

## **DEVELOPMENT AND SENSORY EVALUATION OF SOYAMUSA: A SOYBEAN-PLANTAIN BABY FOOD**

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### **Abstract**

Appropriate technologies were used to process plantain and soybean into flour which were used for the formulation of 'Soyamusa', a soybean-plantain baby food that requires little cooking. Extruded and non-extruded soybean grits were produced and mixed with plantain flour in varying proportions to determine the blend that would give the required energy and protein level in baby foods. A mixture of sugar, vitamins and minerals was added to improve the taste and to meet the recommended daily vitamin and mineral requirements for babies. The final blend was subjected to nutritional and sensory evaluations. The sensory test was to determine the acceptability of the two products of 'Soyamusa' and compare them with other popular market brands. It was found that a mixture of 60% plantain flour, 32% soybean grit and 8% sugar produced a blend whose proximate analysis showed 15.8% protein, 8.0% fat, and 72.8% carbohydrate with an energy content of 457.4 kcal per 100g. The sixteen weaning Wister rats on 'Soyamusa' had normal growth, packed cell volume and white blood cell count. Hemagglutination test did not indicate any immunological reaction against 'Soyamusa'. Results of the comparative assessment of the two samples for color, flavor, consistency, mouthful, taste and overall acceptability did not show any significant difference ( $P > 0.05$ ). However, the samples differ significantly in all attributes ( $P < 0.01$ ) from the two popular market brands but were equally acceptable.

### **1. Introduction**

Traditionally, babies are breast fed in Nigeria. This has been possible especially for mothers who are mostly housewives devoting their time to take care of their children. Solid foods have been often incorporated to the diet of six months old children. The solid foods are regarded as a supplement to the breast milk, which may be inadequate for the rapid growth and development of the infants after four months of life (Brown, 1978).

The major problems with traditional weaning foods are that they are usually starchy paste of low solid concentrations (high volume/unit weight) with low protein content (Mitzner, *et al.*, 1984). A young child may have difficulty eating enough to meet their energy and protein requirements, thus resulting in protein-calorie malnutrition.

Many attempts have been made to improve traditional weaning food (Akinrele and Edwards 1971; Fashakin and Ogunsola, 1982). The Federal Institute of Industrial Research Oshodi (FIIRO) developed a process for incorporation of a full fat soybean flour into 'ogi' (gruel from fermented corn) and gave it the name 'Soy-Ogi' which contained 30% soybean flour and 70% fermented corn. The product was found to contain adequate nutrients in the right proportions (Akinrele and Edwards, 1971). Also, Fashakin and

Ogunsola (1982) incorporated groundnut flour into fermented corn flour in the production of a nutritionally adequate weaning diet.

The use of an ingredient other than cereal grain in the formulation of industrially processed baby food is not common in Nigeria. However, there are other sources of calories which are unexploited such as plantain and this crop is available and abundant in many tropical humid regions. Plantain is a versatile crop in the kitchen as well as the raw material for many popular delicacies and snacks where it is abundant. With improved processing of the plantain into flour, it could serve as a very good source of carbohydrate for the formulation of a weaning food. Thus research was initiated at the Nigerian Horticultural Research Institute (NIHORT) at Ibadan to produce a weaning formula that would meet the local taste and suit the traditional custom using plantain and soybean as the base raw material (Ogazi and Adeyemi, 1989). Also the effect of processing variables on the product quality of the 'soy-plantain' food was tested (Ogazi *et al.*, 1994).

## 2. Materials and Methods

### 2.1. Materials

Raw materials include, green plantain, soybean, sugar, multi-vitamin and calcium carbonate. Green plantain, sugar and calcium carbonate were purchased from the open market, while high grade soybeans of cv. TGX536-02D were obtained from the International Institute of Tropical Agriculture (IITA) at Ibadan. The multi-vitamin was obtained from the Agro, Vitamin and Fine Chemicals Div., Roche (Nigeria) Ltd. (Agege, Lagos).

### 2.2. Methods

#### 2.2.1. Development and production of 'soy-plantain' weaning food

The stages involved in the development of 'Soyamusa' are the production of plantain flour and soybean grit (extruded and non-extruded), formulation, laboratory production, and nutritional as well as sensory evaluation.

##### 2.2.1.1. Plantain flour production

Green mature plantain fruits were hand peeled and sliced to an appropriate thickness of about 15 mm. The slices were dried in a cabinet dryer. Dryer temperature was 100 to 120 °C for the first 2 h and then reduced to about 80 °C for the remaining 3 to 4 h of drying. The drying was deemed complete when the moisture content of the dried plantain was below 10%. The dried plantain was milled using hammer mill. The flour was packed and stored in a dry, hygienic condition until required for use in the baby food formulation.

