J Bangladesh Agril Univ 16(3): 337–342, 2018 https://doi.org/10.3329/jbau.v16i3.39489

ISSN 1810-3030 (Print) 2408-8684 (Online)

Journal of Bangladesh Agricultural University

Journal home page: http://baures.bau.edu.bd/jbau, www.banglajol.info/index.php/JBAU

Effect of guava leaf and lemon extracts on postharvest quality and shelf life of banana cv. Sabri (*Musa sapientum* L.)

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ARTICLE INFO OPEN ACCESS

Article history:
Received : 07 May 2018
Accepted : 05 September 2018
Published: 31 December 2018

Keywords:
Banana; plant extract; postharvest; shelf life; microbial infection

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Abstract

Banana is a common and popular subtropical fruit worldwide. Its postharvest life is very short which causes difficulties in marketing and preserving banana at good condition. To find out a better solution of this problem, the current study was conducted during 2017 in the Horticulture Laboratory, Khulna University, Bangladesh, by following the Completely Randomized Design (CRD) of experiment. Harvested banana fruits, sabri (*Musa sapientum* L) were treated with guava leaf and lemon extracts at different concentrations. Non-treated fruits were considered as control. Both treated and non-treated bananas were stored in covered paper carton at ambient condition. Postharvest performances of the stored fruits during storage were observed for two weeks. After two weeks of storage, lower changes in color (score 6.77), firmness (score 4.43), less TSS content (8.21%), minimum infection (48.89%) and disease severity (score 3.33) and maximum shelf life (8.75 days) were observed in banana fruit with treatment of T_3 (guava leaf extract 20% + lemon extract 15%) followed by treatment of T_5 (guava leaf extract 40% + lemon extract 15%) treated fruits. However, the T_4 treated banana fruit showed maximum vitamin C (1.83 mg/100 g), titratable acidity (0.11%) and reduced sugar (7.13%) after two weeks of storage. In conclusion, combination of guava leaf extract (20% or 40%) + lemon extract (15%) could be suggested for long term storage and maintenance of postharvest qualities at ambient conditions.

Introduction

Banana occupies an important position among the fruits of Bangladesh not only for its highest production but also for its increasing popularity to many farmers as an economic crop. Among the fruit crops grown in Bangladesh, banana ranks first in terms of production comprising nearly 42% of the total (Akter *et al*., 2013). In the year 2015–2016, about 47,412.61 ha of land were used for the cultivation of banana and the production was 7,98,012MT (BBS, 2016), with an average yield of 1.68 tha^{-1} (FAOSTAT, 2016). Sabri is the best cultivar among other widely cultivated bananas in Bangladesh which counts 1,02,000.00 TK for a production from 1ha of land (BBS, 2016). From nutritional point of view, a medium sized banana per 100g contains energy (89 Kcal), carbohydrates (22.84 g), protein (1.09 g), fat (0.33 g), vitamin-A (64.29 IU), vitamin-C (8.7 mg), B-complex vitamins and many other vital minerals in a considerable amount (Singh, 1998).

However, in Bangladesh a considerable amount of banana is being spoiled due to prevailing higher temperature and humidity during main harvesting period (Ullah, 2007). Recently Hassan (2010) reported that the postharvest loss of banana is 24.62% which accounts for 56.7 crore Tk. annually in Bangladesh where 5–25% in developed countries (Khader, 1992). Banana is a highly perishable fruit. A dramatic change in physico-chemical characteristics in banana occurs due to the rise in respiration in storage conditions while peel color changes and pulp texture decreases due to conversion of starch into sugar (Kajuna *et al*., 1997, Marriott *et al*., 1981 and Prabha and Bhagyalakhmi, 1998). Significant increase in weight loss, TSS content along with microbial growth also occurs during ripening (Misir *et al*., 2012). To minimize these unwanted changes in banana an appropriate postharvest treatment without any negative impact on human health is an urgent necessity. Low temperature handling and management of storage are the important postharvest operations (Johnson *et al*., 1997) though they are costly for growers. Prolongation of shelf life by MAP (Modified Atmosphere Packaging) (Basel *et al*., 2002 and Hassan, 2000) and sealed polythene cover along with $KMnO_4$ (Bhadra and Sen, 1997), hot water treatment (Ullah, 2007) and application of fungicide (benzimidazole) (Ram and Vir, 1984) are also cost intensive. Use of synthetic chemicals as preservatives, different growth regulators, and chemical fumigants etc. cause different harmful health hazards (Sanjay, 2015). On the other hand, plant extracts are easily available worldwide and cost effective. Moreover, plant extract (aloe vera, neem, onion, garlic etc.) are widely popular as a postharvest treatment (Anjum *et al*., 2016). Hence the current study has been undertaken to identify the effectiveness of plant extracts in maintaining physico-chemical characteristics and prolonging shelf life of banana during postharvest period at ambient condition.

