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# Effect of Different Covering Material on Ripening and Physiochemical Properties of Dasheri Mango (*Mangifera indica*)

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***Authors' contributions***

*This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.*

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## ABSTRACT

The present experiment was conducted at Department of Horticulture, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj during the session 2021-2022. The experiment was laid out in randomized block design with three replications, and the study consists of Nine treatments combinations including control by using different covering materials on ripening and physiochemical properties of Dasheri Mango (*Mangifera indica*)". The best treatment was $T_2$ (Banana Leaves) & $T_6$ (Rice Straw) which shows highest values in all the parameters viz. Fruit weight (g) (163 & 155.41),Fruit diameter (mm) (59.16 & 58.41), Days of ripening (11.50 & 10.83), Total soluble solids ($^0$Brix) (13.21 & 12.83), Ascorbic acid (mg/100g) (28.21 & 28.25), Total sugar(%) (12.21 & 11.95 ), Reducing sugar(%) (4.87 & 4.88), Non-reducing sugar(%) (7.34 & 7.05) and also found superior in organoleptic score of colour and appearance, texture, flavour and overall acceptability of Mango fruit. In terms of benefit cost ratio, the highest net return was found in the same treatment $T_2$ (Banana Leaves).

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## 1. INTRODUCTION

"*Mangifera indica*, is commonly known as mango, aam. Mangoes belong to genus *Mangifera* which consists of about 30 species of tropical fruiting trees in the flowering plant family *Anacardiaceae*. Mango is the king among tropical fruits. Mango is evergreen tree of about 50-60 feet in height and is greatly relished for its succulence, exotic flavour and delicious taste in most countries of the world" [1]. "Apart from its delicacy, Mangoes are important sources of pro-vitamin A (carotenoids), particularly βcarotene" (Rodriguez-Amaya 2001). "These have diverse roles and benefits for human health including antioxidant activity, cell communication, immune function enhancement and UV skin protection" (Palozza and Krinsky 1992).

"Mango has its origin in India and approximately a thousand different types of mango fruits are produced in the country. Annual production of mango in India is 15.19 million tonnes" (FAO, 2011). "Worldwide production of mango is 38.95 million tonnes" (FAO, 2011). It is reported that about 75 % of the fruits are knocked off, right from the flowering stage till ripening. The losses, however, can be minimized to a great extent by utilizing the dropped fruits. Fortunately, mango is one of the few fruits which can be utilized in all stages of maturity [1-3]. But when mango ripened it has delicious taste. Mango can be ripe naturally and artificially, naturally mango is ripened on plant when it goes to the full maturity, but we can also ripen mangos artificially [4,5]. For artificial ripening we can use chemicals and covering materials which enhance the ripening of mango fruits [6-9]. In chemical ripening, unsaturated hydrocarbons such as acetylene and ethylene are used because it can help encourage mango in the ripening process and colour change, but it is harmful for human health [10-13]. Another alternative for ripening mangoes artificially is covering the fruit with different type of covering materials i.e., newspaper, wheat straw, rice straw, plastic bags etc. this is a best option to ripen mangoes artificially [14-16]. This is not harmful for human health and for the fruit quality. Different covering materials have the different effect on the fruits. By the covering of the harvested fruit, we can enhance the shelf life and the quality retention of the fruit.

## 2. REVIEW OF LITERATURE

Buganic et al. (1997) States that "pre harvest wrapping of mango fruits (two months after flower induction) with brown paper or newsprint was studied in different production areas. After field sorting and at the exporter's packinghouse, bagging resulted in at least 70% exportable fruits compared with only about 50% if unbagged".

Debing et al. (2004) states that red mango (Tommy) fruits were bagged with different bagging materials, i.e., sulfate paper, white paper, black double layer paper, black un-woven cloth, white un-woven cloth, and newspaper. The effect of different bagging materials on fruit quality and sticking was studied. The results showed that bagging was effective in preventing diseases and pests and improving fruit appearance qualities. The bagging treatment also improved the effect of sticking words on the surface of red mango fruits.

Martins et al. (2007) observed that "wrapping of guava fruit with paper bag one month prior to harvesting reduced black spot *(Guignardia psidii)* and anthracnose *(Colletotrichum spp.)* infestation. However no noticeable research works have been conducted on safe guava production and handlings".

