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Impact of Tree Bagging on Physico-chemical Qualities and Economics of Mango cv. BARI Aam 7

Sheikh Shah Asadullah Salehin[1,2], Mst. Ananya Khatun[1,2], Md. Rukunuzzaman[1] and Md. Tariqul Islam[1,*]

[1]Department of Horticulture, Hajee Mohammad Danesh Science and Technology University, Dinajpur-5200, Bangladesh

[2]Equal Contributions

[*]**Corresponding author:** tariqul.hrt@tch.hstu.ac.bd

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Abstract: During fruit development, bagging protects fruit from biotic stress and improves quality without reducing yield. Hence, this study investigates the impact of bagging on mango cv. BARI Aam 7, focusing on quality and storage life. Employing a Randomized Complete Block Design, fruits were bagged at marble-sized stage using brown paper (T1), white paper (T2), polythene (T3), and no bag (T0) as control. Brown paper bags significantly enhanced fruit retention (90.33%) and weight (349.70g), with increased length (11.23 cm) and diameter (7.26 cm). Fruits of brown paper-bagged exhibited higher citric acid (0.49-0.35%) and β-carotene (158.87-535.00 µg/100 g). White paper bags yielded elevated ascorbic acid, total soluble solids, and sugars. Brown paper bags extended shelf life up to 12 days, surpassing polythene bag (8 days) and control (10 days). Sensory evaluation favored brown paper-bagged fruits. Overall, Brown paper bagging shows promise for enhancing mango quality, being cost-effective, and prolonging storage life.

Key words: Bagging, cost, mango, physico-chemical properties, storage life.

1. Introduction

The mango (*Mangifera indica* L.), is a climacteric fruit of member of the Anacardiaceae family. Because of its appealing colour, flavour, taste, and average nutritional value, this fruit is known around the world as a popular and well accepted fruit (**Hossain, 2016**). Bangladesh ranks as the seventh-largest mango producer globally, cultivating 0.124 million hectares and yielding approximately 1.482 MT annually (**BBS, 2024**). BARI Aam-7 is a variety especially grown in the northern region of Bangladesh, having a moderate taste. After being harvested, fruits undergo physiological and biochemical changes that result in a decline in quality and shelf life. This limited shelf life poses challenges for both national and international exports (**Mahmud *et al.*, 2015**). The use of chemical fungicides has been a longstanding practice to mitigate deterioration and has successfully extended the shelf life of mangoes for several years (**Diskin *et al.*, 2019**). Fruits are visually appealing, and free from pests command a higher price in the market. Environmental concerns and the issue of chemical residue have led to the discontinuation of the use of chemical fungicides in preventing postharvest decay of mangoes (**Sellitto *et al.*, 2021**).

Various effective agricultural practices are gaining popularity for mitigating both biotic and abiotic stress all over the world (**Jakhar and Pathak, 2016**). One of the most important agricultural techniques that improve the yield of aesthetically pleasing crops by minimising flaws and obvious markings is bagging (**Sharma *et al.*, 2014**). Pre-fruit bagging, which is typically done for pears, involves covering fruit with paper bags. (**Qian *et al.*, 2013**), apple (**Rajametov and Nurbekov, 2020**), pomegranate (**Hamedi Sarkomi *et al.*, 2019**), litchi (**Pal *et al.*, 2016**), guava (**Sharma *et al.*, 2020**), and mango (**Akter *et al.*, 2020**). In particular, pre-bagging modifies the microenvironment, leading to a decrease in susceptibility to pest attacks, sunburn, skin imperfections (**Ali *et al.*, 2021a; Nadeem *et al.*, 2022**).

Mangoes are predominantly cultivated without protective bagging for both domestic and international markets. Besides, it faces challenges in export due to its short postharvest life caused by ripening and decay. A significant portion of the harvested fruit never reaches consumers due to postharvest losses. In fact, the post-harvest loss of mangoes estimated to be around 35% in Bangladesh (**Alom *et al.*, 2019**). Fruits with pre-harvest bagging enhanced postharvest attributes by controlling the mango quality with minimizing losses (**Rahman *et al.*, 2019**). Due to the short shelf life of mango, its marketability is still limited to the local market, though Bangladesh has great potential to export. Thus, tree fruit bagging is more effective to enhance quality and shelf life of fruits. To satisfy domestic and global demand, premium fruit production is required. Hence, the primary goal was to find out how bagging materials affected the physico-chemical attributes of mango and shelf-life extension while also reducing the number of pests and diseases.

