases up to 40 DAS.

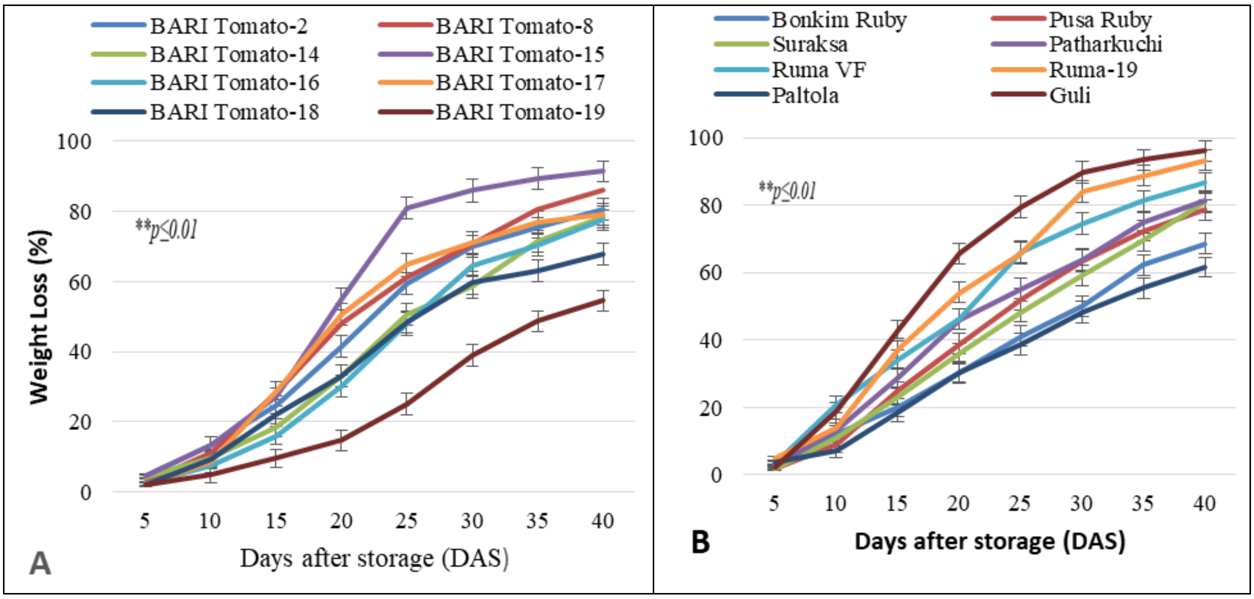


Figure 7. Weight loss (%) of different varieties up to 40 days after storage (DAS), 7A BARI released variety and 7B. local variety

3.6.2 Impact of treatment on weight loss (%)

The effects of treatment on weight loss (%) of tomato were significantly different (Figure 8A). The maximum weight loss (%) was recorded from the treatment T7 (sand wet) followed by T3 (coir wet). The minimum weight loss (%) was recorded from the treatment T1 (AC Room) followed by T4 (saw dust dry), T8 (Neem leaf) and T9 (Mahogany oil (5%)) and these treatment control weight loss about 20% to 15%.

3.6.3 Effect of treatment on weight loss (%) at different days after storage (DAS)

The treatment gave significantly different weight loss (%) in different dated to up 40 DAS (Figure 6B). On an average, T7 (sand wet) gave the maximum weight loss (%) that was statistically identical to T3 (coir wet). The minimum number of weight loss (%) was obtained from T1 (AC room) that is statistically identical to T9 (mahogany oil (5%)), T4 (saw dust dry), and T8 (neem leaf). The difference between maximum and minimum level weight loss (%) was 11% at 10 DAS, 38.9% at 20 DAS, 41% at 30 DAS, and 37 % at 40 DAS. It indicated that weight losses (%) were seriously influenced by the treatment.

