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Review Article

Effect of Different Storage Media on Physical and Proximate Composition of Plantain (*Musa paradisiaca*) Fruits and Associated Pathogens

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Abstract Freshly harvested plantain bunch (Musa paradisiaca) was obtained from a farmer in Eziowelle, in Idemili North Local Government of Anambra State and were taken to Plant Pathology Laboratory of Department of Crop Science and Horticulture. The plantain fruits were then surface sterilized by dipping into 5% sodium hypochlorite for 5 mins and stored in three different storage media which include; polythene, jute bag, wood shavings and control and were replicated three times. The physical characteristics measured included; fruit colour, tenderness, fruit weight, and temperature of the storage media which was observed for 12days. Proximate analysis of the fruits before and after storage was also conducted as well as isolation and identification of the spoilage organisms from the infected plantain fruits during storage. The experiment was laid out in a Completely Randomized Design. The data collected were subjected to analysis using Genstat (2008) model. Mean separation was done by using Least Significant Difference (LSD) at 5% probability level. The result showed that the Plantain fruits that were stored in different storage media had their shelf life extended up to 12 days, where the best shelf life qualities were obtained in plantain fruits stored in the polyethylene bags, followed by wood shavings while the least was the jute bag. Also, there was slight differences in the proximate composition of plantain fruits before and after storage, where the best proximate retention was obtained in polythene bags, followed by wood shavings and the least in Plantain fruits stored in jute bags. The result also revealed that the only pathogen isolated was Asperigillus niger. From the study, it is therefore recommended that the three storage materials could be used by farmers especially polythene bag for the storage of fresh plantain fruits. Also more research should be done on how to reduce disease infestation in Plantain fruits in the storage media used in this investigation.

Keywords: Plantain fruits, storage media, physical characteristics, proximate composition and pathogens

Introduction

Plantain is one of the most important crops of the tropical region. It belongs to the family Musaceae and the genus Musa. Musa paradisiaca, also known as is native to India. The plant consists of long, overlapping leafstalks and bears a stem which is 1.22 to 6.10 m high (Oladiji et al., 2010), with a life span of about 15 years (Philips, 2009). The fruits grow in clusters, each separate plantain fruit of the cluster being about 1 inch in diameter and somewhat longer than a banana fruit. Agbakoba (2001) highlighted that plantain species are classified either by bunch type, floral size or size of the pseudostem (false stem). Plantain is a very rich staple food in most tropical countries of the world.

Adeniji, et al., (2006) reported that 100g edible portion of plantain friut contain 67.30g moisture, 0.4g crude Fat, 31.15g Carbohydrate, 0.95Mg Potassium, 35.1Mg Sodium, 71.5Mg Calcium, 28Mg Phosphorus, 2.4Mg iron, and yielded 116Kcal of energy. Agricultural Organization (FAO, 2003) reported that it can be eaten in many forms either ripe or unripe. The report revealed that unripe fruit can be boiled or roasted, eaten with oil or vegetables. It can also be boiled and pounded or mixed with boiled yams and eaten as fufu. The ripe fruits can be eaten alone or fried, used for garnishing rice. Plantain is ground into powder and prepared into food paste called amala which is eaten with suitable soup. The report further that though plantain fruit is the main economic product, but other parts of the crop plant can be used as food, fodder or as raw materials for the industries for manufacturing acids.

The quality of the fresh and processed plantain fruit

depends on the postharvest handling during harvesting, transportation, and storage, and these should be handled effectively to keep the best quality of fruit at harvest. Lack of storage facilities, limited access to transportation, and risk of high losses which forces growers to sale their produce over a short period of time (Haidar and Demisse, 1999). Postharvest losseses is a major limiting factor in the availability of plantain fruits in the market all the time.

Bunches are harvested when fingers are well filled or rounded and are wrapped in plastic bags mixed with powder of dry cocoa leaves or rice husk are preserved without remarkable modifications of their organoleptic characteristics (Agbo et al, 1996). Studies carried out on the conservation of plantains recommend that they be packaged in suitable plastic bags to reduce air circulation.