2. Materials and Methods

A study conducted at the Regional Horticulture Research Station in Chapainawabgonj, Bangladesh, implemented a randomized complete block design (RCBD) with three replicates. The experiment involved 10-year-old BARI Aam-7 mango trees and three types of bags: brown paper, white paper, and polythene (25 × 20 cm dimensions). Polythene bags had perforations for ventilation. After 45 days of fruit set, bagging was carefully done to prevent fruit damage. Fruits were harvested at 80-85% maturity, transported in ventilated plastic containers, and ripened under ambient conditions. Data were evaluated at the Department of Horticulture, HSTU, Dinajpur, Bangladesh, including fruit retention percentage and days required to harvest. Twenty fruits were chosen from each treatment for the subsequent observations.

2.1. Physical attributes

The length from the base of the fruit to the peak and the diameter were assessed using a digital Vernier caliper, and showed in centimeters (cm). The weight of the fruit, pulp, and stone was determined using an electronic balance and reported in grams (g).

2.2. Chemical parameters

Content of ascorbic acid was assessed using the method described by **Rangana (2002)**. Using a Hand-Held Oil Refractometer, total Soluble Solids (TSS) was determined. The unit of measurement of TSS values ranged from 0 to 32° Brix. The assessment of reducing sugars followed the protocol outlined in the procedures detailed by **Haq *et al.* (2012)** and **Santini *et al.* (2014)**. For the determination of reducing sugar, the titration was conducted using Fehling's solution following a procedure similar to **AOAC (2004)**. Non-reducing sugars was estimated by the subtraction of % reducing sugar from the % total sugar. The content of citric acid was assessed using the described method outlined by **Rangana (1979)**. The β-carotene content was assessed using the method of **Nagata and Yamashita (1992)**.

2.3. Incidence of Fruit fly and Shelf life of fruits

The fruit was taken from each treatment and visually observed if there was any infestation or not. The calculation of infested fruits was performed in percentage. The shelf life of mango fruits was determined by assessing the days (number) needed for them to ripen fully while maintaining optimal marketing and eating qualities. Shelf life was considered reached when 50% of the fruits showed signs of spoilage.

2.4. Sensory evaluation

Ripe fruits from both the bagged and control were evaluated for sensory attributes. A panel of five judges utilized nine-point Hedonic Scale for assessment (**Amerine *et al.*, 1965**).

2.5. Statistical analysis

The data were analyzed using the Statistical Tool for Agricultural Research (STAR) version 2.0.1, employing the Least Significant Difference (LSD) test at a 5% significance level.

3. Results and Discussion

3.1. Fruit retention percentage and Number of days required for harvesting

Pre-harvest bagging using brown paper bags showed higher fruit retention (90.33%) than the fruits covered with white paper bags (89.67%) respectively in mango cv. BARI Aam-7. On the other hand, polythene bag showed the least fruit retention (82.33%) over the control (86.00%). Because temperature inside the polythene paper bag was higher and warmed up more quickly over the day. High temperatures also encourage the abscission layer to form (**Akter *et al.*, 2020**).

The harvesting was earlier in the polythene bag (60.67 days) followed by the control (61.67 days), and the harvesting got delayed in the white paper bag (65.67 days) over the brown paper bag (64.33 days) (Fig. 1). **Debnath *et al.* (2001)** reported early fruit harvesting in litchi and Fujii Supreme Apple when polythene bags were utilized. Additionally, **Islam *et al.* (2017a)** discovered that mango fruit with pre-harvest bagging extended its shelf life by retarding the ripening process. Bagging attributed to its protective barrier, which minimizes biotic stress and promotes optimal fruit development. According to **Sharma *et al.* (2014)**, fruit bagging alters the microclimate, influencing factors such as light, temperature, and humidity within the bag, thereby playing a pivotal role in the development of fruits. Delayed harvest was observed in pre-harvest bagging of Alphonso mango cultivar when brown paper bags were used (**Haldankar *et al.*, 2015**).

