Oriental Journal of Chemistry Vol. **25**(3), 471-476 (2009)

A comparative study on the effect of traditional and improved methods of fermentation in the production of Ogi food

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(Received: July 11, 2009; Accepted: August 04, 2009)

ABSTRACT

Traditionally applied spontaneous fermentation was compared with the use of starter cultures to initiate fermentation after dry milling and sterilizing at 121^{0}C for 10 minutes. Lactic acid bacteria (LAB) populations comprised 80% of the total viable bacteria and remained prominent throughout the fermentations, while number of moulds declined as the fermentation progressed. The fermentation method involving the application of starter culture helps most to control the prevalence of coliforms and pathogens because of the rapid decrease in pH. Lactic acid bacteria, such as *Lactobacillus plantarum* and *L. brevis*, were isolated at different processing stages of ogi. Highest increase in acidity and protein was observed in LAB and *Aspergillus niger* fermented samples respectively.

Keywords: Spontaneous (traditional), biotechnology, fermentation techniques, dry milling, ogi, starter cultures.

INTRODUCTION

Ogi is a popular fermented food produced by grinding cereals such as maize, sorghum or millet, sieving it wet and then allowing the starch to sediment and ferment in a liquid menstrum. The sediment is known as ogi which is then boiled to form a boiled aqueous porridge known as “ogi” porridge (Muller, 1970).

In Nigeria and some other parts of the world, ogi is used as weaning food for infants, breakfast food for adults and application in traditional medicine (Antai and Nzeribe, 1992). Traditional methods of preparation of ogi are restricted to definite localities and ethnic groups. Some cereal based fermented foods around the world which have been studied include tarhana, widely consumed in the Middle East and Turkey; donkunnu, a Ghananian dish; masa, consumed in India and Mexico; mawè, a popular food among the Beninese and Boza, a traditional fermented beverage from whole-wheat grain found in Bulgaria among others (Ali *et al.,* 2008; Abdurahaman and Kolawole, 2006; Nkam and Malleshi, 1998; Mathurin *et al.,* 1998; Velitchka *et al.,* 2001).

Ogi fermentation has been established from time immemorial by the traditional spontaneous fermentation technique (Onyekwere *et al.,* 1989). The fermentation process is initiated as a result of chance inoculation by microorganisms from the environment (Odunfa and Adeyele, 1985; Steinkraus, 1996). Although, very convenient, there are concerns about its reliability and safety especially when spontaneous fermentation is used during large-scale production. The presence of unspecified microorganisms complicates the control of the fermentation process (During natural / traditional fermentation fungi which produces mycotoxins contaminating food, food poisoning flora and coliforms may grow with tactics) (Olukoya

et al., 1994; Olasupo *et al.,* 1997; Teniola and Odunfa, 2001). The traditional method of ogi production is labour intensive, time consuming and have low productivities, with success depending upon observation of good manufacturing practice. Several traditional fermentations from Asia have been upgraded to high technology production system because of the strong research tradition in fermented food technology. Their experience can be used to upgrade some African's indigenous fermented foods (Achi, 2005).

There are many studies about different fermentation techniques during ogi production such as accelerated batch fermentation, starter culture fermentation and dry milling before fermentation with the aim of replacing the traditional (spontaneous) fermentation technique. However, there is no much information on dehulling and dry milling of maize grains before fermentation for ogi production. The aim of this work was to investigate the effect of starter culture fermentation on ogi production after dehulling and dry milling of maize grains in comparison with the traditional (spontaneous) fermentation technique.

MATERIAL AND METHODS

Materials

Dry yellow maize grains were purchased from Oja Oba market in Akure, Ondo State, Nigeria. Grains were thoroughly cleaned and screened to remove broken and cracked grains, dust and other foreign materials

Ogi fermentation

Fermentation experiments for each technique studied were prepared in duplicate. The washed grains were processed to ogi by steeping in water (1:4 kg/L) for 24 h as earlier described (Onyekwere *et al.,* 1989; Teniola and Odunfa 2002) except that the steep water was not discarded to avoid losses of water soluble nutrients and a Waring blender was used for milling. The wet-milled maize was hand sieved. Natural microûora from the fermenting substrates was allowed to initiate the spontaneous fermentation as done traditionally. For second technique dried maize grains were dehulled and milled into flour with a hammer mill. The maize flour was then parboiled at 121°C for 10 minutes to sterilize it. Pure and combination of cultures previously isolated from fermenting ogi was used at 2.5mL (10^9 cfu/g)as inoculum for the starter culture fermentation. Samples were aseptically withdrawn at daily intervals for 4 days of fermentation. Microbial enumerations were carried out from freshly drawn samples while pH and total titratable acidity were determined from samples stored at -20°C.

