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Acceptability of Instant Cassava-soybean Based Complementary Food by Weaning Mothers

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Authors' contributions

This work was carried out in collaboration between all authors. Authors FDWM and MBO designed the study, performed the statistical analysis, wrote the protocol, wrote the first draft of the manuscript and managed literature searches. Authors EA, CQ and IO managed the analyses of the study and literature searches. All authors read and approved the final manuscript.

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ABSTRACT

Aims: The objective of this study was to formulate and evaluate some functional properties and sensory qualities of cassava-soybean complementary food using a relatively cheaper method; Steam Blanching

Study Design: Qualitative and quantitative.

Place and Duration of Study: Department of Food Science and Technology, Kwame Nkrumah University of Science and Technology and Ayeduase Community Clinic in Kumasi, Ghana between August 2014 and May 2015.

Methodology: The processing and heat treatment used were varied (fermentation (24 h) and non-fermentation; steam blanching (15 min) and non-steam blanching) to obtain Fermented Steam Blanched (FSB) blend, Non-Fermented Steam Blanched (NFSB) blend, Fermented Non-Steam Blanched (FNSB) blend and Non-Fermented Non-Steam Blanched (NFNSB) blend. Four cassava-soybean blends in a 65:35 ratio were processed. The products were formulated using 75%

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cassava-soybean blend, 20% sugar and 5% mango. Fifty (50) mothers assessed the attributes of the formulated blends using preference test with 5-point hedonic scale.
Results: Results showed that the flavour and taste of steam blanched blends were most preferred while non-steam blanched blends were most preferred in terms of smoothness. There was no significant difference between the acceptability of the blends in terms of colour at p = 0.05. Steam blanching significantly affected the sensory qualities and functional properties; FSB and NFSB were scored 2.02±0.73 and 2.05±0.85 while FNSB and NFNSB scored 2.19± 0.74 and 2.12±0.83 respectively in terms of preference of their sensory attributes. Steam blanched blends had higher bulk densities and swelling index as compared to non-steam blanched blends. Fermentation decreased the swelling power of the blends but not at a significant level because of the shorter duration (less than 48 h) Fermented Steam Blanched product scored the highest in terms of all the sensory attributes and had low bulk density (0.70±0.02) and swelling index (2.63± 0.13).
Conclusion: The study showed that Steam Blanching could be employed in developing an instant cassava-based complementary food capable of meeting the nutritional needs of children 9-11 months old.

Keywords: Food formulation; food processing; fermentation; steam blanching.

1. INTRODUCTION

Children are a blessing in many homes, and most mothers are very cautious about the nutrition and health of the child mostly within the 1st to 6th or 12th month of the child's life. It is reported that after the 6th month of the child's life, breastfeeding becomes insufficient in providing the nutrient needs of the child [1]. Mothers are therefore expected to provide in addition to the breast milk, complementary foods to provide the essential nutrients that are not fully met from the intake of only breast milk [2].

In many developing countries, maize, rice and cassava are mostly the staple crops used in complementary feeding. In Ghana, a major staple crop, which is consumed in all parts of the ten administrative regions, is cassava [3]. Most cassava cultivars have water as the major constituent with high energy but low nutrient density [4,1]. This is confirmed by work done by Stupak [5] where the protein content among common cassava cultivars was found to be only about 1%.

The standard of living of most mothers in the developing areas is low, hence the provision of complementary foods containing the essential nutrients in their right proportions is a major problem [6,7]. Increased consumption of cassava, yam and other tubers which are poor sources of protein, vitamins and minerals by children living in areas where these staples are commonly grown puts them at a high risk of suffering from protein energy malnutrition [8,9].

Some works have been done on fortification of most staple crops used for complementary feeding. One of such work is the development of a cassava-based complementary food fortified with soybean by Muoki et al. [10]. Most complementary foods found on the market which contain the required nutrient level are instant or precooked. They therefore require only addition of warm water to prepare. The processing technologies mostly used in the production of instant foods are extrusion and drum drying. Work done by Muoki et al. [10] showed that most mothers prefer extruded complementary foods to the conventionally cooked ones. It has been reported from research that the cost of capitalization and operation confers an extra cost on the final product making it expensive for most mothers in developing countries especially the rural areas [6]. Adeyemi et al. [11] proposed that steam blanching for 15 minutes can produce a product with similar characteristics as that extruded. This work therefore sought to determine the practicability of the steam blanching method in producing an instant complementary food which is acceptable.