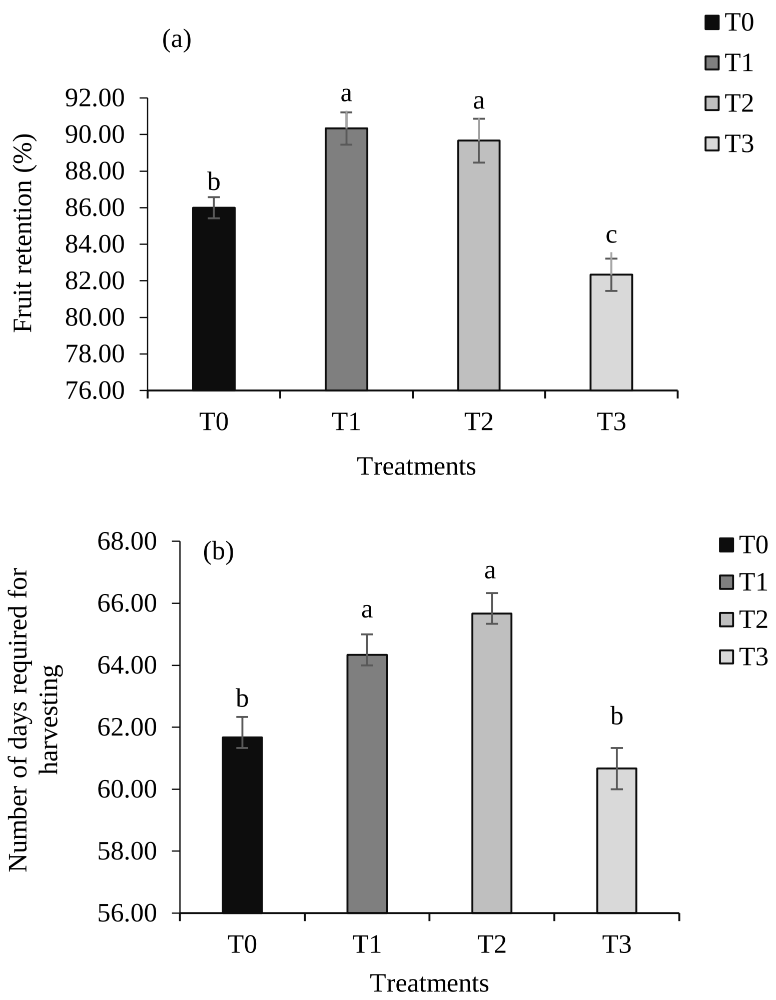

Fig. (1). The impact of various bagging on fruit retention (%) (a) and number of days required for harvesting (b) in mango cv. BARI Aam-7. The vertical bar represents the standard error, and distinct lowercase letters (a-c) denote significant differences among treatments (LSD at $p \leq 0.05$). (T0-Control, T1-Brown Paper bag; T2-White Paper bag; T3-Polythene bag)

3.2. On tree bagging effect on Fruit weight, length, and diameter

The pre-harvest bagging with brown and white paper bags resulted in a statistically significant improvement in physical quality, particularly in terms of fruit weight, compared to those bagged in polythene. Brown paper bagged fruits were significantly higher in weight (349.70 g) followed by white paper bags (329.53 g), while lower in polythene bags (146.87 g). Both brown and white paper bag resulted the maximum fruit length (11.23 cm and 11.17 cm) compared to polythene bags (7.13 cm). The maximum diameter was also observed in the brown and white paper bags (7.26 cm and 6.91 cm) over the control and polythene bags (6.67 cm and 6.17 cm), respectively presented in Table 1.

3.3. Pulp and stone weight

Fruits subjected to brown paper bags exhibited the highest pulp weight (299.90 g), followed by those treated with white paper bags (283.90 g) over control (249.57 g), and polythene bags

(104.00 g) (Table 1). Pre-harvest bagging increased the stone weight of the BARI Aam-7. The maximum stone weight was observed in the group treated with white paper bags (49.17 g), followed by brown paper bags (44.73 g), control (45.37 g), and polythene bags (20.00 g) showed in Table 1.

3.4. Pulp-Stone ratio

Regarding the pulp-stone ratio, the topmost value was noted in the treatment involving brown paper bags among the various study treatments (6.70), followed by white paper bags (5.77), control (5.50), and polythene bags (5.20) represented in Table 1.

Table (1). The impact of tree bagging on physical parameters of mango cv. BARI Aam-7

Treatments	Fruit Weight (g)	Fruit length (cm)	Fruit diameter (cm)	Fruit pulp weight (g)	Stone weight (g)	Pulp: Stone ratio
T0	317.80±2.03 a	9.20±0.23ab	6.67±0.24ab	249.57±1.73a	44.73±0.89 a	5.50±0.07 b
T1	349.70±20.00a	11.23±0.52 a	7.26±0.26a	299.90±34.96 a	45.37±2.52 a	6.70±0.40 a
T2	329.53±13.53a	11.17±1.77 a	6.91±0.19ab	283.90±15.10 a	49.17±5.19 a	5.77±0.31 b
T3	146.87±2.67 b	7.13±0.07b	6.17±0.17b	104.00±1.57b	20.00±0.41 b	5.20±0.05 b
CV (%)	5.85	14.11	1.67	12.39	10.53	9.02
LSD	33.42	2.73	0.23	57.39	8.39	0.21

Means ± standard error (SE) with the same letter(s) are not significantly different within a column (LSD, $p < 0.05$), while different letters indicate significant differences. (T0-Control, T1-Brown Paper bag; T2-White Paper bag; T3-Polythene bag).

