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Full Length Research Paper

Effect of process modification on the physio-chemical and sensory quality of fufu-flour and dough

Okoro Casmir Chukwuemeka

Department of Food Technology Yaba, College of Technology, Lagos, Nigeria. E-mail: emoko102003@yahoo.com.

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A modified cassava processing method was used for the production of fufu flour and the flour obtained was compared analytically with that obtained using the traditional process. The flour obtained from the modified process had hydrocyanide (HCN) levels of 200 - 300% lower (10 – 16 mg/kg) than that of the traditionally processed fufu flour (38 mg/kg). Lighter fufu flours and dough were obtained as indicated by their lower bulk densities (0.47 - 0.58 mg/ml), lower swelling index (2.29 - 3.25) and lower water absorption capacity (2.21-2.98 ml/g) than that from the traditional process (0.85, 3.25, and 3.15 ml/g, respectively). The peak viscosity (478.95 - 288.75 RVU) and pesting temperature (64 - 65°C) were lower respectively than that obtained from fufu flour of the traditional process (482.14 RVU; 75°C). Sensory scores showed a general preference for fufu from the modified process in terms of odour, colour, texture, and overall acceptability and absence of repulsive fufu odour.

Key words: Fufu, HCN, modified process, traditional process.

INTRODUCTION

Cassava (*Manihot esculenta* Crantz) of species Palmata (sweet variety) and Utilisima (biter cassava) have been variously used in the production of different types of food in Africa (Okafor, 1984; Lasekan et al., 2004). Some traditional cassava products include Fufu, 'Akpu', Lafun, Garri, Abacha and Tapioca. The product of interest of this research is fufu, a fermented cassava mash, which comes as a wet mash or a dry powder (Okpokiri et al., 1985) and is most commonly consumed in the eastern and south-south zone of Nigeria. Traditional processes commonly used and their improved versions still involved peeling, cutting, soaking for 3 - 4 days, maserating, sieving to obtain the fufu and followed by drying (Okpokiri et al., 1985; Ejiofor et al., 1985; Ketiku et al., 1978). However, this method tended to yield fufu mash that has repulsive odour, poor keeping quality, moderately high HCN content and the attendant difficulty in handling of the wet mash.

Owing to the presence of the cyanogenic glucoside, various methods which bring about a reduction in the toxicity of the roots are employed during the processing. However, most of these methods are tedious, having long fermentation period and ends up yielding products with repulsive odour and moderate levels of HCN. Although the HCN levels (20 – 50 mg/kg) reported by some workers (Okpokiri et al., 1985; Onwueme, 1978) may be within SON (1985) standard, the cumulative effect due to its continuous consumption as a staple food may still lead to chronic cyanide toxicity (Collins et al., 1976; Cooke Maduagwu, 1978).

Trend in modern processing methods tend to imply ready to prepare, easy to handle, near absence of HCN and drastic reduction of the repulsive fufu odour. This is to make the product more acceptable to wider range of consumers. The traditional and improved methods commonly in use are targeted at encouraging natural linamarinase to cause the hydrolysis of the cycnogenic glycoside, hence the long fermentation periods. However, evidences (Ejiofor et al., 1984; Okafor, 1983) show that the drastic reduction in HCN content during fermentation could be due to microbial enzyme activity which is usually released during fermentation.

The common procedures for fufu production does not include pre-soaking cooking of the cassava tuber as is practiced in the production of edible wet or dry cassava chips 'Abacha'. According to Iwuoha et al. (1997), submerged boiling of raw cassava tuber in water for 35 min, followed by sun drying effected to 81.5% reduction in cyanide content of the steamed product. This work is therefore undertaken to develop a modified process for fufu production by adopting the pre-gelatinization treatment of cassava tuber before the soaking operation, as opposed to the traditional process where raw cassava tubers are soaked directly.

Table 1. Proximate composition fufu flour.

