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Physico-Chemical and Microbial Quality of Sorghum-Based Complementary Food Enriched with Soybean (*Glycine max*) and Sesame (*Sesamum indicum*)

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Abstract: In this study, ogi, a Nigerian fermented weaning food was prepared from sorghum seeds using the traditional process. Four complementary foods, containing 50-80% sorghum ogi flour were prepared from blends of sorghum ogi flour, soybean flour and sesame meal. The complementary foods contained 46.9-66.0% carbohydrates, 16.0-24.6% protein, 14.13-21.75% fat and 1.35-1.93% ash. These values were significantly ($p<0.05$) higher than values obtained for ogi. The loose bulk densities of complementary flours ranged from 0.37-0.43 g mL^{-1} and packed bulk densities from 0.70-0.75 g mL^{-1} while ogi flours were 0.42 and 0.70 g cm^{-3}, respectively. Sorghum ogi had highest reconstitution index (104.5) while complementary foods ranged between 92.30 and 100.30. The total plate counts ranged from 2.0×10^3-2.4×10^4 cfu g^{-1}; coliforms, mould and yeast were absent in some of the products. This approach can be made use of in Community Nutrition and in Emergency Feeding Programmes.

Key words: Sorghum ogi flour, soybean, sesame, complementary foods, yeast, coliforms

INTRODUCTION

In developing countries where malnutrition remains a major health problem in infants, considerable efforts to improve the health and nutritional status of growing children have focused on the production of nutritious, locally sourced complementary foods. Breast milk is the perfect food for the infant during the 1st 6 months of life. It contains all the nutrients and immunological factors an infant requires to maintain optimal health and growth. Furthermore, breast milk also protects infants against the two leading causes of infant mortality, upper respiratory infections and diarrhea (UNICEF, 1999). However, at the age of 6 months and above when the child's birth weight is expected to have doubled, breast milk is no longer sufficient to meet the nutritional needs of the growing infant. Nutritious complementary foods are therefore introduced also known as weaning foods which typically covers the period from 6-24 months of age in most developing countries (WHO/OMS, 2000). Most traditional weaning foods in developing countries are made from cereals, starchy fruits, root and tuber. Cereals are more widely utilized as food in African countries than in the developed world. In fact, cereals account for as much as 77% of total caloric consumption in African countries (Mitchell *et al*., 1997) and contribute substantially to dietary protein intake in a number of these countries.

Generally, traditional wearing foods in West Africa are known to be of low nutritive value (Akinrele and Edwards, 1970) and are characterized by low protein, low energy density and high bulk. Pap or koko has been implicated in the aetiology of protein energy malnutrition in children during the weaning period (Onofiok and Nnanyelugo, 1992). The protein content of sorghum is of poor quality, low in lysine and tryptophan and these two amino acids are indispensible to the growth of the young child (Oyenuga, 1968).

Processing of cereals before use in complementary food also resulted in loss of nutrients other than protein (Osifo, 1971). Having identified the problems associated with the use of cereals alone as a wearing diet the research is aimed at strategic use of legumes and oil seed to improve the nutritional value. A different approach is developed to offer rural and poor urban women the opportunity to feed their infants properly through appropriate household or village scale technology. Sorghum could be improved by combining locally available soy bean and sesame seeds and this can be

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made use in Community Nutritional Programs. This study reports on the physic-chemical and microbial quality of sorghum-based complementary foods enriched with soybean and sesame.

MATERIALS AND METHODS

Production of sorghum ogi flour and complementary foods: Ogi, a traditional Nigerian fermented weaning food was prepared from sorghum using improved method of Akingbala *et al*. (1987). Fresh ogi was dried at 60°C and milled to obtain sorghum ogi flour. Soybean flour was produced by soaking in hot water for 4 h to loosen the hulls. The seeds were manually dehulled, dried at 60°C and milled into flour.

Sesame meal was prepared from sesame seed. The seeds were soaked for 6 h and manually dehulled. The dehulled seeds were oven dried and milled to obtain full-fat sesame meal. Four complementary foods, containing 50-80% sorghum ogi flour were prepared from blends of sorghum ogi flour soy bean flour and sesame meal.

