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## Effect of Processing Methods on the Microbiological Quality of Liquid Pap Ogi Prepared from Maize

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**Abstract:** The effect of processing methods on the microbiological quality of liquid pap ogi was observed. The major processing methods aimed at were fermentation for increasing the nutritional contents of maize sieving to attain quality ogi and the effect of hot water on the associated microorganisms and its effect on antinutritional factors for the safety and nutritional value for human consumption. Healthy corn kernels were steeped in distilled water for 72 h. One milliliter of the steeped kernel liquor was withdrawn every 12 h for pH and microbiological analysis. A decrease in pH from 5.01-3.25 was sequentially observed for the 72 h fermentation period. The total viable microbial counts in the steeping liquor increased alongside days of fermentation up to 48 h and thereafter dropped. Yeast counts was more in the steep liquor, followed by molds and bacterial counts coming least. The proximate composition of the corn slurry had moisture, fat ash, protein and carbohydrate contents (%) of 75.5, 1.75, 0.13, 3.33 and 19.3, respectively. Seven bacteria, three yeasts and five mould species were isolated and identified during this study. The liquid prepared by boiling for 5 min at 100°C had no microbial load, but the one prepared with hot water (100°C) without any extension of further boiling on fire, had microbial load of between 0.42-2.2 log (cfu) mL<sup>-1</sup>.

**Key words:** Quality, liquid pap, processing, microbiological methods

## INTRODUCTION

Pap ogi is one of the food products of maize (*Zea mays*) kernels. It is produced by soaking clean and healthy maize grains in water for 2-3 days. The grains are washed several times in water and grinded to obtain a paste. The paste is sieved to smooth slurry in clean water which is allowed to settle and the supernatant decanted. The settled mash-like substance (slurry) is the raw pap ogi. To prepared it of food, the slurry is mixed with hot water on stirring until it form a thick gel. This thick gel is referred to as the liquid pap ogi. Ogi as a weaning food for babies could be mixed with milk or grinded crayfish before fed to babies. Also as a very nutritive diet in Africa, for adults consume it with bean cake, fried ripe plantain, or mixed with little sugar and milk. The characteristic qualities of fermented foods including liquid pap (ogi) are of interest to researchers. Many fermented foods are known, while some serve as main meals, others are beverages or high prized food condiments. Those which serve as main meals and beverages are usually from fermentation of carbohydrate rich raw materials most of which have low protein and vitamin contents. Despite the dawn of science and technology in Africa, the production of fermented foods is still largely a traditional formula and done on homes in crude manner (Steinkraus, 1991; Awada *et al.*, 2005). The crude form of processing encourages high microbial contaminations which at times make some foods undesirable when organisms causing spoilage, food poisoning or food intoxication are present.

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Food poisoning and infections can lead to fatal consequences in infected individuals, therefore, efforts should be geared at preparing foods that are free of organisms that can lead to these conditions. The safety of fermented foods has been reviewed (Nout, 1991). Major risk factors include the use of contaminated raw materials, lack of pasteurization and use of poorly controlled fermentation conditions. Also, during fermentation, toxic fungal substances such as mycotoxins are degraded in fermented foods (Nakazato *et al.*, 1990).

The fermentation process of staples serves as a means of providing a major source of nourishment for large rural populations and contributes significantly to food security by increasing the range of raw material which can be used in the production of edible products. Fermentation enhances the nutrient content of foods through the biosynthesis of vitamins, essential amino acids and protein by improving protein quality and fibre digestibility. It also enhances micronutrients bioavailability and acids in degrading antinutrient factors (Gabriel and Akharaiyi, 2007; Achinewhu *et al.*, 1998). The use of biological and natural means in the improvement of nutritive value of food products have greater advantages over the use of chemical because biotechnological synthesized products are less toxic and environmentally friendly (Liu *et al.*, 1998; Motarjemi, 2002). This study therefore examines the effects of processing methods on the microbiological quality of liquid pap ogi prepared from corn kernels.

## **MATERIALS AND METHODS**

### **Processing of Corn Kernels into Liquid Pap (ogi)**

White corn kernels purchased at a local market in Akure, Nigeria, in the year 2006, was used for the study. After winnowing, two kilogram of the corn kernel was weighed into a plastic bucket, washed and rinsed several times. The rinsed kernels were covered with sterile distilled water in a plastic bucket container to ferment for three days. After fermentation, the soaked corn kernels were thoroughly washed and rinsed in water before grinding to coarse paste using a local grinder. The coarse paste was sieved with muslin cloth in a basin of water and was allowed to settle for about an hour to form smooth slurry. This was washed by exchanging water at intervals of 30 min for three times.

