Research Article ISSN 2641-4295

Food Science & Nutrition Research

Processed Sesame Protein Hydrolysate as a Base for Complementary Food

Philip John Kanu[1,2,3*]

[1]Milton Margai Technical University, Freetown, Sierra Leone.

[2]Institute of Food Technology, Nutrition and Consumer Studies, School of Agriculture and Food Sciences, Njala University, Sierra Leone.

[3]Centre for Development and Food Safety, Freetown, Sierra Leone.

*Correspondence:
Philip John Kanu, Milton Margai Technical University, Freetown, Sierra Leone, Tel: +232 76612050/+232 88612050.

Received: 25 Feb 2025; **Accepted:** 10 Apr 2025; **Published:** 19 Apr 2025

Citation: Kanu PJ. Processed Sesame Protein Hydrolysate as a Base for Complementary Food. Food Sci Nutr Res. 2025; 8(1): 1-8.

Keywords
Debittered Sesame, Sesame Protein Hydrolysate, Nutrient-Rich Food, Infant Nutrition.

Introduction
Over the past years, some authors have shown that the preparations of rich protein food with small peptides from partially hydrolyzed protein could be utilized more efficiently and have a higher nutritive value than the native protein (protein not hydrolyzed [1]. Moreover, these peptides have a lower osmolarity than free amino acids being better tolerated by individuals with reduced absorption and some allergy problems to native protein [2].

Plant protein is well known as a vegetable protein with a high nutritional value, however, it has a number of unpleasant properties, including allergenicity, an unpleasant odor, insolubility, acid instability, heat instability, and indigestibility [3]. As a result, various enzymatic methods have been developed to modify plant proteins in an attempt to reduce or eradicate these properties. However, the enzymatic hydrolysis of plant protein frequently leads to the production of a bitter taste, which is due to the presence of strongly hydrophobic bitter peptides that arise as natural degradation products of the proteolytic reaction [2]. Nonetheless, this problem can be addresses by cheap debittering procedures which have proved very successful [2]. Protein hydrolysates have many applications in foods as in formulations planned to avoid allergies due to high molecular compounds since the decrease of chain length has direct relationship with the immugenicity [1]. Therefore, they are used in special foods such as those destined to premature newborn, and to children presenting diarrhea, gastroenteritis, malabsorption syndrome and phenylketonuria [1]. The timely introduction of properly formulated and prepared complementary food (CF) is necessary for the growth and survival of infants [3] especially in developing countries [4,5]. Nonetheless there has been no attempt to hydrolyzed defatted sesame flour and used the hydrolysate to formulate food for infants as CF.

The objectives of this work was to formulate a CF milk-based powder for infants using the protein hydrolysates from defatted sesame flour as protein supplement in rice flour and other ingredients for the formulation and analyzed it biochemical and physicochemical properties.

Materials and Methods
Whole milk powder (WMP), sesame oil, rice and cerelac baby food which was used to compare with the formulated CF were purchased from a supermarket in Wuxi, P.R. China. Fructooligosacchirides (FOS) and lecithin were bought from a food supplementary store in Wuxi, PR China. The defatted sesame protein hydrolysate (DSPH) was prepared and desalted in our lab as described in Chapter four and six respectively. The rice was soaked for 6hrs, drained the water and ground and passed through a 60µm sieve mesh. The rice flour was scorted/roasted at a temperature of 60°C for 10 min. in an oven. The flour was seal in a food graded polythene bag then stored in a freezer of 10°C for later use.

Methods
Formulation
The formulation of the CF for infants was designed according to the nutritional requirements of infants as described in CAC/GL08 [6]. The product is to contain an approximately less than 56% carbohydrate, between 20-25% protein and 20% fat. Mineral content around 4% and moisture content less than 5%. Table 1 gives a summary of the nutrients of the different raw materials used in the formulation.

Calculation of the Mixture

After the composition of the mixture intended to be utilized as raw materials has been decided, the calculation of the amount of each ingredient was done according to the algebraic equation of Junshi [7] as shown below;

Let x = amount of WMP in the mix for the formulation y = amount of DSPH in the mix

z = amount of sesame oil in the mix v = amount of lecithin in the mix

w = amount of rice flour in the mix

t = amount of FOS in the mix

Table 1: The nutrients content of the different raw materials used to formulate the recipe.

Raw	Nutrient Content (g/100g raw Materials)				
Material	Protein	Fat	Carbohydrate	Moisture	Ash
WMP (x)	28.7	10.3	49.8	2.4	3.7
DSPH(y)	96.2	0	0	2.64	1.21
Sesame oil (u)	0	100	0	0	0
Lecithin (v)	0	100	0	0	0
Rice flour (w)	0.8	2	90	3	4.2
FOS	0	0	85	15	0
EQNFP	26.00%	18.00%	50.00%	3.00%	3.00%

EQNFP-Expected quantity of nutrients in the final product

Thus will give the following ratios according to Junshi [7].

