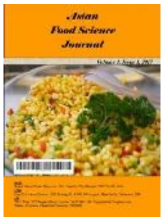

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Quality Assessment of Fermented Gruel (*ogi*) Made from Sorghum (*Sorghum bicolour*) and Moringa Leaves (*Moringa oleifera*)

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Authors' contributions

This work was carried out in collaboration between all authors. Author VFA designed the study, supervised the project and corrected the first draft of the manuscript. Author BFO contributed to the processing method used and helped in correction of the final manuscript. Author SAO contributed to the analysis and carried out the products. Author OOO carried out all the laboratory procedures and wrote the first draft of the manuscript. All authors read and approved the final manuscript.

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ABSTRACT

The effect of moringa leaf supplementation on the nutrient composition, quality attributes and consumer acceptability of sorghum-ogi was investigated the present study. Sorghum-ogi samples were produced from different ratios of sorghum grains and moringa leaf powder in the formulation of 100:0, 90:10, and 85:15, respectively. The effect of the moringa leaf powder substitution on the proximate composition, mineral content, swelling capacity, β-carotene content and on the sensory properties of sorghum-ogi was determined. The sorghum–ogi increased in the protein, ash and crude fibre with an increase in Moringa leaf substitution. An increase in the mineral content with increase in the level of substitution was observed as follows: calcium (75-390.10 mg/100 g); magnesium (21-88 mg/100 g); iron (12.40-14.13 mg/100 g); potassium (46.67-295.0 mg/100 g); zinc (0.33-0.77 mg/100 g); copper (0.53-0.67 mg/100 g). The swelling capacity decreased with increase in the substitution level while the β-carotene content of the sorghum-ogi samples ranged between

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230-1241.67 µg/100 g. This study revealed that the fortification of ogi with moringa leaves at 15% improved the nutritional quality of sorghum-ogi and sorghum-ogi samples with 10% moringa leaf substitution is generally accepted by the consumers.

Keywords: Sorghum grains; sorghum-ogi; moringa leaves; supplementation; weaning food.

1. INTRODUCTION

Protein-energy malnutrition (PEM) is a clinical disease condition that results from inadequate and/or under-utilisation of food proteins. The problem of cheap sources of high-quality proteinous foods for the over-populated developing nations like Nigeria is a lingering issue till date [1]. Ogi or pap is a fermented porridge or gruel which can be made from maize, sorghum or millet [2,3]. It is used as the first native food given to babies at weaning to supplement breast milk and also as breakfast for pre-school, school children and most adults [4,5]. Ogi has a very smooth texture and a sour taste similar to that of yoghurt [6,7]. It can be prepared with 7-10% dry matter concentration and eaten as a breakfast meal or prepared with 12-15% dry-matter concentration as a thick gruel.

Sorghum-ogi is prepared from sorghum grains (*Sorghum bicolour* (L)) through traditional processing technique. The traditional preparation of ogi involves soaking of sorghum in water (1 to 3 days), wet milling and sieving to remove bran, hulls and germs [8,9]. This processing method has been reported to result in the loss of proteins and minerals, thereby affecting the nutritional quality of the ogi adversely [10]. However; this may be inadequate to meet the nutritional demands of growing infants [11].

Sorghum is a cereal that is indigenous to the semi-arid tropics of Africa and has achieved the highest growth rate of any major food crops in Western Africa [7]. It is believed to have the greatest potential among food crops for attaining technological breakthroughs that will improve food production in any region. In the semi-arid tropical region, sorghum is much better suited for cultivation than non-indigenous cereals, such as wheat or maize. It can withstand both hot and dry conditions as well as heavy rainfall along with waterlogging. In fact, sorghum can consistently survive under the climatic conditions where other cereals fail to grow [12]. The only major problem identified with the nutritional value of sorghum is that cooked sorghum has less digestible protein than that of other cooked cereals [13].

Moringa oleifera is referred to as the miracle plant or the tree of life due to its medicinal and nutritional value. It is native to India, Pakistan, Bangladesh and Afghanistan [14,3]. It is a tree plant with many uses; the leaves can be eaten fresh, cooked or stored as dry powder for many months without refrigeration without any loss of nutritional value [15]. *Moringa* leaves have an immense nutritional value. It contains minerals, vitamins and amino acids and it has been used to alleviate malnutrition problems especially among infants and nursing mothers [16].

Due to the undesirable effects of traditional processing on the nutrient content of sorghum-ogi, several researchers have worked on improvement of the nutritional quality of sorghum-ogi. There have been reports about quality improvement of sorghum ogi; processing [17] fortification with other food substances such as soybean [7], pawpaw [18], crayfish [12] etc. Moringa leaves have been reported to increase the nutritional value of ogi prepared from other grains, such as maize [19] and yellow maize [15]. This work therefore aimed to investigate the effects of moringa leaf powder supplementation on the nutritive value, quality attributes and sensory properties of sorghum-ogi.

