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*Research paper*

# Effect of different types of bags and timing of bagging on quality of Mango grown in Chittagong hill tracts of Bangladesh

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**The study was carried out to determine the bagging time and quality of mango fruits using various bagging materials in Chittagong hill tracts areas of Bangladesh from April to July 2018. Treatments were bagged with brown paper bag ($T_1$), white paper bag ($T_2$), transparent polyethylene bag. ($T_3$) and control ($T_4$). The results showed that among all treatments, the brown paper bag gave the best performance for all parameters after 35 days, while without the bagging it gave poorer results. To increase the fruit quality in terms of fruit color change (green-yellow and green-yellow), fruit length (8.81 cm and 14.30 cm), fruit diameter (6.39cm and 16.39cm), fruit weight (229.10g and 585.95g), TSS (22.33% and 21.85%) and marketable yield (20.41 t / ha and 23.52 t / ha) in BARI Aam 3 and BARI Aam 4. Finally, it can be concluded that the results of this experiment in terms on bagging time and bagging of fruits in mango are very effective in improving fruit quality. So, brown paper treatment is recommended for mango traders and growers as it is easy and cost-effective for small organic growers who want to sell high quality healthy fruit in the market, also as environmentally friendly technology. This has a positive impact on BARI Aam 3 and BARI Aam 4. However, researchers continue to study the bagging techniques using standard bagging time and bagging material.**

***Key words:*** *bagging time, bagging types, fruit quality, mango, hill tracts*

## INTRODUCTION

Mango (*Mangifera indica* L.) belongs to the Anacardiaceae family and is known as the "King of Fruits" (Singh, 1996). It is a tropical organic product that is mainly known in Asia. Organic products are the source of numerous basic mixtures for the human body and are known for a robust and adapted diet. Proposals of the Food and Agriculture Organization of the FAO and the WHO a daily intake of essentially 400g of new soil products (Singh, 1996). It is quite possible that it is a staple organic business product in Bangladesh and one of the best options for all ages. Currently, the mango ranch covers approximately 41,676 hectares and produces approximately 1,288,315 tons (BBS, 2017). The area of the mango estate grew from year to year, But the production of protected and first-class mangoes did not develop. The main outcomes show that different mango varieties have different preferences (Berardini et al. 2015), beneficial properties (Ahmad et al. 2007), and social security (Kim et al. 2007). In Bangladesh, mangoes are considered as the best of all local natural

products because of their great taste, seductive aroma, stunning color, aromatic flavor and natural interaction. Like some unique mango fruits, mangoes spoil incredibly in nature. Haldankar et al. (2015) found that this method had never been used for mangoes in India, especially when it was used to grow in the Alphonso in the Konkan agro-climatic conditions. Therefore, an attempt was made to investigate the effect of the organic material of the product in the marble stage on the pace of the mango cv. Alphonso.

All processed, harvested mango fruits were verified upon harvest, according to Sarker et al. (2009), to document the invasion of the mango fruits by flies and the genuine nature of the mango fruits. After harvesting from each treatment, 10 mango fruits, including the untreated control, were randomly selected and destroyed to establish the level of complete solubility. Dry matter (% TSS) is used as a synthetic quality maker of mango fruits quality. Karim (1989) showed that *Bactrocera dorsalis* likes to lay eggs in mangoes 30-40 days before harvest, so he chose a period that is good for bagging 30 days before harvest. Bagging involves placing young mango fruits in a food bag and closing the package with tape or clasps. Mango fruits from the external climate can protect them against mechanical or organic damage, especially if the mango fruits are defenseless against attacks by sprouts, microorganisms, insects, and even birds (Sharma et al., 2014). Pears and gapes bagging innovation in Japan, China, Korea, Australia, and the United States protect organic products from environmental influences from temperature, water/humidity and air (mainly light and microbes, then air pressure at this point) and a protective cover that effectively forms the border around a mango fruit (Sharma et al., 2014).

