

Development And Evaluation Of Complementary Foods Based On Soyabean, Sorghum And Sweet Potatoes Flours Blends

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ABSTRACT

Introduction: The study evaluated the nutrient, antinutrient and sensory properties of complementary food (gruels) based on fermented soyabean, sorghum and sweet potatoes flour blends.

Methodology: The soyabean, sorghum and sweet potatoes were subjected to different fermentation periods, 24, 48 and 72hr. The unfermented flour samples served as the control, the fermented flour were used to prepare gruels. The chemical and sensory properties of the gruels were analyzed using the standard assay method. The data obtained were analyzed using descriptive statistics to determine the mean and standard deviation.

Result: Based on the result, there was increase in the protein content of the gruel made from the 48hr fermented flours relative to the control (46.78 to 56.15%). There were decreases in the fat content of the gruel on the 24 and 72hr fermentation period when compared with the control (14.01 to 5.55 and 6.98%) respectively. Relative to the control fermentation increase the ash and fiber level at 72hr period (2.01 to 4.94) and 1.64 to 3.25) the carbohydrate content was increased on the 24hr fermentation period respectively. The tannin and phytate levels were drastically reduced due to fermentation. The gruels based on 48 and 72hr fermented composites were much more acceptable when compared with the 2hr and the control. As judged by the results, fermentation improved the nutrient composition of the gruels.

Conclusion: These gruels can serve as a good complementary food that can substitute the popular maize gruel (pap) which is the commonly available complementary food especially in rural areas.

Keywords: Development, Evaluation, Complementary Foods, Soyabean-Sorghum-Sweet Potatoes, Flours Blends

INTRODUCTION

In many developing countries including Nigeria, protein energy malnutrition (PEM) is endemic. PEM is found to be more among children because they are weaned abruptly into starchy foods. Hunger and malnutrition remain among the most devastating problems facing the majority of the world's population and continue to dominate the health of the world's poorest nations. Nearly 30% of infants and children in the developing world are currently suffering from one or more of the multiple forms of malnutrition ⁽¹⁾.

The formulation and development of nutritious complementary foods from local and readily available raw materials has received considerable attention in many developing countries. The commercially standardized foods are generally very good and can help meet the nutritional requirements of young children in both developed and developing countries. However, the development of low-cost, high protein food supplements for weaning infants is a constant challenge for developing countries where traditional foods used during the weaning process are frequently characterized by low nutrient density and high bulk which can adversely affect infants health ⁽²⁻³⁾.

Protein- energy malnutrition generally occurs during the crucial transitional phase when children are weaned from liquid to semi-solid foods. During this period, because of their rapid growth children need nutritionally balanced, Calorie-dense complementary foods in addition to breast milk. Global nutrition survey revealed that the most dietary deficit is protein of high biological value. This is because using expensive and beyond the reach of the majority of the population. However vegetable protein complements each other, a combination of legume and cereal proteins will have a nutrition value as good as animal protein ⁽⁴⁾. According to Baldi ⁽⁵⁾ protein deficiency cannot be overcome by using animal products as they are not easily affordable. He maintained that the only alternative is to push up the vegetable protein intake which already makes up to 70% or so of world's protein production.

The high prevalent rate of malnutrition has led to researches into ways of processing locally available foods to improve their nutritive value and introduce variety in the diet. This will help to meet the need of the growing population especially children who are more prone to malnutrition. WHO ⁽⁶⁾ reported that breast milk is the best

for the infants, (0-6months) but as they continue to grow, they are gradually introduced to semi- solid and solid foods known as complementary foods. In developing countries such as Nigeria complementary foods are mainly starchy staples such as Maize, Sorghum, rice, etc. This is because cow's milk of various modifications and artificial complementary foods are expensive and many families cannot afford it. The higher food prices in recent years and the need for protein rich foods have created the need to develop less expensive, more nutritious and ready to serve complementary foods based on edible legumes, cereals, and tubers⁽³⁾.

Protein-energy malnutrition is widespread in both rural and urban communities in Nigeria. This is due to strict economic measures, inadequate production and supply of foods, especially protein and micronutrients rich foods. There are little advances in the processing and preservation techniques and neglect of our indigenous crops. Furthermore, artificial complementary foods are expensive, especially the low income group cannot afford them.