Plant/animal protein ratio 2:1

DSPH/ WMP ratio 4:1

Sesame oil/ lecithin ratio 3:1

Rice flour/FOS ratio 20:1

Five simultaneous equations were developed to get the amount of the final ingredients needed.

2.041y + 0.024z :1.275 x = 6% ....Eq. (1)

4.275y : 1.032x = 26.0% ....Eq. (2)

3.203z : 1.231v = 18.0% ....Eq. (3)

19.910 w + 0.785 t = 50.0% ....Eq. (4)

2.041y: 0.04z +4.275y: 1.032x + 3.203z: 1.231v + 19.910w: 0.785 t = 100 %...Eq. (5)

According to the equations above, equation 1 gives the plant/ animal protein, equation 2 is the protein equation, equation 3 the fat, equation 4 the carbohydrate while equation 5 represents the total mixture. The amount of each ingredient used for the formulation was got by solving the above five equations.

Milk-based Powder Supplemented by DSPH Processing Technology

Raw materials were weighed and mixed together according to the amount after solving the five simultaneous equations of the formulation and dissolved into water at 30ºC for10 min the ingredients mixture was homogenized (17 MPa, 50-60°C), pasteurized (85° C for 10 min) and spray dried to get the final product as depicted in Figure 1.

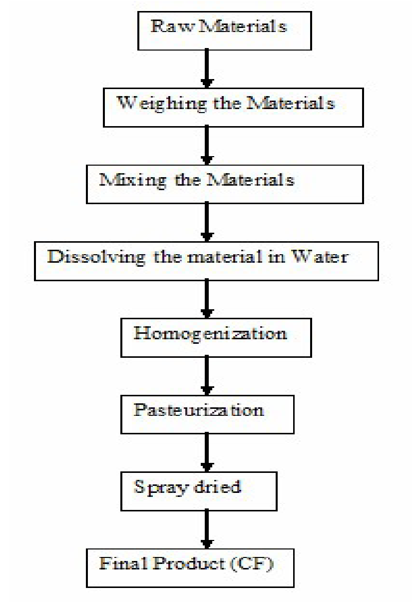

Figure 1: Supplemented DSPH CF processing flow chart.

Proximate Analysis of the Final Product

Protein content was determined according to section 2.2.2.1.1. The determination of fat was performed according to the method of Ünal1 & Yalçin [8]. Moisture, carbohydrate and ash contents were determined according to sections 2.2.2.1.2, 2.2.2.1.4 and 2.2.2.1.3 respectively.

Minerals

Minerals were analyzed according to the method of James [9]. The sample was prepared by ashing the sample as described in section 2.2.2.1.3. The following minerals (Ca, K, Mg, Fe, Cu, Zn, Na, Mn, Pb, Cd, As and Se) were analyzed.

Calculation of Caloric Value and %Protein Calorie

Table 2. Shows the energy conversion factor used in the calculation of calorie value of the energy content of the final products it was done according to James [9], as described in equation 6.

Energy value of food (in KJ per 100 g) = [(% available carbohydrates X 17) + (%

protein X 17) + (% fat X37)]……………….......…………Eq. (6)

% protein calories = %Protein X 17/ total energy of formulation………..Eq. (7)

Table 2: Calorific value of food constituents.

Nutrients (g)	Calorific value (Kcal/g dry Matter)	Calorific value (Kj/g dry Matter)
Carbohydrate	4	17
Protein	4	17
Fat	9	37

Determination of *in vitro* protein digestibility (IVPD)

The IVPD was determined according to section 5.2.1.11

Dispersibility

Dispersibility was measured by placing 10 g of the sample (CF) in a 150ml stooppered measuring cylinder, adding distilled water to reach a volume of 100ml, stirring vigorously with an overhead stirrer, allowed to settle for three hours. The volume of the settled particles was subtracted from 100 and the difference reported as percentage dispersibility [9].

Microbial Total Plate Counts (TPC) and E. coli Analysis

Microbial determination was done according to Kunene et al. [10] with slight modifications. A beef extract peptone medium for total plate count TPC and Mac conkey's medium for E. coli. Prior to the preparation of the media, the pipettes, test tubes, petri-dishes and deionised water for sample dissolution were properly sterilized according to standard procedures proponded by CAC/GL08 [6] with slight modifications. The materials were washed dried and autoclaved in our laboratory autoclave pressure of 1 kg/cm^2 for 60 min. 10g of the final product was weighed into a baker containing 100ml of autoclaved deionised water and stirred to dissolve. The mixture was diluted as follows; (a) 1:10 (b) 1:100, (c) 1:1000 (d) 1: 10000. 1ml of solution was pipetted into 6 labeled test tubes (3 x 10^{-1} and 3 x 10^{-2}) with 9ml medium for E. coli. 1ml of solution was also pipetted into 8 labeled Petri-dishes and slightly topped with the beef extract peptone medium for TPC. The procedure was repeated for all the investigated samples. The petri-dishes and test tubes for each sample solution were incubated at a temperature of 37-38° C for 65 days. The microbial enumeration was done by standard plate count procedures according to CAC/GL08 [6].