Proximate analysis of plants samples, gives valuable information about the nutritional composition of such sample and help to assess the quality of the sample. It provides information on moisture content, ash content, carbohydrate, Protein, Fiber etc. (Adeyemi and Oladiji, 2009) Ash is the in organic residue remaining after water and organic matter has been removed by heating, which provides a measure of total amount of minerals with in the food (Adeyemi and Oladiji, 2009) Studies have shown that fruits (seeds) and vegetables contain among other vital nutrients an appreciable quantity of Carbohydrate, Proteins, Fats, Fibers and phytochemicals (Egbebi and Bademosi,2012) Carbohydrate is the chief source of energy to the body; they are constituent of compound lipid, conjugated protein and mucopolysaccharides which form ground substance of mesenchymal tissues (Egbebi and Bademosi,2012). Protein provides amino-acids which are the substrates required for the support of body Protein synthesis and maintenances of cell and organ Protein content. Thus it furnishes amino acid the building block of all protein (Egbebi and Bademosi, 2012)

Therefore, the main objective of this study is to assess the effect of different storage media on the physical and proximate composition of Plantain and the associated pathogens.

The objectives of this study were to assess the effect of different storage media on shelf life of fresh plantain fruits, to investigate the effect of different storage media on proximate composition of stored plantain fruits and to isolate mycopathogens associated with plantain fruits stored in different media.

Materials and Methods

The experiment was carried out in the Research and Teaching Laboratory of the Department of Crop Science and Horticulture, Nnamdi Azikiwe University, Awka, Nigeria. Bunches of matured green plantain fruits were harvested from a farmer's farm in Eziowelle, Anambra State, Nigeria. The fruits which were taken to the Plant Pathology Laboratory were washed and dipped into 5% sodium hypochlorite for 5 minutes and then air-dried in aseptic condition and stored. The fruits were separated individually from the bunch for storage in the various storage media. . The treatments comprised of three different storage media.

1. Plastic bowls containing five fingers of Plantain wrapped with transparent .polythene materials
2. Baskets filled with sterilized wood shavings
3. Plastic crates lined with Jute bag material.

The jute bag materials were sterilized by boiling for two hours at a temperature of 1400C and dipped into 20% sodium hypochlorites for 5 minutes and then oven-dried at a temperature of 1200C. The polythene was dipped into 5% Sodium hypochlorite and air-dried in aseptic condition. The wood shavings were soaked in 20% sodium hypochlorite for one hour and then air-dried in an aseptic condition.

Five fingers of the matured green Plantains were buried in wood shavings kept in a wooden basket, while the other set were wrapped in a transparent polythene bag and put in a rubber bowl, the last storage media was a plastic crate covered with Jute bag. The research was laid out in completely randomized design using Genstat (2008) statistical software package. Mean separation was done by using least significant deference (LSD) at 5% probability level.

Data collection: Data collected include

1. Temperature of the storage medium.
2. Colour of the plantain fruits.
3. Tenderness of the plantain fruits.
4. Weight of the plantain fruits.

Determination of the physical characteristics of the stored plantain fruits and temperatures of the storage media.

The temperature of the different storage media was measured with a Laboratory thermometer.

The matured fruits were observed for changes in weight before storage and at intervals during storage and at the end of storage. This was done by use of weighing scale, and the weights were recorded Plantain fruits were observed for changes in peel colour and tenderness at three days intervals rated subjectively on a scale of 1 to 5 by a method adapted from banana ripening guide (Snedecor et

al, 1967)). By the grading scores for visual attributes are as follows:

5 = very fresh and no trace of colour breaking

4 = fresh and fairly green

3 = slightly fresh and slightly bleached

2 = poorly fresh and bleached

1 = onset of deterioration

Preparation of PDA for isolation of associated pathogens

Ten grams of PDA powder was weighed with the electronic weighing balance and was mixed in 250 ml of distilled water in a conical flask. The mixture was stirred vigorously until it became homogeneous. It was then corked using cotton wool wrapped with aluminum foil before being placed into the autoclave. The autoclave used was the portable steam autoclave. The conical flask containing PDA was placed into the autoclave and was properly sealed. The autoclave was set at a temperature of 120?C and pressure of 15±1 Psi for 20-25 minutes after which it was ready for use.

