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Production and quality evaluation of complementary food formulated from fermented sorghum, walnut and ginger

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ABSTRACT
Objective: To evaluate the effect of sorghum and walnut variation on physicochemical properties and acceptability of breakfast meal.
Methodology and results: Sorghum, walnut and ginger were processed into flour separately and were then blended in ratios 100:0:0(SWG1); 80:15:5(SWG2); 70:25:5(SWG3); 60:35:5(SWG4) and 50:45:5(SWG5). The sorghum was soaked in water for 48hr to softened kernel and then milled, sieved to remove the hulls and allowed to ferment naturally for 72hr. The fermented cake was dried in hot air oven at 60^{0}C for 10hr and milled to produce the fermented sorghum flour. Walnut was cooked for 30min, deshelled, soaked in 0.2% potassium metabisulfite and dried in air oven at 60^{0}C and then milled to obtain walnut flour while ginger flour was obtained by peeling, washing, dried in oven at 50^{0}C 5hr and then sieved. Different samples were prepared by combining 80%, 70%, 60% and 50% fermented sorghum flour, 15%, 25%, 35% and 45% walnut flour with a constant 5% of Ginger powder. The proximate, pasting, and sensory properties of processed flour were determined. The result indicates that the protein content increases as walnut proportion of the samples increased. The protein content of the resulting flour increased significantly from 6.52 to 10.21%, with a corresponding decrease in the carbohydrate content from 85.23 to 77.22%; the moisture content(flour) ranged from 6.30 to 9.01%; fat content from 1.67 to 2.28%; ash content from 0.05 to 0.11%; crude fibre from 0.27 to 0.3%; carbohydrate from 85.23 to 77.22%. The break down set point ranged from 5.57 to 66.30 RVU; peak viscosity from 90.40 to 212 RVU; final viscosity from 114 to 277 RVU; set back from 23.75 to 64.57 RVU; peak time from 5.32 to 8.51min and the pasting temperature from 74.16 to 677.16^{0}C. The set back value and breakdown viscosity of sorghum flour containing zero or 10% walnut flour were significantly higher than those containing 30 and 50% walnut flour. There exists significant difference ($P < 0.005$) among the samples analyzed. Sensory evaluation conducted on the porridge showed no significant difference ($p < 0.05$) in color and odour.
Conclusion and application of findings: The nutritional and textural qualities of sorghum flour were improved with the addition of walnut and ginger flour. Samples with 25% walnut and 5% ginger were more acceptable than the samples containing 15% walnut and 5% ginger, 35% walnut and 5% ginger, 45% walnut and 5% ginger. Processing of sorghum into flour and porridge will encourage the use and utilization of the sorghum

in other forms. Fortification of sorghum with walnut and ginger flour makes the food more nutritious thereby alleviating the problem of malnutrition especially in children.
Keywords: Sorghum, walnut, ginger, fortification, proximate analysis, sensory properties

INTRODUCTION

Inadequate intake of protein in developing countries has led to various forms of malnutrition in both children and adults. It has been reported that in developing countries; protein malnutrition persists as a principal health problem among children below the age of five in Nigeria (UNICEF, 1996). Nutritionists believe that animal source proteins provide the best proteins for good diets. However, animal source of proteins are quite expensive in most of the sub Sahara Africa-Saharan (SSA) countries and thus there is a high dependence dependency on plant protein. Proteins. Consequently, the need to find inexpensive sources of protein of good quality cannot be overemphasized. Plant proteins are known to have limiting amino acids (Ihekoronye and Ngoddy, 1985) and it is therefore pertinent to combine these plant proteins in proportions that would improve the protein intake of majority of consumers in SSA. In Nigeria, the infant complementary foods have been found to be inadequate in protein contents (Nnam, 2002). About 40% of the Nigerian population lives below poverty line and therefore cannot afford commercial feeding formula for their infant (Wardlaw, 1999) or good quality animal source of proteins. Also, most of these infants are fed with high carbohydrate gruels made from cereals which are not nutritious and too watery to meet the nutritional needs of a growing infant. Adequate processing and judicious blending of the locally available foods could result in improved intake of nutrients to prevent malnutrition problem (Nnam, 2002).

