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308 Lasani Town, Sargodha Road, Faisalabad - Pakistan
Mob: +92 300 3008585, Fax: +92 41 8815544
E-mail: editorpjn@gmail.com

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Effect of Germination and Fermentation of Pearl Millet on Proximate, Chemical and Sensory Properties of Instant "Fura"- A Nigerian Cereal Food

C.U. Inyang[1] and U.M. Zakari[2]
[1]Department of Microbiology, Faculty of Science, University of Uyo, Uyo, Nigeria
[2]Department of Food Technology, Kaduna Polytechnic, Kaduna, Nigeria

Abstract: The study examined the effect of the germination and natural fermentation on the quality of instant "fura"-(a Nigerian cereal food). Pearl millet (Pennisetum glaucum) seeds were soaked for 12 h at room temperature (32±2°C) and sprouted for 48h at the same temperature. The sprouted seeds were washed, dried and milled into flour. The flour was divided into two portions, the first was allowed to ferment naturally at room temperature for 48h and used to produce germinated and fermented fura (GFF). The second portion was used for the production of Germinated Fura (GF). The cleaned, ungerminated grains were milled and the flour also divided into two portions. The first portion was wetted, fermented and used to produce Fermented Fura (FF). The second portion was used to produce Traditional Fura (TF). Standard assay procedures were used to evaluate the fura samples for nutrient composition and phytic acid levels. Germination and fermentation increased the protein, ash, crude fibre, phosphorus, calcium and iron levels of the fura samples. The phytic acid levels were significantly reduced ($p<0.05$) compared with the control (220 mg/100 for GFF, 230 mg $100g^{-1}$ for GF, 266 mg $100g^{-1}$ for FF and 416 mg $100g^{-1}$ for the control, TF. The sensory panelists rated the fura sample from germinated grains highly for all the sensory parameters investigated. Germination appeared to be a promising food processing method for improving the nutrient and energy densities of fura and when combined with fermentation, reduced phytic acid significantly ($p<0.05$).

Key words: Germination, fermentation, millet, instant "Fura"

Introduction

In tropical Africa, cereal grains are milled and used to produce thick porridges, which are known by various names in different parts of the continent. In West Africa, particularly in Nigeria, Ghana and Burkina Faso, one of such thick porridge is called 'fura'-a semi-solid dumpling cereal meal (Jideani *et al*., 2001).

Cereal grains are the major source of calories and proteins for the people of Nigeria. Those receiving less than 20% of the calories and protein intake from cereal mainly consist of those in southern Nigeria, where starchy roots and tubers are staple foods (Nkama and Gbenyi, 2001). The major cereals cultivated in Nigeria are sorghum, millet, rice and maize. The major states that produce pearl millet in Nigeria are Borno, Yobe, Jigawa, Kano, Katsina, Zamfara, Sokoto and Kebbi states. Millets are usually cultivated under extremely harsh conditions of high temperature, low and erratic precipitation, short growing seasons and acidic and infertile soils with poor water holding capacity (Nkama and Ikwelle, 1998).

Traditional technologies available for processing of millet include, threshing, cleaning, washing, dehulling, soaking, germination, wet and dry milling and fermentation (Makuru, 1992). Several studies have shown that germination improves the nutritive value of cereals and legumes (Marero *et al*., 1989a; Marero *et al*., 1989b; Hansen *et al*., 1989) Germination has also been found to decrease the levels of antinutrients present in cereals and maximizes the levels of some of the utilizable nutrients (Nkama and Ikwelle, 1998).

Fermentation has been found to increase pepsin digestibility of millet protein, decrease the concentration of phytic acid and polyphenols (Mahajan and Chauhan, 1987) with improvement in the availability of minerals (Khetarpaul and Chauhan, 1989).

"Fura" originated from the Hausa/Fulanis and is produced mainly from most flour, blended with species, compressed into balls and boiled for thirty minutes (Jideani *et al*., 2001). While still hot, the cooked dough is worked through in the mortar with the pestle (with addition of hot water) until a smooth, slightly elastic cohesive lump fura is formed.

Since the consumption of this cereal based flour food is very popular among children and adults in northern Nigeria, there is need for detailed study of various traditional methods of improving the nutritive value and acceptability of this important indigenous food product.

This work was conducted to produce fura from germinated and fermented millet and the effect of these processes on proximate chemical and sensory properties of the product examined.

