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DEVELOPMENT AND QUALITY EVALUATION OF COMPLEMENTARY FOOD FORMULATED FROM SORGHUM, SOYBEAN AND SESAME FLOUR BLENDS

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ABSTRACT

Complementary foods are foods that are not breast milk or infant formula introduced to an infant to provide nutrients due to inadequacy of breast milk. The quality of Complementary foods prepared from sorghum, soybean and sesame flour blends was determined in this research. The flours were prepared and blended at different ratios; 70:30:0, 70:20:10, 60:30:10, and 50:40:10. The chemical, sensory and physical properties of the individual flours and the most acceptable complementary food were determined. The results show that the complementary food (50% SORF, 40% SOYF AND 10% SESF) contained 24.1% protein while SORF, SOYF and SESF had 7.8%, 48.4% and 15.1% respectively. The complementary food has higher carbohydrate 48.1% than those of the SOYF (19.4%) and SESF (23.3%). However, the SOYF flour had higher carbohydrate (82.2%) than the other flours. The bulk density of the complementary food was 0.72g/cm^3 while those of the flours ranged from 0.53 g/cm^3 to 0.81g/cm^3. All the flours lacked foaming capacity, values ranging from 0.98 to 6.9%. However, the complementary food had higher water absorption capacity and emulsion capacity than the individual flours. The sensory evaluation result showed that the blend containing 50% SORF, 40% SOYF and 10% SESF received higher scores for taste, flavor, texture, colour and overall acceptability than the other flour blends and the commercial weaning food. The result showed that acceptable complementary food with chemical and physical properties similar to commercial weaning food may well be prepared from sorghum, soybean and sesame flour blends.

Contribution/Originality: This study is one of very few studies that have investigated the production of complementary foods from local raw materials. The complementary food was produced from low-cost, nutrient dense cereal; legume and oil seed which will help solve the problem of malnutrition as the blend is rich in protein and other nutrients.

1. INTRODUCTION

Complementary foods are foods that are not breast milk or infant formula (liquids, semi solids, and solids) introduced to an infant to provide nutrients. Complementary foods or supplement are not necessarily milk based. They are used primarily when giving breast milk alone to the infant is no longer adequate in quantity to provide the growing needs of the infants. This period is from 6 months onwards. The food given to an infant must be very nutritious. Infant foods should be carefully selected to be small in quantity but high in nutritive value.

Childhood malnutrition is very common in developing countries [1]. Nigeria is well endowed with adequate food supplies; however, most children under the age of five are malnourished. The causes of this public health problem in Nigeria are complex, but poor quality and quantity of foods given to children play a major role. The capacity of a complementary diet to meet the protein energy requirements of infants depends on its nutritional quality [2].

Sorghum (*Sorghum bicolor*) commonly called guinea corn is the world's fourth important food grain. It is surpassed only by rice, wheat and maize in world importance [3]. Sorghum is one of the most important staple in many parts of Africa particularly in Nigeria [4] and it is consumed by both adults and infants. It is eaten in large quantities and it is the main source of both major and minor nutrients. On the average, sorghum has protein level of about 9% [4] and it is an important source of vitamin B-complex and some other minerals like phosphorous, magnesium, calcium and iron [5]. It is prepared as gruel and used in feeding infants [6].

Sesame (*Sesamum indicum*) is a flowering plant in the genus sesamum. Sesame has been reported as one of the locally grown crops that are rich in sulphur containing amino acids, particularly methionine [7]. The seeds are exceptionally rich in vitamin E (tocophenol) which is an antioxidant, calcium, potassium, phosphorus, vitamin B_1 (Thiamine), iron and it has no cholesterol [8] and also magnesium, manganese and copper.

Soybeans (*Glycine max*) belong to the legume family and are native to East Asia. They have been an important protein source for over five thousand years. Soybean contains 35-40% high quantity protein [9] 20% oil [3] 35% carbohydrate [10] 5% ash and has excellent digestibility [11, 12]. Soybeans have in addition to lecithins essential minerals [13] and lecithins are useful for the development of the brain especially in infants [9]. Like other legumes soy protein is rich in lysine and relatively low in methionine-sulphur containing amino acids [14].