The purpose of this review is to investigate the impact of packaging on the nature of mango fruits, in particular their appearance and color, which are likely to be the main quality features of mango fruits designed to protect bags against microorganisms and parasites. Insect pests and changes in the microenvironment resulting from improved mango fruits influence the development and quality of mango fruits (Guzman, 2004; Thorp et al., 2007; Son and Lee, 2008; Li et al., 2008). Encourage elective strategies to work with the appearance and nature of soil disease products and pathways of infection. For safety, customer well-being and environmental protection, people pay more attention to reducing pesticide use (Sharma et al. 2009). Under these conditions, an ongoing study was conducted to consider whether the different types of bags and bagging times are suitable for the nature of the mango fruit bagging, the BARI Aam 3 and BARI Aam 4.

## MATERIALS AND METHODS

From April 2018 to July 2018, research work was carried out on various mango plantations in the Chittagong hill tracts of Bangladesh, and the experimental parameters in RARS, Hathazari Chattogram, Mango cv BARI Aam 3, and BARI Aam 4 were used for evaluations. The bagging material was considered as a treatment, and the absence of bagging for mango fruit (open fruit) was considered as a control, so the sample had four (04) treatments: $T_1$: brown paper bag, $T_2$: white paper bag, $T_3$: transparent polyethylene bag, $T_4$: control. Bagging materials were purchased from Lal Teer. Two mango varieties were treated in duplicates, namely 50 fruits from BARI Aam 3 and BARI Aam 4. So, each interaction is 10 trees of 5 repetitions and 40 trees of 4 treatments. The test was organized as a randomized complete block design (RCBD), four (04) treatments were repeated five (05) times, and each treatment included 50 fruits as a unit, and each replicate.

Depending on the processing conditions, decide whether the fruit will develop evenly (35, 45, 55 days after fruit setting). The fruit is bagged in appropriate bagging materials. Insects cannot get into the bag. The sturdy bag is properly wrapped on the stem and properly cared for so that it does not fall down or leave an empty space. During the research period, all trees were kept in once crop. After three (03) months of curing, it is fully tested. Ten (10) mango fruits were randomly selected for each treatment, and various physical parameters were recorded using an accompanying iterative system.

### *Fruit physical properties*

### *Length and diameter of fruit (cm)*

A caliper is used to measure the length from the tip of the stem to the tip of the fruit, as well as the diameter, 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.

### *Fruit chemical properties*

### *Total soluble solid (TSS)*

The total soluble solids (TSS) concentration of the mango is estimated with a portable digital refractometer (Erma Hand Refract Meter 0 to 32 ° Brix). A drop of mango juice is extracted from the flesh, and the TSS content is the percentage of Brix obtained by direct reading from the device.se the temperature correction chart (AOAC, 2004) for temperature correction.

$$\% \text{ Total sugar} = \frac{\text{Fehling Factor x Dilution x 100}}{\text{Weight of sample x Titre}}$$

### *Statistical analysis*

Field data were recorded and a table for statistical analysis was created. ANOVA was performed using R software version 3.2 (20141031) (package = "Agricolae") (De Mendiburu, 2009) with support for the Randomized Complete Block Design (RCBD). A multiple range test (DMRT) is used to separate treatment, so the least significant difference (LSD) test significance level and a 5% significance level are used to determine the significance of the difference between a pair of means (Steel et al. 1997).

## RESULTS AND DISCUSSION

### *Changes in peel colour*

Among the treatments, results showed that the brown paper bag improved the complexion of BARI Aam 3 even more. After 12th long periods of use, the brown paper bag turned greenish yellow color in the BARI Aam 3. Then again the white paper bag and transparent polythene bag turned yellowish-green and trace of yellow, separately 12 days after capacity (Table 1).

