Processing and Characteristics of African Breadfruit Tempe-Fortified Lafun

Njoku Ho, Ibe Sn, Odu Nn And Oyeyipo Oo

Department of Microbiology (Food and Industrial Division), University of Port Harcourt, P.M.B. 5323 Port Harcourt, Rivers State, Nigeria.

Abstract: Cassava cultivar, TME 1 was fermented for 3days to produce lafun and supplemented with African Breadfruit 'tempe' flour in the ratio 70:30 to formulate 'lafun-tempe' that requires minimal cooking. The pH of lafun and lafun-tempe were 4.70 ± 0.32 and 5.61 ± 0.22 respectively. Total cyanide was 1.40 ± 0.70mg HCN/100g for lafun-tempe and 1.70 ± 0.32mg HCN/100g for lafun. The crude protein content of lafun-tempe was 9.78 ± 0.37 much higher than the unfortified lafun (2.96 ± 0.44). Lafun recorded higher scores in visual appearance and texture while lafun-tempe was superior in taste and aroma ($p<0.05$). In contrast, lafun had higher crude carbohydrate (82.29 ± 3.77) vs (75.84 ± 1.55) for the lafun-tempe. Animal feeding trial show that weaning wistar rats fed on lafun-tempe had normal growth comparable to the control commercial feed. Fortification of lafun with African breadfruit tempe flour gave values of improved nutritional quality and is recommended for use in areas were cassava is consumed and protein intake is inadequate.

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1. 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 (Oyewole, 1991). Cassava is well known not only for its high carbohydrate content but also for the poor quality and concentration (<1%) of its protein (Sanni and Sobamiwa, 1994). In addition, cassava contains cyanogenic glycosides which can cause pathological conditions, such as konzo, an irreversible paralysis (Essers et al., 1991).

In Nigeria, cassava is processed into various products that are consumed in various ways. Among the fermented cassava products of cassava roots are 'garri', 'fufu', 'tapioka', and 'lafun' (FAO, 2002; Oyewole, 1991). Lafun is fermented cassava flour, popularly consumed in south west Nigeria, owing to its high carbohydrate contant which serves as a source of energy. It is usually prepared as a stiff porridge using boiled water, prior to being consumed (Oyewole and Afolami, 2001). The basic procedure for lafun processing is well documented (Oyewole and Afolami, 2001; Oyewole, 1991; FAO, 2002).

Fortification of inexpensive staples such as cassava and maize has resulted in products of high nutritional value (Onilude et al., 2004; Marero et al., 1988; Oyarekua, 2009; Sanni and Sobamiwa, 2001). African breadfruit (Treculia africana) is cheap and readily available throughout the year (Onyekwelu and Fayose, 2007). It has a high protein content (17.40%) and nutritive quality (Fasasi et al., 2004).

An acceptable, nutritionally-enriched food that can be stored in the home should be produced for consumption in areas where protein intake is low. However, there is little or no information on the fortification of cassava or its products with African breadfruit seed or its products. This paper, therefore, evaluates the fortification of lafun with African breadfruit tempe flour to produce such a food.

2. Materials and methods

2.1. Raw materials

Cassava (*Manihot esculenta* Crantz) variety, TME 1, used for this work was obtained from the Nigerian Stored Product Research Institute (NSPRI), Rumueme, Mile 4, Port Harcourt, Rivers State, Nigeria. African breadfruit (*Treculia africana)* was obtained from a farm settlement in Obite II in Etche Local Government Area of Rivers State.

2.2. Processing and Analysis

Lafun: lafun was produced essentially as described by (Oyewole and Afolami, 2001), except that the peeled cassava tubers were fermented for 72 hours.

2.2.1. African breadfruit tempe flour:

One kilogram (1kg) of freshly harvested breadfruit seeds was measured and sorted. The sorted seeds were parboiled in water for 20minutes and dehulled manually. African breadfruit seed tempe was prepared essentially as described by (Njoku *et al.,* 1991). The freshly harvested tempe was fried in oil (Devon Kings vegetable oil, Wilmar Trading PTE Ltd) and then ground into powder using wooden mortar and pestle and sieved repeatedly to remove testa using a 1.2mm iron mesh to produce uniform texture.