Sorghum, walnut and ginger are food materials that are readily available in Nigeria and they have promising nutritional attributes. Sorghum (*Sorghum bicolor* (L.) is an important cereal crop grown in the semi-arid tropics of Africa and Asia due to its drought tolerance. It is a staple food crop cultivated on a substantial level by farmers in these areas for human consumption (Murty and Kumar, 1995). Whole sorghum grain is an important source of vitamin B complex and some minerals like phosphorus, magnesium, calcium and iron (FAO, 1995). The protein content of sorghum is similar to that of wheat and maize with lysine as the most limiting amino acid (FAO, 1995). Sorghum grains serve as an ingredient for many unique indigenous foods and beverages. Fermented sorghum porridge is an important staple food item for people of the West African sub-region and is also important weaning foods for infants and convalescents due to its high caloric value and significant presence of some mineral elements. A porridge or stiff paste, a basic diet in most of east Africa, is prepared by adding pounded flour to hot water. In Nigeria, particularly in the northern region, it is utilized mainly in the preparation of *tuwo a* thick dough prepared by mixing sorghum flour in hot water and allowing the paste to cool and gelatinize which is then eaten with soup. *Akamu, koko* or *pap* is prepared by soaking the grains in cold water, milling and filtering through a cloth and the expressed mass is reconstituted in cold water after which boiling water is added to it. The rhizome of the popular ginger species, *Zinger officinale*, is widely used as a spice and food seasoning due to its sweet aroma and pungent taste. It is well known to have antioxidant activity (Jitoe *et al*., 1992; Zia-ur-Rehman *et al*., 2003,) and effective antimicrobial agents. A ginger rhizome extract exhibited the highest **a**ntioxidant activity (Mansour and Khalil. 2000) due to the effect of its total phenols (Stoilova *et al*., 2007). Apart from the antimicrobial properties, spices are believed to have medicinal values (especially in African settings) and have desirable determinative influences on the overall organoleptic quality of food when used. In addition, the use of low temperature storage to retard and stabilize

microbial growth in food is well documented (Jay, 1978; Ogiehor *et al*., 1998; Ogiehor *et al.,* 2004).

The conophor plant (*Tetracarpidium conophorum*), commonly called the African walnut, is a perennial climbing shrub found in the moist forest zones of sub-Sahara Africa. Conophor plant is cultivated principally for the nuts which are cooked and consumed as snacks, along with boiled corn. Ogunsua and Adebona (1983) and Nwokolo (1987) have all reported on the high nutrient value potentials of cooked conophor nut. Adesioye (1991) reported on the impact of traditional processing on the nutrient and sensory qualities of the nut. Adebona *et al.* (1988) developed a biscuit-like snack food from conophor nut, throwing some light on the functional significance of the oilseed.

With the increased interest in the exploitation of less-common oilseeds, sorghum like other cereals having limitations in some essential amino acids particularly lysine, while legumes and oilseeds are rich in both protein and lysine, but usually deficient in sulphur containing amino acids (methionine and cystine) can form good complements for each other (Eggum *et al*., 1983). It is often, therefore, emphasized that legume protein and oil seeds are the natural supplement to cereal grain to improve the level of essential amino acid. Also, there is a growing recognition that legumes, oil seeds and their products are good sources of vitamins and minerals (Amjad *et al*., 2006). This study forms part of exploration work on the improvement of the nutritional quality of the traditional complementary foods in Nigeria using cheap and locally available foods. In this study, an attempt is made to improve sorghum protein quality and quantity by formulating a composite flour from fermented sorghum, walnut and ginger for possible use as complementary food for older infants and young children.