Chemical analysis

Proximate analysis: Moisture, crude protein, ash and fibre contents of the flours and formulations were determined using standard (AOAC, 2005) methods.

Bulk densities: The procedure of Akpapunam and Markakis (1981) was used in determining bulk density. The flour of known weight was transferred into a 250 mL graduated cylinder and the volume was determined. The bulk density of packed flour was calculated after tapping the cylinder until the flour stopped settling after about 2 min.

Reconstitution index: The reconstitution index was determined by mixing 10 g of the flour with boiling water for 90 sec. The mixture was then poured into a 250 mL graduated glass cylinder and amount of clear supernatant read after 10 min.

Microbiologcal analysis: The complementary food were examined microbiologically after serial dilution for total aerobic bacteria using plate count agar (Oxoid), coliforms, molds and yeast using violet red bile agar (Oxoid) and ozytetracyline glucose yeast extract agar (Oxoid), respectively.

RESULTS AND DISCUSSION

The proximate composition results of sorghum, ogi, soybean, sesame and complementary foods are shown in Table 1. Soybean and sesame contain high levels of protein; 44.6% for soybean and 25.89% for sesame meal. Sesame meal was also rich in fat (59.95%) which was present in smaller amounts in soybean. The complementary foods had an average protein content of 20.35% which was much >12.07 and 10.92% for sorghum and ogi, respectively while fat ranged from 14.3-21.75%. The protein and fat values of the complementary foods were above 16.7 and 6.0%, respectively which are the minimum recommendations of FAO/WHO pattern for weaning foods.

The fat content of the complementary diets were relatively higher than the sorghum flour and also met the recommended dietary allowance. This could be attributed to the inclusion of oil-dense soya beans and sesame seeds in the complementary diets. This attribute will not only increase the energy density but also be a transport vehicle for fat soluble vitamins. In addition, sesame oil contains two important antioxidants believed to promote cell integrity and the healthy function of body tissues in the presence of oxidizing compounds: sesamolin and sesamol. These antioxidants maintain fats and increase Vitamin E activity dramatically.

The moisture content of the complementary diets (5.26-5.94%) is within FAO/WHO recommended safe limit (<10%) as higher moisture may affect the storage quality of the foods. High moisture content in foods has been shown to encourage microbial growth (Temple *et al*., 1996). This is an important consideration in local feeding methods in Nigeria because most mothers often prepare large quantities of dry infant foods and keep in containers, to avoid frequent processing in order to have spare time and energy for other domestic activities. It is however recommended that such food ingredients

Table 1: Chemical composition of complementary foods

Composition (%)	Sorghum	Ogi	Soybean flour	Sesame meal	$SOSS_1$	$SOSS_2$	$SOSS_3$	$SOSS_4$	FAO/WHO pattern
Moisture	11.12 ± 0.3^{g}	7.10 ± 0.14^{f}	6.000 ± 0.1^{e}	3.60 ± 0.25^{a}	5.600 ± 0.4^{d}	5.260 ± 0.3^{b}	5.940 ± 0.4^{e}	5.570 ± 0.4^{c}	<10.0
Protein	12.07 ± 0.2^{b}	10.92 ± 0.1^{a}	44.60 ± 0.2^{h}	25.89 ± 0.1^{g}	16.02 ± 0.1^{c}	18.87 ± 0.1^{d}	21.92 ± 0.2^{e}	24.590 ± 0.2^{f}	16.7
Fat	4.120 ± 0.1^{a}	4.050 ± 0.3^{a}	25.20 ± 0.1^{f}	56.95 ± 0.1^{g}	14.13 ± 0.2^{b}	16.34 ± 0.1^{c}	18.40 ± 0.2^{d}	21.750 ± 0.1^{e}	>6.0
Ash	1.320 ± 0.2^{b}	0.520 ± 0.2^{a}	2.830 ± 0.1^{g}	3.51 ± 0.3^{h}	1.350 ± 0.1^{c}	1.490 ± 0.2^{d}	1.630 ± 0.2^{e}	1.930 ± 0.1^{f}	-
Carbohydrate	71.87^{g}	79.47^{h}	23.41^{b}	12.23^{a}	65.98^{c}	64.08^{d}	52.64^{e}	46.900 ± 0.3^{f}	-

