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Full Length Research Paper

Microbiological safety and quality assessment of some fermented cassava products (*lafun*, *fufu*, *gari*)

A. O. Obadina[1]*, O. B. Oyewole[2] and A. O. Odusami[2]

[1]Department of Food Science and Technology, Bells University of Technology, P. M. B. 1015, Ota, Nigeria.
[2]Department of Food Science and Technology, University of Agriculture, P. M. B. 2240, Abeokuta. Nigeria.

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Some cassava fermented products namely "lafun", "fufu" and "gari" obtained from various markets in Abeokuta were investigated when stored at ambient condition for seven days. The qualities of these products, not only revealed changes in the physical appearance but also in some sensory attributes such as colour, aroma, drawness, mouldiness, stickiness and smoothness during storage period. The microbiological assessment of these fermented products during storage showed that some moulds developed at various times within the several days of exposing them to ambient conditions. The moulds associated with these products during storage include *Aspergillus* spp., *Fusarium* spp., *Mucor* spp. and *Rhizopus* spp. Factors promoting the growth of these spoilage moulds were discussed.

Key words: Cassava, fufu, lafun, gari, safety, quality, eba.

INTRODUCTION

In Africa, cassava is one of the most important food crop (FAO, 1999) and Nigeria is the current leading cassava producing country in the world (FAO, 2002).

In Nigeria, cassava is consumed in boiled, baked and fried forms in addition to various other products that are gotten from fermenting the crop. Cassava root is normally processed before consumption so as to detoxify, preserve and modify them (Oyewole, 1991). Among the fermented cassava products of cassava roots are "gari", "fufu", "lafun", "pupuru" and "tapioca" (Lancaster et al, 1982). Earlier investigation on fermented products of cassava had been on the microorganisms involved in the fermentation process. These include bacteria, yeast and moulds.

A study conducted by Oyewole and Odunfa (1988), showed that *Bacillus* spp., *Lactobacillus* spp., *Geotrichum* spp. and *Aspergillus* spp. were present in cassava during fermentation of "lafun". Out of these, *Geotrichum* spp. and *Aspergillus* spp. disappeared during the first 36 hours of fermentation and disappeared as the fermentation progresss. However, little or no interest has been shown on the microbiological safety of fermented cassava products. Hahn, (1989) investigated the fungi associated with gari; several fungi were isolated by these workers. These include *Aspergillus* and *Penicillum* spp, *Mucor fusillus* were dominant at the commencement of storage. They also isolated *Fusarium* spp., *Curvularia* spp and *Cladesperium* spp. during the period of storage.

"Fufu" is a pasty cassava mash which is cooked in boiling water and consumed with soup. It is processed by peeling the cassava, cutting into small sizes, fermentation (submerged), pulping, screening, sedimentation and dewatering (Oyewole et al., 2001). Unlike other fermented cassava products, it has a very strong odour and is very popularly consumed in East and West Africa (Lancaster et al., 1982). Fufu is an important staple food widely eaten in Nigeria and many parts of West Africa and the Tropics (Sanni, 1989). It is consumed in the eastern and western parts of southern Nigeria as well as some other areas of West and Central Africa. It is known as "chikwuangue" or "chikwange" in Zaire; "fufu" or "foo-foo" in southern Nigeria and in conflict with another product of boiled cassava, it is also called "akpu" in some parts of eastern Nigeria (Okafor et al., 1984; Longe, 1990).

Gari is a dry granular, fermented product of cassava which is widely consumed across West Africa, Central Africa and in some parts of North and Southern Africa. Gari can be consumed directly without cooking. Alternatively, it is soaked in water with sweeteners prior to con-

*Corresponding author. E-mail: obadinaw@gmail.com.

sumption or is made into a stiff gel by mixing with hot water (Oyewole, 2000). Gari is process by peeling the root, washing, grating, solid state fermentation, pulverizing and roasting (Oyewole and Sanni, 1995).

Lafun is a fermented cassava flour, popularly consumed in south west Nigeria. It is usually prepared as a stiff porridge using boiling water, prior to being consumed with soup. But it is processed from cassava by peeling, cutting, submerged fermentation, dewatering, sun-drying and milling (Oyewole and Sanni, 1995).

Unfortunately, there is no report on the fungi associated with the spoilage of these fermented cassava products. Knowing that fermented products of cassava constitute a major part of daily diet of many Nigeria homes and most part of West Africa, information on this study will help to develop appropriate storage for cassava products. “Gari”, “Fufu” and “Lafun” are known to be the most popular of cassava products (Oyewole and Odunfa, 1988). A further study into these products will also help to ensure the microbiological safety of fermented cassava products.

MATERIALS AND METHODS

Some cassava fermented products mainly “fufu”, “gari” and “lafun” were collected from five local markets in Abeokuta (Kuto, Osiele, Lafenwa, Iberekodo and Adatan). The fermented cassava products were collected in sterile polyethylene bag and labeled appropriately for identification and exposed under dew for 7 days.

