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Changes in Proximate Composition of Corn Meal (Ogi) Assisted with *Lactobacillus* Species

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Authors' contributions

This work was carried out in collaboration between all authors. Authors UOE, RUBE, EMU, UME, GMI and NWN designed the study, performed the statistical analysis, wrote the protocol and the first draft of the manuscript. Authors UOE and CUO managed the analyses of the study and cultivation of Lactobacillus species, respectively. Authors EMU and UOE managed the literature searches. All authors read and approved the final manuscript.

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Short Research Article

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ABSTRACT

Ogi also known as corn meal is a carbohydrate rich food that forms the diets of most weaning infants and adults in some West African countries including Nigeria. The aim of this study was therefore to investigate the effect of *Lactobacillus brevis* and *L. plantarum* on the proximate composition of ogi. All analyses were carried out using standard techniques. Fresh ogi was prepared from corn via selection, washing, steeping for 2 to 3 days, wet milling and sieving. *L. plantarum* and *L. brevis* were then inoculated into the corn meal and incubated anaerobically for 24 hours at 37℃. Following inoculation, the proximate compositions of the control and *Lactobacillus* species inoculated samples were determined. On enrichment with *L. brevis* and *L. plantarum*, the

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protein, fat, ash, crude fibre, and moisture contents were significantly increased ($p < 0.05$) while carbohydrate was lowered after fermentation. The amounts of moisture were 65.73-68.30, ash 1.63-1.44, protein 12.24-14.30, fat 6.42-7.47, fibre 2.30-2.72 and 77.24-73.90 g/100g dry matter, respectively for *L. brevis* and *L plantarum*. The increase in protein is of great significance in weaning infant diets. Thus, there is a need to conduct further studies to assess the palatability of the enriched corn meal.

Keywords: L. brevis; L. plantarum; Ogi; proximate composition.

1. INTRODUCTION

Across Africa, maize is an important cereal that is used as food and raw material for industries. Proximate composition studies have shown that the dry maize contains moisture, protein, fat, fibre, metabolisable energy, and minerals such as phosphorus, sodium, sulphur, copper, magnesium calcium, iron, and potassium in varying amounts [1]. It is therefore not surprising that in most part of the Nigeria, ogi is a delicacy consumed by both adults and infants. It is usually the first food given to babies singly or side by side with formulated ones [2,3].

Conventionally, it is prepared from maize, however, millet or sorghum can also be used. It preparation and microbiology is well studied [4][5][6]. Steeping and souring are identified as the two fermentation stages involved in the long-established process of Ogi preparation [6]. Its colour when ready for eating depends on the cereal used in its preparation. Where maize is used, it has a creamy or white appearance [5]. When boiled, it turns into a porridge called pap and can be served with protein rich foods such as beans. Typically, the carbohydrate rich pap is usually served as weaning food for infants, as breakfast for children and convenient meal for its convalescence [7].

Furthermore, nutrient loss seems inevitable during the preparation of ogi [7,8]. It is therefore not surprising that several attempts aimed at improving its nutritional status such as enrichment with protein rich substrates have been made. In an earlier study, nutritional enhancement with proteineous foods lowered their pasting viscosities and also sensory qualities [9]. Interesting, it has been shown that the intrinsic fermenters could be majorly responsible for its nutritional improvement [10].

Fermented cereal based foods consumed in West Africa are important for a number of reasons. Studies have shown that the fermentation microorganisms such as *Lactobacillus* and *Bifidobacterium* have the ability to produce healthy and safe products with better shelf lives, probiotics and probiotics potentials, nutritional and health benefits, ability to dominate indigenous microbiota and even hydrolyze starch [11-13]. Others include alleviation of lactose intolerance, flavour enhancement, improvement of immune system, neutralization of toxin effects, bioavailability of nutrients, phytate degradation and fortification of folate amongst others [12,13].

