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Short Communication

A comparative study on the storage of yam chips (gbodo) and yam flour (elubo)

A. O. Ojokoh[1]* and R. A. O. Gabriel[2]

[1]Department of Microbiology, Federal University of Technology, P. M. B. 704, Akure, Nigeria.
[2]Department of Microbiology, Adekunle Ajasin University, P. M. B. 001, Akungba-Akoko, Nigeria.

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Comparative study on the storability of yam chips and yam flour was carried out on traditionally processed and stored yam chips (gbodo) and yam flour (elubo) over a period of three months. Their keeping qualities were accessed at intervals by determining the nutritive qualities and the microbial properties of both samples. During the three months of storage, the yam flour showed greater deterioration with regards to nutritive value and microbial load because the yam chips were less accessible to spoilage microorganisms as a result of lower surface area. It is recommended that storage of yam products as chips should be encouraged.

Key words: Yam chips, yam flour, carbohydrate, gbodo, elubo.

INTRODUCTION

Yam (*Dioscorea* sp.) is the second most important root /tuber crop in Africa after cassava, with production reaching just under one third the level of cassava (FAO, 1997). More than 95% (2.8 million ha) of the current global area under yam cultivation is in Sub Saharan Africa, where the mean gross yields are 10 t/ha (FAO, 1996, 1997). Yam is an important source of carbohydrate for many people of the Sub Saharan region especially in the yam zone of West Africa (Akissoe et al., 2003).

Up till today, the age-old traditional method is still being used for the processing of yam, to dry yam (gbodo) and yam flour (elubo). The quality of the "gbodo" and "elubo" varies from processor to processor and from location to location (Akisseo et al., 2003; Hounghouigan et al., 2003; Mestres et al., 2004). Indeed, local consumers of yam flour (elubo) have preference for the product made from a particular area of South-west Nigeria (Bricas et al., 1997).

Yam chips can be completely dried within 2 days by using the energy from the sun and the wind. However, the drying period is mostly much longer and frequently takes between two and three weeks (Mestres et al., 2004). During the long drying period the chips often become mouldy and ferment. This makes the chips discoloured and also changes their flavour. Chips laid out to dry are often soiled by rain, sand and animal excrement which leads to losses in quality due to hygiene (Adams and Moss, 1991). The demands yam chips are hygroscopic and tend to draw moisture which promotes the formation of mould and thus early deterioration (Frazier and Westhoff, 2003).

Condition or soundness of products can be critical in establishing microbial invasion. Nutritional investigations have shown that simple carbon and nitrogen sources plus selected mineral salts provide the necessary nutrients for the growth of most microorganisms (Frazier and Westhoff, 2003). Condition of the product is influenced by the environment during growth and maturation, the degree of microbial invasion, the maturity at harvest, the methods of handling prior to and after crack and mechanical damage or breakage and predispose stored products to microbial invasion.

The objective of this paper is to investigate the effect of storage on the microbiology and nutrient composition of yam chips and flour stored for three months.

MATERIALS AND METHODS

Yam tubers

Fresh yam tubers (*Dioscorea rotundata*) were obtained from

*Corresponding author. E-mail: tonyojokoh@yahoo.com.

Table 1. Total viable bacteria count for the different samples (cfu/g).

Sample	Total viable bacteria count during storage (cfu/g)		
	First month of storage	Second month of storage	Third month of storage
Yam chips (Gbodo)	1.0×10^4	1.2×10^4	2.5×10^4
Yam flour (Elubo)	1.1×10^4	2.3×10^4	3.5×10^4

Table 2. Total spore forming units present in the different samples (sfu/g).

Samples	Total spore forming units during storage (sfu/g)		
	First month of storage	Second month of storage	Third month of storage
Yam chips (Gbodo)	1.8×10^2	1.7×10^2	1.8×10^2
Yam flour (Elubo)	2.0×10^2	2.2×10^2	3.2×10^2

Oja-Oba Market in Akure, Ondo State.

Processing and storage of yam chips (Gbodo) and yam flour (Elubo)

Fresh undamaged white yam (*D. rotundata*) tubers were peeled and sliced to a thickness of 2 mm. They were washed and placed in a container of clean water that had been heated to 60°C for blanching. Fermentation for a period of 24 h was carried out (Achi and Akubor, 2000). After fermentation, the yam slices were laid out on a clean spread of polythene sack for sun drying. Sun drying continued for 8 weeks until the moisture content of the chips was 10%. Some of the dried chips were ground into powder with a milling machine and sieved to produce fine flour. The chips and flour were each placed into separate polythene bags and stored under cool and dry microbial and proximate analysis of both the yam chips and flour were monitored monthly throughout the period of storage.

Microbial analysis

A 1 g of sample was weighed and crushed to powder with sterile mortar and pestle (This was not necessary for the flour sample). It was then placed in a sterile test tube and dissolved with 10 ml of distill water to make the stock. Serial dilution was done to the necessary dilution factors and pour-plated. The plates were left to gel and then incubated. The bacteria plates were incubated at 37°C for 48 h while the fungal plates were incubated at 25°C for 72 h. At the end of each incubation period, the colonies were counted and sub-cultured onto fresh media maintained on slants and preserved at 4°C in the refrigerator.

