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INFLUENCE OF BAGGING TIME ON FRUIT QUALITY AND SHELF LIFE OF MANGO (*MANGIFERA INDICA* L.) CV. AMRAPALI IN BANGLADESH

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ABSTRACT

The present experiment titled "pre harvest bagging enhanced quality and shelf life of mango cv. Amrapali" was conducted during the year 2017 at the mango orchard near the Hajee Mohammad Danesh Science and Technology University, Dinajpur, Bangladesh. The research was carried out in the Randomized Complete Block Design with three replications. Mango fruits were bagged at 35, 45 and 55 days after fruit set with different types of bags which constituted various treatments viz.: T_1: Transparent polythene bag, T_2: White paper single layered bag, T_3: Brown paper double layered bag, T_4: control (no bagging). In fruit, physical parameter result bagged at 35 days after fruit set with white paper and brown paper bag recorded maximum fruit length (91.2 and 106.4 mm), fruit diameter (65.27 and 78.67 mm), fruit weight (207.8 g and 380.6 g), pulp weight (163.6 g and 195.4 g) respectively, and minimum result was found in polythene bag and control. Meanwhile in fruit chemical parameter of total sugar, reducing and non-reducing sugars, total soluble solids, ascorbic acid, pH and β-carotene were improved over control. Brown paper bag changed fruit color. The sensory qualities in fruits of brown and white paper bags were

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improved over control. Fruits treated with brown paper bag showed shelf life upto 14.67 days with lowest weight loss and good physical quality as against 4 days of polythene bag fruits. These results specify that fruit bagging at 35 to 45 days after fruit set can improve fruit quality through diminution in disease and insect-pest infestation and shelf life of mango cv. Amrapali.

Keywords: Bagging time, Fruit quality, Shelf life, Mango

INTRODUCTION

Mango (*Mangifera indica* L.) belonging to the family Anacardiaceae, commonly known as the "King of fruits" (Singh, 1996), is a popular tropical fruit, especially in Asia. In Bangladesh, it's one of the most important commercial fruits and choice fruit for all age's people. Currently, there are about 41676 hectares of land occupied with mango orchard and produced about 1288315 ton (BBS, 2017). The area under mango cultivation is increasing every year but safe and quality mango production not increased. Mango fruits and trees are subject to several animate and inanimate diseases. The outbreak of different mango diseases and insect-pest attack reduce the target mango yield every year. To control these problems farmers are using 15-62 times pesticides in their mango orchard and increasing as alarming ratio (Uddin et al., 2015). To prevent the losses caused by biotic and abiotic factors, several good agricultural practices are becoming popular throughout the World (Sharma et al., 2009). Furthermore, the development of alternative techniques to improve the appearance and quality of fruits and to reduce diseases and insect infestations is becoming increasingly important as consumer anxiety over the use of manmade agro-chemicals and environmental awareness increases. Thus, more emphasis is being placed on reducing the use of pesticides to ensure worker safety, consumer health, and environmental protection (Sharma, 2009). An attractive, spotless and pest free fruits of this variety fetch premium rate in the market. In recent years, the climatic aberrations such as sudden rise in the temperature and humidity, abnormal rains especially during fruit development are often experienced. It had not only affected the external appearance of the fruit but also aggravated the pest such as mealy bugs and physiological disorder like spongy tissue which further added in the losses. The affected fruits gain poor price in the market and such fruits are also rejected for processing. It causes serious economic loss to mango growers.

Among several such alternatives, the pre-harvest bagging technique of fruits has been used extensively in several fruit crops to improve skin color and to reduce the incidence of diseases, insect pests, mechanical damages, sunburn of the skin, agrochemical residues on the fruits, and bird damages (Islam et al., 2017a & 2017b; Jakhar and Pathak, 2016; Nagaharshitha et al., 2014; Sharma et al., 2014; Xu et al., 2010). Therefore, the present research work was undertaken to compare the effectiveness of different time of bagging in mango fruit (*Mangifera indica* L.) cv. Amrapali.