Values are means of three replicate determinations (Mean±SD), SD = Standard Deviation; *Different letters in the same row indicate significant differences. **The same letter in same row indicates no significant differences; $SOSS_1$ = 80% Sorghum ogi flour +10% soybean flour +10% Sesame meal; $SOSS_2$ = 70% Sorghum ogi flour +15% Soybean flour +15% Sesame meal; $SOSS_3$ = 60% Sorghum ogi flour +20% Soybean flour +20% Sesame meal; $SOSS_4$ = 50% Sorghum ogi flour +25% Soybean flour +25% Sesame meal

Table 2: Physical properties of sorghum-based complementary foods

	Bulk density (g mL^{-1})		
Mixture	Loose	Packed	Reconstitution index (mL)
Sorghum	0.470 ± 0.02^d	0.770 ± 0.01^d	96.00 ± 0.21^b
Ogi	0.356 ± 0.02^a	0.690 ± 0.01^a	104.50 ± 0.22^c
$SOSS_1$	0.433 ± 0.01^c	0.700 ± 0.02^a	100.30 ± 1.20^c
$SOSS_2$	0.400 ± 0.01^c	0.730 ± 0.02^b	98.20 ± 0.78^b
$SOSS_3$	0.381 ± 0.02^b	0.750 ± 0.01^c	97.00 ± 0.81^b
$SOSS_4$	0.374 ± 0.01^b	0.755 ± 0.02^b	92.30 ± 0.75^a
FAO/WHO pattern	-	0.75	-

Table 3: Coliforms, molds, yeast and total plate count of sorghum based weaning foods

Counts (cfu g^{-1})	Sorghum	Ogi	$SOSS_1$	$SOSS_2$	$SOSS_3$	$SOSS_4$
Coliforms	Absent	Absent	Absent	Absent	Absent	Absent
Molds	Absent	$<3.0\times10^1$	Absent	Absent	Absent	Absent
Yeast	Absent	$<3.0\times10^1$	$<3.0\times10^2$	$<3.0\times10^1$	$<3.0\times10^1$	$<3.0\times10^2$
Total plate count	2.0×10^3	2.4×10^4	2.0×10^3	2.0×10^3	2.3×10^3	2.2×10^4

intended to be used in the preparation of weaning diet should be prepared only in small quantities at a time to avoid prolonged storage.

Loose and packed bulk densities and reconstitution index of the complementary foods are shown in Table 2. In general, all the products reconstituted well in water however, there was a slight difference in the bulk densities of the loose and packed flour. The loose bulk densities of complementary flours ranged from 0.37-0.43 g mL^{-1} and packed bulk densities from 0.70-0.75 g mL^{-1} while ogi flours were 0.42 and 0.70 g cm^{-3}, respectively.

These results agrees with the findings of Oluwamukomi *et al*. (2005) when soybean was incorporated (30:70) at different stages and states in the flow line for ogi production. Contrastingly, Edema *et al*. (2005) reported a decrease in the bulk density of maize with increasing soy supplementation. The relatively high packed densities however suggest that packaging would be economical.

Sorghum ogi had highest reconstitution index (104.5) while complementary foods ranged between 92.30 and 100.30. Coliforms, mold, yeast and total plate counts are shown in Table 3. Coliforms were absent in sorghum ogi and the complementary foods. Yeast and mold were present in some of the foods but at a relatively low level ($<3.0\times10^1$). Total plate count ranged between 2.0×10^3-2.3×10^3 and 2.2×10^4-2.4×10^4 cfu g^{-1}. However, all sorghum based complementary foods require cooking before feeding to children.

CONCLUSION

This research shows that there is potential for using soybean and sesame in cereal based formulas to reduce malnutrition in children.

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