Cite this article
Tabassum P., Khan S.A.K.U., Siddiqua M. and Sultana S. 2018. Effect of guava leaf and lemon extracts on postharvest quality and shelf life of banana cv. Sabri (Musa sapientum L.). *Journal of Bangladesh Agricultural University*, 16(3): 337–342.

Materials and Methods

Experimental material: Four bunches (locally called kadhi) of fresh mature banana (cv. Sabri) free from any kind of injury were collected from farmer's field in Noapara, Jessore, Bangladesh.

Design of experiment: The experiment was conducted at ambient conditions in the Horticulture Laboratory, Khulna University, Bangladesh during 2017. It was laid out in a completely randomized design (CRD) with three replications including 10 bananas in each replication. Five treatments were applied on banana under study where non-treated fruits were considered as control groups (T_1) and different concentrations of guava leaf extract (GLE), lemon extract (LE) and their combinations were taken as T_2 (GLE 20% + LE 5%), T_3 (GLE 20% + LE 15%), T_4 (GLE 40% + LE 5%) and T_5(GLE 40% + LE 15%).

Preparation and application of botanical extracts: The botanical extracts were prepared and applied on the fruit samples in the Horticulture Laboratory, Khulna University, Khulna. Lemon juice extracted by squishing manually. Fresh green leaves of guava (500g) were collected from Khulna University campus and blended with 1000 ml of distilled water. Then 20% or 40% GLE were prepared by taking 60 ml or 120 ml raw guava leaf extract in 500 ml beaker with the addition of 240 ml or 180 ml distilled water separately to make a final volume of 300 ml. Similarly, for the preparation of LE (15% or 5%), 45 ml or 15 ml of lemon juice extract were added with 255 ml or 285 ml of distilled water respectively and blended (Mia, 2003). These blended samples were filtered with the help of Whatman Filter paper No. 2, taken in an aluminum foil sealed beaker and stored in the refrigerator at 5°C until further use. The fruit samples were placed on a sterilized surface in five groups having three replications for each treatment and the extracts were sprayed over the fruit according to the treatments.

Data collection: The treated fruit samples were observed every day for physical parameters while chemical parameters were observed every alternate day for two weeks.

Weight loss: The physiological losses in weight (PLW) of fruits were calculated by following the formula of Kaur (2016) as follows-

$$\text{Percentage of weight loss (\%WL)} = \frac{IW - FW}{IW} \times 100$$

Where, %WL = percentage of total weight loss; IW = initial weight; FW = final weight

Change in color and firmness: The changes in peel color of fruit and firmness were determined by visual observation by using a scale ranging from 1 to 7 for color and1 to 5 for firmness as described by Dadzie and Orchard (1997) and Dang *et al*.. (2008).

Disease severity and disease incidence: The percentage of infected area on banana fruit indicates the disease severity which was determined visually by numerical scale of 1 to 5 (Ullah, 2007) and the percentage of disease infected banana fruit was determined by counting the number of infected fruit. Black spots and visible symptoms were considered as disease and calculated by following the equation suggested by Ullah (2007) as follows-

$$\text{Disease incidence} = \frac{\text{Number of infected banana}}{\text{Total number of banana}} \times 100$$

Determination of Total Soluble Solid (% Brix) content: TSS of extracted juice was estimated every alternate day by using Abbe's refractometer (REF 10/111). A drop of banana juice placed on the prism of refractometer and the percent TSS was obtained directly from the scale of refractometer (Ranganna, 1979).