The aim of the work was to use composite flour from soybean, sorghum, sweet potatoes in the production of complementary foods. The specific objectives are stated below:

1. To determine the effects of fermentation on the chemical composition of soybean, sorghum and sweet potatoes flours.
2. To formulate composite flours from soybean, sorghum and sweet potatoes flours.
3. To produce porridges (gruel) from the composite flours and evaluate their organoleptic attributes.

The result of this study would enlighten mothers both in the rural and urban communities on the methods of producing nutritious and cheap complementary foods from the soybean, sorghum, and sweet potatoes flours. It will also help the government food policy makers and food industries to produce more nutritious and cheap complementary foods from locally available staple to alleviate the problem of protein- energy malnutrition.

MATERIALS AND METHODS

The soybean (glycine max), and Sorghum, sweet potatoes (IpomocaBatata) used for this study were purchased from Owerri market, Imo state.

PREPARATION OF SAMPLES

(i) Sorghum

About 3kg sorghum grains were cleaned to remove sand, broken grains and other foreign materials. The cleaned grains were divided into four portions. One portion served as the control. It was milled into fine flour and sieved (70mm mesh screen). The flour was stored in polythene bags until analyzed. The remaining three portions were soaked separately in cold water in a ratio of 1:3 (W/V) and allowed to ferment by the micro flora inherent in them for 24, 48 and 72hrs at $28 \pm 2^\circ\text{C}$. At the end of each fermentation period, the soaking water was completely drained. The fermented grains were separately milled into fine flour (70mm mesh screen) and the flour samples were packed separately in polythene bags and stored in the refrigerator until analyzed.

(ii) Soyabean

Soyabean seeds weighing 3kg were cleaned and boiled for 25 minutes. The boiled seeds were dehulled and divided into four portions. One portion was oven dried at temperature of 60°C . The other three portions were fermented for 24, 48 and 72 hrs respectively at room temperature $28^\circ\text{C} \pm 2^\circ\text{C}$. They were also oven dried and milled separately. All the four samples were packed into polythene bags and stored in refrigerator until analyzed.

(iii) Sweet Potatoes

About 3kg of sweet potatoes tubers were peeled and sliced into smaller pieces. The sliced sweet potatoes were washed and divided into four portions. One portion was dried and milled into fine flour. The remaining three portions were subjected to different fermentation periods Viz. 24, 48, and 72 hrs in cold water in a ratio of 1: 3 (W/V). The fermented sweet potatoes were dried and milled separately into fine flour and kept in polythene bag in a refrigerator until analyzed.

PROXIMATE ANALYSIS OF THE SAMPLES

MOISTURE DETERMINATION

The hot oven method as described by AOAC⁽⁷⁾ was adopted. The Petri dishes were washed, dried in the oven at 100°C for 30 minutes, cooled in the desiccators and then weighed. 2g of each sample were weighed into the dishes. The weights were recorded, that is the weight of the samples and empty dish. The dishes were then placed in the oven at 100°C for 4hrs, after which they will be removed, cooled and weighed. The drying was

continued and weighing down repeatedly until a constant weight is obtained. The percentage moisture content will be calculated from the weight loss of the sample.

$$\% \text{ Moisture} = \frac{\text{Weight of Moisture}}{\text{Weight of Sample}} \times \frac{100}{1}$$

DETERMINATION OF ASH

The A.O.A.C⁽⁷⁾ (Official methods of analysis of the association of analytical chemists) method was used. Clean crucibles were oven dried, cooled in desiccators and weighed. 2g of each sample was weighed into the crucibles and placed inside a muffle furnace at 550°C for 6hrs. After ashing, the furnace will be switched off and the temperature allowed to drop before the removal of the crucible. The crucibles will then be weighed after cooling.

$$\% \text{ Ash} = \frac{\text{Weight of Ash}}{\text{Weight of Sample}} \times \frac{100}{1}$$

DETERMINATION OF FAT

This was determined using the soxhlet extraction methods described by AOAC⁽⁷⁾. 2g of each sample was weighed into a folded filter paper and inserted into a thimble. The thimble containing the sample was filled into the extraction instrument using a rack. 4Sml acetone (solvent) was poured into a weighed empty cup (i.e. extraction flask) and the cup and its content was poured into the instrument chamber with the aid of a rack. The thimble containing the samples was inserted into the solvent by pulling the knobs on the machine upwards. The system was allowed to stand for 30minutes at 100°C. The instrument was connected to a tap, which refluxed within the system at the end of 50 minutes, the solvent was recovered by an automatic siphoning device in the machine the solvent was recorded leaving fat in the flask.

