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Full Length Research Paper

Nutritional and sensory properties of soybean fortified composite ogi – A Nigerian fermented cereal gruel

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The effect of soyabeans fortification on acceptability and shelf life of ogi was investigated. The pH of the fermenting ogi decreased steadily with a corresponding increase in titratable acidity (TA). The pH and TA ranged between 3.03 and 4.30; and 1.07 and 1.54 (mg/100 g) respectively. During fermentation, a significant increase in yeast and lactic acid bacteria (LAB) counts was observed. The aerobic plate count (log cfu/ml) of fermenting ogi samples ranged between 5.96 and 5.99. Sample A containing sorghum, millet and soybeans had the highest protein content (9.2%) while sample D containing sorghum only had the lowest (8.16%). Sample D was rated best in all the parameters tested. This study revealed that fortification with soybean at 10% level and a combination of sorghum and millet improved the nutrition quality of ogi without adverse effect on acceptability.

Key words: Nutritional quality, soybean, fortification, composite ogi, acceptability.

INTRODUCTION

Ogi is a fermented porridge or gruel from West-Africa, which could be made from maize, sorghum or millet. It serves as a major weaning food for the infant in West Africa (Oyewole, 1997). When a child reaches about 4 to 6 months old, the breast milk is replaced or supplemented by other food made from cereals (ogi), starchy tubers, legumes and vegetables (Adams and Moss, 1995). Ogi is also consumed as breakfast meal by many, and it serves as a choice food for the sick (Oyewole, 1997).

Lactic acid bacteria and yeasts have been identified as the most predominant microorganisms involved in the fermentation of ogi (Odunfa and Adeyele, 1985). These organisms responsible for the fermentation of ogi play important role for aroma, microbial stability and flavour (Omemu et al., 2007). Fermentation of ogi most of the time is spon-taneous but could also be induced. The combination of different types of cereals in the production of ogi increases the protein quality and relative nutritive values which would have been lost during steeping, milling and sieving processes compared to the use of single cereal (Hamad and Fields, 1979).

Efforts are currently on in Africa to modify the processing of ogi with a view to enhancing its nutritive value, shelf-life and possible therapeutic qualities (Olukoya et al., 1994; Banigo and Muller, 1972; Akinrele, 1970). One likely method of achieving this is by fortification with soyabeans. Some efforts have been made in the use of soybeans for improving the nutritional qualities of some food products such as gari, tapioca, corn-drink and maize snack (Sanni and Sobamiwa, 1994; Kolapo and Sanni, 2005; Lasekan and Akintola, 2008).

Also several authors have reported improvement in nutritional quality of ogi by soybeans fortification (Oluwamukomi et al., 2005; Adeleke and Oyewole, 2010). It is also very possible to improve upon the nutritional content of ogi achievable by fortification with soybean alone. This could be done by combining two or more different cereals (Banigo and Muller, 1972). Therefore; this present work was aimed at improving the nutritional quality of ogi using soybeans fortification and a combination of sorghum and millet.

MATERIALS AND METHODS

The soyabeans (*Glycine max*) used in this study was obtained from the Institute of Agricultural Research and Training (IAR & T), Ibadan

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while the sorghum (*Sorghum bicolor*) and millet (*Penniserum typhoides*) were obtained from Bodija Market, Ibadan, Nigeria.

Production of composite ogi

Ogi was prepared using a modified method previously described by Adesokan et al. (2010). The sorghum and millet were washed and steeped in clean water for 2 days in plastic containers with covers and the water was decanted after 2 days. Soybeans were parboiled for 20 min (Sanni and Sobamiwa, 1994) after which it was dehulled manually. The dehulled soybeans were then added to the softened grain of sorghum and millet and were then wet milled into slurry. The slurry was sieved using muslin cloth, which separates the pomace from the filtrate. The filtrate was then allowed to settle and ferment for 3 days (Figure 1). The proportion of sorghum, millet and soybeans used in the production of the soybean-fortified composite ogi was in ratio 9:9:2. (Sample A). Other batches of ogi also produced were from sorghum and soybeans (9:1) (Sample B), Sorghum and millet (1:1) (Sample C); and Sorghum only (Sample D). During the fermentation of ogi, physico-chemical and microbiological analyses were carried out.

