



Production of Complementary Food for Infants Made from Sweet Potatoes, Soybeans, Maize and Guinea Corn

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Authors' contributions

This work was carried out in collaboration among all authors. Author AA designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Author AO participated in the processing of the complementary foods in the laboratory and managed the analyses of the study. Author AO managed the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

The transition from breastfeeding to family or complementary food is challenging for most mothers. This is a critical period of growth during which nutrient deficiencies and illnesses contribute globally to higher rates of under-nutrition among children less than five years of age. This study was carried-out to compound an indigenous complementary food that is nutritious, cheap, and with considerable shelf life. Blends of soya beans, sweet potato, yellow maize and guinea corn flours were mixed in proportions and proximate analysis was carried out to determine the nutritive and preservative quality. Carbohydrate (80.33-84.72 g) was 123% more and protein (3.43-4.26 g) was 26.6% less than commercially available complimentary food. More research is needed in this area to achieve our goal.

Keywords: *Complementary food; sweet potatoes; soybeans; maize and guinea corn.*

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1. INTRODUCTION

A recent paper by World Health Organization defined complementary feeding as the process that starts when breast milk alone is no longer sufficient to meet the nutritional requirements of infants and therefore other foods and liquids are needed, along with breast milk [1]. It further explained that the transition from exclusive breastfeeding to family foods is referred to as complementary feeding and it typically covers the period from 6 - 24 months of age. The European Society for Paediatrics Gastroenterology, Hepatology and Nutrition, food be used for foods and liquids that are not breast milk or infant formulas [2]. The common weaning food in Nigeria is called pap in English, akamu in Igbo language, ogi in Yoruba or koko by the Hausas and is made from maize (*Zea mays* L.) before the introduction of other staples such as yam, sweet potatoes and rice meals [3].

In African countries, there were approximately ten million annual deaths of under-five-year-old children. Over one third of under-five mortality is caused by malnutrition-related to inadequate complementary feeding. Initiating safe and nutritionally adequate complementary foods at six month is crucial to achieving optimal growth, development and health. The world health organization has defined complementary feeding period as the period during which other foods or liquids are provided along with breast milk and any nutrient containing foods or liquids given to young children. Optimal infant and young child feeding have the highest potential impact on child survival. Plant based foods provide at least 50% of the dietary energy and nutrients for Nigeria children [4].

Complementary feeding starting at 6 months was third among 15 top ranked child survival interventions. Complementary feeding interventions alone were estimated to prevent almost one fifth of under five children mortality in developing countries. The most crucial time to meet child's nutritional requirements is the first 1,000 days. The child has increased nutritional needs to support rapid growth and development. Production of cost-effective weaning diets that can be fortified with micronutrients was also canvassed for by many researchers in Africa [5].

2. MATERIALS AND METHODS

2.1 Preparation of Samples

Potatoes, soy beans, guinea corn and yellow maize were all purchased from local market in Lagos Nigeria.

2.1.1 Soy beans flour

Soya bean grains were sorted to remove dirt, stones and foreign materials. The clean soybeans were soaked in hot water for 3 hours to remove hull. The dehulled soy bean was roasted using gas cooker to remove some anti-nutrients. The roasted soybeans were allowed to cooled, dried and milled using dry milling machine, sieved and packaged in an air tight container [6].

2.1.2 Production of sorghum flour and maize flour

Sorghum and maize flours were produced by soaking sorghum and maize differently in clean plastic containers for 48 hrs. The softened coats were milled and sieved to remove the germs and hulls. The sorghum and maize slurry were allowed to ferment naturally in clean plastic buckets an aerobically for 72 h and the steep water decanted. The fermented meal were then pressed using a clean muslin cloth to produce the fermented cake. The cakes were then dried separately in hot air oven at 60°C for 10 h and milled to produce the fermented sorghum flour and maize flour which is packaged in airtight containers.

2.1.3 Sweet potato flour

Sweet potato roots were washed and cleaned. These were peeled, flaked and left in water to prevent change in color. It was dried in a hot air oven immediately at 30°C for 5 hours. It was milled, sieved and packaged in an air tight container also.

