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Research Article

Effect of Different Botanical Extracts on Shelf Life and Quality of Mango (*Mangifera indica* L.)

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ABSTRACT

The study was carried out to minimize the postharvest loses and extend shelf life of mango fruit by using botanical extracts. The popular mango variety 'Amrapali' was used as experimental materials for the study. The study comprised of 6 different botanical extracts as treatment. The treatment combinations were T_0=Control (no botanical extract), T_1 = Neem extract, T_2 = Biskatali (Water Pepper) extract, T_3 = Neem + Biskatali (Water Pepper) extract, T_4 = Ghagra extract, T_5 = Biskatali (Water Pepper) + Ghagra extract. The maximum shelf life (15.58 days) was observed from T_1 treatment, whereas the minimum shelf life (9.00 days) was recorded from T_0 treatment in Amrapali mango. At 3, 5, 7 and 9 days after harvest (DAH), the most firmness score (1.70%, 3.48%, 4.53% and 5.28% respectively) was found from T_0 treatment in Amrapali mango, whereas the lowest firmness score (1.01%, 2.05%, 3.23% and 4.11% respectively) was observed from T_1 treatment. At 3, 5, 7 and 9 days after harvest (DAH), the highest weight loss (3.06%, 5.92%, 8.63% and 9.55% respectively) was found from T_0 treatment in Amrapali mango, whereas the lowest weight loss (2.10%, 4.07%, 7.12% and 8.14% respectively) was observed from T_1 treatment. At 5, 7 and 9 days after harvest (DAH), the extreme disease incidence (27.77%, 61.11% and 100.00%, respectively) was recorded from T_0 treatment and the moderate disease incidence (0.00%, 11.11% and 20.83%, respectively) was observed from T_1 treatments. So, consideration of shelf life and quality treatment T_1 as stored in neem extract treatment were superior on other botanical treatment for 'Amrapali' mango. The results clearly showed that the neem extract proved as the best choice for the extend shelf life and quality of mango.

Introduction

Mango (*Mangifera indica* L.) is the favourite fruit in Bangladesh (Alam et al., 2017) and belongs to the family Anacardiaceae is a tropical to sub-tropical fruit (Sethi et al., 2011). It is a famous fruit and additionally referred to as the king of fruit (Tharanathan et al., 2006). Mango has been cultivated for extra than 4000 years (Candole, 1984). The Asian international locations bill about 77% of worldwide mango manufacturing and it grows in local to South-East Asia including 62 species (Anonymous, 2013).

The Mango of Rajshahi and Chapainawabgonj are more famous than those of other areas of Bangladesh (Sultana et al., 2018). Mango ranks first in phrases of region and 1/3 in phrases of manufacturing and occupies 34,000 hectares of land in Bangladesh (BBS, 2020). Mango is mentioned because the pleasant culmination with inside the international market place due to its outstanding utility, superb taste and appealing fragrance. Nutritionally, Mango is a wealthy supply of carbohydrates, nutritional fiber, vitamins (vit A, beta-carotene, vit C, vit K etc), minerals arid (iron, calcium, magnesium, manganese etc) protein, general soluble`solids, low fats with 250 kcal in 100g mango powder and it allows to save many human diseases (Ajila et al., 2010; Ajila et al., 2007; Aziz et al., 2012; Kim et al., 2010; Sogi et al., 2013 ; Purohit, 1985; USDA, 2013).

Nevertheless, number of obstacles prevent mango production from being profitable, such as improper agronomic practices, inadequate planting materials, improper controlling diseases and pest's methods, inadequate extension support systems, insufficient postharvest handling technologies, insufficient marketing infrastructure, and a lack of suitable credit support facilities (Sarmin et al., 2018). About 27% of

