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Effect of Malting Duration on Yield and Proximate Composition of ' Fura' Produced with the Grains of *Pennisetum typhoides*

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Abstract
The effects of malting duration on yield (g/kg) and proximate composition of 'Fura' produced from the grains of *Pennisetum typhoides* was studied. The grains were cleaned and subjected to 24hr, 30hr and 36hr of malting. Unmalted grains used to produce the 'Fura' served as control (0hr, unmalted). Malting of the grains up to 30hr caused a decrease in protein from 15.0 to 6.25% with a corresponding increase in carbohydrate from 25.14±0.71% to 39.65±0.32%. Further malting, up till 36hr showed reversed compositions of 16.67±1.4% and 26.20±2.55% for protein and carbohydrate respectively. Lipid content of 3.33% remained constant in unmalted and malted 'Fura' products. Ash and fibre were not affected significantly ($p<0.05$). However, the mean dry matter yield with unmalted Fura product (951.05^{d}) was significantly different from the malted products at 24, 30 and 36hr of 920.38^{c}, 850.38^{b}, and 831.04^{a} respectively. The colour, smell, taste and texture of the malted Fura' products did not make them clearly distinct from each other. The effects of malting are only conspicuous on the protein and carbohydrate compositions, which may be taken advantage of in human nutritional issues.
Keywords: Malting, Duration, Yield, "Fura", *Pennisetum typhoides,* Proximate composition.

1. Introduction

Pearl millet is a traditional crop in Africa, particularly in the sahel; central, eastern and southern Africa, as well as in Asia; India and Pakistan (FAO, 1994). *Pennisetum typhoides* is one of the most widely cultivated pearl millet (FAO, 1994). It has been consumed since pre-historic times in North Africa where it is believed to have originated (Crawford, 1992).

The millet grain is tiny in size and round in shape and can vary in colour from white to gray to yellow to red (WH Food, 2010). The plant is a stout annual grass usually with a single stem, 1 – 4 m high, though one or more tillers may be produced in some forms. The green mature grain ripens about forty days after fertilization. Millet is grown in regions with annual rainfall ranging from 200 to 800mm, and temperature from 28 – 42˚C (Dike *et al.*, 1999).

Protein contents in pearl, proso, and foxtail millet are comparable with those in wheat, barley and maize. Finger millet has slightly lower protein content, but it is in fact nutritionally superior because the protein quality is generally good as or better than in other cereals. Finger millets are also high in calcium and iron and contain fairly high levels of methionine, a major limiting amino acid in many tropical cereals (FAO, 1994).

In tropical Africa, cereal grains are hulled 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 porridges is called "Fura" – a semi – solid dumping cereal meal (Jideami *et al*, 2001). "Fura" originated from the Hausa/Fulani's and is produced from the flour, blended with species, compressed into balls and boiled for thirty minutes. While still hot, the cooked dough is pounded in mortar with the pestle (with addition of hot water) until a smooth, slightly elastic cohesive lump Fura is formed (Inyang and Zakari, 2008; Bello *et al*. 2009).

1.1 *Process of Malting*

According to Warren *et al* (1963), malting is a controlled germination or sprouting of the cereals during which enzymes are activated. Insoluble and non-diffusible substances are transformed into simpler compounds through the action of enzymes. During germination, enzymes are produced or liberated in an active state. The extent of this enzymatic action determines the mellowness and friability to the finished malt. The amylase enzyme which converts the starch into maltose sugars and dextrin in brewing are probably the most important enzymes in malting. The malting process that generates mono- and disaccharides is dependent upon the alpha and beta amylase and the maltose splitting enzyme, maltase, which develops in the cereals during germination. The malting process also contributes nutrient that stimulates growth and the rate of fermentation by the micro organisms involved. According to Ikediobi (1990), desirable properties of cereals required for malting includes, low gelatinization; temperature of starch granules and easily accessible protein bodies associated with starch, high amylase activity, low polyphenol and tannin content, high protease and beta gluconase activities and low rate of cyanogenoses.

2. Materials and methods

The millet grains *Pennisetum typhoides* that was used in this study was obtained directly from the farmers at

harvest, in Bosso village, Niger State, Nigeria. The grains were cleaned of stones and all other foreign objects.

