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*Full Length Research Paper*

# Effect of dry and wet milling processing techniques on the nutrient composition and organoleptic attributes of fermented yellow maize (*Zea mays*)

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**The Study compared the chemical composition and sensory attributes of fermented yellow maize (*Zea mays)* processed by two methods. The grains were divided into two equal portions and fermented for 48 h. One portion was drained, sun-dried, dry-milled and subdivided into two equal parts: one was unsieved-dried-milled flour (UDM) and the other was sieved-dried-milled flour (SDM). The second portion of the grains was drained, wet-milled and subdivided into two equal parts unsieved-wet-milled flour (UWM) and sieved-wet-milled flour (SWM). The flours of UDM, SDM, UWM and SWM were analyzed for crude protein, crude fat, carbohydrate, crude fibre and ash. Gruels were prepared from the flour samples and their organoleptic attributes were tested for colour, texture, flavour and general acceptability. The nutrient content of UDM and SDM flour were significantly higher than the UWM and SWM in terms of protein, fat, ash and fibre contents. There was no significant difference in the carbohydrate levels based on the processing techniques used. Organoleptic attributes of gruels also showed no significant difference for SDM, UWM, and SWM. However, the effect of dry-milling without sieving seems to offer more benefits in conserving and improving the proximate (nutrient) levels of fermented maize – 'ogi'.**

**Key words:** Nutrient composition, fermented maize, organoleptic attributes.

## INTRODUCTION

Cereals, such as maize, sorghum, millet, rice among others are processed to detoxify the anti-nutritional factors, increase palatability and improve bioavailability of nutrients. There are many household food technologies used in the processing and preparation of foods and they include soaking, fermentation, milling (dry and wet milling), and sun-drying among others (Eka, 1984).

Fermentation is one of the household food technologies reviewed extensively as means by which the nutritive value of plant foods could be improved (Obizoba, 1998; Nnam 2000; Obadina et al., 2008). Food samples such as maize, sorghum, millet, rice can be fermented to increase the nutrient content, carbohydrate digestibility, and energy densities of gruels, increase the bio-availability of amino acids and also improve their shelf life under controlled environment (WHO, 1998). Fermentation can also reduce the high bulk of the traditional complementary foods by reducing the viscosity of the cereal gruel or porridge (Potter and Hotchkiss, 1995).

Sun-drying of food removes water, reduces moisture content and concentrates nutrients (Baiyeri, 2004). Sun-drying of foods such as fermented maize is a cheap traditional method of food preservation, because solar radiation (free gift of nature from sunlight) does the drying and enhances the shelf life of foods products.

However, a greater loss of nutrient has been found associated with wet-milling of maize-ogi. Akingbala et al. (1981), found a decrease in protein, fat, ash and crude fibre in wet-milled maize-ogi as compared with maize-ogi that was processed by dry-milling: Dry-Milling of fermented maize has shown that the nutrient content of complementary foods can be improved by conserving the nutrient contents as well as enhancing the shelf life while wet-milling results mostly into nutrient-loss, yield mainly starch and allows contamination from dirty water. It is therefore advisable to dry-mill fermented maize because, it is more hygienic, retains nutrient contents and improves shelf life. (Ruud and Rosa, 2002; Dal et al., 2007) Maize (*Zea mays*) is an important cereal crop produced extensively in Nigeria. Maize is the third most important cereal crop in the world and ranked the second most important cereal crop in Nigeria (Enwere, 1998). In some countries, maize constitutes a substantial part of the diet of most of the population (FAO, 1992). The carbohydrate levels of maize grains are very high and the protein quality of common maize is similar to that of rice and wheat with lysine as the most limiting amino acids (FAO, 1992). Maize is reasonably fair in sulphur containing – amino acids (methionine and cystine) and vitamin A precursor, beta-carotene (Obi, 1991; Obiakor, 2001). However, maize-ogi is still the usual first traditional complementary food given to children in Nigeria. It is called ogi, akamu, koko, pap (Enwere, 1998). Adequate processing and preparation of fermented maize-ogi using dry-milling method will reduce loss of nutrient, and improved the shelf life as well as decrease the antinutrient factors hence, the objective of this study.

## MATERIALS AND METHODS

### Preparation of samples

Two kilograms of yellow maize that were purchased at Nsukka market in Enugu State, Nigeria, were cleaned by hand picking to remove dirt, stones and unwanted materials. Furthermore, maize grains were steeped in deionised water in a ratio of 1:3 (w/v) and allowed to ferment at 28 $\pm$ 2°C for 48 hr. At the end of fermentation, grains were divided into two equal portions; one portion was drained, sun-dried, dry-milled and sub-divided into two equal parts, one part was not sieved (unsieved dried-milled flour) UDM while the other part was sieved (sieved dried milled flour) SDM. Both flours were packaged separately in airtight polythene. The second portion of the fermented maize was also drained, wet-milled and sub-divided into two equal parts. One portion of the wet-milled flour was wet-sieved (using 70mm mesh screen) and the bran was washed away from the endosperm with adequate water. The filtrate collected (corn-starch sediment) was poured into a muslin bag, tied and pressed to dewater sample.