**Table 1: Changes in peel colour of BARI Aam-3 as influenced by different bagging materials**

| Treatments | Days after harvest | | | | |
|---|---|---|---|---|---|
| | 0 days | 3 days | 6 days | 9 days | 12 days |
| Brown paper bag | Green | Green | Trace of yellow | Greenish yellow | Greenish yellow |
| White Paper bag | Green | Green | Trace of yellow | Trace of yellow | Yellowish green |
| Transparent polythene bag | Green | Green | Green | Trace of yellow | Trace of yellow |
| Control | Green | Green | Trace of yellow | Yellowish green | - |

**Table 2: Changes in peel colour of BARI Aam-4 as influenced by different bagging materials**

| Treatments | Days after harvest | | | | |
|---|---|---|---|---|---|
| | 0 days | 3 days | 6 days | 9 days | 12 days |
| Brown paper bag | Green | Green | Green | Trace of yellow | Greenish yellow |
| White Paper bag | Green | Green | Green | Trace of yellow | Yellowish green |
| Transparent polythene bag | Green | Green | Green | Trace of yellow | Trace of yellow |
| Control | Green | Green | Trace of yellow | Yellowish green | - |

Roy et al. (2011) found 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. The results are described by Alves et al. (1998) for polythene wrapping announced that thin polythene bags are more effective in reducing the color of fruit.

Among the treatments, the results showed that the brown paper bag improved the complexion of the BARI Aam 4 even more. After the 12th extended periods of use, the brown paper bag turned greenish yellow color in the BARI Aam 4. Then again, the test bag and the transparent polyethylene bag were yellowish-green and trace of yellow, individually twelve days post-can (Table 2). The consequences of this study, along with the bunding of the prop compaction in a bundle, prevented the appearance of a strand (Straten and Oosthuyse, 1994).

### *Length of fruit (mm)*

Table 3 shows that the treatment of the brown paper bag and the white paper bag gave the maximum fruit length (8.81cm and 8.36 cm, separately) at 35 days after solidification of the BARI Aam 3 fruit. The control treatment gave the fruit a length (8.45 cm). Whatever the case, the least fruit length was recorded when processing the polythene bag (7.90 cm) at 45 and 55 days after the fruit set (Table 3). On the other hand, BARI Aam 4, the treatment of a brown paper bag and a white paper bag gave the maximum fruit length (14.30 cm and 14.14 cm, separately) at 35 days after fruit set. Control treatment resulted in the lowest fruit length (13.47 cm) (Table 4). After setting, the fruit gradually unfolds and grows into development. Covering the fruit with a pocket at some stage of improvement may affect its development and size. There are conflicting reports about the effect of fruit grouping on fruit size and weight, which may include the different types of bags used, 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 harvest (Tyas et al., 1998; Zhen et al., 2000; Wang et al., 2002; He et al., 2003; Huang et al., 2007; Chen et al., 2012; Chow et al., 2012). Fruit bagging may increase, decrease, or decrease the weight and size of the fruit.

### *Diameter of fruit (mm)*

According to BARI Aam 3, pre-harvest fruit bagging into a brown paper bag and a white paper bag gave the maximum (6.39 cm and 6.13 cm) between the fruit compared to the control and polythene bag (6.17 cm and 5.78 cm) 35 days after harvesting the fruit, which roughly equates to 45 days after fruit set. Fruit measurement worsened slightly at 45 and 55 days after consuming mango fruits (Table 3). Again, BARI Aam 4, the pre-harvest the fruit in a brown paper bag and white paper bag, gave the highest (16.39 cm and 15.13 cm) spacing between the fruit compared to the control and polythene bag (14.17 cm and 16.38 cm) 35 days after fruit setting, which can be measured comparable to 45 days after fruit set. The size of the fruit decreased slightly 45 and 55 days after setting the fruit (Table 4).

