African Journal of Biotechnology Vol. 9(42), pp. 7114-7121, 18 October, 2010
Available online at http://www.academicjournals.org/AJB
ISSN 1684–5315 © 2010 Academic Journals

Full Length Research Paper

Production of *Ogi* from germinated sorghum supplemented with soybeans

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Accepted 28 January, 2009

Three varieties of sorghum grains were germinated before fermentation to *Ogi*. The protein and ash contents of *Sorghum vulgare, Sorghum guineensis and Sorghum bicolor* increased by 7.20 and 40.20%; 5.44 and 29.20%; and 4.00 and 42.18% respectively. Fermentation of the germinated grains however caused decreases in the protein, ash, fibre and fat contents. Supplementation of oven-dried (60%) powder with treated 30% (w/w) soyabeans flour yielded products of higher protein contents which ranges from 284% for *Ogi* made from *S. vulgare*, 270% for *Ogi* made from *S. guineensis* and 271% for *Ogi* made from *S. bicolor*. Similarly, supplementation of *Ogi* with 30% (w/w) soya-flour generally resulted in increase in fat contents (approx. 130%), ash (approx. 54.9%) and fibre (approx. 217%). A panel of evaluators showed greatest preference for soya- supplemented *Ogi* porridge made from *S. vulgare*, while soya-supplemented *Ogi* porridge from *S. guineensis* was the least acceptable. The soya-supplemented *Ogi* flour (moisture content 10%) kept well and retained their original flow- properties after twenty-one days of storage.

Key words: Sorghum, germination, fermentation, soya-supplementation.

INTRODUCTION

Ogi is popular in Nigeria and in most parts of West Africa (Banigo and Muller; 1972). It is a fermented cereal porridge made from maize (*Zea mays*), sorghum (*Sorghum vulgare*) which is also known as guinea corn or millet (*Pennisetum typoideum*). The colour of *ogi* depends on the colour of the cereal used and includes: cream colour for maize-*ogi*, reddish-brown colour for sorghum-*Ogi* (Banigo, 1977; Onyekwere, 1981; Akinrele, 1970). The *ogi* porridge is very smooth in texture and has a sour taste reminiscent of that of yoghurt (Banigo and Muller, 1972).

The cereal sorghum (*Sorghum bicolor*) is indigenous to the semi-arid tropics of Africa. The increased use of sorghum as a food in sub-Saharan Africa could alleviate the problem of chronic under-nourishment, as sorghum is much better suited to cultivation in the semi-arid tropics than non-indigenous cereals such as wheat or maize. It can endure hot and dry conditions and also withstand heavy rainfall accompanied by some water logging. In fact, sorghum can consistently produce a crop under climatic conditions where other cereals fail.

However, a well-identified and important problem relating to the nutritional value of sorghum is that the protein of cooked sorghum is significantly less digestible than that of other cooked cereals. Since cereals are invariably cooked prior to consumption, the lower digestibility of sorghum protein militates significantly against the use of this cereal. Malting has been identified as a traditional processing technology that could possibly be used to improve the nutritional quality of the protein (Wang and Fields, 1978).

Akinrele and Edwards (1971) reported the fortification of *ogi* with legumes, vitamins and minerals. Improvement in the technology of *ogi* has led to the development of *soya-ogi*, a combination of maize and soyabeans. Soya-beans has a high protein content of about 44% and carbohydrate content of about 18% (Salunkhe and Kadam, 1989). The major limiting factor of soyabeans in its processing is the flavour (Cowan et al., 1973).

The nutritional quality of *soya-ogi* has been applauded to meet the needs of children in many developing countries,

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the technology for *soya-ogi* production currently utilize maize, no effort has been made to produce *soya-ogi* using other cereals. Thus, the present study has been embarked upon with the following objectives: to produce *Ogi* from malted sorghum and supplemented with soya-beans, and to investigate the changes occurring during storage of *soya-ogi* flour in order to determine its shelf-stability.