The cup containing the fat was removed dried in the oven for 15 minutes, cooled in desiccators and then reweighed; the weight of fat i~ the weight of dish plus fat minus the weight of dish.

$$\% \text{ Fat} = \frac{\text{Weight of Extracted Fat}}{\text{Weight of Sample}} \times \frac{100}{1}$$

DETERMINATION OF PROTEIN

The micro-kjeldahl method as described by AOAC⁽⁷⁾ was used to determine the protein content of samples.

DIGESTION

2g of the sample was placed inside a 100ml digestion flask. 2g of anhydrous sodium sulphate, 1g of hydrated cupric sulphate, a pinch of selenium powder and 10ml of concentrated sulphate acid was added to the flask. The mixture was then placed on an electric heater and boiled gently at first until the solution becomes clear and was continued for the next one hour. The flask was allowed to cool. Distilled water was introduced into flask shaken thoroughly.

DISTILLATION

Steam was passed through micro-kjeldahl distillation apparatus for 10 minutes. 5ml of boric acid was placed into 250ml conical flask and 2 drops of the indicator will be added. The conical flask was placed under condenser such that the condenser tip will be on surface of the liquid. 5ml of the diluted was placed in the distillation apparatus and rinsed down with distilled water. The evaporator was closed with rod and 5ml of 40% sodium hydroxide was added carefully to prevent ammonia from escaping steam was let in for about 5minutes until the amount of liquid in the conical flask was about twice the volume at the beginning of distillation.

TITRATION

The ammonia trapped was titrated against a standard 0.1 NHCL to the end point (green to pink) and the volume of the titre was recorded. The titre was then used to calculate the nitrogen content and converted to crude protein using the factor 6.25.

$$\% \text{ Crude Protein} = \frac{T \times 14.01 \times 0.1 \times 6.25 \times 20}{1000 \times \text{Weight of Sample}} \times \frac{100}{1}$$

Where:

T	=	Titre
0.1 NHCL	=	Normality of the Acid
2.0	=	Dilution Factor
6.25	=	Conversion Factor

DETERMINATION OF CRUDE FIBRE

Crude fibre content was determined by the method of AOAC⁽⁷⁾. 2g of the sample was hydrolyzed in a beaker with 200ml of 1.25% H₂SO₄ for 30minutes. The mixture was filtered under function, washed with hot distilled water and then boiled again for another 20 minutes with 200ml of 1:25% NaOH. The digested sample washed with 1%HCL toneutralize the NaOH and washed several times with hot distilled water.

The residue collected was put into a weighed crucible and dried at 100°C for 2hrs in an oven. It was then cooled in a desiccator, weighed and ashed. The ash obtained was cooled and weighed.

$$\% \text{ Crude Fibre} = \frac{\text{Weight of Fibre}}{\text{Weight of Sample}} \times \frac{100}{1}$$

CARBOHYDRATE DETERMINATION

This was determined by the difference, that is subtracting the sum of % ash, % protein, % fat, % moisture and % crude fibre from 100%.

$$100\% - (\% \text{ ash} + \% \text{ protein} + \% \text{ fat} + \% \text{ moisture} + \% \text{ Crude fibre})$$

The result of the subtraction above gives the carbohydrate content.

DETERMINATION OF MINERALS

2g of each sample was prepared for mineral analysis using the method of Ranjihana and Gopal⁽⁸⁾ phosphorus was determined by the stannous Chloride method after wet digestion of sample. The total iron content was determined by phemanthroline method, using specitric 70 spectrophotometer.

The other minerals (Zn, Cu, P, Ca) were determined by using the atomic absorption/emission spectrophotometer equipment.

DETERMINATION OF ANTINUTRIENTS TANNIN

A few drops of dilute HCL was mixed with 3ml of the aqueous extract and shaken vigorously. The mixture was then boiled in water bath. A reddish coloration showed the presence of tannins. The content was then added to a volumetric flask and made up do 540mls with water and filtered 5.0mls of the filtrate was pipetted into test tube containing 3mls of 0.1m FeCl₃ in 0.1m HCl and 3ml of 0.008m potassium Ferro cyanide (K₃te (CN)₆). The absorbance was read at 720nm. A standard curve was plotted and used for calculation of the concentration of tannin in the sample.

$$\text{Tannin Concentration} = \frac{X \times DF \times 100}{1000}$$

$$= \text{mq/ 100g}$$

Where: DF = Dilution factor

X = Reading from the curve

PHYTATE

2.0g of the sample was weighed into test and mixed with 2.0ml of distilled water. The resulting solution was boiled for 10 minutes. A few drops of picric acid was added. A yellowish coloration showed the presence of phytic acid. 0.5g of the sample was weighed into a 500mls flat bottom flask. The flask with the sample was placed in a shaker and extracted with 100mls 2.4% HCl for 1 hour at room temperature.

