Original Research Article

Evaluate the effect of different packaging materials on the shelf life and quality of banana fruit

Abstract

The experiment was carried out to determine *the* impact *of shelf life on banana cv. grand*naine under various packing materials during storage for the current study in the department of horticulture lab at ITMU from October to December 2022. In this experiment, low-density polybags and black newspaper bags were employed as packing materials. paper bag, cardboard gunny bag high-density polybag white paddy straw with banana leaves Banana samples were taken at intervals of four days after each treatment to test a range of biological and physical traits, including pH, physiological weight, and peel colour. As these values were given for the analyses of variance and ANNOVA, the treatment group showed the greatest physiological weight reduction as compared to the control group; however, the Treatment T_6 high-density white polybag showed the lowest physiological weight loss and the most appealing colour. is recorded in the treatment T_6 high-density white polybag, whereas the peel's least yellow hue is observed throughout treatment to regulate the highest total soluble solid brix value was recorded in Treatment T_1 low-density black polybag, and the minimum values recorded for these parameters are found in Treatment T_0 control, while the maximum ph value was recorded in Treatment T_7 banana leaf and the minimum ph value was noted in Treatment T_0 control. According to the observational data, the banana fruit's pHrose as it ripened, further from the present experimental findings. The best packaging material suitable for the enhancement of shelf life and maintenance of visual appearance and quality for bananas is low-density black polythene Treatment T_1.

Keywords: Banana, Packaging Materials, GrandNaine, 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 carbs. 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).High levels of vitamins and minerals can be found in bananas. It may be grown in a variety of environmental settings and is readily available. The versatile uses of the sugar-rich, low-fat bananas include infant food, functional food, dessert, and staple foods high in carbohydrates (Mohapatra et al., 2009). With an output of 28.45 million tonnesfrom an area of 802.6 thousand ha and a productivity of 37 mt/ha, India is the world's greatest producer of bananas (Musa sp.) (NHB, 2015).Bananas are grown under a variety of climatic circumstances, with varying amounts of precipitation and dry seasons. It can be raised in a wide range of temperatures, making it simple to adapt to various weather patterns. There are various climates inside this zone, each with its dry season length, degree, and pattern of precipitation. Most producing sites see temperatures in the range of 15 to 38°C, with 27°C being the ideal temperature (Nakasone and Paul et. al, 1999).The abiotic elements including temperature, rainfall, and water hurt yields. To improve the quality of banana fruits sold in local markets, it is imperative to look forthe best alternative ways that don't harm human health and can at the very least be implementedin a small-scale ripening system. The packaging is crucial in maintaining the product's long-termfreshness,
look,andquality.Asaresult,thisstudywascreatedtoevaluatethecurrentlyusedpost-harvest handling method for packaging materials, identify the more economical methods incomparisontoothertraditionalmethodsusedforpackagingbananas,andidentifyabetterand saferalternativefor enhancingthequality andshelflifeofbananas.

Materials and Methods

Experimental location

The experiment was conducted in the laboratory of the Department of Horticulture, ITM University during the period from October to December 2022. The experimental laboratory is located in Gwalior which is in the center of the surrounding area, and is mostly flat. Although its southern part is surrounded by hills, above sea level is only a few hundred feet height. Gwalior is located at 26.22 N 78.18E. It has an average elevation of 197 meters (646 feet).Climate of Gwalior experiences extremes in both summer and winter. During the summer months, the climate of Gwalior is dominated by the heat and the level of humidity also increases. From April to June of April, Gwalior gets 45 to 47 °C temperature. The climate of Gwalior is particularly humid in the year. Gwalior has 30°C average temperatures in summer. **(nic.in).?????**

Treatments and Experimental Design

The Experiment was conducted in a Completely Randomized Design (CRD) with 9 treatments of Banana with four replications of four fruits per replication in the Post-Harvest Laboratory of the Department of Horticulture, ITM University, and Gwalior during October 2022. The total number of treatments was nine viz. T_0: Control, T_1: Low Density Polybag (Black), T_2: Newspaper Bag, T_3: Cardboard, T_4: Gunny Bag, T_5: Paper Bag, T_6: High Density Polybag (White), T_7: Banana leaf, $T_{8:}$ Paddy Straw.

Table 1. Details of Treatments and Experimental Design

S.No	Treatment Symbols	Treatments
1	T_0	Control
2	T_1	Low Density Polybag (Black)
3	T_2	Newspaper Bag
4	T_3	Cardboard
5	T_4	Gunny Bag
6	T_5	Paper Bag
7	T_6	High Density Polybag (White)
8	T_7	Banana Leaf
9	T_8	Paddy Straw

Experimental Methods

The experiment was carried out in laboratory conditionsat room temperature and open air as control. Physiologically green mature Grand Naine fruit was harvested from the Gwalior Farmer market site. Transportation was carried out in the morning and fruits were packaged in cardboard to avoid light, and heat damage and it is easy to handle. In the laboratory, the collected banana was separated into32 observations of different packaging materials and stored at room temperature. The samples have uniform sizes, shape, and colour. The fruits were graded in each packaging material and placed in the laboratory with four replications. Three fruits were packed per treatment and twelve fruits per replication. A total of 96 fruits were used for all eight packaging materials and 4 replicationsper treatment.