MATERIALS AND METHODS

Sorghum and soyabeans used

The sorghum and soyabeans used are purchased from a local market (Lafenwa market) in Abeokuta, Ogun state, Nigeria. The samples were thoroughly cleaned by picking all broken kernels, stones, together with other foreign particles and the goods ones were sorted out.

Malting of sorghum

Sorghum was malted following the procedure of Wang and Fields (1978). The sorghum grains were cleaned and steeped in water at room temperature for 18 h and washed at 6 h intervals to present fermentation. Steeped grains were spread on sterile jute bags, watered and left to germinate in a dark cupboard at room temperature (30 ± 1°C) for 2-3 days. The germinating grains were watered when necessary but not less than once daily. Germinated grains were dried at 48 ± 2°C to 10% moisture content. This is the sorghum malt used for *Ogi* manufacture after separation and removal of the sprouts.

Pre-treatment of soyabeans

The soyabeans were first thoroughly cleaned by picking all the stones and other foreign particles present in them while sorting out the good ones. The cleaned soyabeans were boiled in water at a temperature of 100°C for 60 min. The beans were then washed by hands to remove the seed coat. The dehulled beans were cooked for 3 h and then oven dried at 60°C for 18 h. The dried beans were allowed to cool and then dry-milled into flour using Kenwood chef major blender. The dried soya-flour was allowed to cool before use (FIIRO, 1973).

Preparation of *Ogi-baba* (fermentation of sorghum)

Ogi-baba was prepared using the wet-milling process described by Akingbala et al. (1981a). Two hundred grams of the cleaned sorghum samples were soaked in each plastic bucket containing 300 ml of distilled water and steeped for 72 h at room temperature (28 ± 2°C). The steep water was discarded by decantation and the steeped grains were wet-milled using a Kenwood chef grinder. The milled slurry was then sieved through a fine mesh sieve to remove the over tails which were discarded. The over tails were further washed off with 700 ml of distilled water. The troughs were allowed to stand and further fermented for 48 h by allowing to stand and sediment at room temperature (Akinrele, 1970). The souring water was decanted from the sediments and the *Ogi* slurry obtained was collected into a muslin cloth and hand squeezed to remove excess water leaving behind the semi-wet *ogi* samples which were dried at 60°C for 12 h to obtain dry *ogi* powder samples (Figure 1).

Supplementation of fermented sorghum with soybeans

The soyabeans flour and sorghum flour were mixed together in the ratio 30:70; 30 g of soy-flour was mixed with 70 g of *sorghum-ogi* flour. This was allowed to ferment naturally for 24 h before using it for the preparation of *soya-ogi* porridge (Figure 2).

Storage of fermented products

The prepared *soya-ogi* flour samples were kept under different storage temperatures (ambient and refrigeration) to check whether there would be changes in the properties of the *soya-ogi* flour when used for preparing *soya-ogi* porridge. The samples were kept under this condition and evaluated at one week interval for a period of three weeks.

Preparation of *soya-ogi* porridge

The laboratory preparation of *soya-ogi* porridge for analysis was carried out by weighing 25 g of the flour (on dry basis) into 50 ml of distilled water to obtain the *Ogi* slurry. 150 ml of boiling water was then added with stirring to obtain the *Ogi* porridge which was then allowed to cool.

pH determination

The pH of the samples was determined according to the method of AOAC (1984). 10 g of the sample was added to 50 ml of distilled water and stirred for 10 min. The pH of the sample was determined by dipping the electrode of the Kent pH meter in the mixture. Duplicate determinations were made in all cases. The pH meter was calibrated using pH 4.0 and 9.0 buffers.

Total titratable acidity

This was determined by extracting with 30 ml distilled water and 20 ml methanol at 45°C for 15 min in a water bath. The mixture was filtered and 4 ml of filterate was pipette into flask containing 5 ml distilled water and 3 drops of phenolphthalein. The mixture was titrated against 0.1 m NaOH / KOH (Adeyemi, 1983).

