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Microbiological Quality Enhancement of Nutritive Value and Shelf-Life of Corn-Meal (OGI) Using *Lactobacillus plantarum*

Takon I. A., Regil Otu
Department of Microbiology, Faculty of Biological Sciences, University of Calabar, Calabar - Nigeria
Corresponding Author Email: iquotee@yahoo.com or iatakon@unical.edu.ng
234-8034505221

***Abstract*—*The microbiological quality enhancement of the nutritive value and shelf-life of cornmeal (ogi) using Lactobaccillus plantarum has been investigated using standard microbiological methods. Fifty grammes of ogi were prepared from moist steeped corn grains for 2 to 3 days, wet milled, sieved and dried. Corn steep liquor was enriched with L. plantarum strain that was amplified using UV-irradiation in a limiting lysine medium, ranging from 0.1ml – 2.0mls. The proximate composition for enriched cornmeal was: 2% crude fibre, 7.5% fats, 9.50% ash, 19.96% protein, 24.05% carbohydrate and 43.00% moisture respectively, as compared to fresh wet cornmeal without enrichment with L. plantarum, which had 6.68% protein, fat 0.50%, ash 30.00%, crude fibre 0.40%, carbohydrate 30.82% and moisture 30.00%. Unenhanced dry cornmeal had 0.20% fat, 1.20% crude fibre, 4.42% protein, 10.0% ash, 10.00% moisture and 32.38% carbohydrate. The enhanced nutritive value was significantly different at P>0.005, when compared to the fresh cornmeal. This enhanced nutritive value will help improve food security and may eliminate certain malnutrition related childhood diseases in under-developed and developing countries.*

***Keywords*—** *Food quality, Lactobacillus plantarum, corn meal, enhancement*.

I. INTRODUCTION

Malnutrition is one of the major problems facing babies and infants in many developing countries of the world (Ohenhen and Ikenebomeh, 2012). While malnutrition is partly due to non-availability of food, it is also partly due to low energy and nutrient density and low bio-availability of nutrients in the available foods (Trustwell, and Brock 1996). The presence of some anti-nutritional factors such as phytic acid, tannins and polyphenols in some cereals used as weaning food, may be responsible for the low availability of proteins (Adebolu *et al.*, 2007) and iron (De vries *et al*; 2006). Traditional lactic acid fermentation of cereals has been effective in reducing the amount of phytic acid, polyphenols and tannins metabolites, and thus, improve protein availability in cereal (De vries *et al.*; 2006). Fortified ogi or corn meal, has a low sensory texture as compared to the unfortified one. The texture and viscosity have an imperative role as these determine its acceptance among local community (Adebolu, *et al*; 2007).

Cereals are grasses cultivated because of their edible grains (Trustwell, and Brock 1996). They are dominant in the world agriculture, with a total of 2,500 million tons being harvested globally (Blandino and Webb 2003). In their natural form, they are a rich source of vitamins, minerals, carbohydrate, fat, oil, and proteins to diets of humans and livestock (Adesokan *et al.*; 2010).

Major reasons for the success of cereals include: their adaptability, high yields and ease of harvest and storage. Similarly, their processing and eating properties are important (Akande *et al.*, 2013). Maize or corn (*Zea mays*) is one of the world's important cereal crop primarily grown for human and animal consumption (Adeniyi and Porter, 1978). It could be eaten as boiled, roasted, or processed into foods such as Ogi or cornmeal. tortillas, pozol, kenke, etc. (Adesokan *et al.*; 2010). Maize is the most widely grown staple food crop in sub-saharan Africa (FAOSTAT, 2015). It is consumed by people with varying food preferences and socio-economic backgrounds (Adebolu et al., 2007). Maize is also used for manufacture of starch, syrup, sugar, industrial spirits and whisky (Akandi *et al*; 2013). Milled maize products include flour, meal grits and corn steep (Odunfa and Adeleye, 2005). Ethanol derived from maize has been used as bio-fuel (Akandi *et al.*; 2013).

Ogi or cornmeal is a fermented cereal product from maize, which could either be consumed as porridge (pap) or gel-like (agidi) in some West African countries (Oyarekua & Adeyeye, 2009). The pap could be served as a breakfast meal, as convalescing patients or weaning food for infants (Odunfa and Adeleye 2005). The colour of ogi depends on the type of cereal used (Adebolu *et al.*; 2007).