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MATERIALS AND METHODS

The research work was conducted at different mango orchards in Dinajpur, Bangladesh during April to July, 2017. Chemical analyses were conducted at the laboratory of Atomic Energy Commission, Savar, Dhaka and other parameters were evaluated at the Department of Horticulture, HSTU, Dinajpur. Mango cv. Amrapali used as test materials. The experiment was constructed in Randomized Block Design with four treatments replicated three times with a unit of 10 fruits per treatment per replication. Different types of bags were constituted the treatments viz.: T_1: Transparent polythene bag, T_2: White paper single layered bag, T_3: Brown paper double layered bag, T_4: Non-bagged (control). Uniformly grown fruits (35, 45 and 55 days after fruit set) were selected for bagging. The sizes of bags were 25 × 20 cm. Before bagging two perforations (≤4 mm diameter) was made for proper ventilation at the bottom of polythene bag. White and brown paper bags were not perforated. The particular bags were wrapped properly at the stalk of each fruit of respective treatments so that it would not be fall down as well as there would not be open space. Five fruits were randomly selected per treatment per replication to record various physical and chemical compositions which were estimated by the following procedures.

Physical parameters

Length and diameter of fruit were measured with the help of digital varner caliper and expressed in millimeter (mm). Weight of fruit and pulp was recorded by using electronic balance and expressed in grams (g).

Weight Loss (%): Weight of fruits was recorded with the help of physical balance and weight loss per cent was calculated by using the following standard procedure mentioned in AOAC (2000).

$$\text{Weight loss (\%)} = \frac{\text{Initial fruit weight (g)} - \text{Weight of fruit on observation day(g)}}{\text{Initial fruit weight (g)}} \times 100$$

Chemical composition

Total sugars: Total sugar content of mango pulp was estimated by Anthrone reagent as per the method given by Hansen and Moller (1975). D- Glucose at the concentration of 20 to 100 g ml-1 was used to prepare the standard curve.

Reducing sugars: Total reducing sugar content of the samples was determined according to the classical and widely used method (Nelson-Somogyi, 1944). Briefly, mango pulps were homogenized with benzoic acid solution (0.2%). An aliquote of the filtrate was mixed with the copper reagents (a mixture of alkaline Rochelle salt and acidic $CuSO_4$). After heating in boiling

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water (15 min) and cooling, arsenomolybdate color reagent was added. Finally a blue color produced, the absorbance measured at 520 nm and compared with a set of standard (glucose).

Non-reducing sugar: Non reducing sugar content was determined by subtracting the reducing sugar content from total sugar content (Banik, 1995). Non-reducing sugar content was determined by using the following formula.

% Non-reducing sugar = (% Total sugar-% Reducing sugar) × 0.95

Total soluble solid (TSS): total soluble solids were found out by using Erma Hand Refract meter (0 to 32°Brix) and expressed in °Brix (AOAC, 2004).

Ascorbic acid (mg/100g of Fruit pulp): Ascorbic acid was estimated as described by (McHenry and Graham, 1935) Mango pulp (5g) was mixed with 5 ml of 20% metaphosphoric acid solution and filtered. The filtrate (5 ml) was put in a small beaker and shaken with 2 drops of phenolphthalein solution and titrated against 2, 6-indophenol until pink color developed. Results were expressed on a fresh weight basis as mg ascorbic acid equivalent per 100 g sample.

$$\text{Vit C (mg/100 g)} = \frac{\text{0.5 X Titrat volume unknown soln X Made volume of unknown sample}}{\text{Titrat volume known soln X Alikuot taken X Sample weight}} \times 100$$

β-Carotene (µg/100 g of pulp): β-carotene in mango pulp was determined according to the method of (Nagata and Yamashita, 1992). One gram of pulp was mixed with 10 ml of acetone: hexane mixture (4: 6) and vortex for 5 minutes. The mixture was filtered and absorbance was measured at 453nm, 505nm and 663nm.

$$\beta\text{-carotene (mg /100ml)} = 0.216\ A_{663} - 0.304\ A_{505} + 0.452\ A_{453}$$

pH of fruit juice: The pH of each sample was determined by digital pH meter (JENWAY 3510). Fruit juice was made for each sample by homogenizing 10g of sample in a homogenizer. The value was noted after adjusting and stabilizing the pH meter.

Sensory evaluation: The ripe fruits were also examined for their sensory qualities for assessing color, flavor and texture by panel of five judges with nine point Hedonic Scale viz. 1-Dislike extremely, 2-Dislike very much, 3-Dislike moderately, 4-Dislike slightly, 6-Like slightly, 7-Like moderately, 8-Like very much and 9-Like extremely (Amerine et al., 1965).

