Impact of Fermentation on the Proximate composition and Organoleptic Quality of Maize flour in cake production

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Abstract

The impact of fermentation on the proximate composition of maize flour and organoleptic quality of maize cake was investigated. Maize (Zea mays) flour was processed into unfermented flour (UFMF) by drying sorted and washed maize grains (500g), after which they were milled into flour using a disc-attrition mill and sieved using a 250 μm sieve to obtain uniform particle size. Fermented maize flour (FMF) was prepared by drying, milling and sieving 500g of maize grains fermented for 72 hr using Saccharomyces cerevisiae. Proximate analysis was carried out on both flours (FMF and UFMF). Sensory evaluation of cake produced from both flours and various compositions with wheat flour was also carried by a 10-man panel using a 9-point hedonic scale. Statistical analysis on the sensory scores was performed to ascertain if there was significant difference in Organoleptic Quality. The result of the proximate analysis indicated a 35.8% increase in crude protein in FMF. The percentage lipid also increased by about 75% in FMF. The carbohydrate content was lower in FMF; 79.68 than UFMF; 82.22. Statistical analysis of the results of the sensory evaluation of the cake products showed no significant difference in the Organoleptic Quality of cake produced from wheat flour and fermented and unfermented maize flours. Highest overall acceptability was recorded for cake produced from wheat flour; 8.6, followed by that made from fermented maize flour FMF 7.7.

Key words: Fermentation, Proximate composition, Organoleptic Quality.

Introduction

Maize flour is produced from dried maize grains after harvest. It serves as an effective processing against storage loss. Locally the curbs are sundried, or dried over heat. The dried grains are grounded into flour using a wooden mortar and pestle and repeatedly sieved to produce a uniform texture or the use of motor driven milling machine. The resulting product is a white to cream flour, which can be stored for months. The storage environment must be dry to prevent the growth of moulds and must be well protected from weevils, which may infest the dried products (Uchechukwu-Agua, 2015).
Fermentation is an essential technology that is required for converting lignocellulosic materials in food produce such as yam, cassava, rice, maize and so into value-added products which have potential to used for animal nutrition to solve the problem of inadequate intake of protein and calories. This will also reduce waste, pollution as well increase quality of animal products. According to Anupama and Ravindra (2000) fermented products contain proteins that can feed both humans and animals thereby replacing expensive conventional sources of protein like fishmeal and soymeal. However it is important to use microorganism that are “Generally Regarded as Safe for fermentation in order to promote its use. Saccharomyces cerevisiae is widely accepted due to long history of its use in traditional fermentation and its nutritional quality.

The principal problem in agricultural products in Nigeria is the high post harvest losses. Another constraint to maize production is the limited processing technology. About 30% of harvested maize grains are lost to waste. The bulkiness of fresh transport and low margins for both famers and traders are thus a matter of serious concern in the urban market. During the processing of maize through sun-drying method the problem encountered is the losses due to potential contamination of the product variability in drying time, rain damage and so on. Health challenges owing to gluten content of wheat flour as well as high cost of wheat flour are factors driving research efforts at finding an alternative to wheat flour. This work, therefore investigates optimum conditions for processing maize into other valued products in order to increase its shelf-life.

Materials and Method

Collection of Samples
White maize (Zea maize) used for this study was purchased from a local market in Auchi, Etsako West Local Government Area of Edo State, Nigeria. They were identified in the Department of Agricultural Technology, Auchi Polytechnic, Auchi. Wheat flour used as control was also purchased from a local market in the same Local Government Area.

Processing of Maize Flour
The maize grains were washed with tap water and rinsed with distilled water. One part (500 g), was sundried for 48 hr. The dried maize grains were milled into flour using a disc-attrition mill. The resulting flour was then sieved (using a 250 μm sieve) to obtain uniform particle size. The unfermented maize flour, UFMF, was then packed in a clean plastic bucket with a lid (labeled UFMF), and kept for subsequent use (Eriksson, Koch, Tortoe, Akonor, and Oduro-Yeboah, 2014).

The other part of the maize grains were placed in a 20 L plastic bucket with lid. Boiling water was added to it to solubilize the starch granules (Eriksson, et al., 2014). It was
allowed to stand until the temperature of the slurry became 45°C. Yeast cells (*Saccharomyces cerevisiae*) were then added, 0.3 g/L of fermentation substrate and the slurry was stirred to allow proper spread of the yeast (Azoulay, Jouanneau, Bertrand, Raphael, Janssens and Lebeault, 1980). The set up was then allowed to ferment for 48hrs. The fermented mash was then drained of water and sundried for 48 hrs. The dried mash was milled into flour using a disc-attrition mill. The resulting flour was the sieved (using a 250 μm sieve) to obtain uniform particle size. The fermented maize flour, *FMF*, was then packed in a plastic bucket with a lid (labeled FMF), and kept for subsequent use (Eriksson, *et al*, 2014).