Materials and Methods

Procurement of raw materials: Pearl millet (*Pennisetum glacum)* was obtained from Wadata

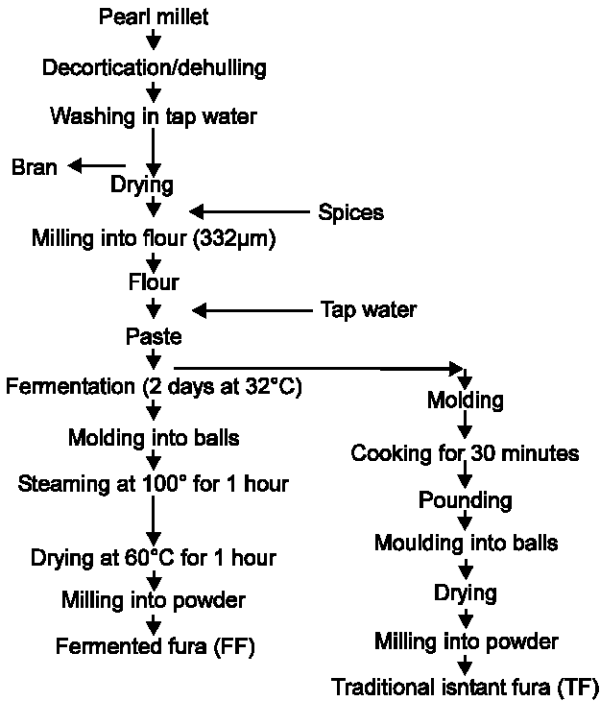

Fig. 1: Flow chart for the production of fermented and traditional instant fura

market, in Makurdi, Nigeria, together with spices such as red pepper (*Capsicum annum*), ginger (Zingiber offinale) and cloves *(Syzygium) aromaticum)*. The seeds were cleaned and the broken ones removed by hand. The cleaned seeds were kept in jute bag and stored at ambient temperature in the laboratory.

Preparation of Instant Fura: Four fura products were produced. The first fura product was from combined germination and fermentation. About 2.5kg of cleaned seeds were washed three times in tap water, soaked for 12h in tap water (1:3 w/v) at room temperature (32±2°C). After soaking the grains were drained and uniformly spread on wet cotton cloth. The grains were covered with another cotton cloth and water was sprinkled on the top. Germination was carried out at room temperature (32±2°C) for 48h. The grains were devegetated, mouldy seeds were removed by hand and the sprouted seeds washed with tap water before drying in hot air oven at 100°C for 6h to about 12% moisture content. The dried, germinated grains were dehulled by washing in tap water to remove the bran. The dehulled grains together with spices were milled into flour using hammer mill. The flour from germinated grains were divided into two portions. The first portion was fermented while the second was not. About 1kg of the germinated flour mixture (flour+spices) was weighed into plastic container and 1.5l of tap water added. The contents were stored, covered with aluminum foil and allowed to ferment naturally at room temperature for 48h with occasional stirring of the mixture for proper aeration. The paste was molded into balls, steamed at 100°C for 1h. The balls were cooled, broken into small pieces and dried in a cabinet dryer at 60°C for 1h to about 7% moisture. The dried fura was milled with a hammer mill to flour of particle size of about 322µm, to give germinated and fermented instant fura (GFF). The second portion of the germinated flour, was steamed, dried and milled into flour to give germinated fura GF.
Similar method as above was used to produce fermented fura, except that the grains were not germinated (Fig. 1). Untreated fura was also produced following the traditional process (Fig. 1). The products were packed in polyethylene bag and stored at ambient temperature for analysis.

Analysis of sample: pH and titratable acidity was determined by the method of AOAC (1984). Proximate composition was analysed by the method of AOAC (1984). Calcium, Iron and phosphorus were determined by AOAC (1984). The phytic acid of the sample was determined by the method described by Davies and Reid (1979). The products were assessed for sensory characteristic by sensory (organoleptic) panel method. A 15-member panel (untrained) consisting of male and female students of Department of Food Science and Technology, University of Agriculture, Makurdi who were familiar with the product was used. The quality index was assessed on 7-seven point hedonic scale. The ratings from hedonic scale were subjected to analysis of variance. The significance of mean differences was determined by Fischer's Least Significant Difference (LSD) test as described by Ihekoronye and Ngoddy (1985).

Results and Discussion

The result of the proximate composition of instant fura from germinated and fermented pearl millet flours on dry weight basis showed significant increase ($p<0.05$) in protein levels with germination and fermentation (Table 1), from 8.82% in control (untreated grain) to 10.67% in combined germination and fermentation. Many workers have also observed such increases in protein during germination and/or fermentation of various cereals and legumes (Nnam, 2000; Akpapunam *et al.*, 1996). The increase in protein could be attributed to a net synthesis of enzymic protein by germinating seeds (WHO, 1998). Nzeribe and Nwasike (1995) also reported increased activities of protease during germination of "acha". The increase in protein might also be due to the fact that some amino acids are produced in excess of the requirement during protein synthesis and these tend to accumulate in free amino acid pool (Marero *et al.*, 1989a). Other researchers have attributed the increase to the degradation of storage protein and synthesis of

Table 1: Effect of germination and fermentation on proximate composition

Samples	Proteins (%)	Fat (5)	Moisture (%)	Ash (%)	Crude fiber (%)	CHO (%)
GFF	10.67[a]	2.74[c]	7.6[a]	2.72[a]	2.40[a]	73.87[d]
GF	10.39[b]	2.70[c]	7.4[b]	2.70[a]	2.38[a]	74.43[c]
FF	9.18[c]	3.45[a]	7.3[b]	1.87[c]	2.35[ab]	75.67[b]
TF	8.82[d]	3.34[b]	7.3[b]	2.04[b]	2.33[b]	76.17[a]
LSD	0.16	0.04	0.25	0.07	0.03	0.25

