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EFFECTS OF PACKAGING MATERIALS ON PROXIMATE, MINERAL AND PHYSICOCHEMICAL PROPERTIES OF PLANTAIN CHIPS (*MUSA PARADISIACA*) IN STORAGE

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ABSTRACT

The effects of packaging materials on proximate, mineral and physicochemical properties of plantain chips, *Musa paradisiaca* was studied in the laboratory at ambient temperature of 28 $\pm$ 2^{0}C and relative humidity of 75$\pm$5%. The packaging materials assessed include craft paper, transparent polyethylene, black polyethylene, plastic and tin containers. The proximate compositions of the dried plantain chips in different packaging materials were obtained before and after storage. After 3 months of storage, plantain chips stored in craft paper recorded an increase in moisture content (12.26%) when compared with the other packaging materials. Transparent polyethylene recorded the lowest moisture content (9.92%) but was not significantly different (p>0.05) from plastic and tin containers. Tin container recorded the lowest ash content (0.83%). The protein content, crude fibre, crude fat and carbohydrate content showed no significant difference (p>0.05) when all the packaging materials were compared. There was significant (p<0.05) increase in the sugar content of chips in all the packaging materials. There were slight increase in the mineral element of the plantain chips after storage for 3 months but not significantly different (p>0.05) from each other. The lowest acid value (8.90%) was obtained in tin container and the highest was recorded in craft paper (11.32%) and all were significantly higher (p<0.05) than the values obtained before storage. The free fatty acid, peroxide and the iodine value increased and were significantly different (p<0.05) from each other. Craft paper and transparent nylon recorded highest insect perforation and insect population. Therefore, plastic and tin containers were more suitable in maintaining the nutritive value of plantain chips since they offered total protection against insect pest infestation. Moreover, if an insect free environment could be maintained, it will be more preferable to use transparent polyethylene for the storage of *Musa paradisiaca*.

Keywords: packaging material, proximate composition, *Musa paradisiaca*.

INTRODUCTION

Plantain (*Musa paradisiaca*) is a starchy fruit crop grown all over the tropics. It is an important staple food in Central and West Africa (Stover and Simmonds, 1987) which along with bananas provides millions of people with 25% of the calories (Wilson, 1987). Nigeria produces about 2.11 million metric tonnes of plantain annually (FAO, 2004). However, about 35 to 60% post harvest losses had been reported in West and Central Africa and attributed to lack of storage facilities and inappropriate technologies for food processing (Olorunda and Adelusola, 1997). It constitutes a major source of carbohydrate for millions of people in Africa, Asia, the Caribbean, Latin America and the Pacific. Plantain are rarely eaten raw (Tortoe *et al.,* 2008).but are often cooked or made into flour as it contains more starch and less sugar than banana, which is often eaten raw as fresh fruit. It can be brewed into alcoholic drinks (Ogazi, 1996). The plantain chips can also be used as foods for the diabetic patients in form of flour "Elubo Ogede" and "moinmoin ologede" (Ogazi, 1985). Complexes of diseases and pests have been identified as the most important biotic factor that imposes serious limitations on plantain production including *Fusarium* rot, Black sigatoka and infection by plant parasitic nematodes (Gwanfogbe *et al*., 1988). Various studies have been carried out on the processing and utilization of plantain. Ukhum and Ukpebor (1991) determined the sensory evaluation and physico-chemical changes during storage of instant plantain flour. Onyejegbu and Olorunda (1995) studied the effects of processing conditions and packaging on the quality of plantain chips. Ogazi (1996) carried out a lot of studies ranging from processing to utilization of plantain in various forms including complementary diets. None of those studies was on the effect of packaging materials on proximate, mineral and physiochemical properties of plantain chips. Therefore, the objectives of this research are to determine the effects of packaging materials on insect infestation and the nutritive value of plantain chips.

MATERIALS AND METHODS

Matured unripe and disease free plantain (*Musa paradisiaca*) as in Dadzie and Orhard (1997) was collected from Ilara- Mokin local market in Ondo State, Nigeria. Plantain fingers were removed from the bunch, peeled, washed and sliced inside a clean bowl and later sundried on a raised platform.

Proximate Analysis

The routine proximate analysis of the plantain chips was done using the method of AOAC (1990). Estimations were made of nitrogen as an index of crude protein, moisture, fat, ash and crude fibre. When these parameters were subtracted from 100, the difference was termed carbohydrates. These analyses were carried out on dried plantain chips before storage and after three months of storage in three replications.

Mineral Analysis

To obtain the concentration of minerals in the chips, 1g of each sample was placed in a crucible and placed in a muffle furnace at 550^0C for 5 hours to ash and then transferred into desiccators to cool. The cooled ash was dissolved in 10% HCI and filtered into a clean graduated sample bottle. The solution was made up to 50ml with distilled water. The solution was aspirated into the atomic absorption spectrophotometer to obtain the mineral concentration. This was carried out before and after storage for all the samples.

Determination of Insect Infestation

Replicated from each treatment were left in the open laboratory for three months in order to determine the effects of packaging materials on the level of insect pest infestation. Thereafter, the numbers of insects present were determined.