Cereals are generally low in protein and are deficient in the essential amino acids lysine and tryptophan [5]. It is ideal to combine cereals with legume as this will improve their nutritive value [14]. Soybean contains all the essential amino acids [9] and sesame on the other hand contains better quality protein than most legumes [8]. The combination of sorghum, sesame and soybean flour in food formation could adequately provide most nutrients needed by infants [15].

Many Nigerian mothers use gruels made from maize and sorghum as complementary foods for their infants and the gruel may be too watery with low energy density or too bulky there by leading to reduction in the rate of consumption in infants. This is because they cannot afford the cost of nutritionally superior commercial complementary foods. There is therefore the need for strategic use of inexpensive high protein sources that complement the protein quality of these staple food crops in order to enhance their nutrition value [16]. There have been several reports on the production of complementary foods from local raw materials [17]. Yusufu, et al. [18] produced complementary food from Sorghum, African Yam Bean and Mango Mesocarp, Agu and Aluyah [19] produced complementary food from Sorghum, maize, soybean and fluted pumpkin seed flour and Onwurafor, et al. [5] produced complementary food from Sorghum-Maize-Mungbean Malt. Therefore the aim of this study is to prepare complementary food from sorghum, soybean and sesame blends which are affordable, readily available and rich in nutrient for the growing infant.

2. MATERIALS AND METHODS

2.1. Source of Raw Materials

The red variety of Sorghum (*Sorghum bicolour*), the yellow variety of Soybean (*Glycine max*) and the white variety of Sesame (*Sesame indicum*) were purchased in Anyigba market in Dekina Local Government Area of Kogi State.

2.2. Preparation of Sorghum Flour

Sorghum grains were washed and steeped in water (18hrs), the steep water was discarded at 3 hours intervals and sodium benzoate (1%, W/V) was added to prevent fungal growth during germination. The steeped grains were drained and then laid thinly on the perforated tray lined with moist muslin cloth. The grains were germinated at room temperature for 72hours and thereafter oven dried (50ºC, 18hours). The dried rootlet was removed and the grain milled. It was sieved through a 60 mesh sieve and then packed in HDPE. The flow chart for the production of sorghum flour is shown in Figure 1.

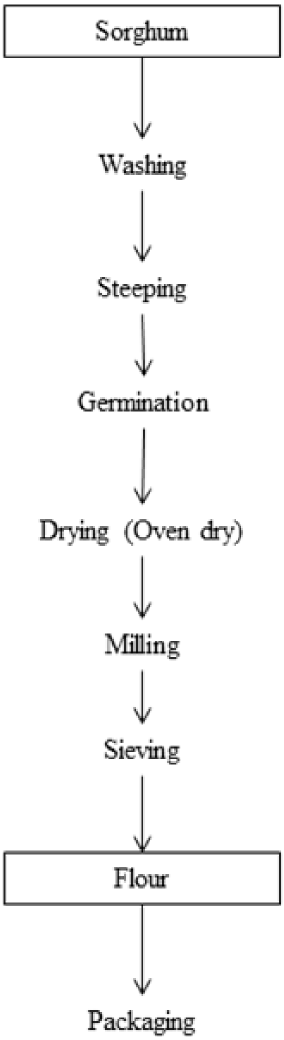

Figure-1. Flow diagram for the production of Sorghum flour.

2.3. Preparation of Soybean Flour

Soybean was washed and steeped in water (18hrs). The hydrated seeds were germinated in perforated tray lined with moist muslin cloth for 72hrs. The grains were oven died (50ºC, 24hrs), dehulled manually, milled and sieved through a 60 mesh sieve. The flour was then packed in HDPE. The flow chart for the production of soybean flour is shown in Figure 2.