2. MATERIALS AND METHODS

2.1 Materials

Sorghum grains (*Sorghum bicolour* (L)) were collected from a local market in Ogbomoso, Oyo State, Nigeria and Moringa leaves were obtained from the research farm of the Ladoke Akintola University of Technology school farm, Ogbomoso, Oyo State, Nigeria. The samples were collected on July 2017.

2.2 Methods

2.2.1 Production of sorghum- ogi

Sorghum-ogi was produced using a modified method of Akingbala et al. [9]. Sorghum grains were cleaned thoroughly by picking out broken kernels and other foreign particles. The cleaned sorghum grains were washed, soaked in a clean container and allowed to steep for 72 h at room temperature (27°C). The steep water was changed each day for the next three days. After the third day, the steep water was discarded and the grains wet milled with a grinding machine/grinder. The milled slurry was then wet sieved using a muslin cloth to remove bran, hull and germ. The sorghum-ogi slurry was collected in a muslin cloth and hand squeezed to remove excess water leaving behind a semi-wet sorghum-ogi which was then dried at 50°C for 48 h in the cabinet drier to obtain dry ogi powder.

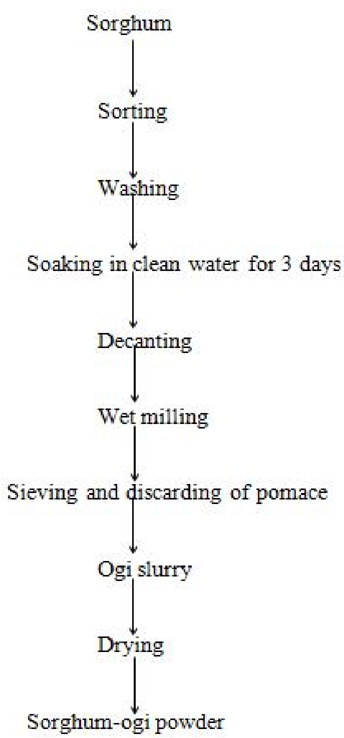

Fig. 1. Flow diagram of sorghum-ogi powder production
Source: [9]

2.2.2 Preparation of *Moringa-sorghum*-ogi powder

Moringa oleifera leaf was processed into powder samples. Freshly plucked moringa leaves were weighed, cleaned (rinsed) and dried at 45°C in the cabinet dryer. It was allowed to cool, and after cooling it was milled and packaged in cellophane bags until further use.

Sorghum-ogi powder was supplemented with moringa leaves powder at a substitution level of 0, 10, and 15, and then mixed thoroughly to obtain a homogenous powder.

2.3 Analysis

2.3.1 Determination of proximate composition

Sorghum-ogi samples supplemented with moringa leaf powder were analyzed for moisture, ash, crude fibre, protein (N*6.25), crude fat and the carbohydrate according to the method described by AOAC [20].

2.3.2 Determination of minerals

Selected minerals, such as calcium, magnesium, iron, potassium, zinc and copper were extracted from dry ash samples and were determined by atomic absorption spectrophotometer [20].

2.3.3 Determination of beta-carotene

The β-carotene contents of the sorghum-ogi samples were determined out by the procedure as described by Aniedu and Omodamiro [21].

2.3.4 Swelling capacity

The swelling power of the sorghum-ogi samples was determined by the methodology as described by Tester and Morrison [22]. About 0.2 g ground sample (< 60 mesh) was suspended in 10 mL of water and incubated in a thermostatically controlled water bath at 95°C in a tarred screw cap tube of 15 mL. The suspension was stirred intermittently over 30 min periods to keep the starch granules suspended. The tubes were then rapidly cooled down to room temperature (27°C). The cool paste was centrifuged at 2200 xg for 15 min to separate the gel and the supernatant. Then, the aqueous supernatant was removed and the weight of the swollen sediment was determined.

2.3.5 Sensory evaluation

The sorghum-ogi supplemented with moringa leaves was prepared into aslurry by heating on fire with constant stirring with a clean stirrer until a thick paste was formed. The prepared moringa sorghum-ogi samples were dished into sample plates and the sensory properties were evaluated by a trained panel of 30 people who are familiar with the product. The tested parameters were: appeal, colour, mouthfeel, taste and flavour using a nine-point hedonic scale ranging from 9 = like extremely to 1= dislike extremely.