Total Amino Acid

Total amino acids were analyzed according to the method described in section 2.2.2.1.9.

Determination of Fatty Acid

Fatty acid was determined according as described in section 2.2.2.2.1.8.

Analysis of Some Functional Properties

Bulk density and water absorption for the CF and cerelac weaning food, was determined by the method of Mahgoub [11]. The final materials tested were expresses as g/ml and g/100g respective. The apparent viscosity of CF and cerelac was done according to Thathola & Srivastava [12] with slight modifications. The two samples (CF and cerelac) were stirred separately into cold water and mixed into a uniform mixture to form slurries; the slurries were put in a boiling water bath (75°C) and constantly stirred until they boiled and were left for a period of five minutes. The samples were then removed and cooled down at room temperature (23-25°C) and the viscosity was calculated by measuring with a Brookfield Synchro-electric Viscometer (BSEV-2230- Japan), using RVT Spindle No. 4 at a constant speed of 100 rpm. For the pasting properties, the two samples (CF and cerelac) their slurries were heated from 40°C to 92.5°C at the rate of 3°C/min, maintained at 92.5°C for 15 min, and then cooled to 40°C at the same rate and their pasting properties were determined by a Rapid Visco Analyzer (RVA-4, Newport Scientific, Warriewood, USA) this was done to observe how the two products behaves when subjected to heat and see their spoonability as that has direct relationship with the swallowing ability of the child. All the measurements were in triplicate readings.

Sensory Evaluation

The sensory evaluation was done according to section 6.2.2.7. A 50-member panel was constituted to assess the sensory attributes of flavor, taste, colour, mouth feel after taste, consistency and overall acceptance with 9 = like extremely, 8 = like very much, 7 = like moderately, 6 = like slightly, 5 = neither like or dislike, 4 = dislike slightly, 3 = dislike moderately, 2 = dislike very much and 1 = dislike extremely.

Statistical Analysis

The results were subjected to statistical analysis of variance (ANOVA) as described in section 2.3.

Results and Discussion

The Formulation

The quantity of the raw material for the formulation of CF is shown in Table 3. According to results in Table 3, it was observed the quantity of each raw material resulted to 100 g. It was an indication of the raw materials to give a satisfactory composition when combine accordingly.

Table 3: Raw material quantities obtained from the infant formula design.

Raw Materials	Quantity (g)
WMP (x)	20.51
DSPH (y)	33.78
Roasted sesame oil (z)	3.49
Lecithin (v)	0.58
Rice flour (w)	40.1
FOS (t)	1.54

According to Table 3 the nutritional requirements of the infants of which the complementary food is meant for should be appropriately met. The recipe formulated from the combination of the various ingredients as given in Table 3 met the nutritional requirements of the infants as could be seen in Table 4 which shows the physicochemical index of the DSPH milk-based powder CF for infants.

Proximate analysis of the CF

The proximate analysis of the CF is shown in Table 4. It was observed that protein was significantly ($p< 0.05$) high that meets the requirement recommended by CAC/GL08 [6] and FAO/WHO [13]. The result of the CF was significantly higher than the reported results of Egounlety [14] for the nutritive value of protein-energy legume-fortified weaning for 'ogi'. Fat was significantly higher ($p< 0.05$) in the CF. The higher fat content observed could be attributed to the sesame oil added in the formulation. Nonetheless, moisture was observed to be significantly low. This could be attributed to the fact that the product was spray-dried that must have remove significant amount of moisture from the CF.

Table 4: Physicochemical index of SPH milk-based powder complementary food.

Index	Amount
Protein (%)	18.15±1.08a
Fat (%)	13.62±0.87b
Moisture (%)	3.57±1.21a
Carbohydrate (%)	53.08±0.56a
Ash (%)	4.50±0.62a
Minerals (µg/g)	
Calcium (Ca)	9920
Potassium (K)	1915
Magnesium (Mg)	7025
Iron (Fe)	170.6
Copper (Cu)	48.95
Zinc (Zn)	178
Sodium (Na)	599
Manganese (Mn)	31
Lead (Pb)	1.52
Phosphorus (P)	158
Cadmium (Cd)	0.041
Arsenic (As)	ND
Selenium (Se)	ND
Energy (Kj/100 g)	1714.85
% protein calorie (%)	17.99
IVPD (%)	86.35
Dispersibility (%)	84
TPC (cfy/g)	2.28
E. coli (cfu/100g)	ND

[a]Values are mean ± SEM (n=3), different letters in the same column are not significant at level ($p< 0.05$) but significant at $p< 0.01$. ND= Not detected.

The low moisture observed for the product is a good indicator of their longer shelf life. Our result was observed to be lower than Kanu et al. [15].