Data analysis

A completely randomized design was used for the experiment (i.e. each treatment was randomized inside insect breeding cages). Data were subjected to analysis of variance and where significant differences existed, treatment means were compared at 0.05 significant levels using the New Duncan's Multiple Range Test (SPSS, version 17) (Zar, 1984).

RESULTS

The moisture content of chips stored in craft paper increased from11.59 to 12.26% during storage and it was significantly different ($p<0.05$) from others. The result of the crude protein content after storage were not significantly different ($p>0.05$) from each other in all packaging materials but reduced significantly when compared with initial value after storage (Table 1). Crude fat increased from 1.08 to 1.26% in transparent polyethylene and also to 1.23% in black polyethylene after storage and were significantly different from initial value before storage. The fibre content increased while carbohydrate value deceased during storage (Table 1). Generally, the minerals that were present in the chips increased in value after storage. The total iron concentration increased significantly ($p<0.05$) in all packaging materials during storage and were significantly different ($p<0.05$) when compared with total iron content before storage (1.21). Similarly, the free fatty acid value increased from 0.49 to 1.52% across all the packaging materials but not significantly different ($p>0.05$) when compared with each other. The acid value increased from 8.2mgoh/g to 11.32mgoh/g in craft paper after storage and were significantly different ($p<0.05$) from initial value before storage (Table 3). The weight loss obtained from the chips stored in different packaging materials were significantly different ($p<0.05$) from each other. Craft paper recorded the highest weight loss of 8.63% followed by transparent polyethylene (7.96%), while tin container recorded the least weight loss of 1.16%, but was not significantly different ($p>0.05$) from chips stored in plastic container (1.53%). The level of insect infestations in different packaging materials after 3 months of storage was significantly higher in craft paper (11.67) followed by black polyethylene (9.38) and transparent polyethylene (9.04). The least numbers of insects was recorded in tin (0.67) but was not significantly different (p>0.05) from the value obtained from plastic container (Table 4)

DISCUSSION

There were variations in moisture content of dried plantain chips stored in different packaging materials. This finding was similar to the findings of Claus (2000) that chips packaged in craft paper recorded high moisture content among all the packaging materials used. The increase in moisture content of the plantain chips stored in craft paper may be attributed to permeability of water and gas. The changes in the moisture content may also be due to the hygroscopic nature of the chips thereby absorbing moisture from the environment. The results corroborate the earlier findings of Rehman and Shah (1999) that the porous nature of the craft paper allowed it to take water from the environment. There was a decrease in the moisture content of chips stored in polyethylene, tin and plastic containers because of the fact that they were not permeable to gas and water. In addition, increase in crude fat during storage could have resulted from the possible transformation of carbohydrates by lipolytic enzymes (Oboh and Akindahunsi, 2003). This finding did not agree with the result obtained by Haridas *et al.* (1983) that crude fat decreased during storage in flour stored in polyethylene bag. Also, increase in minerals most especially iron might be attributed to decrease in moisture content of chips. The total iron concentration increased significantly across all packaging materials during storage when compared with total iron content before storage. This finding did not agree with the result obtained by Nancy *et al.* (2006) who also observed reduction of iron during storage in flour. Similarly, high peroxide value is an indication of deterioration of food, although the peroxide values obtained in this study were within the acceptable limits (10mg/g) which was recommended by Mepba *et al.* (2007). Moreover, craft paper has no adequate strength to protect chips against insect's infestation. These findings agreed with the work of Mitsuhiro (1990) who reported that paper board used as a packaging material are prone to insect infestation. High level of insect infestation in craft paper may be attributed to its soft texture in which insects can perforate thereby penetrating and infesting the products in them. The plastic and tin containers provided good and better resistance against moisture and insect infestation than the polyethylene and craft paper. This result tallied with the work of Koji (1990) in which plastic container was found to protect food materials against moisture and insect infestation.

Table 1: Proximate composition of plantain chips in different packaging materials before and after storage

Packaging Material	Moisture	Ash (%)	Fibre (%)	Protein	Fat (%)	Carbohydrate	Sugar (%)
Before Storage	11.59 ± 0.23^{b}	1.49 ± 0.15^{ab}	1.74 ± 0.41^{b}	4.52 ± 0.31^{b}	1.08 ± 0.27^{b}	79.58 ± 0.19^{ab}	0.16 ± 0.21^{a}
Transparent Polyethylene	9.92 ± 0.12^{a}	2.25 ± 0.40^{bc}	7.93 ± 0.32^{a}	0.25 ± 0.07^{a}	1.26 ± 0.34^{c}	78.38 ± 1.25^{a}	0.47 ± 0.41^{c}
Black Polyethylene	11.19 ± 0.39^{b}	3.05 ± 0.02^{c}	7.97 ± 0.24^{a}	0.40 ± 0.06^{a}	1.23 ± 0.01^{c}	76.16 ± 0.62^{a}	0.20 ± 0.26^{ab}
Craft Paper	12.26 ± 0.15^{c}	1.61 ± 0.3^{ab}	8.01 ± 0.03^{a}	0.26 ± 0.07^{a}	1.00 ± 0.17^{a}	76.87 ± 0.73^{a}	0.40 ± 0.35^{c}
Plastic	10.41 ± 0.23^{a}	1.70 ± 0.31^{ab}	8.02 ± 0.04^{a}	0.41 ± 0.04^{a}	1.12 ± 0.09^{a}	76.33 ± 2.36^{a}	0.36 ± 0.07^{bc}
Tin	10.11 ± 0.17^{a}	0.83 ± 0.10^{a}	8.46 ± 0.03^{a}	0.35 ± 0.03^{a}	1.04 ± 0.03^{a}	79.20 ± 0.76^{ab}	0.28 ± 0.60^{b}