Physico-chemical analysis

The pH of the various ogi samples was determined at 24 h interval as described by Sanni (1994) using the digital pH meter (Crison MicropH).The titratable acidity (TA) of the ogi sample was also analysed at 24 h interval by titrating 0.1 M NaOH solution against a measured volume of ogi using phenolphthalain indicator as previously described by Adesokan et al. (2008).

Microbiological analysis

Samples of fermenting ogi were collected at 24 h interval and serially diluted using sterile distilled water. Appropriate dilutions were plated on nutrient agar (Total viable count), MRS agar (LAB count) and malt extract agar (Yeast/mould count). The nutrient agar plates were incubated at 35°C for 24 h while MRS agar plates were incubated microaerophically using candle jar method for 48 h; and malt extract agar plates were incubated at 28°C for 72 h. The plates containing 30 to 300 colonies were counted using a colony counter.

Preparation of cooked ogi

Ogi was prepared by separately heating the slurry of the fermented ogi samples in boiling water under constant stirring using a clean stirrer to form a thick paste. The prepared ogi was allowed to cool and was transferred into a sterile, thick; transparent polyethylene bags, tied and stored at ambient temperature (28±2°C).

Proximate composition

Proximate parameters such as %crude protein, %crude fibre, %ash, %carbohydrate (%CHO) and %moisture content (MC) were determined on the cooked ogi samples using standard procedures as described by AOAC (1990).

Sensory evaluation

Sensory evaluation of the composite ogi was carried out by a ten-man panel comprising the students of The Polytechnic, Ibadan who are familiar with the product. The parameters evaluated were appearance, colour, aroma, taste and texture using a 9-point hedonic scale, ranging from 9 = like extremely to 1 = dislike extremely.

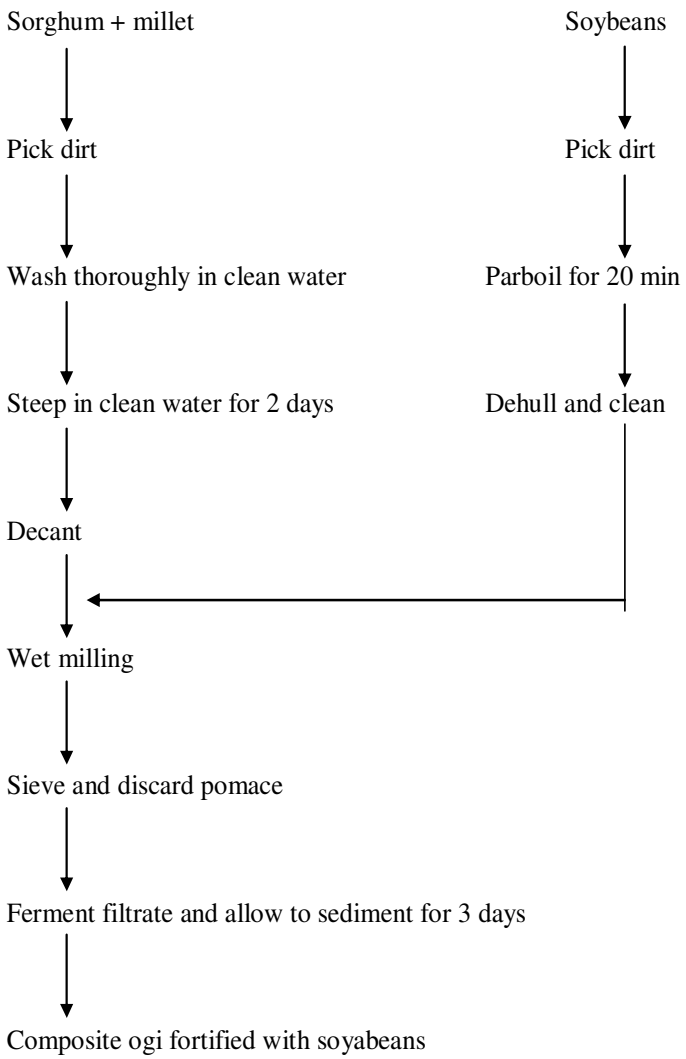

Figure 1. A scheme of steps followed in the production of composite ogi fortified with soybeans; modified from Adesokan et al. (2010).

Storage study on cooked ogi

The cooked ogi which have been put in transparent polyethylene bags were stored at ambient temperature (28±2°C) for 72 h; and physico-chemical and microbiological analysis were carried out during storage as described earlier.