Several researches have been carried out on various aspects of ogi, such as, shelf life improvement (Adesoke *et al.*; 2002), starter cultures (Wakil and Daodu 2011), and co-fermentation with legumes (Oyarekua & Adeyeye, 2009). *Lactobacillus plantarum* is a widespread lactic acid bacterium commonly found in fermented foods as well as in the human gestro-intestinal tract (GIT). Their use as probiotics has increased recently (Ijabadenyi, 2007).

According to Chavan and Kadem (2013), cornmeal or ogi forms the main weaning diets of infants in underdeveloped or developing countries. Substantial nutrients losses were inevitable during fermentation and also during the various steps of ogi processing: such as steeping, milling and sieving. Much of the protein in cereal grains is located in the testa and germ, which are usually sifted off during processing

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(Ijabadenyi 2007). This loss have been evaluated and reported by several workers (Dike and Sanni, 2010). The effect of fermentation on the nutritive value of foods is variable, although, there is evidence for significant or substantial improvements in the relative nutritive value, especially protein quality. The mechanism by which fermentation improves the levels of proteins and amino acids is not clear, but high concentrations of microbial proteins in this meal could be a contributory factor (Dike and Sanni, 2013).

According to Akande *et al.*; (2013), fermentation temperature and pH of the cornmeal play important role in the antibacterial properties of the cornmeal. They inhibit a number of gram-negative enthero-pathogens, thus improving the food microbiological quality and eliminating an important route for the transmission of infantile diarrheal pathogens (Dike and Sanni; 2010). It also increased resistance of the gut to bacterial infection (Blandino and Webb 2003). Lactobacilli ferment food and have metabolic products similar to indigenous gut flora (FAOSTAT, 2015). These metabolites produced, if consumed in fermented food, can augment protection against gut colonization by invading pathogens (Onyekwere and Akinrele 2003). It also meets the energy and nutrient requirements of young children. Not much information is available on the effect of its nutritive value, shelf life and possible therapeutic qualities.

Proteins are complex organic compounds or macronutrients that provide energy for the body (De vries *et al.*; 2006). It is an important component of energy cell in the body, especially the hair and nails (Akande *et al.*, 2013). Proteins is used by the body to build and repair tissues, enzymes, hormones and other body chemicals (Dike and Sanni, 2010) but the body does not store protein, so it needs to replenish when needed (Wakil and Daodu, 2011). Dehydration of ogi by drum or ray-drying has been shown to prolong its shelf-life (De vries et al.; 2006) but destroy heat-sensitive nutrients in ogi (Charavan and Kadem; 2013) and appreciable loss in available nutrient content of ogi (Oyarekua & Adeyeye, 2009). Bacteriocin produced by *Lactobaccillus* isolates were found to be active against common food borne pathogens including salmonella sp. (Onyekwere and Akinrele 2003). This bacteriocin also improved the shelf-life of 'jellied' ogi (Dike and Sanni 2010).

The aim of this study is to modify the processing of ogi with *Lactobaccillus plantarum*, with a view of enhancing its nutritive quality and shelf-life.

II. MATERIALS AND METHODS

Collection and Transportation of Samples

Fifty grammes of yellow maize variety were purchased locally and transported to microbiology laboratory of the Department of Microbiology, University of Calabar, Calabar for processing.

Media and Reagents Used

A selective culture medium, MRS agar (i.e. De Man, Rogosa and Sharpe agar) was used for growth of lactobacilli. The medium was prepared according to manufacturers' instruction.

Methods

Sample processing

Fifty grammes of sorted out fresh mature yellow maize grains were steeped (soaked) in 40L of sterile distilled water for 72hr to ferment. After which the surface water (corn steep liquor) was stored in a clean sterile container and used as starter culture for the production of *Lactobacillus plantarum*. The grains were wet milled with an electronic grinder, washed and sieved. The mixture was preserved in a sterile container for the sedimentation of the starch for future use.

Isolation of test organisms

The corn steep liquor was put into a 250ml conical flask with intermittent agitation. A ten-fold serial dilution was carried out according to the method described by (Wakil and Daodu 2011). A spread plate of MRS agar for lactic acid bacteria was made in triplicates and control and were later incubated at 37^0C for 24 hrs in anaerobic jar. Enumeration of bacterial isolates were carried out and representative colonies screened for pure culture. These were stored as stock cultures for further identification and characterization.