5ml of the filtrate was diluted to 25ml with distilled water. 15ml of 0.1m sodium chloride was added to 100ml of the diluted sample and pass through an ampletraisen grade 200 - 400 mesh to elude in organic phosphorus and 15ml 0.7m sodium chloride was also added to elute phytate. Read at 500nm by using water to zero the spectrophotometer. A calibration curve was constructed and was used to calculate the concentration of the phytate.

$$\text{Phytate Concentration} = \frac{X \times DF \times 100}{1000}$$

FORMATION OF COMPOSITE FLOUR

The protein levels of the flours were formulated using the Microkjeldahl procedure ⁽⁷⁾. Blends were formulated based on proteins basis in the ratio of 70: 30, 70% of the flour came from soyabean while 30% came from Sorghum and sweet potatoes. The composites are shown in the table below.

	Soyabean	Sweet Potatoes	Sorghum
Sample 1	70:	15:	15
Sample 2	50:	25:	25

PREPARATION OF PORRIDGES

All the products were made based on the recipe developed for porridge using fermented soybeans, sorghum and sweet potatoes.

The following recipe was used:

Flour	-	150g
Water	-	1000ml
Sugar	-	10g

PREPARATION OF THE SLURRY

The quantity of flour and water used was measured out.

METHOD

The gas was lighted, cold water was poured into the pot and the flour properly mixed with water. The pot was put on fire and was continuously stirred with a wooden spoon. It was cooked for 12 (twelve) minutes until it thicken and porridge was done. A little quantity of sugar was added to improve the taste.

SENSORY EVALUATION OF THE PORRIDGES

The hedonic scoring form was used as the instrument for evaluating the porridges. The forms include the test for flavour, colour, texture and the general acceptability. A nine-point scale was used in order to help the panelist fully express their degree of liking/disliking.

SELECTION OF JUDGES

The judges were chosen based on their ability in sensory evaluation of foods. The porridges were organoleptically evaluated using a panel of 20 judges.

PRESENTATION OF PRODUCTS TO JUDGES

The porridges were presented for evaluation at a temperature of 40°C (serving temperature). All the products were presented in a dish -labeled with appropriate codes. Each judge was given a glass of water at room temperature to rinse his/her mouth after tasting to avoid interfering with the taste of the proceeding products. The sensory evaluation forms were placed near the products such that each judge collected and uses for the evaluation ⁽⁹⁾.

STATISTICAL ANALYSIS

The chemical and the sensory evaluation results were analyzed using descriptive statistics to determine the means and standard deviations.

TABLE 1: PROXIMATE COMPOSITION OF GRUEL BASED ON SOYABEAN, SORGHUM AND SWEET POTATOES (% DRY WEIGHT)

Sample (%)	Protein	Fat	Ash	Fibre	CHO
U – S ₇₀ Sp ₃₀	46.78 ± 0.07	14.01 ± 0.33	2.01 ± 0.16	1.64 ± 0.07	35.47 ± 0.07
U – S ₅₀ Sp ₅₀	33.02 ± 0.18	9.48 ± 0.76	1.53 ± 0.15	3.87 ± 0.50	52.10 ± 0.15
F – S ₇₀ Sp ₃₀	13.08 ± 0.85	5.56 ± 0.38	1.54 ± 0.74	1.16 ± 0.15	78.66 ± 0.38
F – S ₇₀ Sp ₃₀	12.64 ± 0.16	8.81 ± 0.83	1.51 ± 0.15	2.49 ± 0.46	74.55 ± 0.15
S – S ₅₀ Sp ₅₀	56.15 ± 0.01	14.81 ± 0.17	0.94 ± 0.15	2.19 ± 0.14	25.91 ± 0.17
S – S ₇₀ Sp ₃₀	37.76 ± 2.9	14.28 ± 4.35	1.00 ± 0.76	3.28 ± 0.15	43.68 ± 0.35
T – S ₇₀ Sp ₃₀	39.16 ± 0.10	6.98 ± 0.81	3.94 ± 0.15	2.45 ± 0.15	47.47 ± 0.15
T – S ₅₀ Sp ₅₀	29.43 ± 0.5	8.67 ± 0.69	4.74 ± 0.15	3.25 ± 0.78	53.91 ± 0.69

Mean ± Standard Deviation of 3 replications.

