Nutrient composition and acceptability of cereal gruel (Ogi) produced from sorghum (*Sorghum bicolour*) supplemented with soybeans (*Glycine max*) and Ginger (*Zingiber officinale*)

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ABSTRACT

Sorghum is one of the important crops used for production of different fermented foods in Africa. The nutrient quality of sorghum is insufficient, there is need to supplement it with legumes or other commodity to make it nutritionally rich and accepted as fermented product. The processing involved picking of the grain (sorghum), fermenting, grinding, sieving and cooking. The aim of this work is to evaluate the nutritional composition and sensory acceptability of supplemented cereal gruel. The cereal gruel was produced from sorghum supplemented with different blends: sorghum only 100%; sorghum and soybean of ratio 80%:20%; sorghum, soybean and ginger in ratio 76%:20%:4%. Proximate analysis, minerals content and sensory attributes were determined using standard methods AOAC (2000). Crude fibre had the highest value (11.38%) in the sorghum sample compared to other blends. The highest Calcium level 2.3mg/100g was found in sorghum supplemented with soybeans and ginger. The sample supplemented with ginger and soybean had the highest percentage composition of protein, fat and minerals like calcium, magnesium, sodium and copper. Sample supplemented with soybeans and ginger had a significantly higher preference in taste, flavour, aroma and overall acceptability compared to sorghum supplemented with soybeans and sorghum only. Supplementing sorghum with ginger and soybean will increase the nutritional qualities and improve the sensory attributes in terms of taste, flavour, aroma and overall acceptability.

***Keywords**: sorghum, soybean, ginger, gruel, sensory analysis*

INTRODUCTION

Sorghum bicolour has many health benefits. It is rich in vitamin and minerals contains a lot of dietary fibre helpful in digestion FAO (2006). Sorghum extract has potent antioxidant ability, acting as antidote against free radicals that cause various diseases such as cancer, diabetes, and ageing. It has been used as herbal remedy to boost the bodies' immunity. Sorghum is cultivated in many parts of Asia and Africa where the grains are used to make flat breads that form staple food in many cultures. Dendy (1995). The grain is commonly eaten with the testa which retains the majority of the nutrients. It is the fifth most important cereal crop grown in the world. US Grain council (2010). It is called a variety of names; great millet and guinea corn in west Africa, kafir corn in South Africa,' dura' in Sudan, mtama in Eastern Africa, jowar in India and kaoling in China Purseglove (1972).

There are other classes of sorghum such as sorghus, grass sorghum, brown corn sorghum and special purpose sorghum. The sorghum kernel varies in colour from white through shades of red and brown to pale yellow to deep purple-brown. The most common colour are white, bronze and brown. Kernels are generally spherical but vary in size and shape. The caryopsis can be rounded and bluntly pointed 4 to 8 mm in diameter purseglove (1972). The grain is partially covered with glumes. Large grains with corneous endosperm are usually preferred for human consumption. Dendy (1995). Yellow endosperm with carotene and xanthophylls increases nutritive value. Sorghum grain that has a testa contains tannins in varying proportions depending on the variety. Several other food substances like soybean and ginger have been used to boost the nutritional value of sorghum.

The soybean (*Glycine max*) is a species of legume native of East Asia, widely grown for its edible bean which has numerous uses. The plant is classed as an oil seed rather than a pulse by the Food Agricultural Organization FAO (2012). Fat-free (defatted) soybean meal is a significant and cheap source of protein for animals' feeds. For example, soybean products such as Textured Vegetable Protein (TVP) are ingredients in many meats and diary analogues Riaz (2006). Traditional food uses of soybean include soy milk, tofu, soy sauce, fermented beans paste, natto, and teuph, etc. The oil is used in many industrial applications. The main producers of soy are the United States (35%), Brazil (27%), Argentina (19%), China (6%), and India (4%). USDA (2012). The beans contain significant amount of phytic acid, alpha-linolenic acid, and isoflavones. Soybean is a source of complete protein Henkel (2000).

Ginger or ginger root is the rhizome of the plant *Zingiber officinale* consumed as a delicacy medicine or spice. Other notable members of this plant family are turmeric, caedamom, and galangar. Ginger cultivation began in South Asia and has since spread to East Africa and the Carribean. It has a distinct flavour that can stimulate appetite. The part that is used as spice on the plant itself is the rhizomes or ginger root. It was claimed to alleviate conditions relating to diabetes, headaches, colds, fatigue, nausea and flu when used in tea or food. Ernst and Peter (2000). Food supplementation or enrichment is the process of adding nutrients to food. It can be purely a commercial choice to provide extra nutrient in a food, or sometimes it is a public health policy which aims to reduce numbers of people with dietary deficiencies in a population. Diets that lack variety can be deficient in certain nutrients. Sometimes the sample foods of a region can lack particular nutrients, or because of the inherent inadequacy of the normal diet, addition of micronutrients to staples and condiments can prevent large scale deficiency diseases in these cases. FAO (2006).