2.1 *Malting of the Millet Grains*

The malting was done using the method described by Bello *et al.* (2009). 12kg quantity of cleaned millet grains were thinly spread on moist Jute sack. Water was sprinkled at an interval of 4 hours to keep the sack and the grains moist. The condition was maintained in a well-ventilated and 37±2^{o}C room temperature until the grains germinated and sprouted for 24h, 30 hr, and 36 hr (malting). At the end of the sprouting, the malted grains were dried in oven at 55^{o}C (Kilning). The remaining grains served as the unmalted (0hr) for the control study, which was also processed to produce the 'Fura.'

2.2 *Production of 'Fura' with Grain*

The malted and the unmalted grains were processed in the traditional way for the production of 'Fura'. Four kilograms of each of the malted samples was processed.

The grains were dehusked by abrasion; using mortar and pestle. The endosperm of the grains were washed, rinsed, ground into flour and sieved. The flour were mixed with little water to make a paste and then moulded with hand into balls, the moulds were put into boiling water and cooked for 40 minutes. The cooked "Fura" dough was ready to serve.

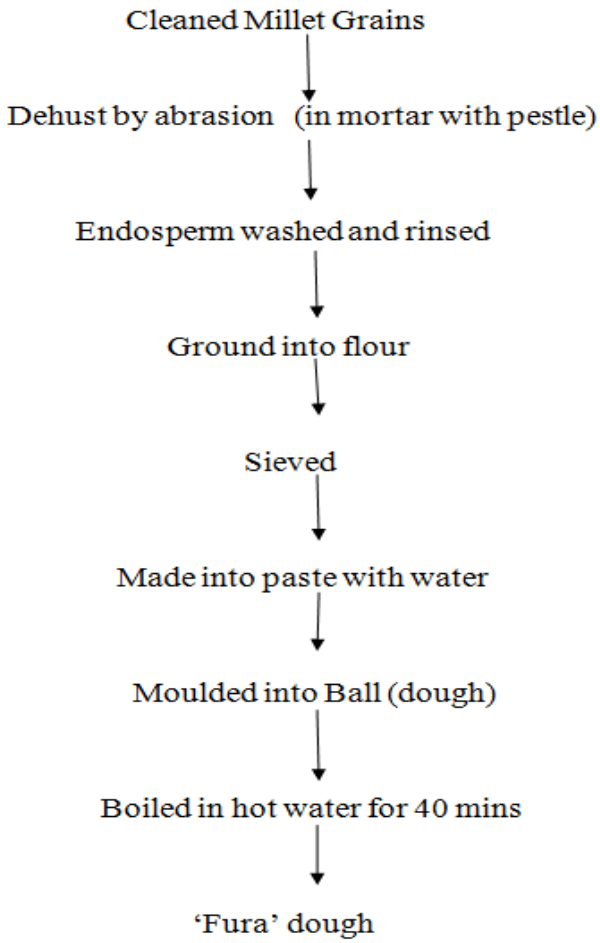

Figure 1. Flow chat of traditional preparation of 'Fura' (Bello *et al*, 2009).

2.3 *Proximate Analysis*

Proximate composition of Fura was determined by the official methods of the Association of Official Analytical Chemist(AOAC) as follows ; moisture (section 926.08 and 925.09); protein (section 955. 04 and 979.09); fat (section 922.06 and 954.02); ash (923.03) and fibre (section 962.09). Carbohydrate was calculated by difference(AOAC international,2010).

2.4 *Sensory Evaluation*

The sensory evaluation of the Fura samples were carried out based on mean acceptability of different sensory attributes; colour, smell, taste and texture. 1 to 5 structured scales was used for this evaluation (Bartolome *et al.,*1995; Bello *et al.*, 2009). Assessment of the Fura samples were done among primary pupils, secondary and tertiary students.

2.5 *Statistical Analysis*

The data obtained for the Fura samples were subjected to analysis of variance (ANOVA). The critical difference at $p< 0.05$ was estimated and used to find significant difference among the sample mean.

3. Results

3.1 *Effect of Malting on Proximate Composition of Fura Produced from Pearl Millet*

The proximate composition of 'Fura' analysed included protein, carbohydrate, lipid, ash, fibre content, moisture content and yield; as presented in Table1.

