DEVELOPMENT AND QUALITY EVALUATION OF SOY-SORGHUM, SESAME-SORGHUM AND SORGHUM BASED WEANING FOODS

Ugwuona Fabian* and Abe Abigail, B.
Department of Home Science and Management, Faculty of Agriculture, Shabu-Lafia Campus, PMB135,
Nasarawa State University, Keffi, Nigeria
*Corresponding author: ugwuortafu@yahoo.com
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This study evaluated the nutrient composition, sensory and functional properties of weaning foods developed fnm soy-sorghum, sesame-sorghum and sorghum (negative control) as the base ingredients. Cooked (95-lOffC), fermented (18 h) soybean seeds (2 kg) were processed into flour. Parboiled (90-98 x) sorghum grains (4 kg) were processed into sorghum flour. Sesame seeds (2 kg) fermented (18 h) and toasted (100-12ffC) for 20 min were processedintoflour.Weaningfoodsweredevelopedwith-sorghum (23% :45%;36%: 33%), sesame-sorghum (22%: 45%; 35% .' 32%) and sorghum (63%) as the base ingredients, with other ingredients in approximately equal proportions in the 5 samples. The processed flours and weaning foods were analysed for nutrient composition while the weaning foods only were further analysed for sensory and functional properties. Soy and sesame seed flours substitution for sorghum improved nutrient composition of weaning samples. Protein content (4.6%) increased with increasing seame seed flour addition (13.1% protein maximum) and with increasing soy flour addition (17.1% protein maximum). Crude fibre, fat and ash contents increased with increasing sesame and soy flours additions, The minerals calcium, iron, zinc, magnesium and phosphorus increased in contents with soy and sesame flours addition. Soy flour improved nutrient contents higher than sesame flour in the food samples. The legume-sorghum wearning foods were very soluble in water and formed good consistent gruels. The soy-sorghum, sesame-sorghum and sorghum based food samples had acceptable colour, flavour, texture and mouth-feel among the assessors.

Key words: Quality, soy-sorghum, sesame-sorghum, weaning foods.

INTRODUCTION

Weaning is a period of transition of the infant, during which its changes gradually in consistency and source, from a liquid milk-based diet, to semi-solid food (Draper, 1994). Such weaning food should ideally be easily digestible, have high energy density and low bulk (Ezeji & Ojimelukwe, 1993). Weaning period is a transitional phase during which foods order than the mother's breast milk supply a high proportion of the child's nutritional requirements and finally replace the breast milk altogether. It is a critical phase with respect to digestive, psychology, and nutrition functioning of the child. For these reasons weaning food has received considerable attention from nutritionists, food scientists, pediatrician and community health workers (Faashakin &Ogunmola, 1982). Incidentally in Nigeria and many developing countries, commercially available weaning foods are expensive for the average family to afford; so nursing mothers often depend on traditional weaning foods which often are of low nutrients value (Okeiyi & Futrell, 1983). Meanwhile, there are many indigenous and unexploited legumes which can be processed and when properly complemented with commonly available, carbohydrate source such as cereals, provide relatively, affordable weaning foods that will help alleviate protein-energy mal-nutrition and improve infant nutrition.

Locally produced weaning foods in the developing countries, Nigeria in particular, are made from cereals such as sorghum, maize, millet, barley and Oat. In most cases the steps involved in the preparation are steeping water, wet-milling, and sieving. The cereal may or may not be fermented which is then cooked into a smooth texture end Even when fermented, cooked into a smooth gruel and even fermented, the gruel is inadequate as i sole weaning food (Akobundu, 1992). In Nigeria! the usual weaning foods for infant are gruels made from locally produced cereals. Such weaning foods are high in carbohydrate but deficient in protein and vitamins. Commercial weaning foods which are rich in these nutrients are costly and not affordable by most average Nigeria. Nigeria is endowed with both cereal and legume grains, both of which when combined in preparing weaning foods locally give adequate nutrients for the infants. It is therefore necessary to combine the readily available soybean and sorghum to produce high nutrient, low bulk derivate weaning foods for Nigerian infants. The main aim of this study is to develop and evaluate the quality of weaning foods from soy-sorghum, sesame-sorghum and sorghum flourmixes.

