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# IDENTIFICATION OF THE BEST PACKAGING MATERIALS FOR INCREASING SHELF LIFE AND QUALITY OF BANANA CV. GRAND NAINE DURING STORAGE CONDITION

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**ABSTRACT**

The present study was conducted in the Department of Horticulture, I.T.M. University, Gwalior, M.P., India from August to October 2022 to identify the best packaging materials for increasing shelf life and quality of banana cv. Grand Naine during storage condition. Low Density Poly bag (Black), News paper Bag, Cardboard, Gunny Bag, Paper Bag and High Density Poly bag, Banana Leaf and Paddy Straw were used as packaging materials. Four days following each treatment, banana samples were collected to measure several biological and physical characteristics such as pH, physiological weight, and peel colour. In comparison to the control group, the treatment group displayed the largest physiological weight loss, as indicated by the results provided for the analyses of variance (ANNOVA). The treatment $T_6$ high-density white poly bag, on the other hand, had the most aesthetically pleasing hue and the least physiological weight loss is recorded in the treatment $T_6$ high-density white poly bag, while the minimum values recorded for these parameters are found in Treatment $T_0$ control. The peel's least yellow hue is observed throughout treatment to regulate the highest total soluble solid brix value, which was recorded in treatment $T_1$ low-density black poly bag. The maximum pH value was recorded in Treatment $T_7$ banana leaf and the lowest pH value was noted in treatment $T_0$ control. In contrast to the current experimental findings, the observational data showed that the banana fruit's pH increased as it ripened.

***Key words :*** Banana, Packaging material, Aesthetically, Grand Naine, Shelf-life.

## Introduction

Because of its inexpensive cost and great nutritional content, banana consumption is extremely high. Both the raw and cooked forms of the fruit are eaten. Bananas are a good source of vitamin B and carbohydrates. Additionally, it is a good source of calcium, magnesium, potassium, and phosphorus. Due to its simple digestion and lack of fat and cholesterol, it can be easily incorporated into a balanced diet. When used frequently, it lowers the risk of heart disease and is advised for people with high blood pressure and kidney problems (Jadhav *et al.*, 2018).

Banana can be classified into two groups that is *Musa acuminata* and *Musa balbisiana*. The modern edible species of *acuminata* are considered as edible and widely consumed while the species of *balbisiana* are used for cooking purposes. The cultivated banana cultivars are descendent of either *Musa acuminata* or *Musa balbisiana* or their hybrids.. They are consumed both as an energy yielding food and as a dessert (Dadzie and Orchard *et al.*, 1997).

The cultivation of banana is done in varied climatic conditions with different spells of dry season and precipitation. It can be grown in wide range of temperatures which makes it easy to adopt in different weather conditions. Within this band, there are varied climates with different lengths of dry season and different degrees and patterns of precipitation. A temperature range of 15 to 38°C occurs in most production areas, with the optimum temperature being 27°C (Nakasone and Paul *et al.*, 1999).

The abiotic elements including temperature, rainfall, and water have a negative impact on yields. Tropical and subtropical climates are the only places, where bananas are grown. The variation in temperature reflects the variation in the crop's yield. Longer time is needed for maturation. Reduced rainfall during the growing season may result in lower crop yields. Production of bananas is only permitted in tropical or nearby tropical areas, roughly between latitudes 30°N and 30°S. When temperatures are over 24°C for an extended length of time, yields are higher. The crop needs more time to mature in cooler climates. Low humidity and temperature during the active growth period of the plant result in lower growth and yields. Rainfall of 100 mm per month on average is necessary for banana crops and there should not be more than 3 months of dry season (Morton *et al.*, 1987).

Maintaining the product's long-term freshness, appearance, and quality depends heavily on its packaging. Therefore, this study was designed to assess the post-harvest handling methods currently in use for packaging materials, determine which methods are more cost-effective than other conventional methods for packaging bananas and determine which alternative is better and safer for extending the shelf life and quality of bananas.

## Materials and Methods

### Experimental location

The experiment was conducted in the laboratory of Department of Horticulture, I.T.M. University, Gwalior, M.P., India during the period from October to December 2022. The experimental laboratory is located in Gwalior which is in the center of the surrounded area, and is mostly plain. Although its southern part is surrounded by hills. Gwalior is located at 26.22 N 78.18E. It is at an average elevation of 197 meters (646 feet).

### Treatments and experimental design

The Experiment was conducted in Completely Randomized Design (CRD) with 9 treatments of Banana with four replications of four fruits per replication in the Post-Harvest Laboratory of Department of Horticulture, I.T.M. University, Gwalior during October 2022. Total numbers of treatments were nine *viz*. $T_0$: Control, $T_1$: Low Density Poly bag (Black), $T_2$: News paper Bag, $T_3$: Card board, $T_4$: Gunny Bag, $T_5$: Paper Bag, $T_6$: High Density Poly bag (White), $T_7$: Banana Leaf, $T_8$: Paddy Straw.