U – S ₇₀ Sp ₃₀	=	Unfermented soyabean, sorghum and sweet potatoes gruel (70: 30)
U – S ₅₀ Sp ₅₀	=	Unfermented soyabean, sorghum and sweet potatoes gruel (50:50)
F – S ₇₀ Sp ₃₀ gruel (70:30)	=	First day fermentation of soyabean sorghum and sweet potatoes
F – S ₇₀ Sp ₃₀ gruel (50:50)	=	First day fermentation of soyabean, sorghum and sweet potatoes
S – S ₇₀ Sp ₃₀ gruel (70: 30)	=	Second day fermentation of soyabean, Sorghum and sweet potatoes
S – S ₇₀ Sp ₃₀ gruel (50:50)	=	Second day fermentation of soyabean, Sorghum and sweet potatoes
U – S ₇₀ Sp ₃₀ (70:30)	=	Third day fermentation of soyabean, sorghum, sweet potatoes gruel
U – S ₇₀ Sp ₃₀ (50: 50)	=	Third day fermentation of soyabean sorghum, sweet Potatoes gruel

THE PROXIMATE COMPOSITION OF THE GRUEL AS SHOWN IN TABLE 1
PROTEIN

The protein content varied. It ranged from 12.64 to 56.15% the S – S₇₀Sp₃₀ had the highest protein value (56.15) while the F – S₅₀Sp₅₀ had the lowest protein level of 12.64. The gruel based on 24hrs. Fermentation has the highest value while the First fermentation had the least.

FAT

The value for fat differed. It ranged from 5.56 to 14.81%. The gruel based on flours (S – S₇₀ Sp₃₀) had the highest value of 14.81% while the F – S₇₀Sp₃₀ had the lowest value or 5.56.

The U – S₇₀Sp₃₀, S – S₅₀Sp₅₀ and S – S₇₀Sp₃₀ had comparable values (14.01 to 14.81%)

ASH

The ash values of the gruel differed. The S – S₇₀Sp₃₀ had the lowest value 0.94% and U – S₅₀Sp₅₀ had the highest value 4.74. The F – S₅₀ Sp₅₀, U – S₅₀Sp₅₀ and F – S₇₀Sp₃₀ had comparable values (1. 52 to 1. 54%).

CRUDE FIBRE

The fibre content of the product varied. The U – S₅₀Sp₅₀ had highest value 3.87% and F – S₇₀ Sp₃₀ with the lowest value 1.16%. F – S₇₀Sp₃₀ and U – S₇₀Sp₃₀ had comparable values

(1.16 to 1.64%), S – S₇₀Sp₃₀, T – S₇₀Sp₃₀ and F – S₅₀Sp₅₀ had comparable values (2.19 to 2.49%) and T – S₅₀ Sp₅₀ and S – S₅₀Sp₅₀ had comparable values (3.25 to 3.28).

CARBOHYDRATE

The carbohydrate value for the gruel F – S₇₀Sp₃₀ had the highest value (78.66%), the U – S₇₀Sp₃₀ had the east carbohydrate content (35.47) S – S₅₀Sp₅₀ and T – S₇₀Sp₃₀ had comparable values (43.68 to 47.47%) U – S₅₀ Sp₅₀ and T – S₅₀Sp₅₀ had comparable values 2.10 to 53.91%) and F – S₅₀Sp₅₀ and F – S₇₀Sp₃₀ had comparable value (74.55 to 78.66%).

TABLE 2: MINERAL COMPOSITION OF FOOD BASED SOYABEAN, SORGHUM AND SWEET POTATOES

Mg/100g	Iron	Copper
U – S ₇₀ Sp ₃₀	81.05 ± 0.92	19.30 ± 0.57
U – S ₅₀ Sp ₅₀	40.20 ± 0.85	14.15 ± 0.35
F – S ₇₀ Sp ₃₀	51.65 ± 1.48	21.20 ± 0.57
F – S ₇₀ Sp ₃₀	28.95 ± 1.20	15.85 ± 1.34
S – S ₅₀ Sp ₅₀	55.30 ± 1.98	12.35 ± 0.07
S – S ₇₀ Sp ₃₀	41.80 ± 1.98	11.25 ± 0.49
T – S ₇₀ Sp ₃₀	81.35 ± 1.48	16.80 ± 0.14
T – S ₅₀ Sp ₅₀	16.60 ± 0.42	12.85 ± 0.35

Mean ± Standard Deviation of 3 replications.