MATERIALS AND METHODS

Flour preparation: Sorghum, walnut and ginger were all purchased from local market in Lagos. The fermented sorghum flour was produced by soaking sorghum grains in water for 48hrs. The softened kernel was milled and sieved to remove the germs and hulls. The sorghum slurry was allowed to ferment naturally in clean plastic bucket anaerobically for 72hrs and the steep water decanted. hours. The fermented meal was then pressed using a clean muslin cloth to produce the fermented cake. The cake was then dried in hot air oven at 60^0C for 10hrs and milled to produce the fermented sorghum flour which is packaged in clean polyethylene bag. The walnut was washed to remove adhering contaminants and then cooked for 30mins minutes in sulphited water to the removal of the shell and then soaked in 0.2% potassium metabisulfite for 5mins.facilitate the deshelling process. The deshelled walnut was size reduced with a stainless steel kitchen knife to increase surface area and then blanched by adding into boiling water and allowed standing for 5mins before draining . This helps to reduce the tannin content of the walnut The blanched walnut was then dried in hot air oven at 60^0C for 5hrs to produce walnut flour. The ginger flour was produced by washing in sterile water after peeling and then in air oven at 50^0C 5hrs and sieved using 0.25mm mesh screen. Different samples were prepared by combining 80%, 70%, 60% and 50% fermented sorghum flour, 15%, 25%, 35% and 45% walnut flour with a constant 5% of Ginger powder (Table1). The flours were then made into porridges. The flours were evaluated for their nutrient composition, pasting properties and while the sensory properties of porridges were also evaluated.

Table 1: Blends of Sorghum, walnut and ginger used in breakfast meal production

Code	Sorghum	Wall nut	Ginger	sugar
SWG1 (100%Sorghum)	95	------	-------	5
SWG2 (75% Sorghum: 15% walnut: 5% ginger)	75	15	5	5
SWG 3 (65% Sorghum: 25% walnut: 5% ginger)	65	25	5	5
SWG 4 (55% Sorghum: 35% walnut: 5% ginger)	55	35	5	5
SWG 5 (45% Sorghum: 45% walnut: 5% ginger)	45	45	5	5

Moisture content determination: 5grammes of sample was weighed into a Petri-dish of known weight. The weighed sample was put into an oven pre-set at 110°C for 3hrs. The sample was removed and cooled in a dessicator to room temperature and the weight was determined after which it was returned into the oven at 110°C for 30 minutes until constant weight was obtained: AOAC (2004).

Ash content determination: 5grammes of sample was weighed into a previously ignited and cooled silica dish. The dish was ignited gently first and then at 600^{0}C for 3 hours in a muffle furnace. The dish and its content were cooled in a dessicator and reweighed; the weight of the residue was recorded as ash content.

Crude fat determination: Crude fat was determined by the method of AOAC (2004). This was determined using a Soxtec System HT2 fat extractor. Crude fat was extracted from the sample with hexane, and the solvent evaporated off to get the fat. The difference between the initial and final weight of the extraction cup was recorded as the crude fat content.

Crude protein determination: Crude protein was determined by Kjeldahl method using Kjeltec TM model 2300, as described in Foss Analytical manual, AB, (2003). The method involved digestion of the sample at 420^{0}C for 1hr to liberate the organically bound nitrogen in the form of ammonium sulphate. The ammonia in the digest ammonium sulphate was then distilled off into a boric and receiver solution, and then titrated with standard hydrochloric acid. A conversion factor of 6.25 was used to convert from total nitrogen to percentage crude protein (AOAC, 2004).