Shelf life of fruits (Days): Mature fruits were harvested at 80-85 percent maturity. Twenty harvested mature fruits of each treatment were ripened at ambient temperature by using plastic crates with perforation and traditional paddy straw as ripening material. At the bottom, 2.5 cm layer of paddy straw was made on which fruits were arranged. Simultaneously, two more layers were kept on the first layer. After ripening the various observations viz. shelf life (days) and

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incidence of mealy bug (%) were recorded. The end of shelf life was noted when the fruits were spoiled.

Disease incidence: Diseases incidence means percentage of fruits infected with disease. This was measured by calculating the percentage of fruits infected in each replication of each treatment. The diseased fruits were identified symptomatically. The disease incidence was calculated as follow:

$$\text{Disease incidence (\%)} = \frac{\text{Number of infected fruits in each replication}}{\text{Total number of fruits in each replication}} \times 100$$

Statistical analysis: The data were analysed by partitioning the total variance with the MSTATC programme. The treatment means were compared using Turkey's Test.

RESULTS AND DISCUSSION

Length of fruit (mm): The treatment of brown paper bag and white paper bag were gave the maximum fruit length (106.4 mm and 91.2 mm, respectively) at 35 days after fruit set while minimum fruit length was recorded in the treatment of control (70.87 mm) (Table 1).

Table 1: Effects of pre-harvest bagging on physical parameters of mango cv. Amrapali at ripe stage

Treatments	Time	Fruit length (mm)	Diameter of fruit (mm)	Fruit weight (g)	Pulp weight (g)	Weight loss (%)
No bagging		70.87d	51.87d	171.0de	138.0f	17.53bc
Polythene bag	35 days	78.40d	64.60bcd	174.3de	130.3f	24.82a
	45 days	82.00cd	60.87cd	186.4cde	125.5f	17.68bc
	55 days	75.33d	64.13bcd	166.4e	141.3ef	14.47bcd
White paper bag	35 days	91.20bc	65.13bcd	207.8c	163.6cd	18.68b
	45 days	78.53d	58.67cd	178.3cde	133.0f	14.77bcd
	55 days	78.67d	65.27bcd	201.9cd	158.1de	13.49cd
Brown paper bag	35 days	106.4a	78.67a	380.6a	195.4a	11.15d
	45 days	102.1ab	75.33ab	272.7b	190.3ab	12.09d
	55 days	96.33ab	69.67abc	200.6cd	176.9bc	11.63d
LSD		10.99	12.26	27.52	17.26	4.129
CV%		7.77	11.46	7.81	6.69	15.34

Means followed by the same letter(s) within each column didn't significantly differ at 5% level.

Diameter of fruit (mm): Pre-harvest fruit bagging with brown paper gave the maximum fruit diameter (78.67 mm) over control (51.87 mm) at 35 days after fruit set. The diameter of fruit was slightly decreased at 45 and 55 days after fruit set bagging (Table 1).

Weight of fruit (g): The maximum fruit weight (380.6 g) was found in the treatment of brown paper bag at 35 days after fruit set and minimum in the control treatment (171.0 g) which is statistically similar with 45 days after fruit set with polythene bagging (Table 1). Bagging increased fruit weight, size over control fruits (Chonhen chob et al., 2011).

Pulp weight (g): The maximum pulp weight was found in the treatment of brown paper bag (195.4 g) at 35 days after fruit set. The minimum (125.5 g) was found in the treatment of polythene bag at 45 days after fruit set which was statistically similar with the treatment of control (138.0 g) (Table 1).

Weight loss (%): The maximum weight loss was found in the treatment of polythene bag (24.82%) while lowest in brown paper bag (11.15 %) at 35 days after fruit set which was statistically similar with 45 and 55 days after fruit set bagging (Table 1).

These findings are accordance with some previous reports that the effects of pre-harvest bagging increased fruit growth, size, and weight (Yang et al., 2009; Harhash and Al-Obeed, 2010; Zhou et al., 2012; Sharma et al., 2014; Haldankar et al., 2015; Islam et al., 2017a and 2017b).