Carbohydrate was observed to be significantly ($p< 0.05$) higher for the CF but significantly lower than reported result of Mahgoub [11]. The high carbohydrate content of the CF is attributed to the high carbohydrate content in the rice that is the major ingredient in the formulation. Ash was observed to be low (4.50 %). The value was similar to the value reported from the production and evaluation of porridge-type breakfast [16].

The mineral composition for the CF is also presented in Table 4. The CF was rich in calcium, magnesium followed by potassium with a significant difference ($p< 0.05$) as compared to the other minerals investigated. The results were within the range of those reported by Kulkarni et al. [17]. Calcium is by far the most important mineral that the body requires and its deficiency is more prevalent than many other mineral. The child requires significant amount of calcium for the development of bones and teeth and more is also needed for the circulation of blood and blood clotting [18]. Since FOS was part of the formula it will facilitate the absorption of calcium which is always difficult to be assimilated by the human intestine. But it has been reported that FOS and inulin promote calcium absorption in both the animal and human intestine [18]. The intestinal microflora in the lower gut can ferment FOS, which results in a reduced pH. Calcium is more soluble in acid and therefore more of it comes out of food and is available to move from the intestine into the bloodstream [12]. FOS can be considered a small dietary fiber with (like all fibres) low caloric value. The fermentation of FOS results in the production of gasses and acids. The latter provide some energy to the body [18]. Lead and cadmium were observed to be present but in an insignificant amount which could not cause any harm to the infant as it is below the amount to be allowed in food for infant as recommended by the guidelines on formulated supplementary food for infants and young children [6] while arsenic and selenium were not detected.

The result of the caloric energy is shown in (Table 4). It was observed to be high for the formulation. Significantly higher ($p< 0.05$) than the results reported by Mahgoub [11] and Kulkarni et al. [17] they studied sorghum malted-based weaning food formulation: Preparation, functional properties and nutritive value. However, the results corroborated those of Egounlety [14]. Energy content is a parameter used to determine the quality of food especially for formulations designed for infant with high energy requirements. The high energy observed in the product could be due to the fat and carbohydrate. Fat and carbohydrate are in high amount in the product. This was due to that fact that rice was the main ingredient the DSPH was substituted to improve it protein content and sesame oil was added in the formulation for it healthy properties [19].

Percentage protein calorie was also shown in (Table 4) and was also significantly higher ($p< 0.05$) than those reported by Mahgoub [11] also higher than the required amounts for children in People's Repblic of China [7] India [11,12]. According to the Indian Council of medical research, the required optimal protein-calorie requirement for pre-school children for India is 7.1% [11]. But our results are within the range of the required amount for children in Sierra Leone as reported by Robin-Coker & Jalloh [4]. In most African and Western countries their protein calorie is 14% [13]. Protein-energy ratio gives the protein content of a food or diet expressed as the proportion of the total energy provided by protein. The high amount of % protein calorie (17.99%) was attributed to the DSPH used as protein supplement to rice flour.

The IVPD

The pepsin-pancreatin IVPD of CF is shown in Table 4. The IVPD was observed to be significantly higher than reported results of Mahgoub [11] but lower than cerelac (87%) as reported by Mahgoub [11] but the difference was not significant ($p< 0.05$). The high IVPD observed could be since the protein supplement was hydrolyzed exposing the protein matrix to be degraded further by the enzymes used to investigate the IVPD.

The Microbial Total Plate Count and *E. coli*

The microbial total plate count and *E. coli* results are shown in Table 4. It was observed that the microbial total plate count was significantly low while E. coli was not detected. It is possible that during the production process of CF, the hazard analysis critical control points (HACCP) were properly managed. This makes the product safer for consumption within the period (65 days) studied. The microbial plate count was lower than the results reported by Kunene et al., [19] for all the results of fermented porridge but fell within the results for cooked fermented porridge and sorghum powder in the same study.

Total Amino Acid

The results of the amino acids are shown in Table 5. The amino acid content of the product was compared with the recommended requirement for infants by FAO/WHO [13] particularly the essential amino acids (EAAs) The CF was observed to have significant higher amount of those essential amino acids and even the non-essential amino acids. The results in Table 5 indicate that the amino acid composition for the product exceeds especially that of lysine which is in low quantity in sesame [20].

Table 5: Total amino acid composition of the complementary food (CF) developed for the infants (g 100g protein).

Amino acid	Amount of CF	EAAa	
		Infant	**Adult**
EAA			
Isoleucine	3.35	2.8	1.3
Leucine	7.86	6.6	1.9
Threonine	3.73	3.4	0.9
Methionine	6.54	2.50_b	1.70_b
Lysine	7.44	5.8	1.6
Histidine	5.95	1.9	1.6
Tryptophan	3.5	1.1	0.05
Valine	4.65	3.5	1.3
nEAA			
Alanine	15.59		
Glycine	17.11		
Proline	8.34		
Phenylalanine	2.18		
Tyrosine	3.78		
Serine	3.14		
Arginine	7.22		
Aspartic acid	5.54		
Glutamic acid	9.44		

[a]Suggested profile of essential amino acid requirement for infant and adult [13].
[b]Methionine + Cysteine, EAA= Essential amino acid, nEAA= Non-essential amino acid.