2. MATERIALS AND METHODS

2.1 Materials

The fresh cassava root (Debor variety) was obtained from CSIR-Crops Research Institute, Fumesua. Soybean (Anidaso variety) was purchased from a market in Tamale, Ghana. Fresh mangoes (Rosemary variety) were also purchased at Sogakope in the Volta region and sugar was bought from the open market, all in Ghana.

2.2 Sample Preparation

Individual ingredients were prepared as described in 2.2.1 to 2.2.4 and Figs. 1 and 2 while the final blends of the products is shown in Table 1 and Fig. 3.

2.2.1 Preparation of mango flour

Six kilograms of mangoes at the breaker and turning stage were sorted and washed with potable water. The fruits were peeled into thin strips about 3 mm thick using a fruit slicer. The sliced flesh was spread on stainless steel trays coated with glycerol and placed in the oven (Beschickung – Loading Modell 100 – 800, memmert, Schwabach) at a temperature of 80°C for 3 h. The dried mangoes were milled, sieved into a particle size of 762 μm and stored in low density polyethylene bags [12].

2.2.2 Preparation of soybean flour

Four kilograms of soybean was sorted to remove unwanted materials and washed. About 30 L of water was brought to a boil and then the soybean was added to it and allowed to boil for 25 min without covering with the lid. The water was drained and the soybean was washed and dehulled with cold water. The beans were separated from the hulls and top pan roasted for 15 minutes; roasting 500 g of the beans at a time. The roasted beans were milled, sieved into flour using a 762 μm sieve and packaged in low density polyethylene bags.

2.2.3 Preparation of cassava- soybean blend

About 20 kg of the fresh cassava roots were weighed. The roots were peeled using a sharp knife, washed in potable water and grated. The grated cassava (500 g each) was mixed in 500 mL of water using a blender for 40 sec and manually pressed a muslin cloth. Two bowls were labelled Fermented Cassava-Soybean (FCS) and Non-Fermented Cassava-Soybean (NFCS). About 1.7 kg of the pressed cassava was weighed separately into each bowl and 0.9 kg of the soybean flour added. The cassava and soybean were mixed thoroughly to ensure a