3.2 *Protein*

Protein content in 'Fura' produced from unmalted and 36hr malted pearl millet gave significantly higher content than those malted for 24hr and 30hr. Unmalted had 15.0±0.0%, while 36hr malted 'Fura' had 16.67±1.4%. These were followed by the 24hr malted Fura which gave a value of 10.83±1.4% and 30hr malted 'Fura' which gave the value of 6.25±0.0%.

3.3 *Carbohydrate*

Carbohydrate content in 'Fura', produced from 30hr and 24hr malted pearl millet gave significantly higher values than those malted for 36hr and unmalted. 30hr malted Fura had 39.65±0.32%, followed by 24hr malted 'Fura', 35.52 ± 2.55% while in the 36hr malted 'Fura' carbohydrate content was 26.20 ± 2.55% and unmalted 25.14±0.71%.

3.4 *Lipid*

Lipid content in 'Fura' produced from malted and unmalted pearl millet was 3.33±0.0%. Malting did not influence the composition of the lipid.

3.5 *Ash*

Ash content in Fura produced from 24hr malted pearl millet (0.57±0.08%) was significantly higher than the unmalted (0.4±0.05%). However, malting at 30hr (0.48±0.08%) and 36hr (0.57±0.08%) was not different from unmalted and 24hr malted pearl millet.

3.6 *Fibre*

Fibre content in 'Fura' produced from 36hr malted pearl millet gave significantly higher composition than those malted for 24hr, 30hr, and unmalted. 36hr had 4.67±1.04%. This was followed by 30hr malted 'Fura' which gave a value of 0.67±0.29%, while 24hr had 0.50±0.0% and unmalted had 0.67±0.29%.

3.7 *Moisture*

Moisture content in 'Fura' produced from unmalted pearl millet gave significantly higher composition than those malted for 24hr, 30hr, and 36hr. Unmalted had 55.61±0.70%. It was followed by 30hr malted 'Fura' which gave a value of 49.93±0.06%, 24hr malted 'Fura' had 49.25±0.15%, while 36hr malted 'Fura' had 48.65±0.10%.

3.8 *Dry Matter (Yield)*

Yield in 'Fura' reduced with malting duration, unmalted 'Fura' (951.05g/kg) been highest, and lowest in 36hr malted fur (831.04g/kg). Malting duration caused a significant difference in yield between the duration study intervals.

Table 1: Effect of malting on proximate composition of pearl millet

MALTING TIME	PROTEIN CONTENT	CARBOHYDRATE CONTENT	LIPID CONTENT	ASH CONTENT	FIBRE CONTENT	MOISTURE CONTENT	DRY MATTER (YEILD) (g/kg)
Unmalted	15.0000 ± 0.0000c	25.1367 ± 0.7095^{c}	3.3300 ± 0.0000^{a}	0.4000 ± 0.0500^{b}	0.6667 ± 0.2887^{a}	55.6167 ± 0.7006^{b}	951.05^{d}
24hours	10.8333 ± 1.4434a	35.5200 ± 1.2990^{a}	3.3300 ± 0.0000^{a}	0.5666 ± 0.0764^{a}	0.5000 ± 0.0000^{a}	49.2500 ± 0.1500^{a}	920.38^{c}
30 hours	6.2500 ± 0.0000b	39.6533 ± 0.3215^{b}	3.3300 ± 0.0000^{a}	0.4833 ± 0.0764^{a,b}	0.6667 ± 0.2887^{a}	49.9333 ± 0.0577^{a}	850.38^{b}
36hours	16.6667 ± 1.4434c	26.2033 ± 2.5467^{c}	3.3300 ± 0.0000^{a}	0.4833 ± 0.0289^{a,b}	4.6667 ± 1.0408^{b}	48.6500 ± 0.1000^{a}	831.04^{a}

Means followed by the same letter on a vertical column are not significantly ($p<0.05$) different,

Table 2: Overall results of sensory evaluation of malted Fura samples among various academic qualification level