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fresh food is lost due to improper handling, insufficient storage, or a lack of postharvest technical expertise for growers and dealers (Hassan, 2011). This perishable item is estimated to lose up to 320.7 thousand tons annually in Bangladesh, with a value of Tk 3,000 lakh (Haq, 2002). Thus, it's critical to discover a workable, affordable, and non-toxic way to stop mangos from rotting. Plant extracts are available worldwide and can be managed with low cost. In using natural plant extracts offers a way to reduce or completely eliminate the need for synthetic preservatives. Furthermore, there is no negative impact on health from plant extracts. (Pervin, 2016). However, chemicals can have a variety of negative effects on the human body. A thin coating is formed around the treated fruit by plant extracts used as a postharvest treatment. By controlling the diffusion of carbon dioxide and oxygen into and out of the fruit, this layer functions as a semi-permeable barrier, slowing down the pace of metabolism and preventing water loss (Sarmin et al., 2018). However, only a small number of studies have been conducted in Bangladesh on the unusual application of plant extracts as postharvest treatments. Different plant extracts has been used for centuries in Asia as insecticides and fungicides (Chaturvedi et al., 2003). Botanical extract is considered as the most active substance which has growth regulating, fungicidal, and insecticidal properties (Schmutterer, 1990) with minimal impact on non-target organisms and eco-friendly biocontrol agents (Srivastava, 2003)

The study was taken with the following specific objectives:

(i) To find out shelf life and quality of mango through different botanical treatments.
(ii) To minimize economic losses of 'Amrapali' mango variety through different management practices.

Materials and Methods

Experimental site, time and storage climate

The study was conducted in Dinajpur District of Bangladesh during the period from June to August 2020. The experiment was done at room temperature.

Treatments and design of the experiment

The experiment was laid out following Completely Block Design (CRD) comprising six treatments with three replications. The treatments were T_0: Control condition (no botanical treatments and stored in open condition), T_1: Neem extract, T_2: Biskatali (Water Pepper) extract, T_3: Neem + Biskatali (Water Pepper) extract, T_4: Ghagra extract, T_5: Biskatali (Water Pepper) + Ghagra extract. Total of 108 'Amrapali' mangos of more or less similar shape and size and free of visible disease symptoms were collected. Six uniform sized mango fruits were kept in each treatment. The skin adherences, dots and latex were cleaned by gently wiping the fruits with moist and clean towel.

Experimental materials

The popular Mango variety 'Amrapali' was used as experimental materials for this study. These mangos at matured stage were collected from "Mijan and Jesmin Agro Farm" mango orchard from Dinajpur District.

Extraction procedure

Fresh leaves of Neem, Biskatali (Water Pepper) and Ghagra (about 250g) were collected from Dinajpur. Then individually the leaves washed by water and blended with 500 ml of distilled water. Then 40% Neem, Biskatali and Ghagra leaves extract solution was prepared by taking 120 ml raw Neem, Biskatali and Ghagra leaves extract in 500 ml beaker with the addition of 180 ml distilled water separately to make a final volume of 300 ml (Mia, 2003).Combination treatment of Neem and Biskatali (Water Pepper) made with mixed 150 ml of Neem extract solution and 150 ml Biskatali extract solution. Another combination made with the extract solution of Biskatali (Water Pepper) and Ghagra (150 ml + 150 ml).

Application of post-harvest management practices

Different management practices were applied as per the treatment of the experiment which was presented in treatments of the experiment. Treatments were applied at the mango orchard in Dinajpur after few hours of harvesting mangoes.

Observation

During the entire period of storage, the mangos were observed every day with seen observation. Data were recorded at an interval of 2 days starting from 3 Days after harvest (DAH) and continued up to 50% of samples per replicate had been deteriorated that influenced by different post-harvest management practices.

Collection of data

Estimation of shelf life

Shelf life of mango treated with different treatments was calculated by counting the number of days until the score for color, firmness and disease severity.

Physical parameters:

Firmness change

Days required to reach different stages of firmness during storage and ripening were determined at an interval of 2 days using numerical rating scale of, 1-6, where 1 = mature hard, 2 = sprung, 3 = between sprung and eating ripe, 4 = eating ripe, 5 = over ripe, 6 = totally unfit for consumption. Similar rating scale was used by Hassan (2006).

Color change

Data were collected at interval of 2 days during storage and ripening using numerical rating scale of, 1-7, where 1 = green, 2 = breaker, 3 = One-quarter yellow (< 25%),

4 = two-quarter yellow (< 50%), 5 = three-quarter yellow (< 75%), 6 = fully yellow (75-100%), 7 = blackened/rotten (fully yellow and black). Similar rating scale was used by Hassan (2006).