Sample	M/C (%)	Crude protein (%)	Fat (%)	Ash (%)	Carbohydrate (%)
P_{11}	10 ± 2	0.56 ± 0.01	0.89 ± 0.01	0.75 ± 0.3	87.8 ± 0.46
P_{21}	10 ± 1.5	0.50 ± 0.01	0.84 ± 0.02	0.81 ± 0.02	87.91 ± 0.24
P_{22}	10 ± 1.0	0.45 ± 0.04	0.82 ± 0.02	0.84 ± 0.02	87.90 ± 0.32
P_{23}	10 ± 1.0	0.41 ± 0.02	0.81 ± 0.01	0.81 ± 0.01	88.0 ± 0.28

Results are means of triplicate samples ± SD.

Table 2. Physio-chemical characteristics of fufu flour.

Sample	HCN (mg/kg)	Bulk density (mg/ml)	Swelling index	Water Absorption capacity (ml/g)	PH
P_{11}	38.14 ± 1.2	0.87 ± 0.6	3.25 ± 1.1	3.15 ± 0.5	3.81 ± 0.1
P_{21}	16.20 ± 0.8	0.85 ± 0.02	3.05 ± 0.9	2.91 ± 0.3	3.78 ± 0.02
P_{22}	13.16 ± 1.0	0.52 ± 0.8	2.44 ± 0.4	2.40 ± 0.7	3.65 ± 0.01
P_{23}	10.87 ± 0.7	0.47 ± 0.4	2.29 ± 0.7	2.21 ± 0.1	3.57 ± 0.1

Results are means of triplicate samples ± SD.

MATERIALS AND METHODS

The raw material used in this work was the bitter cassava variety (*Manihot utilisim*) harvested from a farm in Yaba College of Technology, Lagos, Nigeria, 12 months after planting and processed 8 - 10 h after harvesting. Samples were divided into four portions of 5 kg each and processed respectively as shown in Figure 1. In process (P_{II}) the cassava tubers were cut into 3 - 4 parts of even sizes (6 cm – 8 cm long and 12 – 15 cm thick) and soaked submerged in water in large pots for four days to enable it ferment and soften. It was wet washed, dewatered, sieved and dried in air draft oven at 65°C to 10% moisture content. The modified process involved peeling, washing and cutting into sizes (6 - 8 cm long and 12 – 15 cm thick) to increase surface area and reduce boiling time. It was boiled for 10 – 15 min to enable the cassava tubers to partially gelatinize. They were then soaked in water at ambient temperature (30 ± 3°C) (1 part of cassava to 3 parts of water) for 24 h, 84 h, and 72 h respectively with washing after each 24 h; as shown in Figure 1. They were dried, milled to a particle size of 0.5 mm using hammer mill and then packaged as fufu flour.

Proximate analysis

Moisture, protein (N x 6.25), fat, fibre ash and carbohydrate content were determined using the AOAC (1990) method.

Physio-chemical analysis

The pH of the reconstituted fufu flour samples were determined using metrolin precision pH meter. The water absorption capacity (WAC) was determined using the process of Abbey and Ibeh (1980). The process of Ukpabi and Ndimele (1990) was used in determining the swelling index (SI). The Bulk density of the samples was determined by the process of Abbey and Ibeh (1980). The HCN content of the flour was determined using the AOAC (1990) method. The Rheological pasting characteristics of the samples were determined using the Roto-Visco analyzer and reported in RVU (Roto-Visco-analyser unit).

Sensory evaluation

The fufu flour were made into dough by reconstituting 1.5 parts of the flour in 2 parts of water, this was then placed over five and stirred vigorously until it steamed and formed into a suitable dough. The dough samples were then presented to a panel of 15 trained panelist. The attributes assessed included colour, odour (level of presence of fufu odour), texture, flavour, overall acceptability. These were scored using a 9 point hedonic scale and the results were analysed using the ANOVA method and differences amongst means compared using the multiple F-test Duncan (1955) at 5% level of significance.