Determination of Vitamin C Content: Vitamin C contents of the samples were determined at one day interval which was calculated by using the following formula as suggested by Majumdar and Majumdar (2003).

$$\text{Vitamin C (mg per 100 gm)} = \frac{e \times d \times b}{c \times a} \times 100$$

Where, a = weight of sample; b = volume made with meta-phosphoric acid; c = volume of aliquot taken for estimation; d = dye factor; e = average burette reading for sample.

Determination of Titratable Acidity (TA): Titratable acidity was determined every alternate day by using the formula described by Khan and Singh (2008) as follows-

$$\text{Malic acid (\%)} = \frac{0.0067 \times \text{vol. of NaOH} \times 30 \times 100}{5 \times 10}$$

Where, 0.0067 = Milli-equivalent weight of malic acid; 30 = Total volume (ml); 5 = Extracted juice sample (ml); 10 = Volume of aliquot (ml).

Determination of Reducing Sugar Content: Amount of reducing sugar in fruit was recorded every alternate day during the study by using titrametric method (AOAC, 2005) and the results were expressed in percentage.

$$\text{Reducing sugars (\%)} = \frac{\text{Fehling factor (0.05)} \times \text{Volume of filtrate used} \times \text{Dilution made} \times 100}{\text{Dilution used} \times \text{Volume of juice}}$$

Microbial Test: The microbial test was conducted immediately after observing any type of infection on the fruit samples. The sample was taken from infected portion with the help of inoculators and was placed on sterilized slide. After that the slide was prepared for the examination through microscope (Pervin, 2016).

Shelf life: The shelf life was determined by recording the number of days for which the fruits remained in good condition until the score for texture and disease severity retains less than or equal to 3 and score for color

retains less than or equal to 5. The number of days for attaining a loss of 25% weight was also considered to calculate shelf life. The average of the number of days required to reach the mentioned level for the considered parameters were recorded as the shelf life of the fruit.

Statistical analysis: The collected data on various parameters were statistically analyzed using STAR (Statistical Tool for Agricultural Research) statistical package, Version 2.0.1 (IRRI, 2013). The means for all the treatments were calculated and analyses of variances (ANOVA) for all the parameters were performed by F-test. The significance of difference between the pair of means was compared by LSD (least significance difference) test at 5% level of probability (Gomez and Gomez, 1984).

Results and Discussion

Physical characteristics: Color and softness of treated and non-treated fruits increased gradually. Control fruits (T_1) exceeded the acceptable color limit (score 5) on 4 DAT (Days after treatment) while T_3 and T_5 treated fruits retained the acceptable color limit for 5 more days than control (Fig.1). Similar result was reported by Malik *et al*. (2015). They recorded the highest score for color after 16 days in 20% neem extract treated guava fruits whereas in control fruit color acceptability retained for only 8 days.

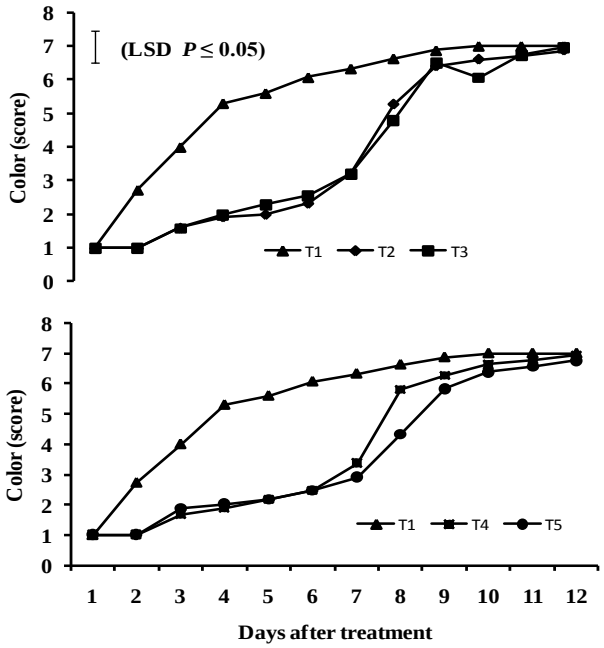

Fig. 1. Change in color of banana treated with plant extracts

The firmness of untreated fruit reduced more drastically than other treatments and crossed the acceptable limit of firmness score (3) on 7 DAT while T_5 treated fruits retained the acceptable limit of firmness for 2 more days than control (Fig. 2). The control banana fruit showed faster rate of firmness reduction than treated ones irrespective of varieties as earlier reported by Ullah (2007).

