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EFFECT OF DIFFERENT TYPES OF BAGGING MATERIALS AND ITS TIMING ON QUALITY MANGO FRUIT (*MANGIFERA INDIC*A, CV. BANANA) PRODUCTION IN BARIND REGION OF BANGLADESH

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Abstract

To improve the quality fruits of mango (cv. Banana) in Barind areas of Bangladesh three bagging materials were used for three time points e.g. 35, 45 and 55 days. Based on the paper bag three treatments (T_1, T_2 and T_3) were undertaken for the study. Here, T_1 = brown, T_2 = white, T_3 = black polyethylene bag, and for the Control (C) no paper bag was used. When the fruit size was around (7.24 cm long) the bagging materials were applied for its proper covering. Results showed that for all cases like- fruit color (green-yellowish), length (13.75-15.24 cm long), diameter (4.70-5.08 cm long), weight (293.20 g to 350.12 g), TSS (27.00-32.33%), yield (25.34-30.41 t/ha), skin colour (skin sunburn), and fruit quality (reducing splitting and mechanical damage, internal quality of mango), and finally for the ix) shelf life (15.25 days) the brown paper bag gave the best results at 35 days comparisons with other treatments. Without paper bag the control gave the poor results of the studied parameters. Results showed that the shortest shelf-life (8.56 days) was found in control. From this finding it may be concluded that for quality fruits production the bagging types and the duration is very much important. It is clear to us that the bagging with brown paper at 35 days showed better and it is recommended for mango traders, growers and all stakeholders in Bangladesh. It is important for small organic growers who want to sell high quality and healthy fruit of Banana mango to our local and foreign market. This technology is very environment friendly and also cost-effective.

Key words: Bagging time and types, Barind area, Fruit quality, Mango (cv. Banana), Shelf life.

Introduction

Mango (*Mangifera indica* L.) is one of the most important fruit crops covering the largest area (44,366 hectares) with the total production is about 11,65,800 metric tons and it ranks second in terms of production after banana in Bangladesh (BBS 2019). Mango is a king fruits and cash crop in Bangladesh. It is famous among all fruits because of its taste, variety and color, thus also known as "King of Fruits" (Karar et al. 2019). The area of the mango estate grew from year to year, but the suitable methods of protected and first-class mango quality production were not standardized yet. According to the BBS (2022) report, mango is produced very well in the northern region of Bangladesh, especially in Barind areas. Fruit bagging is one of the effective methods to protect the fruit from the attack of many pests and diseases as well as other environmental hazards (Islam et al. 2024). An effective measure to control of fruits by borer of *Nephopteryx* sp. was reported by Biosecurity Australia (2010). Fruit bagging in mango not only protects fruits from the pest and diseases but also improve the quality of fruits (Haldankar et al. 2015, Akter et al. 2020, Gethe et al.

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2021, Islam et al. 2024). In addition, this technique increases the quality of mango with skin colour, yield, size, weight and fulfill the demands in the local and foreign markets (Chonhenchob et al. 2011). Bagging fruits is a physical protection technique commonly applied to mango by many scientists in the world (Wu et al. 2009, Nagaharshitha et al. 2014, Haldankar et al.2015, Jakhar and Pathak 2016, Islam et al. 2017a,b). To increase the marketable value of the mango fruits, explicitly, improving its coloration (Kim et al. 2007), internal quality of mango (Zhou et al. 2012), reducing splitting and mechanical damage (Amarante et al. 2002) and skin sunburn (Muchui et al. 2010) scientists are reported on the basis of their findings. It also decreases pesticide residues in the fruit (Amarante et al. 2002) and control from insect (Sarker et al. 2009), disease (Wang et al. 2011) and bird damaging (Amarante et al. 2002). Bagging is a physical protection technique, not only defend pest and diseases but also affects the quality of the production by changing microenvironment of fruit during development (Sharma et al. 2014, Zhang et al. 2015, Islam et al. 2024). Therefore, this study was conducted to evaluate the impact of bagging of mango fruit (*Mangifera indica* L.) cv. Banana which is very popular and economically important than other mangoes in Bangladesh and also in some other countries. In this case three different type of bags and its application for different time points were examined and the fruit growth, maturity at harvest, skin presence, storage behavior, shelf life etc. in Barind areas of Bangladesh.