Micronutrients are nutrients required by humans and other living things throughout life in small quantities for a whole range of physiological functions. Canadian UNICEF Committee (2006). Approximately 4% of the body's mass consists of minerals. Mc addle *et al.,* (2000). Minerals serve divers roles such as providing structures for bones and teeth, help to maintain normal heart function, muscle contractility, neural conductivity and electrolyte balance. Minerals regulate cellular metabolism by becoming part of enzymes and hormones that modulate cellular metabolism. Mc Addle *et al.*, (2000). The commonly consumed gruel consisting of only sorghum does not contain sufficient nutrients needed for proper body functioning and therefore, needs to be supplemented with other food material that will enhance the nutritional qualities. The aim of this work is to evaluate the nutrient composition and sensory acceptability of supplemented cereal gruel.

MATERIALS AND METHODS

Raw sorghum, soybeans and ginger were bought at Apata market, Ibadan, Nigeria. Reagents used were of analytical grades.

Sample preparation

The samples were picked to remove contaminations. Ginger was cleaned to remove extraneous materials, dirt, sand etc.

Fermentation

Raw sorghum was washed and soaked in water for 72 hours, the soybeans was boiled for 30 mins and dehulled while the ginger was cleaned. The samples were prepared with (1) sorghum-100%, (2) sorghum + soybeans-80:20%, (3) sorghum + soybean + ginger-76:20:4%.

Grinding

The samples were ground separately in a well-cleaned grinding machine, filtered and cooking was done to make *ogi* (cereal gruel).

Determination of nutrient composition

Portions of the sediment after sieving were dried, using the oven at 60 ^{o}C into powder and used in determining the nutrient composition. Standard methods of the Association of the Official Analytical Chemist AOAC. (2000) were used to determine the moisture content, crude protein, crude fat, total ash and crude fiber content of each sample.

Moisture content Determination

Powdered sample was weighed (2 g each), into pre-weighed and oven dried moisture dishes, which was later transferred into the oven and dried sample was cooled in the desiccators and the loss in weight was determined.

Ash Content Determination

Powdered sample of processed and unprocessed sorghum, soybeans and ginger were weighed (2.0 g each) into pre-weighed oven dried crucibles. The crucibles were placed in the Muffle furnace and the temperature was increased gradually between 200 ^{o}C and 450 ^{o}C. The samples were heated until white ash was obtained. There after the crucibles were removed and cooled in the desiccators after which their weights were taken and percentage ash was subsequently calculated.

Fat Determination

Oven dried, well ground samples were weighed (2.0 g each) into filter paper of a known weight. Then the extraction was carried out using Soxhlet extractor. About 400 ml petroleum ether was used for the extraction.

Crude fibre determination

Exactly 2.0 g of the samples was weighed accurately into the fibre flask and 100 ml of 0.225N H_2SO_4 was added. The mixture was heated under reflux for one hour on the heating mantle. The hot mixture was filtered through a fibre sieve cloth. The filtrate obtained was thrown off and the residue was returned to the fibre flask to which 100 ml of 0.313N NaOH was added and heated under reflux for another 1 h. The mixture was filtered through a fibre sieve cloth and 10 ml of acetone was added to dissolve any organic constituent. The residue was washed with about 50 ml hot water on the sieve cloth before it was finally transferred into the crucible. It was afterwards drained, dried in the oven at 105 ^{o}C, cooled in the desiccator and weighed to obtain the weight W1. The crucible with sample was transferred to the Muffle furnace for ashing at 550 ^{o}C for 4 h. After ashing, it was cooled and weighed to obtain weight W2 and the percentage fibre was calculated.

Crude Protein Determination

Oven dried samples (2.0 g) each was weighed into 50 ml micro-Kjeldhal flask. Then 5 ml of concentrated H_2SO_4 with half kjeldhal catalyst tablet were added after which the samples were digested by heating until the digest was clear. Heating was allowed to continue for another 2 min to ensure complete digestion. After cooling, the volume was made up to 50 ml. A 5 ml of Boric acid was transferred into 100 ml conical flask placed in such a way that the tip of the condenser tube was below surface of the boric acid. Thereafter 5 ml of the digested boric acid was transferred into distiller with the addition of 10 ml of NaOH. Approximately, 5 ml of the distillate was collected into the receiving flask and titrated against 0.025 H_2SO_4 and the crude protein was calculated.

