ISSN NO. 2320-5407

Journal homepage: http://www.journalijar.com

INTERNATIONAL JOURNAL OF ADVANCED RESEARCH

RESEARCH ARTICLE

FERMENTED SPROUTED AND UNSPROUTED MAIZE FOR OGI PRODUCTION

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Manuscript Info

Manuscript History:

Received: 11 November 2013
Final Accepted: 22 November 2013
Published Online: December 2013

Key words:
fermentation, sprouted, unsprouted, *ogi*

Abstract

Ogi is an important weaning food for infants as well as a dietary staple for adults in Nigeria produced by spontaneous fermentation of maize or sorghum. This study was aimed at comparing *ogi* produced from sprouted and unsprouted maize samples fermented for 96 hours. *Lactobacillus plantarum, L. fermentum, Corynebacterium* spp, *Micrococcus luteus, Staphylococcus aureus, Aspergillus niger, Rhizopus nigricans* and *Saccharomyces cerevisiae* were isolated from both samples. However *Pediococcus acidilactici* and *Candida crusei* occurred in unsprouted sample only while *Leuconostoc mesenteroides, Lactobacillus brevis* and *Saccharomyces pastorianus* were isolated in sprouted sample. Both substrates were dominated by *Lactobacillus* and *S. cerevisiae* while *M. luteus, Staphylococcus aureus* and *Aspergillus niger* appeared on the earlier days of fermentation. Bacterial and fungal counts increased in both samples with the highest counts in sprouted samples. The pH values of *ogi* from sprouted and unsprouted maize decreased from 5.8 to 3.2 and 5.7 to 3.7 while their total titratable acidity increased from 1.3% to 4.9% and 1.5% to 4.1% respectively. Moisture contents increased in both samples after fermentation with the higher contents in sprouted slurry. Sprouted slurry had higher protein (14.4%) and fat (3.7%) contents than the unfermented maize having 9.1% and 2.2% while the unsprouted slurry had the least contents of 8.5% and 1.5% respectively. However, unsprouted slurry contained higher crude fibre and carbohydrate contents and lower ash content than the sprouted slurry after fermentation respectively but all were lower than contents in whole maize grain. Sprouted slurry was rated better in terms of colour, taste, flavour and overall acceptability than the unsprouted slurry.

Introduction

Cereals are grasses are cultivated because of their edible grains. They are grown in greater quantities and provide more food energy worldwide than other crops and are therefore called staple crops (Chavan and Cadam, 1989). In their natural form (as in whole grain) they are a rich source of vitamins, minerals, carbohydrates, fats, oils and protein. Maize (*Zea mays)* is one of the world's most important cereal crops primary grown for human consumption. It can be boiled, roasted or processed into other food e.g. *tortillas, pozol, kenkey* (Adesokan *et al*., 2010) .

Fermentation has been reported to improve the nutritive value of their end products; it provides a way to food preservation, improvement of appearance and taste of some foods and reduces the energy required for preparing food, safer food products and enhancement of nutritive value (Ohenhen and Ikenebomeh, 2007; Osungbaro, 2009).

Ogi is a fermented cereal product which is consumed across West African countries (Ohenhen and Ikenebomeh, 2007). *Ogi* is known by various names such as *ogi* and *akamu* by the Yoruba and Igbo tribes of Nigeria respectively while it is called *akosa* in Ghana.ogi could either be consumed as porridge (pap) or as a gel-like product (*agidi*) in some West African countries (Ijabadeniyi, 2007). The pap could serve as a breakfast meal, food for the sick or weaning food for the infants. It could be prepared from maize (*Zea mays*), sorghum

(*Sorghum* spp) also known as guinea corn or millet (*Pennisetum typhoideum*). The colour of *ogi* depends on the colour of the type of cereal used; cream for maize, reddish brown for sorghum and dirty grey for millet (Adebolu *et al*., 2007; Akanbi *et al*., 2010) resulting in various colours.

Several researches have been carried out on various aspects of *ogi* such as improvement on the shelf life (Adesokan *et al*., 2010), the use of starter cultures (Teniola *et al*., 2005) and co-fermentation with legumes (Oyarekua and Adeyeye 2009; Zakari *et al*., 2010). However, there is no information on the use of sprouted maize for ogi production. Therefore, this work investigated the effect *ogi* produced from fermented sprouted and unsprouted maize grains on the microbial contents, nutrient value and organoleptic value of the product.