Specific gravity

This was determined using the specific gravity bottle. The weight of the specific gravity bottle with distilled water was first taken (W_1), followed by the weight of the specific gravity bottle with porridge sample (W_2). All the weights determinations were carried out on an analytical balance (Pearson, 1981).

$$\text{Specific gravity} = W_2/W_1$$

Total soluble solids and refractive index

This was determined using the pocket Abbe type refractometer. The TSS value was read directly from the calibrated scale of the refractometer. The refractive index was then determined from the standard table of refractive indices at 20°C (Pearsons, 1981).

The total titratable acidity (TTA), pH, specific gravity, refractive index and total soluble solids (TSS) were carried out on the samples at 1 week interval for a 3 weeks storage period.

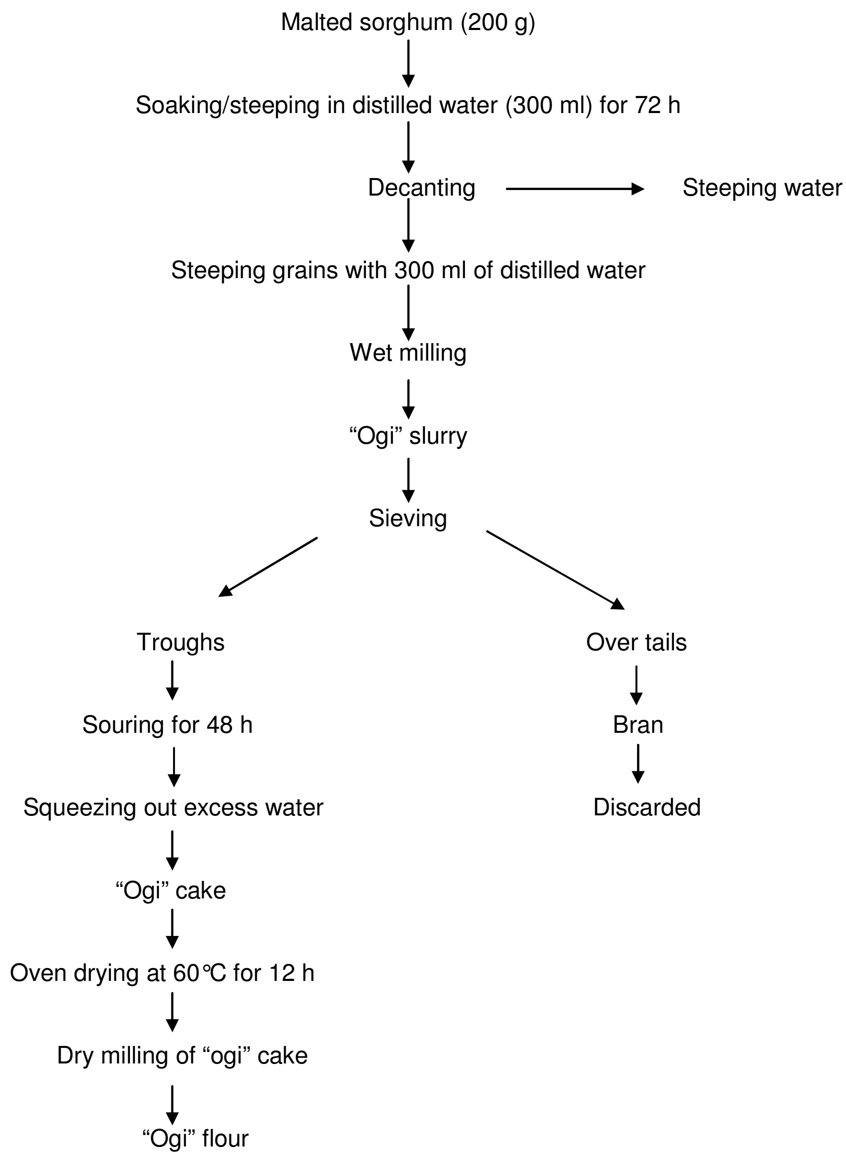

Figure 1. Flow chart for the laboratory preparation of *ogi* (Akingbala et al., 1981a).