Total sugars (%): The total sugars were the highest (16.45 %) with the white paper bag treatment while the lowest in the polythene bag treatment (8.79 %) at 55 days after fruit set (Table 2). Earlier, Harhash and Al-obeed (2010) reported that date palm fruit bagged with blue color bag showed the highest total sugars as compared to control.

Table 2: Effects of pre-harvest bagging on chemical composition of mango cv. Amrapali at ripe stage.

Treatments	Time	Total sugars (%)	Reducing sugars (%)	Ascorbic acid (mg/100g)	TSS(% Brix)	Pulp pH	β-carotene (µg/100 g)
No bagging		12.10bc	1.043e	5.720b	14.86cd	5.360ab	495.1a
Polythene bag	35 days	12.72ab	1.993ab	6.480b	16.53cd	4.967b	509.7a
	45 days	13.41ab	2.02ab	6.72ab	15.54cd	5.273ab	511.0a
	55 days	8.790c	1.303de	6.720ab	14.00d	4.733b	506.5a
White paper	35 days	14.16ab	1.800bc	7.773ab	22.38a	6.533a	514.3a

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bag	45 days	14.78ab	2.330a	6.960ab	21.57ab	5.987ab	514.3a
	55 days	16.45a	1.800bc	6.387b	18.79abc	5.060ab	511.3a
Brown paper bag	35 days	14.57ab	2.310a	8.970a	18.95abc	5.217ab	517.6a
	45 days	13.59ab	1.723bc	6.92ab	16.30cd	5.420ab	511.3a
	55 days	14.48ab	1.510cd	7.213ab	17.56bcd	5.783ab	514.3a
LSD		3.385	0.3387	2.083	4.136	1.316	19.48
CV%		15.07	10.65	18.15	14.19	14.39	2.26

Means followed by the same letter(s) within each column didn't significantly differ at 5% level.

Reducing sugars (%): The highest reducing sugars were recorded in brown paper bag (2.33 %) at 45 days after fruit set which is statistically identical with white paper bag after 45 days fruit set while the lowest (1.043%) was recorded in the non-bagged control fruit (Table 2). Similar findings were found in some previous research (Haldankar et al., 2015; Islam et at., 2017a). They reported that fruits of brown paper, newspaper and white paper bag exhibited the maximum reducing sugars at ripe stage in mango due to pre-harvest bagging treatments.

Ascorbic acid (mg/100g): The highest (8.97 mg/100 g) ascorbic acid content was recorded in the treatment of brown paper bag which was found statistically at per with white paper bag (7.77 mg/100 g) at 35 days after fruit set while the lowest (5.72 mg/100 g) was recorded in the control treatment (Table 2). The above results are very close to the findings of (Islam et al., 2017a; Haldankar et al., 2015 and Sharma et al., 2013) in mango.

Total soluble solid (% Brix): The fruits of white paper bag at 35 days after fruit set showed the highest (22.38 % Brix) soluble solids content while lowest (14.86 % Brix) was recorded in the unbagged control treatment (Table 2) Similar finding was recorded in some previous studies (Islam et al., 2017a; Haldankar et al., 2015). They reported that, total soluble solid were sharply increased due to pre-harvest fruit bagging treatment.

Pulp pH: The content of pulp pH in the white paper bag treatment (6.53) is higher than the other treatments of fruit bagging with brown paper bag (5.21), polythene bag (4.96) and control treatment (5.36) at 35 days after fruit set (Table-2).

β-carotene (µg/100 g): The treatments were statistically non-significant variation in respect of β-carotene (Table 2). The highest β-carotene content at 35 days after fruit set was recorded in the treatment of brown, white paper and polythene bag (517.3 µg, 514.3 µg, and 509.7 µg, respectively) while the lowest was recorded in the control fruits (495.1 µg). These findings are accordance with previous reports that a flesh lycopene and β-carotene content was increased due

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to pre-harvest bagging treatments in mango (Zhao et al., 2013; Haldankar et al., 2015; Islam et al., 2017a).