### *Weight of fruit (g)*

For BARI Aam 3, the maximum fruit weight was found when processing a brown paper bag at 35 days after setting the fruit (229.1 g) and the minimum weight when processing a transparent polythene bag (193.70 g) (Table 3). After bagging, the weight of the fruit increased compared to the control fruit (Chonhenchob *et al*. 2011). On the other hand, BARI Aam 4, the maximum fruit weight was found in processing the brown paper bag at 35 days after fruit setting (585.95 g) and the minimum in the control plot (504.66 g) (Table 4). Stover and Simmonds (1987), Xu et al. (2008), Xu et al. (2008) reported the positive effect of harvesting on the height, size, and weight of a mango fruit. Watanawanet et al. (2008), Yang et al. (2009), Harhash and AlObeed (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. Honhenchob et al. (2011) investigated the effect of pre-harvest bagging with special

bags of varying frequency in the mango 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).

***Total soluble solid (% Brix)***

In BARI Aam 3, there was no significant difference between the treatments (Table 3). Brown paper fruit and control plants showed the highest content of soluble solids (22.33 % Brix and 21.36 % Brix, respectively) while the lowest total soluble solid was recorded in the transparent ploythene bag (17.03 % Brix) at 45 days after fruit set. It was found that the percentage of completely soluble solids as a percentage of bag (18.45 % Brix) at 45 days after harvest installed. 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 (Karemera and Habimana, 2014; Burondkar et al., 2009). Watanawan et al., (2008) increased the TSS content of mangoes even more during pre-bagging.

***Mango fruit yield (ton/ha)***

In the case of BARI Aam 3, the highest marketable yield was obtained in brown paper bags (20.41 t / ha), then in white paper bags (19.17 t / ha), control (18.38 t / ha) and transparent polyethylene bags (15.46 t / ha). TSS (%) was highest in the brown paper bag (22.33%) among the

**Table 3. Effect of different types of bagging on fruit quality of mango var. BARI Aam 3**

| Treatments | Time | Total No. of mango/ Plant | Length of individual fruit (cm) | Diameter of individual fruit (cm) | Weight of individual fruit (g) | Yield (t/ha) | TSS (%) | Color |
|---|---|---|---|---|---|---|---|---|
| Brown paper bag | 35 days | 812.3 a | 8.81 a | 6.39 a | 229.1 a | 20.41 a | 22.33 a | Excellent |
| | 45 days | 819.0 a | 8.78 a | 6.35 a | 228.78 a | 20.37 a | 22.30 a | |
| | 55 days | 822.5 a | 8.70 a | 6.30 a | 228.70 a | 20.30 a | 22.32 a | |
| White Paper bag | 35 days | 728.5 c | 8.36 b | 6.13 b | 217.70 c | 19.17 b | 17.68 c | Good |
| | 45 days | 730.5 c | 8.20 b | 6.10 b | 217.50 c | 19.15 b | 17.55 c | |
| | 55 days | 735.5 c | 8.15 b | 6.00 b | 217.30 c | 19.10 b | 17.59 c | |
| Transparent polythene bag | 35 days | 621.7 d | 7.90 c | 5.78 c | 193.70 d | 15.46 d | 17.03 d | Poor |
| | 45 days | 625.0 d | 7.60 c | 5.75 c | 193.60 d | 15.40 d | 17.00 d | |
| | 55 days | 629.5 d | 7.75 c | 5.70 c | 193.20 d | 15.34 d | 17.13 d | |
| Control | | 751.8 b | 8.45 b | 6.17 b | 221.34 b | 18.38 c | 21.36 b | Poor |
| **CV (%)** | | **3.21** | **4.56** | **3.77** | **5.36** | **4.28** | **3.89** | |

In a column, means followed by same letter(s) are not significantly different by LSD test at P<0.05.