Statistical analysis

The data obtained were expressed as mean ± standard deviation; the significant difference between the means was analysed using

Table 1. Changes in pH during fermentation of composite ogi-an indigenous fermented food.

Sample	Time (h)			
	0	24	48	72
A*	4.11**±0.01^{aa}	3.54±0.01^{ab}	3.48±0.00^{ac}	3.39±0.01^{ad}
B	4.30±0.01^{ba}	3.61±0.01^{bb}	3.58±0.01^{bc}	3.49±0.01^{bd}
C	4.01±0.01^{ca}	3.31±0.01^{cb}	3.25±0.01^{cc}	3.21±0.01^{cd}
D	4.29±0.01^{da}	3.46±0.01^{db}	3.39±0.01^{dc}	3.03±0.01^{dd}

**values are means of determination ± standard deviation; means with different superscripts are significantly different (P≤0.05) along the rows and columns.*A =sorghum + millet + soyabeans (9:9:1); B = sorghum + soyabeans (9:1); C = sorghum + millet (1:1); D = sorghum only

Table 2. Changes in TA (mg/100 g) during fermentation of ogi -an indigenous fermented food**.**

Sample	Time (h)			
	0	24	48	72
A*	0.98**±0.01^{aa}	1.25±0.01^{ab}	1.44±0.00^{ac}	1.54±0.01^{ad}
B	0.82±0.01^{ba}	1.07±0.01^{bb}	1.35±0.00^{bc}	1.61±0.01^{bd}
C	0.46±0.01^{ca}	0.55±0.01^{cb}	0.82±0.01^{cc}	1.17±0.00^{cd}
D	0.71±0.01^{da}	0.76±0.00^{db}	0.81±0.01^{dc}	1.07±0.01^{dd}

**values are means of determination ± standard deviation; means with different superscripts are significantly different (P≤0.05) along the rows and columns. *Sample codes are as stated in Table 1.

Duncan Multiple Range Test using SPSS for windows ver. 11.0 statistical package.

RESULTS

The changes in pH during fermentation of composite ogi were presented in Table 1. The pH of all samples decreased steadily during fermentation and ranged between 3.03 and 4.30. On the other hand, the TA of all the ogi samples increased significantly (P≤ 0.05) throughout fermentation and it ranged between 0.46 and 1.61 (Table 2). The microbiological changes in ogi samples during fermentation are presented in Figure 2 (a-c).

An increase in yeast population was recorded during fermentation (Figure 2a). The yeast count ranged between 5.88 and 6.12 logcfu/ml after 72 h of fermentation. As fermentation progressed, the LAB population increased significantly (P≤0.05). The highest LAB count of 9.02 logcfu/ml was recorded for Sample A at the end of fermentation while Sample C had the lowest LAB count of 8.94 logcfu/ml. The aerobic plate count (logcfu/ml) of all the fermenting ogi samples ranged between 5.96 and 5.99 after fermentation.

The proximate composition of (cooked) ogi samples is presented in Table 3. Sample A had the highest protein content of 9.98% while Sample D had the lowest (8.16%). Moreover, the percentage carbohydrate for all samples ranged between 20.82 and 25.81%.The sensory evaluation of the ogi samples showed that Sample D was rated best in all parameters tested (Table 4).

There was a slight decrease in pH during 72 h storage of the cooked ogi samples and it ranged between 3.87 and 4.05 (Table 5) while the TA ranged between 1.09 and 0.82% within the same period (Table 6).The microbiological changes during storage of ogi sample is presented in Figure 3 (a-c). The mould/yeast count was between 4.95 and 5.12 logcfu/ml at the end of storage while aerobic plate count was between 5.01 and 5.44 logcfu/ml within the same period.

DISCUSSION

The results from this study showed that there was a significant decrease in pH during fermentation of ogi with a corresponding increase in titratable acidity. This could be as a result of acid production by the fermentative organisms such as lactic acid bacteria (Adesokan et al., 2008; Sanni 1996; Oyewole, 1997; Montel et al., 1993; Litopoulou-Tzanetaki et al., 1993).