MALTING TIME	COLOUR	SMELL (ODOUR)	TASTE	TEXTURE
Unmalted	2.9000 ± 0.8871^{b}	3.2286 ± 0.7834^{b}	3.2174 ± 0.9054^{c}	3.1571 ± 0.9111^{b}
24hours	2.6143 ± 0.7080^{a}	2.8714 ± 0.7207^{a}	2.5507 ± 0.6310^{a}	2.3286 ± 0.6962^{a}
30hours	2.6143 ± 0.7282^{a,b}	2.8714 ±0.7003^{a}	2.7971 ± 0.6769^{a,b}	2.8714 ± 0.6576^{b}
36hours	2.7857 ± 0.7593^{a,b}	2.9714 ±0.6804^{a,b}	3.0725 ± 0.6712^{b,c}	2.9571 ± 0.6689^{b}

Means followed by the same letter on a vertical column are not significantly ($p<0.05$) different

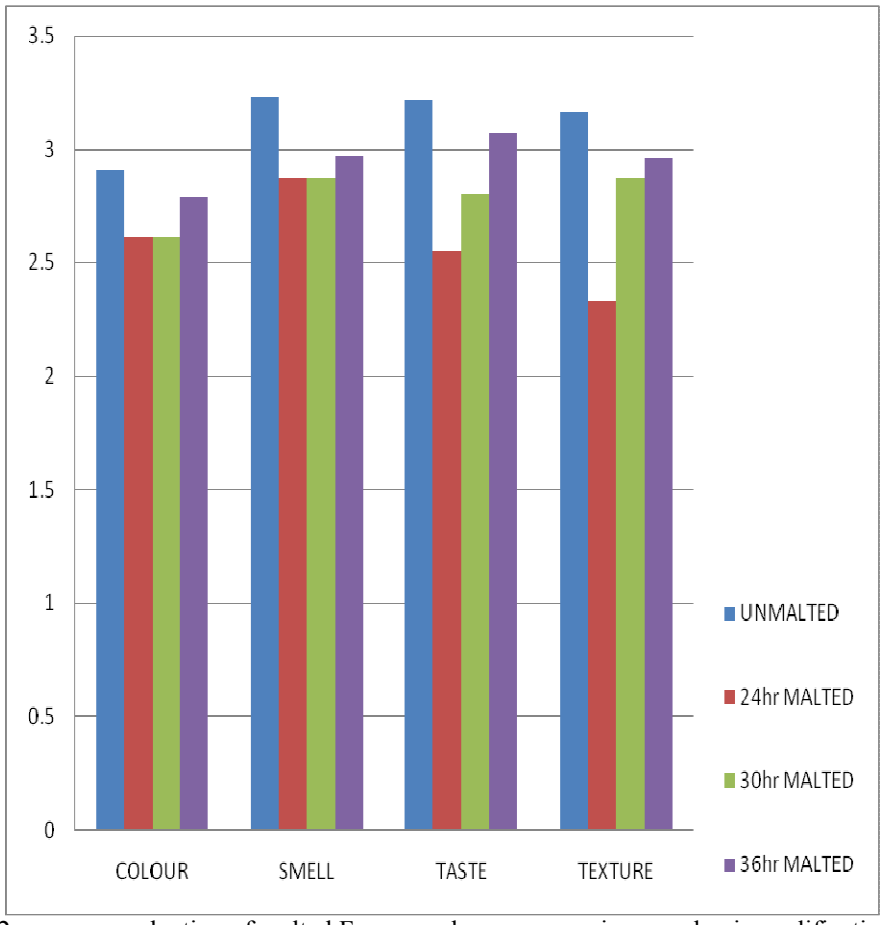

Figure 2: sensory evaluation of malted Fura samples among various academic qualification levels

3.9 *Colour*

The colour of the Fura evaluated by primary pupils, secondary and tertiary students showed that Fura with unmalted millet (2.9±0.9) was more acceptable than 24hr (2.6±0.7) Fura malted millet. However, 30hr (2.6±0.7) and 36hr (2.79±0.76) malted millet were not significantly different from the unmalted and 24hr malted millet (Table 2).

3.10 *Smell (Aroma)*

The smell (aroma) of Fura conducted among primary pupils, secondary and tertiary students showed that Fura with malted millet at 36hr and the unmalted were rated high. They were scored; 3.23±0.78 for the unmalted and 2.97±0.68 for 36hr malting followed by 24hr which had 2.87±0.72 and 30hr which scored 2.87±0.70.