Moisture content determination

Moisture content of the samples was determined by oven air method (AOAC, 1984).

Ash content determination

This was determined using the method described by Pearson (1981). 5 g of each sample was burnt over a Bunsen burner until smoke ceases (pre-charred) and was ashed in the muffle furnace at 550°C until a white ash was obtained for 6 h.

Protein content determination

Protein content of the samples was determined by the semi micro-Kjeldahl method using a factor of 6.25 as described by Pearson (1981).

Fat content determination

This was determined using the Soxhlet extraction method, as described by Oyeleke (1984). 5 g of each sample was extracted with hexane for 6 h.

Crude fibre determination

This was determined using the method described by Pearson (1981).

Sensory evaluation

An eight-man panel that is familiar with the attributes of *Ogi* was used for this study. The porridge samples made from *soya-ogi* flour stored under different conditions were assessed for colour, taste and aroma using a five point hedonic scale on the basis of their

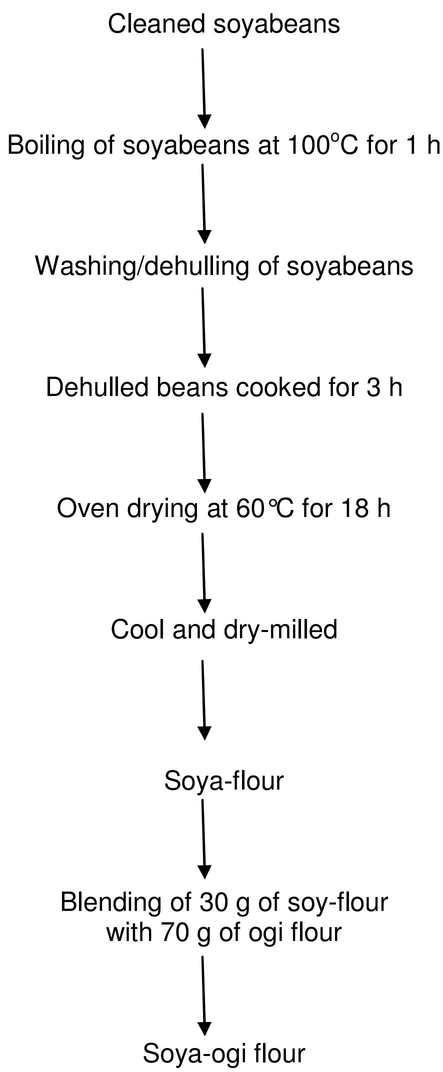

Figure 2. Flow chart for the preparation of soya-ogi flour (Akinrele and Edwards, 1971).

acceptability with 1 = unacceptable and 5 = most acceptable. The analyses were carried out at one week interval for a three weeks storage period.

The samples were also ranked according to their flow properties (viscosity and consistency). The sample which flow least was ranked 1, while the one which flow most readily was ranked 5. The evaluation was carried out at one week interval for three weeks.

The scores of the eight panelists on the attributes were subjected to analysis of variance and mean score of the attributes were used in assessment of results as described by (Larmond, 1977).

RESULTS

pH changes during steeping of sorghum

There was a gradual decrease in the pH of all the samples used (*S. bicolor; S. guineensis; and S. vulgare*) during the steeping stage. The pH of *S. vulgare* decreased from 6.3 to 4.5 that of *S. guineensis* decreased from 6.3 to 4.6 while that of *S. bicolor* decreased from 6.3 to 4.8 at the end of the steeping period of 72 h.

Chemical composition

The chemical composition of the sorghum grains, soyabeans, germinated sorghum grains and sorghum *Ogi* flour obtained from the sorghum varieties and soya-supplemented *Ogi* flour from the sorghum varieties are presented in Tables 1 and 2. Differences in the values of *ogi* flour compared to soya-supplemented *Ogi* flour were as a result of high protein content of soyabeans.

