

Post-harvest application of botanical extracts from the sunderbans for controlling disease and extending shelf life of mango (*Mangifera indica* L.)

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Abstract

An experiment was conducted with aqueous extracts of leaves of three plants of Sunderbans *i.e.* Sundari (*Heritiera fomes*), Keora (*Sonneratia apetala*) and Kankra (*Bruguiera gymnorhiza*) to find out the efficacy of controlling post-harvest disease and extending shelf life of mango. In this study, the efficacy of the three plant extracts at four different concentrations viz., 20%, 30%, 40% and 50% along with control were used. The experiment was laid out in CRD with four replications. Infection percentage as well as percent disease index (PDI) was observed up to 20 days after treatment. The highest disease index (100%) was observed at control (0% concentration) within 12 days after treatment while at 50% concentration disease index reached to 100% after 18 days of treatment in case of Sundari and Kankra extract and after 20 days of treatment for Keora extract. An increasing trend in post-harvest disease control was noticed with the increase in concentration of leaf extracts. Thus, maximum shelf life was observed at 50% concentration of all the three botanicals. In comparison to other leaf extracts, Keora at 50% level also found more effective in extending shelf life of mango up to 18 days having statistical similarity with that of Kankra extract (17.25 days). Now, it is obvious that botanical extracts efficiently control post-harvest disease and extend shelf life of mango up to certain degree of concentration.

Keywords: mango, botanical extract, post-harvest disease control, shelf life extension

1. Introduction

Mango (*Mangifera indica* L.), the “King of the fruit” of Bangladesh (Ahmed, 1994) [4, 8], is one of the top five fruit crops in the world (Abd-Alla and Haggag, 2013) [2]. Among the fruit crops grown in Bangladesh, mango ranks first in area and third in production. It has a unique position in respect of nutritional quality, taste, consumer’s preference etc. (Ahmad, 1985) [3]. One medium size mango of about 200 grams has about 135 calories. Besides, mango contains appreciable quantity of carbohydrates, provitamin A, vitamin C and soluble sugar (Samad *et al.*, 1975) [13]. But the yield is lower than that of our neighboring countries (Hossain and Ahmed, 1994) [4, 8] and it is mainly due to diseases of pre- and post-harvest. Fruits infected at mature stage carry the fungus into storage and cause considerable loss during storage, transit and marketing (Abd-Alla and Haggag, 2010) [1]. In Bangladesh, 25 to 30% losses of total production of mango due to anthracnose and stem end rot diseases (Hossain and Ahmed, 1994) [4, 8]. Over decades, synthetic fungicides like benomyl, mancozeb, carbendazim, and thiabendazol were particularly investigated to prevent, control or eradicate diseases (Lee *et al.*, 2009) [9]. But the use of synthetic chemicals to control post-harvest deterioration of food commodities is restricted for their possible carcinogenicity, teratogenicity, high and acute mammalian toxicity, environmental pollution and other side effects (Unnikrishnan and Nath, 2002; Tripathi *et al.*, 2004) [15, 14]. So, a new technology is needed. Among the various alternatives, natural plant products, including essential oils

from higher plants are bio-efficacious and environmentally safe for controlling post-harvest diseases of mango (Macias *et al.*, 1997). There are 334 species of plants under 245 genera and 75 families in the Sunderbans. Mukherjee *et al.* (2011) [11] found Keora fruit extracts of the Sunderbans are moderate effective to inhibit that *Colletotrichum gloeosporioides*. A vast group of plant has not been tested to control plant pathogen yet. Hence, the present research with Sundari, Keora and Kankra leaf extracts is adopted to control post-harvest diseases and extend the shelf life of mango.

2. Materials and Methods

2.1 Location and design of study

The experiment was conducted in the Plant Pathology Laboratory of Agrotechnology Discipline, Khulna University, Khulna, Bangladesh during May 2014 to July 2014 in Completely Randomized Design (CRD).

