British Journal of Applied Science & Technology
15(4): 1-5, 2016, Article no.BJAST.23670
ISSN: 2231-0843, NLM ID: 101664541

SCIENCEDOMAIN *international*
www.sciencedomain.org

Mycoflora and Moisture Content of Garri Sold in Anyigba, Kogi State

C. K. Mofolorunsho[1*], U. S. Iyaji[1] and K. Agboola[2]

[1]Department of Microbiology, Kogi State University, Anyigba, Nigeria.
[2]Department of Soil and Environmental Management, Kogi State University, Anyigba, Nigeria.

Authors' contributions

This work was carried out in collaboration between all authors. Authors CKM, USI and KA were involved in the study design, drawing up of protocol, samples collection and analyses. Authors CKM and KA performed the statistical analyses, managed the literature search and drafting of the manuscript. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/BJAST/2016/23670
Editor(s):
(1) Teresa De Pilli, University of Foggia, Department of Science of Agriculture of Food of Environment (SAFE), Via Napoli, 25; 71100 Foggia, Italy.
(2) Singiresu S. Rao, Prof. at Department of Mechanical and Aerospace Engineering, University of Miami, Coral Gables, USA.
Reviewers:
(1) N. Murugalatha, Quantum School of Technology, Uttarakhand, India.
(2) Anonymous, Evangel University Akaeze, Nigeria.
(3) Sara Robinson, Oregon State University, USA.
Complete Peer review History: http://sciencedomain.org/review-history/14166

Original Research Article

Received 14th December 2015
Accepted 17th February 2016
Published 14th April 2016

ABSTRACT

Aims: Investigations were carried out to determine the mycoflora and moisture content of garri sold in Anyigba, Kogi State.
Methodology: Samples of white and yellow garri collected from two major open markets namely; Garage and Anyigba old markets were used for the study. Enumeration of fungal counts in all samples was carried out using the pour plate method. Isolates were identified based on examinations of conider heads, phialides, conidiophores, and the presence or absence of rhizoids and data analyzed using SPSS version 18.0. The moisture content of each sample was also determined.
Results: Moulds isolated from these samples were; *Aspergillus* spp, *Rhizopus* spp, *Penicillium* spp, *Mucor* spp *and Neurospora* spp. Higher mould species were recorded in yellow garri samples compared with that in white garri samples. The mean total fungal counts showed that white garri ranged from 2.03 x 10^4 to 6.40 x 10^6 while yellow garri was from 3.96 x 10^4 to 8.60 x 10^6. Significant differences in mean fungal counts were recorded in the various dilutions of white

**Corresponding author: E-mail: ckmofolorunsho@gmail.com;*

and yellow garri (*P* = 0.05). Results from this study revealed high moisture contents which were not within safe levels and encouraged the growth of fungi.
Conclusion: Proper handling, packaging and storage under hygienic conditions are recommended. Also proper drying of garri to lower its moisture content should be encouraged.

Keywords: Garri; fungi; moisture content; Anyigba.

1. INTRODUCTION

Garri, a fine to gritty roasted granular stachy staple, is produced from cassava tubers [1,2]. It is a popular and common cassava staple consumed by several millions of people across various ethnic and socio-economic classes in the West Africa Sub region [3,4]. It is stored and marketed in a ready-to-eat form; making it a convenient product [4,5]. Garri can be consumed using boiled water to make a dough called 'eba' and eaten with vegetable soup of various types [4,6] or consumed directly with dried fish, groundnut, pea nut, or coconut [6,4,5].

Garri is rich in starch, fibre and contains some essential vitamins [7,8,9]. Its high fibre content helps in preventing or at least reducing the likelihood of constipation and bowl diseases [7]. The process of preparation of cassava into garri involves grating and fermentation of the tuber [10]. The cassava pulp is put in jute bags and weighed down with hudraulic press to dehydrate for 2-5 days. The fermented lump is subsequently fried at high temperature in a pan [6,10].