Materials and Methods

Collection and preparation of sample

Yellow variety of maize used for the study was purchased from Ibaka market in Akungba-Akoko, Ondo state, Nigeria. The grains were sorted to remove dirts and spoilt ones from the healthy ones. The maize grains were divided into two portions of 1kg each. One portion was spread on clean metal trays and wet with water for 72 hours to enhance sprouting. One kilogram of each sample was separately soaked (or steeped) in four litres of sterile distilled water for 96 hours (Teniola *et al*., 2005). They were then separately wet milled in a commercial milling machine with addition of 2 litres of sterile water each. The milled grains were then sieved using a clean muslin cloth while the resulting *ogi* slurry was collected in a clean plastic bucket for analyses.

Isolation of Microorganisms

Stock culture was prepared from each slurry on daily basis by aseptically adding 5 ml of the sample into sterile 250 ml conical flask containing 45 ml of sterile distilled water. The mixture was shaken to form a suspension. Serial dilutions of each slurry were carried using the Ten-fold dilution method and pour plate plating method using Nutrient agar for bacteria, MRS agar for lactic acid bacteria and Sabouraud dextrose agar for fungi (Oxoid) under aseptic conditions. Bacterial plates were incubated at 37^{o}C for 24hours while fungal plates were incubated at 25^{o}C for 3 days. Total plate counts were done and representative colonies were isolated and later subcultured by repeated streaking in order to obtain pure cultures. The pure cultures were transferred into agar slants and stored in the refrigeration.

Identification of Isolates

Inocula were aseptically transferred from each slide into plates of respective media using streak plate technique. Bacterial plates were incubated at 37^{o}C for 24 hours while fungal plates at 25^{o}C for 72 hours. A 24 hour old culture was prepared from each plate for identification purposes. Bacteria isolates were identified based on their cultural characteristics, Gram staining reaction and various identification tests Isolates were identified according to Holt *et al*. (1994). Fungal isolates were identified through a range of parameter including lactophenol-blue staining of young fungal isolate culture prior to microscopy. Macroscopic examination of the cultural characteristics as well as the biochemical tests of the fungal isolates was also used (Alexopolous and Mims, 1979).

Total Titratable Acidity (TTA) and pH

Total titratable acidity was determined daily by titrating 20 ml of the sample against 0.1 M NaOH into which two drops of phenolphthalein were added until reaction mixture turned pink. The pH of the slurry was determined using Ph meter (Hanna Instruments, 8520) (Mensah *et al*.,1995).

Proximate Analysis

Proximate compositions of the samples were carried out according to the AOAC (2006) methods for moisture ash, fiber and carbohydrate contents. Crude protein was determined using Kjeidahl method and fat content using Soxhlet apparatus.

Sensory evaluation

Sensory evaluation of the gruels was carried out by a 20 member panel consisting of students of the Department that were familiar with *ogi*. The parameters used include colour, texture, taste flavour and overall acceptability. The ratings were presented on a 7 point hedonic scale ranging from7 = highly acceptability to 1= low acceptability.

RESULTS

Microorganisms isolated from both samples include *Lactobacillus plantarum, L. fermentum, L. brevis, Leuconostoc mesenteroides, Pediococcus acidilactici, Micrococcus luteus, Staphylococcus aureus, Corynebacterium* spp, *Aspergillus niger, Candida crusei, Saccharomyces cerevisiae, S. pastorianus* and *Rhizopus nigricans. Leuconostoc mesenteroides, Lactobacillus brevis* and *Saccharomyces pastorianus* occurred in unsprouted sample only while *Pediococcus acidilactici* and *Candida crusei* were isolated in sprouted sample

only.

Lactobacillus species and *Saccharomyces cerevisiae* were the most predominant bacterium and fungus isolated from both samples respectively. *Micrococcus luteus*, *Staphylococcus aureus*, *Aspergillus niger*, *Rhizopus nigricans* and *Aspergillus niger* were isolated in few numbers at the earlier days of fermentation in both samples (Table 1).

Bacterial and fungal counts increased in both samples but higher in sprouted sample (bacterial count, 9.37 log cfu/ml; fungal count, 4.79 log cfu/ml) than the unsprouted sample (bacterial count, 8.44 log cfu/ml; fungal count, 4.41log cfu/ml) (Tables 2 and 3).

The total titratable acidity of the sprouted slurry increased from 1.6% to 4.1% while the unsprouted sample increased from 1.3% to 4.9%. However, their pH values decreased from 5.7 to 3.7 and 5.8 to 3.2 respectively (Table 4).