Sonand et al. (2008) observed that "bagging of fruits with plastic, paper, and two-layer commercial bags was evaluated for control of insect pests and diseases in an experimental apple orchard planted with 'Red Delicious' trees. Results from fruit damage evaluations at harvest showed that bagging significantly reduced fruit damage from direct apple pests compared with non-bagged control plots, and generally provided similar levels of fruit protection when compared with a conventional pesticide spray program. Of the three bagging materials evaluated, plastic bags provided numerically higher levels of fruit protection from insect pests, and two-layer commercial bags provided numerically higher levels of fruit protection from fruit diseases. Fruit quality as measured by percentage Brix was higher in non-bagged control plots than all other treatment plots".

Chonhenchob et al. (2010) States that "pre harvest bagging has been shown to improve development and quality of fruits. Different light transmittance bags showed different effects on fruit quality. This study presents the benefits of using newly developed plastic bagging materials with different wavelength-selective characteristics for mangoes (cv. Nam Dok Mai #4). Mangoes were bagged at 45 days after full bloom (DAFB) and randomly harvested at 65, 75, 85, 95, and 105 DAFB. The bags were removed on the harvest days".

Bilck et al. (2011) observed that "to produce guavas with good commercial or industrial potential, fruit farmers use phytosanitary practices such as fruit bagging. Bagging protects the fruit mainly from the attack of pests, such as the fruit fly (*Anastrepha* spp.) and the guava weevil (*Conotrachelus psidii*) and reduces the use of insecticides and fungicides. This investigation aimed to develop and produce biodegradable films from cassava starch and poly (butylene adipate-co-terephthalate) (PBAT) by extrusion for application in pre harvest guava fruit bagging. After the fruit harvest, for 6–9 weeks all films were more fragile and rigid but did not present cracks. BF70 was the most fragile and had the greatest tendency to tear; however, it remained whole until harvesting".

Pongener et al. (2011) states that "peach (*Prunus persica* L. Batsch) fruits cv. Shan-i-Punjab were harvested at physiologically mature, i.e., colour break stage and packed in small CFB trays, followed by over-wrapping in commercially available packaging films, viz. LDPE, HDPE, shrink and cling films. The film-packed fruits were then stored under cold storage conditions (0-1°C and 90-95% RH) and analysed for quality parameters atweekly intervals. Shrink film proved to be the best among the films in maintaining superior quality up to 28 days of storage as indicated by higher fruit firmness (7.55 lb force), total soluble solids (12.16%), total sugars (9.12%), titratable acidity (0.76%), and lower weight loss (0.93%). The control fruits maintained marketable quality up to 14 days".

Malshe et al. (2017) "The research trial was conducted at Mango Research add danny love Sub-Centre, Rameshwar, Deogad to study the effect of stage of pre harvest bagging with skirting bags on quality of Alphonso mango. The bagging with skirting bags (PP nonwoven fabric) was done at marble stage and retained the bags upto 45, 60, 75 days and at egg stage and retained upto 45, 60 days and at harvest".

Chowdhury et al. (2018) conducted an experiment to evaluate the effect of packaging techniques on the quality and shelf life of mango fruit (cv. kirsapath). Uniform size matured fresh mango (mature stage) was selected and washed with 200 ppm clorax solution for preventing microbial infestation. Then mangoes were kept in five different perforated polypropylene packet (34 micron) viz.O%, 0.25%, 0.5%, 0.75% and 1%. Unpacket mango was used as control treatment. Mangoes were stored at ambient condition (temperature) for observation. Physical appearance and physio-chemical paramefers was observed and recorded. The obtained result stated that stored mango kept in 0.75% peiorated packet was effective in prolonging the shelf life up to 12 days at ambient condition whereas the shelf life of control treatment was 7 days.

Khan et al. (2021) observed that "the interaction of wrapping materials and storage requirements influenced the shelf life and chemical fruit quality of the 'Khirsapat' mango. 'Khirsapat' mangoes were harvested when they were fully mature and wrapped in various materials, viz. Low-density polyethylene (LDPE) + No perforation, LDPE + 5 % perforation, LDPE + Blotting paper inside, LDPE + 5 % perforation+ Blotting paper inside, Corrugated Fiber Board (CFB) Box (5% ventilation), LDPE (5% perforation) + CFB Box (5% ventilation), Plastic crate & Control (without any wrapping). Biochemical parameters such as TSS, titratable acidity, reducing sugars, and total sugars were measured in the fruits".

## 3. MATERIALS AND METHODS

The present investigation was laid out in the Post Harvest Laboratory of Horticulture Department, SHUATS, Prayagraj during the year 2021-2022. We harvest these mangoes from the Central research field, SHUATS Prayagraj. The experiment was laid out in the Rendomized block design (RBD) with 9 treatments and 3 replications the treatments were $T_0$ (Control), $T_1$ (Mango leaves), $T_2$ (Banana leaves), $T_3$ (Guava leaves), $T_4$ (Newspaper), $T_5$ (Plastic bags), $T_6$ (Rice straw), $T_7$ (Wheat straw), $T_8$ (Grasses).

