Journal of Applied & Environmental Microbiology, 2014, Vol. 2, No. 1, 12-15
Available online at http://pubs.sciepub.com/jaem/2/1/3

DOI:10.12691/jaem-2-1-3

The Effects of Packaging Materials on Shelf-Life Stability of Garri Bought From Markets in Lapai Niger State Nigeria

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Received November 29, 2013; Revised December 16, 2013; Accepted January 01, 2014

Abstract Samples of white garri were collected at weekly intervals in May, June and July 2011 from Central and Gbako markets in Lapai Local Government Area, Paikoro and Tunga-mallam markets in Paikoro Local Government Area all in Niger State Nigeria. The purchased garri with initial moisture content of 14.30 % was aseptically weighed (5 kg / pack) into Polythene bags, Fertilizer bags and Plastic buckets, these were stored at 28 ± 2°C for eight months. The changes in the sample moisture content, associated fungi, biochemical and sensory quality were monitored. The result revealed that the average moisture content of garri offered for sale in these markets (13.90 %) was slightly higher than safe level (12.70 %). The moisture and mould contents were observed to increase with period of storage while the nutritional content and PH were reduced. The degree of deterioration was observed to be generally low and was in the order Plastic buckets < Polythene bags< Fertilizer bags. Changes in the various sensory quality attributes such as colour, aroma, texture, and mouldness at the end of the storage period followed the same trends. Four fungi species (*Aspergillus niger, Aspergillus flavus, Aspergillus fumigatus and Rhizopus stolonifer)* were isolated during the storage period in all the packaging materials. The total viable fungal count was in the order fertilizer bags > Polythene bags > plastic buckets. On the whole air-tight plastic buckets or polythene bags were observed and recommended to be the best packing materials for garri for a long period of time in this study.

Keywords: *air tight, deteriorate, fungi, moisture content, nutritional, storage*

Cite This Article: Adebola, Matthew O, Dadi-Mamud N. J, and Nusa Halima M.K, "The Effects of Packaging Materials on Shelf-Life Stability of Garri Bought From Markets in Lapai Niger State Nigeria." *Journal of Applied & Environmental Microbiology* 2 no. 1 (2014): 12-15. doi: 10.12691/jaem-2-1-3.

1. Introduction

Garri (yellow and white) prepared from cassava roots is very common staple food stuff in Nigeria. It is used as food by adding cold water to which it impacts a sour flavor and is very good as a drink. Traditionally, it is made into a dough with hot water and eaten with vegetable or any other soup. Garri is one of the food stuffs that has microbiological problem only during storage. The process of preparation involves frying the stuff at high temperature which would have killed all micro-organisms, but after preparation however, other fungal spores infect the garri and most of them cause spoilage [1,6].

The most important factor encouraging mould contamination of garri is the initial high moisture content and the relative humidity (R.H) of the air within and around the commodity. during storage. It is known that microbial activity is reduced to minimum at relative humidity of 70 % or less [3,5].

Moulds especially Aspergillus species have been isolated and identified from samples of garri under various storage and marketing conditions. The development of mould leads to great modification in the chemical composition of infected stored produce. One of the most significant changes is an increase in free fatty acids (FFA) and reducing sugars as well as a loss in protein content [1]. An increase in the moisture content and mould colony counts of white and yellow garri samples stored below safe moisture level in polythene bags was earlier reported [7]. This study therefore investigated the moisture and mould content of garri offer for sale in four major markets in Lapai and Paikoro Local Government Areas in Niger State Nigeria and their effects on shelf- life of garri during storage using different packaging materials. The results of which will be used to make recommendation for the best packaging materials for storage of garri in these areas towards food sustainable programme.

2. Materlals and Methods

2.1. Sample Survey and Collection

Samples of white garri were collected for twelve weeks at weekly intervals in May, June and July 2011 from Central and Gbako markets in Lapai LGA, Paikoro and Tunga-mallam markets in Paikoro LGA all in Niger State Nigeria. Oral interview was conducted to know the level

of participation of men and women in the preparation of garri and types of cassava use in these areas. Weekly moisture contents of garri collected from these markets were determined [1].

2.2. Determination of Moisture Content (MC)

The Association of Official Agricultural Chemists (A.O.A.C) [2] method was used. Evaporating dishes of known weights were used. One gramme of each sample was weighed into each dish. All weighed garri samples were kept in the oven at 70°C for 24 hours to dry up. The samples were brought out and weighed again. Loss in weigh of sample was represented by the water content and was calculated thus:

Weight of dish = Xg
Initial weight of dish + sample = Yg
Initial weight of the sample = Y – X = Pg
Final weight of dish + sample = Zg
Final weight of the sample = Z – X g = Qg
% moisture loss = (P – Q)g / P X 100

2.3. Packaging of Garri for Storage

The purchased garri from the market with initial moisture content of 14.30 % was aseptically weighed (5 kg / pack) into Polythene bags, Fertilizer bags and Plastic buckets. Prior to packaging, all the packaging materials were sterilized with 95 % ethanol. Thereafter, the various packs were hermetically sealed with paper tape. All packaged samples were kept in the laboratory at room temperature (30.0 ± 2°C) for 8 months. Moisture content, fungal growth and proximate content were determine before storage and at the end of three months of storage [1,2,6].