Estimation of total weight loss

The fruits of each treatment were individually weight by using electric balance and percent total weight loss was calculated at an interval of 2 days during storage by using the following formula: Total Weight Loss Percent = [(Initial weight - Current weight) / Initial weight] x 100.

Estimation of moisture content

Ten (10) gram of fruit pulp of 'Amrapali' mango was weighed in a porcelain crucible (which was previously cleaned, dried and weighed) from each treatment and replications. The crucible was placed in electric oven at 80^0C for 72 hours until the weight became constant. It was then cooled in desiccators and weighed again. Percent moisture content was calculated by using the formula:

$$\text{Moisturecontent}\,(\%) = \frac{IW - FW}{IW} \times 100$$

Where,
IW= Initial weight of fruit pulp (g) and
FW= Final weight of oven dried fruit pulp (g)

Estimation of dry matter content

Percent dry matter content of the pulp was calculated from the data obtained during moisture estimation using the following formula: Dry matter (%) = 100 - % moisture content.

Microbial characters:

Assessment of disease incidence

The percentage of disease infected mango is called disease incidence. Black spots and visible symptoms were considered as disease. For determining the percentage of infected mango fruit, the infected fruits were counted and calculated using the following equation.

Disease incidence (%) =

$$\frac{\text{Number of infested fruits in each replication}}{\text{Total number of fruits in each replication}} \times 100$$

Statistical analysis

The recorded data on the different parameters of the study were analyzed statistically using excel data sheet and Minitab software'17 version. Various descriptive statistical measures such as mean, Least Significant Difference (LSD), coefficient of variation (CV) and ANOVA test were used for categorization and describing the variable.

Results and Discussion

Shelf life

Shelf life of 'Amrapali' mango varied significantly due to different post-harvest treatments under the present trial **(Table 1 and Figure 1)**. The highest shelf life (15.58 days) was observed from T_1 treatment and the 2nd highest of shelf life (14.62 days) was found from T_3 treatment, whereas the lowest shelf life (9.00 days) was recorded from T_0 treatment. This result showed that the application of botanical extracts increased Shelf life of mango but application of neem extract for mango preservation gave better shelf life. The longer shelf life was observed in neem leaf extract treated mango fruits which support the findings of the present study (Sarmin et al., 2018; Habiba, 2012). Mango fruits treated with neem oil (10%) proved to be most effective with respect to slower increase in TSS (Shinde et al., 2009 and Ferdowsi, 2014).

Table 1. Effect of different botanical treatments on shelf life and firmness change at different days after harvest (DAH) of mango

Treatments	Shelf life (days)	Firmness change (%) at			
		3 DAH	5 DAH	7 DAH	9 DAH
T_0	9.00	1.70	3.48	4.53	5.28
T_1	15.58	1.01	2.05	3.23	4.11
T_2	13.50	1.00	2.13	3.49	4.12
T_3	14.62	1.00	2.08	3.38	4.16
T_4	12.53	1.13	2.86	3.88	5.07
T_5	11.75	1.25	3.00	4.15	5.14
LSD(0.01)	0.656	0.075	0.319	0.474	0.311
CV (%)	2.05	2.53	4.92	5.03	2.68
Level of significance	**	**	**	**	**

** Significant at 1% level of probability

(T_0= Control, T_1 = Neem extract, T_2 = Biskatali (Water Pepper) extract, T_3 = Neem + Biskatali (Water Pepper) extract, T_4 = Ghagra extract, T_5 = Biskatali (Water Pepper) + Ghagra extract).

Figure 1. Effect of neem extract on shelf life and color change of mango

Physical parameters

Firmness change

Firmness change of 'Amrapali' mango at 3, 5, 7 and 9 days after harvest (DAH) varied significantly due to different post-harvest treatments **(Table 1)**. At 3, 5, 7 and 9 days after harvest (DAH), the highest firmness change (1.70, 3.48, 4.53 and 5.28, respectively) was found from T_0 treatment and the 2nd highest firmness change (1.25, 3.00, 4.15 and 5.14, respectively) was recorded from T_5 treatment, while the lowest firmness change (1.01, 2.05, 3.23 and 4.11, respectively) was observed from T_1 treatment under the present trial. The finding of the current study was supported by (Sarmin et al., 2018; Shinde et al., 2009).