MATERIALS AND METHODS

Collection of Samples

Soybean seeds *(Glyrine max)* (2 kg), sorghum *(sorghum vulgare)* (4 kg) and sesame *(sesamu indicum) (2* kg) grains were purchased from rural faimers in Laifia Main Market, Nasarawa State, Nigeria.

Processing of Sorghum Seed Flour

Four kilograms of sorghum grains were cleaned by winnowing and removing stones, dirt, immature seeds and other debris. The seeds were washed with clean water, parboiled (90 to 98°Q for 20 min and fermented overnight (18 h) in excess cold water. Seeds were washed and drained out of water; sun-dried for 48 h and then oven-dried for 48 h at 60°C. The dried seed sample was milled into powder and sieved through a hand sieve of 60|im pore size to get fine flour for the weaning food production, i

Process of Soybean Flour

dean soybean seeds (2 kg) were washed, cooked (95°C lOO'Q for about 30 min, allowed to cool and then dehulled manually. This was fermented (18 hr) in excess cold water, washed but of water, sun-dried for 48 h and then oven-dried (60°Q for 72 h. The dried seed dhal were milled and sieved through a hand sieve of 60 nm pore size. This was packaged in an air-tight polyethylene container until used for weaning food formulation.

Processing of Sesame Seed Flour

Sesame seeds (2 kg) free of dirt were cleaned washed with clean water and then fermented overnight (18 h) at room temperature (27±2°Q. The seeds were washed out of clean water, sun-dried for (48 h) and then toasted (100 to 120°C) for 20 minutes. The seeds were dehulled manually in a household mortar and winnowed to get fine the nibs. The nibs were ground into powder in an attrition mill and sieved through a hand sieve of 60 (im pore sizes to get fine flour which was stored

Weaning Food Formulation ; ; The soybean, millet and sorghum flours were first compounded into five different blends, and each of the remaining ingredients admixed with them, one by one with the most weighted ingredient admixed lastly.. The proportion of each ingredient was as shown in Table l.Each blend was separately mixed thoroughly in a kenwood kitchen mixer and then packaged in an air-tight container until used for chemical, functional and sensory analysis.

Chemical Analysis

Triplicate samples of soybean, sesame seed and sorghum flours or each of the complementary blends were analysed for moisture, fat, protein (N x 6.25), crude fibre and ash using the procedure of AOAC (2006). Moisture content was estimated as the loss in weight after heating 2 g of each sample in an air oven maintained at 105°C for 4 h. Total nitrogen was determined by the micro-Kjeldahl method, and crude protein estimated by multiplying total nitrogen (N) by 6.25 (a conversion factor). Crude fibre was estimated as the loss in weight after acid and alkaline digestion of a defatted sample. Total lipids were estimated by extracting with petroleum ether (40-60°C B.P.) using Tecator Soxtec apparatus. Carbohydrate content was estimated by difference. Total ash was estimated by incinerating 2 g of each sample in an ashing muffle furnace maintained at 550°C for 12 h. Calcium, iron, zinc, magnesium and manganese contents were determined on filtrates of ash samples dissolved in distilled water, using a Buck Model 200Aflame atomic absorption spectrophotometer, while phosphorus content was estimated using the vanadomolybdate method (AOAC, 2006).