Sensory Analysis

The organoleptic property of the cereal gruel produced from the blends was carried out using the method of Larmond (1977). The product was assessed using the following characteristics (colour, taste, flavour, aroma, texture, overall acceptability) on a 9 point hedonic scale (9-like extremely; 8-like very much 7- like moderately; 6 like slightly; 5- neither like nor dislike; 4- dislike slightly ; 3- dislike moderately ; 2-dislike very much ; 1- dislike extremely) attribute and mean was calculated.

Statistical analysis

Data was analysed using SPSS version 15. Analysis of Variance (ANOVA) was used to compare the difference between mean sensory characteristics, proximate and mineral compositions estimated. Post hoc test was used to identify the contributors to the mean differences seen. The level of statistical significance was 5%.

RESULTS AND DISCUSSION

Table 1 shows the proximate composition of sorghum only, sorghum with soybean and sorghum supplemented with soybean and ginger. Significant increase in protein was observed in the samples supplemented with soybean and that supplemented with soybean and ginger. Soybeans is a good source of protein, therefore its inclusion would have contributed to the increased protein content of the blend as confirmed by Khetarpaul *et al*., (2004), Bachknudsen and Munck (1985). Sorghum do not contain essential amino acids but majorly proteins known as kafirins, which are resistant to digestion as earlier noted by De Mesa-Stone street and alavi (2010). It is therefore, necessary to supplement with other protein plant materials Dendy (1995). Soybeans and ginger contributed to the increase in the ash content of the blends: this indicates that the supplemented blends would contain more mineral elements needed for proper body functions.

Fat increased with the addition of soybeans as observed in table 1, soybeans contain a considerable quantity of fat and oil which are majorly polyunsaturated. The polyunsaturated fat content of soybeans is of importance because it includes linolenic acid, an omega-3 fatty acid. Omega-3 fatty acids may be essential nutrients for infants and help to reduce risk of both heart disease and cancer. To reduce heart diseases and hypertension a diet rich in fibre, minerals and unrefined carbohydrates, but low in saturated fat is recommended.
The mean of moisture content ranged from 8.7 to 9.2%. Crude fibre had the highest value (11.38%) in the sorghum sample compared to other blends. Lower moisture content in food samples will promote longer shelf life, therefore the sorghum supplemented with soybeans and ginger will possess longer shelf life. The carbohydrate contents of the blends were different from one another in which the highest was obtained from sorghum with soybean (65.57%). Sorghum contain majorly carbohydrates made up of starch and dietary fibre. Dietary fibre decreases diets metabolizable energy, thereby reducing the tendency to be obesed. Tucker and Thomas (2009)

Table 1: Proximate composition of sorghum only, sorghum with soybean and sorghum supplemented with soybean and ginger

Nutritional composition (%)	Sorghum (100%)	sorghum + soybeans (80:20)	sorghum + soybeans + ginger (76:20:4)
Protein	6.130 ±0.020	6.440±0.020	6.690±0.020
Ash	4.670±0.010	5.810±0.020	6.950±0.020
Fat	3.877±0.015	4.020±0.020	3.710±0.020
Moisture Content	9.210±0.020	8.670±0.020	8.670±0.020
Crude Fibre	11.377±0.015	10.230±0.020	10.540±0.020
Carbohydrate	64.420±0.020	65.570±0.020	63.130±0.020

Table 2 also showed the mineral elements of different gruel blends from sorghum only, sorghum with soybean and sorghum supplemented with soybean and ginger. The highest Calcium level 2.3mg/100g was found in sorghum supplemented with soybeans and ginger. Likewise, Sodium content (20mg/100g) was highest in sorghum supplemented with soybean and ginger. As seen, the minerals determined in the blends, samples containing sorghum with soybean and ginger is also richer in potassium, and copper while blends containing sorghum and soybean is richer in manganese and zinc. The iron content of sorghum only (128mg/100g) is higher than that of the other blends.