Color change

Statistically significant variation was recorded in terms of color change of 'Amrapali' mango at 3, 5, 7 and 9 DAH due to different post-harvest treatments **(Figure 1 and Figure 2)**. At 3, 5, 7 and 9 DAH, the highest color change (1.23, 2.38, 3.41 and 5.70 respectively) was recorded from T_0 treatment and the 2nd highest color change (1.09, 2.13, 3.37 and 4.91, respectively) was found from T_5 treatment; whereas the lowest color change (1.03, 1.63, 3.01 and 4.02, respectively) was observed from T_1 treatment. The finding of Ferdowsi (2014) and Malik et al. (2015) supports the findings of the current study.

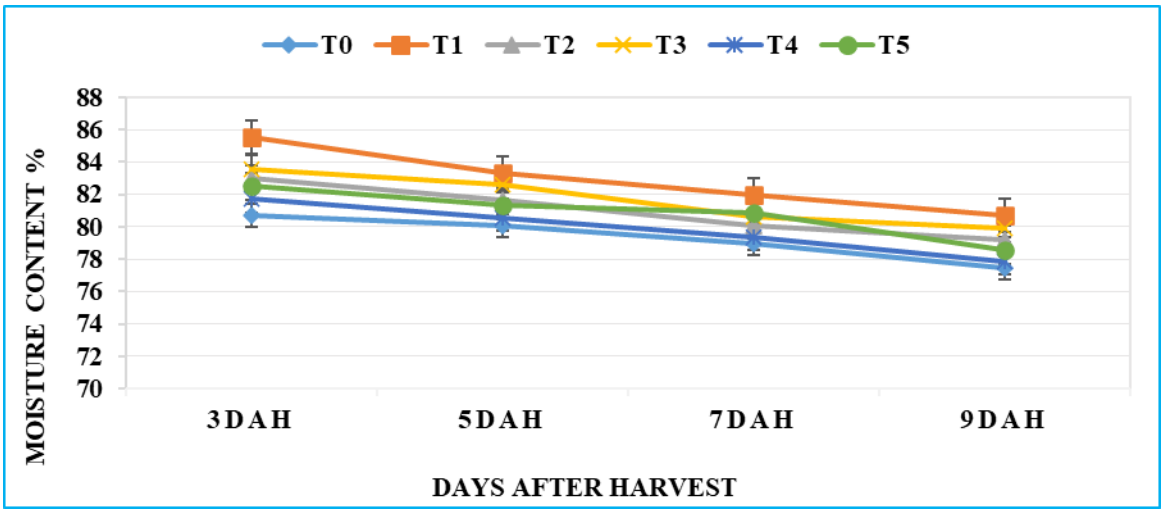

Figure 2. Showing different botanical treatments comparison on color change of mango.
(T_0 = Control, T_1 = Neem extract, T_2 = Biskatali (Water Pepper) extract, T_3 = Neem + Biskatali (Water Pepper) extract, T_4 = Ghagra extract, T_5 = Biskatali (Water Pepper) + Ghagra extract).

Weight loss

Different post-harvest treatments showed statistically significant differences in terms of weight loss of 'Amrapali' mango at 3, 5, 7 and 9 DAH (**Table 2**). At 3, 5, 7 and 9 DAH, the highest weight loss (3.06%, 5.92%, 8.63% and 9.55%, respectively) was observed from T_0 treatment and the 2nd highest weight loss (3.18%, 5.83%, 8.07% and 9.07%, respectively) was found from T_4 treatment, while the lowest weight loss (2.10%, 4.07%, 7.12% and 8.14%, respectively) from T_1 treatment .The findings of Singh et al. (2000), Shinde et al. (2009) and Habiba (2012) supports the findings of the current study.