Isolation of Fungal Pathogen

The working bench was surface sterilized with methylated spirit and cotton wool so as to prevent contamination. A sterile inoculating loop was used to place the infection into sterile petri dishes containing the 10mls of PDA with two drops of lactic acid. This was done to inhibit the growth of bacteria, after which it was properly sealed and labeled. The plates with 5 replicates were incubated at temperature (28±2?C) and left for seven days and closely observed daily for fungal growth.

The initial culture was sub-cultured twice to obtain a pure culture. The method used in sub-culture was the disc method where an inoculating sterile cork borer was used to cut the culture then giving three lines (streaks) into the fresh plate of the prepared PDA after which it was sealed to prevent contamination. The sub-culture was left for three days and observed daily for fungal growth. The resulting pure cultures were used for characterization and subsequent identification of the fungi with the aid of a compound microscope and identification guides (Sulton, 1980).

Identification of isolated pathogen using a compound microscope

A compound microscope of the model (Olympus-XN 50) was used to view the organisms. A drop of distilled water was placed on the slide using a dropper, and a small portion of the culture from the seven days culture was collected from the growth using a sterile needle, it was then covered the slide cover and placed under the microscope for viewing. The identification of the fungal inoculum was based on the morphology of the culture and the fruiting bodies. An illustrated Manual on the identification of fungi by (Barnet and Hunters, 1994) and (Alexopolus et al., 2002) were used for identification. The organism identified was Aspergillus niger.

Proximate composition of fruit pulp at different stages of ripening

Pulp samples were taken from the middle portion of fruits and analysed for moisture, ash, crude protein, crude fibre and fat content by standard analytical methods (AOAC, 1990).

Results

Results of the Proximate Analysis of Plantain before and After Storage

The results of the proximate analysis of plantain fruits before and after storage showed that there were differences in the proximate composition of the plantain fruits before and after storage. It was observed that the highest Moisture content value (68.00%) was obtained in jute bag after storage, followed by the wood shavings (64.20%) while the least (63.90%) was obtained in those stored in polythene. The result also showed that 56.60% moisture was obtained before storage. However, the Moisture content in control was higher than those stored in various storage media after storage. (Table.1). It was observed that the Carbohydrate content of plantain fruit before storage (38.57%) was higher than those stored in various storage media after storage. However, the highest value was obtained in those stored in polythene (31.05%) followed by 30.91% obtained in fruits stored in wood shavings while the least (27.13%) was obtained in jute bag. The Carbohydrate content of the plantain fruits stored in the different media were higher than the control.

It was observed that the Ash content of the plantain before storage (2.05%) was higher than the plantain after storage, however, the highest value of ash content (2.03%) was obtained in the polythene followed by the jute bag (1.92%) while the least (1.88%) was obtained in the wood shavings. However, the Ash content was the least in control.

It was observed that the highest value of Fat content in plantain fruits (0.85%) was obtained in jute bag, followed by the (0.83%) obtained in wood shavings while the least value (0.69%) was obtained in the polythene. However, control had the same value of Fat content with that of wood

shavings. It was observed that the Protein content of plantain fruit before storage (1.49%) was higher than the treatment after storage. However, the highest value was obtained in polythene (1.34%) followed by that obtained in fruits stored with wood shavings (1.22%) while the least (0.92%) was obtained in jute bag. The Protein content of the plantain fruits were higher than the control except in jute bag.

It was observed that the highest value of Fibre (1.02) was obtained in the jute bag followed by the polythene (0.99) while the least (0.96) was obtained in the wood shavings. However, control showed the lowest value of Fibre (Table 1).

Table 1: The Proximate Composition of Plantain Fruits Before and After Storage

Treatment	Moisture (%)	Carbohydrate (%)	Ash (%)	Fat (%)	Protein (%)	Fibre (%)
JB	68.00	27.30	1.92	0.85	1.08	1.02
WS	64.20	30.91	1.88	0.83	1.22	0.96
POLY	63.90	31.05	2.03	0.69	1.34	0.99
CON	69.50	25.59	1.87	0.83	1.29	0.92
Before Storage	**56.60**	38.57	2.05	0.40	1.49	0.89

Where; JB = jute bag WS = wood shavings POLY = polythene CON = control.