U – S ₇₀ Sp ₃₀	=	Unfermented soyabean, sorghum and sweet potatoes gruel (70: 30)
U – S ₅₀ Sp ₅₀	=	Unfermented soyabean, sorghum and sweet potatoes gruel (50:50)
F – S ₇₀ Sp ₃₀ gruel (70:30)	=	First day fermentation of soyabean sorghum and sweet potatoes
F – S ₇₀ Sp ₃₀ gruel (50:50)	=	First day fermentation of soyabean, sorghum and sweet potatoes
S – S ₇₀ Sp ₃₀	=	Second day fermentation of soyabean, Sorghum and sweet potatoes

- gruel (70: 30)
 S – S₇₀ Sp₃₀ = Second day fermentation of soyabean, Sorghum and sweet potatoes
 gruel (50:50)
 U – S₇₀ Sp₃₀ = Third day fermentation of soyabean, sorghum, sweet potatoes gruel (70:30)
 U – S₇₀ Sp₃₀ = Third day fermentation of soyabean sorghum, sweet Potatoes gruel (50: 50)

THE MINERAL COMPOSITION OF GRUEL AND SHOWN IN TABLE 2 ACCORDING TO THEIR VARYING FERMENTATION PERIODS

IRON (Fe)

Fermentation reduced the iron content of the gruel accept, in samples containing 70%soyabean.

There are variations in the iron content of the gruel products. T – S₇₀Sp₃₀ had the highest iron value of 81.35mg. The comparable values for iron are seen in U – S₇₀Sp₃₀ and T – S₇₀Sp₃₀ (81.05mg to 81.35mg) respectively. T – S₅₀Sp₅₀ had the least value (16.60mg).

COPPER (Cu)

The value for copper differed among the gruel products. The value ranged from 11.25 to 21.20mg of S – S₅₀Sp₅₀ and F – S₇₀Sp₃₀. S – S₇₀Sp₃₀ and T – S₅₀Sp₅₀ had comparable Cu values (12.35 to 12.85mg).

TABLE 3: ANTI-NUTRITIONAL FACTORS OF GRUEL BASED ON SOYABEAN, SORGHUM AND SWEET POTATOES

	Tannin	Phytate
U – S ₇₀ Sp ₃₀	7.20 ± 0.14	24.00 ± 0.57
U – S ₅₀ Sp ₅₀	6.50 ± 0.00	29.60 ± 0.28
F – S ₇₀ Sp ₃₀	0.00 ± 0.00	6.30 ± 0.14
F – S ₇₀ Sp ₃₀	0.00 ± 0.00	3.40 ± 0.00
S – S ₅₀ Sp ₅₀	2.85 ± 0.01	2.85 ± 0.07
S – S ₇₀ Sp ₃₀	2.60 ± 0.14	2.45 ± 0.21
T – S ₇₀ Sp ₃₀	2.83 ± 0.07	15.03 ± 0.21
T – S ₅₀ Sp ₅₀	2.55 ± 0.07	13.70 ± 0.14

Mean ± Standard Deviation of 3 replications.

- U – S₇₀ Sp₃₀ = Unfermented soyabean, sorghum and sweet potatoes gruel (70: 30)
 U – S₅₀ Sp₅₀ = Unfermented soyabean, sorghum and sweet potatoes gruel (50:50)
 F – S₇₀ Sp₃₀ = First day fermentation of soyabean sorghum and sweet potatoes gruel (70:30)
 F – S₇₀ Sp₃₀ = First day fermentation of soyabean, sorghum and sweet potatoes gruel (50:50)
 S – S₇₀ Sp₃₀ = Second day fermentation of soyabean, Sorghum and sweet potatoes gruel (70: 30)
 S – S₇₀ Sp₃₀ = Second day fermentation of soyabean, Sorghum and sweet potatoes gruel (50:50)
 U – S₇₀ Sp₃₀ = Third day fermentation of soyabean, sorghum, sweet potatoes gruel (70:30)
 U – S₇₀ Sp₃₀ = Third day fermentation of soyabean sorghum, sweet Potatoes gruel (50: 50)

TANNINS

The values for tannins differed. The U – S₇₀Sp₃₀ has the highest value 7.20% and F – S₇₀Sp₃₀ and F – S₅₀Sp₅₀ had the lowest value 0.00% which means that at the first day fermentation tannin content of the gruel is nil. The T – S₇₀Sp₃₀ and F – S₇₀Sp₃₀ had comparable values (2.83 to 2.85%).