Table 2. Effect of different postharvest treatments on weight loss at different days after harvest (DAH) of mango

Treatments	Weight loss (%) at			
	3 DAH	5 DAH	7 DAH	9 DAH
T_0	3.06	5.92	8.63	9.55
T_1	2.10	4.07	7.12	8.14
T_2	2.29	4.20	7.18	8.19
T_3	2.53	4.57	7.30	8.22
T_4	3.18	5.83	8.07	9.07
T_5	2.95	5.25	8.03	8.86
LSD(0.01)	0.089	0.154	0.121	0.149
CV (%)	1.34	1.24	0.63	0.69
Level of significance	**	**	**	**

** Significant at 1% level of probability

(T_0 = Control, T_1 = Neem extract, T_2 = Biskatali (Water Pepper) extract, T_3 = Neem + Biskatali (Water Pepper) extract, T_4 = Ghagra extract, T_5 = Biskatali (Water Pepper) + Ghagra extract).

Moisture content

Moisture content of 'Amrapali' mango at 3, 5, 7and 9 DAH showed statistically significant variation due to different post-harvest treatments **(Figure 3)**. At 3, 5, 7 and 9 DAH the highest moisture content (85.55%, 83.30%, 81.95% and 80.68%, respectively) was found from T_1 treatment and the 2nd highest moisture content (83.54%, 82.59%, 80.64% and 79.88%, respectively) was recorded from T_3 treatment, whereas the lowest moisture content (80.72%, 80.10%, 78.92% and 75.48%, respectively) was observed from T_0 treatment. Karemera and Habimana (2014) reported that 1.50% $CaCl_2$ significantly increased moisture content of mango compared to control.

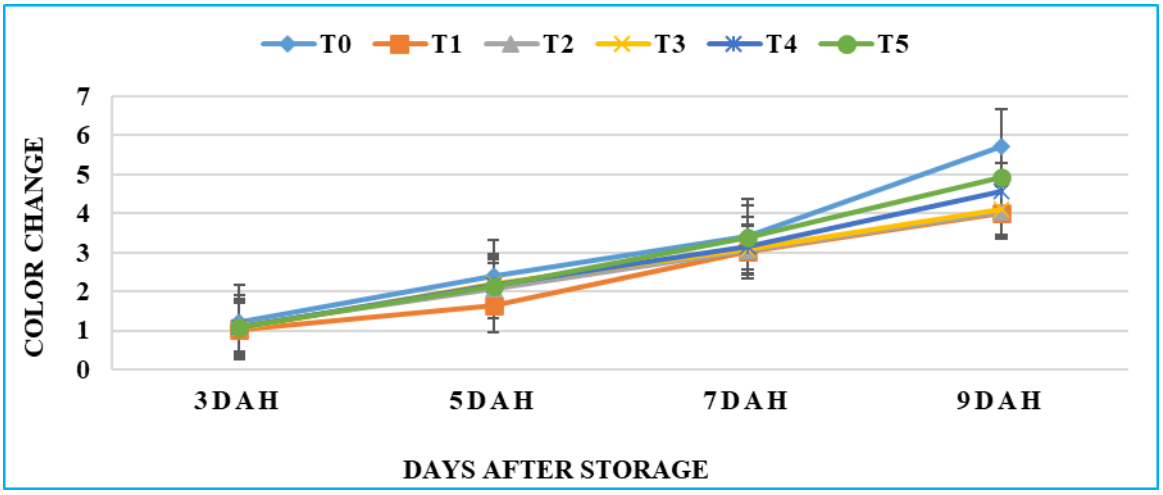

Figure 3. Showing different botanical treatments comparison on moisture content of mango.
(T_0 = Control, T_1 = Neem extract, T_2 = Biskatali (Water Pepper) extract, T_3 = Neem + Biskatali (Water Pepper) extract, T_4 = Ghagra extract, T_5 = Biskatali (Water Pepper) + Ghagra extract).

Dry matter content

Significant variation was found for dry matter content of 'Amrapali' mango at 3, 5, 7 and 9 DAH due to different post-harvest treatments **(Table 3)**. At 3, 5, 7 and 9 DAH, the highest dry matter content (19.28%, 19.90%, 21.07% and 22.51%, respectively) was observed from T_0 treatment and the 2nd highest dry matter content (18.28%, 19.44%, 20.62% and 22.15%, respectively) was found from T_4 treatment, while the lowest (14.45%, 16.69%, 18.04% and 19.31%, respectively) from T_2 treatment. Singh et al. (2017) reported that potassium permanganate treated mango showed the highest dry matter content.