Despite westernization of infant food, ogi prepared into pap still remains an important first line meal and the food of choice of most West African and Nigerian babies. It has been shown that maize, millet and guinea corn paps contain less protein and fibre which increases on fortification with soya bean milk by over three-fold [14]. In Nigeria and Ghana, a number of studies aimed at fortification with peanuts, soya bean and cowpea have been carried out [15-17]. The aim of the study was to improve on the protein content of ogi by enrichment with *L. brevis* and *L plantarum.*

2. MATERIALS AND METHODS

2.1 Source of Sample

Freshly harvested corn (*Zea mays*) used for this study was purchased from Obo Market, located in Etim Ekpo Local Government Area of Akwa Ibom State, Nigeria.

2.2 Processing of the Corn Meal (Ogi)

The ogi used in this study was prepared using the methods previously described by Akingbala et al [18] but with slight modifications. Briefly, 1,000 g of dried white corn were measured and weighed out. The weighed corn was washed thoroughly with water and soaked in about 10 liters of cold water for 3 days for fermentation to take place at room temperature (25℃). On the third day, the seeds were washed and blended till it became smooth using a milling machine.

The blended corn was then sieved using a clean siphon cloth tied over a big clean bowl. The sieving was done with water rinsing where necessary until what was left was only the chaff. The resulting sieved milled corn meal with the water (also called *Akamu*) was then set aside to settle overnight with the help a piece of white cloth or a muslin bag to drain water from the ogi. This was then placed in sample containers and stored at 4℃.

2.3 Isolation, Identification and Characterization of *Lactobacillus* Species

The isolates used in this study were sourced from Microbiology Department, University of Calabar. The isolate were identified and characterized using morphological and several biochemical tests. All biochemical tests were done with the help of the *Lactobacillus* identification kit (API 50). The isolates were identified as *L. brevis* and *L. plantarum*.

2.4 Inoculation of Samples with *Lactobacillus*

L. brevis and *L. plantarum* are then used to inoculate the samples. Briefly, 100 g of the samples were weighed into clean sample bottles and then 2 ml of the *Lactobacillus* species kept overnight was then used to inoculate into the samples. They were then kept overnight at 37℃ anaerobically. Each inoculum was adjusted to 0.5 Mac Farland standard before use.

2.5 Proximate Composition

Both the control and *Lactobacillus* inoculated samples were then analyzed for food composition according to the Association of Official Analytical Chemists (AOAC) [19]. Parameters examined were crude fiber, ash, crude protein, fat, carbohydrate and moisture.

2.6 Statistical Analysis

The data obtained was analyzed using Microsoft excel 2010. Replicate readings were analyzed using Analysis of variance (ANOVA) and Student t-test for significance at 95% level of significance.

3. RESULTS

The results of the proximate composition (g/100g dry matter) of the freshly prepared ogi and those inoculated with *Lactobacillus* species are presented in Table 1. The proximate analysis of the control sample shows that carbohydrate was highest 78.79 ± 0.01, followed by moisture 62.20 ± 0.12, protein of 11. 70 ± 0.10, fat of 5.82 ±0.02, fibre of 2.10 ± 0.10 and ash 1.25 ± 0.01(g/100g)..

Following inoculation with *L. brevis*, proximate analysis reveals that the highest was carbohydrate 77.24 ± 0.02 (g/100g) which was slightly reduced compared to that of control. Furthermore, moisture content was 65.73 ± 0.12, protein 12. 24 ± 0.02, fat 6.42 ±0.02, fibre 2.30 ± 0.1 g/100g and ash 1.63 ± 0.01 (g/100g). It is important to note that the protein, fat, ash and fibre were all significantly increased following treatment with *L. brevis* as compared to the control.

L. plantarum inoculated ogi on analysis shows that the carbohydrate content of 73.90 ± 0.01 (g/100g) which was lower compared to the control and *L. brevis*. Moisture content was 68.40 ± 0.01, protein 14. 30 ± 0.10, fat 7.48 ±0.01, fibre of 2.72 ± 0.02, and ash 1.44 ± 0.01.The protein content of 14.30± 0.10 (g/100g) was far better than that of *L. brevis* and the control.