### Experimental methods

The study was conducted in a laboratory setting with room temperature and an open environment as a control. Mature Grand Naine fruits that were physiologically green were gathered from the Gwalior Farmer market. Fruits were packed in cardboard to prevent light and heat damage and to make handling easier. The transportation was done in the morning. The obtained banana was divided into 32 observations using various packaging materials in the lab and it was kept there at room temperature. The samples are all the same hue, shape and size. The fruits were put in a lab after being rated in each type of packaging.

### Data collection

Data were collected from banana fruit of different packaging materials on four days interval the sample of banana fruits in each treatment was taken randomly for assessment data was recorded at three days interval over the storage period.

### Physical parameters

### Fruit weight (g)

Following the last picking, the following formula was used to determine the fruit's average weight:

Average fruit weight = Total weight of fruits (g)/ Number of fruits

### Fruit length (cm)

Fruit length was measured using a centimeter scale and expressed as a length in centimeters.

### Fruit volume (ml)

Using a measuring cylinder and the water displacement method, the fruit's volume was calculated and expressed in milliliters.

### Fruit specific gravity

By dividing the fruit's weight by its volume, the specific gravity of the fruit was calculated.

### Physiological weight loss

The bananas used in this study were weighed using a top balance and kept for storage. The initial weight of banana fruits was taken before storing at different packaging materials and records the weight at four days interval. The sum of the weight loss was taken as the four days interval gives total weight loss, which was converted to percentage weight loss using the following formula. Percent total weight loss was calculated at intervals of 0, 3, 6 and 9 days of storage using the following formula:

$$\text{Percent weight loss (\%)} = \frac{\text{Initial weight of banana (g)} - \text{Weight after interval (g)}}{\text{Initial weight of banana (g)}} \times 100$$

**Peel colour**

Colour was measured by comparing with the colour chart described by Dadzie and Orchard (1997). The chart consisted of the seven stages of banana ripening where 1 is dark green, 2 is light green, 3 is more green than yellow, 4 is more yellow than green, 5 is yellow with green tips, 6 is fully yellow, and 7 is flecking (Kader, 1992).

**Decay or spoilage (%)**

At 0, 3, 6 and 9 days following storage, data on fruit decline or spoilage were also collected from the four replications. After that, it was statistically averaged and examined. Weight was used to calculate decay loss. Fruits that showed signs of degradation from over ripening and pathogenic infection were weighed the day of each inspection. Fruits that had already started to rot were included in the weight of the deteriorated fruits. The Srivastava and Tandon (1968) formula was used to compute the percent decay loss.

$$\text{Decay loss (\%)} = \frac{\text{Weight of decayed fruit}}{\text{Initial weight of fruits at the time of packaging}} \times 100$$

**Chemical parameters**

**Pulp pH**

The pH of the sample banana juice was measured using a bench top digital pH meter (model: CP-505, Poland). The pH meter was periodically calibrated with buffer at pH 4.0 and 7.0 before taking the measurements. Only 15gm banana samples were homogenized in distilled and de-ionized water and the pH of homogenate was measured with a pH meter.

**Total soluble solids (°Brix)**

Total soluble solids (°Brix) Sample fruits were blended using a juice blender and TSS of the juice was measured by the refractive index, expressed as °Brix, using a bench top digital Refractometer (Model: SN-003007). Total soluble solids (TSS) content of banana fruit pulp was estimated by using Abbe's refractometer. A drop of banana juice squeezed from the fruit pulp on the prism of the refractometer. Percent TSS was obtained from direct reading of the instrument. Temperature corrections were made by using the methods described by Ranganna (1979).

**Total sugar content (%)**

The fruits' total sugar content was measured using the following technique at 0, 3, 6 and 9 days after storage: A 250 ml flask was filled with 50 ml of the cleared solution, 5g of citric acid, and 50 ml of water. To completely invert the sucrose, it was gently cooked for 10 minutes, after which it was chilled. Transferred, neutralized with 1 N NaOH using phenolphthalein, and titrated with Fehling solution in a 250 ml flask. The following formula was used to determine the total sugar percentage:

$$\text{Total sugar (\%)} = \frac{\text{Factor} \times \text{Dilution} \times 100}{\text{Weight of the sample}}$$

**Reducing sugar content (%)**

The following method was applied to calculate the reducing sugar content (%) at 0, 3, 6, 9 and 12 days after storage:

**a) Preparation of fruit juice solution**

2 g of fruit were crushed in 20 millilitres of ethanol, and the mixture was then filtered through muslin to create a uniform pulp juice. The estimate of sugars was done by diluting 20 ml of juice sample to 100 ml with distilled water.