Total energy: The total energy value of the five formulations was determined according to the method of Mahgoub (1999) using the formula as shown below:

Total energy (kcal/100g) =
[(% available carbohydrates X4) + (% protein X4) + (% fat X9)]

Percentage protein calories were determined according to James, (1995) as shown below:

% Protein calories = % Protein × 4/ total energy of formulation

Determination of pasting properties: Pasting properties were determined with a Rapid Visco Analyzer (RVA) (Newport Scientific RVA Super 3). An aliquot 3grammes of sample was weighed in a vessel; 25ml of distilled water was dispensed into a new test canister. The sample was then transferred into the water surface in the canister. The paddle was placed into the canister and the blade vigorously jogged through the sample up and down ten times. The test proceeded and terminated automatically. The slurry was heated from 50 to 95^{0}C and cools back to 50^{0}C within 12min, rotating the can at a speed of 160rpm with continuous stirring of the content with a plastic paddle. Parameters estimated were peak viscosity, setback viscosity, final viscosity, trough, breakdown value, pasting temperature and time to reach peak viscosity.

Sensory evaluation: Porridges were prepared from each of the composite flour. One hundred grams of each flour sample was homogenized with 500mls deionized water. The slurry was heated slowly with constant stirring for 15mins. One (1) teaspoon of sugar was added to each sample. The porridges were kept separately in thermos flask for sensory evaluation with 20 untrained panelists drawn from Yoruba ethnic group among the staff and students of Department of Food Technology, Yaba College of Technology. They evaluated the samples using a nine point hedonic scale ranging from 1(extremely disliked) to 9 (extremely liked) (Watts *et al.*, 1989). The five porridges were coded appropriately in the hedonic scale. Each judge was given six white plastic cups and teaspoon for use in the sensory evaluation. The judges were provided with clean water to rinse their mouth in between testing of the porridges to avoid carry over effect. Each panelist evaluated the porridges for color, flavour, texture, taste and overall acceptability.

Data analysis: Proximate analysis was carried out in three triplicates while pasting properties was in duplicate. The data were subjected to Analysis of Variance (ANOVA) ($p < 0.05$). Means with significant differences were separated by Turkey test using SPSS 11.0 software.

RESULTS AND DISCUSSIONS

Proximate composition: The proximate composition is shown in Table 2. The proximate analysis showed that all the samples were within the normal moisture contents of dried food (flour blends). According to these results there are significant differences ($p<0.05$) in the moisture content of the five formulations. The moisture content ranged between 6.30±0.01% and 9.01±0.01%. The low moisture observed for the five formulations is a good indicator of their potential to have longer shelf life. This is in line with the findings of Vincent, 2002. It is

believed that materials such as flour and starch containing more than 12% moisture have less storage stability than those with lower moisture content. For is this reason, a water content of 10% is generally specified for flours and other related products. It should be pointed out that when these products are allowed to equilibrate for periods of more than one week at 60% relative humidity and at room temperature (25 to 27^{0}C), moisture content might increase. The ash content ranged from 0.05% to 0.11%. These values are similar to the values reported from the production of legumes-fortified weaning food (Egounlety, 2002) but lower than reported results of Kanu *et al*., 2009 from production and evaluation of breakfast cereal-based porridge mixed with sesame and pigeon peas for adults. Fat content ranged from 1.67% to 2.28%. Fat was significantly different for all the formulations.

SWG 5 had the highest fat content followed by SWG 4. From the results the differences were significant ($p<0.05$). Protein content ranged from 6.52% to 10.21%. The protein content for the five formulations was significantly different ($p<0.05$) from each other. SWG 5 has the highest protein content followed by SWG 4. The result of the SWG 5 was significantly lower than the reported results of Egounlety (2002) for the nutritive value of protein-energy legume-fortified weaning for '*ogi*' and reported results of Kanu *et al*., 2009 who also studied production and evaluation of breakfast cereal-based porridge mixed with sesame and pigeon peas for adults and the result reported for Binnimix (Kanu *et al*., 2007c). Ashaye et al. (2001) reported an increase in protein content (7.28%) and ash (3.58%) when yam flour was substituted with 40% cowpea flour while Achi (1999) reported an increase in protein content from 3.5% in the control (yam flour) to 19.7% for yam flour fortified with 40% soybeans flour. Carbohydrate content varied and decreased with addition of walnut flour. This was in agreement with the findings of Jimoh and Olatidoye (2009) who reported a decrease in carbohydrate content with increase in soybean flour fortification.