Means followed by the same letter on the vertical column are not significantly ($p<0.05$) different from each other, Note: GFF: Germinated and fermented instant fura poweder, GF: Germinated instant fura, FF: Fermented instant fura, TF: Traditional instant fura

Table 2: Effect of germination and fermentation on some chemical composition of instant fura powders

Sample	Ca (mg)	Fe (mg)	P (mg)	Phytic acid (mg)	pH (%)	TTA (%)
GGF	1.690[a]	4.770[a]	17.55[b]	220.000[d]	4.500[c]	0.2500[b]
GF	1.690[a]	4.480[b]	16.54[c]	230.000[c]	5.640[b]	0.2200[c]
FF	1.610[b]	3.450[a]	7.30[b]	1.870[c]	2.350[ab]	83.2000[b]
TF	1.210[c]	3.340[d]	715.81[d]	416.000[a]	5.860[a]	0.2000[d]
LSD	0.004	0.0040	0.40	3.871	0.147	0.0157

TTA (Titratable acidity), GFF Germinated and fermented fura, GF Germinated fura, TF Traditional fura

Table 3: Results of sensory evaluation of instant fura samples

Samples	Taste	Colour	Texture	Overall Acceptability
GF	5.83[a]	5.60[a]	5.73[a]	5.87[a]
GFF	4.67[a]	5.13[a]	4.80[ab]	4.80[a]
TF	4.73[a]	3.20[a]	5.20[a]	4.87[a]
FF	4.13[ab]	5.60[a]	5.33[b]	4.53[ab]
LSD	1.36	Ns	0.87	1.21

Means followed by the same letter on a vertical column are not significantly ($p<0.05$) different, NS: Means not significant, FF: Fermented fura, GFF Germinated and fermented fura, GF Germinated fura, TF Traditional fura

new protein and other materials (King and Puwastien, 1987), while Tsaio *et al.* (1975) stated that the increase in protein on germination of corn seed was due to mobilization of storage nitrogen producing the nutritionally high quality proteins which the young plant needs for its development.

The fat levels of fura samples decreased on germination. The fura from germinated grains (GF) had the least fat value. The observed decrease might be due to the increased activities of the lipolytic enzymes during germination (Raham and Aal, 1986), which hydrolyse fats to fatty acids and glycerol. The simpler products can be used for synthesis of carbohydrate and protein or as a source of energy for developing embryo. Similar observation was made by Obizoba and Atti (1994) and Nnam (2000). Inyang and Idoko (2006) also reported reduced fat content in malted millet for "Ogi) production and low lipid levels are known to increase shelf-life. However, the fat level was observed to increase on fermentation.

A significant decreased ($p<0.05$) in carbohydrate levels of the instant fura samples was observed with germination and fermentation. The decrease might be due to increase in alpha-amylase activity (Lasekan, 1996). The alpha-amylase breaks down complex carbohydrates to simpler and more absorbable sugars which are utilized by the growing seedlings during the early stages of germination. Germination and fermentation were observed to improve the mineral contents of the instant fura (Table 2). Fura from combined germination and fermentation (GFF) and that from germinated millet (GF) had the highest calcium levels of 1.69mg each, followed by the Fermented Fura (FF) with 1.61mg and the Traditional Fura (TF) with the lowest calcium level of 1.21mg.

The iron level was highest in the combined germinated and fermented fura (GFF) 4.77mg, followed by the germinated product (GF). The result was consistent with Nnam (2000), who reported two fold increase in iron level of sprouted hungry rice (acha). There was recorded increase in phosphorus levels, following germination and fermentation (Table 2), which is expected as a result of increased activity of the enzyme, phytase, during germination and fermentation. This enzyme hydrolyses the bond between protein-enzyme-mineral to free more phosphorus (Nnam, 2000). It also accounted for the observed decrease of phytic acid content of instant fura samples during germination and fermentation, by the increased activity of phytase degrading phytic acid. Report on phytic acid reduction from germination and/or fermentation of cereals have been documented (Nkama and Gbenyi, 2001; Sutardi and Buckle, 1985).

Acids were produced during germination and fermentation; and this increased acidity helps to preserve the product. Fermentation has also been strongly suggested to have inhibitory effects on the groups of micro-organisms that can cause spoilage or food poisoning (Odumodu and Inyang, 2006).

The sensory evaluation showed the germinated fura (GF) to be highly rated for all the parameters investigated (Table 3). There was no significant change in colour ($p<0.05$) for the four fura samples. However, the panelists indicated preference for the germinated instant product (GF).

Conclusion: The study showed that germination and fermentation of pearl millet grain prior to fura production,

increased protein, ash, crude fibre, iron, calcium and phosphorus levels of instant fura. The study has also demonstrated that the combined effects of germination and fermentation can significantly reduce the phytic acid content of instant fura and enhance the acceptability of the product. It is recommended that animal feed experiment be carried out to evaluate the effects of these processing steps on the nutritional quality of fura.

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