The yeast population increased steadily during fermentation; various studies have implicated yeasts in the fermentation of ogi where they contribute to flavour and aroma development of ogi (Odunfa and Adeyele, 1985; Omemu et al., 2007). Furthermore, the LAB population also increased during fermentation. This might be due to the ability of the LAB isolates to predominate and suppress the growth of other undesirable microorganisms. Odunfa and Adeyele (1985) and Oyewole (1997) also reported domination of lactic acid bacteria in some

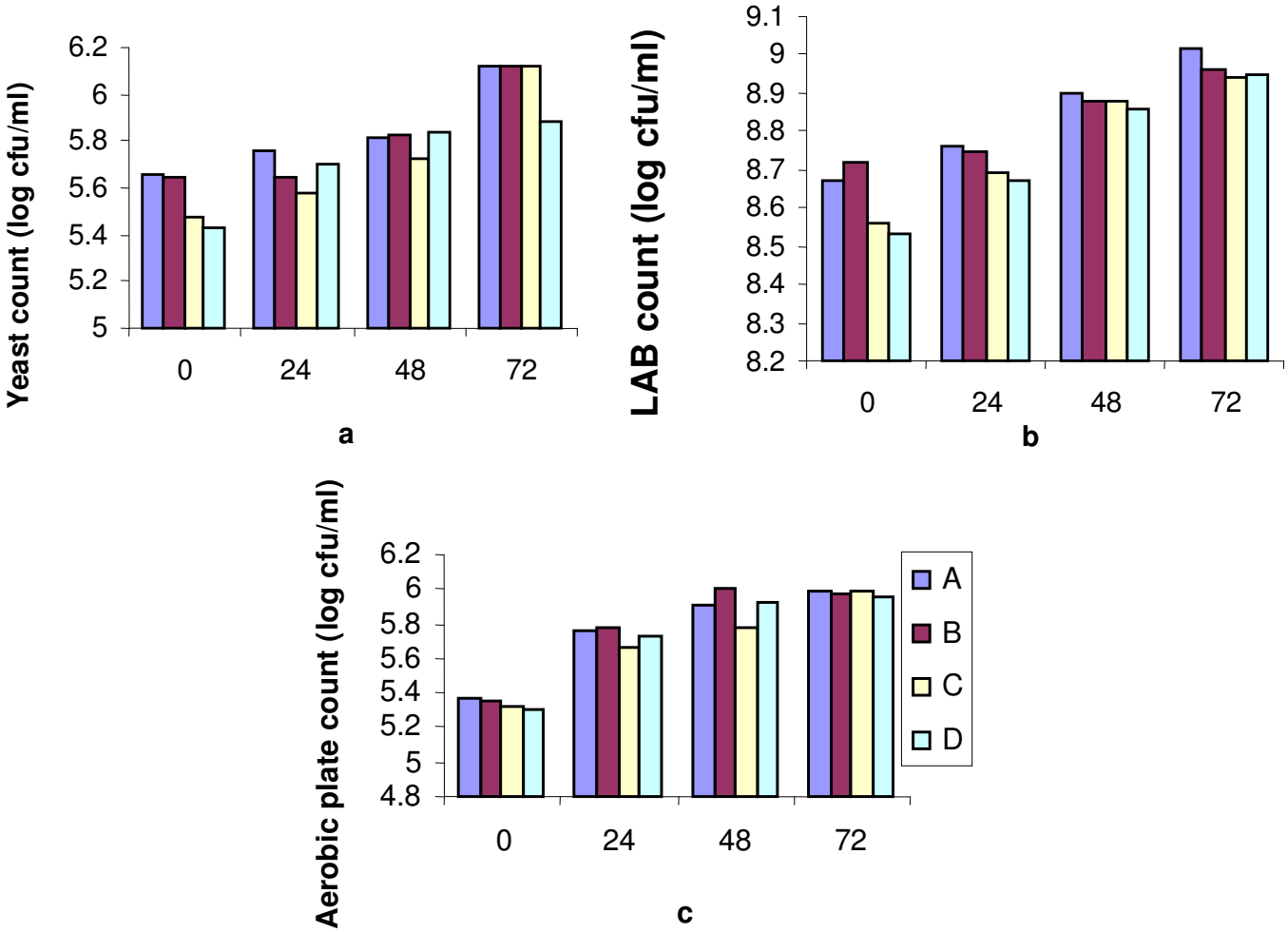

Figure 2. Microbiological changes during fermentation of composite ogi.