2.2 Collection of materials

Fresh and disease free fully matured green mangoes (*Mangifera indica* L.) of the variety BARI Mango 3 (Amropoli) uniform in shape, size and age were collected directly from the farmer’s field and kept in the laboratory for a while to mitigate the field heat. Then the mud or filth adhered on the fruit surface was cleaned. Plant extract of Sundari, Keora and Kankra was applied to the fruits at respective concentrations (Table 1). Leaves were used as plant part for extracting juice.

Table 1: List of plant materials that were used in the experiment with their respective concentrations

Common name	Botanical name	Family	Plant parts	Concentration (%)
Sundari	<i>Heritiera fomes</i>	Sterculiaceae	Leaves	0, 20, 30, 40 & 50
Keora	<i>Sonneratia apetala</i>	Sonnertiaceae	Leaves	0, 20, 30, 40 & 50
Kankra	<i>Bruguiera gymnorrhiza</i>	Sterculiaceae	Leaves	0, 20, 30, 40 & 50

2.3 Preparation and application of treatments

The botanicals used in the experiment were prepared following the standard procedure (Ashrafuzzaman and Hossain, 1992) [5]. Fresh leaves of each plant were firstly washed with tap water and finally washed with distilled water and blended in 1:1 (g:ml) ratio where 400 g of leaves and 400 ml of sterilized distilled water. A total 600 ml of stock solution was prepared for each of the three botanicals. For each of the five treatments 400 ml of botanical solution with desired concentrations were prepared (Table 2). Then, randomly selected four mangoes were dipped in each concentration of three botanicals for 15 minutes. The excess extract was drained off and treated mangoes were air dried. Mangoes soaked in distilled water for same duration (untreated mango) served as control.

Table 2: Preparation of botanical solutions for treatment

Treatment	Concentration (%)	Amount of botanical (ml)	Amount of distilled water (ml)
T ₀ (Control)	0	0	400
T ₁	20	80	320
T ₂	30	120	280
T ₃	40	160	140
T ₄	50	200	200

2.4 Data collection and calculation

Number of spots and area covered (%) by infection were measured in order to find out the disease severity and percent disease index (PDI). Shelf-life of fruits was calculated from the period of treatment applied up to rotting when the fruits became unsuitable for marketing and consumption. Infection percentage was measured according to Corikidi *et al.*, (2006) [6].

Area covered by infection

$$\text{Infection (\%)} = \frac{\text{Total surface area of the mango}}{\text{Area covered by infection}} \times 100$$

Percent disease index (PDI) was calculated by using the following formula as proposed by Prabakar *et al.*, 2005 [12].

$$\text{PDI} = \frac{\sum(\text{Disease class} \times \text{Fruit number in that class})}{\text{Total number of fruits} \times \text{Maximum disease grade}} \times 100$$

Where, total number of fruits and fruit number in a class was same (1 piece).

Data was collected by using the following scales as proposed by Corikidi *et al.*, 2006 [6].

- 1 = 0-1% fruit area infection (no disease)
- 2 = 2-5% fruit area infection (slight disease)
- 3 = 6-9% fruit area infection (moderate disease)
- 4 = 10-49% fruit area infection (severe disease)
- 5= 50-100 % fruit area infection (very severe disease)

2.5 Statistical analysis

The collected data on various parameters were statistically analyzed using MSTAT-C statistical package program to find out the variation resulting from experimental treatments following F variance test. The significance of difference between the pair of means was compared at 1% and 5% level of probability (Gomez and Gomez, 1984) [7].

3. Results and Discussion

3.1 Effect of Sundari extract on the Percent Disease Index (PDI) of mango (*Mangifera indica* L.)

There was a significant effect of different concentrations of Sundari extract in controlling post-harvest diseases of mango over control at 1% level of significance.