It is noted that mixing the ingredients with cereal increases the lysine content. Cereals have been reported to have higher quantity of lysine [21]. Lysine content in the formulation, however, exceeds the FAO/WHO recommended amount for infants. Amino acids are the chemical units or "building block" of the body that make up the protein. Protein substances make up the muscles, tendons, organs, glands, nails, and hair. Growth, repair and maintenance of all cells are dependent upon them. Next to water, protein makes up the greatest portion of our body weight [22]. The CF formulated was observed to be appropriate as it possesses significant high amount of amino acids, based upon these results however, DSFPH is a good supplement that will improve the nutritional value of rice flour utilized in the formulation for a CF food for infants.

Fatty Acid

The fatty acid results are shown in (Table 6) The peak integrations of the fatty acid content in the DSPH milk-based powder CF Figure 2 (A) GC (B) MS, shows that the food formulated has a very high oleic acid followed by linoleic acid next by palmitic acid.

Table 6: Fatty acid content (%) in the SPH milk-based powder complementary food.

Fatty Acid Common name	Scientific name	%
Capric acid	decanoic acid	0.25
Palmitic acid	hexadecanoic acid	9.36
Palmitoleic Acid	9-hexadecenoic acid	0.13
Stearic acid	octadecanoic acid	7.86
Oleic acid	9-octadecenoic acid	42.85
Linoleic acid	9,12-octadecadienoic acid	37.89
Alpha-Linolenic Acid (a-LA)	9,12,15-octadecatrienoic acid	0.29
Ricinoleic acid	12-hydroxy-9-octadecenoic acid	0.07
Arachidic acid	eicosanoic acid	0.89
Gadoleic Acid	9-Eicosenoic acid	0.25
Lauric acid	dodecanoic acid	0.08
Behenic acid	docosanoic acid	0.07

The two highest fatty acids have been reported to have several health benefits. Oleic acid is a monounsaturated fatty acid found naturally in many plant sources and in animal products and it is an omega-9 fatty acid, and considered as one of the healthier sources of fat in diets [23]. The product shows to have high essential fatty acids (EFAs). The human body can produce all but two of the fatty acids it needs.

These two, linoleic acid (LA) and alpha-linolenic acid (a-LA), are widely distributed in plant oils [24]. Since these important fatty acids are observed in significant amounts, this scenario added more value to the product since they cannot be made in the body from other substance they must be supplied in food. The essential fatty acids are important in several human body systems, including the immune system and in blood pressure regulation, since they are used to make compounds such as prostaglandins [25]. It was also observed that the product has palmitic acid in a significant amount which contains vitamin A which is a precursor of retinol that will help to develop the sight of the infants that the product is meant for. Fatty acids play an important role in the life and death of cardiac cells because they are essential fuels for mechanical and electrical activities of the heart [25,26]. This good attributed displayed by the product could be because of the addition of the sesame oil which is known to carry lots of “good healthy fats”. It is because of that fat that made sesame seed to be a good source of antioxidant.

Functional Properties

The functional properties investigated in CF as compared to cerelac are shown in (Table 7). The bulk density of CF was higher than cerelac but the difference was not significant ($p< 0.05$). It was attributed to the high presence of carbohydrate in the food. That indication is highly correlated with the high viscosity and pasting of CF because when a highly carbohydrate food absorbed more water, it makes the food to have a thick.