2.2.2. Nutritional improvement process:

The cassava flour and breadfruit-tempe flour were combined in different proportions: 90/10, 80/20, 70/30, 60/40, 50/50 of lafun and breadfruit-tempe flour respectively. One hundred grams (100g) of each combination was then added into 400ml water in stainless steel pot on a gas cooker; wooden stirrer was used to stir the rehydrated flour continuously to attain appropriate consistency. The 70/30 combination of cassava and breadfruit-tempe flour gave the desired consistency (determined by comparison with the texture of the prepared lafun) and was the combination used for further investigation in this study.

2.3. Physico-chemical analysis

The pH (Oboh and Akindahunsi, 2003), titratable acidity (Speck, 1984) and the cyanogenic potentials (Williams, 1979) of the products were determined. The lipid, carbohydrate, moisture, fibre and percentage ash of the samples were analyzed by the method of (Osborne and Voogt, 1978). Crude protein content was determined using the Kjeldahl method in which the nitrogen percentage was multiplied by a factor of 6.25 to obtain crude protein (AOAC, 1990).

2.4. Sensory evolution

The evaluation of the organoleptic characteristics of the unfortified lafun and African breadfruit tempe fortified lafun were carried out using a nine point hedonics questionnaire. The assessment involved 10 panelists who were habitual lafun consumers. The parameters, score on a scale of 1 to 9 by each penalist, were visual appearance, texture, aroma and overall acceptability. The data obtained were subjected to analysis using student t-test and means were separated using the least significant difference method (Steel and Torries, 1980).

2.5. Animal feeding trial

The nutritive evaluation was determined by animal assay technique using weaning litter mate rats of the Wister strain obtained from the Department of Human Physiology, Faculty of Basic Medical Sciences, University of Port Harcourt, Rivers State, Nigeria. The technique used was similar to that previously described (Oladapo *et al.,* 1984; Egonu and Njoku, 2006).

3. Results analysis

3.1. Production of lafun-africa breadfruit tempe

The fortification of 70% cassava flour with 30% tempe flour resulted in a light brown lafun-tempe flour whereas the unfortified lafun was white. The textures of the flours were comparable. Following reconstitution of the lfun-tempe and lafun in boiled water, lafun-tempe had a better perceptible aroma than lafun. The 70:30 lafun-tempe blends was smooth and not sticky to the hand. Table 1 shows the changes in pH and titratable acidity (g lactic acid/100g).

Table 1: Changes in pH and Titratable acidity (g lactic acid/100g)

Fermented Sample	Parameter	Fermentation Time (hour)			
		0	24	48	72
ABFS	pH	6.53±0.41	6.01±0.29	5.61±0.22	ND
	Titratable acidity	0.08±0.06	0.06±0.03	0.16±0.08	ND
	pH	6.32±0.02	5.40±0.33	4.50±0.22	4.70±0.32
FCAS	Titratable acidity	0.05±0.02	0.04±0.01	0.02±0.04	0.90±0.02
PLAF		ND	ND	ND	ND
PLAB		ND	ND	ND	ND

Values are means ± standard deviation of two replicates (n=4), ND = Not determined. ABFS- African Beanfruit Tempe Seed, FCAS- Fermented Cassava, PLAF- Prepared Lafun, PLAB- Prepared Lafun-African Breadfruit Tempe

3.2. Sensory analysis

Sensory evaluation gave no significant difference (p>0.05), except for aroma. Lafun-tempe recorded higher scores in aroma, taste and overall acceptability (Table 2), while lafun recorded higher in visual appearance and texture.