Both sieved and unsieved samples were dried to produce unsieved wet-milled flour (UWM) and sieved-wet-milled flour (SWM) respectively. These were also packaged separately in airtight polythene for chemical analysis and sensory evaluation.

### Chemical analysis

The proximate composition of the flours (UDM, SDM, UWM and SWM) was determined by AOAC (1995) procedure. Protein determination was done by micro Kjeldahl procedure, crude fat was by soxhlet extraction, carbohydrate was determined by difference. Ash was determined by dried ashing method in a muffle furnance and crude fibre by a modified Weende method.Gruel (pap) was prepared from the flour samples for organoleptic evaluation.

### Preparation of gruels for organoleptic evaluation

A recipe was developed and used to prepare gruel from the four samples of fermented maize flour of UDM, SDM, UWM and SWM respectively. 100g of flour was mixed with 100 ml of deionised cold water to make the paste; then slurry was made by boiling with 500 ml of deionised water. The deionised water was boiled and samples were mixed with cold deionised water. The hot water was then poured into the cold paste and covered for 5 minutes.

### Organoleptic attributes

The sensory evaluation of the gruels was conducted in the Maternal and Child Health Centre (MCHC) of Bishop Shanahan Hospital, Nsukka. During one day, a panel of 20 nursing mothers was used by random sampling from the MCHC to determine the organoleptic attributes of the products. Each of the panelists was seated comfortably with window open for proper ventilation, fluorescent lighting and free from distraction. The judges evaluated the samples using a nine point hedonic scale, where 9 was the highest score and 1 the lowest score. The degree to which a product was liked was expressed as like extremely (9 points), like very much (8 points), like moderately (7 points), like slightly (6 points), neither like nor dislike (5 points), dislike slightly (4 points), dislike moderately (3 points), dislike very much (2 points), dislike extremely (1 point). The gruels were presented to each of the panelist as coded in the hedonic scale. Each panelist was given a take-away serving bowl, with spoon and a cup of water to rinse the mouth at interval of testing the gruels to avoid carry over effect. An ambient room temperature was maintained throughout the testing sessions. The 20 panelists for flavor, texture, colour and general acceptability evaluated the four products (tests and control).

### Data analysis

Data obtained from the study were analyzed statistically. Analysis of variance (ANOVA) was used to test for treatment effect (Obi, 1986). Duncan's New Multiple Range Test (DNMRT) was used to test the significance of the differences among means ($p < 0.05$).

## RESULTS

Table 1 presents the proximate composition (% dry matter) of dried and wet-milled fermented yellow maize flours. The protein levels of the flours ranged from 0.89% in SWM (control) to 11.48% in UDM (unsieved dried-milled flour) of the fermented yellow maize. The dried-milled flours of the fermented yellow maize (UDM and SDM) had higher crude fat levels of 3.57% and 3.55% than the wet-milled flours (UWM and SWM) having low crude fat levels of 1.67% and 0.67%.

The carbohydrate levels ranged from 80.4% to 99.22%. The wet-milled flours (UWM and SWM) had higher levels of carbohydrate (99.22% and 98.22%). The crude fibre levels of sieved dried milled flour and sieved wet-milled flour (SDM and SWM) was in trace amount (0.00%) whereas, the unsieved dried-milled flour and the unsieved wet-milled flour (UDM and UWM) had appreciable quantity of crude fibre (0.66% and 0.50%). Ash levels of the four samples (tests and control) ranged from 0.22% in SWM flour (control) to 1.89% in UDM. Ash level was low in the wet-milled flours of UWM and SWM (0.22%). However, the highest level of ash was 1.80% to 1.89% found in the unsieved-dried-milled flours (UDM and SDM).

Table 2 showed the sensory scores of gruels made

**Table 1.** Proximate composition of dried and wet-milled floursmade from fermented yellow maize (% dry matter)

| Nutrient 100 g/samples | UDM | SDM | UWM | SWM* |
|---|---|---|---|---|
| Protein | 11.48[a] | 10.48[a] | 1.89[b] | 0.89[b] |
| Fat | 3.57[a] | 3.55 [a] | 1.67[b] | 0.67[b] |
| Carbohydrate | 82.4[b] | 80.4[b] | 99.22[a] | 98.22[a] |
| Fibre | 0.66[a] | Trace | 0.50[a] | Trace |
| Ash | 1.89[a] | 1.80[a] | 0.22[b] | 0.22[b] |

*** Control**
For each nutrient, values with similar letter in each row are statistically similar (*p* > 0.05) while those with different letters are significantly different (*p*< 0.05).