Table 3. Effect of different postharvest treatments on dry matter content at different days after harvest (DAH) of mango

Treatments	Dry matter content (%) at			
	3 DAH	5 DAH	7 DAH	9 DAH
T_0	19.28	19.90	21.07	22.51
T_1	14.45	16.69	18.04	19.31
T_2	17.04	18.39	19.91	20.78
T_3	16.46	17.41	19.36	20.11
T_4	18.28	19.44	20.62	22.15
T_5	17.51	18.69	19.13	21.47
LSD(0.01)	1.62	0.84	0.97	0.71
CV (%)	2.29	1.09	1.19	0.81
Level of significance	**	**	**	**

** Significant at 1% level of probability

(T_0 = Control, T_1 = Neem extract, T_2 = Biskatali (Water Pepper) extract, T_3 = Neem + Biskatali (Water Pepper) extract, T_4 = Ghagra extract, T_5 = Biskatali (Water Pepper) + Ghagra extract).

Microbial parameters

Disease incidence

Disease incidence of 'Amrapali' mango at 5, 7 and 9 DAH showed statistically significant variation due to different botanical treatments **(Table 4)**. At 5, 7 and 9 DAH, the highest disease incidence (27.77%, 61.11% and 100.00%, respectively) was recorded from T_0 treatment and the 2nd highest disease incidence (12.50%, 38.88% and 61.11%, respectively) was found from T_4 treatment, while the lowest disease incidence (0.00%, 11.11% and 20.83%, respectively) was observed from T_1 treatments. This result showed that the application of botanical extracts decreased disease incidence of mango but application of neem extract for mango preservation gave better results. The finding of the current study is supported by Sarmin et al., 2018 who stated that the disease incidence was greatly influenced by neem extract treatments. Similarly Bagwan (2001) reported that the treatment of banana fruits with neem extract (*Azadirachta indica)* for 5 minutes is most effective for controlling various postharvest diseases which support the findings of the current study.

Table 4. Effect of different postharvest treatments on diseases incidence at different days after harvest (DAH) of mango

Treatments	Diseases incidence (%) at		
	5 DAH	7 DAH	9 DAH
T_0	27.77	61.11	100.00
T_1	0.00	11.11	20.83
T_2	11.11	20.83	38.89
T_3	0.00	11.11	27.78
T_4	12.50	38.88	61.11
T_5	11.11	20.83	38.89
LSD(0.01)	10.394	12.96	14.90
CV (%)	40.01	19.03	12.47
Level of significance	**	**	**

** Significant at 1% level of probability

(T_0 = Control, T_1 = Neem extract, T_2 = Biskatali (Water Pepper) extract, T_3 = Neem + Biskatali (Water Pepper) extract, T_4 = Ghagra extract, T_5 = Biskatali (Water Pepper) + Ghagra extract).

Conclusion

The results indicated that Neem extract had a positive impact on shelf life and different quality parameters which has statistically significant differences compared with different treatments. The highest shelf life (15.58 days) was observed from T_1 treatment, whereas the lowest shelf life (9.00 days) was recorded from T_0 treatment. At 9 days after harvest (DAH), the highest firmness score (5.28) was found from T_0 treatment and the lowest firmness score (4.11) was observed from T_1 treatment. At 9 DAH, the highest color score (5.70) was recorded from T_0 treatment, whereas the lowest color score (4.02) was observed from T_1 treatment. At 9 DAH, the highest weight loss (9.55%) was observed from T_0 treatment and the lowest weight loss (8.14%) was recorded from T_1 treatment. At 9 DAH, the highest disease incidence (100.00%) was recorded from T_0 treatment and the lowest disease incidence (20.83%) was observed from T_1 treatments. In consideration of

shelf life and quality treatment (T_1: Stored in Neem extract) were superior and minimize botanical losses of 'Amrapali' mango variety.

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