Materials and Methods

The research work was carried out on different mango plantations areas in Barind region of - i) Banghabandhu Live Mango Museum, Chapainawabganj, and ii) Postgraduate Laboratory of the Mango Research Institute, Chapainawabganj during April 2022 to July 2022. The experiment was conducted in randomized complete block design for the mentioned four treatments and replicated three times with a unit of 20 fruits per treatment and 80 fruits per replication. Different types of bags constituted for each treatment e.g. Control = no bagging, T_1 = Brown paper bag, T_2 = White paper bag, and T_3 = Black polythene bag. Depending on the processing conditions, decide whether the fruits were developing evenly 35, 45, 55 days after fruit setting. The fruit was bagged with an appropriate material where insects cannot entrance inside of the bag. The size of bags was 25 × 20 cm. Proper ventilation is very important for bagging systems and for that perforated (≤4.0 mm diameter) were made at the bottom of all bags. Twenty (20) mango fruits were randomly selected for each treatment, and various physical parameters were recorded using an accompanying iterative system.

Physical parameters: Skin color was measured for each fruit using a Minolta color difference meter (https://www.cdwkj.cn/catalog-4.html?gad_source=1&gclid). The fruits weight was measured by electrical balance in gram (g). The length and breadth of fruits at mature stage for each replication were measured by a centimeter scale in centimeter (cm).

Fruit physical properties

Length and diameter of fruit (cm): A calliper(s) was used to measure the length from the tip of the stem to the tip of the fruit, as well as the diameter, length, thickness or depth which is expressed in centimeters (cm).

Fruit weight and pulp weight (g): The weights of the fruits were measured with a Monopan electronic balance and expressed in grams (g). The weight of the pulp was then determined using the same approach.

Total soluble solids (%TSS): The total soluble solids (TSS) concentration of the mango was determined with a portable digital Refractometer (Erma Hand Refract Meter 0 to 32° brix). A drop of mango juice was extracted from the flesh, and the TSS content was measured. In this case the percentage of brix was obtained by direct reading from the devices the temperature correction chart for temperature correction was done following the methods of AOAC (2004).

Shelf-life (days): Shelf-life of mango fruits as influenced by different postharvest treatments was calculated by counting the number of days required to ripen fully with retained optimum marketing and eating qualities.

Statistical analysis: The recorded data were compiled and analyzed by two factorial design to find out the statistical significance of experimental results by using the analysis of variance (ANOVA) technique with the help of statistics 10 that was an analysis software.

Results and Discussion

Skin color: Color is one of the most important criteria of quality of most fruits. Statistically highly significant variation was observed in respect of color between the fruits of with and without bagging before and after storage. The effects of pre-harvest bagging treatments were statistically significant (0.5% level) on the change of skin color in storage. At harvesting time and after 12^{th} day of storage, the most attractive color (greenish yellow) was found in brown paper bagged fruits and worst color without bagging mango fruits (Table 1). Roy et al. (2011) reported that a total of 12 days was yellowish-green, greenish-yellow, and trace of yellow. Increasing shading may be due to the movement of certain proteins responsible for aging mangoes. Tyas et al. (1998), and Chen et al. (2012) reported that the brown paper bagged fruit became most attractive color after harvest and storage time and the recorded bagging improves the color of fruit by increasing their anthocyanin content. It is believed that bagging increases the light sensitivity of fruit and stimulates anthocyanin synthesis when the fruit are re-exposed to light after removal of bag. The results were described by Alves et al. (1998) for polythene wrapping announced that thin polythene bags are more effective in reducing the color of fruit.

Table 1: Changes in peel color of mango (cv. Banana) as influenced by different bagging materials after harvesting.