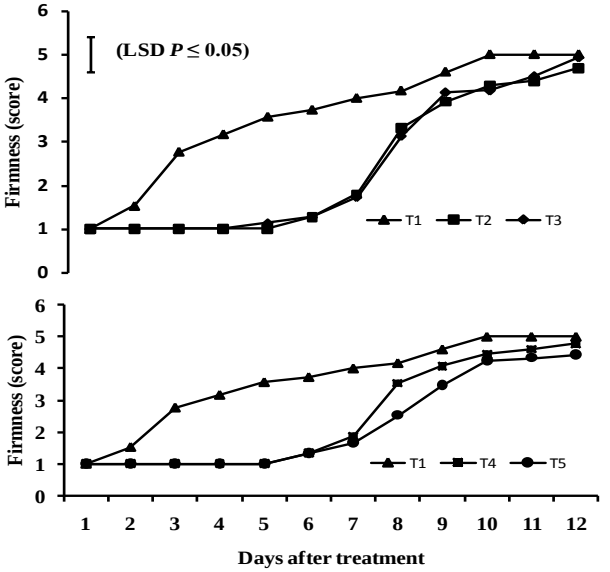

Fig. 2. Change in firmness of banana due to treatments with plant extracts

The control fruits crossed the acceptable weight loss limit (25%) on 6 DAT while other treatments on 7 DAT (Fig. 3). Flavia *et al.* (2016) also reported delayed weight loss in propolis extract coated pera orange fruits at ambient conditions.

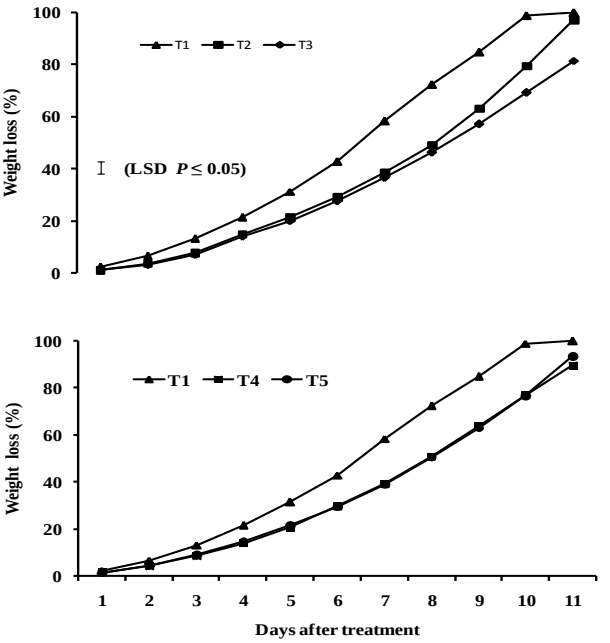

Fig. 3. Change in weight of banana treated with plant extracts

Chemical characteristics: Irrespective of the treatments the TSS content increased dramatically from 1.72%to 19.05% during the study period (Fig. 4). Barakat *et al*., (2012), reported that the TSS content of fruits increased with time that supports the findings of the current study. A similar increase of TSS was reported by Alique and Oliveira (1994) in cherimoya. An increase in sugar content and decrease in acidity during fruit ripening was also reported by Illeperuma and Jayasuriya (2002). However, less TSS was scored in T_5 (combination of

40% GLA and 15% LE) treated fruits (8.21%) which was 0.69-parts lower than T_4 (combination of 40% GLA and 5% LE) (11.96%).This finding indicates that the treatment with higher concentration of lemon extract enhances the reduction of TSS in treated fruit. This might be due to the acidic nature of lemon juice which hindered the physiological changes and delayed the ripening process in treated fruits as reported earlier by Wills *et al*. (1998). According to them, acid acts as a reserve source of energy to the fruit which tends to decline by the enhanced metabolic activities during fruit ripening.