### **Preparation of Liquid Pap (ogi)**

The preparation was done using two methods. The first method involved the pouring of hot water (100°C) to some of the slurry until it gels. The second method was same as in method one but cooked further at 100°C for 5 min in a steam pot. The prepared liquid pap samples were covered immediately to avoid contamination from the environment.

### **Isolation and Enumeration of Microorganisms**

One milliliter of the steep liquor and the corn slurry were withdrawn and 10 fold dilution were made for microbiological analysis. Using nutrient agar and malt extract agar, 0.5 mL of the diluted samples were pour plated in duplicates. Also, 1 mL each of corn slurry, prepared liquid pap with 100°C and the boiled for 5 min after preparation were as well diluted and pour plated in duplicates. The nutrient agar plates were incubated aerobically at 37°C for 24 h while the malt extract agar plates were incubated at 28±2°C for 72 h. The respective resultant bacterial and fungal colonies, after incubation were enumerated with a gallenkamp colony counter and the counts were expressed in log (cfu) m<sup>-1</sup>.

The streak plate technique was used to purify the bacteria isolates while cork borer transfer of mycelium was used to purify the fungi isolates (Gabriel and Akharaiyi, 2007). The purified

bacteria isolates were identified based on the criteria of Holt *et al.* (1994), yeast were identified on the criteria (Barnet *et al.*, 1983; Van Rij, 1984) and moulds based on the criteria of Rhode and Hartman (1980).

### Proximate Analyses of Corn Steep Liquor and Corn Slurry

The fat contents of the samples was determined by Gerber method (Marshall, 1992). Protein was determined using the Kjeldhal procedure (Marshall, 1992). The crude fibre, moisture, ash and carbohydrate in the samples were evaluated with the standard methods of AOAC (1990).

pH was estimated with pH meter (Griffin England) at 28°C. All analysis were run in duplicates.

## RESULTS

Bacteria, yeasts and mold counts increased tremendously alongside hours of fermentation till 48 h and decreased thereafter till end of fermentation (72 h). The least microbial counts was recorded at 0 h of fermentation where it was  $1.6 \pm 0.4$ ,  $1.2 \pm 0.1$  and  $2.6 \pm 0.1$  log (cfu) mL<sup>-1</sup>, respectively for bacteria, yeast and molds. The highest microbial counts was observed at 48 h of fermentation ( $4.6 \pm 0.1$ ,  $4.7 \pm 0.5$  and  $2.7 \pm 0.1$ ) log (cfu) mL<sup>-1</sup> also respectively for bacteria, yeast and molds (Table 1).

Sequential decrease in microbial load was observed from the corn slurry, prepared pap with 100°C and the boiled further for 5 min (Table 2).

The microorganisms isolated and identified during the study are *Streptococcus lactis*, *Bacillus megaterium*, *Micrococcus reseau*, *Aeromonas aerogenes*, *Lactobacillus* sp., *Corynebacterium fermentum*, *Staphylococcus aureus*, *Saccharomyces cerevisiae*, *Pediococcus* sp., *Candida stellata*, *Penicillium italicum*, *Aspergillus flavus*, *Aspergillus niger*, *Rhizopus stolonifer* and *Fusarium* sp.

The proximate composition of the samples showed higher fat contents (3.45%) in the unfermented corn floor than corn steep liquor (2.28%) and corn slurry (1.75%). Higher protein content (5.14%) was observed in the corn steep liquor than the corn slurry (3.33%). However, carbohydrate content was observed to be more in the corn steep liquor (38.53%), followed by the corn slurry (19.31%) and was least in the unfermented corn flour (11.14%) (Table 3).

Table 1: Microbial counts in steep liquor during fermentation

| Hour | pH   | Bacteria (log cfu mL <sup>-1</sup> ) | Yeast (log cfu mL <sup>-1</sup> ) | Mold (log spore mL <sup>-1</sup> ) |
|------|------|--------------------------------------|-----------------------------------|------------------------------------|
| 0    | 5.10 | $1.6 \pm 0.4$                        | $1.2 \pm 0.1$                     | $2.6 \pm 0.1$                      |
| 12   | 5.01 | $2.2 \pm 0.2$                        | $2.3 \pm 0.0$                     | $2.6 \pm 0.3$                      |
| 24   | 4.84 | $2.4 \pm 0.5$                        | $3.5 \pm 0.3$                     | $2.5 \pm 0.7$                      |
| 36   | 4.63 | $3.5 \pm 0.1$                        | $3.5 \pm 0.7$                     | $2.6 \pm 0.5$                      |
| 48   | 4.51 | $4.6 \pm 0.1$                        | $4.7 \pm 0.5$                     | $2.7 \pm 0.1$                      |
| 60   | 3.26 | $3.0 \pm 0.2$                        | $3.5 \pm 0.2$                     | $1.8 \pm 0.3$                      |
| 72   | 3.05 | $2.8 \pm 0.3$                        | $3.0 \pm 0.0$                     | $1.6 \pm 0.4$                      |