Proximate analysis of ogi or cornmeal

The protein, ash, fibre, carbohydrate, fat, moisture content of unfortified and fortified ogi was determined using the method described by David *et al;* (2016),.

Fortification of cornmeal (Ogi) with Lactobacillus plantarum

A loopful of *Lactobacillus plantarum* was used to enrich 50mg of ogi in order to fortify and enhance its protein limiting level. Fifty nutrients strains of *Lactobacillus plantarum* and five(5) nutrients strains from yeasts were selected from this lysine resistant culture using the process of amplification, capable of over-production of lysine and analysed for lysine production using the method described by Dike and Sanni, (2010).

III. RESULTS

The results of the proximate composition of the unfortified wet cornmeal (ogi) without *Lactobacillus plantarum* is presented in Table 1. The crude protein is 6.68%, while the carbohydrate content is 32.82% and moisture is40.40%. Similarly, the results of the fortified cornmeal (ogi), with L. *plantarum* is presented in table 2. Results showed an increase in crude protein content of 19.96%, carbohydrate 24.05% and moisture 43.00%. Results of unfortified dry cornmeal (ogi), showed crude protein content of 4.90%, carbohydrate 35.06% and moisture 15.32%.

TABLE 1. The proximate composition of unfortified wet cornmeal (ogi) without *Lactobacillus plantarum*.

Parameters	Composition %
Crude protein	6.68
Carbohydrate	32.82
Crude fibre	0.04
Ash	30.00
Moisture	40.40
Fat	0.50

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TABLE 2. The proximate composition of fortified cornmeal (ogi) with *Lactobacillus plantarum.*

Parameters	Composition %
Crude protein	19.96
Carbohydrate	24.05
Crude fibre	2.03
Ash	9.50
Moisture	43.00
Fat	7.50

TABLE 3. The proximate composition of unenhanced dry cornmeal (ogi) without *Lactobacillus plantarum*.

Parameters	Composition %
Crude protein	4.42
Carbohydrate	32.38
Crude fibre	1.20
Ash	10.0
Moisture	10.0
Fat	0.20

IV. DISCUSSION AND CONCLUSION

The microbiological quality of enhancement of the nutritive value of cornmeal (ogi) using *Lactobacillus plantarum* has been investigated using microbiological techniques.

Results obtained from the proximate analysis of the unfortified maize, revealed initial protein composition of 3.06%, which is quite low when compared with delay dietary requirement for protein. This work agrees with the results obtained by that substantial nutrient losses occur during the various steps of ogi processing. This work is also in agreement with results obtained by several workers (Blandino and Webb 2003) who reported, that the presence of protein in the testa and germ of the cereal grains, which are usually sifted off during processing may be responsible for the loss of protein or low content of protein by ogi.

Lactobacillus plantarum was isolated from the corn steep liquor which had a motley of fermenting organisms which included *Corynebacterium* sp and Aerobacter and lactic acid bacteria, different yeasts, such as *Candida mycoderina*, *Saccharomyces* cerevisiae and Rhodotonella and molds, such as Aspergilli, penicillium, Fasaruim and cephalosporium. These were the major organism responsible for the fermentation and nutritional improvement of the ogi. These organisms have also been reported by (Onyekwere and Akinrele 2003) as quality enhancer of nutritive value in fermenting medium. Results obtained in Table 2, revealed that *Lactobacillus plantarum* was the predominant organism in the fermentation of ogi responsible for lactic acid production. This result is also in agreement with that obtained by De vries *et al*; (2003) who opined that *Lactobacillus plantarum* due to its ability to withstand very low pH conditions, and improve the nutritional content and shelf-life of ogi, destroying harmful substances such as phytic acid therefore improving digestibility, was the best organism for this process. The result obtained in this work (Table 2) revealed that the fortified cornmeal (ogi) had a three-fold increase in the protein content of ogi, during the utilization of the mutants as starter cultures. The use of *Lactobacillus plantarum* for improving the nutritional value of ogi has been reported by Adeniji and Porter, (1978).

Results obtained from this work had revealed substantial losses of nutrients during the different processed steps of steeping, milling and sieving of ogi. It is therefore suggested that improved method of ogi preparation be adopted, by fortifying it with *Lactobacillus plantarum* rather than the traditional method, which normally leads to nutrient loss. The impact of this, fortification on weaning meal and food security of the world cannot be over-emphasised.

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