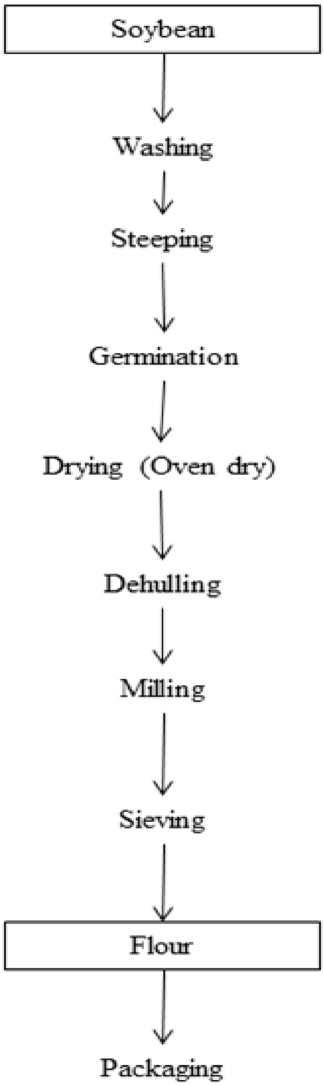

Figure-2. Flow diagram for the production of soybean flour.

2.4. Preparation of Sesame Flour

Sesame seeds were cleaned, dipped in hot water containing 50% NaOH for 2 minutes, rinsed in hot water and then dehulled manually. The kernels were toasted, milled, sieved through a 60 mesh sieve, and then packed in HDPE. The flow diagram for the production of sesame flour is shown in Figure 3.

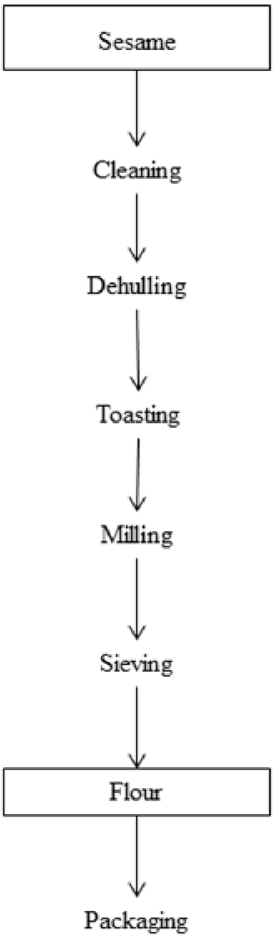

Figure-3. Flow diagram for the production of sesame flour.

2.5. Flour Blending

The sorghum, soybean and sesame flours were blended as shown in Table 1. The flour blends were homogenized in a food blender operated at full speed for 5 minutes.

Table-1. Formulation of the complementary food.

Sorghum	Soybean	Sesame
70	30	0
70	20	10
60	20	10
50	40	10

3. CHEMICAL ANALYSIS

The blends were analyzed for moisture, crude fibre, protein (Kjeldahl x 6.25), fat (Soxhlet extraction) and ash content using AOAC [20]. The carbohydrate content of the blend was estimated by difference 100 - (% protein + % fat + % ash + % crude fibre + % moisture) and taking the sum according to Ihekoronye and Ngoddy [21].

Bulk density was determined by the method described by Okaka and Potter [22]. Emulsion, Foam, and water Absorption capacity were determined by the method described by Okezie and Bello [23].

4. SENSORY EVALUATION

The formulated complementary foods and cerelac (a commercial complementary food) were evaluated as described by Ihekoronye and Ngoddy [21] for colour, taste, texture, flovour and overall acceptability on a 5 point hedonic scale (1= dislike extremely, 5= like extremely). A panel of 10 mothers was recruited to evaluate the likeness of the product. They were regular users of commercial weaning foods, staff members and undergraduate student of Kogi State University Anyigba.

The samples were coded and the panelists were asked to rate them according to their degree of likeness for each of the quality attribute. Scores obtained from the sensory evaluation were subjected to analysis of variance (ANOVA) according to Ihekoronye and Ngoddy [21]. Means where significant were separated by least difference (LSD) test $P<0.05$.

5. RESULTS AND DISCUSSION

The chemical composition of sorghum flour (SORF), soybean flour (SOYF), sesame flour (SESF) and the flour blend (50% SORF/40% SOYF/10% SESF) are shown in Table 2. Ogi which is a complementary food in Nigeria according to Makinde and Ladipo [15] has a protein content of 10.92% and fat content of 4.05%. These values were lower than that of the complementary food which was 24.41% protein and 21.50% fat. The protein content of the complementary food (24.41%) was higher than that of cerelac which was 15.1% as reported by Akapo, et al. [24]. Olukemi and Omolara [25] Reported that Ogi-soybean has a protein content of 14.16% which is also lower than that of the complementary food (50% SORF/40% SOYF/10% SESF). The protein content of the complementary food met the required daily allowance for protein contents in the complementary foods which is ≥15% [26].