Table 2: Microbial counts (cfu mL<sup>-1</sup>) in corn slurry, prepared pap with 100°C and the boiled further for 5 min

| Samples              | Bacteria      | Yeast         | Molds         |
|----------------------|---------------|---------------|---------------|
| Corn slurry          | $1.2 \pm 0.5$ | $2.2 \pm 0.4$ | $2.1 \pm 0.3$ |
| Prepared pap (100°C) | $0.8 \pm 0.8$ | $1.8 \pm 0.2$ | $0.4 \pm 0.5$ |
| Boiled for 5 min     | 0.0           | 0.0           | 0.0           |

Table 3: Proximate composition of the corn steep liquor, corn slurry and unfermented corn flour (%)

| Samples                | Moisture | Fat  | Ash  | Fibre | Protein | CHO   |
|------------------------|----------|------|------|-------|---------|-------|
| Corn steep slurry      | 100.00   | 2.28 | -    | -     | 5.14    | 38.53 |
| Corn slurry            | 85.50    | 1.75 | 0.13 | 0.15  | 3.33    | 19.31 |
| Unfermented corn flour | 9.22     | 3.45 | 1.30 | 4.73  | 11.90   | 11.14 |

## DISCUSSION

The fermentation process facilitates the multiplication of microorganisms and their activities in softening the corn kernels for the possible process to liquid pap ogi. The microbial load observed during the study was envisaged hence contaminations from different sources were involved, majorly from the corn kernels, human and environment during processing. It could also be due to the contaminants from the grinding engine which was only washed before use. The sequential increase of microbial load from beginning of fermentation to the 48 h of fermentation could lead to the nutrients being released from the corn kernels to the steeping liquor, low lactic acid concentration and the absence of other inhibitory substances in the steep liquor. The dominance of yeast in the corn steep liquor could be as a result of low oxygen tension under which the fermentation was carried out (under cover). This observation is in accordance with Shuan *et al.* (1990) who reported that a low oxygen tension favours growth of yeasts. The fermentation of the corn kernels, attracted diverse microflora of bacteria, yeast and mold species. This is however a general feature of the fermentation of plant materials, whereby the diverse microflora, contribute their activities in reducing microbial load, increasing values in some vital mineral elements (Oboh *et al.*, 2002) useful for the body, reducing antinutrient substances (Achinewhu *et al.*, 1998) harmful to the body system and addition of aroma taste and texture for desired and acceptable products.

Hence liquid pap ogi, is a product of fermentation by different microorganisms with diverse metabolic activities, organic substances will be released from the corn kernels to reduce their nutritional measures. This is the reason of the low nutrient compositions recorded. Much of the required nutrients was released in the steep liquor which however is not of any dietary value compared to the role liquid pap ogi plays in African diet. Therefore, the loss in nutrient values of the corn kernels during fermentation, is an unavoidable step in processing, if a desired product of ogi must be attained. The results of the proximate analysis of this research was due to the activities of the microbial enzymes during the fermentation process (Rombouts and Nout, 1995). Hence these microbial enzyme activities causes reduction in fibre content and increase in both reducing and total soluble sugars (Odetokun, 2000), this could lead to the increase in carbohydrate value. With this result of proximate analyses, this work agrees with the previous findings of Evans *et al.* (2003) and Oboh and Akindahunsi (2003). However, from the sieving of the grinded corn kernels to preparation with hot water, sequential microbial reductions in population was observed. These acknowledged and emphasized that every stage involved in ogi is important as a vital role and must be adopted for a quality ogi product.

The decrease in microbial load observed, after 48 h of fermentation, might be as a result of the decreased pH status and the presence of lactic acid bacteria at that period of fermentation. Also, the fermentable sugars in the corn kernels would have been fermented by lactic acid bacteria and could have increased the amount of lactic acid in the corn steep liquor, to serve as an inhibitory substances to other microorganisms of less acid tolerance. Also, the decrease in pH observed in steep liquor could be associated with the production of organic acid and other acid metabolic end product which has culminated to effect the pH reduction (Gabriel and Akharaiyi, 2007).

## CONCLUSION

Ogi is a common weaning food in all parts of Nigeria, thus its importance cannot be ignored. Its daily research and findings will improve the hygienic methods of processing and preparations. Some enterotoxins produced by some food poisoning organisms are heat stable and preparing ogi with hot (100°C) and boiling further for 5 min will enhance safety as it will destroy any existing organism and toxins produced. Also, it will enhance the shelf life of the products.

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