**b) Preparation of Fehling's solution**

(i) Fehling's solution "A" was created by weighing 34.63 g of copper sulphate (A.R.) crystals on an analytical scale and then pouring them into a dry, clean 500 ml volumetric flask. 0.5 cc of strong sulfuric acid was added, along with distilled water. After thoroughly shaking the mixture to dissolve it, distilled water was added to get the volume up to the required level (500 ml).

(ii) Fehling solution "B" was created by dissolving 173.0 g of pure sodium potassium tartrate (Rochelle salts) with 50 g of sodium hydroxide in distilled water.

(iii) A 0.5 percent glucose solution was made by dissolving 2.5 g of glucose (A.R. anhydrous) in 500 ml of distilled water.

(iv) Sugar reduction in fruit juice was calculated using a method Nelson (1944) recommended.

(v) Fehling's "A" and "B" solutions, totaling about 5 ml each, were added to a 300 ml conical flask and diluted with 40 ml of distilled water. The juice solution was added gradually to the heated, boiling Fehling's solution until a faint crimson hue appeared. Three drops of methylene blue indicator were now added, and the titration was maintained until the blue coloration was destroyed by the appearance of a brick red precipitate.

(vi) The reducing sugar in percentage was calculated with the help of following formula:

$$\text{Reducing sugar (\%)} = \frac{0.25}{\text{Buretee reading}} \times 100$$

**Non-reducing sugar content (%)**

Non-reducing sugar content of the fruits was observed at 0, 3, 6 and 9 days after storage. The differences in percentage between total sugar and reducing sugar were taken as the estimate of non-reducing sugar.

Non-reducing sugar (%) = Total sugars (%) – Reducing sugar (%)

**Acidity (%)**

The acidity was calculated using the straightforward acid-alkali titration method as given in A.O.A.C (1970) at 0, 3, 6 and 9 days after storage. Using a pipette, 20 ml of fruit juice solution was placed into a 100 ml flask, and the remaining 100 ml was filled with distilled water. To dissolve, it was vigorously shook. 3 drops of phenolphthalein indicator were added to 0.25 ml of diluted fruit juice that had been pipette-transferred into a 250 ml beaker. Juice was titrated with alkali solution drop by drop while swirling continuously in the burette filled with N/10 NaOH solution until the pink end point was achieved. The end point readings and the percentage

Total acidity per cent = 0.128 × Titre value × 100

## Results and Discussion

Physical and chemical changes are evaluated of shelf life at the end of the storage duration, *i.e.*, 0, 3, 6 and 9 days. Result reported that the different packing materials were significantly influenced physical parameters at different days after storage and the treatment $T_1$ (Black Low density poly bag) was found the best packing material treatment for enhancing shelf life of banana and it gave the maximum physical parameters (*viz*., fruit weight, fruit volume and specific gravity) at 0, 3, 6 and 9 days. According to Tadesse (2011), transpiration and respiration are the main causes of weight loss in fresh fruit. The packaging's effect on this is indirect. High relative humidity, a low respiratory rate and low temperature concentrations in the polyethylene bag prevent the banana fruit from losing weight (Blakely *et al*., 2011) compared to other packaging options fruits wrapped in polythene bags see the least physiological weight loss and controls this because low-temperature storage slows down the synthesis of ethylene and respiration extending the shelf life of bananas and causing less weight loss. Researchers like; Hoffman *et al*. (2002), Perez *et al*. (2004), Workneh and Osthoff (2010), Getnet *et al*. (2011) supported

**Table 1 :** Mean comparison for physical parameters of banana fruit as influenced by packaging material at the end of 9 days.

| S. no. | Treatment Symbols | Treatments | Physiological Weight Loss (G) | Peel colour | Fruit weight (G) | Fruit length (cm) | Fruit volume (ml) | Fruit specific gravity | Decay or Spoilage (%) |
|---|---|---|---|---|---|---|---|---|---|
| 1 | $T_0$ | Control | 11.25 | 4.05 | 58.01 | 13.35 | 50.07 | 0.55 | 3.19 |
| 2 | $T_1$ | Low Density Poly bag (Black) | 4.47 | 5.66 | 73.09 | 13.91 | 68.11 | 0.67 | 2.53 |
| 3 | $T_2$ | Newspaper Bag | 9.36 | 4.75 | 68.28 | 13.64 | 58.20 | 0.61 | 2.40 |
| 4 | $T_3$ | Cardboard | 6.89 | 4.36 | 73.09 | 13.71 | 65.14 | 0.63 | 2.30 |
| 5 | $T_4$ | Gunny Bag | 8.77 | 4.45 | 71.29 | 13.68 | 64.46 | 0.64 | 2.48 |
| 6 | $T_5$ | Paper Bag | 9.85 | 4.83 | 66.57 | 13.64 | 58.53 | 0.55 | 2.69 |
| 7 | $T_6$ | High Density Poly bag (White) | 6.15 | 5.02 | 59.20 | 13.61 | 53.29 | 0.56 | 3.23 |
| 8 | $T_7$ | Banana Leaf | 7.16 | 5.15 | 65.89 | 13.57 | 54.21 | 0.59 | 2.41 |
| 9 | $T_8$ | Paddy Straw | 6.47 | 4.85 | 62.92 | 13.53 | 59.22 | 0.58 | 2.82 |
| | **SEm±** | | **0.709991** | **0.157863** | **0.871** | **0.06910** | **0.615** | **0.015** | **0.021** |
| | **CD at 5%** | | **0.272414** | **0.098847** | **2.479** | **0.16198** | **1.979** | **0.042** | **0.063** |