Various groups of microorganisms have been reported to be associated with garri during production, storage and distribution [5,11,12,13]. Unhygienic practices such as drying on the floor mat after frying, display in open basins, bags, bowls and mats at points of sale and the use of bare hands during handling and sales predisposes garri to contamination and infestation by microorganisms especially moulds which potentiates deterioration and spoilage [5,4,14,15]. An important factor which encourages mould contamination of garri is increased or initial high moisture content during storage [10]. The removal of sands and sticky mud completely from tubers, use of portable/ treated water, cleaning and disinfection of grating machines and fermentation troughs, thorough hand washing with soap and regular washing of sacks with hot water and disinfectants are measures that can be employed to avoid contamination [16].

Previous studies have shown that certain mould species have been isolated from garri during storage and under marketing conditions [17,10,13]. Moulds, present in garri, affect the organoleptic and nutritional properties of the starchy staple and species if toxigenic, may produce mycotoxins [4,18].

The contamination of garri by certain species of moulds and their associated cause of food borne illnesses and public health threat, calls for attention and regular surveillance for their presence in foods. It is in line with the foregoing, that this work was designed to assess the role of moisture in the mycological contamination of garri aimed at developing regulation for the quality and safe handling of product.

2. MATERIALS AND METHODS

2.1 Collection of Samples

Samples of white and yellow garri were collected from sellers in two major open markets in Anyigba, Kogi State, namely; Garage and Anyigba old markets. A total of ten samples from each market comprising of white and yellow garri were randomly collected [19] in sterile polythene bags adopting standard procedures. Samples were then labelled appropriately and transported to the laboratory for analyses.

2.2 Moisture Content Determination

The moisture content of each sample was determined by the modification of methods described by AOAC [20]. Ten grams of each sample was weighed and dried in an oven at 100ºC for 1 hour after which, they were placed in desiccators to cool and then reweighed. This was repeatedly done until a constant weight was obtained. The moisture content was then determined by finding the difference in weight.

2.3 Microbial Analyses of Samples

Enumeration of fungal counts in all samples was carried out using the pour plate method. Ten

grams of each sample was weighed into a beaker containing 90 ml of 0.1% sterile peptone water (w/v) and allowed to stand for 3 minutes with occasional stirring [4]. Six fold serial dilutions of samples were subsequently prepared and 0.1ml aliquots were aseptically plated on Potato Dextrose Agar (Rapid Labs, UK) for viable fungal counts. Plates were incubated for 72 hours at 25ºC. Counts were calculated and expressed as colony-forming units per gram (cfu/g). Isolates were identified based on examinations of conidial heads, phialides, conidiophores, and the presence or absence of rhizoids [21].

2.4 Statistical Analyses

Data obtained from this study were analysed using the Statistical Package for Social Sciences (SPSS) software, vision 18.0. Descriptive data were presented as summaries. ANOVA was used where appropriate. Significant differences of mean were determined [5]. Statistical significance was set at $P = 0.05$.

3. RESULTS AND DISCUSSION

Moisture contents of white and yellow garri samples analysed ranged from 18.0 – 23.0% and 20.0 – 25.0% for white and yellow samples respectively (Table 1). The mean moisture content was 19.8% for white garri and 22.4% for yellow garri.

Table 1. Moisture contents of garri samples from Anyigba markets

Garri samples	Moisture contents (%)
White	
A	20.0
B	23.0
C	18.0
D	20.0
E	18.0
Yellow	
A	25.0
B	24.0
C	20.0
D	22.0
E	21.0

Mean total fungal counts (TFL) of 2.03 x 10^4, 2.20 x 10^5, and 6.40 x 10^6 for white garri and 3.96 x 10^4, 8.80 x 10^5 and 8.60 x 10^6 for yellow garri were recorded (Table 2). Significant differences in total mean fungal counts were recorded in the various dilutions of white and yellow garri ($P = 0.05$).