**Table 2.** Sensory scores of gruels made from dried and wet-milled flours of fermented yellow maize

| | UDM | SDM | UWM | SWM* |
|---|---|---|---|---|
| Flavor | 7.6[a] | 8.2[a] | 8.5[a] | 7.5[a] |
| Texture | 7.2[b] | 8.4[a] | 8.4[a] | 8.0[a] |
| Colour | 6.6[a] | 8.6[a] | 8.7[a] | 8.3[a] |
| General Acceptability | 5.0[a] | 8.4[a] | 8.5[a] | 7.7[a] |

Means not followed by the sample letter in a row are significantly different.
UDM- Unsieved dried-milled flour made from fermented yellow maize; SDM- Sieved dried milled flour made from fermented yellow maize; UWM -Unsieve wet-milled flour made from fermented yellow maize; SWM*- Sieved wet-milled flour made from fermented yellow maize (control).

from dried and wet-milled flours of fermented yellow maize. The flavour of the gruels was statistically similar for tests and control and the products were liked moderately by the judges. There was no significant difference in flavour among the samples. The texture of UDM was liked moderately while SDM, UWM and SWM texture were liked very much. The colours of SDM, UWM and SWM gruels were significantly different from that of UDM. However, judges liked SDM, UWM and SWM very much. The general acceptability of gruels in terms of flavour, texture and colour attributes were comparable (P>0.05). Although, UDM acceptability was significantly different from others, yet the judges like the products moderately.

## DISCUSSION

The higher crude protein levels of the dried-milled fermented yellow maize flours (UDM and SDM) than the wet -milled flours (UWM and SWM) was attributed to the beneficial effect of dry-milling processing method. This agreed with the observation made by (Akingbala, 1981; Olatunji, 1982; Obizoba and Atti 1991; Baiyeri, 2004) that fermented maize nutrients can be improved and conserved when processed adequately. The low levels of protein in the control (SWM) and (UWM) flours may be due to processing and preparation method of fermented maize – 'ogi'. As a result, UWM and SWM had a greater loss of nutrient through wet-milling. Nnam (2002), showed that vital nutrients are leached in the residue sieved out, leaving the sediment (filtrate) as cornstarch. Nkama, (1994) also reported the same loss of nutrients during the production of '0gi' with wet milling and sieving. This leads to considerable loss of essential nutrients, especially protein and dietary fibre of the food content. The lower levels of crude fat in the wet-milled flours (UWM and SWM) than the dried-milled (UDM and SDM) could be attributed to effect of processing on the fermented maize – 'ogi' flour. But, adequate preparation and processing through dry -milling conserved the crude fat levels of UDM and SDM. Crude Fibre was trace in the wet-milled samples because of sieving, leaving the residue with bulk of fibre and the sediment as corn-starch. The same loss of crude fibre was observed by (Baiyeri, 2004) when maize 'ogi' was used as a negative control of complementary foods.

Ash levels of all the samples varied. This could be attributed to the low level of mineral contents of maize. Although UWM and SWM flours had higher quantity of carbohydrate, the difference was not significant in all the samples.

The varying degrees of sensory scores observed for flavour, texture and colour of the gruels made from fermented yellow maize (dried and wet-milled) offers promise for their use at household level. However, the acceptance of all the gruels made from the four samples indicate that without sieving and wet-milling as it is practiced traditionally, the products could gain popularity with increase use of dry-milling without sieving. This is because wet-milling and sieving reduces the nutrient to ordinary corn-starch and chaff while dry-milling without sieving conserved the nutrient as well as improving the shelf life.

The flours of unsieved dried-milled and sieved dried-milled (UDM and SDM) fermented maize – 'ogi' showed nutritional adequacy over the wet-milled flours (UWM and SDM) in terms of crude protein, crude fat, crude fibre and ash. The control (SWM) had the poorest nutrient except carbohydrate level (corn-starch sediment). The effect of dry-milling without sieving was beneficial in conserving and improving the proximate (nutrient) levels of fermented maize – 'ogi'. This may be of importance in terms of nutritive and economic values in developing nations where assess to adequate protein in the diet is not easy to come by amongst the poor population.

We recommend that the flours of UDM and SDM could be used as an improvement to the popular traditional maize – 'ogi' (SWM). Similarly, dry-milling without sieving could be more beneficial for use in the preparation of fermented maize – 'ogi', therefore household method of preparing fermented maize – 'ogi' (wet-milling and sieving) could be change to dry-milling without sieving especially in formulating feed for infants and growing children who need adequate protein.

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