**Proximate Analysis**

Standard analytical procedures for food analysis were adopted in carrying out the determination of moisture content, ash content, crude protein, crude fibre and crude fats and while available carbohydrate was calculated by difference. The proximate composition was determined using the method of AOAC (1990).

**Cake Making**

The cake batter was prepared using 100 g flour, 50 g sugar, 20 g liquid milk, 9 g egg (1 large egg), 25 g soy oil, 5 g baking powder, 3 g salt (Ozkahraman, Sumnu, and Sahin 2015). Wheat cake containing no maize flour was used as control (WF). 100 % Unfermented maize flour (UFMF), and Fermented maize flour (FMF) were used for another treatment. The other samples consisted of different composite mix of these three basic flour; WF:FMF₁ (70:30), WF:UFMF₁ (70:30), WF:FMF₂ (50:50), and WF:UFMF₂ (50:50). The ingredients were mixed for about 5 min manually and thoroughly. Prepared cake batter samples (100 g each) were poured into metal cake cups with 8.7 cm diameter and 4.8 cm in height. These were then transferred to an electric oven, model MC-2121, preheated to 175 °C. The cake samples were baked for 25 min at 175 °C (Ozkahraman, *et al.*, 2015).

**Sensory Evaluation of Cake**

The cakes were allowed to cool and cut into slices of uniform thickness and transferred onto clean plates coded with random single-digit codes. A sensory panel consisting of 10 semi-trained graduate students of Hospitality Management Department, Auchi Polytechnic, familiar with sensory attributes of local cake was employed to evaluate the products. A 9-point Hedonic scale was used to rate the cakes for aroma, texture, appearance, taste, and overall acceptability. A score of 1 represented “dislike extremely” and a score of 9 represented “like extremely” (Erikson *et al.*, 2014). A cake sample was
evaluated at a time with water and neutral cream crackers given to each panelist to refresh palate.

**Statistical Analysis**

Kruskal Wallis non-parametric analysis of variance was performed to calculate mean Ranks and significant levels for aroma, texture, appearance, taste and overall acceptability. Student’s t test was performed to compare the mean values of the proximate composition of the fermented and unfermented yam flours. Significances were determined at P<0.05.

**Results and Discussion**

Table 1 shows the results representing the proximate composition of the fermented and unfermented maize flour. The percentage moisture content of both flour samples did not show much difference; 8.90 for UFMF and 9.10 for FMF. The percentage ash content, however, was higher for UFMF, 1.24 than FMF, 0.74.

The crude protein of FMF increased by about 35.8% over that of UFMF. There was no difference in the percentage crude fibre of UFMF and FMF (0.50 and 0.47). The percentage lipid increased by about 75%. The carbohydrate content showed a slight decrease in percentage for the fermented flour, 79.68 as against 82.22 for UFMF.

The mean scores for the sensory evaluation of cake produced from wheat flour, unfermented maize flour (UFMF), fermented maize flour (FMF) and composite mix of WF, UFMF and FMF are presented in table 2.

<table>
<thead>
<tr>
<th>Cake Sample</th>
<th>Aroma</th>
<th>Texture</th>
<th>Appearance</th>
<th>Taste</th>
<th>Genera</th>
</tr>
</thead>
<tbody>
<tr>
<td>WF</td>
<td>8.6</td>
<td>8.4</td>
<td>8.7</td>
<td>8.5</td>
<td>8.6</td>
</tr>
<tr>
<td>UFMF</td>
<td>7.4</td>
<td>6.4</td>
<td>5.6</td>
<td>5.4</td>
<td>6.4</td>
</tr>
<tr>
<td>FMF</td>
<td>6.5</td>
<td>7.4</td>
<td>7.6</td>
<td>5.6</td>
<td>7.7</td>
</tr>
<tr>
<td>WF: UFMF₁</td>
<td>7.2</td>
<td>8.2</td>
<td>8.4</td>
<td>7.4</td>
<td>7.3</td>
</tr>
<tr>
<td>WF: UFMF₂</td>
<td>6.8</td>
<td>7.2</td>
<td>7.4</td>
<td>6.8</td>
<td>6.2</td>
</tr>
<tr>
<td>WF:FMF₁</td>
<td>7.2</td>
<td>7.6</td>
<td>8.4</td>
<td>6.6</td>
<td>7.5</td>
</tr>
<tr>
<td>WF:FYF₂</td>
<td>6.8</td>
<td>7.8</td>
<td>7.4</td>
<td>5.7</td>
<td>6.4</td>
</tr>
</tbody>
</table>