Mouldness of different levels was observed in all samples. Discoloration and in some cases foul odour and caking were seen to occur mainly in yellow garri samples. Subsequently, five mould species were isolated from both white and yellow garri samples. These were; *Aspergillus* spp*.,* *Rhizopus* spp., *Penicillium* spp., *Mucor* spp*.* and *Neurospora* spp*.* Higher mould species were abundant in yellow garri in this study (Table 3).

Table 2. Total viable fungal counts of yellow and white garri obtained from the main markets in Anyigba

Total fungal counts (TFC)	Cfug^{-1} x 10^4		Cfug^{-1} x 10^5		Cfug^{-1} x 10^6	
Garri samples	**Yellow**	**White**	**Yellow**	**White**	**Yellow**	**White**
	4.50	2.69	2.11	3.00	1.20	1.72
	6.50	1.51	1.20	2.80	1.40	9.40
	3.20	7.40	5.30	2.00	6.00	3.70
	3.10	4.80	2.80	1.80	7.00	6.00
	2.50	4.10	3.00	1.40	4.00	1.10
Average TFC	3.96	2.03	8.80	2.20	8.60	6.40

Table 3. Frequency of occurrence of mould species isolated from garri samples

Fungus	White garri samples					Yellow garri samples				
	A	**B**	**C**	**D**	**E**	**A**	**B**	**C**	**D**	**E**
Apergillus spp	+	+	+	-	-	+	+	-	+	+
Rhizopus spp	-	-	-	-	+	+	-	+	-	-
Penicillium spp	+	+	+	+	-	+	+	+	-	+
Mucor spp	-	+	-	-	-	+	+	+	+	+
Neurospora spp	-	-	+	-	-	-	-	-	-	-

+ = Present, - = Absent

The high moisture contents of garri samples recorded in this study were much higher than the reported safe levels of 12.70% and 13.60% for both white and yellow garri [22]. Other researchers reported similar moisture contents [5,6]. The hygroscopic nature of garri makes it possible to absorb gases and moisture from the surrounding environment [5,22]. In this present study, higher fungal counts were recorded in yellow garri when compared with that recorded in white garri samples. This can be attributed to high moisture contents reported in this study.

A total of five fungal genera were isolated from both white and yellow garri samples. Several reports from various researchers have shown the isolation of some of these fungal genera in garri samples and other fermented foods [4,12,11,5,23]. The rate of occurrence of these moulds may be associated with the inadequate processing and handling practices, ubiquitous nature of fungi and their ability to withstand and tolerate harsh environmental conditions [4,24,2].