Table 2: Sensory Evaluation Test for Lafun and Lafun-African Breadfruit Tempe

	Attribute score				
Sample	**Visual appearance**	**Aroma**	**Taste**	**Texture**	**Overall acceptability**
PLAF	7.76±0.70	5.33±1.74	6.71±2.03	7.43±1.72	7.76±0.89
PLAB	7.29±0.50	6.81±0.81	7.05±1.56	7-10±1.48	7.81±1.12

Values are means ± standard deviation of 10 scores from 10 member panel; PLAF- Prepared Lafun, PLAB- Prepared Lafun-African Breadfruit Tempe flour

3.3. Animal feeding traits

The feeding trial was conducted over a period of 4 weeks with the weekly weight of the rats recorded (Table 3). The average starting weight of the rats was 50 ± 0.02g. There was a steady increase in weight in the control rats fed on commercial feed (Top feed) to about 71.90 ± 0.65g at the fourth week (Table 3). Group 2 rats, fed only on lafun also recorded a steady increase in weight to approximately 65.80 ± 0.42g at the fourth week. Similar trend also occurred in group 3 rats, fed on 70/30 mixture of lafun-African breadfruit tempe to about 69.10 ± 0.28g at week 4 (Table 3).

Table 3: Average Weekly Weights of Rats in Relation to Feed Composition

Group No	Feed Composition	Average weekly weights (g)				
		Week 0	Week 1	Week 2	Week 3	Week 4
1	Top feed (control)	50±0.02	57.60±0.43	62.30±0.40	66.80±0.33	71.90±0.65
2	LAFF	50±0.02	54.20±0.48	58.80±0.16	61.30±0.78	65.80±0.42
3	LAFF/ABTF	50±0.02	56.10±0.02	60.70±0.02	63.60±0.35	69.10±0.28

Values are means ± standard deviation of six measurements; LAFF- Lafun flour; LAFF/ABTF – Mixture of 70/30 Lafun and Lafun-African Breadfruit Tempe flour

3.4. Proximate composition

The ash, moisture and fibre contents of lafun-African Breadfruit tempe were comparable (Table 4). Lafun-African breadfruit tempe recorded higher scores (3.48, 1.27 and 3.64) as against (3.35, 1.24 and 1.24) for lafun, respectively (Table 4). The carbohydrate content of the lafun was significantly (p>0.05) higher than that of lafun-African breadfruit tempe sample (85.29 ± 3.77 vs 75.84 ± 1.55) (table 4). Similarly, higher lipid (6.59 ± 0.33 vs 5.98 ± 0.15) was observed in lafun than lafun-African breadfruit tempe samples, respectively (Table 4). In contrast, crude protein content was significantly (p>0.05) higher in lafun-African breadfruit tempe than in lafun sample, 9.78 ± 0.37 vs 2.96 ± 0.44, respectively (Table 4). The hydrocyanic content was 1.40 ± 0.70mg HCN/100g for the lafun-tempe and 1.70 ± 0.32mg HCN/100g for lafun.

Table 4: Proximate Composition of Lafun and Lafun-African Breadfruit Tempe (g/100g)

Sample	Ash	Moisture	Protein	Fat	Fibre	Carbohydrate	Cyanide (mg HCN/100g)
LAFF	3.35±0.78	1.24±0.46	2.96 ± 0.44	6.59 ± 0.33	1.24±0.80	85.29 ± 3.77	1.70 ± 0.32
LAFF/ABTF	3.48±0.23	1.27±0.11	9.78 ± 0.37	5.98 ± 0.15	3.64±0.34	75.84 ± 1.55	1.40 ± 0.70

Values are means ± standard deviation of two replicates (n=4); LAFF- Lafun flour; LAFF/ABTF – Mixture of 70/30 Lafun and Lafun-African Breadfruit Tempe flour

4. Discussion

African breadfruit seed (*Treculia africana)*, due to its high protein content (17.40%) and nutritive qualities have been gaining increasing interest in recent times (Fassai *et al.,* 2004; Okafor, 1981). Fassai *et al.,* 2004 and Njoku *et al.,* 1991 have shown in their studies that African breadfruit seeds through adequate and appropriate processing can be converted to new products. Maduka (2011), reported the production of tempe-like product from the African breadfruit seed. This is corroborated by the present study on the production of African breadfruit tempe flour for the fortification of lafun.