Table 3: Efficacy of Sundari leaf extract on Percent Disease Index (PDI) after different days of treatment

Treatment Level	Percent Disease Index (PDI)								
	4 day	6 day	8 day	10 day	12 day	14 day	16 day	18 day	20 day
T ₀ (0%)	20	35.00a	80.00a	95.00a	100.0a	100.0a	100.0a	100.0	100.0
T ₁ (20%)	20	20.00b	20.00b	45.00b	80.00b	100.0a	100.0a	100.0	100.0
T ₂ (30%)	20	20.00b	30.00b	40.00b	75.00b	95.00a	100.0a	100.0	100.0
T ₃ (40%)	20	20.00b	20.00b	20.00c	35.00c	80.00b	85.00b	100.0	100.0
T ₄ (50%)	20	20.00b	20.00b	20.00c	20.00d	35.00c	40.00c	95.00	100.0
CV (%)	0.00	19.44	15.19	14.37	10.20	7.71	5.26	4.52	0.00
Level of significance	NS	**	**	**	**	**	**	NS	NS

In a column, those having common letters do not differ significantly according to DMRT. ** Significant at 1% level of significance, NS not significant

Percent disease index was gradually decreased with the increasing concentrations of Sundari extract resulting in greater control of diseases showing minimum PDI in T₄ (50%) treatment and maximum PDI was noticed in untreated mango. No significant differences were found after 4, 18 and 20 days of treatment. Untreated mangoes were infected to 100%

disease index within 12 days after treatment while 100% disease index was observed after 14, 16, 18 and 20 days of treatment in T₁ (20%), T₂ (30%), T₃ (40%) and T₄ (50%), respectively. According to disease rating scale, no/slight disease infection was observed in T₄ treatment up to 16 days of treatment followed by T₃ (40%) treatment (Table 1). These

results have derived the support of Alam *et al.* (2012) who found that *Colletotrichum gloeosporioides* could not be pathogenic to mango due to the treatment of Kankra, Geoa, Keora, Sundari and Pashur extracts at different concentrations in storage.

3.2. Effect of Keora extract on the Percent Disease Index (PDI) of mango (*Mangifera indica* L.)

A significant effect was observed with the treatment of

different concentrations of Keora extract on the disease index over control at 1% level of significance (Table 2).

With the increase in concentration of Keora leaf extract Percent Disease Index (PDI) was observed to be decreased. On the other hand, an increasing trend in percent disease index was found with the advancement in storage duration but the rate of increase was rapid in control (T_0) and slow in T_4 (50%).

Table 4: Efficacy of Keora leaf extract on Percent Disease Index (PDI) after different days of treatment

Treatment Level	Percent Disease Index (PDI)								
	4 day	6 day	8 day	10 day	12 day	14 day	16 day	18 day	20 day
T_0 (0%)	20	35.00a	80.00a	95.00a	100.0a	100.0a	100.0a	100.0a	100.0
T_1 (20 %)	20	20.00b	20.00b	45.00b	95.00a	100.0a	100.0a	100.0a	100.0
T_2 (30 %)	20	20.00b	20.00b	40.00b	80.00b	95.00a	100.0a	100.0a	100.0
T_3 (40 %)	20	20.00b	25.00b	35.00bc	80.00b	95.00a	100.0a	100.0a	100.0
T_4 (50 %)	20	20.00b	20.00b	20.00c	35.00c	60.00b	75.00b	85.00b	95.00
CV (%)	0.00	19.44	13.55	16.48	8.11	7.03	4.71	4.61	4.52
Level of significance	**	**	**	**	**	**	**	**	NS

In a column, those having common letters do not differ significantly according to DMRT. ** Significant at 1% level of significance, NS not significant

After 4 days of treatment no difference was observed among the treated and untreated mangoes (PDI 20%) and up to 8 days after treatment no statistical difference on percent disease index (20%) was found among the treated mangoes but significant difference was observed in between the treated and untreated mangoes except for 4 and 20 days after treatment. In untreated mangoes (T_0) disease index was reached to 100% within 12 days after treatment while it was found 100% after 14 days of T_1 treatment, after 16 days of T_2 and T_3 treatments and 95% disease index after 20 days of T_4 treatment. Similar results were obtained by Mukherjee *et al.* (2011) [11] who reported Keora seed and leaf extracts had antifungal effects on the growth and development of post-harvest diseases of mango.