##### 2.2.1.2. Production of non-extruded soybean grit

A batch method of processing was used for the production of soybean grit. About 25 kg of raw soybean was weighed and heated in a cabinet dryer at 110 °C for 1 h to ease the cracking process. The cracking was done in a disc attrition mill for 40 minutes. The cracked beans were subjected to air aspiration for 15 minutes using the wooden aspirator. The dehulled bean was washed with a large quantity of water and any remaining shaft was decanted and the bean separated from sand or stones by sedimentation. Approximately 45 L of water heated to boiling was used for the cooking of the bean for 4 h. The soybean was considered well cooked by the degree of softness of the beans.

The bulk of the cooked beans was subjected to pressing using filter press in order to remove most of the external water in the beans. The resulting bean after pressing

weighed 36 kg, and was dried in tunnel dryer at 150 °C for 1.5 h. The weight of the dried soybean grit was 15 kg.

#### 2.2.1.3. Production of extruded soybean grit

Pre-extrusion treatment: dried cleaned soybean seeds (10% moisture content and 20% fat) were used for the experiment. The soybean was dehulled and winnowed so as to produce a low fibred and reduced tanins finished product. The dehulled seeds were then hammer-milled into fine powder, bagged and stored in a cold room (20 °C) ready for extrusion cooking.

Extrusion cooking: all flours were extruded within ten days of storage, using an insta pro 600 Jr. model extruder. Double flight screws were used with the steam locks set at 8,8,5 respectively while the nozzle opening was set at 2.5. The feed intake was set to ensure a discharge of between 300 to 350 kg h<sup>-1</sup> at a temperature range of 140 to 150 °C. The approximate residence time was about 30 seconds. All extruded soybeans were automatically dried into grit before being hammer-milled, sieved, packaged and stored in the cold room.

#### 2.2.1.4. Formulation and laboratory production of 'Soyamus'

The principal raw materials for the development of the 'soy-plantain' baby food were blended at varying proportion to determine the best blend (Table 1). The plantain natural flavor which is strong and persistent helped to neutralized the slightly nutty odor of soybean flour. The samples were weighed out as shown in the formulae and blended using a tumbling blender. The blended mixtures were milled in a roller mill to produce a homogenous mixture of uniform particle size. The milled samples were sieved using the vibro sieving machine of aperture 315 µ.

### 2.2.2. Nutritional Evaluation

#### 2.2.2.1. Proximate analysis

The moisture content was determined by drying in forced air oven at 130 °C for 1 h. Protein content, crude fat, crude fiber, ash and carbohydrate (by difference) were determined by standard methods of the Association of Official Analytical Chemists (AOAC, 1975). Potassium, sodium, calcium and phosphorus were also determined by methods adopted in the chemical analysis of food (Pearson, 1976). The vitamin profile of the 'soy-plantain' food was analyzed by standard methods by the technical partners of Roche (Nigeria) Ltd. in Basel (Switzerland) for the key vitamins A, B<sub>1</sub>, C, E, and PP (niacin).

#### 2.2.2.2. Biological analysis

Sixteen weaning rats (Wister strain) of the same weight were used for the biological assay. The rats were divided into two groups of eight each, the experimental group and the control group. Each rat was kept in a metabolic cage and weighed daily. The control rats were fed the laboratory pellets while the experimental rats were fed with the recommended blend of 'soy-plantain' food. The two sets of rats were kept on these diets for ten weeks when they were killed. The packed cell volume (PCV), white blood cell count and hemagglutination tests were carried out using standard clinical methods.

### 2.2.3. Sensory Evaluation

#### 2.2.3.1. Sensory evaluation study

This study was carried out at the FIIRO according to standard methods (Canada Department of Agriculture, 1977). The study was divided into two major parts. Firstly, the sensory evaluation of the two soy-plantain baby food produced respectively by extrusion and non-extrusion methods. The samples with the recommended or appropriate blend were prepacked in cellophane bags. Secondly, the sensory evaluation of the selected samples of 'Soyamusa' for comparative assessment with two similar market brands: 'Soy-Ogi' produced at FIIRO (Akinrele and Edwards, 1971), and 'Nutriend' (product of Nestlé Food Nigeria Plc based on corn and soybeans).

#### 2.2.3.2. Preparation of samples for testing

Cooking procedures were standardized for the test products while the market brands were prepared following their recommended procedure. The prepared samples were kept warm until needed. Samples were served to the panelists in properly coded clean cups.

#### 2.2.3.3. Panelist selection

The panelists consist of randomly selected staff of the FIIRO, and mothers who indicated that they feed their children with similar market brands of baby foods. Thirty-one laboratory panelists participated in first sensory evaluationm while 29 panelists provided the information for the comparative assessment of the two soy-plantain baby foods and two market brands. Care was taken to include almost all the panelists who participated in the first evaluation.