Determination of functional properties

Water and oil absorption capacity (WAC and OAC): A 2 g food sample was mixed with 20 ml distilled or pure ground nut oil and allowed to stand for 30min at room temperature (26±2°Q. This was centrifuged at 3000 rpm for 30 min and the supernatant decanted into 1ml measuring cylinder. Water or oil absorption capacity was expressed as percentage water or oil bound per 1 g flour. Bulk density: This was determined by weighing 50 g of each sample into 100 ml graduated cylinder, and tapping the cylinder consistently until there was no further depression in the volume. The bulk density was calculated as g/ cm^3 of sample Sensory evaluation

Eighteen nursing mothers of ages between 18-36 years were drawn from staff' of Government Secondary School, Bukan-Sidi,, Lafia, Nasarawa state, Nigeria.. The 18 women were trained on sensory attributes of weaning foods according to the spectrum methodology (Mellgaard *et al.*, 1999). Predetermined sensory attributes of gruels (hot-water cooked weaning foods), including colour, flavour, texture, mouth-feel and over-all acceptability were discussed with them for familiarity with definitions and references to these terms when used. Each mother was allowed to discuss freely and contribute on each of the sensory attributes for more knowledgeable. During the sensory testing session, the mothers were made to seat comfortably in a section of the staff room of the college, and provided with score sheets coded on a 7- point hedonic scale, with 1 for disliked very much, 2 for disliked moderately, 3 for disliked slightly, 4 for neither liked nor disliked, 5 for liked slightly, 6 for liked moderately and 7 for liked very much. The five weaning foods were separately gelled into gruel by mixing 20 g of each with about 30 ml of boiling water and stirring vigorously in ceramic bowls. The gruels at about 40°C were served to the women who tasted and scored the gruels for colour, flavour, mouth-feel, texture and overall-acceptability using score sheets coded on a 7-point hedonic scale. The women were provided with unsalted cracker and distilled water to rinse their mouth between each sample. Each sample was rated on perceived intensities of the standard sensory attributes, namely colour, flavour, mouth-feel, texture and over-all acceptability.

Data Analysis

Data were analysed using the general linear model (GLM) procedure with the Genstat Release 4.24 DE (PC Windows, 98) copyright 2003, Lawes Agricultural Trust (Rothansted Experimental Station). Means were separated by LSD analysis at a least significant difference of 0.05 P value

RESULTS AND DISCUSSION

Table 2 shows proximate composition of the formulated soy-sorghum (SOSA, SOSC), sesame-sorghum (SESB, SESD) and sorghum (SORG) based weaning foods. SORG had only sorghum (66.3 %), a cereal, as the base ingredient and served as a negative control. Substitution of soybean or sesame flour fpr part of sorghum flour as exploited in this study, improved nutrient composition of the weaning foods. The moisture contents ranged from 1.05% in SORG (control) to 2.7% in both SOSC (which had 35.6% soybean and 32.5% sorghum) and SESD (with31.1% sesame and 31.5% sorghum). SOSA (with 23.1% soybean and 45.2% sorghum) and SESB (with 22.1% sesame and 47.7% sorghum) had 2.2% and 2.1%.moisture contents, respectively. The five samples had low moisture content, much lower than the minimum 12% moisture, to support microbial growth (Chakraverty, 2004). As a result, they are expected to have long shelf life on storage. The increased moisture content of samples with added sesame seed and soy flours was due to their high water holding capacity, which is a peculiar characteristic of legumes (Carvalho *et al*, 2006). Protein content increased with increasing sesame seed flour addition from 4.6% in SORG (control) to 5.0% in SESB and to 13.1% SESD. Soy flour addition also improved the 4.6% protein content of the control sample to 13.1% in SOSA and to 17.19% in SOSC. Soy flour was more effective than sesame seed flour in improving protein content of the samples, probably due to higher protein content in soy flour than in sesame seed flour. Crude fibre, fat (ether extract) and ash contents also increased with increasing sesame seed flour and soy flour addition but carbohydrate content was maintained within 67 to 69% in the samples. While sesame seed flour was a better source of fibre both sesame and soy flours at the same concentrations seam to add approximately equal amount of fat in the weaning food samples. Studies have shown than cereal-based diets have lower nutritional value than animal-based ones, and that to improve the nutritional status of these cereal-based diets, cereals should be complemented with legumes (Ijarotimi & Arope, 2005; Ikujenlola & Fashokin, 2005).