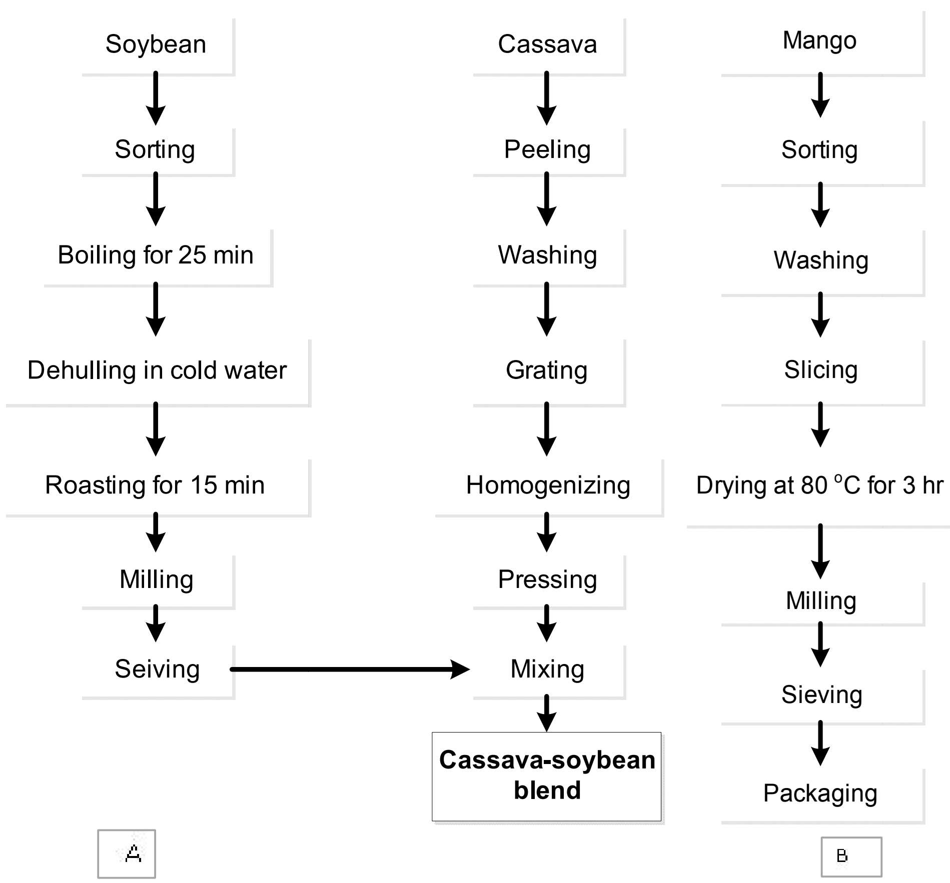

Fig. 1. Preparation of cassava-soybean blend (A) and mango flour (B)

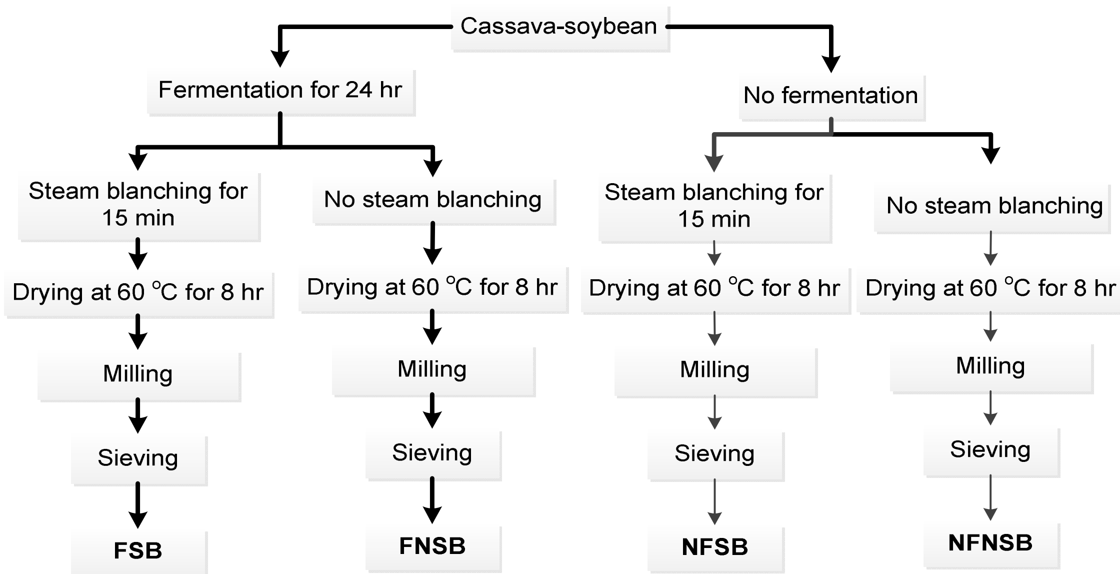

Fig. 2. Preparation of the instant food using steam blanching and non-steam blanching method

uniform mixture. The bowl labelled FCS was covered with a polyethylene bag and stored at 25°C to ferment for 24 h while the non-fermented cassava-soybean was further processed skipping the fermentation stage.

2.2.4 Heat processing methods

The fermented cassava-soybean blend as well as the unfermented cassava-soybean blend were divided into 2 equal parts. One part of the fermented cassava-soybean blend as well as the unfermented cassava-soybean blend was oven dried (Beschickung – Loading Modell 100 – 800, memmert, Schwabach) at a temperature of 60°C for 8 h. The other parts (250 g at a time) were steam blanched for 15 minutes over boiling water (2 L) before drying in an oven for 60°C at 8 h. The dried samples were milled separately, sieved to a particle size of 762 µm and finally packaged into a polyethylene bag.