#### 2.2.3.4. Questionnaire

A modified 9-point hedonic type questionnaire was used for the assessments. The questionnaire was designed for the assessment of attributes of color, flavor, consistency, mouthfeel and taste for the two sensory evaluation assessment. In addition to the above attributes the overall acceptability of the products was evaluated. Also the samples were ranked for preference.

#### 2.2.3.5. Statistical analysis

The scores were given numerical values of 1 to 9 according to ratings. The mean sensory scores were calculated for all the attributes (color, flavor, mouthfeel, consistency, taste and overall acceptability) for each sample. The data obtained from the sensory evaluation of the 'Soyamusa' were analyzed statistically by Student's t-test, using the method of Freund (1973). For the comparative assessment the data collected were analyzed by the analysis of variance according to the method of the Canada Department of Agriculture (Canada Department of Agriculture, 1977). The ranking data were analyzed as suggested by Kahan *et al.* (1973). Duncan's multiple range test (at  $P = 0.05$ ) was used to determine which samples differed from each other after significant differences ( $P < 0.05$  or  $P < 0.01$ ) were determined by the analysis of variance (Canada Department of Agriculture, 1977).

### 3. Results

#### 3.1. Proximate analysis of blends

The blend combining plantain flour (60%), soybean flour (32%) and sugar (8%) (or blend PD in Table 2) was chosen as the blend that would provide the required protein and energy level for the healthy growth of infants. The blend had 15.8% a protein content, 8% fat, 72.8% carbohydrate, and a total energy content of 457.4 kcal per 100g. The percentage of multi-vitamin and calcium carbonate added to the final blend were calculated on the basis of the total weight of plantain, soybean and sugar mixture. These were 0.15% and 0.84% for multi-vitamin and calcium carbonate respectively.

This final blended mixture could be regarded as 'Soyamusa', a 'soy-plantain' baby food containing the necessary minerals and vitamins (Table 3). The results obtained from the analysis of the enriched baby food correspond very well to the vitamins added and also to the natural content of the vitamins of the basic raw materials.

#### 3.2. Biological assay

Rats on the experimental diet gained weight steadily after an adjustment period of about 3 weeks on the final blend of 'Soyamusa'. The rats were alert, active and with smooth furs. Throughout the study, there was no toxicological problem with the diet as there was not a single rat that died on the 'soy-plantain' diet. The hemagglutination test showed adequate immunological responses in all the rats, while both the packed cell volume and white blood cell counts were normal in the blood of all the experimental rats (Table 4).

#### 3.3. Sensory evaluation

The extruded and non-extruded products of 'Soyamusa' did not differ significantly ( $P > 0.05$ ) for any attribute (Table 5). The samples were similarly scored in flavor as moderately pleasant. They were both liked in consistency and were found to be extremely good in taste. The mouth fulls of the two 'Soyamusa' brands were found to be moderately smooth. The color of the extruded sample was liked very much as compared to the non-extruded sample, although it was not significant ( $P > 0.05$ ). All other attributes did not differ in preference ( $P > 0.05$ ) between the two samples of 'Soyamusa'.

The two 'Soyamusa' products and the two popular market brands differed significantly ( $P < 0.01$ ) in all attributes (Table 6). The two 'Soyamusa' products were moderately liked in color while the market brands were liked very much. In flavor, the plantain based products were found to be moderately pleasant while the two market corn-based samples were extremely pleasant and very pleasant, respectively.

### 4. Discussion and Conclusion

The need of baby foods using locally available resources cannot be over emphasized. Haper and Jansen (1985) indicated that there are some advantages associated with the local manufacture of weaning foods in developing countries through the use of appropriate central processing technologies. Such advantages are the formulation and processing of products to meet the local tastes and customs, as well as making provisions for a market of locally grown agricultural commodities.

This study was designed therefore to use plantain and soybean as the principal raw materials for the development of 'Soyamusa' as a suitable weaning food. Plantain and soybean can be produced easily in Nigeria. Plantain is a good source of carbohydrate, while soybean is superior to all other plant foods as the source of protein and have good balance of the essential aminoacids. Plantain and soybean are excellent sources of calories as well as certain vitamins and minerals. The proximate analysis of plantain and soybean

have shown that both contain all the necessary ingredients required for the formulation of weaning food. The other required ingredients, vitamin and minerals have been added as supplementary to the ones contained in the crops.