2.4. Microbiological Analysis and Identification

25 g from the samples were aseptically weighed into 225 ml of 0.1 % (w / v) sterilized peptone water in a beaker and allowed to stand for 5 min and it was stirred occasionally with the aid of sterile glass rod. 1 ml portions of 10^{-1}serial dilutions were inoculated on Potatoes Dextrose Agar (PDA) supplemented with chloramphenicol for total viable fungal count. The colonies that developed were enumerated and expressed as colony forming unit per gram (cfu / g). Isolation, characterization and identification of the microorganisms were carried out for qualitative determinations using colonial, morphological and biochemical characteristics. The fungal isolates were identified based on examination of the colonial heads, phlalides, conidiophores and presence or absence of foot cells or rhizoids [6].

2.5. Biochemical Analysis

The PH was determined by blending 10 g of each sample in 10 ml sterilized distilled water and using a referenced glass electrode pH meter (Jenway, 3020, England). Titratable acidity (TA) was determined by titrating 0.1 N sodium hydroxide against 10 ml of sample (supernantant of garri soaked in water) using phenolphthalein as indicator [2]. The moisture content, crude protein, lipids, and carbohydrate content were determined according to the methods described by AOAC [2], while the hydrocyanic acid content was determined by the alkaline titration method [2].

2.6. Sensory Quality Assessment

The sensory quality was assessed based on parameters such as colour or appearance, aroma (flavor), texture, swelling index and mouldness. Using a nine point hedonic scale, twelve member panel who consumes garri on a regular basis was used to score the various quality attributes for overall acceptability [6].

2.7. Data Analysis

The various data obtained were subjected to statistical analysis of percentage mean, standard deviation and Analysis of variance (ANOVA).

3. Results

The market survey and oral interview conducted revealed that only women were engaged in the processing, buying and selling of garri men only assisted in jacking during processing in these areas understudy. The processors still engage in the use of the traditional methods of using heavy stones to press garri pulp and spreading on mat after frying to complete the drying process. Garri was also offered for sale in large bowls display in the market amidst of dusty environment. The study also revealed that only selected varieties of cassava such as ‘Nwaiwa’, which matures late, ‘Okotoronwa’ that is tall and has a high yield, ‘Karagba’ high yielding and ‘Dan warri’ were used in making fine garri.

The average moisture content (Table 1) of garri on sale in Central and Gbako markets Lapai LGA was 14.00 %and 13.90 % respectively while it was 13.89 % and 13.82 % in Paikoro and Tunga-mallam markets in Paiko LGA. The average moisture contents (MC) of garri on sale in Lapai and Paiko LGA markets were 13.95 % and 13.85 % respectively while it was 13.90 % on the average in all the four markets sampled in the two LGAs. The initial MC level before storage (14.30 %) was observed to increase in all the packaging materials used at the end of storage period (Table 2). This increase was in the order; Fertilizer bags > Polythene bags > Plastic buckets at the end of the storage period. Slight decrease was observed in the pH in all the packaging materials. Plastic buckets gave the least PH (3.81) while it was the same value of 4.00 in Polythene and Fertilizer bags. The various degrees of changes were recorded in the carbohydrates, protein, lipid and hydrocyanic acid contents. The nutritional content reduced with increase in moisture and mould contents. The degree of deterioration observed was in the order Plastic buckets < Polythene bags < Fertilizer bags. Changes in the various sensory quality attributes such as colour, aroma, texture, and mouldness and overall acceptability score at the end of the storage period followed the same trends. Four fungi (Aspergillus niger, Aspergillus flavus, Aspergillus fumigatus and Rhizopus stolonifer) species were isolated during the storage period in all the packaging materials (Table 3). The total viable fungal count was found to be moderately high in all the samples after the eight months

of storage. However, the total fungal counts were in the order fertilizer bags > Polythene bags > plastic buckets. The degree of mouldness was observed to be generally low in the same order of fungal count (Fertilizer bags > Polythene bags >. Plastic buckets). The changes in organoletic quality and overall acceptability was in the order Plastic buckets > Polythene bags > Fertilizer bags.

Table 1. Mean weekly % moisture contents of garri samples from four markets in Lapai and Paiko Local Government Areas in Niger State, Nigeria

	Lapai L.G.A. Markets			Paiko L.G.A. Markets		
Period (wk)	Central (%)	Gbako (%)	Average / wk (%)	Paikoro (%)	Tunyga-m (%)	Average / wk (%)
1	14.30	14.50	14.40	14.52	13.88	14.42
2	14.60	14.60	14.60	14.34	14.00	14.17
3	14.60	14.30	14.45	13.87	13.69	13.78
4	14.30	13.80	14.05	13.68	13.88	13.78
5	13.90	13.50	13.70	13.70	13.69	13.75
6	13.60	13.60	13.60	14.00	13.65	13.80
7	13.90	13.70	13.80	13.92	14.10	14.01
8	14.30	13.60	13.95	13.66	13.68	13.67
9	13.89	13.86	13.87	13.69	14.00	13.85
10	13.34	14.00	13.67	13.65	13.82	13.74
11	13.66	13.76	13.71	13.75	13.85	13.80
12	13.69	13.52	13.60	13.93	13.64	13.79
Average for the period	14.00	13.90	13.95	13.89	13.82	13.85