The fat content was higher in the complementary food (21.5%) than that of Ogi-crayfish reported to be (12.6%) by Olukemi and Omolara [25]. This difference was probably due to the addition of soybeans and sesame to the complementary food. Soybean is important in complementary food because it adds fat and protein (Ramamani, et al. [27]; Alabi, et al. [28]) and sesame contains oil Agarwal, et al. [29]. Fat content for the complementary food (21.50%) was also higher than that of cerelac which was reported to be 8.4% Akapo, et al. [24].

The low moisture content of the complementary food 8.80% will enhance the storage stability if packaged in oxygen and moisture proof packages. The result is slightly higher than that of Onwurafor, et al. [5] who reported (6.35–8.42%) for Sorghum-Maize-Mungbean Malt complementary food. High moisture content affects the storage and quality of food products [19]. High moisture content in a food will encourage biochemical and microbial actions that will adversely affect the quality of the food.

The ash content gives an indication of the mineral content of the complementary food. The 2.0% ash obtained for the complementary food was within the range for weaning food prepared from maize, soybean and fluted pumpkin seed which range from 0.65 to 2.0% [19]. The ash content indicates that the complementary food was not low in minerals [19].

The complementary food was low in crude fibre (1.5%). The low crude fibre is desirable because infants' alimentary canal does not favour bulky food [30]. The low crude fibre of the complementary food makes it digestible [31]. Low fibre content in food enhances nutritional availability [32].

Sorghum is low in protein and ash content but rich in fibre components [33]. Soybean is considered to be a source of complete protein [34]. Sesame contains oil that is rich in oleic acid, linoleic acid, palmitoleic acid arachindin acid and tetracosoic acid. The nutrient contents of these food materials complement each other and improved the nutritional quality of the SORF/SOYF/ SESF blend complementary food.

Table-2. Chemical Composition of Sorghum flour (SORF), Soybean flour (SOYF), Sesame flour (SESF) and their blend.

	Parameters (%)					
Flour	**Moisture**	**Ash**	**Crude fibre**	**Fat**	**Protein**	**Carbohydrates**
SORF	4.9	2.1	1.4	1.6	7.8	82.2
SOYF	4.1	4.9	3.1	20.1	48.4	19.4
SESF	0.8	6.8	5.2	48.9	15.1	23.3
SORF+SOYF+SESF	8.8	2.0	1.5	21.5	24.1	41.8

SORF=Sorghum flour, SOYF=Soybean flour, SESF=Sesame flour. The blend contained 50%SORF, 40%SOYF, and 10% SESF.

5.1. Physical Properties

Some of the physical properties of Sorghum flour (SORF), Soybean flour (SOYF), Sesame flour (SESF) and their blend in comparison with cerelac (control) are presented in Table 3. The bulk density of sesame flour (0.53g/cm^3) was lower than (1.3g/cm^3) reported by Egbekun and Ehieze [35] for beniseed. The bulk density of the flours varied from 0.53-0.81g/cm^3. Bulk density is a reflection of load that the sample can carry if allowed to rest on one another. The low bulk density of the flour would be of an advantage in the use of the complementary food [36]. Fermentation and germination have been reported to be a useful traditional method for the preparation of low bulk weaning foods [37, 38]. High value of bulkiness is undesirable for complementary food due to the physiology of the alimentary canal and stomach capacity of the infant that is usually small to accommodate bulky food material [30]. The bulk density of the cerelac was lower (0.54g/cm^3) than that of the complementary food (0.72g/cm^3). The foam capacity (FC) of the blend was 0.98% which was low when compared to that of cerelac (4.9%). The difference might be due to soluble proteins in the cerelac. Low values of foaming capacity are indicative of soluble proteins [30]. The water absorption capacity of the complementary food was 1ml/g while that of cerelac was 2ml/g. The low water absorption capacity of the complementary food might serve as a desirable attribute for the complementary food considering that the blend must be boiled before consumption. This might increase gelatinzation and swelling thereby increasing water absorption capacity potential [30]. The emulsion capacity of the individual flour ranged from 38.46 to 42% while that of the blend (50%SORF/40%SOYF/ 10% SESF) was 50%. High oil emulsification facilitates flavor retention and enhances the mouth feel and taste of the food [30]. However, emulsion capacity of cerelac was 47.37%. The difference in emulsion capacity was probably due to the higher protein content of the blend when compared to that of cerelac. The emulsion capacity obtained from the complementary food was in agreement with previous study which showed that the higher the concentration of protein in the food flour, the higher the emulsion capacity [39].