Shelf life and disease incidence: The maximum shelf life was found in the treatment of brown paper bag (14.67 days) at 35 days after fruit set while the minimum was found in the treatment of polythene bag (5 days) at 55 days after fruit set due to the early retention of the fruit. Islam et al. (2017a) reported that pre-harvest bagging delayed ripening resulting in extended shelf life mango. The fruits of brown paper bag and white paper bag were free from fruit fly infestation at 35 and 45 days after fruit set but at 55 days showed in less infestation. The maximum incidence of fruit fly (7.45 %) and anthracnose (32.03%) was recorded in control. The maximum infection of stem end rot was recorded in control (35.6 %). The fruit bagging with brown paper bag at 45 days after fruit set had the lowest infection (1.40 %) of stem end rot which is statistically identical with 35 and 55 days (Table 3). Bagging modified the microenvironment near fruit especially in respect to temperature and humidity. The longer shelf life of bagged fruits indicated that the effect of bagging persisted after ripening. Bagging provided physical barrier between fruit and pests. In mango cv. Keitt white paper bags at approximately 100 days before harvest reduced anthracnose and stem end rot (Hofman et al., 1997).

Table 3: Effect of pre-harvest bagging on shelf life and different disease incidence of mango cv. Amrapali at ripe stage

Treatments	Time	Shelf life (days)	Stem end rot (%)	Anthracnose (%)	Fruit fly infestation (%)
No bagging		7.000c	35.60a	32.03a	7.450a
Polythene bag	35 days	5.000cd	22.43d	4.860c	2.300e
	45 days	5.000cd	27.80c	5.430b	4.300c
	55 days	4.000d	31.60b	4.540c	6.000b
White paper bag	35 days	11.00b	15.94e	3.000cde	0.0000f
	45 days	10.00b	12.67e	3.600cd	0.0000f
	55 days	10.00b	13.10e	3.100cde	4.960c
Brown paper bag	35 days	14.67a	2.160f	0.1700de	0.0000f
	45 days	14.00a	1.400f	0.0000e	0.0000f
	55 days	14.00a	2.170f	0.7700de	3.380d
LSD		2.602	4.357	3.105	1.068
CV%		16.97	12.93	19.83	16.18

Means followed by the same letter(s) within each column didn't significantly differ at 5% level

Sensory evaluation: A way to get better final mango quality traits such as colour, appearance, sweetness, flavour and overall expression were significant variation among various bagging

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treatments while texture was non-significant. Beside, brown paper bag at 45 days after fruit set showed less sweetness compared to white paper bag at different time of bagging after fruit set. It indicated that the organoleptic qualities of fruits were affected by pre-harvest bagging in mango (Table 4).

Table 4: Effect of pre-harvest fruit bagging on sensory evaluation in fruits of mango cv. Amrapali at ripe stage

Treatments	Time	Color	Texture	Appearance	Sweetness	Flavour	Overall Impression
No bagging		5.330d	7.670a	5.430c	7.670ab	7.000bcd	4.330ef
Polythene bag	35 days	3.000f	7.703a	3.033d	7.330ab	5.363e	3.330f
	45 days	3.067f	7.620a	3.330d	6.933bc	6.330de	5.463d
	55 days	3.363f	7.680a	3.033d	6.703bc	5.330e	5.000de
White paper bag	35 days	6.670c	7.670a	7.000b	7.363ab	7.00bcd	7.363bc
	45 days	7.703b	7.670a	7.703ab	8.430a	7.00bcd	7.637abc
	55 days	7.737b	7.670a	7.330b	7.703ab	7.397bcd	6.637c
Brown paper bag	35 days	8.363a	7.703a	7.670ab	7.297ab	8.000ab	8.330ab
	45 days	8.737a	7.670a	8.363a	6.000c	8.713a	8.637a
	55 days	7.670b	7.670a	7.330b	7.000bc	7.703abc	7.670abc
LSD		0.3971	0.6470	0.8433	1.087	1.059	1.003
CV%		3.88	5.06	8.34	8.84	9.15	9.68

Means followed by the same letter(s) within each column didn't significantly differ at 5% level

CONCLUSION

Thus, it is concluded that the pre-harvest treatment with brown and white paper bagging were found to be the best to increase the fruits quality in respect of fruits weight, TSS, ascorbic acid, total sugars and β-carotene, with minimum weight loss and less diseases incidence in mango fruits cv. Amrupali. Among all treatments, brown paper bag at 35 to 45 days provided the best performance for all parameters while without bagging in produced inferior. Therefore, the pre-harvest treatment of brown and white paper bagging are suggested to the mango traders and grower of Bangladesh for taking a quality production with prolonged shelf life to obtain a profitable price of mangoes in domestic and export markets.

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