The result of proximate composition (Table 5) revealed that the moisture contents of the fermented samples increased from 11.2% in unfermented maize sample to 32.6% and 34.5% in unsprouted slurry and sprouted slurry respectively after fermentation. Protein contents of the fermented unsprouted sample decreased (8.5%) while the content increased in sprouted sample (14.4%) compared to the unfermented maize grains (9.1%). The same trend was also observed in the fat contents of the samples in which the whole maize grains, fermented sprouted slurry and the unsprouted slurry contained 2.2%, 1.5% and 3.7% respectively. The highest ash content was found in raw maize (2.9%) followed by the sprouted sample (1.0%) while the lowest was obtained in unsprouted sample (0.5%). The crude fibre was higher in raw maize (2.0%) but not significantly higher than the fermented unsprouted sample (1.7%) but however significantly higher than the sprouted sample (1.2%). Similar trend was also observed in the carbohydrate content with significantly higher content in whole maize grain sample (72.6%) than the fermented samples (unsprouted slurry, 55.2%; sprouted slurry, 44.2%).

Fermented sprouted maize slurry was scored higher than the unsprouted slurry in all the sensory evaluation parameters except in texture (Table 6).

Table 1: Occurrence of microorganisms in fermenting sprouted and unsprouted maize slurry for ogi production.

Isolates	Sample	1	2	3	4
Lactobacillus plantarum	Sprouted	-	-	+	+
	Unsprouted	-	+	+	+
Lactobacillus fermentum	Sprouted	-	+	+	+
	Unsprouted	-	+	+	+
Leuconostoc mesenteroides	Sprouted	-	-	-	-
	Unsprouted	-	+	+	+
Lactobacillus brevis	Sprouted	-	-	-	-
	Unsprouted	+	+	+	+
Pediococcus acidilactici	Sprouted	-	+	+	+
	Unsprouted	-	-	-	-
Corynebacterium spp	Sprouted	-	+	+	+
	Unsprouted	-	+	+	-
Staphylococcus aureus	Sprouted	+	-	-	-
	Unsprouted	+	-	-	-
Micrococcus luteus	Sprouted	+	+	-	-
	Unsprouted	+	-	-	-
Aspergillus niger	Sprouted	-	+	-	-
	Unsprouted	+	-	-	-
Candida krusei	Sprouted	+	-	-	-
	Unsprouted	-	-	-	-
Rhizopus nigricans	Sprouted	+	+	-	-
	Unsprouted	+	-	-	-
Saccharomyces cerevisiae	Sprouted	-	+	+	+
	Unsprouted	-	+	+	+
Saccharomyces pastorianus	Sprouted	-	-	-	-
	Unsprouted	-	-	+	+

Table 2: Total viable count of bacteria from fermenting s fermented sprouted and unsprouted maize slurry for ogi production.

Fermentation time (Days)	Sprouted Maize (cfu/ml)	Unsprouted maize (cfu/ml)
1	$2.5 \times 10^5 \pm 0.56$	$2.5 \times 10^6 \pm 0.24$
2	$3.3 \times 10^7 \pm 0.75$	$3.1 \times 10^6 \pm 0.73$
3	$4.5 \times 10^8 \pm 0.63$	$4.3 \times 10^7 \pm 0.77$
4	$2.3 \times 10^9 \pm 0.34$	$2.3 \times 10^8 \pm 0.53$

Table 3: Total viable count of fungi from fermented fermenting sprouted and unsprouted maize slurry for ogi production

Fermentation time (Days)	Sprouted Maize (sfu/ml)	Unsprouted maize (sfu/ml)
1	$1.8 \times 10^3 \pm 0.24$	$3.1 \times 10^3 \pm 0.16$
2	$1.7 \times 10^4 \pm 0.34$	$5.3 \times 10^3 \pm 0.24$
3	$2.1 \times 10^4 \pm 0.39$	$1.6 \times 10^4 \pm 0.32$
4	$4.6 \times 10^4 \pm 0.49$	$2.6 \times 10^4 \pm 0.08$

Table 4: Total titratable acidity and pH of fermented sprouted and unsprouted maize for *ogi* production

Fermentation time (Days)	TTA (%)		pH	
	Sprouted maize	Unsprouted maize	Sprouted maize	Unsprouted maize
1	1.3 ± 0.02	1.6 ± 0.02	5.8 ± 0.1	5.7 ± 0.2
2	2.9 ± 0.04	2.5± 0.02	4.5 ± 0.2	4.7 ± 0.4
3	4.2 ± 0.21	3.8 ± 0.06	4.0 ± 0.2	4.2 ± 0.3
4	4.9 ± 0.04	4.1 ± 0.08	3.2 ± 0.4	3.7 ± 0.2

Table 5: Proximate composition of fermented sprouted and unsprouted maize slurry for ogi production