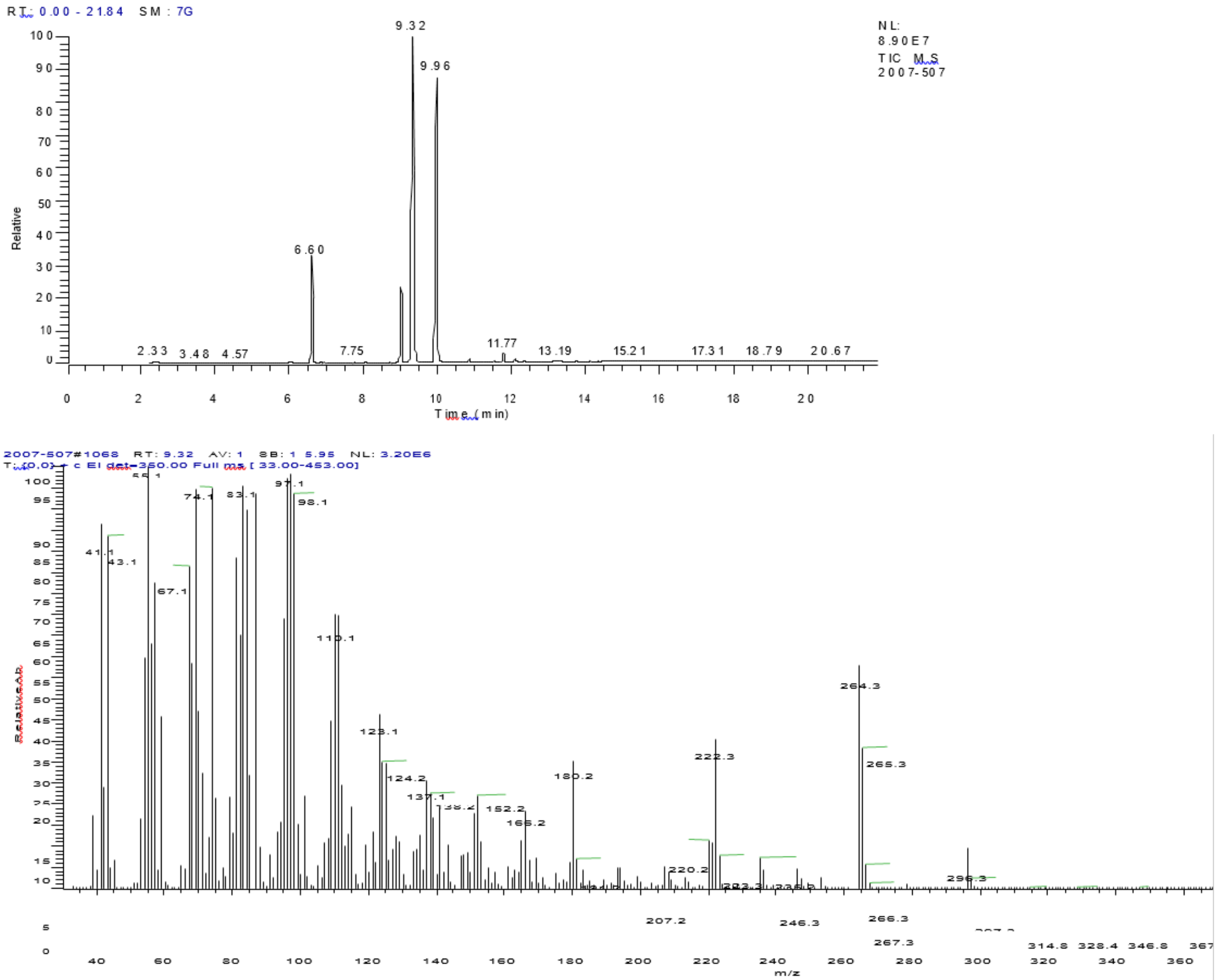

Figure 2: Peak integrations of the fatty acid content in the SPH milk-based powder complementary food (A) GC (B) MS.

Table 7: Some functional properties of BBF and cerelac.

Properties	CF	Cerelac
Bulk density (g/ml)	1.03 ± 0.1a	0.50 ± 0.2 a
Water Absorption capacity (g/100g)	210 ± 3.7b	150 ± 2.5 a
Apparent Viscosity (CPS) (at 20% W/W gruel concentration)	2730 ± 2.0a	2250 ± 9.0 b

[a]Values are mean ± SEM (n=3), different letters in the same column are not significant at level ($p < 0.05$) but significant at $p < 0.01$.

gel because of gelatinization process of the starch granules that gives the high viscosity of the food [16], but this again depends on several molecular properties such as size, shape, flexibility and hydration of the protein. Because solutions of randomly coiled polymers displays greater viscosity**.** Also the ability of the protein and carbohydrate to absorb water and swell affects its viscosity and this can be seen in food containing high protein and carbohydrate [21], which CF is not an exception.

The water absorption capacity which indicates the volume of water needed to form gruel with a suitable thickness for child feeding was higher in CF than Cerelac. This was also attributed to the high carbohydrate content which was observed in CF. As high carbohydrate increases the water absorption capacity of most food systems [27]. The apparent viscosity, cerelac was less viscous than CF and the difference was significant ($p < 0.05$). The results of the functional properties of CF were in accordance with the ones reported by Kulkarni et al., [17] they studied sorghum malted-based weaning food formulation: preparation, functional properties, and nutritive value. When the two samples were analyzed for their pasting properties by heating, the difference was not significant ($p < 0.05$), it was observed that at 10min the cerelac exhibited higher paste of (150RVU) it kept on increasing gradually up to 20 min, and the CF also increased as the time was increased though below the line of Cerelac. At 20 min cerelac was (230RVU) while CF (225RVU) when the temperature was 80°C (Figure 3). Beyond that, the two samples dropped, when the heating time was prolonged between 30-35min the two samples fell on the same line until when the time was extended to 40 min then the CF gradually increased more than the cerelac. The increased of pasting observed from CF was observed also when the viscosity of the CF was analyzed. The viscosity was high as the pasting properties of the CF as these two always correlate.