The weight loss (%) increased with the increasing of days after storage (DAS). The extent of the weight loss (%) is different from treatment to treatment up to 40 DAS. The treatment T1 (AC room) exhibited 59.8% weight loss whereas T7 (sand wet) showed 96.9% weight loss and the control showed 84.9% wet loss at 40 DAS. So, the appropriate treatment save the weight from decay and decrease the weight loss.

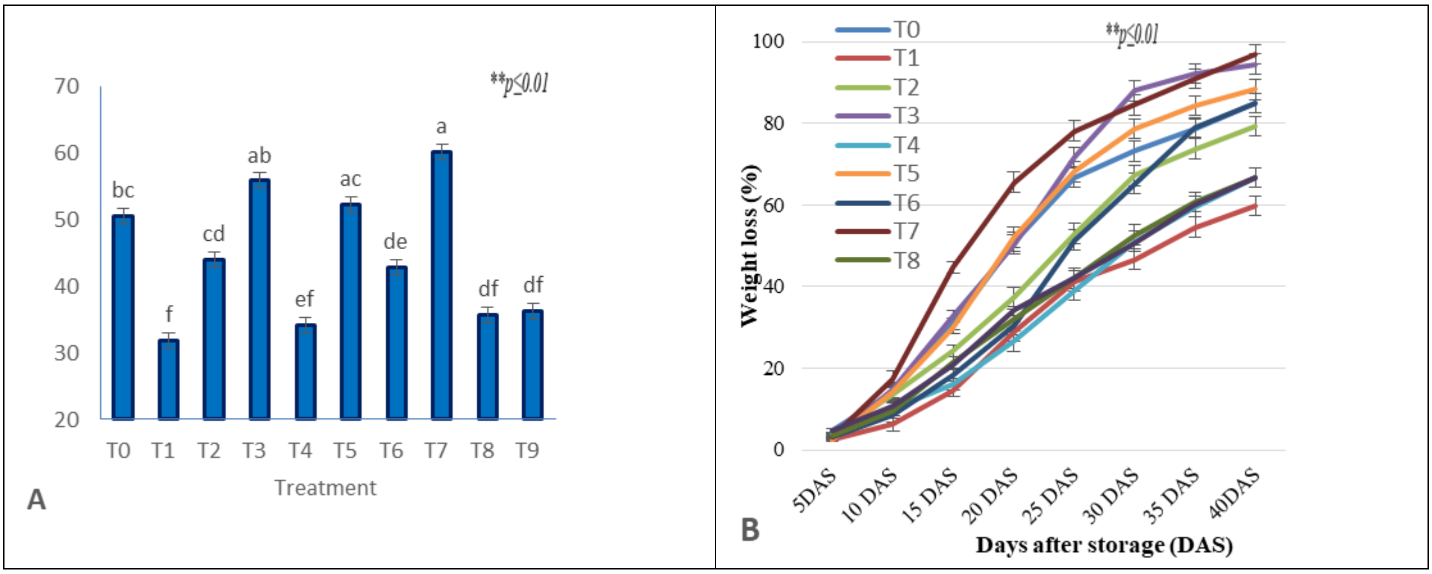


Figure 8. Treatment performance of weight loss (%) of tomato fruits; 8A. Mean value and 8B. In different days after storage (DAS).

Legend: The bars with same letters are not significantly different from each other at 1% level of significance. T0, Control; T1, AC Room; T2, Coir dry; T3, Coir wet; T4, Saw dust dry; T5, Saw dust wet; T6, Sand dry; T7, Sand wet; T8, Neem leaf and T9= Mahogany oil (5%).

3.7 Shelf life

3.7.1 Varietal performance

Shelf life is the most important physiological character of storage life. Shelf life was significantly varied in the studied 16 tomato varieties. The variety BARI Tomato-19 showed the maximum shelf life (40 days) followed by Paltola (37 Days). The minimum shelf life was in the variety Guli (17 Days) that was statistically similar to Ruma-19 and Ruma VF (Figure 9A). The average shelf life was 24 days. The shelf life of BARI Tomato-19 and Paltola gave about 23 days and 19 days more shelf life than the variety Guli.