Table 3. Proximate composition of (cooked) ogi -an indigenous fermented food.

Sample	%Protein	%Fat	%Ash	%Fibre	%CHO	%M.C
A*	9.98**±0.01^{aa}	0.79±0.02^{ab}	2.72±0.01^{ac}	1.20±0.01^{ad}	21.47±0.02^{ae}	64.20±0.16^{af}
B	9.12±0.09^{ba}	0.79±0.01^{bb}	2.63±0.02^{bc}	1.27±0.00^{bd}	20.82±0.01^{be}	65.37±0.50^{bf}
C	8.98±0.01^{ca}	0.78±0.01^{cb}	2.44±0.01^{cc}	1.44±0.01^{cd}	25.16±0.15^{ce}	61.12±0.40^{cf}
D	8.16±0.01^{da}	0.74±0.01^{db}	1.34±0.012^{dc}	1.38±0.03^{dd}	25.81±0.00^{de}	62.57±0.91^{df}

**values are means of determination ± standard deviation; means with different superscripts are significantly different (P≤0.05) along the columns.*Sample codes are as stated in Table 1.

Table 4. Sensory evaluation of (cooked) ogi-an indigenous fermented food.

Sample	Appearance	Colour	Aroma	Taste	Texture
A*	5.1**^{a}	5.3^{a}	5.5^{b}	5.4^{a}	5.7^{b}
B	6.1^{b}	6.5^{c}	6.7^{c}	6.1^{b}	5.6^{b}
C	5.4^{a}	4.7^{d}	5.3^{a}	5.6^{b}	6.2^{b}
D	6.8^{c}	6.7^{c}	6.3^{b}	6.3^{b}	6.5^{c}

**values are means of determination; means with different superscripts are significantly different (P≤0.05) along the columns.* Sample codes are as stated in Table 1.

Table 5. Changes in pH during storage of (cooked) ogi-an indigenous fermented food.

Samples	Time (h)			
	0	24	48	72
A*	4.23**±0.01^{aa}	3.98±0.01^{ab}	3.98±0.01^{ac}	3.93±0.02^{ad}
B	4.66±0.01^{ba}	3.94±0.02^{bb}	3.87±0.01^{bc}	3.85±0.01^{bd}
C	3.96±0.02^{ca}	3.47±0.01^{cb}	3.93±0.02^{cc}	3.89±0.01^{cd}
D	4.09±0.01^{da}	4.08±0.01^{db}	4.06±0.00^{dc}	4.03±0.01^{dd}

**values are means of determination±standard deviation; means with different superscripts are significantly different (P≤0.05) along the rows and columns. *Sample codes are as stated in Table 1.

Table 6. Changes in TA during storage of (cooked) ogi-an indigenous fermented food.

Sample	Time (h)			
	0	24	48	72
A*	0.70**±0.02^{aa}	0.72±0.01^{ab}	0.72±0.00^{ac}	0.91±0.01^{ad}
B	0.81±0.00^{ba}	0.91±0.01^{bb}	0.98±0.01^{bc}	1.08±0.01^{bd}
C	0.71±0.01^{ca}	0.72±0.01^{cb}	0.81±0.02^{cc}	0.82±0.01^{cd}
D	0.78±0.01^{da}	0.80±0.01^{db}	0.99±0.00^{dc}	1.09±0.01^{dd}

**values are means of determination ± standard deviation; means with different superscripts are significantly different (P≤0.05) along the rows and columns. *Sample codes are as stated in Table 1.