Treatments	Peel colour of mango at different days of harvesting				
	0	3	6	9	12
Control	Green	Green	Trace of yellow	Yellowish green	Blackish yellow
T_1	Do	Do	Do	Greenish yellow	Greenish yellow
T_2	Do	Do	Do	Trace of yellow	Yellowish green
T_3	Do	Do	Green	Do	Trace of yellow

Control = Without bagging, T_1 = Brown paper bagging, T_2 = White paper bagging, T_3 = Black polythene bagging.

Fruit length (cm): The treatment of the brown paper bag and the white paper bag gave the highest statistically superior mango fruit (15.24 - 15.08 cm, separately) at 35 days after solidification of the Banana mango fruit showed in Fig. 1. On the other hand, the shortest mango fruit 13.90 cm was recorded in control (no-bagging material was used).

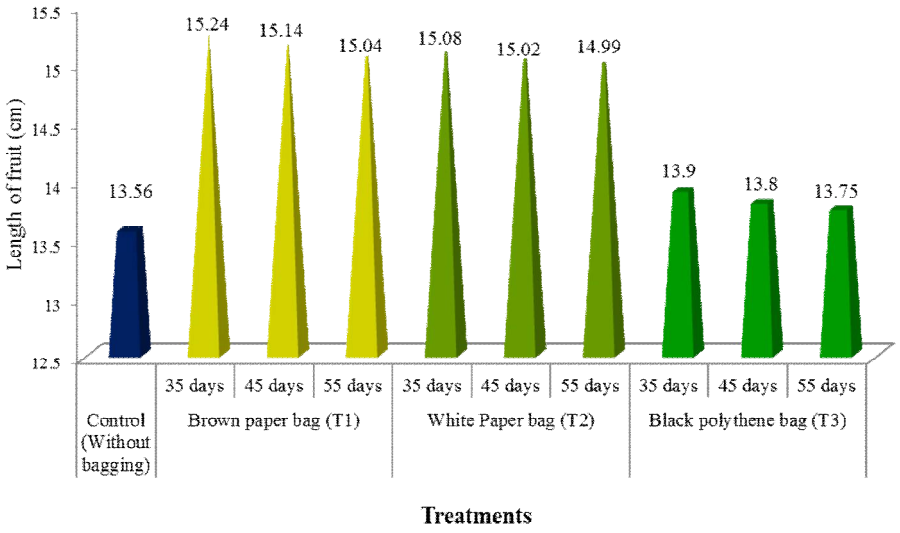

Fig. 1: Effect of different types of bagging material at different days after fruit set on length of fruit (cm) at harvest of mango (cv. Banana).

After bag setting on fruit, the fruit gradually developed in size. Covering the fruit within a packet at some stage of improvement may effects on its development and size. There are some conflicts reported about the effect of fruit grouping on fruit size and weight, which may include the different types of bag using, the age of the fruit per bagging hour, the response of the harvested leafy products, the prevailing environmental condition, and also the condition states of the fruit after harvesting (Tyas et al. 1998, Zhen et al. 2000, He et al. 2003, Huang et al. 2007, Chen et al. 2012). Fruit bagging may increase or decrease the weight and size of the fruit. The results are in agreement with Mingire et al. (2017), Haldankar et al. (2015), Mohapatra (2016), Islam et al. (2017a,b) in mango.

Fruit breath (cm): It was observed that different types of bagging materials were efficient and affected on the breadth of fruits significantly with different time points and bagging systems (4.70 - 5.06 cm) at 0.5% level (Table 2). Pre-harvest fruit bagging into a brown paper bag and a white paper bag gave the maximum size (5.08 - 5.01 cm) between the fruit compared to the black polythene bag and control (4.96 - 4.70 cm) at 35 days after harvesting the fruit, which roughly equates to 45 days after fruit setting. Fruit measurements worsen slightly at 45 and 55 days after harvesting mango fruits (Table 2). The results are in agreement with the reports of Mingire et al. (2017) and Islam et al. (2017a,b).

Table 2. Effect of different types of bagging on fruit quality of mango fruit (cv. Banana).