Table-3. Physical properties of Sorghum flour (SORF), Soybean flour (SOYF), Sesame flour (SESF) and their blend in comparison with cerelac.

Flour samples	Bulk Density (g/cm3)	Physical Foam Capacity (%)	Properties Water absorption Capacity (ml/g)	Emulsion Capacity (%)
SORF	0.81	3.9	0.5	41.67
SOYF	0.59	6.9	2.0	38.46
SESF	0.53	4.9	0.5	42.5
SORF +SOYF +SESF	0.72	0.98	1.0	50
Cerelac	0.54	4.9	2.0	47.37

SORF=Sorghum flour, SOYF=Soybean flour, SESF=Sesame flour. The blend contained 50%SORF, 40%SOYF, and 10% SESF. Cerelac was used as control.

5.2. Sensory Evaluation

The sensory mean score of the complementary foods are shown in Table 4. There was no significant difference in taste of the blends (P>0.05) except for the blend that contained 70% SORF /30% SOYF /10% SESF. The blend 50%SORF/ 40%SOYF/10% SESF which received higher score for flavor differed significantly (P>0.05) from those of the other blends with lower score. The blends containing 70%SORF/20%SOYF/10% SESF and 60%SORF/30%SOYF/10% SESF received lower score for colour and they differed significantly (P>0.05) from the blends containing 70%SORF/30%SOYF/10% SESF and 50%SORF/40%SOYF/10% SESF. The texture scores did not differ significantly (P>0.05) except for the blend containing 50%SORF/ 40%SOYF/10% SESF that was higher than those of the other blends. The overall acceptability score for the blend containing 50%SORF/ 40%SOYF/10% SESF was higher than those of the other blends. All blends were generally accepted. The cerelac (control) received lower scores for all the attributes evaluated except for colour.

Table-4. Sensory mean score of the complementary foods prepared from blends of Sorghum flour (SORF), Soybean flour (SOYF) and Sesame flour (SESF).

Complementary foods SORF: SOYF: SESF	Sensory Attributes				
	Taste	Flavor	Colour	Texture	Overall acceptability
70:30:0	3.0^c	2.9^b	3.8^b	3.4^b	3.2^c
70:20:10	3.7^b	3.1^b	3.2^c	2.8^c	3.2^c
60:30:10	3.7^b	3.2^b	3.1^c	3.4^b	3.2^c
50:40:10	3.8^a	4.2^a	3.7^b	4.0^a	4.0^a
Cerelac	3.7^b	2.8^b	4.1^a	3.4^b	3.6^b
LSD	0.8	1.4	1	1.2	0.8

Means within a column with the same superscript were not significantly different (P>0.05). LSD= Least Significant Difference. Samples were obtained on a 5- point hedonic scale (1=dislike extremely and 5= Liked extremely). Cerelac served as control.

6. CONCLUSION

The result of this study showed that acceptable complementary food with chemical and physical properties similar to commercial weaning food (Cerelac) could be prepared from sorghum, soybean and sesame flour blends. The complementary food contained 24.1% protein. 41.5% carbohydrate and 21.5% fat. The technology for the preparation of this complementary food is simple. Sorghum, soybean and sesame are available and sold at affordable price in Nigeria. A complementary food from the blends of these crops would be an advantage in developing countries where the available commercial complementary foods are sold at exorbitant price. The development of this high protein sorghum/soybean/sesame complementary food would find potential in opening a new channel for introducing sorghum, soybean and sesame base product in the market.

7. RECOMMENDATION

Based on the result of this study, it is recommended that;

1. The protein quality of the complementary food should be accessed.
2. The storage stability of the complementary food should be determined
3. The scale consumer sensory evaluation of the complementary food should be carried out.

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