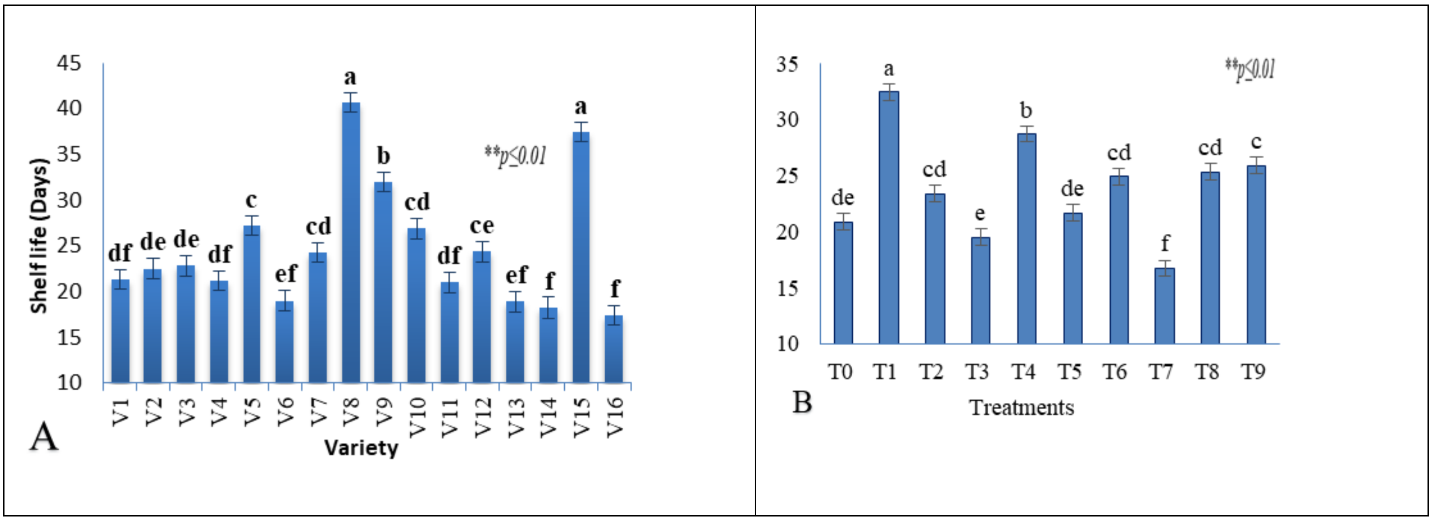


Figure 9. Shelf life of tomato; 9A. Varietal performance and 9B. treatment performance.

Legend: The bars with same letters are not significantly different from each other at 1% level of significance. V1, BARI Tomato-2; V2, BARI Tomato-8; V3, BARI tomato-14; V4, BARI Tomato-15; V5, BARI tomato-16; V6, BARI tomato-17; V7, BARI tomato-18; V8, BARI Tomato-19; V9, Bonkim Ruby; V10, Pusa Ruby; V11, Suraksa; V12, Patharkuchi; V13, Ruma VF; V14, Ruma 19; V15, Paltola and V16, Guli. T0, Control; T1, AC Room; T2, Coir dry; T3, Coir wet; T4, Saw dust dry; T5, Saw dust wet; T6, Sand dry; T7, Sand wet; T8, Neem leaf and T9, Mahogany oil (5%).

3.7.2 Performance of treatment

The effect of different indigenous materials used in the present investigation was highly significant ($P \leq 0.05$) in respect of the shelf life of tomato (Figure 7B). The highest result was found in T1 (AC room) followed by T4 (saw dust dry), T9 (Mahogany oil (5%))

and T8 (Neem leaf). The treatment T1 (AC room) and T4 (saw dust dry) increase shelf life about 12 days and 8 days respectively. Saw dust dry might have some capacity to increase the shelf life of tomato. The lowest result was found in T7 (sand wet) Followed by T3 (coir wet) and those were significantly lower performer than T0. The treatment T2 (coir dry) and T5 (saw dust wet) were significantly identical to T0 (Control). So, those treatments were not beneficial to prolong shelf life.