Table 3 shows the mineral contents of the weaning foods. The legumes soy bean and sesame generally improved the mineral contents of the weaning foods. Substituting soy flour for part of sorghum in the food samples increased all the mineral (Fe, Ca, P, Mg, Mn and Zn) contents. However, substituting sesame seed flour for sorghum increased calcium, phosphorus, manganese and zinc contents but decreased iron and magnesium contents in the weaning foods. Sorghum has more iron and magnesium contents than sesame. The mineral contents were high enough to support normal growth of infants. Minerals are known to play important metabolic and physiologic roles in the living systems (Enechi & Odonwodo, 2003). It is known that iron, calcium and magnesium function as antioxidant to strengthen the immune system (Talwar *et al*, 1983). Magnesium and zinc combine to prevent cardiomyopathy, muscle depression, growth retardation, alopecia, dermatitis, immunologic dysfunction, gonadal atrophy, impaired spermatogenesis and bleeding disorder (Chatunvedi *et al*,. 2004). Calcium and heme iron are some of the nutrients .limiting in the diets of Nigerians due probably to non-consumption of flesh foods, milk and milk products due to costs and cultural constrains (Ene-Obong, 1993; Ene-Obong & Akosa, 1993; Onweluzo & Nwabugwu, 2009). The complementary blends, particularly SOSA and SESD, can serve as good sources of most food nutrients for most people, including children in developing countries.

The scores of trained sensory panelists on sensory attributes of the weaning foods are shown in Table

Table 1: Formulation of soy-sorghum, sesame-sorghum and sorghum based weaning foods

	SOSA (%)	SESB(%)	SOSC(%)	SESD(%)	SORG(%)
Soybean flour	23.1	-	35.6	-	-
Sesame seed flour	-	22.1	-	35.1	-
Sorghum flour	45.2	44.7	32.5	31.5	66.3
Sucrose	21.0	21.0	21.0	21.0	21.0
Vegetable oil	8.5	10.0	8.5	10.0	10.6
Sodium chloride	1.1	1.0	0.1	1.2	1.0
Tricalcium phosphate	0.7	0.7	0.7	0.7	0.7
Milk flavour	0.2	0.1	0.5	0.1	0.2
Vanilar flavor	0.1	0.2	0.1	0.2	0.1
Vitamin a	0.1	0.2	0.1	0.2	0.1
Total	100.0	100.0	100.0	100.0	

SOSA and SOSOsoy-sorghum based, SESB and SESD=seRame-sorghura based, and SORO=sorghum based weaning foods.

Table 2: Proximate composition of soy-sorghum, sesame-sorghum and sorghum based weaning foods

Samples	Moisture (%)	Protein (%)	Carbohydrates (%)	Crude fibre (%)	Ether extract(%)	Total ash (%)
SOSA	2.20	13.10	67.84	1.45	11.41	2.75
SESB	2.10	5.04	68.59	2.19	11.41	2.80
SOSC	2.70	17.19	68.59	1.62	20.30	2.75
SESD	2.70	13.10	66.47	3.05	21.10	3.10
SORG	1.05	4.60	68.20	1.45	9.55	2.60

SOSA and SOSOsoy-sorghum based, SESB and SESD=seRame-sorghura based, and SORO=sorghum based weaning foods.

Table 3: Minerals composition of soy-sorghum, sesame-sorghum and sorghum bwed weaning foods.