Bagging creates a favorable microenvironment, minimizing environmental stress and promoting robust fruit development. The practice of on-tree fruit bagging has demonstrated positive effects on fruit size, and weight, consistent with previous studies (**Zhou *et al.*, 2012**). In the case of 'Nam Dok Mai #4', employing two-layer paper bags, newspaper, or golden paper bags for a duration of 52 days resulted in increased fruit weight, as reported by **Watanawan *et al.* (2008)**. Similarly, **Chonhenchob *et al.* (2011)** found that bagging at different harvest stages with wavelength-selective bags in Taiwan enhanced fruit weight, size, and sphericity compared to non-bagged fruit. **Islam *et al.* (2024b)** noted increased fruit and flesh weight, size, length, and diameter in banana cultivars when using two layered brown paper bags. The duration for harvesting was prolonged for brown and white paper bags compared to control and polybagged fruits. This could be attributed to the favorable microclimates inside the brown and white paper bags, contributing to higher recorded fruit and pulp weight, size, and length compared to poly bags. **Islam *et al.* (2019a)** and **Islam *et al.*, (2019c)** specifically highlighted that brown paper bags led to significantly higher pulp weight compared to the control. The utilization of different bags for pre-harvest bagging consistently resulted in a superior pulp-stone ratio compared to un-bagged (**Haldankar *et al.*, 2015**).

3.5. On tree bagging effect on TSS, Citric acid, Ascorbic acid and β-carotene

Fruit bagging as pre-harvest treatment exerted a significant influence on TSS, citric acid, ascorbic acid, β-carotene, as well as the content of reducing, non-reducing, and total sugars in fruits at both harvest and ripe stages (Table 2).

During the harvesting stage, the white paper bag exhibited the highest total soluble solids content (10.67 ºBrix), surpassing the brown paper bag (9.13 ºBrix), while the control and polythene bags displayed lower values (7.23 and 4.77 ºBrix), respectively. In the ripening stage, fruits treated with the white paper bag demonstrated the highest content of soluble solids (15.87 ºBrix), whereas the lowest was observed in the polythene bag (10.80 ºBrix) (Table 2). In the post-harvest storage of the fruit, total soluble solids may increase gradually, attributed to three potential factors: hydrolysis of cell wall polysaccharides, breakdown of starch into simple sugars, and water loss (**Seyed *et al.*, 2021**). The diminished oxygen levels surrounding fruit within double-layered brown paper bags restrain the activities of amylase and maltase, leading to a reduction in starch conversion into glucose (**Singh *et al.*, 2013**).

The polythene bag recorded the significantly highest citric acid content during the harvesting stage (1.72%), while the lowest was noted in the control group (0.22%). In the ripening stage, the highest citric acid content (1.13%) was recorded in fruits bagged with polythene, while the least was observed in control (0.17%) (Table 2). The research indicated a sharp decrease in citric acid from harvest to ripe fruits. Similar findings observed in previous studies (**Haldankar *et al.*, 2015**).

At the harvest stage, the maximum content of ascorbic acid was found in the control group (24.34 mg/100 g), whereas the minimum was observed in the polythene bag (10.33 mg/100 g). However, at the ripe stage, the highest content of ascorbic acid was obtained from fruits treated with the white paper bag (10.67 mg/100g), while bottom level was recorded in the control (6.80 mg/100g). **Islam *et al.* (2019a)** observed the highest ascorbic acid in mangoes treated with white paper bags (33.79 mg/100 g) and the lowest in the control (28.10 mg/100 g). The use of both brown and white paper bags was discovered to protect fruits from sunlight, leading to an increase in xanthophyll content and the preservation of vitamin C. As a potent antioxidant, ascorbic acid combats reactive oxygen as well as free radicals during fruit ripening (**Fenech *et al.*, 2019**). The gradual decrease in ascorbic acid concentration over time is attributed to its transformation into dehydro-ascorbic acid during oxidation (**Akram *et al.*, 2017**). According to **Nadeem *et al.* (2022)**, bagged mangoes exhibit higher vitamin C levels than non-bagged ones. **Haldankar *et al.* (2015)** reported a non-significant effect of harvest stage bagging on the ascorbic acid content of mango fruits at harvest. The ascorbic acid content in apples and pears was significantly affected by the color and texture of the bagging material (**Zhou et al. 2019**). Our findings aligned with the observation of **Khatun et al. (2024)** where brown paper-bagged fruits exhibited the highest ascorbic acid content at the initial stage of storage among all treatments.