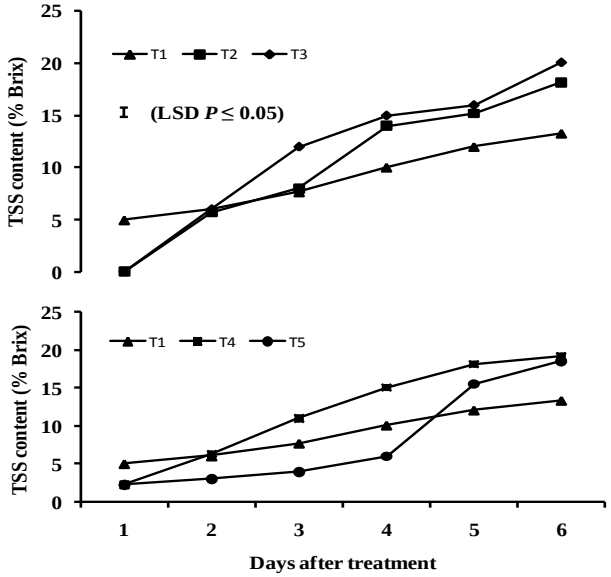

Fig. 4. Change in TSS of treated banana with plant extracts

The highest vitamin C content was observed in T_4, T_2, and T_5 (1.7 mg/100 g) which was approximately 2.4-fold more than T_1 (0.7 mg/100 g) after two weeks of storage (Fig. 5). Similarly, the findings of Gameel (2012) depicts that lemon fruits treated with higher concentration of jasmine oil or garlic extract showed significantly higher content of ascorbic acid.

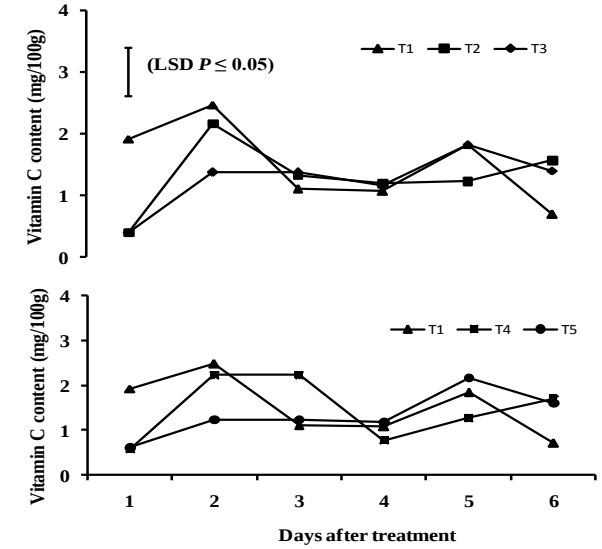

Fig. 5. Change in vitamin-C content of treated banana treated with plant extracts

On the other hand, highest titratable acidity was recorded in T_4 (0.11%) and lowest in T_1 (0.08%) from 3 DAT to 13 DAT (Fig. 6). Kaur (2016) also reported higher level of acid content in postharvest treated guava fruits (0.41%) than control (0.35%).

