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Effects of storage conditions on nutritional compositions of banana

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Abstract

Introduction Banana is an important staple food of millions of people in Africa. In this study the effects of storage conditions on the key nutritional compositions (carbohydrate, crude protein, crude fibre, fat, ash and moisture content) of banana were monitored. *Objectives* The objectives are to determine the effect of storage conditions on the nutritional contents of banana and to ascertain which storage condition will best suit the storage of bananas in a tropical country such as Nigeria. *Methods* In order to achieve the stated objectives, bananas were stored under three different conditions (refrigerator, polythene bag and open shelf) for a period of seven days. Temperature and relative humidity were varied over the storage period. Nutritional compositions of the bananas were monitored daily using standard laboratory analysis. *Results* The results obtained showed that temperature of banana in the refrigerator was between 4 and 5°C at relative humidity of about 84%, for the polythene bag temperature ranged between 24 and 30°C at 90–91% relative humidity, and for open air (shelf), the temperature varied between 23.5 and 26.0°C at 90% relative humidity. *Conclusion* Nutritional analysis showed that all the storage methods experienced increases and decreases in nutrients. However, the refrigerator storage ranked best in terms of quality preservations of banana compared with the other two storage methods and is therefore recommended for small household preservation of bananas and a cold room for commercial storage.

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Introduction

The word banana is a general term embracing a number of species or hybrids in the genus *Musa* of the family *Musaceae*. It is known to have originated from the tropical region of southern Asia. The crop is now cultivated throughout the tropics primarily for its fruits and to a lesser extent for the production of fibres and as ornamental plants (Leslie, 1976; Akinyosoye, 1991). The banana fruit grows in hanging clusters, with up to 20 fruits to a tier (called a hang, 3–20 tiers to a bunch). The total of the hanging clusters is known as a bunch, or commercially as a 'banana stem', and can weigh from 30 to 50 kg. The fruit averages 125 g, of which approximately 75% is water and 25% dry matter content. Each individual fruit (known as a banana or 'finger') has a protective outer layer (a peel or skin) with a fleshy edible inner portion. Both skin and inner part can be eaten raw or cooked. Western cultures generally eat the inside raw and throw away the skin while some Asian cultures generally eat both the skin and inside cooked.

Banana can be processed for a number of food products. Ripe fruits can be pulped for puree for use in a variety of products including ice cream, yogurt, cake, bread, nectar and baby food. Ripe bananas can be dried and eaten, or

sliced, canned with syrup, and used in bakery products, fruit salads, and toppings. Green bananas can be sliced and fried as chips. Whole green fruits can also be dried and ground into flour. Vinegar and alcoholic beverages can also be made from fermented ripe bananas. Other parts of the banana plant are consumed besides the fruit. The banana leaves are not eaten but may be used for wrapping cooked food. The banana foliage and pseudostem are used as cattle feed during dry periods in some banana producing areas. Culled bananas are used to feed cattle.

After harvest, fruits are prone to deteriorate. The fruits having been harvested are severed from their source of water and nutrient, still continue to carry on metabolic activities. It is revealed that about 35–75% of the harvested fruits do not get to the consumer (Olorunda & Aworh, 1983). Physiological factors affecting the quality of banana during storage are the rate of respiration and transpiration. To extend storage life, these should be reduced as much as possible. This is often done by controlling individually or in combination with such factors as temperature, humidity, ventilation rate and atmospheric composition.

Temperature, relative humidity, ventilation rate and atmospheric conditions are the most important factors that influence the deterioration rate of banana (IITA, 1997). Temperature has been reported by Bachmann and Earles (2000) to be the most important factor in maintaining quality of fruits and vegetables after harvest. They reported that the higher the storage temperature, the higher the rate of respiration and the greater the heat generated.

The maintenance of freshness is one of the most difficult aspects of fruits and vegetables production in the tropics (David & Adam, 1985; Bachmann & Earles, 2000). Mejia (2003) reported losses in fruits and vegetables of about 40–50% in the tropics and subtropics. The reasons for the losses were attributed to poverty, lack of appropriate technologies, insufficient or scarce access to information, poor storage and inadequate handling during transportation. Physiological deterioration which results during storage due to natural reactions can lead to significant loss of nutritional value and in many cases, loss of the whole fruits or vegetable (William *et al.*, 1991). Deterioration may also arise from actions of biological or microbiological agents such as insects, rodents and other animals, bacteria, mould, yeast and viruses (William *et al.*, 1991).

In the present study, the effects of storage conditions (temperature and relative humidity) on the nutritional composition of banana stored in refrigerator, polythene bag and open air (shelf) for 7 days were investigated.

Materials and methods

Collection of fresh banana and weight determination

One hundred and five fresh samples of banana used for this study were obtained from Minna Central Market in Niger State, Nigeria. The samples were divided into three equal parts of 35 and stored inside the refrigerator, polythene bag and open air (shelf storage). Five banana fingers were selected from each storage method and weighed every day using an electronic weighing balance. Weighing commenced from the first day of storage and continued throughout the 7 days experimental period.