The processed soy beans, sweet potato, yellow maize and guinea corn flours were combined in different portions in the following ratios respectively to have five different composite flours: INF 1 - 25% each of the four flours; INF 2 - 40%:20%:20%:20%; INF3 - 20%:40%:20%:20%; INF 4 - 20%:20%:40%:20% and INF 5 - 20%:20%:20%:40%. Each portion is one hundred grams of composite flour mixed according to the specified ratio/percentage. Each pack of composite flour was put in a working blender and mixed for five minutes each time and put in the clean plastic containers as

sample. The five composite flours were subjected to proximate analysis using standard techniques.

2.2 Proximate Analysis

2.2.1 Moisture content determination

Five grams of sample was weighed into a Petri-dish of known weight. The weighed samples were put into an oven pre-set at 110°C for 3 h. The sample was removed and cooled in a desiccator to room temperature and the weight was determined. It was returned into the oven at 110°C for 30 minutes until constant weight was obtained. This procedure was repeated for each composite flour [7].

2.2.2 Ash content determination

Five grams of sample was weighed into a previously heated and cooled silica dish. The dish was ignited gently first and then at 600°C for 3 h in a muffle furnace. The dish and its content were cooled in a desiccator and reweighed; the weight of the residue was recorded as ash content. This procedure was repeated for each composite flour [7].

2.2.3 Crude fat determination

Crude fat was determined using the AOAC [7]. 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. This procedure was repeated for each composite flour.

2.2.4 Crude protein determination

Crude protein was determined by Kjeldahl method using Kjeltac TM model 2300, as described in Foss Analytical manual, AB. The method involved digestion of the sample at 420°C for 1 h to liberate the organically bound nitrogen in the form of ammonium sulphate. The ammonia in the digest ammonium sulphate was then distilled off into 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 [7]. This procedure was repeated for each composite flour.

The various analyses were carried out thrice and the average figures recorded as follows:

3. RESULTS AND DISCUSSION

There were significant differences in all the measured parameters. The moisture contents which ranged from (7.32-10.60%) with the highest value observed in the sample INF4. This could be as a result of the incorporation of the yellow maize flour. The lowest value was expectedly observed in INF2 as it contained 40% incorporation of soya beans flour.

The levels of moisture content in the composite flours were within the recommended moisture level 14% for safe storage and could be a moisture stable product as agreed in the finding reported by [8]. The moisture content should be below 14% to prevent microbial growth and chemical changes during storage [9].

The low moisture observed for the five samples was a good indicator of their potential to have longer shelf life. The samples INF4 and INF5 have the highest moisture content 10.60% and 10.50% respectively and this differs with only 0.10%. Different food materials have different capacity for absorbing/retaining moisture which may exist as occluded or absorbed water [10].

As the soya beans flour and sweet potato flour was added to yellow maize and guinea corn flour, it tended to bind moisture, thereby reducing the moisture content of the complementary food samples [8].

The protein content ranged from 3.43 - 4.26% in INF1 having the highest protein content (4.26%) followed by INF2 with protein content of (4.02%). Sample INF5 had the least protein content (3.43%).

The Indian Council for Medical Research affirmed that the required optimal protein-calorie requirement for preschool children in India is 7.10% [11]. The average requirement for percent protein is about 7% of total energy intake for infants. Average Western diets and commercial cereal-based weaning complementary provide about 14% for children and half of it for adults [12].

This could be attributed to the high percentage of protein content in the soya beans flour. It was observed that the protein content increased as the level of soya beans flour and sweet potato flour. The fat content ranged 8.80%-11.45%.