Microbiological analyses

Daily changes in the microbial population (cfu/ml) of the total viable bacteria, lactic acid bacteria (LAB) and fungi were determined using standard plate count agar (Merck), de Man, Rogosa and Sharpe(MRS) agar (Merck) and malt extract agar (MEA, Merck), respectively .Samples were enumerated by using appropriate sterile dilution and spread plate methods. The fungal plates were incubated at 25°C for 2-5 days while the bacterial cultures were incubated at temperatures ranging between 30 and 35°C for 1-2 days. MRS agar was incubated at 25°C for 2-5 days while the bacterial cultures were incubated at temperatures ranging between 30 and 35°C for 1-2 days. MRS agar was incubated under anaerobic conditions simulated using a H_2/CO_2 generating kit (Oxoid) according to the manufacturer's instructions. Classification of isolates was based on the established methods using important biochemical and morphological observations and tests (Buchanan and Gibbons, 1974; Schillinger and Lucke, 1987; Collins *et al.,* 1989; Wood and Holzapfel, 1995). Identification of the yeast isolates was confirmed using standard identification methods.

pH and total titratable acidity

A mixture of 10 g sample and 90 ml distilled water was used for pH determination as described by Mensah *et al.* (1995). Total titratable acidity was determined by titrating 20 mL of the same sample against 0.1 M Sodium hydroxide (Antony and Chandra, 1997). The relative lactic acid content present was determined as percentage lactic acid on a dry matter basis (Oyewole and Odunfa, 1990).

Chemical analyses

The moisture, protein N X 6.25, lipid, and ash contents of the ogi samples were determined

using relevant methods described previously (AOAC, 1995).

Statistical analysis

All determinations were done in triplicate. One-way analysis of variance was used to produce least significant difference (LSD) (Gomez, 1984).

RESULTS

Five microorganisms were identified from the spontaneous (traditional) fermentation of ogi from maize raw material. They include: *Lactobacillus plantarum*, *L. brevis*, *Candida sp.*, *Aspergillus niger* and *Penicillium notatum*. Their frequency of occurrence is shown in Table 1. The lactic acid bacterial groups were prevalent through out the spontaneous fermentation of ogi while *Candida* yeast was detected at the later stage of the fermentation (72h) and then remained till the end of the fermentation. The fermentation decreased the number of moulds after their initial increase with in the first 24h of steeping.

Table 1: Frequency of occurrence of microorganisms isolated during spontaneous (traditional) fermentation of ogi

Organism	% Occurrence
Lactobacillus plantarum	72
Lactobacillus brevis	69
Candida sp.	46
Aspergillus niger	48
Penicilium notatum	23

Changes in pH and total titratable acidity during the different fermentations are represented in Figure 1and 2. On the basis of changes in pH and titratable acidity the two fermentation techniques studied showed similarity with decrease in pH and increase in titratable acidity. However the pH of samples fermented using the starter cultures were relatively lower than the pH of the traditionally fermented ogi at 24 and 48 h of steeping. Reduction of pH from levels 5.2, 5.1 and 5.0 to pH 4.3, 4.0 and 4.2 were observed in the spontaneous and starter cultures fermentation.

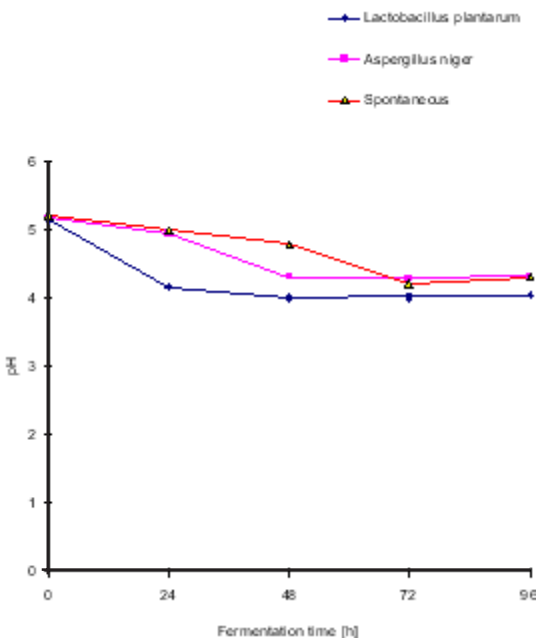

Fig. 1: Changes in pH during ogi production with maize by spontaneous (traditional), *L.plantarum* and *A.niger* starter culture fermentation method

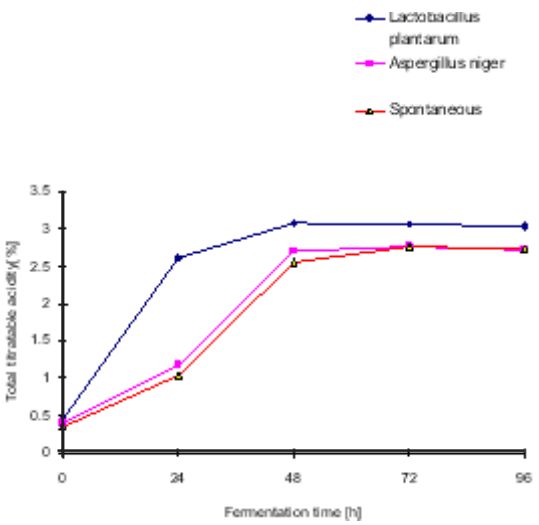

Fig. 2: Changes in total titratable acidity level during ogi production with maize by spontaneous (traditional), *L.plantarum* and *A.niger* starter culture fermentation method