Energy was observed to be high for all the five formulations. Significantly higher ($p<0.05$) than the results reported by Mahgoub (1999) and Kulkani *et al*., (1991) who studied sorghum malted-based weaning food formulation: Preparation, functional properties and nutritive value but lower than the results reported by Kanu *et al*., 2009 who also studied production and evaluation of breakfast cereal-based porridge mixed with sesame and pigeon peas for adults. The results corroborated those of Egounlety (2002). Energy content is a parameter used to determine the quality of food especially for formulations designed for adult with high energy requirements. However percentage protein calories were lower than those reported by Mahgoub (1999) but, higher than the required amounts for adult as reported by Robbin-Coker and Jalloh (1975). According to the Indian Council for medical research, the required optimal protein-calorie requirement for preschool children in India is 7.1% (Mahgoub, 1999). Protein-energy ratio gives the protein content of a food or diet expressed as the proportion of the total energy provided by protein (17KJ, 4kcal/100 g). The average requirement for percent protein is about 7% of total energy intake. Average Western diets provide about 14% for children and half of it for adults (Bender, 2005).

Table 2: Proximate composition (%) complementary foods from sorghum, walnut and ginger blends

Proximate Composition	SWG1	SWG2	SWG3	SWG4	SWG5
Protein (%)	6.52±0.01	7.80±0.01	8.20±0.00	9.05±0.05	10.21±0.01
Moisture (%)	6.30±0.01	7.60±0.01	7.70±0.01	8.01±0.01	9.01±0.01
Ash (%)	0.05±0.00	0.06±0.00	0.08±0.00	0.09±0.00	0.11±0.06
Fat (%)	1.67±0.01	1.72±0.00	1.81±0.00	2.10±0.00	2.28±0.00
Crude fibre (%)	0.27±0.00	0.28±0.01	0.29±0.01	0.31±0.01	0.30±0.01
Carbohydrate (%)	85.23±0.01	82.63±0.01	81.92±0.00	80.52±0.00	77.22±0.01
Energy (kcal/100g)	382.03	377.2	376.78	377.18	358.88
% protein calories	6.82	8.3	8.7	9.6	11.4

Means of duplicate determination, significant at level ($p<0.05$)

SWG1 100% Sorghum , SWG2 75%80% Sorghum: 15% walnut: 5% ginger , SWG3 65%70% Sorghum: 25% walnut: 5% ginger , SWG4 55%60% Sorghum: 35% walnut: 5% ginger , SWG5 45%50% Sorghum: 45% walnut: 5% ginger

Pasting properties: The pasting properties are shown in Table 3. The pasting properties are important as it is used in predicting the behaviour of porridge during and after cooking. The peak viscosity value ranged from 90.40 to 212.65RVU. The highest value was recorded in SWG1 (unsubstituted sorghum flour) while the lowest value was recorded in SWG5 (50:45:5). Peak viscosity is the maximum viscosity attained during or soon after the heating portion of the test in RVU. It also provides an indication of the viscous load likely to be encountered during mixing. The trough value ranged from 84.18 to 146.00 in substituted sorghum flour and unsubstituted sorghum flour respectively. Break down set point ranged from 25.57 to 66.30 while final viscosity value ranged from 114.10 to 277.17RVU. Set back value ranged from 23.75 to 64.57RVU. Peak time value ranged from 5.32min to 8.5min. Pasting temperature value ranged from 74.16^{0}C to 77.16^{0}C. The pasting temperature of the porridge is lower than the boiling temperature; hence the porridge can form a paste in hot water below boiling point. This means at a commercial level, there is a remarkable cost saving.