Samples	Iron mg/100g	Calcium mg/100g	Phosphorus mg/100g	Magnesium mg/100g	Manganese mg/100g	Zinc mg/100g
SOSA	77.3±2.2	12.6±1.1	8.0±1.0	69.4±2.6	21.2±2.2	43.7±2.2
SESB	39.2±1.1	11.1±1.51	7.2±1.0	62.2±3.2	16.3±3.1	41.6±2.3
SOSC	77.3±1.0	23.2±1.1	8.3±0.8	75.2±2.1	32.3±4.2	43.3±3.3
SESD	38.3±2.2	13.1±1.1	8.3±1.0	54.7±2.6	15.2±2.6	41.6±4.4
SORG	76.4±10	12.3±1.0	72.±1.1	67.6±2.1	11.3±2.1	37.7±2.1

Table 4: sensory quality of soy-sorghum, sesame-sorghum and sorghum bwed weaning foods.

Samples type	Colour	Texture	Flavour	Mouth feel	Overall Acceptability
SOSA	5.8[a] ±0.01	5.62[a]±0.0	6.3[a]±0.0	5.89[a]±0.02	6.33[a]±0.02
SESB	5.3[a]±0.0	4.1[a]±0.0	4.3[c]±0.0	4.1[b]±0.0	5.3[b]±0.0
SOSC	5.0[a]±0.01	5.5[a]±0.0	6.2[a]±0.0	5.8[a]±0.0	6.9[a]±0.0
SESD	5.3[a]±0.0	4.6[a]±0.0	5.5[ab]±0.0	4.9[ab]±0.0	5.9[a]±0.0
SORG	4.1[a]±0.0	5.5[a]±0.0	6.2[a]±0.0	5.62[a]±0.0	6.3[a]±0.0

Table *5:* Functional properties of weaning food prepared from soy-sorghum, sesame and sorghum flour mixed.

Samples	WAC mean*SD	OAC meaniSD	Bulk density Mean * SD
SOSA	50±0	50±0	1.04±OJ35
SESB '	32±2.8	30±0	1.34±0,01
SOSC	61.5±2.12	20±0	1.13±0.01
SESD	31.5±2.12	20±0	1.46±0.05
SORG	20±0	20±0	1.36±0.05

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4. Both soy and sesame seed flours improved sensory quality of the weaning foods. The colours, flavours and textures of the complementary food blend were more acceptable than those of the control (SORG) to the sensory panelists. The sensory scores of the control (SORG) ranged from 4.73 (over-all acceptability) to 5.07 (flavour). Substituting 23.1% soy flour for part of sorghum (SOSA) significantly ($P > 0.05$) improved all the sensory attributes of the weaning foods. Scores for this sample were relatively higher than those of other samples and ranged from 6.45 (over-all acceptability) to 6.68 (colour). However, none of the samples was rejected outrightly.

Table 5 shows some functional properties of the weaning food blends. Substituting soy flour or sesame seed flour for sorghum increased the water and oil absorption capacities (WAC and OAQ. WAC indicates the volume of water needed to gel gruel with suitable consistency. The increased WAC and OAC in the legume-cereal complementary foods could be attributed to wider variety of proteins and the presence of some carbohydrates with high hydration capacity (Cheu *et* <rf., 1997). Higher WAC is advantageous to prepare a mealy, consistent gruel. These results also suggest the existence of more components of water-binding polysaccharides in the blends: Both sesame and soybean are good sources of dietary fibres and protein. In general, the substantial ability of the sesame and so flours to interact with both water and oil indicates that they possess well balanced proportions of extremely oriented hydrophilic and hydrophobic groups, allowing a desirable smooth and consistent structure in the gruel. While substituting soy flour for sorghum decreased bulk density, substituting with sesame flour increased the bulk density. Low bulk density indicates small particle sizes of the blend and implies more solubility and readiness to form consistent gruel.

CONCLUSION

Soybean and sesame, legumes, when complemented with sorghum, a cereal, improved the nutrient contents, functional and sensory properties of the weaning foods. Protein, mineral and fat contents, for example, of the cereal-legume complementary blends were higher than those in the sorghum-based control sample. Soybean and sesame are readily available in Nigeria, and should therefore be exploited to complement cereals in formulating indigenous weaning foods.

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