### 3.1 Climatic Condition in the Experimental Site

The area of Prayagraj district comes under subtropical belt in the south east of Utter Pradesh, which experience extremely hot summer and fairly cold winter. The maximum temperature of the location reaches up to $46^o$ C to $48^o$ C and seldom falls as low as $4^oC$ to $5^oC$. The relative humidity ranges between 20 to 94 %. The average rainfall is around 1013.4 mm annually. However, occasional precipitation is also not uncommon during winter months.

## 4. RESULTS AND DISCUSSION

### 4.1 Mango Fruit Weight (g)

Data reveals that lowest weight (g) loss was observed in the treatment $T_2$ (Banana leaves) i.e 194.75 at the harvesting time and 163.00 was observed at 12 Days after storage (DAS) and the highest weight (g) loss was observed in treatment $T_0$ (Control) i.e 126.41at harvesting and 87.66 at 12 DAS. It was occurred due to shriveling, high respiration rate, physiological deterioration, etc.

### 4.2 Mango Fruit Diameter (mm)

Data reveals that the treatment $T_2$ (Banana leaves) gave the maximum fruit diameter (mm) (61.66) during the harvesting time which was *at par* with $T_1$ (Mango leaves). And the treatment $T_2$ (Banana leaves) have the maximum fruit diameter (mm) (59.16) after the storage. All the treatments were significantly superior in their fruit diameter (mm) over control ($T_0$). Best fruit diameter (mm) might be due to the better covering material as compared to uncover fruit.

### 4.3 Mango Fruit Shelf Life (Days)

Data indicates that, after 7 days maximum decay/rotting was occurred in treatment $T_0$ (Control) followed by $T_7$ (Wheat straw). After 12 days of storage the minimum decay was observed in treatment $T_3$ and maximum was found in treatment $T_0$ followed by $T_7$, $T_8$ & $T_4$. Decay increased rapidly after 12 days of storage. This was increasing respiration rate, retarded ripening etc. This might be due to the accumulation or maintenance of high relative humidity in the covering materials that reduced rate of transpiration.

**Table 1. Shelf life (days)**

| Treatment notation | Shelf life (days) |
|---|---|
| T0 | 07.67 |
| T1 | 09.83 |
| T2 | 11.50 |
| T3 | 13.67 |
| T4 | 13.00 |
| T5 | 08.50 |
| T6 | 10.83 |
| T7 | 08.00 |
| T8 | 08.50 |
| F-test | S |
| S.Ed. (+) | 0.38 |
| C.D.at 0.5% | 0.81 |

#### 4.3.1 TSS(°Brix) of mango fruit

TSS of Mango fruit was observed to increase continuously up to the end of research under ambient storage conditions. At beginning of storage maximum Total Soluble Solids (TSS) 10.00 °Brix was observed in $T_6$ (Rice straw) and minimum 8.31 °Brix in $T_0$ (control). It is due to conversion of polysaccharides into sugars during hydrolysis process. Therefore, TSS found to increase slightly with increase in storage period. Similar findings reported by Manivsagan (2011) and by Navitha and Mishra (2018).

#### 4.3.2 Ascorbic acid (mg/100 ml) of mango fruit

Data reveals that at the beginning of storage maximum Ascorbic acid 54.13 mg/100g was observed in $T_2$ (Banana leaves) and minimum is 47.13 mg/100g in $T_0$ (control). At 12 days after storage maximum Ascorbic acid recorded is 31.43 mg/100g in $T_0$ (Control) and minimum 28.21 mg/100g in $T_2$ (Banana leaves). This could be as result of quick evaporation of water from the fruit and concentration of soluble solids which inhibits the reaction of polyphenolase enzymes (Desrosier and desrosier, 1977). The percentage of ascorbic acid loss of this fruit was reported to be about 34-85% with time of storage (Achinewhu, 1983). Also other factors of ascorbic acid loss could be attributed by light, temperature and oxidation at high temperature. (Rai and Chauhan ,2008 and Njoku et al. 2011).

#### 4.3.3 Total sugar (%) of mango fruit

Data revealed that maximum total sugar (5.62 and 12.21) at 0 and $12^{th}$ Days after storage was found in treatment $T_2$ (Banana leaves). Whereas the minimum total sugar (5.38 and 10.35) was found treatment control. The increase in total sugar during storage might be resulting conversion of starch into simple sugar and later reduction in conversion rate was due to utilization of sugar in the process of respiration. Improvement in sugar per cent may be because of converting some cell wall material like hemicelluloses to reducing content under long storing conditions**.** These results are in close similarity with the research because they found, total sugars were improved along with the higher storing period in guava Kaur et al., 2019.