Determination of environmental parameters

The temperature was measured using a thermometer. The relative humidity was taken using a wet and dry bulb thermometer and the reading was measured on the humidity table (i.e. difference between the dry and wet bulb readings). The readings obtained were in degrees Celsius for temperature and percentages for relative humidity and were measured daily for 7 days. The readings were taken from the refrigerator, polythene bag and open air storage.

Nutritional analysis

Nutritional analysis of the stored bananas was carried out during the storage period. The banana samples were analyzed for proximate compositions (moisture, lipid, carbohydrate, crude fibre, ash and crude protein) using AOAC (1980) nutritional guidelines.

Results and discussion

The results of the analysis carried out on nutritional composition of banana stored in three different methods for a period of 7 days are shown in Table 1.

Before storage the initial weight of banana was recorded and proximate analysis taken that served as the control. From Table 1, it can be seen that there was minimal increase in moisture content of banana stored in the refrigerator from the first day to the third day and decreased from the 4^{th} and 5^{th} days of storage for banana stored in the polythene bag and on open air (shelf) respectively. There was a general decrease in moisture content from the first to the seventh day of storage; this decrease may be due to the respiratory act of the banana fruit as shown in Figures 1 and 2.

Percentage crude protein from the three storage methods decreased daily, but refrigerator recorded the least in percentage crude protein compared with the other two storage

Table 1 Effects of storage conditions (temperature and relative humidity) on the nutritional composition of banana using three different storage methods

Days	Storage methods	Temperature (°C)	Relative humidity (%)	Moisture content (%)	Crude fibre (%)	Crude protein (%)	Fat (%)	Ash (%)	Carbohydrate (%)
Day 0	Control	27.0	83	61.58	2.5	5.6	0.2	3.5	26.62
Day 1	Refrigerator	4.0	83	64.16	1.3	5.4	4.5	4.0	20.62
	Polythene bag (2.0 mm)	29.5	91	77.38	2.0	4.5	5.5	4.0	16.89
	Open air (shelf)	23.5	90	74.0	1.3	5.6	4	4.0	11.09
Day 2	Refrigerator	4.0	83	68.09	1.3	4.6	4.0	3.5	18.48
	Polythene bag (2.0 mm)	29.0	90	75.05	1.3	4.2	3.0	3.0	17.0
	Open (shelf)	24.0	90	73.59	1.3	5.4	3.5	3.5	12.7
Day 3	Refrigerator	5.0	84	72.02	1.3	3.8	3.5	3.0	16.3
	Polythene bag (2.0 mm)	29.5	91	72.72	0.6	3.9	3.5	2.0	17.2
	Open air (shelf)	24.2	90	73.17	1.3	4.8	3.0	3.0	14.3
Day 4	Refrigerator	4.5	83	67.46	0.9	3.6	3.0	2.5	22.4
	Polythene bag (2.0 mm)	27.0	91	72.06	1.6	3.7	3.5	1.54	17.6
	Open air (shelf)	24.0	90	72.88	1.3	4.8	3.3	2.2	14.9
Day 5	Refrigerator	5.0	84	62.9	0.6	3.5	2.5	2.0	28.4
	Polythene bag (2.0 mm)	24.0	90	71.4	2.6	3.5	3.5	1.1	17.9
	Open air (shelf)	26.0	91	72.6	2.6	4.4	3.5	1.5	15.48
Day 6	Refrigerator	4.5	83	68.34	0.6	3.0	2.4	1.7	23.9
	Polythene bag (2.0 mm)	28.5	90	67.35	1.9	3.2	2.5	1.0	24.0
	Open air (shelf)	25.0	90	72.7	1.6	3.9	2.7	1.2	17.6
Day 7	Refrigerator	5.0	84	73.78	0.6	2.5	2.3	1.4	19.4
	Polythene bag (2.0 mm)	30.0	91	63.30	1.3	2.9	1.5	0.9	30.1
	Open air (shelf)	26.0	91	72.99	0.6	3.5	2.0	1.0	19.85

methods. This shows that the nutritional content of banana differs in every storage component.

Percentage crude fibre content, ash content and lipid content increased daily throughout the experimental period (7 day). This can be seen from Table 1. These decreased in weight may be due to the respiratory rate of banana fruits that changed as the banana got ripped.

Percentage carbohydrate content of banana stored in a refrigerator reduced from the first day to the third day, increased from the fourth and fifth days and decreased on the sixth and seventh day of the experiment. Banana stored in polythene bag and open air (shelf) increased daily for 7 days as shown in Table 1. Refrigerator methods recorded the highest percentage of carbohydrate in banana. Banana stored in open air (on a shelf), ripened at 90–91% relative humidity and temperature ranging from 23.5 to 26.0 °C, and this agrees with the finding of the work carried out by Morton (1987). Banana stored in the polythene delayed in ripping due to the thickness of the polythene bag and has a temperature of about 24–30 °C at 90–91% relative humidity. High relative humidity gave a minimal reduction in moisture content of banana stored in the polythene bag compared with the three storage methods. Graphical representation of weight loss and moisture content of banana for a period of 7 days for three different storage periods is shown in Figures 1 and 2.