Effect of Different Storage Medium on the Physical Characteristics of Plantain Fruits

Table 2: shows that there was no significant effect of the different storage media on some physical characteristics (colour, tenderness and weight) of unripe plantain fruits but there was significant effect of different storage media on storage temperature.

Colour of the Plantain Fruits

On first day, there was no significant ($P < 0.05$) effect of different storage media on colour, where the colour value for all the plantain stored in the different media had the highest colour value of 5.00. The same trend was also observed in third day. Also, Table 2 shows that the effect of the different storage media had significant ($P < 0.05$) effect on colour on the sixth day, where the highest colour value (5.00) was obtained in polythene followed by 4.0 in wood shaving while the least (3.0) was obtained in jute bag. It was also observed that the highest colour value of (5.00) obtained in polythene was significantly ($P < 0.05$) higher than 3.0 obtained in jute bag. Table 2 also shows that different storage media had significant ($P < 0.005$) effect on the ninth day , where the highest colour value of 4.00 was obtained in polythene which was significantly($P < 0.005$) higher than colour value of 3.00 obtained in wood shavings and jute bag respectively. There was significant ($P < 0.005$) effect of different storage media on colour value on the twelfth day where the highest colour value of 4.00 was obtained in the polythene followed by 3.00 obtained in the other storage media.

Tenderness of the Plantain Fruits

For tenderness value, result showed that there was no significant ($P < 0.05$) effect of storage media on tenderness of plantain fruits, where tenderness value of 5.00 was obtained on first day. The same trend was also observed in third day. From Table 2, it was also observed that different storage media had significant ($p < 0.05$) effect on tenderness on sixth day, where the tenderness value of 5.00 was obtained in polythene, followed by 4.00 obtained in wood shavings while the least (3.00) was obtained in jute bag. These values were significantly ($p < 0.05$) different from each other. There was also significant ($p < 0.05$) effect of the different storage media on plantain fruits on ninth day, where the highest tenderness value (4.00) obtained in polythene which was significantly ($p < 0.005$) higher than (3.00) obtained in wood shavings and jute bag respectively. The same trend was also observed on twelfth day.

Table 2: Effect of different storage media on Colour and Tenderness of plantain fruits.

Days in Storage

Treatment	Day1	Day3	Day6	Day9	Day12
Colour					
POLY	5	5	5	4	4
WS	5	5	4	3	3
JB	5	5	3	3	3
CON	5	5	3	3	2
LSD(0.005)	NS	NS	0.00	0.00	0.00
Tenderness					
POLY	5	5	5	4	4
WS	5	5	4	3	3
JB	5	5	3	3	3
CON	5	5	3	3	2
LSD(0.005)	NS	NS	0.00	0.00	0.00

POLY = Polythene, WS = Wood shavings, JB = jute bag, CON= control,

Weight of the Stored Plantain Fruits

The different storage media also had significant ($p < 0.05$) effect on fruit weight of the stored plantain, where the highest fruit weight 1279g was obtained in polythene followed by 1098g obtained in wood shaving and the least 1090g was obtained in jute bag. The same trend was obtained in weight on the day3. The result from Table 4.3,

also showed that the different storage media had no significant ($p < 0.05$) effect on the fruit weight of plantain on day6 but the highest fruit weight of 1212g was obtained in polythene followed by 1062g obtained in wood shaving while the least 1051g was obtained in jute bag. From Table 4.3, it was observed that there was no significant ($p<0.05$) effect of the storage medium on the weight of plantain fruits in day9 but the highest fruit weight of 1128g was obtained in polythene, followed by 982g was obtained in wood shavings while the least 972g was obtained in jute bag. The result also showed that the different storage media had no significant ($p<0.05$) effect on the fruit weight of plantain in storage but the highest fruit weight of 1124g was obtained in the polythene followed by 985g obtained in the wood shavings while the least was 971g obtained in the jute bag. (Table 3)