Viscosity also depends on the shape and swelling power of the granule and amylopectin granules interaction (Ring et al, 1987). Peak viscosity is the maximum viscosity attained during or soon after the heating portion of the test in RVU. Peak viscosity indicates the water binding capacity of the starch or mixture and it occurs at the equilibrium point between swelling causing an increase in viscosity rupture and alignment causing its decrease. The peak viscosity indicates the water–binding capacity of the flour samples, and is important to the user in order to obtain a useable starch paste (Adeyemi, 1989)Break- down is peak viscosity minus trough viscosity in RVU. Final viscosity indicates the ability of the material to form a viscous paste or gel after cooking and cooling. Also, the final viscosity (277.17 RVU) value of 100% sorghum sample SWG1 indicated the ability to form a firm, visco-elastic paste or gel after cooking and cooling owing to re-association of starch molecules (Newport Scientific, 1998). This was in agreement with the finding of Jimoh and Olatidoye (2009) who reported high values for yam flour and decrease in the soybean fortified yam flour samples. Abiodun *et al. (*2010) also reported an increase in peak viscosity of trifoliate yam flour with increase in cassava starch substitution. Peak time was also higher for starch samples in this work and ranged from 5.32 to 8.51. Set back has been correlated with texture of various products and also, an index of the tendency of the cooked flour to harden on cooling due to amylose retrogradation (Adeyemi, 1989). High set back is also associated with syneresis, or weeping, during freeze-thaw cycles for example, and substituted starches are commonly used where this presents a quality defect. There is a relationship between amylose content and set back; high amylose indicates high leaching hence high set back. The rate of starch breakdown depends on the nature of the materials, the temperature, and the degree of mixing and shear applied to the mixture (Newport Scientific, 1998). The ability of a mixture to withstand heating and shear stress that is usually encountered during processing is an important factor for many processes especially those requiring stable paste and low retrogradation/seneresis. High holding strength exhibited by sample SWG1 (unfortified sample) showed that the flour could withstand high heat treatment during processing than the substituted flour sample. Bhattacharya et al. (1999) indicated that high holding strength generally represents low cooking loss and superior eating quality. The substituted flour samples had lower breakdown values which were not significantly different ($p > 0.05$) from each other. Samples with low breakdown values indicated high stability (Beta *et al.,* 2000). Therefore, substituted flour samples were more stable than the sorghum flour alone. Pasting temperature is a measure of the minimum temperature required to cook a given food sample and also gives an indication of the gelatinization time during processing. It is the temperature at which the first detectable viscosity is measured and an index characterized by initial change due to the swelling of starch, it can have implications for the stability of other components in a formula and also indicate energy costs (Newport Scientific, 1998). Pasting temperature has been reported to relate to water binding capacity, a higher pasting temperature implies higher water binding capacity property of starch due to high degree of association between starch granules (Kulkarni *et a*l., 1991).

Table 3: Paste characteristics of complementary foods from sorghum, walnut and ginger blends

Sample	Pasting temp (^{0}C)	Peak time (min)	Peak viscosity (RVU)	Trough (min)	Breakdown (RVU)	Final viscosity (RVU)	Set back (RVU)
SWG1	74.16	5.32	212.65	146.00	66.30	277.17	64.57
SWG2	75.40	5.46	180.45	120.34	60.06	237.13	56.73
SWG3	75.10	7.01	171.30	117.07	54.23	215.46	44.16
SWG4	76.31	8.23	139.62	114.26	35.34	116.93	37.33
SWG5	77.16	8.51	90.40	84.78	25.57	114.10	23.75

Values are means of triplicates determination. Within column, values with different letters are statistically different ($p \leq 0.05$) . SWG1 100% Sorghum , SWG2 75%80% Sorghum: 15% walnut: 5% ginger , SWG3 65%70% Sorghum: 25% , walnut: 5% ginger , SWG4 55%60% Sorghum: 35% walnut: 5% ginger , SWG5 45%50% Sorghum: 45% walnut: 5% ginger