Analysis of samples

For the various samples obtained, visual inspection (changes in colour, texture and odour); moisture and mycological analysis were carried out.

Moisture content

The moisture content of the samples was determined by the standard AOAC (1984) method. A 5.0 g each of all the samples was weighed into the preset oven and the drying was performed at 105°C for 4 h to a constant weight. Then they were removed from the desiccators to cool and then weighed. The difference in weight was used to obtain the moisture content. All analyses were carried out in duplicate. The percentage moisture content was then calculated as

$$\text{Moisture content MC \%} = \frac{\text{Weight loss}}{\text{Original weight}} \times 100\ \%$$

Sensory evaluation

A nine point hedonic scale with 1 corresponding to extremely poor and 9 corresponding to extremely better was used to analyse the difference in the samples. For each fermented cassava products, “fufu”, “gari” and “lafun”, the samples were subjected to sensory attributes like mouldiness (the presence of mould or staling), drawness (feeling strain and tense), stickiness (level of adhering to the hand), smoothness (having an even surface), aroma (pleasing smell and often of food) and colour. Two samples each from the analysed products, “gari”, “fufu” and “lafun” were reconstituted into “eba” cooked gari, “cooked fufu” and cooked lafun” respectively with additional fresh fermented cassava products in each case. The fresh fermented cassava products (“gari”, “fufu” and “lafun”) were included in the samples to be evaluated and were also used as the preference sample. Fifty panelists were used for the exercise in which each panelist is to evaluate the three fermented cassava products each having 3 samples and a reference sample. Responses obtained from the panelists were subjected to statistical analysis of variance to establish the degree of difference among the samples.

Mycological assessment

Sample preparation: The fufu flour (5 g) was suspended in a 45 ml of sterile distilled water and was homogenized. The suspension was filtered through sterile glass wool. The samples were serially diluted under aseptic conditions. A portion (0.1 ml) of the dilution was aseptically inoculated into appropriate Potato Dextrose agar plates and each organism was spread by using spread plate method. The petri dishes were incubated at 28°C for 3 days.

Viable counting of the fungi growth: Total counts of the colonies that developed on the plates were counted and recorded after 3 days of incubation period.

Identification of fungi: Yeast and molds were identified on the basis of morphological and cultural characteristics. Wet-mounted slides stained with Gram’s iodine were prepared and examined under microscope.

RESULTS AND DISCUSSION

The physical change in the fermented cassava products, “fufu”, “gari” and “lafun”, are shown in Tables 1 - 3 respectively. On day 1 and 2, no visible change was observed on the fermented cassava products “fufu”, “gari” and “lafun”. On day 3, there was a change in the colour and odour of fermented “fufu” and “lafun” while in fermented “gari” a change in odour was observed. By day 4, there were further changes in the colour, odour and over all observation of the fermented cassava products “gari”, “fufu” and “lafun”. By day 7 all the cassava fermented products had profuse spoilage.

Tables 4 and 5 shows the results of analyses on percentage moisture content and the total viable fungi count of the fermented cassava products (“gari”, “fufu” and “lafun”). The “gari” sample have an average of 29.64%, “fufu” sample have an average of 17.68% while “lafun” samples have an average of 22.2%. The average viable fungi count observed in the fermented cassava products “gari”, “fufu” and “lafun” are 1.79 x 10, 1.04 x 10 and 2.62 x 10 respectively. From these results it was observed that “gari” had the highest average percentage moisture content and at the same time had the highest total viable fungi count among the three cassava fermented products “gari”, “fufu” and “lafun”. “Fufu” had the lower moisture content and total viable fungi count compared to “lafun”.

The moulds and yeast isolated from the spoilt fermented cassava products “gari”, “fufu” and “lafun” are shown in Table 6. The fungi isolated in “gari” sample are *Asper-*

Table 1. Changes in the physical appearance of the fresh "fufu" stored for 7 days.

Days	Colour Observation	Odour	Overall
1	No visible colour	No perceive change	No visible change
2	No visible spoilage colour	No perceive change	No visible
3	Green spots observed	Mouldy smell	Partial spoilage
4	Yellowish green	Mouldy smell	Spoilage
5	Deep yellow	Mouldy smell	Spoilage
6	Dirty brown	Mouldy smell	Profuse spoilage
7	Blackish brown	Foul smell	Profuse spoilage

Table 2. Changes in the physical appearance of the fresh "gari" stored for 7 days.

Days	Colour Observation	Odour	Overall
1	No visible change colour	No perceive change	No visible
2	No visible colour	No perceive change	Moistened
3	No visible Change	off odour	Moistened
4	Green spot	Mouldy smell	had clumps
5	Black spots	Mouldy smell	Moistened and clumps
6	Creamy brown	Strong odour	Moistened and clumps
7	Dirty brown	Mouldy smell	Moistened with clumps and profuse smelling

Table 3. Changes in the physical appearance of the fresh "lafun" stored for 7 days.