Proximate analysis

The proximate composition (ash, fat, moisture and crude fibre) of the samples were determined using the methods of AOAC (2005). Protein was determined using the micro-kjeldhal method (N X 6.25).

Analysis of data

The data were analysed by student t-test (Zar, 1984).

RESULTS AND DISCUSSION

In this study, a total of five bacteria and two fungi were isolated and identified from the yam chips and flour. They were *Staphylococcus aureus*, *Escherichia coli, Streptococcus* sp., *Bacillus* sp., *Corynebacterium* sp., *Saccharomyces cerevisiae*, *Candida* sp., *Aspergillus niger* and *Penicillum* sp.

The total viable bacteria and fungi spore present in both samples throughout the period of storage are presented in Tables 1 and 2.

Generally there was increase in both bacteria and fungi spore counts. The bacteria isolates present in the yam chips and flour were mainly aerobic positive cocci and gram negative enteric such as *E. coli* and *Klebsiella* species. The enteric organisms could have come from the washing and steeping water and improper handling (Babajide et al., 2006). The fungal isolates comprised mainly of moulds such as *Aspergillus* and *Penicillum* species. They are associated with the spoilage of yam chips and flour.

Results of the proximate composition of the yam chips and flour during storage for three months are presented in Table 3. The proximate composition of the raw, fermented and dried yam samples are presented in Table 4. There was a decrease in the moisture, fat and protein contents in both the yam chips and flour during the storage period with the yam flour sample having more decrease. There was an increase in fibre and carbohydrate contents in both samples with flour having a higher increase. There was no significant difference in the ash content.

Despite the low moisture content in the stored samples compared to the dried sample, there were still microbial activities which led to decrease in the nutrients. It has been reported by Adeniji (1996) that fungal growth in agricultural produce is directly correlated to the moisture content. The typical water activity which is necessary for fungal growth ranges from 0.70-0.90 (Frazier and Westhoff, 2003). The decrease in protein and fat contents of

Table 3. Proximate composition of the different samples (%).

Content	Samples	Storage period		
		First month of storage	Second month of storage	Third month of storage
Moisture	Yam chips (Gbodo)	9.85 ± 1.51	8.10 ± 3.31	8.02 ± 0.53
	Yam flour (Elubo)	9.10 ± 1.01	8.82 ± 0.44	7.28 ± 1.05
Ash	Yam chips (Gbodo)	1.66 ± 0.04	1.66 ± 0.02	1.65 ± 0.03
	Yam flour (Elubo)	1.60 ± 0.09	1.52 ± 0.07	1.46 ± 0.06
Fat	Yam chips (Gbodo)	1.09 ± 0.05	1.02 ± 0.01	1.01 ± 0.04
	Yam flour (Elubo)	1.01 ± 0.06	0.99 ± 0.02	0.95 ± 0.03
Protein	Yam chips (Gbodo)	6.13 ± 1.12	5.20 ± 0.65	4.58 ± 1.14
	Yam flour (Elubo)	6.11 ± 1.03	5.11 ± 1.15	4.28 ± 0.75
Fibre	Yam chips (Gbodo)	1.19 ± 0.05	1.25 ± 0.08	1.25 ± 0.02
	Yam flour (Elubo)	1.23 ± 0.07	1.26 ± 0.03	1.38 ± 0.01
Carbohydrate	Yam chips (Gbodo)	80.32 ± 5.79	82.77 ± 2.71	84.49 ± 4.00
	Yam flour (Elubo)	80.95 ± 6.52	82.30 ± 2.87	84.37 ± 1.63

Table 4. The proximate analyses of the raw, fermented and dried yam samples (%).

Parameter	Sample		
	Raw	Fermented	Dried
Moisture content	55.81 ± 3.03	68.34 ± 5.99	10.87 ± 0.53
Ash content	1.16 ± 0.72	0.57 ± 0.01	1.66 ± 0.31
Fat content	1.78 ± 0.29	0.88 ± 0.02	1.13 ± 0.01
Protein content	2.10 ± 1.51	3.10 ± 0.08	7.14 ± 1.14
Fibre content	1.11 ± 0.08	0.59 ± 0.02	1.17 ± 0.29
Carbohydrate content	38.04 ± 2.87	26.54 ± 2.71	77.03 ± 4.43

the samples is in agreement with the findings of Amusa (2001) who reported that the percentage crude protein and fat of fleshly processed yam chips were significantly higher than those of the stored ones. Most moulds have high lipolytic activities; therefore fats are broken down into fatty acids and partial glycerides during fungal deterioration of stored products.

There was no significant difference in ash content especially in the yam chips sample. The ash of food stuff is the inorganic residue remaining after the organic matter has been burnt away. It is therefore useful in assessing the quality of edible material. The increase in fibre and carbohydrate contents in the samples might be due to added bi-products of microbial metabolism (metabolites) as well as cell constituents like peptidogly can. The report presented here showed that yam chips have longer shelf life than yam flour because of the lower accessibility of the sample to microorganisms.

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