Physical changes occurring during storage of soya-supplemented *Ogi* flour

The physical changes of cooked soya-supplemented *Ogi* porridge prepared from stored soya supplemented *Ogi* flour were analyzed. Analyses carried out include pH, total titrable acidity, specific gravity, refractive index and total soluble solids. The analyses were carried out at 7 days intervals for 21 days to analyze the shelf stability of the soya-supplemented *Ogi* flour. Specific gravity, refractive index and total soluble solids showed constant values (Tables 3 to 6).

Sensory evaluation

There were no significant difference in colour and taste of the cooked porridge made from the stored soya-supplemented *Ogi* flour at 1% level until the fourteenth day after which there was significant difference. This was as a result of changes taking place during storage. There was no significance difference in aroma throughout the storage period. Panelists preferred the soya-supplemented *Ogi* made from *S. vulgare* variety to others (Tables 7 - 9).

DISCUSSION

pH changes during steeping of sorghum showed a gradual fall and this may be due to acid production during the fermentation. A pH of 4.3 ± 0.2 was reported after steeping (Akinrele et al., 1970). However, the most desirable *ogi* flavour and aroma was achieved at a pH of 3.6 - 3.7. *Ogi* with pH 3.5 was unacceptable (Akinrele et al., 1970).

The variation in the proximate composition of the *ogi* produced was attributed to the fact that, the exact method of *ogi* manufacture would affect the nutrient losses (Banigo et al., 1974). The values of the sorghum grain

Table 1. Chemical composition of germinated and un-germinated sorghum varieties

Component (%)	*Sorghum vulgare*		*Sorghum guineensis*		*Sorghum bicolor*	
	Un-germinated	Germinated	Un-germinated	Germinated	Un-germinated	Germinated
Protein*	10.28 ± 0.04	11.02 ± 0.53	10.67 ± 0.88	11.25 ± 0.64	10.84 ± 0.40	11.27 ± 0.05
Fat	03.12 ± 0.45	01.90 ± 0.01	03.38 ± 0.58	02.95 ± 0.18	02.71 ± 0.32	01.90 ± 0.11
Fibre	02.17 ± 0.35	02.06 ± 0.04	03.28 ± 0.16	02.91 ± 0.11	03.11 ± 0.02	02.56 ± 0.04
Ash	01.48 ± 0.49	02.09 ± 0.53	02.09 ± 0.83	02.70 ± 0.12	01.47 ± 0.24	02.09 ± 0.53
Moisture	10.07 ± 0.85	11.19 ± 0.07	09.60 ± 0.52	10.30 ± 0.51	09.60 ± 0.52	11.19 ± 0.01

* = N x 6.25.

Table 2. Chemical composition of sorghum *ogi* without and with 30% soya supplementation.

Component (%)	*Sorghum vulgare*		*Sorghum guineensis*		*Sorghum biclolor*	
	Without soya	With soya	Without soya	With soya	Without soya	With soya
Protein*	04.94 ± 0.46	18.98 ± 0.08	04.99 ± 0.08	18.46 ± 0.09	05.09 ± 0.23	18.90 ± 0.36
Fat	03.91 ± 0.37	08.99 ± 0.08	03.16 ± 0.04	08.99 ± 0.08	03.79 ± 0.39	09.44 ± 0.12
Fibre	00.34 ± 0.03	01.08 ± 0.06	00.29 ± 0.03	01.08 ± 0.06	00.31 ± 0.03	01.30 ± 0.16

* = N x 6.25.

Table 3. Total titratable acidity values (% lactic acid) of the *ogi* porridge samples.

Product/storage condition	Storage period (in days)			
	0	7	14	21
a. Ambient condition				
Soya-supplemented *ogi* from *S. guineensis*	1.38	1.35	1.35	1.38
Soya-supplemented *ogi* from *S. bicolor*	1.80	2.03	2.03	2.03
Soya-supplemented *ogi* from *S. vulgare*	2.25	2.25	2.70	2.70
b. Refrigeration condition				
Soya-supplemented *ogi* from *S. guineensis*	2.03	2.03	2.23	2.25
Soya-supplemented *ogi* from *S. bicolor*	2.03	2.03	1.80	1.80
Soya-supplemented *ogi* from *S. vulgare*	1.35	1.35	1.40	1.40

Table 4. pH values of the *Ogi* porridge samples.