Table 2: Mineral elements of different gruel blends from sorghum only, sorghum with soybean and sorghum supplemented with soybean and ginger

Mineral components(mg/100g)	sorghum	sorghum +Soybeans	sorghum + Soybeans +Ginger
Calcium	2.070±0.020	1.960±0.020	2.320±0.020
Magnesium	0.860±0.030	0.740±0.020	0.860±0.020
Potassium	0.390±0.010	0.350±0.020	0.410±0.020
Sodium	19.866±0.002	17.643±0.002	20.008+0.002
Manganese	77.675±0.002	81.008±0.002	79.856±0.002
Iron	128.311±0.002	108. 690±0.020	119.088±0.002
Zinc	56.740±0.020	61.230±0.020	59.750±0.020
Copper	11.023±0.001	9.985±0.002	12.350±0.020

Table 3 shows the result of the sensory quality of different gruel blends from sorghum only, sorghum with soybean and sorghum supplemented with soybean and ginger. Sample supplemented with soybeans and ginger had a significantly higher preference in taste, flavour, aroma and overall acceptability compared to sorghum supplemented with soybeans and sorghum only. It seems inclusion of ginger brought about the preference. This is supported by the findings of Bliddal *et al*., (2000) that ginger rhizomes contain biologically active aromatic substances such as 6-gingerol, zingiberene, bisabolene, and several other types of lipids that gave it the characteristics flavor.

Table 3: Sensory characteristics of different gruel blends from sorghum only, sorghum with soybean and sorghum supplemented with soybean and ginger

Characteristics	Sorghum (100%)	Sorghum + soybeans (80:20)	Sorghum + soybeans +ginger (76:20:4)
Colour	7.20 ± 1.06^a	7.00 ± 1.26^a	7.45 ± 1.23^a
Taste	7.25 ± 0.95^b	7.15 ± 1.09^b	7.70 ± 1.29^a
Flavour	7.30 ± 0.79^b	7.20 ± 1.26^b	7.70 ± 0.98^a
Aroma	7.20 ± 1.33^b	7.20 ± 1.21^b	7.60 ± 1.27^a
Texture	6.70 ± 1.30^a	7.40 ± 1.21^a	7.60 ± 0.99^a
Overall acceptability	7.25 ± 0.85^a	7.43 ± 1.08^a	7.80 ± 1.36^a

Values with the same superscript along a row are not significantly different

CONCLUSION

Supplementing sorghum with ginger and soybean will increase the nutritional qualities and improve the sensory attributes in terms of taste, flavour, aroma and overall acceptability.

REFERENCES

AOAC. 2002. Association of Official Analytical Chemists 2000.

Bachknudsen, K.E and Munck, L. 1985. Dietary fibre contents and composition of sorghum and sorghum based foods. Journal of cereal science 3:153-164.

Bliddal, H., Rosetzsky, A., Schlichting, P. 2000. “A randomized, placebo-controlled, cross-over study of ginger extracts and Ibuprofen in osteoarthritis,” Osteoarthritis and Cartilage. 8:1 pp. 9–12.

Canadian UNICEF Committee. 2006. Global child survival and health pp 6

De Mesa-Stonestreet, N. J., Alavi, S. and Bean, S. R. 2010. Sorghum Proteins: The Concentration, Isolation, Modification, and Food Applications of Kafirins. Journal of Food Science, 75: 90–104.

Dendy, D.A.V. 1995. Sorghum and millets: production and importance. In: Dendy DAV, editor. Sorghum and millets: chemistry and technology. St. Paul, Minn.: American Assoc. of Cereal Chemists.P p 11–26.

Ernst, E., Pitter, M. H. 2000. Efficacy of ginger for nausea and vomiting: A systemic review of randomized clinical trials. British Journal of Anesthesia, 84:367-371.

FAO. 2012. World health organization and food and agricultural Organisation of United Nations guidelines on food fortification with micronutrients

FAO. 2006. World Health Organisation & Food & Agricultural Organisation of United Nation Guidelines on Food Fortification with Micronutrients.

Henkel 2000 ‘Soy: health claims for soy protein, Questions about Other components’. FDA consumer (Food and Drug Administration), 34(3):18-20.

Khetarpaul. N, Goyal, R. Garg, R 2004. Nutritional and sensory evaluation of nutritious porridge prepared using combinations of soy and sorghum grits. Nutrition and Health 17 (4) 309-315.

Larmond, E. 1977. Laboratory methods for sensory evaluation of foods. Publication N1637 Department of Agriculture, Ottawa, Canada.

Mc Addle, W.D., Lippincot, O.T., Williams, A.A., Wilkins, P.J., 2000. Micronutrients and water. 2nd edition, Essentials of Exercise Physiology, pp.75

Purseglove, J. W., (1972); Tropical Crops; Monocotyledons London Longman Group Limited Vol 1, pp 334.

Tucker L. A., Thomas, K. S., 2009. Increasing total fiber intake reduces risk of weight and fat gains in women. Journal of Nutrition 139, 576-581

Riaz, M.N. 2006. Soy Application in foods. London: CRC Taylor and Francis pp 273

United States Grain Council, 2010. “Sorghum” U.S. Department of agriculture, Agricultural research service.

USDA. 2012. National Nutrient Database for Standard Reference, SR 23