Lafun- African breadfruit tempe had a light brown colour while prepared lafun was white. Ratings on visual appearance demonstrated that supplementation of lafun with African breadfruit tempe affected the colour (table 2). This was due to the fact that the African breadfruit tempe underwent a frying process. The application of heat may affect the colour of food products (Blanca *et al.,* 2009).

The prepared lafun-tempe recorded higher in aroma than prepared lafun sample (table 2). The differences in aroma ratings between prepared lafun and prepared lafun-tempe may be attributed to the processes applied. The acid aroma may be attributed to the organic acids produced by microorganisms during fermentation process (Oboh and Akindahunsi, 2003), while the nutty aroma may be attributed to the fried African breadfruit tempe. Fermentation and heat treatment significantly impact characteristic aroma which is retained by food products (Oyewole and Afolami, 2001; Blanc *et al.,* 2000; FAO, 1997).

The texture of prepared lafun-African breadfruit tempe was comparable to prepared lafun in this study (table 2). Consumers described good texture as one that does not stick to the hand of the consumers. However, prepared lafun scored higher (7.43 ± 1.73) than lafun-African breadfruit tempe (7.10 ± 1.48) in texture (table 2).

Fermentation of legumes makes possible the bioavailability of the nutrients and helps to increase the nutritive potential of the legume materials (Egonu and Njoku, 2006). This worker's also reported that fermented African oil bean seeds coulb be incorporated in animal feeds. Studies on vitamin production by strains of three *Rhizopus* spp. used in tempe solid fermentation showed that *Rhizopus oligosporus* were generally the best vitamin formers (Efiuvwevwere and Ejikeme, 1998). These findings were corroborated in this present work on fortification of lafun with African breadfruit tempe flour. Lafun-tempe gave a good feed result comparable to the standard commercial feed (Top feed) used as control (table 3). However, there was significant difference (p>0.05) in the final weight of rats fed on lafun (65.80 ± 0.40g) compared to the control feed (71.90 ± 0.65g) during the four weeks feeding trial.

Ash, moisture and fibre contents of lafun and lafun-tempe were comparable (table 4). Lafun-tempe recorded higher score (3.48 ± 0.23, 1.27 ± 0.11 and 3.64 ± 0.34) as against (3.35 ± 0.78, 1.24 ± 0.46 and 3.56 ± 0.80) for lafun respectively. The carbohydrate content of the lafun was significantly (p>0.05) higher than that of lafun-African breadfruit tempe sample (85.29 ± 3.77 vs 75.84 ± 1.55) (table 4). Similarly, higher lipid (6.59 ± 0.33 vs 5.98 ± 0.15) was observed in lafun than lafun-tempe, respectively (table 4). This is due to the dilution of lafun with tempe flour. In contrast, crude protein content was significantly (p>0.05) higher in lafun-tempe than in lafun, 9.78 ± 0.37 vs 2.96 ± 0.44, respectively (table 4). The significant increase recorded in protein level is consistent with earlier reports by Efiuvwevwere and Ejikeme (1998), who reported an 89.6% increase in total prtein content of African pear following inoculation with *Aspergillus niger.* These observations may be partially to the utilization of products of carbohydrate degradation for protein synthesis by the fungus, *Rhizopus oligosporus* used in the fermentation of African breadfruit seeds. It has been reported that fortification of cassava or maize with soybean or cowpea extract increased protein content (Oyarekua, 2009; Sanni and Sobamiwa, 1994; Osho, 2003; Amusa *et al.,* 2005; Modu and Milala, 2004).

5. Conclusion

The fortification of lafun with tempe flour in the present study gave a dual advantage in that the protein content was increased while the cyanide content was decreased, resulting in a more nutritive and safer lafun. Therefore, lafun could be fortified with African breadfruit tempe flour to reduce malnutrition problems caused by root crop based Nigerian/African diets particularly among the low-income groups.

Correspondence to:
Dr. Ngozi Nma Odu
Department of Microbiology, University of Port Harcourt,
P.M.B 5323, Choba, East/West Road, Port Harcourt, Rivers State, Nigeria;
E-Mail: odungozi@yahoo.com;
ngozi.odu@uniport.edu.ng;
Tel: +234-8064341944

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