**Table 4. Effect of different types of bagging on fruit quality of mango var. BARI Aam 4**

| Treatments | Time | Total No. of mango/ Plant | Length of individual fruit (cm) | Diameter of individual fruit (cm) | Weight of individual fruit (g) | Yield (t/ha) | TSS (%) | Color |
|---|---|---|---|---|---|---|---|---|
| Brown paper bag | 35 days | 57.66 c | 14.30 a | 16.39 a | 585.95 a | 23.52 a | 21.85 a | Excellent |
| | 45 days | 60.50 c | 14.20 a | 16.35 a | 585.70 a | 23.35 a | 21.80 a | |
| | 55 days | 65.25 c | 14.15 a | 16.30 a | 585.55 a | 23.20 a | 21.78 a | |
| White Paper bag | 35 days | 48.50 d | 14.15 a | 15.13 b | 535.23 c | 17.67 c | 18.45 c | Good |
| | 45 days | 52.20 d | 14.10 a | 15.10 b | 535.20 c | 17.50 c | 18.40 c | |
| | 55 days | 55.25 d | 14.00 a | 15.00 b | 535.10 c | 17.27 c | 18.35 c | |
| Transparent polythene bag | 35 days | 61.70 a | 13.76 b | 16.38 a | 563.47 b | 21.21 b | 21.37 a | Poor |
| | 45 days | 62.00 a | 13.66 b | 16.35 a | 563.40 b | 21.05 b | 21.35 a | |
| | 55 days | 63.50 a | 13.60 b | 16.33 a | 563.35 b | 21.00 b | 21.30 a | |
| Control | | 51.80 b | 13.47 c | 14.17 c | 504.66 d | 16.43 d | 20.75 b | Poor |
| **CV (%)** | | **2.78** | **5.44** | **3.92** | **4.37** | **2.85** | **3.65** | |

In a column, means followed by same letter(s) are not significantly different by LSD test at P<0.05.

collected into finished fruit was obtained with the aid of (Joshi and Roy, 1988) who mentioned that the problem of dangerous shock immediately builds up and diminishes thereafter. A similar result has been reported in some previous experiments (Islam, 2017a; Haldankar, et al., 2015). In contrast, in BARI Aam 4, there was no significant difference between the treatments (Table 4). The results for brown paper and transparent polythene bag showed the best soluble solids (21.85 % Brix and 21.37 % Brix, separately) while the least full-scale soluble solids were recorded in white paper treatments. Both mango combinations showed that the fruity shade was excellent in contrasting brown paper bags and different treatments (Tables 3 and 4). Current findings suggest the use of a brown paper bag for mango var. BARI Aam 3 and BARI Aam 4 in enhancing the nature of creation in the Chittagong Hills of Bangladesh. The results are fully consistent with the results of pomegranate and (Abdel Gawad Nehad et al., 2017; and ElWafa, 2014) mango. Brown paper bags (23.52 t / ha) were the most appealing treatment followed by clear polyethylene bags (21.21 t / ha), white paper bags (17.67 t /

ha) and control (16.43 t / ha), according to BARI Aam 4 (Table 4). 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 (Sharma et al., 2014; Chonhenchob et al., 2011; Hossain et al., 2020; Islam et al. 2017; Dutta and Majumder, 2012 and Karar et al., 2019).

## CONCLUSION

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 variety mango. BARI Aam 3 and BARI Aam 4. 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 BARI Aam 3 and BARI Aam 4 bag fruit bagging test is extremely effective in improving the quality of the fruit. Either way, scientists still focus on packing techniques, applying standard rules for packing time and bag materials.

## AUTHOR CONTRIBUTIONS

Md. Omar Faruq, Md. Riaj Uddin and Md. Rashidul Alam fostered the idea and the final proposal for the research work established the experiment and contributed to the manuscript write-up. Md. Omar Faruq, Md. Zonayet and Khalid Syfullah helped design the experiment, conducted field experiments, analyzed the data, wrote the manuscript, and finalized it.


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## COMPETING INTERESTS

The authors declare that they have no competing interests.

## ETHICS APPROVAL

Not applicable

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