PHYTATE

The phytate content of the gruel varied. The U – S₅₀Sp₅₀ had the highest value 29.60% and the S – S₅₀Sp₅₀ had the lowest value 2.45%. The Second day fermentation had the lowest phytate content while the unfermented had the highest content. On the Third day of fermentation, the phytate content increased.

TABLE 4: PRESENT THE SENSORY PROPERTIES OF GRUEL BASED ON FERMENTED SOYABEAN, SORGHUM AND SWEET POTATOES FLOUR BLENDS

Sample (%)	Colour	Texture	Flavor	General Acceptability
U – S ₇₀ Sp ₃₀	6.25 ± 0.02	5.95 ± 0.03	5.95 ± 0.03	4.00 ± 0.02
U – S ₅₀ Sp ₅₀	5.85 ± 0.00	6.10 ± 0.00	5.59 ± 0.02	3.60 ± 0.03
F – S ₇₀ Sp ₃₀	5.50 ± 0.07	5.90 ± 0.02	4.95 ± 0.05	4.45 ± 0.00
F – S ₇₀ Sp ₃₀	3.75 ± 0.05	4.00 ± 0.02	5.00 ± 0.02	4.35 ± 0.02
S – S ₅₀ Sp ₅₀	5.15 ± 0.03	4.90 ± 0.01	5.30 ± 0.01	5.55 ± 0.00
S – S ₇₀ Sp ₃₀	5.05 ± 0.03	4.85 ± 0.00	5.00 ± 0.02	5.00 ± 0.01
T – S ₇₀ Sp ₃₀	6.10 ± 0.01	5.60 ± 0.02	6.00 ± 0.03	6.25 ± 0.03
T – S ₅₀ Sp ₅₀	6.50 ± 0.02	5.90 ± 0.02	7.10 ± 0.10	6.10 ± 0.07

Mean ± Standard Deviation of 3 replications.

- U – S₇₀ Sp₃₀ = Unfermented soyabean, sorghum and sweet potatoes gruel (70: 30)
- U – S₅₀ Sp₅₀ = Unfermented soyabean, sorghum and sweet potatoes gruel (50:50)
- F – S₇₀ Sp₃₀ = First day fermentation of soyabean sorghum and sweet potatoes gruel (70:30)
- F – S₇₀ Sp₃₀ = First day fermentation of soyabean, sorghum and sweet potatoes gruel (50:50)
- S – S₇₀ Sp₃₀ = Second day fermentation of soyabean, Sorghum and sweet potatoes gruel (70: 30)
- S – S₇₀ Sp₃₀ = Second day fermentation of soyabean, Sorghum and sweet potatoes gruel (50:50)
- U – S₇₀ Sp₃₀ = Third day fermentation of soyabean, sorghum, sweet potatoes gruel (70:30)
- U – S₇₀ Sp₃₀ = Third day fermentation of soyabean sorghum, sweet Potatoes gruel (50: 50)

COLOUR

The colour of eight porridges varied. The values ranged from 3.75 to 6.50. The gruel from the third day fermented composite flours from both ratios had the highest value for colour (6.50 and 6.10, respectively) which was comparable to that of control (6.25). The F – S₅₀ Sp₅₀ had the least value (3.75). On the other hand, the remaining gruels had also comparable values for colour 5.05 to 5.85.

TEXTURE

The variations in the texture of the porridges were due to treatment. The F – S₅₀ Sp₅₀ had the least value (4.00). The F- S₇₀S₃₀ and the T –S₅₀ Sp₅₀ had similar values for texture which were higher than those of other gruels, except for the control (U – S₅₀ Sp₅₀) that had the highest value (6.10).

FLAVOUR

The flavour value for the porridges differed. The T – S₅₀Sp₅₀ had the highest flavour relative to the control (7.10 VS 5.95). The gruel from 24 hrs fermented composite (F – S₇₀Sp₃₀) had the lowest value (4.95) when compared with the other gruels and the control. The other samples had comparable value which ranged from 5.00 to 6.00 except the control that had 5.95.