Data Collection

Data were collected from banana fruitsof different packaging materials at four days intervals the sample of banana fruits in each treatment was taken randomly for assessment data was recorded at four days intervalsover the storage period.

2.4.1. Physical Parameters

2.4.1.1 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

2.4.1.2 Fruit length (cm)

Fruit length was measured using a centimetre scale and expressed as a length in centimetres.

2.4.1.3Fruit volume (ml)

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

2.4.1.4 Fruit specific gravity

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

2.4.1.5 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 them in different packaging materials and the weight was at four-day intervals. The sum of the weight loss was taken as the four-day 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 4, 8, and 12 days of storage using the following formula:

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

2.4.1.6Peel colour

Colour was measured by comparing it 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).

2.4.1.7 Decay or spoilage (%)

At 0, 3, 6, 9, and 12 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 on 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.

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

2.4.2Chemical Parameters

2.4.2.1 Pulp ph

The pH of the sample banana juice was measured using a benchtop 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 15g banana samples were homogenized in distilled and de-ionized water and the pH of homogenate was measured with a pH meter.

2.4.2.2. Total soluble solids (°Brix)

Total soluble solids (°Brix) Sample fruits were blended using a juice blender and the TSS of the juice was measured by the refractive index, expressed as °Brix, using a benchtop digital Refractometer (Model: SN-003007). The 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 a direct reading of the instrument. Temperature corrections were made by using the methods described by Ranganna (1979).

3.4.2.3 Total sugar content (%)

The fruits' total sugar content was measured using the following technique at 0, 3, 6, 9, and 12 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:

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

2.4.2.4Reducing 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 grams 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:

✓ 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).

- ✓ 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.
- ✓ A 0.5 percent glucose solution was made by dissolving 2.5 g of glucose (A.R. anhydrous) in 500 ml of distilled water.
- ✓ Sugar reduction in fruit juice was calculated using a method Nelson (1944) recommended.
- ✓ 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 added, and the titration was maintained until the blue coloration was destroyed by the appearance of a brick-red precipitate.
- ✓ The reducing sugar in percentage was calculated with the help of the following formula:

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

2.4.2.5Non-reducing sugar content (%)

Non-reducing sugar content of the fruits was observed at 0, 3, 6, 9, and 12 days after storage. The differences in percentage between total sugar and reducedsugar were taken as the estimate of non-reducing sugar.

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

2.4.2.6Acidity (%)

The acidity was calculated using the straightforward acid-alkali titration method as given in A.O.A.C (1970) at 0, 3, 6, 9, and 12 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 shaken. 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. The juice was titrated with alkali solution drop by drop while swirling continuously in the burette filled with N/10 NaOH solution until the pink endpoint was achieved. The endpoint readings and the percentage

$$\text{Total acidity per cent} = 0.128 \times \text{titre value} \times 100$$

3. Results and Discussion

The information gathered on the physicochemical parameters for this chapter at the end of storage times and the results of the current study's statistical analysis of the impact of different packaging materials on banana cv grand naine shelf life during storage are described. The findings involved determining how long bananas would last in various packing materials. A physicochemical analysis of bananas packaged in various materials was conducted, with the results discussed in detail and data recorded for the various packaging materials. Physical and chemical changes are supplied for the evaluation of shelf life at the end of the storage duration, i.e., 0, 4, 8, and 12 days which is given below: 0, 3, 6, 9, and 12

3.1. Physical parameters:

it has been demonstrated that using a variety of treatments such as low-density polybagsblack newspaper bags cardboard gunny bags paper bags high-density polybags white banana leaf and paddy straw can extend the banana's physical characteristics including its peel and physiological weight loss the shelf life of banana fruits after the 12-day experiment the packaging materials employed in this study are critical 15.45g unpackaged and treatment T_7 banana leaf 13.54g had the highest physiological weight loss while treatment T_6high-density white polybag 8.36g followed by treatment T_1 low-density black polybag 8.79g had the lowest physiological weight loss. 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 control 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 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.

3.2. Bio- Chemical Parameters

The results showed that treatment T_1(BlackLow-Density Polybag), which was significantly superior to all other treatments for influencing the shelf life of bananas, had the maximum levels of biochemical parameters at different days after storage, including pH, TSS, total sugar content, reducing sugar content, non-reducing sugar content, and ascorbic acid content, while it had the lowest levels at the end of 12 days interval. The biosynthesis processes or polysaccharide degradation during maturation are responsible for the increase in several biochemical parameters.Fruit quality and shelf life appear to be related to airflow and material hardness.After 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. As the research thesis explains, the acidity of fruits is caused by a variety of organic acids that are consumed during respiration. Scientists like Babitha and Kiranmayi et al. (2010) have shown that amino acids have also been shown to be the main acid in banana juice, with the pH of fruit normally between 6.2 and 6.7. However, work by Moneruzzaman et al. (2009) shows the acidity has thus decreased with advancing.