3.11 *Taste*

Sensory taste of the various 'Fura' produced with pearl millets at various malting hours i.e. 24hr, 30hr, 36hr and unmalted by the pupils and students showed that the unmalted and 36hr malted Fura produced with pearl millet were scored significantly higher than those malted at 30hr and 24hr. The unmalted scored 3.07±0.67 followed by the 30hr with 2.79±0.68 and 24hr malted with 2.55±0.63.

3.12 *Texture (Feel at touch)*

Sensory evaluation for the texture was conducted among the different academic levels. The results showed that unmalted and 36hr were scored significantly high by the three (3) groups, it was followed by 30hr and 24hr respectively. Thus unmalted scored 3.16±0.91, 36hr scored 2.96±0.67, and 30hr scored 2.87±0.66 and 24hr 2.33±0.69.

4. Discussion

The yield (dry matter) is inversely proportional to the duration of malting. This agreed with the work of Katina *et al*. (2007), Chavan and Kadaan (1989), and Choi (1984). During germination there is degradation of starch and other constituents of the grain. The unmalted sample which gave highest yield is due to absence of enzymatic activities that bring about the degradation.

The initial decrease in protein level as a result of malting was due to hydrolysis of native protein to low molecular weight or peptide and increase in enzyme activities (Hussian *et al.,* 1966; Shayos *et al.,* 2001). Contrary to an initial increase in carbohydrate level, Inyang and Zakari (2008) reported significant decrease in

carbohydrate levels of Fura samples with germination and fermentation. However, increase in hours of malting, to 36hr, actually showed decrease in carbohydrate level. 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. However, there was no significant difference ($p<0.05$) between carbohydrate levels of malting. The constant level of lipid at varying hours of malting is in agreement with that of Anuradhas *et al.* (2010) whose report showed that there were no significant differences in fat content in Finger millet. Inyang and Zakari (2008), on the contrary submitted that the fat levels of Fura samples decreased on germination. The Fura from germinated grain 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. The result obtained in this study for fibre content was in conformity with that recorded by Malleshi and Desikachar (1986). They reported that crude fibres content of malted samples was slightly higher than the native samples. This could be due to the dissipation of some of the starchy endosperm during germination which causes apparent increase in seed coat proportion. Similar to this result Singh *et al.* (2006) also observed that the crude fibre content of cake samples was increased as the proportion of malted pearl millets flour was increased. However, statistical analysis showed that there was no significant difference between the samples and the unmalted Fura except the sample obtained after 36hours of malting hours.

The result also showed slight gradual decrease in ash contents with increase in hours of malting. This result is in agreement with that reported by Adul-fatah *et al.* (2010). They reported that there was significant decrease in ash content during the conversion of millet grain into Fura .However great significant difference was recorded in moisture content with increase in hours of malting when compared with unmalted Fura. Contrary to this, Magdi, (2009) observed that ash content showed marked variation during the germination process.

The Fura samples prepared from malted millet (*Pennisetum typhoides*) after different hours were subjected to sensory evaluation among various academic levels of education (primary, secondary and tertiary students) and the results are shown in Table 2. All the Fura samples prepared were after subjected to different malt were organoleptically acceptable to the panellists. The overall results of sensory evaluation of malted Fura samples among various academic levels showed that there was no significant difference among the Fura samples prepared after 36hours and unmalted for all the sensory attributes except taste. The samples prepared after 24hours were scored lowest for taste and texture. This lower value of taste score may be due to the increase in intensity of colour of Fura samples, with increase in hours of malted millet. The lower value of texture may be due to the decrease in sponginess of Fura resulting from the decrease in gluten content. However, the sensory evaluation showed that the unmalted Fura was scored highest for the entire sensory attribute.

From the results of this research, the following conclusions can be drawn.

The seed of pearl millet when germination and fermented prior to 'Fura' production increased protein, ash and crude fibre content. Malting has no effect on lipid content but decrease its moisture content. There was also a gradual decrease in carbohydrate content due to germination and fermentation.

'Fura' produced at the various hours of malting were scored lower for all sensory parameters (smell, texture, colour and odour) than Fura produced from unmalted millet. I therefore recommend that similar studies should be carried out on other cereal grains such as guinea corn, and maize.

Although procedures and equipment used for Fura processing are relatively simple, the microbiology and biochemical aspect have not been adequately researched. I also recommend that studies should be carried out on the shelf life and ionic composition of Fura and the malting effect on consumers.

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