During the harvest stage, the brown paper bag recorded the highest β-carotene content (158.87 µg/100g), and the lowest was observed in the polythene bag (113.40 µg/100g). At the ripe stage, the brown paper bagged fruits exhibited the highest β-carotene content (535.00 µg/100g), surpassing other treatments, while the polythene bag recorded a lower value (187.00 µg/100g) (Table 2). The rise in levels of β-carotene observed in packaged fruits is linked to improved enzymatic activity responsible for the synthesis of carotenoids. Bagging induces a warmer and more humid environment, leading to increased carotenoid production when chlorophyll breaks down due to chlorophyllase. **Islam *et al.* (2019a)** recorded significantly higher β-carotene in brown paper bag-treated fruits at harvest and ripe stage compared to the control. These findings align with previous reports indicating increased the content of β-carotene due to bagging treatments in mango (**Zhao *et al.*, 2013**). The previous studies showed that mangoes which were bagged before harvesting, bagging helped to boost up the levels of lycopene and beta carotene (**Akter *et al.*, 2020**). That's why the beta carotene content was higher in mangoes which were bagged with brown paper bags.

3.6. On tree bagging effect on sugar content

At the harvest stage, the control group displayed the highest content of reducing sugars (1.71%), surpassing the brown paper bag (1.33%), white paper bag (1.23%), and polythene bag (1.13%). In contrast, during the ripening stage, the white paper bag exhibited the highest reducing sugar content (4.44%), surpassing brown paper bag (4.07%), control (3.53%), and polythene bag (2.17%) (Table 2).

At the harvest stage, fruits from the brown paper bag showed the highest non-reducing sugar content (2.01%), significantly exceeding that of the white paper bag (1.31%), control (1.26%), and polythene bag (1.17%). Conversely, the control group exhibited the maximum non-reducing sugar content (10.14%) at the ripe stage, while the minimum was recorded in poly-bagged fruits (2.88%) (Table 2).

During the harvest stage, the control group exhibited the highest total sugar content (3.97%) among the various bagging treatments. In the ripening stage, fruits from the white paper bag displayed the maximum total sugar content (14.59%), whereas brown paper bags and the control showed (7.74% and 13.69%, respectively) (Table 2).

Fruits enclosed in various bags demonstrated the highest levels of reducing sugars at the ripe stage in mangoes, owing to pre-harvest treatments as observed by **Haldankar *et al.* (2015)** and **Islam *et al.* (2017a)**. This outcome is consistent with prior studies, including **Islam *et al.* (2024b)**, which found that bagging resulted in reduced reducing sugar, non-reducing sugar in mango.

Table (2). The impact of various bagging on chemical attributes of mango cv. BARI Aam-7 at harvesting and ripe stage

	TSS (^{0}Brix)		Citric acid (%)		Ascorbic acid (mg/100 g)	
Treatments	At harvest	At ripe	At harvest	At ripe	At harvest	At ripe
T0	7.23±0.08c	15.36±0.32a	0.22±0.00b	0.17±0.01c	24.34±0.01a	6.80±0.23c
T1	9.13±0.35b	13.97±0.15b	0.49±0.01b	0.35±0.00b	16.25±0.02c	8.00±0.61b
T2	10.67±0.22a	15.87±0.20a	0.35±0.01b	0.28±0.00bc	17.38±0.01b	10.67±0.13a
T3	4.77±0.14d	10.80±0.61c	1.72±0.26a	1.13±0.09a	10.33±0.33d	9.60±0.30a
CV (%)	4.56	4.59	31.19	16.41	1.69	7.12
LSD	0.73	1.29	0.43	0.16	0.58	1.25

Contd.

	β-carotene (µg/100 g)		Total sugars (%)	
Treatments	At harvest	At ripe	At harvest	At ripe
T0	125.28±0.02b	451.67±2.33b	3.97±0.00a	13.69±0.01b
T1	158.87±0.02a	535.00±1.73a	3.07±0.02c	7.74±0.01c
T2	114.59±0.01c	262.00±2.08c	3.71±0.01b	14.59±0.01a
T3	113.40±0.30d	187.00±7.37d	1.49±0.00d	4.00±0.11d
CV (%)	0.21	2.27	0.99	1.01
LSD	0.53	16.31	0.06	0.20

Contd.