Table 1. Proximate composition of composite flour from blend of soya beans, sweet potato, guinea corn and yellow maize flour

Sample	Sample mass	Moisture Content		Fat		Ash		Carbohydrate		Protein		Crude Fibre	
		%	g	%	g	%	g	%	g	%	g	%	g
INF1	2g	9.73	0.195	8.85	0.165	1.65	0.033	83.586	1.672	4.264	0.085	1.65	0.033
INF2	2g	7.23	0.145	11.45	0.229	2.10	0.042	80.328	1.606	4.022	0.080	2.10	0.042
INF3	2g	7.83	0.157	9.80	0.196	2.25	0.045	82.096	1.642	3.604	0.072	2.25	0.045
INF4	2g	10.60	0.212	9.00	0.180	1.60	0.032	84.262	1.685	3.538	0.071	1.60	0.032
INF5	2g	10.50	0.210	8.80	0.176	1.50	0.030	84.722	1.694	3.428	0.069	1.55	0.031

INF: Infant formular

Key: INF1 25% Soya beans flour, 25% Sweet potato flour, 25% Guinea corn flour and 25% Yellow maize flour

INF2 40% Soya beans flour, 20% Sweet potato flour, 20% Guinea corn flour and 20% Yellow maize flour

INF3 20% Soya beans flour, 40% Sweet potato flour, 20% Guinea corn flour and 20% Yellow maize flour

INF4 20% Soya beans flour, 20% Sweet potato flour, 20% Guinea corn flour and 40% Yellow maize flour

INF5 20% Soya beans flour, 20% Sweet potato flour, 40% Guinea corn flour and 20% Yellow maize flour

Table 2. INF1 in comparison with a commercial infant formula (Cerelac)

Nutrient	INF1	Cerelac
Carbohydrate	84g	68g
Protein	4g	15g
Fat	9g	10g
Fibre	2g	2g

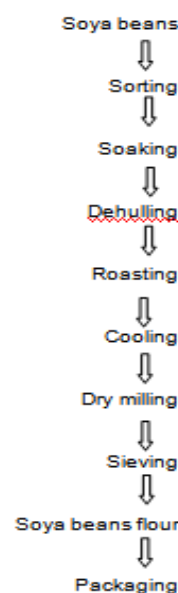
The fat content in INF1 (8.85%) is almost the same with INF 5 (8.80%) which is the lowest, with the highest in INF 2 (11.45%).

The carbohydrate content of sample INF5 had the highest value of 84.72% with sample INF4 having a value of 84.26% which is a difference of 0.46%. INF 1 had the least value of 80.33%. This was in agreement with the findings of [13], who reported a decrease in carbohydrate content with increase in soybean flour substitution and also with the report [14], which showed a decrease in carbohydrate content from 74.82% in the control to 68.46% for sorghum flour enriched with 45% walnut and 5% ginger flour.

The crude fibre content of the samples ranged from 1.55% to 2.25% and was significantly different from each other. The crude fibre level of INF3 was 2.25% having the highest value due to the double ratio of sweet potato flour. But at 20% incorporation of sweet potato flour, the crude fibre level of the other samples dropped. 25% (INF2), 20% (INF4), 20% (INF5) having crude fibre content of 1.65%, 2.10%, 1.60%, 1.55% respectively.

Common commercial infant formulas offer protein between (3.43%-4.20%), energy and some other essential nutrients needed by infants for proper growth and development. The soya beans inclusion helped improve the protein and lowered the moisture content. The incorporation of sweet potato flour by 40% increased the crude fiber content in INF3. As infants do not need lots of fibre in their diet, INF3 may not be a good and acceptable product. The moisture contents which range from (7.32 - 10.6%) with the highest value observed in the sample INF4. This could be as a result of the incorporation of the yellow maize flour. Proximate composition results indicated an increase level of protein and fat from 4.26 - 3.43%, and 8.80 - 11.45% respectively. Carbohydrate range in commercial complementary foods is between 80.33% and 84.72%. The lowest value was expectedly

observed in INF2 as it contained 40% incorporation of soya beans flour. Sample one (INF1) was identified as the most suitable in terms of nutritional content in this study should be packaged for commercial consumption.

**Fig. 1. Flow chat for processing soya beans flour [6]**

4. CONCLUSION

The use of locally produced complementary food should be promoted to save cost and maximize the consumption of traditional food items rich in nutrients. It is also recommended to reduce dependence on processed imported canned foods. The use of soya beans flour, sweet potato, yellow maize flour, and guinea corn flour in the production of complementary food is recommended to fully utilize these tropical crops grown in developing countries like Nigeria. It is also recommended so as to reduce dependence on canned complimentary food. Hence, priority be given to locally processed meals. Further studies could be carried out on these products.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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