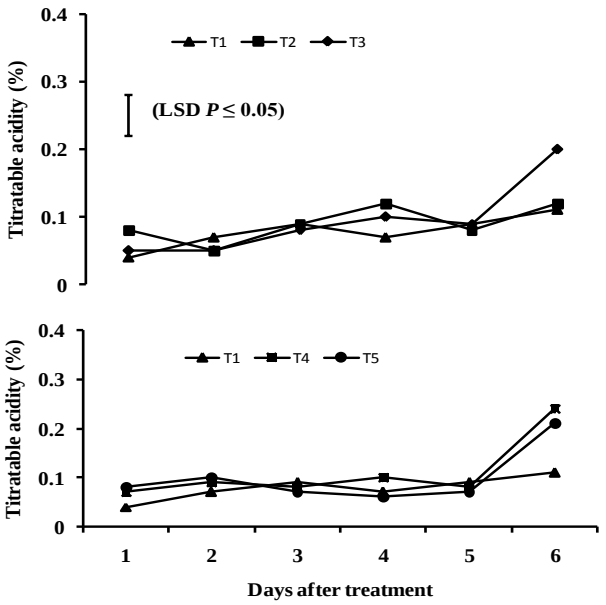

Fig. 6. Change in titratable acidity in banana treated with plant extracts

Reducing sugar was observed from 7 DAT (2.06%) to 13 DAT (8.3%) and the increase was 4.03-fold more irrespective of all treatments (Fig. 7**A**). The mean value of reducing sugar in T_1 (4.73%) was approximately 0.66-part lower than those of T_5 and T_4 respectively from 7 DAT to 13 DAT (Fig.7**B**). Lower level of reducing sugar in control guava fruit was also recorded by Kaur (2016).

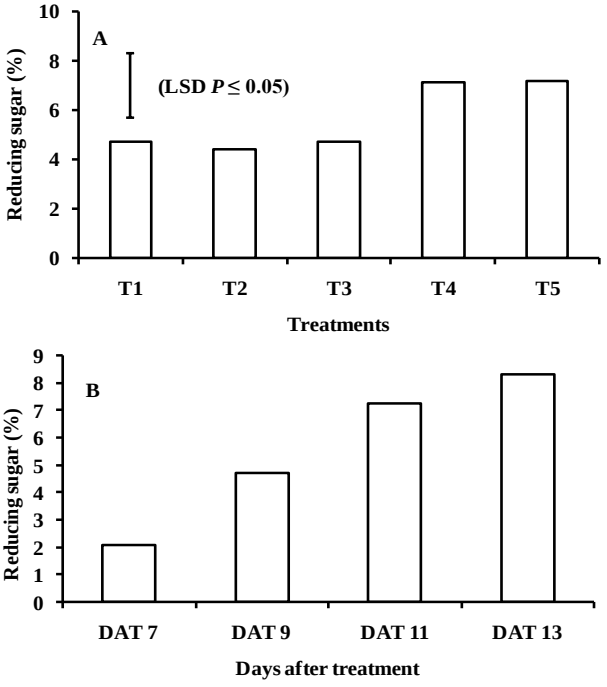

Fig. 7. Change in reducing sugar content in banana treated by plant extracts

Microbial infection: Fruits from every treatment showed more or less microbial infections. The acceptable limit of infection was recorded in T_3 and T_5 until 6 DAT (Fig. 8) which was 4 more days than control (T_1). From 1 to 12 DAT maximum level of disease severity was observed in T_1 (score 3.07) and minimum in T_3 (score 1.66) which was 0.54-parts lower than that of control (T_1) (Fig. 9). Sabri showed less disease severity compared to other varieties at modified atmospheric packaging as reported by Akter *et al*. (2013). Banana fruit treated with neem extract similarly showed to reduce the disease severity (Bagwan, 2001).