Days	Colour Observation	Odour	Overall
1	No visible colour	No visible change	No visible change
2	No visible colour	No visible change	Moistened
3	Off white	No visible change	Moistened and clumps
4	Black spots	Off odour	Moistened and clumps
5	Green colour dominate	Mouldy smell	Partial spoilage
6	Green and white	Mouldy smell	Profuse spots spoilage
7	Dirty white	Mouldy smell	Profuse spoilage

Table 4. Moisture content of fermented cassava products after 7 days of exposure to dew.

Sample	Average moisture content
Gari	29.64 ± 12.54
"Fufu"	17.68 ± 6.80
"Lafun"	22.2 ± 12.8

Each value represent mean of three analyses standard deviation.

Table 5. Average total viable fungi count for fermented cassava products after 7 days.

Sample	Total viable fungi count Cfu/g
Gari	1.79×10^4
"Fufu"	1.04×10^4
"Lafun"	2.62×10^4

gillus spp., *Mucor* spp., *Penicillum* spp. and *Rhizopus* spp. The same fungi were isolated from the "lafun" sample except *Penicillum* spp. While "fufu" sample had all the listed mould above with addition of *Fusarium* spp. and *Aspergillus niger* as yeasts. This is similar to the findings of Obadina et al. 2007 who isolated some fungi from 'fufu' flour stored at different relative humidities in ambient condition. The mean sensory scores of the various reconstituted fermented cassava products "gari", "fufu" and "lafun" are present in Tables 7 - 9. Different test between the spoilt "gari" sample and fresh "gari" sample reconstituted into "eba" revealed some differences in the attributes of the food. In all the attributes (moldiness, drawness, stickiness, smoothness, aroma and colour) used in analyzing the samples, there is a statistical difference (that is, there is a significant difference between the spoilt "gari" and the fresh "gari" reconstituted into "eba"). The same is the case of "lafun" reconstituted into "cooked la-

Table 6. Fungi isolated from the various fer-mented cassava products after 7 days of storage.

Fungi	Gari	Lafun	Fufu
Aspergillus niger	-	-	+
Aspergillus spp.	+	+	+
Fusarium spp.	-	-	+
Mucor spp.	+	+	+
Penicillium spp.	+	-	+
Rhizopus spp.	+	+	+

Table 7. Mean Sensory scores of reconstituted "lafun" powder both spoilt and fresh samples.

Attributes	Spoilt "lafun"	Fresh "lafun"
Mouldiness	5.66 ± 1.61[a]	2.10 ± 1.76[b]
Drawness	5.72 ± 1.63[a]	2.56 ± 1.64[b]
Stickiness	5.64 ± 1.94a	3.00 ± 2.04[b]
Smoothness	4.88 ± 1.83[a]	3.60 ± 2.25[b]
Aroma	5.16 ± 1.35a	2.54 ± 1.87[b]
Colour	4.76 ± 1.36[a]	2.00 ± 1.65[b]

Mean score followed with different letter in the same row is significantly different (P<0.05).

lafun". In terms of "fufu" samples, there is no significant difference in the drawness and stickness of the samples, while other attributes reveals a significant difference. This shows that the spoilage of the "fufu" sample has little or no effect on the drawness and stickness of the cooked food.

Table 8. Mean Sensory scores of reconstituted "gari" powder both spoilt and fresh samples.

Attributes	Spoilt "gari"	Fresh "gari"
Mouldiness	5.42 ± 1.69a	4.14 ± 1.68[b]
Drawness	5.38 ± 1.48[a]	3.70 ± 1.76[b]
Stickiness	5.66 ± 1.49a	4.26 ± 1.81[b]
Smoothness	5.58 ± 1.59a	4.54 ± 1.93[b]
Aroma	5.70 ± 1.52a	2.94 ± 1.68[b]
Colour	5.90 ± 1.2a	2.44 ± 1.54[b]

Mean score followed with different letter in the same row is significantly different (P<0.05).

Table 9. Mean sensory scores of reconstituted "fufu" powder both spoilt and fresh samples.

Attributes	Spoilt "fufu"	Fresh "fufu"
Mouldiness	4.22 ± 1.78[a]	5.86 ± 1.55[b]
Drawness	4.58 ± 1.73a	5.06 ± 1.24[a]
Stickiness	4.74 ± 2.04a	4.96 ± 1.59[a]
Smoothness	4.22 ± 2.21a	5.82 ± 1.51[b]
Aroma	3.38 ± 1.89a	5.20 ± 1.64[b]
Colour	2.72 ± 2.18a	5.46 ± 1.95[b]

Mean score followed with the same letter in the same row is not significantly different (P<0.05).

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