MICROBIOLOGICAL ANALYSIS

Data on the microbiological characteristics of the sample are presented in Table 4. The microbiological analysis was carried out to ascertain the safety of the product for consumption. While microorganism was detected in all the samples, the total viable bacterial count decreased from 1.8×10^4 to 1.6×10^4 in all the samples with 15% and 45% level of supplementation with walnut respectively. The trend in mould and yeast population was similar. This could be probably due antioxidant effect of ginger. The relative presence of bacteria and molds might be due to the processing which sorghum was subjected to. However, the high temperature of cooking is expected to reduce the microorganisms present.

Table 4: Microbiological analysis

Sample	Total Viable count (Cfu/g)	Yeast count x 10^4 (Cfu/g)	Mould count x 10^4 (Cfu/g)
SWG1	1.8×10^4	0.9×10^4	1.4×10^4
SWG2	1.8×10^4	1.6×10^4	1.6×10^4
SWG3	1.4×10^4	1.4×10^4	1.6×10^4
SWG4	1.8×10^4	1.4×10^4	1.4×10^4
SWG5	1.6×10^4	1.0×10^4	1.3×10^4

SWG1 100% Sorghum , SWG2 75% Sorghum: 15% walnut: 5% ginger , SWG3 65% Sorghum: 25% walnut: 5% ginger , SWG4 55% Sorghum: 35% walnut: 5% ginger , SWG5 45% Sorghum: 45% walnut: 5% ginger

SENSORY EVALUATION

Table 5 presents the sensory scores of porridges made from the composite flours. Results significant differences between the control and flour blends for all sensory attributes evaluated. Sample SWG2 (80: 15:5) and SWG3 (70:25:5) were more acceptable compared to other samples but were not significantly different (>0.05) from each other. The variation in the proportion of the walnut was the cause of the perceived differences in taste and general acceptability. The low colour ratings of the blends might be attributed to the presence of ginger and unattractive dark brown colour of sorghum. The consistency of all the samples except the 100% sorghum (control) no significant difference ($p \leq 0.05$). The control had the highest acceptability for all the sensory attributes assessed. This could be due to familiarity in taste, flavour and colour. The results provide a basis for development of an acceptable complementary food that can provide the required protein and energy levels that are essential basic nutrients to enable accomplishment of a day's work (Bilsborough, 2006).

Table 5: Mean sensory scores of complementary foods from sorghum, walnut and ginger blends

Parameter	SWG1	SWG2	SWG3	SWG4	SWG5
Colour	5.6[a]	5.2[b]	5.0[b]	4.4[c]	4.0[d]
Consistency	4.2[b]	4.2[b]	4.0[b]	4.0[b]	4.0[b]
Aroma	6.4[a]	5.7[b]	5.5[b]	4.2[c]	4.0[c]
Taste	7.0[a]	6.6[b]	6.3[b]	5.5[c]	5.0[d]
Acceptability	6.6[a]	5.7[b]	5.4[b]	4.3[c]	4.0[d]

Mean with different letters in the same row are statistically different ($p \leq 0.05$) according to Duncan's Multiple Range Test. SWG1 100% Sorghum , SWG2 75% Sorghum: 15% walnut: 5% ginger, SWG3 65% Sorghum: 25% walnut: 5% ginger , SWG4 55% Sorghum: 35% walnut: 5% ginger , SWG5 45% Sorghum: 45% walnut: 5% ginger

CONCLUSION

The results obtained showed that a blend of fermented sorghum flour, walnut and ginger flour is nutritionally and organoleptically acceptable. Fermented sorghum porridge is an important staple food items for people of the West African sub-region and are also important weaning foods for infants and convalescents due to its high calorie and some other mineral elements. It is high in essential fatty acids, protein and other essential macro and micro minerals, which walnut and ginger have in high value. Therefore a mixture of them provide material for maintenance of the body cells and tissue and also aid in promoting good health by preventing certain diseases.

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