*4.3.3.1 Reducing sugar (%) of mango fruit*

Data reveals that at beginning of storage maximum Reducing sugar 2.75% was observed in $T_3$ (Guava leaves) and minimum is 1.89% in $T_6$ (Rice straw). At 12 days after storage maximum Reducing sugar recorded is 5.03% in $T_7$ (wheat straw) and minimum 4.81% in $T_4$ (Plastic bags). The increase in reducing sugars due to conversion of starch into simple sugar and later reduction in conversion rate was due to utilization of sugar in the process of respiration. Improvement in sugar per cent may be because of converting some cell wall material like hemicelluloses to reducing content under long storing conditions**.**

*4.3.3.2 Non- reducing sugar (%) of mango fruit*

Data reveals that at beginning of storage maximum non- reducing sugar 3.71% was observed in $T_6$ (Rice straw) and minimum is 2.73% in $T_3$ (Guava leaves). At 12 days after storage maximum non- reducing sugar recorded is 7.34% in $T_2$ (Banana leaves) and minimum 5.48% in $T_0$ (Control). It might be because of an increase in reducing sugars and non-reducing sugars resulting conversion of starch into simple sugar and later on reduction in conversion rate was due to utilization of sugar in the process of respiration. Improvement in sugar per cent may be because of converting some cell wall material like hemicelluloses to reducing content under long storing conditions (Stahi and Camp, 1971). These results are in close similarity with the results of Parihar and Kumar (2007).

## 4.4 Sensory Evaluation

The sensory evaluation of different attribute of stored mango was observed according to the opinion of test panel judges which comprising 5 members. The mean score showed that treatment $T_2$ (Banana leaves) (7.99) was most preferred considering all the points as colour, appearance, texture, taste and overall acceptability followed by treatment $T_6$ (Rice straw) (6.74) and treatment $T_1$ (Mango leaves) (6.37).

**Table 2. Sensory evaluation (organoleptic score) of mango fruit**

| Treatment notation | Colour and appearance | Texture | Taste and flavour | Overall acceptability |
|---|---|---|---|---|
| T0 | 5.25 | 5.50 | 6.00 | 5.58 |
| T1 | 6.50 | 6.25 | 6.37 | 6.37 |
| T2 | 8.12 | 7.87 | 8.00 | 7.99 |
| T3 | 6.00 | 6.37 | 6.25 | 6.20 |
| T4 | 5.75 | 6.25 | 6.12 | 6.04 |
| T5 | 5.37 | 5.00 | 5.62 | 5.33 |
| T6 | 7.00 | 7.12 | 6.12 | 6.74 |
| T7 | 5.50 | 5.87 | 6.50 | 5.95 |
| T8 | 5.75 | 5.25 | 5.87 | 5.62 |

**Table 3. Effect of different covering materials on ripening and physiochemical properties of dasheri mango at 0 days after storage**

| Treatment notation | Fruit weight | Fruit diameter | TSS (°Brix) | Ascorbic acid (mg/100ml) | Total sugar (%) | Reducing sugar (%) | Non-reducing sugar (%) |
|---|---|---|---|---|---|---|---|
| T0 | 126.41 | 52.83 | 8.31 | 47.13 | 5.38 | 2.31 | 3.06 |
| T1 | 174.00 | 59.16 | 9.38 | 52.23 | 5.58 | 2.36 | 3.17 |
| T2 | 194.75 | 61.66 | 9.76 | 54.13 | 5.62 | 1.92 | 3.70 |
| T3 | 171.83 | 58.50 | 9.55 | 50.51 | 5.48 | 2.75 | 2.73 |
| T4 | 153.41 | 57.33 | 9.35 | 51.28 | 5.48 | 2.32 | 3.16 |
| T5 | 143.91 | 56.33 | 9.36 | 48.71 | 5.46 | 2.53 | 2.97 |
| T6 | 186.66 | 60.50 | 10.00 | 52.71 | 5.61 | 1.89 | 3.71 |
| T7 | 201.33 | 59.33 | 9.05 | 51.45 | 5.46 | 2.23 | 3.22 |
| T8 | 157.41 | 56.16 | 9.13 | 50.61 | 5.47 | 2.37 | 3.25 |
| F-test | S | S | S | S | S | S | S |
| S.Ed. (+) | 10.61 | 1.47 | 0.6 | 1.82 | 0.18 | 0.22 | 0.25 |
| C.D.at 0.5% | 22.48 | 3.12 | 1.26 | 3.86 | 0.38 | 0.47 | 0.53 |