2.4 Statistical Analysis

Data obtained were subjected to statistical analysis using Statistical Analysis Systems

(SAS) package (version 9.2 of SAS Institute Inc, 2003). Statistically significant differences (p<0.05) in all data were determined by the General Linear Model procedure (GLM) while Least Significant Difference (LSD) was used to separate the means.

3. RESULTS AND DISCUSSION

3.1 Proximate Composition

The proximate composition of the sorghum-ogi supplemented with Moringa leaves is shown in Table 1. The moisture content ranged between 8.67 and 9.03% and not all the values were significantly different. The sample with 15% moringa leaf substitution had the highest values of protein (18.73%) while the sorghum-ogi without moringa leaf had the lowest value (9.73%). This is relatively higher than the protein content obtained by other researchers who fortified sorghum-ogi samples with high protein sources. Ajanaku et al. [18] reported about 14.7% protein content of the sorghum-ogi samples fortified with 100% groundnut substitution and Adelekan and Oyewole [7] reported 10-11% protein. The crude fibre and the total mineral content increased with the increase of substitution level. The values were also significantly (p<0.05) different from each other, indicating that the substitution have effects on the mineral contents of the sorghum-ogi samples. Higher values were recorded in sorghum-ogi samples with 15% moringa leaf substitution. The carbohydrate content of the ogi samples ranged between 61.43% and 72.77%. The values decreased with the increase in substitution level.

3.2 Mineral Contents

The mineral content of the sorghum-ogi sample is presented in Table 2. There was an increase in the mineral content of the sorghum-ogi samples with an increase in moringa leaves substitution. The calcium content increased from 75 to 390 mg/100 g and the magnesium increased from 21 to 88 mg/100 g. The iron content increased from 12.40 to 14.13 mg/100 g. The potassium, zinc and copper contents were found to be increased from 46.67, 0.33, and 0.53 to 295.00, 0.77 and 0.67 mg/100 g, respectively. This is a reflection of the high mineral content of moringa leaves. The high content of calcium, magnesium and iron will be a good fortification, especially for the weaning child.

3.3 Beta-carotene Contents

The beta-carotene contents of the sorghum-ogi samples are displayed in Fig. 2. There was an increase in the beta-carotene content from 230 to 1241.67 µg/100 g. Beta-carotene is a precursor of vitamin A. Moringa fortification of sorghum -ogi will be an advantage in solving the vitamin A deficiency since sorghum-ogi is the commonest weaning food consumed in Nigeria and also it is a breakfast food for the young and the old. Vitamin A deficiency (VAD) is a major public health problem and the most vulnerable include preschool children and pregnant women in low-income countries. In children, VAD is the leading cause of preventable visual impairment and blindness and about 26% are reported in Africa.

3.4 Swelling Capacity

Fig. 3 depicts the swelling capacity of the sorghum-ogi samples. There was a decrease in the swelling capacity with an increase in moringa leaves substitution. The values for the swelling capacity ranged from 10.00% to 40.00% in the samples with and without moringa leaves substitution, respectively. The swelling capacity of flours depends on particle size, variety and processing methods or unit operations (Chandra et al. [23]).

3.5 Sensory Evaluation

The results of the sensory evaluation of the sorghum-ogi samples are displayed in Table 3. The sample substituted with 10% moringa leaf was not significantly different from the sorghum-ogi sample without moringa leaves in general acceptability.

Table 1. Proximate composition of *Moringa* fortified sorghum-ogi (%)

Sample	Moisture content	Protein	Ash	Fat	Crude fibre	Carbohydrate
A	9.03a	9.73a	3.17c	2.53a	2.77c	72.77a
B	8.80b	14.30b	4.30b	2.53a	3.23b	66.90b
C	8.67b	18.73c	5.17a	2.33a	3.67a	61.43c

Means having the same superscript along the same column is not significantly (p< 0.05) different from each other
A – 100% Sorghum-ogi,
B – 90% Sorghum -ogi and 10% moringa leaves
C - 85% Sorghum-ogi and 15% moringa leaves

Table 2. Mineral composition of *Moringa* fortified sorghum-ogi (mg/100 g)

Samples	Calcium	Magnesium	Iron	Potassium	Zinc	Copper
A	75.01c	21.00c	12.40c	46.67c	0.33c	0.53c
B	231.02b	65.01b	13.50b	221.01b	0.53b	0.63ab
C	390.10a	88.01a	14.13a	295.00a	0.77a	0.67a

Means having the same superscript along the same column is not significantly (p< 0.05) different from each other
A – 100% Sorghum-ogi,
B – 90% Sorghum -ogi and 10% moringa leaves
C - 85% Sorghum-ogi and 15% moringa leaves