Table 2: Proximate composition of ogi produced by spontaneous (traditional) and starter cultures fermentation

Sample	%Ash	% Protein	%Fat	%Moisture	% Carbohydrate
AN Fermented	0.2±0.06	4.0±1.20	1.2±0.80	11.8±3.31	82.4±4.00
LP Fermented	0.3±0.03	2.3±0.72	1.8±0.67	10.9±1.51	85.5±2.64
SP Fermented	0.3±0.01	3.8±0.20	1.1±0.99	11.7±1.57	82.8±3.03

Values are mean of three independent determinations

Means with different letters in the same column are statistically different at $P<0.05$

AN *Aspergillus niger*, LP *Lactobacillus plantarum* and SP Spontaneous

Table 2 shows the proximate composition of the fermented ogi from both traditional and starter culture fermentation. Crude fibre was completely absent in the dehulled samples. The changes in percentage ash, protein and lipid were not significantly ($P<0.05$) different but they were notable. There was a decrease in the protein, ash and fat contents in the fermented samples compared with the whole maize grain (Table 3). The sample fermented with *Aspergillus niger* had the highest protein content (4.0%) while the highest lipid content (1.82%) was in the sample fermented with *L. plantarum*.

Table 3: Proximate composition of raw maize

Composition	% present
Moisture	12.2
Protein	8.4
Fat	4.5
Ash	1.1
Crude fibre	1.3
Carbohydrates	73.9
Calories per 100 g	370

Sources: Ranhotra, 1985; Saldana and Brown, 1984

DISCUSSION

The occurrence of *Lactobacillus plantarum, L. brevis, Candida sp.*, *Aspergillus niger* and *Penicillum notatum* during the steeping and souring of maize for ogi production have been reported (Akinrele, 1970; Odunfa and Adeyele, 1985; Adegoke and Babalola, 1988; Muthurin *et al.,* 1998). The high levels of LAB in the fermentations studied confirm the relevance of this group in fermentation as reported in ogi and related products (Hounhouigan *et al.,* 1993; Halm *et al.,* 1996; Teniola and Odunfa, 2002; Panda *et al.,* 2008). The high levels of total titratable acidity recorded in the traditional and LAB fermented samples could be attributed to the high acid production as indicated by the reduction in pH as well as bacteriocin production by the isolates of the LAB cultures imply a possible role in ogi biopreservation and improvement of product shelf-life (Holzapfel *et al.,* 1995; Holzapfel, 1997). One or more lactic acid bacterial metabolites such as lactic acid, acetic acid, hydrogen peroxide, lactoperoxidase system with H_2O_2, lysozyme, reuterin, diacetyl, fatty acids and bacteriocins may contribute to the inhibition of many pathogens and spoilage organisms and also of mycotoxin-forming moulds (Holzapfel *et al.,* 1995; Franz *et al.,* 1997). The presence of hull containing mostly fibres and insoluble non-starch carbohydrates from the spontaneous fermenting sample must have been responsible for the higher pH between the 24 and 48 hours of steeping. Acidification and $pH < 5$ observed from all the fermenting samples after 48 h is necessary to avoid problems with contaminating spoilage or pathogenic organisms, which might counteract the fermentation process, especially in the early stages. The growth of the LAB group must have enhanced the development of the Candida yeast which was detected at the 72 h and remained till the end of the fermentation. Candida has been reported to contribute to the flavour development in ogi (Akinrele, 1970; Adeyemi, 1983). The dehulling and drymilling of the maize grains before fermentation may be responsible for the decrease in percentage ash, protein and fat in the starter cultures fermented

samples (Banigo *et al.,* 1974).Decrease in protein content during ogi production has earlier been reported (38, 39 and 37% decrease)(Mathurin *et al.,* 1998; Adewusi *et al.,* 1991; Hounhouigan *et al.,*1993b). The lower fat and ash contents in the ogi samples than raw grains (Table 2 and 3) is an indication that partial degermination must have occurred during processing (Hounhouigan *et al.,*1993a).

CONCLUSION

In this study, the effect of dehulling and dry milling of maize grains before starter culture fermentation was studied. Ogi produced using LAB starter cultures was sourer than the ogi produced using the traditional (spontaneous) method of fermentation .The short period of acidification (24-48h) coupled with the increased surface area of the dehulled and milled maize grains must have been responsible for the sourer taste in the LAB fermented ogi. Further research work is therefore required to improve on the nutrient losses during dehulling and dry milling of maize before starter cultures fermentation.

ACKNOWLEDGMENTS

Special thanks to my research group members for their support towards this research.

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