Conclusions

It was observed that a lot of losses in weight occurred in polythene bags and the open air (shelves) method, while a least percentage mean loss was recorded in the refrigerator. Considering only the weight losses, it is better to store

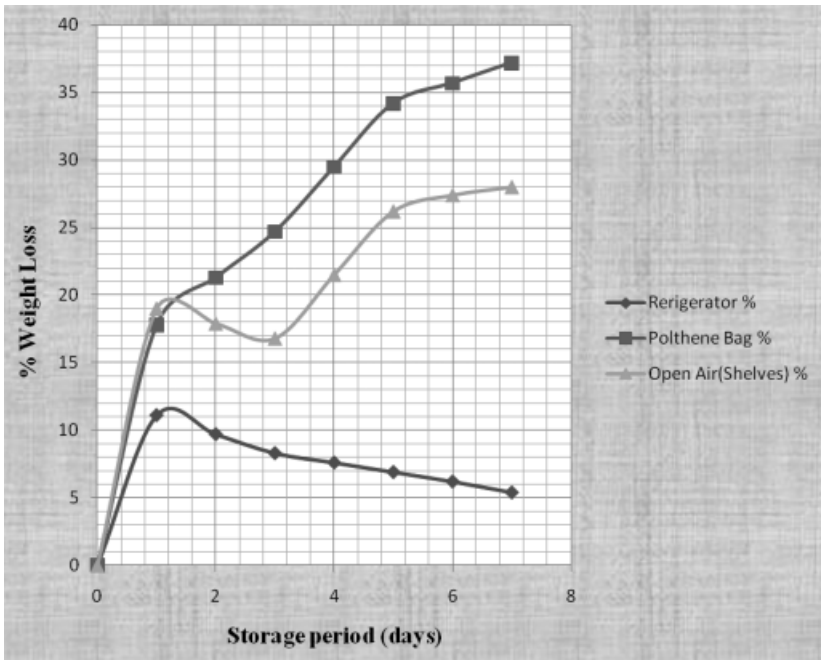

Figure 1 Percentage weight loss against storage periods (measured and calculated values).

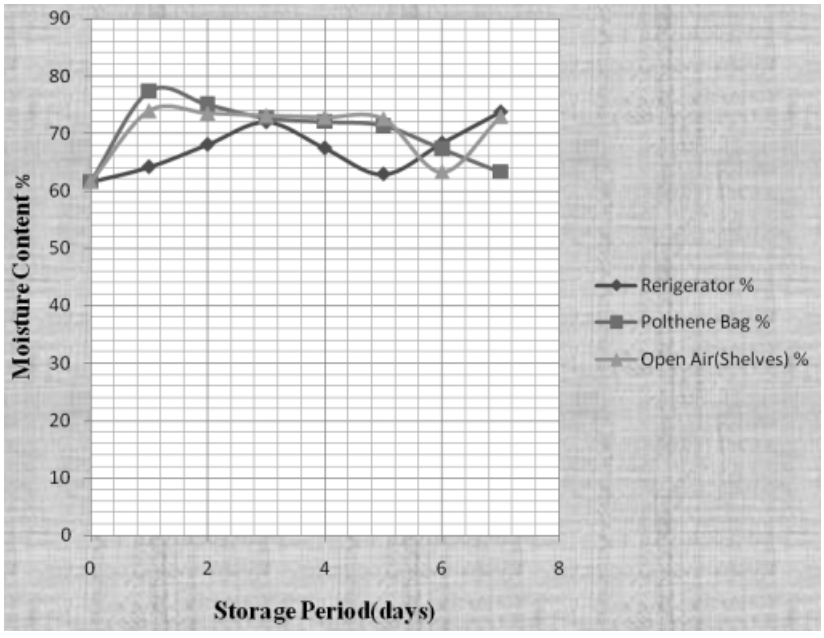

Figure 2 Percentage moisture content against storage periods (days).

banana in the refrigerator for about a period of 7 days than any of the other two methods.

The nutritional changes in the three storage methods used were monitored periodically up to 7 days. The moisture content in the refrigerator was found to have increased for the first 3 days, decreased in the fifth day and increased on the seventh day. Moisture content for other two methods decreased from the first day to the last day of storage, which is the seventh day. Crude protein, ash and fat contents decreased in the three storage methods through the

experimental period. Storage conditions (temperature and relative humidity) affect the three storage methods. High humidity about 91% gave a minimal reduction in moisture content of banana stored in the polythene bag, reduction in crude protein and fat content.

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