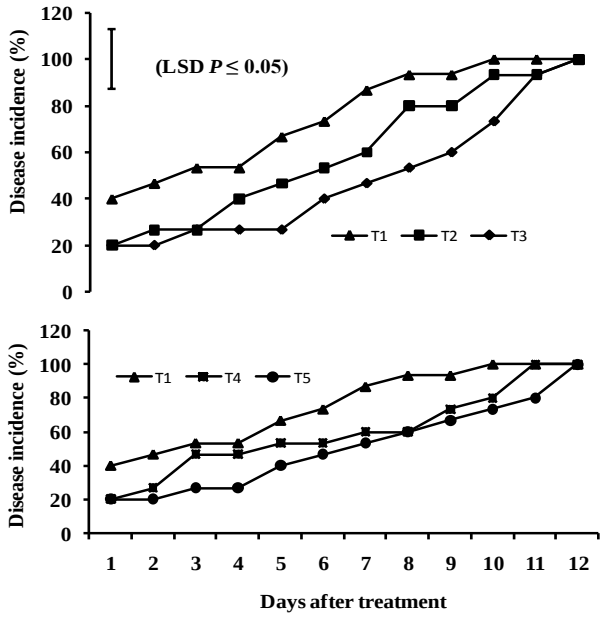

Fig.8. Microbial infection rate in different treatment groups

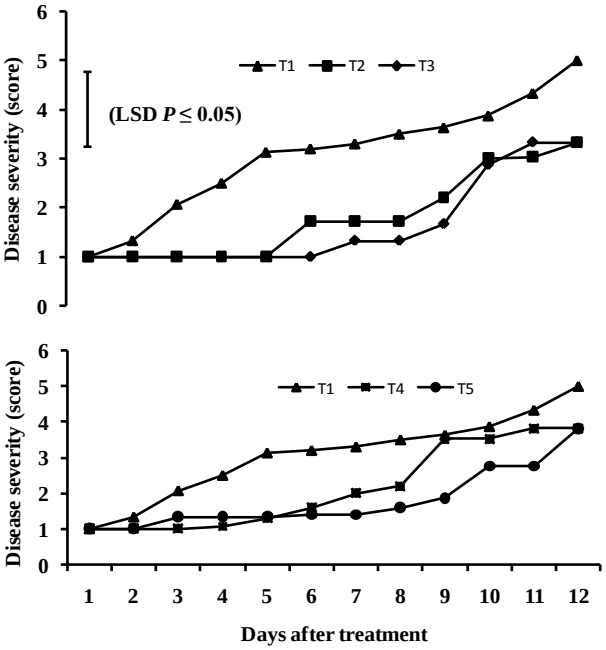

Fig. 9. Disease severity rate of plant extracts treated banana

Shelf life: The longest shelf life was recorded in T_3 treated banana fruits (8.75days) followed by T_5 (8.67 days), T_2 (8.42 days) and T_4 (8.25 days) and the lowest by T_1 (4.67days). The T_3 treated fruit showed almost 1.87-fold longer shelf life than T_1 (Fig. 10). Guava leaf extract is effective in lengthening the shelf life of bananas. Longer shelf life of fruits and vegetables was also reported by Stephen (2014) while observing the combined effect of guava leaf extract (20%) and lemon extract (15%).

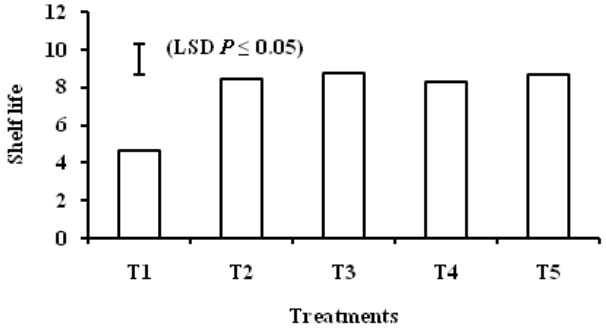

Fig.10. Influence of plant extracts on shelf life of banana

Summary and Conclusion

Rapid and significant changes in physical parameters were observed in the banana fruit during ripening. However, color and firmness changes were slower in T_5 (score 6.77 and 4. 43on 12 DAT) in comparison to other treatments. Presence of microbial infection was observed in all treatments along with surface severity. Minimum incidence and severity on 12 DAT was recorded in T_3 (48.89% and 3.33 score, respectively).

Significant changes in chemical parameters were also identified during the study period. Lowest TSS content was recorded in T_5treated banana fruit (8.21%) than other treatments from 3 DAT to 13 DAT. Vitamin-C content was maximum in T_4treated fruit(1.7 mg/100g) on 13 DAT and highest reducing sugar was recorded on 13 DAT (8.3%) irrespective of all treatments.

Maximum shelf life of banana fruit was recorded in T_3 (8.75 days) with similar findings from T_5, T_2 and T_4 (8.67, 8.42 and 8.25 days, respectively). Minimum shelf life (4.67 days) was recorded in control fruit. Considering the findings of the present study, it could be concluded that the combined plant extracts such as combination of guava leaf (20%) and lemon extracts (15%) maintained a positive impact on the desired physico-chemical characteristics during storage of sabri banana at ambient conditions.

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