Product/storage condition	Storage period (in days)			
	0	7	14	21
a. Ambient condition				
Soya-supplemented *ogi* from *S. guineensis*	5.76	5.78	5.79	5.76
Soya-supplemented *ogi* from *S. bicolor*	5.28	5.43	5.40	5.38
Soya-supplemented *ogi* from *S. vulgare*	5.06	5.02	5.00	5.00
b. Refrigeration condition				
Soya-supplemented *ogi* from *S. guineensis*	5.19	5.20	5.01	5.02
Soya-supplemented *ogi* from *S. bicolor*	5.34	5.41	5.28	5.28
Soya-supplemented *ogi* from *S. vulgare*	5.12	5.18	5.14	5.13

varieties are in agreement with the values reported in Literature: protein 8.3%, fat 2.5%, ash 0.52%, starch 84.3% and soluble sugar 1.3% (Akinrele and Edwards, 1971).

Table 5. Specific gravity values of the *ogi* porridge samples.

Product/storage condition	Storage period (in days)			
	0	7	14	21
a. Ambient condition				
Soya-supplemented *ogi* from *S. guineensi*	1.0100	1.0100	1.0100	1.0100
Soya-supplemented *ogi* from *S. bicolor*	1.0083	1.0083	1.0083	1.0083
Soya-supplemented *ogi* from *S. vulgare*	1.0100	1.0100	1.0101	0.0111
b. Refrigeration condition				
Soya-supplemented *ogi* from *S. guineensis*	1.0100	1.0100	1.0100	1.0100
Soya-supplemented *ogi* from *S. bicolor*	1.0083	1.0083	1.0083	1.0083
Soya-supplemented *ogi* from *S. vulgare*	1.0100	1.0100	1.0100	1.0101

Table 6. Total soluble solids and refractive index values of the *Ogi* porridge samples

Product/storage condition	Storage period (in days)			
	0	7	14	21
a. Ambient condition				
Soya-supplemented *ogi* from *Sorghum guineensis*	6.00 1.34176	6.00 1.34176	6.00 1.34176	6.00 1.34176
Soya-supplemented *ogi* from *Sorghum bicolor*	6.00 1.34176	6.00 1.34176	6.00 1.34176	6.00 1.34176
Soya-supplemented *ogi* from *Sorghum vulgare*	6.00 1.34176	6.00 1.34176	6.00 1.34176	6.00 1.34176
b. Refrigeration condition				
Soya-supplemented *ogi* from *Sorghum guineensis*	6.00 1.34176	6.00 1.34176	6.00 1.34176	6.00 1.34176
Soya-supplemented *ogi* from *Sorghum bicolor*	6.00 1.34176	6.00 1.34176	6.00 1.34176	6.00 1.34176
Soya-supplemented *ogi* from *Sorghum vulgare*	6.00 1.34176	6.00 1.34176	6.00 1.34176	6.00 1.34176

Table 7. Mean scores of colour of soya-supplemented *ogi* porridge samples.

Product/storage condition	Storage period (in days)			
	0	7	14	21
a. Ambient condition				
Soya-supplemented *ogi* from *Sorghum guineensis*	2.88b	2.75b	3.63a	3.13b
Soya-supplemented *ogi* from *Sorghum bicolor*	2.88b	3.38a	2.75b	3.25b
Soya-supplemented *ogi* from *Sorghum vulgare*	3.63a	3.75a	3.25a	4.38a
b. Refrigeration condition				
Soya-supplemented *ogi* from *Sorghum guineensis*	2.88b	2.88b	3.38a	3.13b
Soya-supplemented *ogi* from *Sorghum bicolor*	3.13a	3.50a	3.13a	3.38b
Soya-supplemented *ogi* from *Sorghum vulgare*	3.75a	3.88a	3.00a	3.63b

Soyabeans are valued for their high protein content which varies between 38% and 42% and for their oil which is mainly for cooking purposes (Kent, 1985). Soya-beans have in addition been found to be very good nutri-tionally, rich in lysine, which is not in sufficient quantities in most cereal grains.