Table 2. Changes in the physico-chemical and nutritional quality of garri in different packaging materials at the end of storage period of 8months

Parameter	Initial or before storage	Polythene bags	Fertilizer bags	Plastic buckets
M C (%)	14.30 ± 0.01	14.48 ± 0.25	15.41 ± 0.03	14.43 ± 0.05
PH	4.12 ± 0.01	4.00 ± 0.08	4.00 ± 0.10	3.81 ± 0.01
CHO (%)	73.31 ± 0.34	69.15 ± 0.07	68.54 ± 0.32	68.62 ± 0.32
protein (%)	2.34 ± 0.01	1.65 ± 0.11	1.01 ± 0.03	1.99 ± 0.02
lipid (%)	0.63 ± 0.02	0.58 ± 0.04	0.53 ± 0.01	0.60 ± 0.01
HCN (mg / g)	3.71 ± 0.01	2.20 ± 0.14	2.11 ± 0.4	2.34 ± 0.00

Each value is the overall mean ± standard deviation for duplicate determinations

Table 3. Fungi isolated and their occurrence per gramme after 8 months of storage at 14.30 % moisture content using different packaging materials

Mould species	Initial mould Content	Polythene bags	Plastic containers	Fertilizer bags
Aspergillus flavus	0.04×10^2	2.0×10^2	1.8×10^2	2.1×10^2
Aspergillus niger	0.01×10^2	1.5×10^2	1.4×10^2	1.6×10^2
Aspergillus fumigatus	0.01×10^2	1.0×10^2	0.9×10^2	1.8×12^5
Rhizopus stolonifer	0.02×10^2	1.3×10^2	1.2×10^2	1.7×12^5
Total mould	0.08×10^2	5.8×10^2	5.3×10^2	7.2×10^2

4. Discussion

The results of this study showed that the average moisture content of garri on sale in the markets in Lapai and Paiko Local Government Areas in Niger State, Nigeria was very close to the reported safe levels (12.70 % white). This result was probably due to the geographical location of the State which is towards the northern Nigeria where the relative humidity is very low. As against the higher moisture contents in garri samples offered for sales in the markets at Ibadan and in Ilorin in the southern parts as earlier reported by as in [1,7] respectively. This was also supported by the earlier report of [6] that the moisture content of any produce will depend on factors such as location, season, produce itself and methods of processing. In this research, fertilizer bags preserved garri bought in the markets fairly well probably due to the porosity of the bags which might caused moisture leakage thus preventing dried garri which is known to be hygroscopic from retaining absorbed moisture from the air. Garri was kept well in Polythene and plastic containers probably because they were able to keep their microclimate shielded from the influence of the surrounding environment. The low but gradual increase recorded in the total viable fungal count in all the samples in the various packaging materials suggests unfavourable micro-environmental conditions which probably disallowed the fungi spores to germinate and proliferate. However, the higher counts observed in fertilizer bags may be attributed to its relative permeability to atmospheric gases such as oxygen, carbon dioxide and water vapour that favoured the growth of microorganism. The small quantity of fungi isolated from polythene bags and plastic buckets may be due to the ability of these fungi to tolerate and survive in slightly harsh environmental conditions such as low pH and low moisture content as in [4]. The decrease in pH recorded in all the samples in the various packaging materials at the end of the storage period may be related to the activities of the associated microbes which might have increased the release of some organic acids and other metabolites as earlier reported in [6]. The decrease recorded in the carbohydrate, protein and lipid contents of garri in all the packaging materials

(in the order plastic bucket < Polythene bags < Fertilizer bags) at the end of the storage period might be as a result of increase in number of fungi which probably led to increase in the metabolic activities and thus utilization of these metabolites as in [1]. Little changes was observed in the quality attributes of colour, flavor or aroma, texture and mouldness amongst the different samples and these may be caused as a result of the migration, permeation, absorption properties of these packaging materials used and the associated microbes as earlier reported in [1,5].

5. Conclusion

These findings revealed that all the packaging materials used for storage, stored the garri well for the period of this study, but plastic bucket was still the best in keeping the quality attributes throughout the storage period at moisture content at which the garri was bought at the markets. If garri is well dried to a moisture content level below recommended safe levels of 12.7-13.6 % and are stored in such a way that there is no subsequent moisture uptake from the atmosphere, garri might be stored very well for a long period of time. Therefore garri meant to be stored for longer periods should be properly dried to lower moisture content level using an air tight plastic buckets. The local methods of using heavy stones to press garri in order to remove the juice and spreading after frying should be discouraged. Lastly garri offered for sale in the markets should be adequately covered to prevent being contaminated with spores of microorganisms in the dusty air.

Acknowledgement

The authors acknowledge the privilege given to us by Ibrahim Badamasi Babangida University to serve as Lecturers and Researchers.

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