4. DISCUSSION

As the world population continues to reach record high figures, imminent challenges include attainment of food security and combating protein malnutrition amongst others [20]. Protein malnutrition is even made worse because of high rate of poverty in sub-Saharan African. Single cell protein (SCP) is not just cheaper but more sustainable compared to plants and animal protein sources [21]. Proximate composition studies have shown that maize is very rich in a plethora of nutrients such as carbohydrate, protein, fat, fibre, and moisture as confirmed in our study [22,23] Aminigo et al [24] also highlighted the importance of developing high protein corn food of plant origin because of the high cost of animal protein. Protein loss seems inevitable during the preparation of ogi and is explained by sieving step that leads to the removal of the testa and germ that contains a good amount of protein [5,22,23].

Lactobacillus brevis isolated from fresh water fish have been shown to produce bacteriocins with broad spectrum inhibition against *Escherichia coli, Enterococcus faecalis, Lactobacillus casei, Lactobacillus sakei* and *Staphylococcus aureus*. Furthermore, the antimicrobial activity of crude supernatant fluid was stable after heating at 121℃ for 60 minutes [25]. Similar results were also obtained with *Lactobacillus* species isolated from locally fermented maize [26].

Table 1. Proximate composition of control (freshly prepared ogi) and Lactobacillus treated samples (g/100g dry matter)

Parameters	Control	*L. brevis*	*L. plantarum*
Moisture	62.20±0.12[a]	65.73±0.01[b]	68.30±0.01[c]
Ash	1.25±0.01	1.63±0.01	1.44±0.01
Protein	11.70±0.10	12.24±0.02	14.30±0.10
Fat	5.82±0.02	6.42±0.02	7.47±0.01
Fibre	2.10±0.10	2.30±0.10	2.72±0.02
Carbohydrate	78.79±0.10	77.24±0.02	73.90±0.01

[a]ANOVA of replicate reading shows significance with probability values of $p < 0.001$.

Following enrichment with *L. plantarum* and *L. brevis*, all other components except carbohydrate were significantly higher ($p < .0.05$) than the non-enriched ogi. Furthermore, the amount of protein, fat, ash and fibre of the enriched corn meal with the test organisms were higher when compared to the control in our study, and those previously reported [1,6]. Interestingly, when the enriched samples were compared to the non-enriched, it was observed that the carbohydrate content of the enriched substrate decreased significantly whereas the protein content increased significantly ($p<0.05$).

Oluwafunmilayo et al [27] in their study to examine the chemical changes during the fortification of cassava meal (garri) with African breadfruit (*Treculia africana*) revealed proximate composition changes in different mixtures of breadfruit and cassava with overall acceptability of 7.2 and 7.3 when used in the ratio of 30:70 after grating and dewatering. The ash content rose from 1.08 to 4.42 and 4.53, while moisture decreased from 4.61 to 1.11 and 1.13, protein increased from 1.96 to 9.62 to 10.71, fat increased from 5.71 to 6.93 and 6.98, fibre 3.62 to 3.41 and 3.40 and carbohydrate 81.98 to 75.74 to 74.25 (g/100g) in the after grated and dewatered samples, respectively. When compared to our findings, similar results were obtained for carbohydrate, protein, fat and ash but moisture and fibre contents of the treated samples were higher than what was obtained in the control. A study by Sanni and Adesulu [28] accessing the microbiological and physico-chemical changes during fermentation of maize for massa production showed changes in proximate composition using *L. plantarum, P. acidilactici, L. fermentum, S. cerevisiae* used singly and as a consortium. The results indicate that when used singly, *L. plantarum* gave the highest changes in moisture, ash, crude fibre, ether extract, crude protein and carbohydrate. However, as seen in their study, ash and fibre contents were increased not just for *L. plantarum* but for other isolates used in the study while moisture was slightly reduced. Increase in protein in our study is in conformity with the findings of Opere et al [29] which recorded increased values of reducing sugars, proteins and essential amino acids such as lysine, isoleucine and arginine.

5. CONCLUSION

Given, the prevailing experimental conditions, the proximate composition of the *Lactobacillus* species treated ogi samples increased significantly the amount of protein, fat and ash and fibre than the non treated ogi. These findings are particularly important for diabetics and weaning infants. Thus, there is a need for further studies aimed at evaluation of sensory properties of the ogi enriched with *Lactobacillus* species.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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