	Reducing sugars (%)		Non-reducing sugars (%)	
Treatments	At harvest	At ripe	At harvest	At ripe
T0	1.71±0.03a	3.53±0.01c	1.26±0.03bc	10.14±0.02a
T1	1.33±0.09b	4.07±0.02b	2.01±0.04a	3.60±0.01b
T2	1.23±0.05b	4.44±0.01a	1.31±0.02b	10.13±0.01a
T3	1.13±0.03b	2.17±0.07d	1.17±0.03c	2.88±0.43c
CV (%)	7.37	1.67	2.37	5.81
LSD	0.19	0.12	0.07	0.78

Means ± standard error (SE) with the same letter(s) are not significantly different within a column (LSD, $p < 0.05$), while different letters indicate significant differences (T0-Control, T1-Brown Paper Bag; T2-White Paper Bag; T3-Polythene Bag)

3.7. On tree bagging effect on organoleptic evaluation

Fruits with brown paper bags had a significantly higher sensory score (8.17) for fruit color, which indicates a class of "like very much," while polythene bag showed the lowest score (4.50) given in Fig. (2). While comparing the sensory scores of flavors, texture, and sweetness with control and poly bagged fruits. The top-tier result was observed in brown paper bags (7.67), while the least was in polythene bags (6.33) for flavor. Brown paper bag had the significantly greatest score (7.33) indicating a class of "like moderately," whereas poly bag got the lowest score (4.67) for texture, and sweetness (7.17 & 4.67) which indicates a class of "dislike slightly". Brown and white bagged fruits had a better overall impression (7.67, 7.56) respectively, than the control except polythene bag (4.67).

The use of two-layer paper bags advanced the development of skin color in mangoes from green to yellow. Changes in peel color may arise from chlorophyll breakdown and an increase in carotenoid pigments due to enzymatic oxidation. Diminished chlorophyll levels in bagged fruits, attributed to reduced light exposure, were suggested by **Ding and Syakirah (2010)**. Our results align with **Nadeem *et al.* (2022)**, supporting the notion that bagged fruits exhibit more vibrant colors compared to non-bagged mangoes. Pre-harvest bagging has employed in various fruit crops widely to improve the fruit coloration (**Kim *et al.*, 2010**), reducing mechanical damage and sunburn (**Muchui *et al.*, 2010**) of the skin. Similar findings were found by **Khatun *et al.* (2024)**, where pre-harvest brown paper bagged fruits retained attractive yellowish peel color of mango cv Amrapali.

3.8. Shelf life (days) and fruit fly incidence (%)

Fruits bagged with brown paper demonstrated a significantly extended shelf life (12.67 days) after harvest, while fruits in polythene bags exhibited a shorter shelf life (8.00 days). The incidence of fruit fly was observed in control fruits (10.00%) and polythene bag fruits (5.67%) (Fig. 3).

Akter *et al.* (2020) observed that brown paper bags exhibited the prolonged shelf life and are less susceptible to diseases and insect infestation. The temperature inside the plastic bag is warmer than the outside temperature for all fruits. The humidity rises quickly, and water droplets consistently accumulate inside the bag. For that reason, fruits stored in polythene bags have the shortest shelf life.

Bagged mango fruits serve as protection against the mango fruit fly, a significant pest affecting various mango varieties. The bagging method prevents female flies from coming into contact with the fruits, thereby safeguarding them from oviposition. Brown and white paper bags were effective in protecting mangoes from pests and extending their shelf life. Brown paper bags, in particular, altered the microclimate around the fruits, managing temperature and humidity effectively and reducing the incidence of decay (**Yang *et al.*, 2009**). Bagging practice has been greatly utilized in various fruit crops to enhance skin color, increase anthocyanin content, and mitigate insect pests, mechanical damage, sunburn, agrochemical residues, and bird damage (**Xu *et al.*, 2010**). Same results were also obtained by **Ali *et al.* (2023b)**.