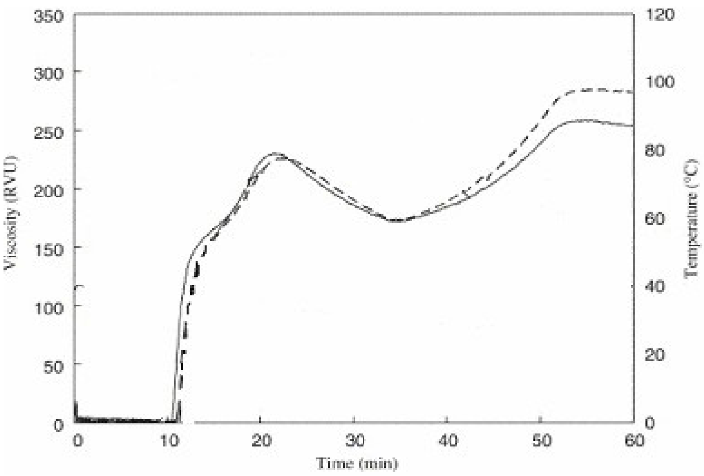

Figure 3: Pasting results for CF and cerelac.

From the results obtained it was observed that CF was able to have that pasting properties even at high temperatures (88°C and 96°C) the pasting was (250 and 280 RVU respectively) which is still within an acceptable range for infant formula [12]. As it has been reported that most of the food items particularly infant foods prepared within the range of 80°C and above which is considered as high temperature, will exhibit a pasting property that will be good for infant consumption [17]. That aspect will kill any pathogen organism might be present in the food. At the above temperatures (88 and 96°C) CF exhibited a gradual increase as the time was also increased; this was observed because solution conditions, such as time, ionic strength, and temperature affect pasting of food made from cereals and legumes. The high temperature helped to denature the protein and exposes more sites of the present starch granules that are in that food, it can increase the pasting properties. It was reported that the pasting properties of albumin proteins which is mostly found in sesame as report in section 2.4.3 and peas generally decrease as time and temperature are decreased and increase when the two are increased [28]. The high pasting properties were actually dependent on the high protein and carbohydrate concentrate which could be seen in the formulation of the CF. The formation of paste composed of swollen starch granules dispersed in the heated solution also increases the pasting properties of infant foods [28]. Our result was in accordance with the results of Onweluzo & Nnamuchi [16] they compared a native and acid thinned normal and waxy corn starches: and studied the physicochemical, thermal, morphological and pasting properties.

Sensory Evaluation

The mean sensory evaluation attribute scores of the CF formulated from the mixture for infant is shown in Table 8. The panelists rated the food according to their taste and feeling attributes. They rated flavour, as like extremely, colour as like moderately, taste was rated as like slightly, mouthfeel as like very much, aftertaste as neither like nor dislike, while consistency was rated like very much and overall was rated as like very much. Flavour was rated as the best this could be attributed to the fact that, sesame oil has appealing flavour that made it to be utilized in many food product. While mouthfeel was rated second as like very much could be attributed to inclusion of lecithin which as the ability to soften food when included in food and with it health benefits, as Lecithin is a lipid that consists mostly of choline, but also includes inositol, phosphorus, and linoleic acid. Lecithin helps to prevent arteriosclerosis, protects against cardiovascular disease, improves brain function, helps keep the liver and kidneys healthy, aids in thiamin and vitamin A absorption, this nutrient is essential to every living cell in the human body [29].

Table 8: Sensory evaluation/quality attributes of porridge of the complementary Food formulated.

Quality	Complementary	Food
	HS	SCM
Flavour	9	Like extremely
Colour	7	Like moderately
Taste	6	Like slightly
Mouthfeel	8	Like very much
aftertaste	5	Neither like or dislike
Consistency	8	Like very much Overall
Acceptance	8	Like very much

HS = Hedonic scale. SCM = Score card method.

The rice flour was scorted/roasted that gave the colour of the product to be rated in that category. This method was investigated as a result that extrusion machines will be very expensive for the communities that are to utilize our formulation. This method proved to be very successful in many communities where local material particularly rice is used for the product of CF [15].

Conclusion

A complementary food for infant was successfully produced using defatted sesame proteins hydrolysate as protein supplements in rice flour. The product possesses good biochemical and physicochemical properties. Based on standard nutritional values and the attributes shown by the product the supplementation of protein hydrolysates into rice flour for infant complementary food can be highly recommended for different food systems and also in the medical industry. This will bring hope to those countries as it will help them to reduce the incidence of infant energy/protein malnutrition.