**Table 4. Effect of different covering materials on ripening and physiochemical properties of dasheri mango at 12 Days after storage**

| Treatment notation | Fruit weight | Fruit diameter | TSS (°Brix) | Ascorbic acid (mg/100ml) | Total sugar (%) | Reducing sugar (%) | Non-reducing sugar (%) |
|---|---|---|---|---|---|---|---|
| T0 | 87.66 | 51.25 | 11.70 | 31.43 | 10.35 | 4.86 | 5.48 |
| T1 | 153.25 | 57.75 | 12.66 | 28.81 | 11.78 | 4.83 | 6.97 |
| T2 | 163.00 | 59.16 | 13.21 | 28.21 | 12.21 | 4.87 | 7.34 |
| T3 | 143.00 | 57.08 | 11.83 | 30.48 | 11.10 | 4.91 | 6.19 |
| T4 | 129.00 | 55.83 | 11.25 | 29.38 | 11.28 | 4.81 | 6.46 |
| T5 | 117.16 | 54.91 | 11.60 | 30.68 | 10.97 | 4.90 | 6.07 |
| T6 | 155.41 | 58.41 | 12.83 | 28.25 | 11.95 | 4.88 | 7.05 |
| T7 | 130.16 | 57.66 | 11.35 | 30.15 | 11.01 | 5.03 | 5.98 |
| T8 | 139.00 | 54.66 | 11.81 | 29.16 | 11.03 | 4.87 | 6.16 |
| F-test | S | S | S | S | S | S | S |
| S.Ed. (+) | 5.5 | 1.36 | 0. 18 | 2.73 | 0.26 | 0.13 | 0.3 |
| C.D.at 0.5% | 11.66 | 2.88 | 0.38 | 5.8 | 0.55 | 0.27 | 0.63 |

## 5. DISCUSSION

The treatment $T_2$ (Banana leaves) gave the maximum fruit weight (g) (163) followed by $T_6$ (Rice straw) with fruit weight (155.41) and lowest fruit weight (87.66) was recorded in $T_0$ (control). All the treatments were significantly superior in their fruit weight (g) over (control) $T_0$.

The treatment $T_2$ (Banana leaves) gave the maximum fruit diameter (mm) (59.16) followed by $T_1$ (Mango Leaves) with fruit diameter (57.75) and lowest fruit diameter (51.25) was recorded in $T_0$ (control). All the treatments were significantly superior in their fruit diameter over control ($T_0$).

The treatment $T_2$ (Banana leaves) gave the maximum total soluble solids ($^0$Brix) (13.21) followed by $T_6$ (Rice straw) with the TSS (12.83 $^0$Brix). All the treatments were significantly superior in their total soluble solids ($^0$Brix).

The treatment $T_0$ (control) gave the maximum ascorbic acid (mg/100g) (31.43). Whereas the minimum ascorbic acid (mg/100g) (28.21) was found in treatments $T_2$ (Banana leaves).

Total sugar has shown an increasing trend during storage. The maximum Total sugar (12.21%) was recorded in $T_2$ (Banana leaves) and minimum total sugar (10.35%) in $T_0$ (control). All the treatments were significantly superior in their total sugar (%) over control $T_0$ and $T_5$ (Newspaper).

Reducing sugar has shown an increasing trend during storage and the maximum Reducing sugar (5.03%) was recorded in $T_7$ (Wheat straw) and minimum reducing sugar (4.81%) was recording in $T_4$ (Plastic bag).

Non-reducing sugar has shown an increasing trend during storage. The maximum non-reducing sugar (7.34%) was recorded in $T_2$ (Banana leaves) and minimum non-reducing sugar (5.48%) in $T_0$ (control). All the treatments were significantly superior in their non-reducing sugar (%) over control $T_0$ and $T_7$ (Wheat straw).

## 6. CONCLUSION

Based on the present findings, it is concluded that treatment T2 (Banana leaves) performed best in terms of TSS (13.21°Brix), Ascorbic acid (28.21mg/100 ml), total sugar (12.21%), reducing sugar (4.87%), non-reducing sugar (7.34%) and the treatment $T_3$ (Guava leaves) gave the longest shelf life (13.67 Days) followed by treatment $T_4$ (Newspaper) and treatment $T_2$ (Banana leaves) (13.00 Days & 11.50 Days) respectively.

Highest B:C ratio (1.7) was also found in the same treatment i.e., T2 (Banana leaves) and the lowest B:C ratio (1.3) found in treatment $T_0$ (control).

## COMPETING INTERESTS

Authors have declared that no competing interests exist.

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