Treatments	Time (days)	Breadth of fruit (cm)	Weight of fruit (g)	Yield (t/ha)	TSS (% brix)
Control	-	4.70c	293.20d	25.34d	28.36b
	35	5.08a	350.12a	30.41a	30.33a
T_1	45	5.04a	338.78a	30.37a	30.30a
	55	5.01a	338.70a	30.30a	30.32a
	35	5.01b	317.70c	29.17b	29.68c
T_2	45	4.98b	317.50c	29.15b	29.55c
	55	4.95b	317.30c	29.10b	29.59c
	35	4.96b	321.34b	28.38c	29.03d
T_3	45	4.78c	293.70d	28.46d	29.00d
	55	4.75c	293.60d	28.40d	29.13d
CV (%)		3.77	5.36	4.28	3.89

Control = Without bagging, T_1 = Brown paper bagging, T_2 = White paper bagging, T_3 = Black polythene bagging. In a column, means followed by a common letter are not significantly differed of 5% level by Tukey HSD test. Here CV= Co-efficient of variance.

Fruit weight (g): Fruit weight of mango (cv. Banana) fruit was significantly affected by different types of bagging materials in three time points after fruit setting. The maximum fruit weight was found when it was processing with a brown paper bag at 35 days after setting the fruits (350.12 g) and the minimum weight when processing no bagging materials were used (Control = 293.20 g) followed with black polythene bagging material treatment at 55 days (Table 2). After bagging, the weight of the fruit was increased compared to the control was previously reported by Chonhenchob et al. (2011). Reports on the effects of fruit bagging on fruit size and weights are depends on different type of bags were used, in this case mango cultivars also an important factor are mentioned by Sharma et al. (2014). Chonhenchob et al. (2011) investigated the effect of pre-harvest bagging with special bags of varying frequency in the mango cv. Nam Dok Mai#4 in Taiwan and found that varied and unbagged fruits, when bundled, increased the weight, size, and roundness of the fruit. In the case of Xiangtian olives, China used Shengda bags for additional processing (Zhou et al. 2012). Again Xu et al. (2008) reported that the positive effect of harvesting on the height, size, and weight of a mango fruit. Watanawan et al. (2008), Yang et al. (2009), Harhash and Al-obeed (2010), Chonhenchob et al. (2011), Zhou et al. (2012), and Xu et al. (2008) reported that the use of plastic bags within 10 days germination increases carambola fruit potency.

Yield (t/ha): The highest marketable yield was obtained in brown paper bags (20.41 t/ha), then in white paper bags (19.17 t/ha), black polythene bag (15.46 t/ha) and in control (18.38 t/ha). Both mango combinations showed that the fruity shade was excellent in contrasting brown paper bags and different treatments are shown in Table 2. Current findings suggest the use of a brown paper bag for mango cv.

Banana in enhancing the nature of creation in the Barind area of Bangladesh. The results are fully consistent with the results of pomegranate (El-Wafa 2014, Abdel et al. 2017). These results are in line with previous reports from a pair of manufacturers who believe dumping will increase mass of popular products and increase overall productivity (Chonhenchob et al. 2011, Dutta and Majumder 2012, Sharma et al. 2014, Hossain et al. 2020, Islam et al. 2017b, Karar et al. 2019).

Total soluble solids (TSS) content (%): Data shows there was no significant difference between the treatments mentioned in Table 2. Fruits with brown paper, white paper and black ploythene bag showed the highest content of soluble solids with brix (30.33%, 29.68% and 29.36%, respectively) at 35 days after fruit set while the lowest total soluble solid was recorded in the control (29.0% brix). The observation revealed that percent total soluble solids increased sharply from harvest to ripe fruits are in agreement with findings of Joshi and Roy (1988) who mentioned that TSS increase initially and declined later on. Similar finding was recorded in some previous studies (Awad 2007, Singh S et al. 2007, Haldankar et al. 2015). The reason for higher total soluble solids in bagged fruits compared to control was due to heat built up in the micro-environment which favors early maturity. In addition, previous reports have shown that the initial release of $CaCl_2$ and K_2SO_4 contributes to the further development of the toxic shock disorder found in mangoes (Burondkar et al. 2009, Karemera and Habimana 2014).