*Table 1: Proximate composition of the unfermented and fermented maize flour

<table>
<thead>
<tr>
<th>Flour</th>
<th>M(%)</th>
<th>Ash(%)</th>
<th>CP(%)</th>
<th>CL(%)</th>
<th>CF(%)</th>
<th>C(%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>UFMF</td>
<td>8.90</td>
<td>1.24</td>
<td>6.34</td>
<td>0.80</td>
<td>0.50</td>
<td>82.22</td>
</tr>
<tr>
<td>FMF</td>
<td>9.10</td>
<td>0.74</td>
<td>8.61</td>
<td>1.40</td>
<td>0.47</td>
<td>79.68</td>
</tr>
</tbody>
</table>

*M- moisture, CP- crude protein, CL- crude lipid, CF- crude fibre, C- carbohydrate

*Table 2: Mean Scores for sensory evaluation of the cake samples
*WF-wheat flour, *WF:UFMF₁-composite flour 70:30, *WF:UFMF₂, 50:50, UFMF, 0:100
*WF:FMF₁-composite flour 70:30, *WF:FMF₂, 50:50, FMF₄, 0:100
*FMF-fermented maize flour, *UFMF-unfermented maize flour

Scores for Aroma ranged from 6.5 - 8.6, with wheat flour (WF) having the highest mean score of 8.6, followed by 7.4 for unfermented maize flour (UFMF). Fermented maize flour had the least score for aroma of 6.5, followed by WF:UFMF₂ and WF:FMF₂. The mean scores for texture ranged from 6.4 to 8.4. Wheat flour had the highest mean score of 8.4 followed by WF:UFMF₁, 8.2, with WF:FMF₂, and WF:FMF₁ having 7.8 and 7.6 respectively. Wheat flour also had the highest scores for appearance, taste and general acceptability; 8.7, 8.5 and 8.6 respectively. UFMF had 5.6, 5.4 and 6.4 respectively. While FMF, had 7.6, 5.6 and 7.7 respectively. The least score for general acceptability was recorded for WF:UFMF₂; 6.2, while the highest score was recorded for wheat flour; 8.6, followed by FMF; 7.7.

Generally, the fermentation process had significant impact of the protein and lipid content of maize flour. The lipid content recorded about 75 % increase; this can be attributed to microbial growth during the fermentation process. It has been reported that organisms can produce microbial fat during fermentation (Joko and Kazuhiko, 2013). This argument is also applicable to for the enhancement of the protein content, which recorded about 35.8% increase due to fermentation. Microbial strains have been reported to secrete extracellular proteins into yam starch granules during fermentation, forming single cell protein (Oboh and Elusinya, 2007). Osman (2011) also reported increase in protein content through fermentation process of millet during traditional preparation of Lohoh. The decrease in carbohydrate is consistent with the fact that the carbohydrate formed a carbon source for the fermenting organisms.

Statistical analysis of the results of the sensory evaluation of the cake products show no significant difference in the Organoleptic Quality of cake produced from wheat flour and fermented and unfermented maize flour. Highest overall acceptability was recorded for cake produced from wheat flour (8.6), followed by that made from fermented maize flour FMF (7.7). Statistical analysis indicate that cake made from fermented maize flour and unfermented maize flour compared favorably with that made from wheat flour. The result is similar to that obtained by Edema, Sanni, and Sanni (2005) who reported that bread baked with 10 and 20% yam – wheat composite flour were not significantly different in any sensory attributes. The result varied slightly from that of Lemchi, Mbah, and Obi-Anyanwu, (2016) who reported that 50:50 combination of wheat flour and maize flour cake were unacceptable, however, the taste and overall appearance of maize flour and yam flour were also acceptable except in the 50:50 composite combination of wheat and maize flour cake.
Conclusion

This research is aimed at evaluating the impact of fermentation of maize on the nutrient content of maize flour and organoleptic quality of maize cake. Specifically the study determined how fermentation using *Saccharomyces cerevisiae* impacted on the nutrient and sensory attributes of maize flour. This work was able to establish that: fermentation enhanced the nutrient content of maize flour; and that Maize flour presents a good combination with wheat for baked products. Thus, this study has added to scientific facts showing that maize can be fermented and processed into flour to enhance its nutritional value as well as reduce post harvest losses and that maize flour can be used in combination with wheat for baking purposes.

References