Temperature of the Storage Medium

There was significant ($p < 0.05$) effect of different storage temperature in day1, where the highest storage temperature of 29.200C was obtained in polythene which was significantly ($p < 0.05$) higher than 28.500C obtained in wood shavings. This was also statistically the same with 28.900C obtained in jute bag while the least was 28.500C obtained in wood shavings. In day3, the different storage media did not have significant effect on the temperature measured but the highest temperature value (28.930C) was obtained in polythene followed by 28.870C obtained in the jute bag while the least 28.600C was obtained in wood shavings. From Table 4.3, the different storage media had significant ($p < 0.05$) effect on temperature on day6 where the highest temperature 29.430C was obtained in polythene followed by 28.930C obtained in jute bag while the least 28.600C was obtained in wood shavings. The storage temperature of 29.430C was significantly ($p < 0.05$) higher than 28.600C obtained in wood shavings and 28.930C obtained in jute bag. There is also significant ($P < 0.05$) difference in 28.930C obtained in jute bag and 28.600C obtained in wood shavings which was the least. From Table 4.3, there was significant ($p < 0.05$) effect of the different storage medium on temperature in day9, where the highest value of (29.430C) was obtained in polythene followed by 28.930C obtained in jute bag while the least (28.600C) was obtained in wood shavings, it was also observed that the temperature of 29.430C obtained from polythene was significantly ($p <0.05$) higher than 28.930C obtained in the jutebag and 28.600C obtained in the wood shavings respectively. Also, the storage temperature of 28.930C obtained in the jute bag was significantly ($p <0.05$) higher than (28.600C) obtained in wood shavings which was the least. On day12, different storage media had significant ($p<0.05$) effect on storage temperature where the highest temperature of 29.370C was obtained in polythene followed by 28.970C obtained in jute bag while 28.670C was obtained in wood shavings. The temperature of 29.370C obtained in polythene was significantly ($p < 0.05$) higher than 28.970C obtained in jute bag and 28.670C obtained in wood shavings respectively. Also, the storage temperature of 28.970C obtained in jute bag was significantly ($p < 0.05$) higher than 28.670C obtained in wood shavings. (Table 3)

Table 3: Effect of different storage media on the Temperature (0C) and weight (g) of plantain fruits.

Days in Storage

Treatment	Day1	Day3	Day6	Day9	Day12
Temperature(^{0}C)					
POLY	29.20	28.93	29.43	29.43	29.37
WS	28.50	28.60	28.60	28.63	28.67
JB	28.90	28.87	28.93	28.97	28.97
CON	29.15	29.15	29.07	29.11	29.07
LSD(0.005)	0.56	0.70	0.23	0.22	0.24
Weight(g)					
BP	1279	1098	1212	1128	1124
WS	1098	1298	1062	987	985
CJB	1090	1090	1051	972	971
CON	1279	1127	1037	986	985
LSD(0.005)	195.4	191.9	197.8	196.0	196.4

POLY= polythene, WS = wood shavings, JB = jute bag, CON = control,

The effect of the different storage media on disease incidence

The result of the isolation and identification of the spoilage microorganism showed that it was Aspergillus niger that was implicated for causing the spoilage symptoms observed in plantain fruits.

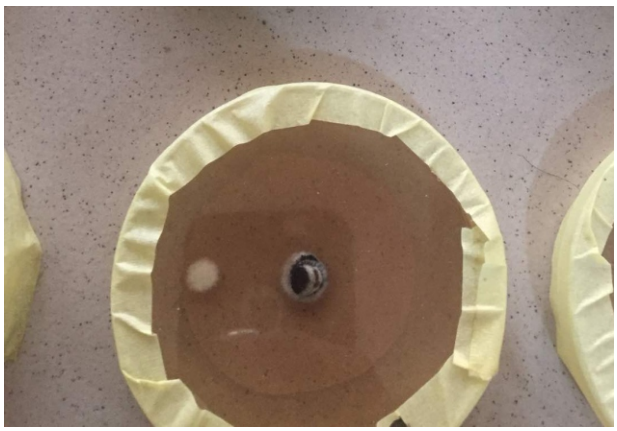

Plate 1: A pure culture of Aspergillus niger isolated from the infected plantain fruits.