Ogi has poor biological value, thus children weaned entirely on *Ogi* are known to suffer from protein-energy malnutrition (PEM). So, a good supplemental relationship thus exists between *Ogi* and soyabeans. Addition of 30%

Table 8. Mean scores of taste of soya-supplemented *ogi* porridge samples

Product/storage condition	Storage period (in days)			
	0	7	14	21
a. Ambient condition				
Soya-supplemented *ogi* from *S. guineensis*	3.38b	3.63a	3.25b	3.38a
Soya-supplemented *ogi* from *S. bicolor*	3.50b	3.13a	3.25b	2.50b
Soya-supplemented *ogi* from *S. vulgare*	4.00a	3.13a	4.38a	3.88a
b. Refrigeration condition				
Soya-supplemented *ogi* From *S. guineensis*	3.25b	3.38a	2.50c	3.88a
Soya-supplemented *ogi* from *S. bicolor*	3.38b	3.13a	3.38b	3.63a
Soya-supplemented *ogi* from *S. vulgare*	4.00a	3.00a	3.63b	3.88a

Table 9. Mean scores of aroma of soya-supplemented *ogi* porridge samples

Product/storage condition	Storage period (in days)			
	0	7	14	21
a. Ambient condition				
Soya-supplemented *ogi* from *S. guineensis*	3.63a	3.38a	3.88a	3.50a
Soya-supplemented *ogi* from *S. bicolor*	3.75a	3.25a	3.38a	3.38a
Soya-supplemented *ogi* from *S. vulgare*	3.88a	3.25a	3.88a	3.50a
b. Refrigeration condition				
Soya-supplemented *ogi* from *S. guineensis*	3.75a	3.75a	3.75a	3.50a
Soya-supplemented *ogi* From *S. bicolor*	3.63a	3.75a	3.88a	3.25a
Soya-supplemented *ogi* from *S. vulgare*	3.75a	3.75a	3.63a	3.25a

soyabeans into soya-supplemented *Ogi* improves the protein content of *Ogi* and also shortens the souring process, reducing it to 3 - 4 h.

The use of malted cereal in *Ogi* preparation also increases the nutritive value. Wang and Fields, (1978) showed an increase of 32.7 and 22.8% in the relative nutritive value of germinated corn and sorghum respectively.

The amylolytic enzymes in germinated flour hydrolyzed gelatinized starch turning a solid porridge into one which is free flowing. Such porridges have both energy density and a low viscosity and therefore suitable for feeding infants. Differences in values of *Ogi*/*soy-ogi* flour as compared to sorghum/soyabeans can be as a result of losses during processing such as steeping and washing with water.

The result of the TTA showed a gradual change. The increase in TTA values may be due to the activities of acid producing micro organisms such as *Lactobacillus plantarum* and *Cephalosporium fusarum* (Akinrele, 1970; Banigo and Muller, 1972). The decrease in pH may be due to increase in total soluble solids (TSS) and refractive index (RI) showed a constant plot throughout the storage period. This may be due to the storage condition (ambient and refrigeration) not affecting the flow properties of the stored soya-supplemented *ogi* used in preparing the soya-supplemented *Ogi* porridge.

This implies that the soya-supplemented *ogi* flour can be stored in any of these storage conditions without loss of its flow properties.

Sensory evaluation results showed that there were no significant difference in colour and taste of the samples until the fourteenth day after which there was significant difference at 1% level. This is as a result of changes that took place during storage.

There was no significant difference in the aroma throughout the storage period. The soya-supplemented *ogi* porridge made from *S. vulgare* variety has the highest scores in taste, colour and aroma. Hence it was considered most acceptable while soya-supplemented *ogi* porridge made from *S. guineensis* variety gave the lowest scores, hence the least acceptable.