Composition	Whole maize	Sprouted slurry (%)	Unsprouted slurry (%)
Moisture content	11.2 ± 0.8	34.5 ± 2.6	32.6 ± 2.2
protein content	9.1 ± 0.4	14.4 ± 1.2	8.5 ± 0.2
Fat (ether extract)	2.2 ± 0.2	3.7 ± 0.2	1.5 ± 0.1
Total ash	2.9 ± 0.1	1.0 ± 0.1	0.5 ± 0.1
Crude fibre	2.0 ± 0.1	1.2 ± 0.1	1.7 ± 0.2
Total carbohydrate	72.6 ± 4.0	44.2 ± 4.2	55.2 ± 5.0

Table 6: Organoleptic properties of fermented sprouted and unsprouted of *ogi* slurry production

Sample	Colour	Texture	Taste	Flavour	Overall acceptability
Sprouted slurry	5.6 ±0.2	4.8 ±0.3	5.4 ±0.3	5.7 ±0.2	5.6 ±0.2
Unsprouted slurry	4.4 ±0.2	5.2 ±0.2	4.8 ±0.2	4.8 ±0.4	5.2 ±0.3

Discussion

Similar microorganisms were implicated in the fermentation of sprouted and unsprouted maize grains for *ogi* production. Various species of lactic acid bacteria have been implicated during production of fermented foods (Kolawole *et al*., 2007). David and Aderibigbe (2010) isolated *Lactobacillus*, *Streptococcus* and *Pediococcus* during the fermentation of melon seed for *ogiri* production. Dike and Sanni (2010) also reported the

involvement and predominance of various lactic acid bacteria while fermenting maize for agidi production. The association of yeasts has been confirmed in wide varieties of traditional fermented foods and beverages (Sanni 1993; Faid *et al*., 1993; Omoya and Akhairayi, 2008). *Mucor* and *Aspergillus* which were isolated at earlier hours had been reported to be mycoflora of some seeds under storage and have been known to be surface contaminants of most agricultural products. Some of them have been reported to cause decay of agricultural produce thereby reducing their market and nutritional value (Amusa *et al.,* 2002). Higher microbial counts in ogi produced from the sprouted sample could be as a result of malting process which enhanced the development of the natural microbial flora during the fermentation process. This was similar to the findings of Michodjehoun *et al*. (2005) while fermenting sorghum for *gowe* production. Besides, higher total titratable acidity and subsequent pH in the sprouted sample than the unsprouted sample could be accounted for by the predominance of lactic acid bacteria and *Saccharomyces cerevisiae* (Wakil and Daodu, 2011). The yeast has been reported to contribute to flavour development in some of these foods (Osungbaro, 2009). Fermentation of cereals has been reported to be accompanied with increase in acidity (Agarry *et al*., 2010). This could consequently contribute to improved shelf life of the sprouted sample. The increase in moisture contents of these samples agreed with Omafuvbe *et al.* (2004). The higher moisture contents observed in sprouted and unsprouted sample was due to absorption of water by the seeds during steeping (Fadahunsi *et al.,* 2011).The higher moisture content in the sprouted sample could be due to its higher microbial load which will certainly enhance better decomposition of the substrate thereby releasing water (David and Aderibigbe, 2010). The highest protein content in sprouted sample might result from the malting process which would invariably release protease responsible for the synthesis of protein or the increased microbial cells of the sample. The lowest protein content in unsprouted sample could be due to the processing method which could not be subsequently complemented by fermentation (Osungbaro, 2009). Similar findings were also reported on fat contents by Osman (2007) in addition to possibility of the fermenting organisms to synthesise fats (Akindumila and Glatz, 1998). The slight decreases in the ash contents of fermented samples was in agreement with Esenwah and Ikenebomeh (2008) while fermenting African locust bean seeds. Loss in ash contents may be due to leaching of soluble inorganic salts into the processing water during the fermentation period (Osman, 2007) or the fermenting microflora used it for their metabolism (Reebe *et al*., 2000). However, Enujuigha (2003) observed increase in ash from 2.1% to 2.9% dry weight within 72 hours during oil bean fermentation. The highest significant decrease fibre and carbohydrate contents in fermented sprouted slurry than the unsprouted slurry and whole maize grain indicated that these contents were easily metabolised by the fermenting microorganisms for their proliferation (Omafuvbe *et al*., 2004). The preference of the sprouted sample by the panelists particularly in terms of taste and odour could be as result of higher proliferation of *Lactobacillus* and *Saccharomyces cerevisiae* which have been implicated in flavour development during fermentation (Osungbaro, 1990; Osungbaro, 2009).

Conclusion

This study showed that sprouted maize is a better substrate for *ogi* production because of its improved protein content and sensory parameters. Future work on sprouted maize for *ogi* production should include the use of starter cultures which could improve its nutrient contents and sensory attributes.

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