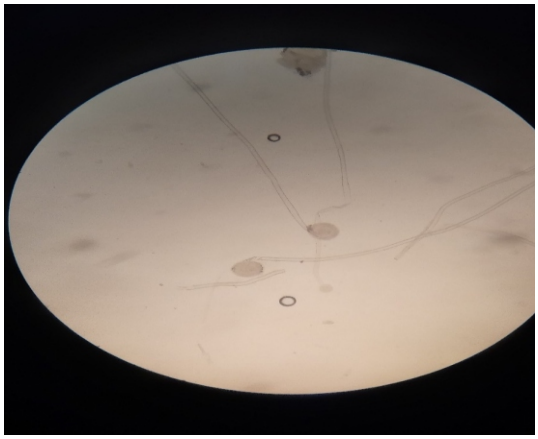

Plate 2: micrograph of Aspergillus niger isolated from infected plantain fruits.

Discussion

Effect of the different storage media on some proximate composition of the plantain fruits before and after storage

The result of the proximate composition of the plantain fruits before and after storage showed that there were slight differences in the effect of the different storage media on the nutrient components assessed. This showed that the different storage media were effective in extending the shelf life of the plantain fruits stored in them as well as the nutrient composition of the fruit after storage. This report is in agreement with the findings of Iwuagwu et al (2013), who observed that fruit and leafy vegetables stored in jutebag lined with transparent polythene material and jutebag alone had there shelf life extended up to 7 days and 8 days respectively as compared with those stored in control (ambient) which lasted for only 3 days.

The result also showed that polythene storage medium had the best effect on nutrient retention of the plantain fruits after storage. This is similar to the report of Scott et al, (1974), who reported that polythene bag packaging delayed ripening, restricted weight loss and resulted in considerable reduction of mechanical injury during transport and storage. Also the result on the proximate composition of plantain fruits before and after storage showed that moisture content of the fruits after storage was higher than before storage in all the treatments. This is in agreement with the report of Onwuka and Onwuka (2005), who reported that the moisture content, ash, crude fibre increased with ripening while the carbohydrate decreased.

Effect of the different storage media on some physical characteristics of the plantain fruits after storage.

The result of the different storage media on some physical characteristics (colour, temperature, tenderness, weight) of the plantain fruits showed that there was a significant difference in effect of the different storage media on physical parameters tested where plantain fruits stored in transparent polythene bags had the best physical quality characteristics than the other storage media. This is in agreement with the findings of Narayana et al (2004), who observed that plantain and banana sealed in polythene bags remained green for a longer period than fruits that received some ventilation.

Effect of the Different Storage Media on Disease Occurrence of Plantain Fruits after Storage.

The result of isolation and identification of microorganisms from infected Plantain fruits stored in different media used in this experiment incriminated Aspergillus niger since it was the only fungi pathogen isolated from the fruits stored in the different storage media. This is in agreement to the findings of Iwuagwu et al (2014), who also isolated Aspergillus niger, Rhizopus stolonifera, Fusarium moniliforma from some horticultural crops stored in vegetable basket lined with transparent polythene of different thickness.

Conclusion

From this investigation, it was observed that the plantain fruits that were stored in different storage media had their shelf life extended up to 12 days, where the best shelf life qualities were obtained in plantain fruits stored in the polyethylene bags, followed by wood shavings while the least was the jute bag. Also, there was slight differences in the proximate composition of plantain fruits before and after storage where the best proximate retention was observed in polythene bags, followed by wood shavings and the least was jute bags The result also revealed that the only pathogen isolated was Asperigillus niger.

Recommendations

From the study, it is therefore recommended that the three storage materials could be used by farmers especially polythene bag for the storage of fresh plantain fruits.

Also more research should be done on how to reduce disease infestation in Plantain fruits in the storage media used in this investigation.

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