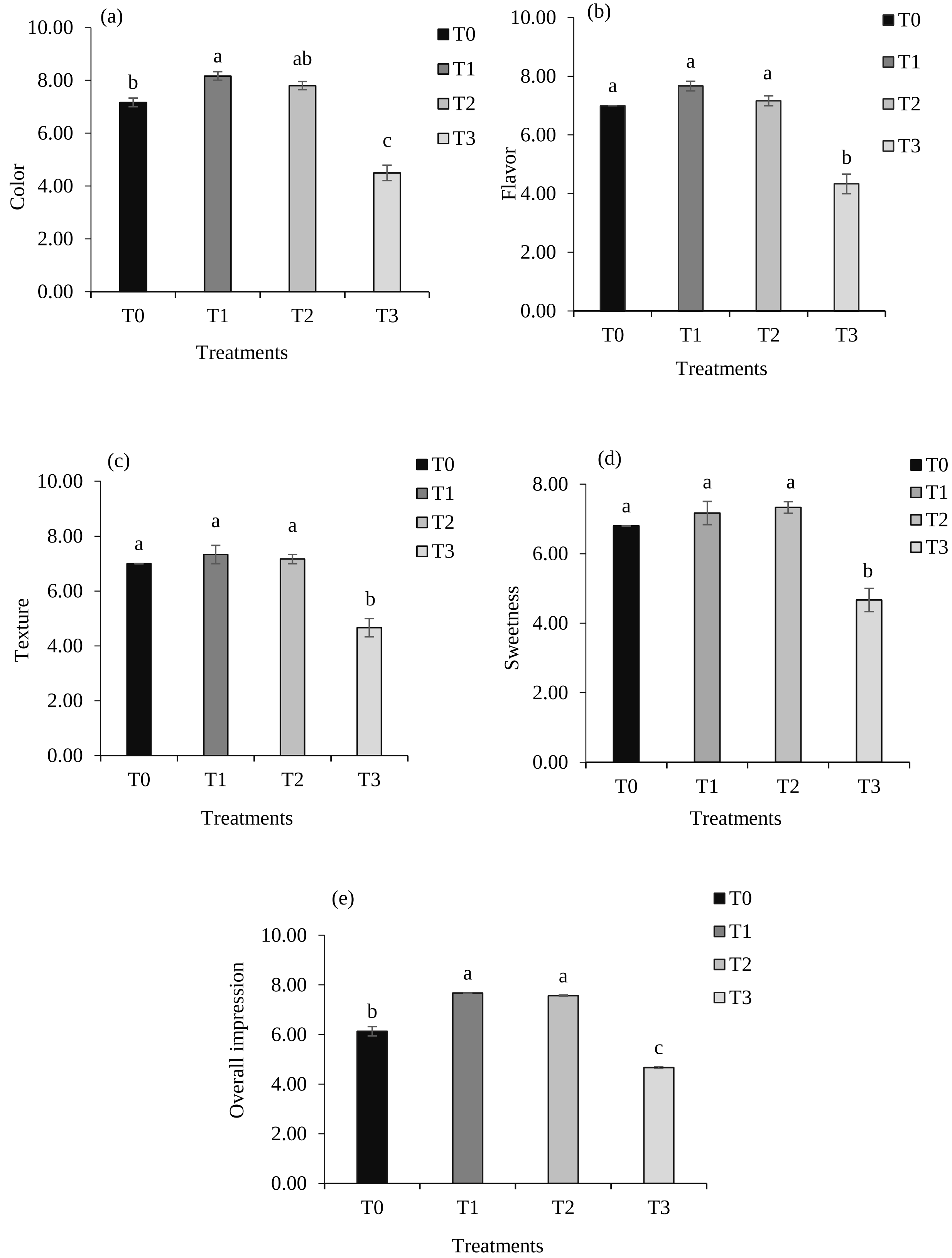

Fig. (2). The impact of various bagging materials on color (a), flavor (b), texture (c), sweetness (d) and overall impression (e) of mango cv. BARI Aam-7. The vertical bar represents the standard error, and distinct lowercase letters (a-c) denote significant differences among treatments (LSD at p ≤ 0.05). (T0-Control, T1-Brown Paper Bag; T2-White Paper Bag; T3-Polythene Bag).