GENERAL ACCEPTABILITY:

There were variations in the acceptability of the gruels. The T – S₇₀ Sp₃₀ and T – S₅₀ Sp₅₀ has the higher scores 6.25 and 6.10 respectively relative to the control (3.60 and 4.00) and those of other samples.

DISCUSSION

PROXIMATE COMPOSITION OF THE (GRUELS)

PROTEIN

The protein content of the gruel differed depending on their varying fermentation periods. The protein content of the unfermented was highest, this is because, Soyabean has the highest proportion with Sorghum and sweet potatoes that are low in protein in their unfermented State. As the fermentation periods progresses, the third day fermentation had the highest protein content, this is because the food products has supplemented each other's in

adequacies and constituted a well- balanced amino acid pattern ⁽⁵⁾ hence, the micro- organisms inherit in them has been released through fermentation in sorghum and sweet potato to give a balanced protein.

FAT

The third day fermentation was the highest in fat which varies from (70:30 – 50:50). This is because soyabean with the highest proportion of 70:30 contributed to the high fat content. At the ratio of 50:50, the fat content reduced due to sorghum and sweet potatoes which has low fat content. The oil of soyabean is of high quality and low in cholesterol. However, the lowest fat content is S – S₇₀ Sp₃₀.

ASH

The lower ash values relative to the control except for the third day fermentation (3.94 and 4.74) was contrary to some of the findings in literature. It is known that fermentation increases ash content thereby making minerals more bioavailable.

CRUDE FIBRE

The high crude fibre content of all 50:50 proportions is not surprising, this is because sorghum and sweet potatoes has a high fibre content.

CARBOHYDRATES (CHO)

The high carbohydrate content of all 50:50 except second day fermentation is high this is because sorghum and sweet potatoes has a high carbohydrate content.

MINERAL COMPOSITION OF THE FOOD PRODUCTS

IRON (Fe)

The Iron content of the unfermented gruel is highest in the ratio of 70:30 of while the 50:50 is lower. This is because soyabean has the highest iron content when compared with sorghum and sweet potatoes. The fourth day fermentation increases the iron content of gruel in relative to the control (81.35 Vs. 81.35)

COPPER (Cu)

The second day fermentation has the highest copper content. This suggests that second day fermentation increases the copper content. Other has varying values.

ANTI- NUTRITIONAL FACTORS

TANNIN

Tannin is highest on the unfermented State. (U – S₇₀Sp₃₀ and U – S₅₀ Sp₅₀). The second day fermentation was nil- there was no tannin present. On the third day it increased a little and decreased on the Fourth day. However, this could be due the microflora responsible for the fermentation.

PHYTATE

Phytate content of the unfermented gruel is high. However, the three day fermentation drastically reduced the phytate content of the blends. This finding was in line with the observation of many workers ⁽¹⁰⁻¹¹⁾.

ORGANOLEPTIC ATTRIBUTE

COLOUR

The lower colour for all the fermented samples relative to the control (6.25) except for the third day fermentation (6.10 and 6.50) might be attributed to treatment.

CONCLUSION

Fermentation is a simple household food processing technology for improving the nutritional quality of local staples in many homes. It does not require much space and equipment. Fermentation increases the nutrient density and low bulk which is important in young children feeding. It is found that fermentation is a promising processing method for preparing nutritious and acceptable complementary food from Legume-cereal grains, since they have high nutrient potentials. Low cost complementary foods are neglected due to lack of information on their nutritive value. Meanwhile, the nutrient content of these food depends on their fermentation period, hence fermentation helps in the improvement of nutritional content of food and makes it available for the body to be utilized especially children that are undergoing weaning. As judged by the results, the combination of soyabean, sorghum and sweet potato gives a more balanced nutrient content.

However, greater attention should be geared towards diversifying their genetic potentials to produce cheap, nutrition and acceptable products.

RECOMMENDATIONS

Based on the result of the study, the researcher recommended that:

1. Soaking, milling and cooking should be most cost effective processing method to be adopted at household level for improving nutrient quality of foods.
2. Nutrition Education Programme should be established to advocate food diversification by combination and food supplementation should be planned and practiced in rural communities.
3. Children should be weaning with semi solid foods that are nutritionally balanced.
4. Second day fermentation should be used at household level, as this gives the most balanced nutrient content.

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