RESULTS AND DISCUSSION

Proximate composition result (Table 1) show that the modified cassava flour samples had crude protein values (0.41 – 0.56%) and carbohydrate (87 - 88%) that falls within the values of similar products (Iwuoha et al., 1997; Ayinde et al., 2003; Okpokeri et al., 1985). Noticeably, these proximate values were not significantly different from those obtained from the traditional process. Physiochemical characteristics of the samples shown on Table 2 indicated a progressive decrease in the HCN content of the flours (from 16 to 10.00 mg/kg) with soaking period. The HCN content of the flours from the modified process were also 200 – 300% lower than those obtained from the traditional process (38 mg/kg). These values are far lower than the 50 mg/kg minimum tolerant level recommended by SON (SON, 1985). The low level of HCN could be attributed to the modified process which employed boiling for 10 – 15 min before soaking for 24 – 48 h, respectively. This observation conforms with the results of Iwuoha et al. (1997) and Onwueme (1978), where it was reported that boiling of cassava tubers reduced the initial cyanide content by 80 - 85%. Slicing

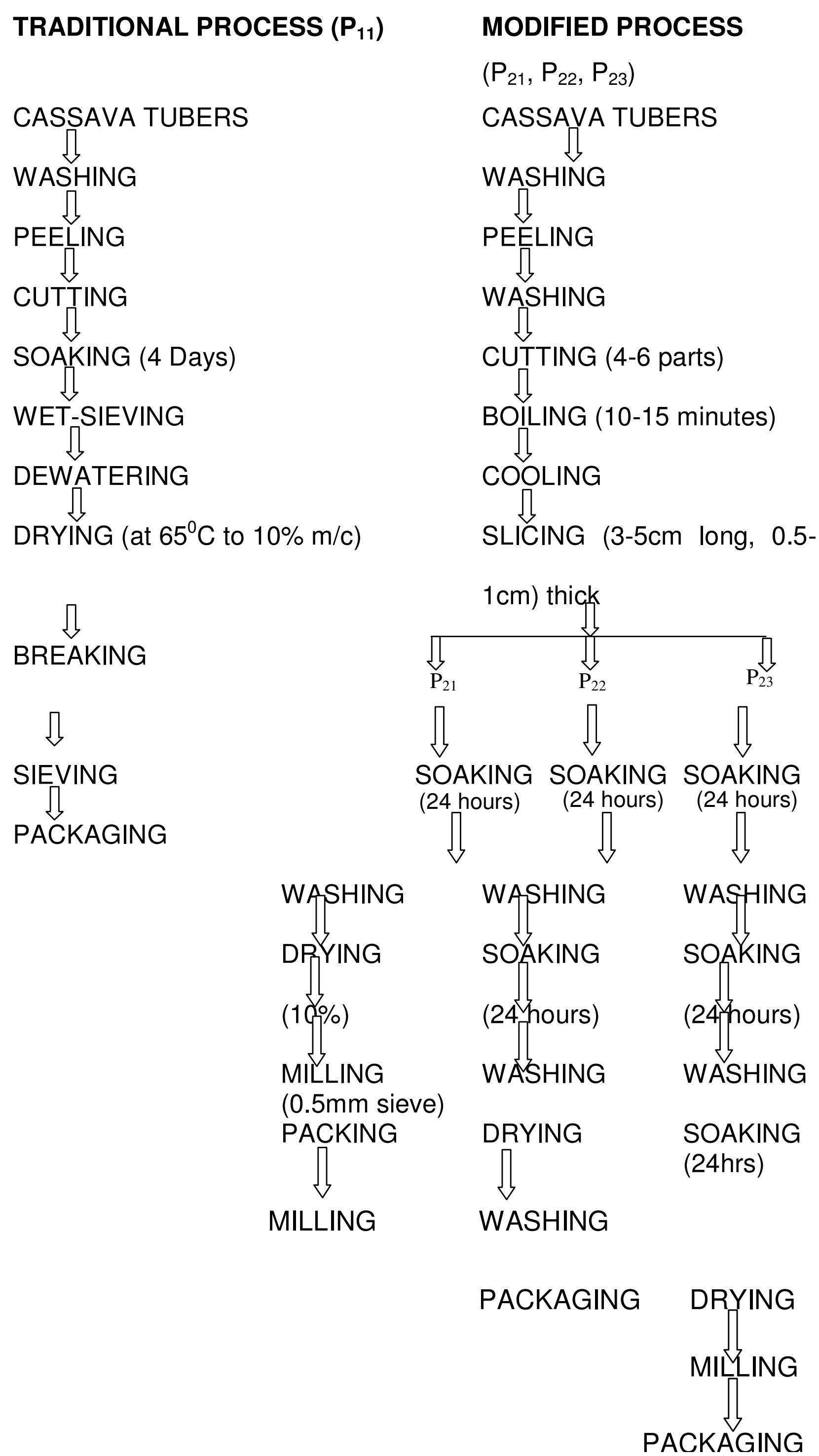

Figure 1. Methods employed in the processing of the traditional and three modified fufu flour samples.

(increase in surface area) with soaking of the pregelatinized cassava chips enhanced the fermentation rate of the cassava starches, hydrolysis of the cyanogenic glycoside and solubilization of the HCN with further removal during the twenty-four hourly washing (Figure 1). This is consistent with the report of Ejiofor (1985) that microbial enzymes activity liberates HCN during fermentation.

The modified process yielded fufu flours of lower bulk density, swelling capacity and water absorption capacity and these decreased with soaking period. This may be due to the reported increase in microbial activity in the

Table 3. Rheological characteristics of the fufu flour samples.

Parameter	P_{11}	P_{21}	P_{22}	P_{23}
Peak viscosity (RVU)	482.14	478.92	375.92	288.75
Trough (RVU)	268.25	264.68	204.33	96.75
Breakdown (RVU)	218.38	216.83	181.17	192.00
Final viscosity (RVU)	378.13	386.83	340.00	253.83
Set back (RVU)	134.72	124.75	133.17	157.08
Peak time (min)	3.95	3.52	3.88	1.04
Pasting temperature (°C)	75.25	64.35	64.35	65.10

Table 4. Sensory evaluation of the fufu flour samples.

Attribute	P_{11}	P_{21}	P_{22}	P_{23}