The study on the flow properties also showed that there was no significant difference in all the samples. It can then be said that soya-supplemented *ogi* porridge made from *S. vulgare* variety is the most acceptable and that the storage condition in which the samples were subjected to, does not affect their flow properties.

Conclusion

It is evident from the results that soya-supplemented *ogi* could be made from malted cereal before supplementation with soyabeans which increased the nutritive value of the product. The soya-supplemented *ogi* flour could be stored under different storage conditions without affecting the overall characteristics of the product. The TTA and pH of the products varied throughout the storage period while the specific gravity, refractive index and total soluble solids showed constant values through-out the period. This implies that the storage condition does not affect the flow properties of the stored soya-supplemented *ogi* flour. Based on the sensory evaluation results and the physicochemical analyses, it can be concluded that soya-supplemented *ogi* flour from *S. guineensis* variety had the least acceptable attributes. The storage condition in which the samples are subjected to, does not affect their flow properties. Supplementation of *ogi* with soyabeans increases the protein content and biological value of *ogi* which reduced the occurrence of protein-energy malnutrition (PEM) in children weaned with *ogi*. Malting of sorghum before fermentation produced a flour which contains amylolytic enzyme that help to hydrolyze gelatinized starch, turning a solid porridge into one which is free flowing. Such porridge have high energy density and a low viscosity and therefore suitable for feeding children.

REFERENCES

AOAC (1984). Official Methods of Analysis. Association of Official Analytical Chemists. Ed.Sidney Williams. AOAC. Arlington USA.

Adeyemi IA (1983). Dry milling of sorghum for *Ogi* manufacture. J. Cereal Sci., 1: 221-227.

Akingbala JO, Rooney LW, Faubion JM (1981a). (In. Press). A laboratory procedure for the preparation of Ogi, a Nigerian fermented Food. Journal of Food Science.

Akinrele IA (1970). Fermentation studies on maize during the preparation of a traditional African starch-cake food. J. Sci. Food Agric. 21: 619-622.

Akinrele IA, Edwards CA (1971). An assessment of the nutritive value of Maize-Soya Mixture, Soy-Ogi as a weaning food in Nigeria. Br. J. Nutr. 26: 177-185.

Banigo EOI (1977). Ogi: a Nigerian Fermented Cereal Food. Symposium on Indigenous Fermented Foods. Bangkok, Thailand.

Banigo EOI, Muller RG (1972). Manufacture of *Ogi* (A Nigeria fermented cereal porridge). Comparative evaluation of corn, sorghum and millet. Cam. Inst. Food Science Tech. 5: p. 217.

Banigo EOI, Deman JM, Duischaever LC (1974). Utilization of high-lysine corn for the manufacture of *Ogi* using a new improved processing system. Cereal Chemical, 51: p. 559.

Cowan JC, Rackis J, Wolf WJ (1973). Soybeans protein flavour components: A review J. Oil chem. Soc., 50: p. 426.

FIIRO (1973). Soy-Ogi: Nigerian traditional *Ogi* enriched with proteins. The Technical Bulletin for industry 2(3): 1-4.

Kent NL (1985). Technology of Cereal. An introduction for students of Food Science and Agric. (3rd edition). Pergamen press, oxford. pp. 193-202.

Larmond E (1977). Laboratory methods for sensory evaluation of Foods. Published by Canadian Dept. of Agriculture, Ottawa.

Onyekwere CO (1981). The story of Soy-ogi. An Infant weaning food. A paper presented at the Food week of the Dept. of Food Technology. I.M.T. Enugu.

Oyeleke OA (1984). Outlines of Food Analysis. Dept. of Biochemistry, Ahmadu-Bello University Zaria, Nigeria.

Pearson D (1981). The Chemical Analysis of Food Chemistry Publishing Company.

Salunkhe DF, Kadam SS (1989). CRC Handbook of legumes Nutritional Chemistry, Processing, Technology and Utilization.

Wang YD, Fields ML (1978). Germination of corn and sorghum in the home to improve nutritive value. J. Food Sci. 43: 1113-1115.