3.3 Effect of Kankra extract on the Percent Disease Index (PDI) of mango (*Mangifera indica* L.)

Treatment with Kankra leaf extract also showed similar results as per Sundari and Keora in controlling disease which varied

significantly during storage after treatment except for 4, 18 and 20 days after treatment.

There was a gradual increase in percent disease index with corresponding days after treatment but a decreasing trend in PDI with increasing concentration of Kankra was noticed at each of days of observation up to 16 days after treatment which means that increasing concentrations showed increasing effect in controlling disease. In T_4 (50%) treatment, no/slight infection (20% PDI) was observed up to 10 days after treatment. T_4 (50%) treatment significantly controlled disease up to 16 days after treatment showing 75% PDI which was statistically similar to that of T_2 (30%) followed by T_3 (40%) treatment. Among the treated ones, disease index was found 100% after 16 days in T_1 (20%) treatment, after 18 days in T_2 (30%) and T_3 (40%) treatments and after 20 days of treatment in T_4 (50%). Abd-Alla *et al.* (2013) [2] also reported similar result in extending shelf life of mango using botanical extracts.

Table 5. Efficacy of Kankra leaf extract on Percent Disease Index (PDI) after different days of treatment

Treatment Level	Percent Disease Index (PDI)								
	4 day	6 day	8 day	10 day	12 day	14 day	16 day	18 day	20 day
T_0 (0%)	20	35.00a	80.00a	95.00a	100.0a	100.0a	100.0a	100.00	100.00
T_1 (20 %)	20	20.00b	35.00b	60.00b	80.00b	90.00ab	100.0a	100.00	100.00
T_2 (30 %)	20	20.00b	20.00c	35.00c	65.00c	75.00c	85.00ab	100.00	100.00
T_3 (40 %)	20	20.00b	20.00c	35.00c	65.00c	80.00bc	95.00a	100.00	100.00
T_4 (50 %)	20	20.00b	20.00c	20.00c	40.00d	60.00d	75.00b	95.00	100.00
CV (%)	0.00	19.44	12.78	15.81	6.48	8.43	8.51	4.52	0.00
Level of significance	NS	**	**	**	**	**	**	NS	NS

In a column, those having common letters do not differ significantly according to DMRT. ** Significant at 1% level of significance, NS not significant

3.4 Effect of Sundari, Keora and Kankra leaf extracts on the shelf life on mango (*Mangifera indica* L.)

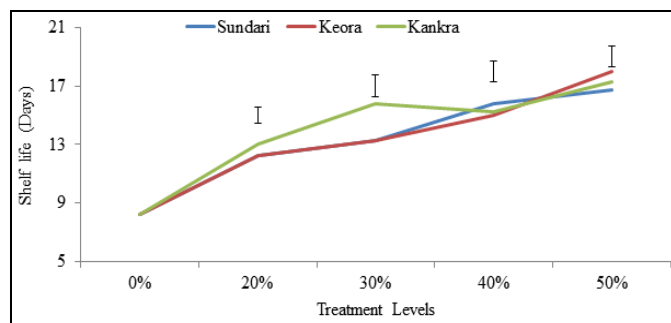


Fig 1: Shelf life extension of mango through the treatment of different concentrations of Sundari, Keora and Kankra leaf extracts. Vertical bars represent the LSD at 1% level of significance.

From the present experiment it was observed that shelf life of mango was increased with the increase in concentration of plant extracts from 0% to 50%. With all the plant extracts shelf life was minimum (8.25 days) at control whereas, maximum shelf life was found at T₄ (50%) treatment which was 16.75, 18 and 17.25 days with Sundari, Keora and Kankra leaf extracts, respectively. Thus, Keora leaf extract at 50% concentration resulted in maximum shelf life followed by Kankra and Sundari. Again, with Kankra extract shelf life was decreased from 15.75 days to 15.25 days though the concentration of extract was increased from 20% to 30% (Fig. 1).

4. Conclusion

Now, it can be concluded that Sundari, Keora and Kankra leaf extracts possessed the characteristics feature of controlling post-harvest diseases and an increasing concentration of these extracts extended shelf life of mango up to a limit.

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