Reference

1. Clemente A. Enzymatic protein hydrolysates in human nutrition. Trends Food Sci Technol. 2000; 11: 254-262.
2. Cheison SC, Wang Z, Xu SY. Use of macroporous adsorption resin for simultaneous desalting and debittering of whey protein hydrolysates. Int J Food Sci Technol. 2007; 42: 1228-1239.
3. Mensa-Wilmot Y, Philips RD, Hangrove JC. Protein quality evaluation of cowpea-based extrusion cooked cereal/legume weaning mixture. Nutri Res. 2001; 21: 849-857.
4. Robbin-Coker DJ, Jalloh MA. Infant feeding and protein-calorie malnutrition in Freetown. J Trop Ped Env Child Health. 1975; 21:14-5.

5. Jansen GR. Centrally processed weaning foods for use in developing countries. Food Rev Int. 1992; 8: 307-346.
6. CAC/GL08. The Guidelines on formulate supplementary food for infants and young children were adopted by the Codex Alimentarius Commision at its 19th Session. 1991.
7. Junshi CMD. Institute of Nutrition and Food safety. Paper presented at the Legislations and Regulations in China, related to Food Formulation. 1997.
8. Ünal1 MK, Yalçin H. Proximate composition of Turkish sesame seeds and characterization of their oils. GRASAS Y ACEITES. 2008; 59: 23-26.
9. James CS. Analytical chemistry of foods. Blackie Academic and Professional, Chapman & Hall. Glasgow, UK. 1995.
10. Kunene NF, Hastings JW, von Holy A. Bacterial population Associated with a sorghum-based fermented weaning cereal. Int J Food Microbiol. 1999; 49: 75-83.
11. Mahgoub SEO. Production and evaluation of weaning foods based on sorghum and legumes. Plants Foods Hum Nutri. 1999; 54: 29-42.
12. Thathola A, Srivastava S. Physicochemical properties and nutritional traits of millet-based weaning food suitable for infant of the Kumaon hills, Northern India. Asia Pac J Clin Nutr. 2002; 11: 28-32.
13. FAO/WHO. Protein quality evaluation. Report of the joint FAO/WHO expert consultation, Food and Agriculture Organization of the United Nations, Rome. 1990.
14. Egounlety M. Production of legume-fortified weaning food. Food Res Inter. 2002; 35: 233-237.
15. Kanu PJ, Kanu JB, Huiming Z. Studies on physicochemical composition of Bennimix: A traditional weaning food. Am J Food Technol. 2007; 2: 652-661.
16. Onweluzo JC, Nnamuchi OM. Production and evaluation of porridge- type breakfast product from Treculia africana and sorghum bicolor flours. Pak J Nutr. 2009; 8: 731-736.
17. Kulkarni KD, Kulkarni DN, Ingle UM. Sorghum malt-based weaning food formulations: Preparation, functional properties, nutritive value. Food Nutr Bull. 1991; 13: 322-329.
18. Zafar TA, Weaver CM, Zhao Y. Nondigestible oligosaccharides increase calcium absorption and suppress bone resorption in ovariectomized rats. J Nutr. 2004; 134: 399-402.
19. Kanu PJ, Kexue Z, Kanu JB, et al. The effects of enzymatic hydrolysis with alcalase on the functional properties of the protein hydrolysates from defatted sesame flour. J Food Sci Technol. 2009.
20. Kanu PJ, Huiming Z, Kanu JB, et al. The use of response surface methodology in predicting sesame (Sesamum indicum L.) protein extractability with water and the analysis of the protein extracted for it amino acid profile. Biotechnol. 2007; 6: 447-455.
21. Pérez-Conesa D, Ros G, Periago MJ. Protein nutritional quality of infant cereals during processing. J Cereal Sci. 2002; 36: 125-133.
22. Imura K, Okada A. Amino acid metabolism in pediatric patients. Nutr. 1998;14: 143-148.
23. Moreno JJ, Mitjavila MT. The degree of unsaturation of dietary fatty acids and the development of atherosclerosis [review]. J Nutr Biochem. 2003; 14: 182-195.
24. Herbaut C. Omega-3 and health. Rev Med Brux. 2006; 27: S355-S360.
25. Reiffel JA, McDonald A. Antiarrhythmic effects of omega-3 fatty acids. Am J Cardiol. 2006; 98: 50-60.
26. Landmark K, Alm CS. Alpha-linolenic acid, cardiovascular disease and sudden death (in Norwegian). Tidsskr Nor Laegeforen. 2006; 26: 2792-2794.
27. Dorosko S, Rollins N. Infant formula preparation by rural and semi-rural women in South Africa. Food Policy. 2003; 28: 117-130.
28. Sandhu KS, Singh N, Seung-Taik L. A comparison of native and acid thinned normal and waxy corn starches: Physicochemical, thermal, morphological and pasting properties. LWT-Food Sci Technol. 2007; 40: 1527-1536.
29. Nnam NM. Chemical, sensory and rheological properties of porridges from processed sorghum (Sorghum bicolor), bambara groundnut (Vigna subterranea L. Verdc) and sweet potato (Ipomoea batatas) flours. Plant Foods Hum Nutri. 2001; 56: 251-264.