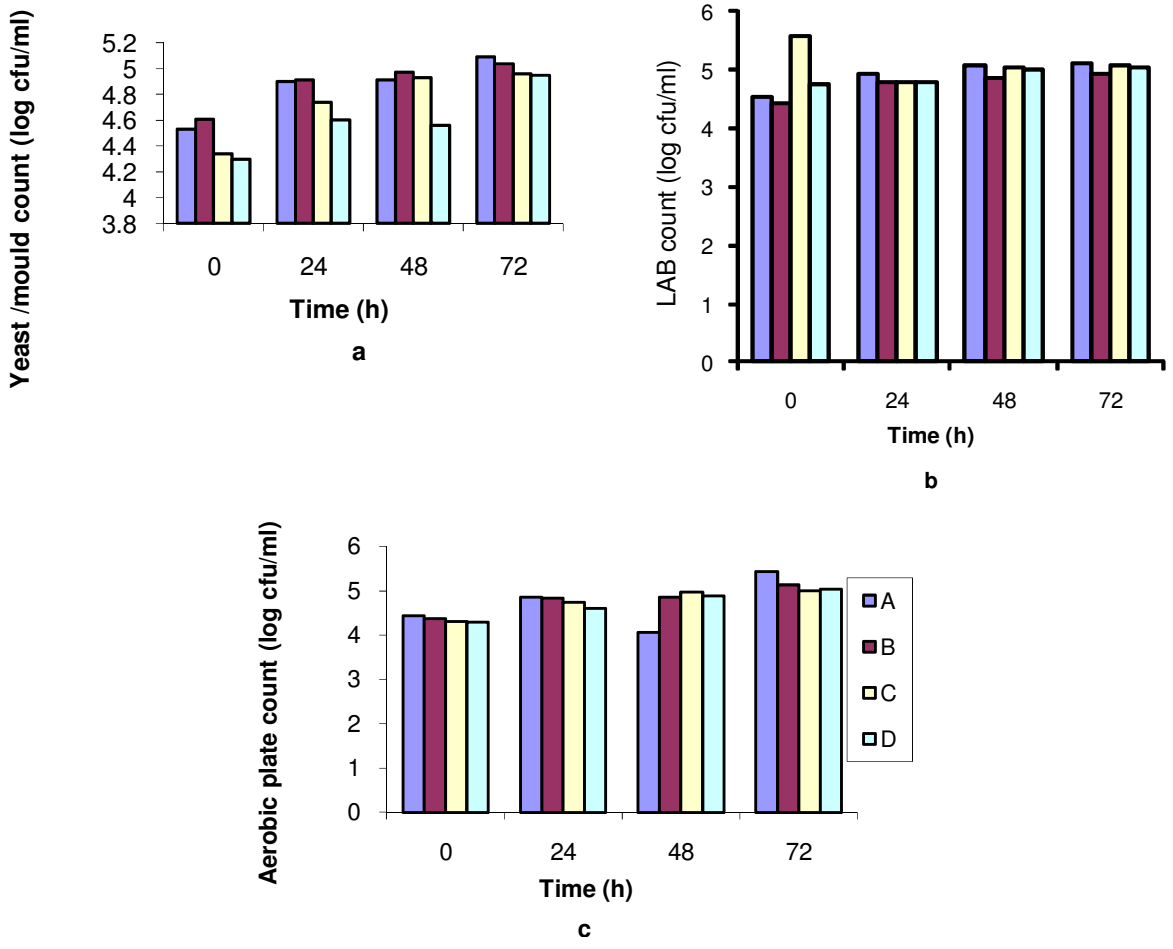

Figure 3. Microbiological changes during storage of ogi.

traditional fermented foods in Nigeria.

The highest protein content was recorded in sample produced from a combination of sorghum, millet and 10% soybeans. Previous studies have indicated that loss in nutrient during the various stages of ogi production might be compensated by combining two different cereals (Banigo and Muller, 1972); and incorporation of soybeans (Adeleke and Oyewole., 2010). Kolapo and Sanni (2005) and Sanni and Sobamiwa (1994) also reported improvement in protein content of tapioca and gari respectively due to fortification with soybeans. There was a significant difference in sensory property of ogi samples fortified with soybeans and unfortified samples. The unfortified samples were rated best in all the tested parameters. This might be as a result of beany taste of the soybeans used in the fortification.

This observation is in agreement with the reports of previous studies carried out by Sanni and Sobamiwa (1994) and Kolapo and Sanni (2005). The population of yeasts increased during storage of the ogi. This might bedue to the proliferation of the fungi in the stored samples, a property that would aid its spoilage (Kolapo and Sanni, 2005). Moreover, the aerobic organisms of the fortified samples increased significantly than the unfortified samples, this might be due to the enrichment of the fortified samples by soybeans which made it to be a more suitable medium for the growth of microorganisms.

This study revealed that incorporation of 10% soybeans in the composite ogi produced from sorghum and millet significantly improved the nutritional qualities of the product and was acceptable to the taste panel. However, the presence of soybeans in the fortified samples adversely affected the shelf life of the product. Therefore, further studies could be aimed at improving the shelf-life of soybeans fortified composite ogi.

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