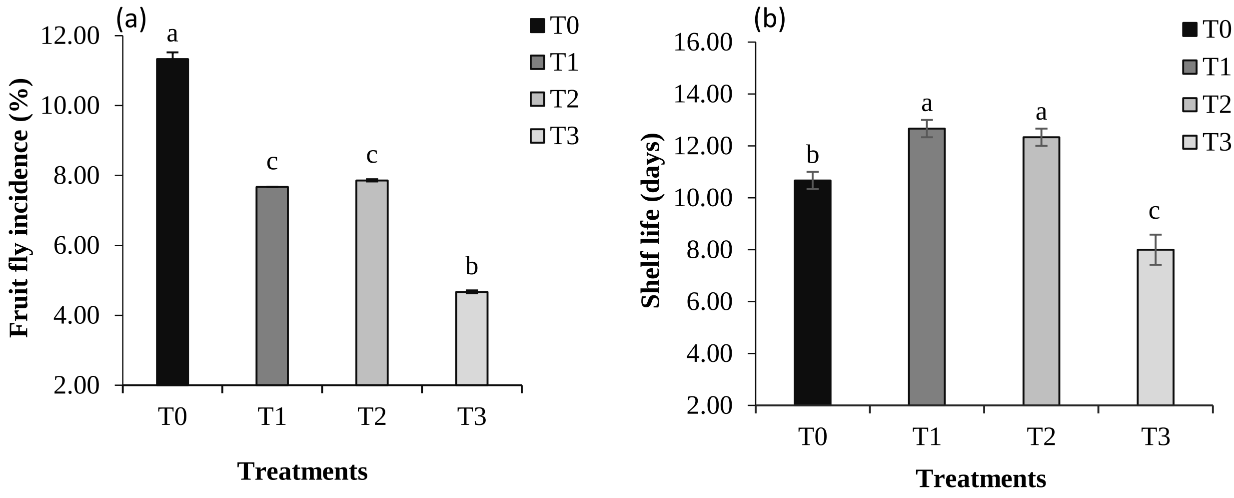

Fig. (3). The impact of various bagging materials on (a) Fruit fly Incidence (%) and (b) shelf-life (days) of mango cv. BARI Aam-7. The vertical bar represents the standard error, and distinct lowercase letters (a-c) denote significant differences among treatments (LSD at p ≤ 0.05). (T0-Control, T1-Brown Paper Bag; T2-White Paper Bag; T3-Polythene Bag).

3.9. Cost of production

The production cost analysis of mangoes (cv. Amrapali), highlighted significant variations in the benefit-cost ratio (B:C) among different bagging materials in Table 3. The highest B:C ratio (1.31) was recorded in fruits bagged with brown paper, while the lowest ratios were observed in poly-bagged (1.09) and control fruits (1.22). The choice of bagging materials influenced production costs, which subsequently affected net income and the B:C ratio.

Among the various treatments examined, brown paper bagged fruits stood out with the highest benefit-cost ratio. It yielded the most favorable economic returns in relation to the incurred production costs. The economic viability of the brown paper bag resulted higher net income and the maximization of the benefit-cost ratio. Conversely, the treatment involving control and other bags displayed the lowest benefit-cost. This implies that the economic returns generated by these treatments were comparatively lower in relation to the costs incurred.

Table (3). The impact of various bagging on cost analysis and profitability per mango plant

Treatments	General cost (‘000’Tk.)	Price of bag (Tk.)	Total cost (‘000’ Tk.)	Yield (kg)	Price rate (Tk./kg)	Gross Income (‘000’ Tk.)	Net Income (Tk.)	B:C
T_0	3.33	0.0	3.33	60	68	4.08	748	1.22
T_1	3.33	375	3.70	65	75	4.87	1168	1.31
T_2	3.33	300	3.63	65	72	4.68	1050	1.29
T_3	3.33	150	3.48	58	66	3.83	346	1.09

(B:C= Benefit: Cost) (T0-Control, T1-Brown Paper bag; T2-White Paper bag; T3-Polythene bag)

4. Conclusion

The current study showed brown and white paper bags significantly increase harvesting time compared to control and polythene bags. These bagging methods improve various physio-chemical qualities, including fruit retention percentage, weight, length, diameter, TSS, ascorbic acid, citric acid, β-carotene, reducing sugar, and total sugar content, particularly at the ripe stage, outperforming control and polythene bag treatments. Sensory evaluation highlights significant differences in color and overall impression among treatments, while flavor, texture, and sweetness show non-significant variations. Pre-harvest brown paper bagging notably extended the shelf life of mango. Brown and white paper-bagged fruits exhibit freedom from fruit flies and other insect infestations compared to control and poly-bagged fruits. The implementation of a double-layered brown paper bag in mango cv. BARI Aam-7 proves highly effective in enhancing fruit quality. This method, characterized by its simplicity, eco-friendliness, and cost-effectiveness, positively impacts mango production, benefiting both growers and consumers.

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Author's contribution

Conceptualization and study design (TI); Execution of field/laboratory experiments and data acquisition (SS, AK); Data analysis, interpretation, and graphical representation (SS, AK); Manuscript drafting and preparation (SS, TI, AK, MR); Review, editing, and finalization of the manuscript (TI, AK).

Declaration

The authors confirm that there are no conflicts of interest to declare.

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