**Table 2 :** Mean comparison for biochemical parameters of banana fruit as influenced by packaging material at the end of 9 days.

| S. no. | Treatment Symbols | Treatments | pH of fruit | Tss (°brix) | Total sugar Content (%) | Reducing sugar Content (%) | Non-Reducing Sugar Content (%) | Acidity (%) |
|---|---|---|---|---|---|---|---|---|
| **1** | **$T_0$** | Control | 4.28 | 12.65 | 2.13 | 1.47 | 0.55 | 0.48 |
| **2** | **$T_1$** | Low Density Poly bag (Black) | 4.86 | 23.02 | 2.96 | 2.72 | 0.79 | 0.36 |
| **3** | **$T_2$** | Newspaper Bag | 4.52 | 17.69 | 2.68 | 1.86 | 0.66 | 0.38 |
| **4** | **$T_3$** | Cardboard | 4.52 | 19.48 | 2.90 | 2.13 | 0.76 | 0.39 |
| **5** | **$T_4$** | Gunny Bag | 4.25 | 19.76 | 2.84 | 2.56 | 0.66 | 0.33 |
| **6** | **$T_5$** | Paper Bag | 4.22 | 17.35 | 2.58 | 1.86 | 0.62 | 0.36 |
| **7** | **$T_6$** | High Density Poly bag (White) | 4.58 | 21.10 | 2.48 | 1.56 | 0.66 | 0.54 |
| **8** | **$T_7$** | Banana Leaf | 4.65 | 18.64 | 2.46 | 1.76 | 0.69 | 0.46 |
| **9** | **$T_8$** | Paddy Straw | 4.78 | 19.13 | 2.36 | 1.65 | 0.56 | 0.43 |
| | **SEm±** | | 0.149078 | 0.9556 | 0.021 | 0.014 | **0.010** | **0.013** |
| | **CD at 5%** | | 0.091982 | 0.1528 | 0.053 | 0.041 | **0.029** | **0.033** |

according to Thompson *et al*. results from 2002 fruits in polyethylene bags lost weight at a rate that was noticeably lower than that of fruits that weren't packaged.

For the purpose of extending the shelf life of banana fruits, a number of treatments, such as low-density poly bag (black), news paper bag, cardboard, gunny bag, paper bag, high-density poly bag (white), banana leaf and paddy straw have been demonstrated to be effective. The biochemical properties of the banana, particularly the pulp's pH and total soluble solids (°Brix) were altered by the packaging materials used in this experiment and this is crucial information to grasp. The unpackaged banana in treatment $T_0$ (Control) followed by treatment $T_7$ (Banana Leaf) had the lowest TSS at the end of the 12-day experiment. At the conclusion of the 12-day experiment, the unpackaged banana in treatment $T_0$ (control) had the lowest TSS, followed by treatment $T_5$ (paper bag) and the highest pH value was found in treatment $T_7$ (banana leaf), followed by treatment $T_8$ (paddy straw). The findings of Albertini *et al*. (2006), which showed that the pH of the banana fruit rose as the fruit ripened, confirmed the conclusion.

## Conclusion

The physical and biochemical factors can be used to compare the impacts of different packaging materials on the shelf life and quality of banana fruit and identify the best packaging material. These parameters have a significant impact on the shelf life of banana fruits. For the physiological weight loss, peel colour, pulp pH and total soluble solids with having a superior perish ability visual appearance and better quality. The treatment $T_1$ low density black poly bag was found to be the best. I will advise using low density black poly bag treatment $T_1$ as the best packaging material to extend the shelf life and maintain good quality of banana fruit after harvesting.

### Recommendations

The further research work is needed to correlate with the finding of the present and previous investigations. Investigations should try on larger number of fruits to confirm the results of the research work. Due to their great perish ability; it might not be possible to draw clear conclusions from this single trial by concentrating exclusively on the effects of various packaging materials. In order to preserve its quality and shelf-life and to reach definitive conclusions, advance packaging materials should be included in further time-treatment trials using a range of parameters.

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