Means followed by the same letter in the same column are not significantly different (p>0.05) from each other using New Duncan's Multiple Range Test.

Table 2: Mineral analysis of plantain chips in different packaging materials before and after storage

Packaging Material	Calcium	Copper	Zinc	Iron	Sodium	Magnesium	Potassium	Lead	Manganese
Before Storage	ND	ND	1.43±0.09[a]	1.21±0.11[a]	232.98±0.41[a]	265.70±0.36[a]	ND	ND	ND
Transparent Polyethylene	ND	ND	1.27±0.16[a]	1.97±0.10[b]	299.97±0.06[b]	294.95±0.52[b]	299.69±0.32[a]	ND	ND
Black Polyethylene	ND	ND	1.29±0.15[a]	1.97±0.06[b]	299.54±0.48[b]	294.29±0.81[b]	299.54±0.48[a]	ND	ND
Craft Paper	ND	ND	1.28±0.17[a]	2.01±0.08[b]	299.77±0.33[b]	294.47±0.68[b]	299.78±0.34[a]	ND	ND
Plastic	ND	ND	1.27±0.16[a]	2.14±0.09[b]	299.79±0.30[b]	280.16±0.70[b]	299.78±0.32[a]	ND	ND
Tin	ND	ND	1.15±0.08[a]	1.86±0.14[b]	299.78±0.29[b]	299.60±0.38[b]	300.32±0.41[a]	ND	ND

Means followed by the same letter in the same column are not significantly different (p>0.05) from each other using New Duncan's Multiple Range Test.

Table 3: Physio-chemical properties of plantain chips before and after storage

Packaging material	Acid value(mgoh/g)	FFA (as oleic acid)	Peroxide value (mgoh/g)	Iodine value (wiji's)
Before Storage	8.20 ± 0.17[a]	0.49 ± 0.08[a]	1.55 ± 0.15[a]	13.40±0.11[a]
Transparent Polyethylene	9.40 ± 0.06[b]	1.10 ± 0.28[b]	2.98 ± 0.21[b]	15.52±0.09[c]
Black Polyethylene	9.50 ± 0.06[b]	1.34 ± 0.17[b]	3.00 ± 0.22[b]	15.38±0.15[c]
Craft Paper	11.32 ± 0.16[c]	1.43 ± 0.09[b]	3.48 ± 0.28[bc]	14.80±0.40[b]
Plastic	9.32 ± 0.19[b]	1.36 ± 0.13[b]	2.48 ± 0.32[ab]	15.52±0.06[c]
Tin	8.90 ±0.16[ab]	1.52 ± 0.01[b]	3.27 ± 0.09[b]	13.33±0.17[a]

Means followed by the same letter in the same column are not significantly different (p>0.05) from each other using New Duncan's Multiple Range Test.

Table 4: Weight of dried plantain chips and quantitative values of perforations by insects

Packaging Materials	Initial Weight (g)	Final Weight (g)	% Weight Loss	Insect Holes	Insect Found
Transparent Polyethylene	500.00±0.00[a]	460.20±0.84[ab]	07.96±0.77[bc]	68.11±0.19[b]	09.04±0.61[b]
Black Polyethylene	500.00±0.00[a]	466.10±0.72[ab]	06.78±0.56[b]	56.33±0.4[b]	09.38±0.63[b]
Craft Paper	500.00±0.00[a]	456.85±0.66[a]	08.63±0.39[c]	76.15±0.71[c]	11.67±0.64[c]
Plastic	500.00±0.00[a]	492.35±0.53[c]	01.53±0.47[a]	0.00±0.33[a]	01.01±0.06[a]
Tin	500.00±0.00[a]	494.20±073[c]	01.16±0.25[a]	0.00±0.12[a]	00.67±0.24[a]

Means followed by the same letter in the same column are not significantly different (p>0.05) from each other using New Duncan's Multiple Range Test.

CONCLUSION

This study has revealed that transparent polyethylene, plastic and tin containers having moisture content of 9.92%. 10.41% and 10.11% respectively provided maximum protection against moisture which is the major determinant of the shelf life of chips. Plastics and tin containers were also found to provide complete resistance against insect and moisture. Therefore, plastics and tin containers are more suitable in maintaining the nutritive value of plantain chips as demonstrated in this study.

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