The sensory assessment revealed that the two products of 'Soyamusa' (based on extruded and non-extruded soybean grit) were similar for all attributes and even comparable to market brands. It should be remembered however that 'Soyamusa' is a new product for consumers accustomed to corn-based diets. Although the market brands were preferred to the plantain-based ones, they were not badly scored, nor were they rejected at all. They were acceptable and were mainly moderately liked in attributes. Therefore, this study has shown that acceptable weaning food can be produced from plantain and soybean using appropriate technology.

### References

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Table 1. Properties of ingredients for the formulation of 'soy-plantain' baby food.

	Samples (g)				
	A	B	C	D	E
Plantain Flour	1500 (75%)	1458 (70%)	1393 (65%)	1313 (60%)	1222 (55%)
Soybean Grit	400 (20%)	500 (24%)	600 (28%)	700 (32%)	800 (36%)
Sugar	100 (5%)	125 (6%)	150 (7%)	175 (8%)	200 (9%)

The sugar content increased with increase in soybean in order to improve the taste of the mixture

Table 2. Proximate Analysis of plantain-soybean-sugar blend (%).

	PA <sup>z</sup>	PB	PC	PD	PE
Moisture	3.50	4.00	3.60	4.20	4.10
Fat	3.60	4.50	5.30	6.00	8.60
Protein	1.70	10.50	12.00	15.80	16.50
Carbohydrate	2.50	76.80	73.51	70.80	70.40
Fibre	0.83	1.57	1.78	1.00	1.17
Ash	2.50	2.77	2.73	1.85	3.04
Potassium	0.10	0.20	0.10	0.30	0.20
Sodium	0.07	0.07	0.07	0.06	0.06
Calcium	0.30	0.40	0.35	0.35	0.35
Phosphorus	0.13	0.28	0.15	0.15	0.16
Energy kcal per 100g	417.70	420.70	419.74	457.40	458.70

Addition of multi-vitamin and mineral to the 'Soyamusa'

z PA = 75% plantain flour, 20% soybean grit, 5% sugar; PB = 70% plantain flour, 24% soybean grit, 6% sugar; PC = 65% plantain flour, 28% soybean grit, 7% sugar; PD = 60% plantain flour, 32% soybean grit, 8% sugar; PE = 55% plantain flour, 36% soybean grit, 9% sugar

Table 3. Vitamin content of 'Soyamusa'.

	Added per kg of baby food	Found
Vitamin A	20,000 I.U	19,000 I.U
Vitamin B	6 mg	9.3 mg
Vitamin C	470 mg	448 mg
Vitamin PP (niacin)	85 mg	91 mg
Vitamin E	48 mg	50 mg

The non-vitaminized product was analysed for two vitamins only and showed the following: Vitamin B<sub>1</sub>= 0.8 mg per kg, and Vitamin PP (niacin): 12 mg per kg

Table 4. Hemagglutination results with the antibody titres of the rats after 10 weeks on the 'soy-plantain' diet (also known as 'Soyamusa').

Immune Response	Control rats	Experimental rats
Pre-Immune	-	-
Primary Response	512	597
Secondary Response	10240	10922

Table 5. Comparison of 'Soyamusa' processed by extruded and non-extruded methods.

Attributes	Extruded 'Soyamusa'	Non-extruded 'Soyamusa'
Color rating	2.9 <sup>z</sup> Liked very much	3.1 Likef moderately
Flavour rating	3.2 Moderately pleasant	3.3 Moderately pleasant
Consistency rating	2.8 Liked very much	2.8 Liked very much
Mouthfeel rating	3.6 Moderately smooth	3.2 Moderately smooth
Taste rating	2.8 Extremely good	2.6 Extremely good

<sup>z</sup> Panelist score: 1 (like extremely) to 9 (dislike extremely)

Table 6. Comparison of brands of baby foods containing processed soybean flour.

Attributes	Extruded 'Soyamusa'	Non-extruded 'Soyamusa'	'Soy-Ogi'	'Nutriend'
Colour rating	3.52a <sup>z</sup> Liked moderately	3.66a Liked moderately	2.41b Liked very much	2.00b Liked very much
Flavour rating	3.70a Moderately pleasant	3.20a Moderately pleasant	2.14b Very pleasant	1.31c Extremely pleasant
Consistency rating	2.45a Liked very much	2.31a Liked very much	1.52b Liked very much	2.30a Liked very much
Mouthfeel rating	2.72a Very smooth	2.60a Very smooth	1.52b Extremely smooth	4.14c Slightly smooth
Taste rating	3.12 Moderately good	2.90a Very good	2.30 Very good	1.78b Extremely good
Overall acceptability	3.80a Liked moderately	3.70a Liked moderately	2.60b Liked very much	2.35c Liked very much

Values in the row followed by the same letter do not differ significantly at  $P = 0.05$

<sup>z</sup> Panelist score: 1 (like extremely) to 9 (dislike extremely).