Shelf-life (days): The effects of different pre-harvest fruit bagging treatments were statistically significant at 0.5% in respect of prolonging shelf life of mango cv. Banana where bagging has done different days after fruit set showed in Fig. 2.

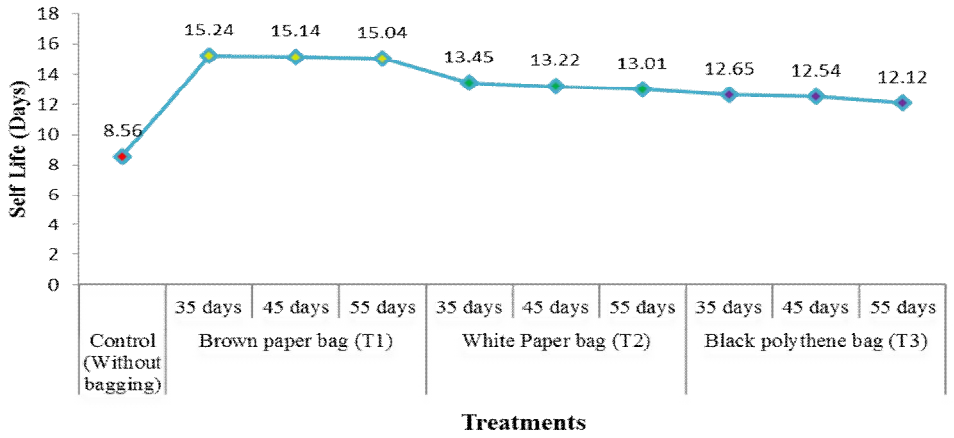

Fig. 2: Effect of different types of bagging material on self-life (days) after harvesting of cv. Banana mango fruit.

The shelf life of mango fruits ranged was 8.56 to 15.24 days. The shortest shelf-life was 8.56 days in control and longest (15.24 days) was observed with brown paper bagged fruits respectively where bagging duration was 35 days after setting of fruits. The shelf-lives were extended by 4.09, 4.89 and 6.68 days in black polythene bag, white paper bag and brown paper bag treatments, respectively over control (Fig. 2) where bagging has done 35 days after setting of fruits. In contrast, untreated fruits were affected by diseases earlier giving the shortest shelf-life was recorded. The greater storability of the bagged fruits that were bagging might be due to the reduced level of disease both in terms of incidence and severity. And this reduced

disease may be due to the effects of antimicrobial components in sap that were not allowed to remove from the fruits. The antimicrobial properties of sap had been extensively investigated by Hassan (2010). Singh et al. (2007) reported that pre-harvest bagging delayed ripening resulting in extended the shelf-life of Perla, a black table-grape. Here, all bagging treatments showed highly significant effect compared to control. The bagging modified the micro-environment near fruit especially in respect to temperature and humidity. The humidity as well as temperature in paper bag was greater than that in polythene bag. The longer shelf-life of bagged fruits indicated that the effect of bagging persisted during ripening. Bagging provided physical barrier between fruit and pests. The spongy tissue disorder is associated with convective heat and exposure of fruit to sunlight (Prakash 2004).

Conclusion

Considering the physical, chemical and sensory parameters it is proved that pre-harvest bagging had a significant effect to increase the shelf-life maintaining quality of mango cv. Banana. The implications of this study indicate that the processing of brown paper bags proved to be the best complement to the fruit idea in terms of fruit color change, fruit weight, TSS and the commercial yield of the cv. Banana mango. Of all the treatments, the brown paper bag after 35 days gave the best result in all respects, without packing in poor quality bags. Finally, it can be assumed that the result of this fruit bagging test is extremely effective in improving the quality of the Banana mango fruit. Either way, scientists still focus on packing techniques, applying standard rules for packing time and bag materials. Also, bagging fruits have a good shelf-life which is important criteria for exportable mango. Therefore, farmers might be used this technology for commercial mango cultivation to fulfill the demand of quality mango in country and exportation in abroad.

Conflict of interest: The authors declare no conflict of interest.

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