4. DISCUSSION

The sixteen selected varieties were significantly different from each other in respect of fresh fruit (%), weight loss (%) as well as shelf life. It was the interaction effect of their genotype and environment. So, the shelf life is an important factor of a variety for storage, the results is supported by Kabir et al., 2019.

From the ancient period, indigenous materials were being used to store crops. All indigenous materials are not suitable for all crops. Storage materials and condition is very important factor for storage. The treatment T4 (dry saw dust), T8 (fresh neem leaf) and T9 (mahogany oil (5%)) gave about 27%, 26% and 29% more fresh fruit (%) than the control. The pesticidal effect of treatment T8 (neem leaf) and T9 (mahogany oil (5%)) keep the fruits from pest and pathogen. During storage, fruit deteriorate through spoilage by microorganisms and changed the physiological state of the fruit. Singh et al. (2000) also informed that 10% Neem leaf extract dipping reduced the microbes growth in mango fruits.

After harvest, control of temperature was found to be the most essential issue in controlling decay of fruits and vegetables (Kitinoja and Kader, 2015; Kabir et al., 2019). The treatment T1 (AC room) gave the highest fresh fruit (%) and the minimum weight loss (%) this result is supported by Cantwell, 2001. They found that tomatoes do not tolerate low temperatures below 10ºC, while high temperatures can accelerate their respiration rate. AC room temperature was lower than all others treatments temperature and not less than 10º C. Finally, this treatment increased the shelf life.

Tomatoes stored at low relative humidity (below 85% to 90%) levels can shrivel, whereas completely saturated atmospheres of 100% relative humidity may encourage mould and fungal development (Arah et al., 2015). Temperature and relative humidity are vital environmental factors acting the quality and storage life of horticultural commodities. Changes in temperature and humidity can cause severe injuries to harvested horticultural commodities (Yahia, 2019). Here, the treatment T7 (sand wet) and T3 (coir dust wet) gave minimum number of fresh fruit (%) it may be due to their high relative humidity (wetness).

The treatment T4 (dry saw dust), T8 (fresh neem leaf) and T9 (mahogany oil (5%)) increased the shelf life 8 days, 5 days, 5 days over the control, respectively and gave about 27%, 26% and 29% more fresh fruit (%) than the control. The pesticidal effect of treatment T8 (fresh neem leaf) and T9 (mahogany oil (5%)) keep the fruits from pest and pathogen. During storage, fruit deteriorate through spoilage by microorganisms and changed the physiological state of the fruit. Islam et al. (2011) also found disease incidence and severity were less in allamanda + mahogoni extract treated banana than the control. Neem leaf was found to be effective in the present study which is supported by Sarmin et al. (2018) and Habiba (2012) who found positive effect on the shelf life of mango and banana, respectively. Similarly, the longer shelf life (14.87 days) was observed in neem leaf extract (10%) treated mango fruits (Sarkar, 2012), which also supports the findings of the present study.

Here the T7 (sand wet) and T3 (coir wet) treatments gave minimum fresh fruit (%) as well as shelf life. Storage of tomatoes with low relative humidity (below 85% to 90%) can cause shriveling and a humid environment with 100% relative humidity may encourage mold and fungal growth (Arah et al., 2015). Temperature and relative humidity are important environmental factors that effects on storage life of horticultural commodities. Variations in temperature and humidity can cause serious loss to harvested horticultural commodities (Yahia, 2019).

5. CONCLUSION

The shelf-life of tomato fruits were depended on the variety, storage conditions and use of indigenous materials. The maximum shelf life and fresh fruit (%) was observed in BARI Tomato-19 followed by Paltola and the minimum was in Guli. The maximum shelf life and fresh fruit (%) was observed in the treatment AC room followed by dry saw dust, mahogany oil (5%) and fresh neem leaf prolong the shelf about a week.

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CONFLICT OF INTEREST: The authors declare no conflict of interest.

DATA AVAILABILITY STATEMENT: Data will be available on a formal request from the corresponding authors.

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