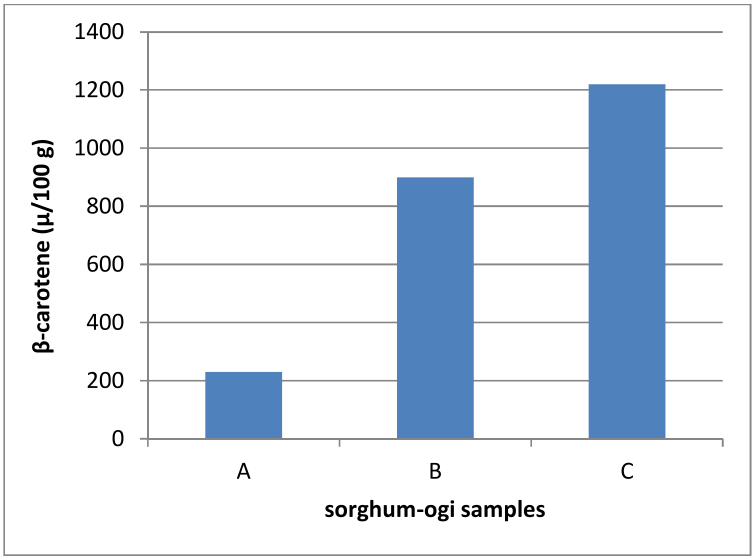

Fig. 2. β-carotene of *Moringa* fortified sorghum-ogi samples
A – 100% Sorghum-ogi,
B – 90% Sorghum -ogi and 10% moringa leaves
C - 85% Sorghum-ogi and 15% moringa leaves

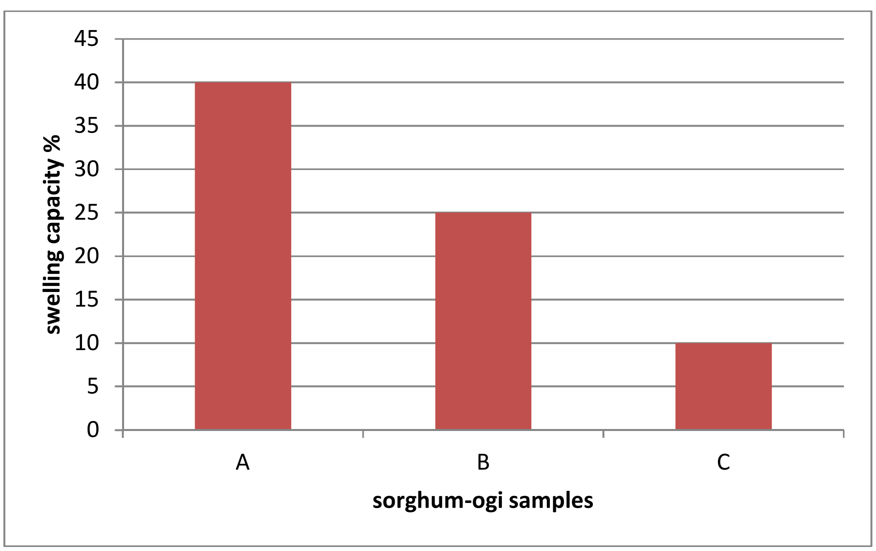

Fig. 3. Swelling capacity of *Moringa* fortified ogi samples
A – 100% Sorghum-ogi,
B – 90% Sorghum -ogi and 10% moringa leaves
C - 85% Sorghum-ogi and 15% moringa leaves

Table 3. Result of the evaluation of the sensory properties of *Moringa* fortified sorghum- ogi samples

Samples	Colour	Taste	Mouth feel	Appeal	Flavour	General acceptability
A	6.40ab	6.90a	7.00a	5.00a	6.60a	7.10a
B	7.10a	6.10a	6.10a	5.80a	5.70a	6.70a
C	5.20c	5.90a	5.50a	4.40b	5.10a	5.80b

Means having the same superscript along the same column is not significantly (p< 0.05) different from each other
A – 100% Sorghum-ogi,
B – 90% Sorghum -ogi and 10% moringa leaves
C - 85% Sorghum-ogi and 15% moringa leaves

4. CONCLUSION

The increase in the nutritional value of sorghum-ogi samples may be attributed to the relatively higher protein, fat and ash contents of moringa leaves compared to the unfortified sorghum-ogi sample. This study revealed that the incorporation of 10% moringa leaf powder in the composite ogi produced from sorghum significantly improved the nutritional qualities of the product and the sensory properties were acceptable. Therefore it can be stated that the incorporation of moringa leaves in this traditionally fermented gruel will enhance the nutritional status of the populace.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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