Colour	3.7a	8.5c	6.1b	3.5a
Texture	6.4a	7.3ac	7.0ac	3.1b
Taste	2.8a	8.8b	5.4b	2.6a
General acceptability	4.7a	7.2d	6.8a	5.3b

Sample means with different alphabets on the same row are significantly different ($p \leq 0.05$).

presence of gelatinized soluble fermentable carbohydrates, when compared to that from the traditional process. These results indicate production of lighter flours, lighter and easy to digest fufu which could be preferred to the heavy meals obtained from the traditionally processed fufu.

The Rheological characteristics results (Table 3 and 4) showed a marked reduction in the peak viscosity of the samples P_{23} (288.75 RVU) compared to P_{11} (482.14RVU) and P_{21} (478.92 RVU). This indicates that the viscosity of pre-gelatinized cassava decreased with increasing soaking (fermentation) time. This may be associated with the increased fermentation rate with soaking. However, the samples from the traditional process (P_{11}), which was soaked for 4 days, still had highest viscosity (482.14 RVU) which could be due to the low rate of fermentation of ungelationized (native) starch. The peak viscosity of the samples were closely related to their pasting temp with samples P_{11} having higher pasting temperature (75.25°C) than samples P_{21} – P_{23}, (64.45 – 65.0°C). This is consistent with the report of Lee (1975) that pre gelatinization reduces pasting temperature. The lower pasting temperature of the modified fufu flours implies that their preparation times will be reduced as compared to that of traditional fufu.

Sensory evolution mean scores showed a general preference for the samples of the modified process (P_{21} – P_{23}) than (P_{11}). However, the products of process P_{21} and P_{22} were not significantly different (P = 0.05) from each other although they were significantly different from samples P_{11} and P_{23}. Specifically, mean scores for colour showed that the colour of fufu decreased with increased soaking time irrespective of process adopted. There was near absence of the offensive fufu odour in samples P_{21} and P_{22}.

Conclusion

Conclusively, a fufu product without the offensive fufu-odour, with improved rheological and sensory qualities can be obtained by modifying the traditional process. Specifically, processes P_{21} and P_{22} are generally recommended going by their results.

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