Table 2. Mean comparison for physical parameters of banana fruit as influenced by packaging material at the end of 12 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	13.95	4.83	35.13	5.28	31.27	0.49	15.40
2	**T_1**	Low Density Polybag (Black)	8.79	6.14	48.39	6.93	34.96	0.57	10.16
3	**T_2**	Newspaper Bag	12.45	5.36	43.74	5.59	33.20	0.54	11.19
4	**T_3**	Cardboard	11.55	5.96	46.06	6.30	37.00	0.55	10.14
5	**T_4**	Gunny Bag	10.96	5.28	44.21	6.25	37.66	0.51	10.43
6	**T_5**	Paper Bag	12.38	6.77	43.28	6.22	35.27	0.48	11.75
7	**T_6**	High Density Polybag (White)	8.36	6.75	37.60	5.68	34.34	0.49	15.45
8	**T_7**	Banana Leaf	14.52	6.11	42.15	6.17	35.52	0.51	12.43
9	**T_8**	Paddy Straw	13.54	5.88	41.69	6.46	34.65	0.52	13.11
	SEm ±		**0.76**	**0.213041**	**0.517**	**0.035**	**0.489**	**0.014**	**0.087**
	CD 5%		**0.19**	**0.107859**	**1.435**	**0.073**	**1.534**	**0.037**	**0.228**

Table 3. Mean comparison for biochemical parameters of banana fruit as influenced by packaging material at the end of 12 days.

S. No	Treatment Symbols	Treatments	Ph Of Fruit	Tss (ºbrix)	Total Sugar Content (%)	Reducing Sugar Content (%)	Non-Reducing Sugar Content (%)	Acidity (%)
1	**T_0**	Control	13.95	4.83	2.05	1.63	0.43	0.70
2	**T_1**	Low Density Polybag (Black)	8.79	6.14	2.99	2.94	0.63	0.49
3	**T_2**	Newspaper Bag	12.45	5.36	2.76	2.69	0.59	0.57
4	**T_3**	Cardboard	11.55	5.96	2.93	2.30	0.49	0.72
5	**T_4**	Gunny Bag	10.96	5.28	2.87	2.89	0.48	0.62
6	**T_5**	Paper Bag	12.38	6.77	2.61	2.19	0.50	0.64
7	**T_6**	High Density Polybag (White)	8.36	6.75	2.58	1.69	0.59	0.69
8	**T_7**	Banana Leaf	14.52	6.11	2.59	1.95	0.56	0.69
9	**T_8**	Paddy Straw	13.54	5.88	2.49	1.90	0.49	0.66
	SEm ±		0.765927	0.213041	0.019	0.017	0.009	0.013
	CD 5%		0.192965	0.107859	0.045	0.048	0.026	0.034

Conclusion

It is crucial to gain access to the outcomes of various packaging materials since they can be used as local resources and the outcomes can be used by local farmers as these varied packaging materials. viz low-density polybag black newspaper bag cardboard gunny bag paper bag high-density polybag white banana leaf paddy straw are easily available in the market therefore the current study is conducted with the objectives to evaluate The physical and biochemical parameters have a substantial impact on the shelf-life of the banana fruits and can be used to compare the effects of various packaging materials on shelf life and quality of banana fruit and determine the optimum packaging material. the Treatment T_1low density black polybag was considered best for the physiological weight loss g peel colour pulp ph and total soluble solids^{0}brix parameters which have a better perishability visual appearance and better quality at the end of 12 days of storage, I will suggest that Bananas perish quickly, thus using low-density black polybag Treatment T_1 as an optimal packing material will increase the shelf life and quality at room temperature and the use of cardboard for storage of bananas for long periods should be avoided to retain the perishability and quality of the banana fruit so we can conclude that Using polyethylene bag is important for growers, farmers, wholesalers, retailers, and consumers as it is readily available and is important to maintain banana quality and longer perishability. Polyethylene bags can be used to enhance increased shelf life and maintain the good quality of banana fruit after harvesting.

Recommendations:

Further research work is needed to correlate with the findingsof the present and previous investigations. Investigations should tried on a larger number of fruits to confirm the results of the research work. Several other physical and bio-chemical parameters should be tested for evaluation of enhancement of the shelf life of bananas. Since bananas are highly perishable, focusing only on the impact of different packaging materials may not be sufficient to draw firm conclusions from this one experiment. Therefore, advancedpackaging materials should be included in future time-treatment studies with a variety of factors to maintain their quality and shelf-life and to draw firm conclusions.

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