4. CONCLUSIONS

In conclusion, this study revealed that high moisture content encourages the growth of fungi in garri and highlights the need to properly dry garri to lower its moisture content. Also, proper handling, packaging and storage under hygienic conditions should be encouraged.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Ernesto M, Cardoso AP, Cliff J, Bradbury JH. Cyanogens in cassava flour and roots and urinary thiocyanate concentration in Mozambique. Journal of Food Composition and Analysis. 2000;13:1-12.
2. Ogiehor IS. Extension of shelf life of garri by combination of preservative factors. Ph.D thesis, University of Benin, Benin city, Nigeria; 2002.
3. Jekayinfa SO, Olajide JO. Analysis of energy usage in the production of three selected cassava-based foods in Nigeria. Journal of Food Engineering. 2007;82: 217-226.
4. Ogiehor IS, Ikenebomeh MJ, Ekundayo AO. The bioload and aflatoxin content of market garri from some selected states in southern Nigeria. African Health Sciences. 2007;7(4):223-227.
5. Ogugbue CJ, Obi G. Bioburden of garri stored in different packaging materials under tropical market conditions. Middle-East Journal of Scientific Research. 2011; 7(5):741-745.
6. Egbebi AO, Aboloma RI. Fungi and Moisture content of gari sold in some locations in Southwestern Nigeria. Archives of Applied Science Research. 2012;4 (6):2361-2364.
7. Adepoju OT, Adekola YG, Mustapha SO, Ogunola SI. Effect of processing methods on nutrient retention and contribution of cassava (*Manihot spp*.) to nutrient intake of Nigerian consumers. African Journal of Food, Agriculture and Nutritional Development. 2010;10(2):2099-2111.
8. Oboh G, Akindahunsi AA, Oshodi AA. Nutrient and anti-nutrient contents of *Aspergillus niger*-fermented cassava products (flour and Gari). Journal of Food Composition and Analysis. 2002;15:617-622.
9. Okwu DE, Awurum AN. Effects of fertilizer application on the chemical composition of cassava tubers and their garri product. Journal of Applied Chemistry and Agricultural Research. 2001;7:112-119.
10. Amadi JE, Adebola MO. Effect of moisture content and storage conditions on the stability of garri. African Journal of Pure and Applied Sciences. 2008;7(24):4591-4594.
11. Aguoru CU, Onda MA, Omoni VT, Ogbonna IO. Characterization of moulds associated with processed garri stored for 40 days at ambient temperature in Makurdi, Nigeria. African Journal of Biotechnology. 2014;13(5):673-677.
12. Ebidor LU, Alade T, Pelessai G. The mycological content of ready to eat garri in Amassoma, Bayelsa State. African Journal of Food Science. 2015;9(2):51-58.
13. Osho A, Mabekoje OO, Bello OO. Comparative study on the microbial load of *Gari*, *Elubo-isu* and *Iru* in Nigeria. African Journal of Science. 2010;4(10):646-649.
14. Cock JH. Cassava, a basic energy source in the tropic. Journal of Science. 1985; 218:755-762.
15. Adeyemi MO, Balogh E. Processing of indigenous fermented foods. Nigerian food Journal. 1985;3:31-34.
16. Abass BA, Dziedzoave TN, Alenkhe EB, James DB. Quality management Manual

for the production of *gari*. International Institute of Tropical Agriculture, Ibadan. Nigeria. 2012;23-27.
17. Adeniyi MO. Fungi associated with the deterioration of garri. Nigerian Journal of Plant Protection. 1976;2:74-77.
18. Efiuvwevwere BJO, Isaiah AU. Effects of hygienic handling in combination with potassium sorbate treatment and smoking on the microbial quality and shelf-stability of croaker (*Micropogonias furnieri*). Zlebensm Unters Forsch. 1998;207:13-17.
19. Babalola OO. Cyanide content of commercial gari from different areas of Ekiti State, Nigeria. World Journal of Nutrition and Health. 2014;2(4):58-60.
20. AOAC. Official Methods of Analysis, 15th ed. Association of Official Analytical Chemists, Arlington, VA; 1990.
21. Samson RA, Reenen – Hoekstra, Van ES. Introduction to foodborne fungi. 2nd ed. Central bureau voor schimmel cultures: Baarn; 1988.
22. Halliday DJ, Quareshi AH, Broadbent JA. Investigations on the storage of garri. Rep. Niger. Stored Prod. Res. Inst. Tech. Rep. 1967;16:131-141.
23. Adebayo CO, Aderiye BI, Akpor OB. Assessment of bacterial and fungal spoilage of some Nigerian fermented and unfermented foods. African Journal of Food Science. 2014;8(3):140-147.
24. Ibeh IN, Uriah N, Ogonor JI. Dietary exposure to aflatoxin in Benin City, Nigeria: A possible public health concern. International Journal of Food Microbiology. 1991;14:171-174.

© 2016 Mofolorunsho et al.; This is an Open Access article distributed under the terms of the Creative Commons Attribution License (http://creativecommons.org/licenses/by/4.0), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Peer-review history:
The peer review history for this paper can be accessed here:
http://sciencedomain.org/review-history/14166