

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

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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 2.03×10^4 to 6.40×10^6 while yellow garri was from 3.96×10^4 to 8.60×10^6 . Significant differences in mean fungal counts were recorded in the various dilutions of white 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 starchy 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 bowel 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 hydraulic 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 100°C 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 90ml 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 25°C. 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, version 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 2.03×10^4 , 2.20×10^5 , and 6.40×10^6 for white garri and 3.96×10^4 , 8.80×10^5 and 8.60×10^6 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 ($P = 0.05$).

Table 2. Total Viable Fungal Counts of Yellow and White Garri Obtained from the Main Markets in Anyigba

Total Fungal Counts (TFC) Garri Samples	$\text{Cfug}^{-1} \times 10^4$		$\text{Cfug}^{-1} \times 10^5$		$\text{Cfug}^{-1} \times 10^6$	
	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

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 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
<i>Apergillus</i> spp	+	+	+	-	-	+	+	-	+	+
<i>Rhizopus</i> spp	-	-	-	-	+	+	-	+	-	-
<i>Penicillium</i> spp	+	+	+	+	-	+	+	+	-	+
<i>Mucor</i> spp	-	+	-	-	-	+	+	+	+	+
<i>Neurospora</i> 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.

Authors' Contributions

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

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