2.3 Product Formulation

The final products were formulated in a 75:20:5 ratio, as detailed in Table 1 below.

2.4 Sensory Evaluation

The samples were reconstituted by mixing 8 g of sample in 32 mL of already boiled water (40-50°C) and then served in plastic cups to panelists for evaluation. Samples were coded with three-digit random numbers. Untrained panellists with educational background below secondary level were used for the analysis but they were briefed on how to assess the products. Panelists were asked to express their liking for colour, flavour, taste and smoothness using a 5-point hedonic scale where 1= like very much, 2= like slightly, 3= neither like nor dislike, 4= dislike slightly and 5= dislike very much. Females (n=50) aged >20 years with children aged below 2 years participated in the study. These mothers were recruited from the Ayeduase Community Clinic in Kumasi. Consent forms were obtained from the Anatomy Department of the School of Medical Science (Kwame Nkrumah University of Science and Technology. The method used in the sensory evaluation was as according to Muoki et al. [10].

Table 1. Formulation of cassava-soybean complementary food per 500 g

Sample	Cassava-soybean. 75%	Mango 5%	Sugar 20%
NFNSB	375	25	100
FNSB	375	25	100
NFSB	375	25	100
FSB	375	25	100

Key: FSB (Fermented steam blanched), NFSB (Non-fermented steam blanched), FNSB (Fermented non-steam blanched), NFNSB (Non-fermented non-steam blanched)

Product preparation and sensory evaluation

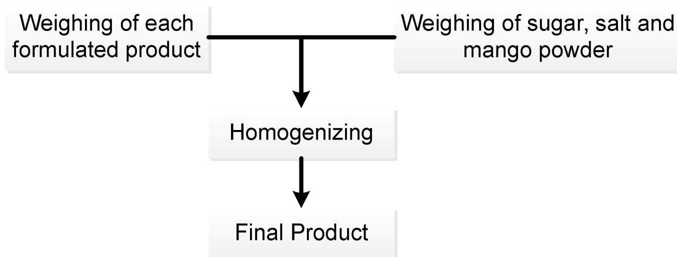

Fig. 3. Formulation of instant cassava-soybean complementary food

2.5 Analytical Methods

2.5.1 Determination of tapped bulk density (B.D)

The method of Onwuka and Onwuka [13], was used with little modifications. Fifty grams of each sample was measured into a clean 180 cm^3 graduated cylinder and its volume was recorded in each case. The bottom of the cylinder was tapped repeatedly on a padded table till there was no visible drop in volume. The volume was then recorded as the packed volume. The bulk density was calculated for the packed volume using the general formula below:

$$Bulk\ Density\ (g/cm^3)\ = \frac{weight\ of\ sample\ (g)}{Volume\ occupied\ (cm^3)}$$

2.5.2 Swelling index (S.I)

Swelling index was calculated using the method of Ojinnaka et al. [14], with little modifications. The sample was filled to the 2 mL mark of a 15 mL measuring tube and topped up with water to the 10 mL mark. The tube was closed and shook until even mixture of the water and the sample was attained and the tube was allowed to stand for 1 h. The final volume occupied by the sample was then recorded and the swelling index calculated as the ratio of the final volume of the sample to the initial volume of the sample.

$S=V_2/V_1$

Where,

S= Swelling index (ml/ml),
V_1= Initial volume occupied by the sample,
V_2 =Final volume occupied by the sample.

2.5.3 Proximate composition of most preferred blend (FSB)

Moisture, ash, protein and fat were determined using standard methods of the AOAC [15]. Carbohydrate was estimated by difference.

Apparent energy= (4 kcal/g of protein and carbohydrate, 9 kcals/g for fat) x proximate composition values

Available energy= apparent energy x 0.95 (crude fibre above 2.0%)

2.5.4 Statistical Analyses

SPSS was used to analyze data obtained. Data obtained from the study was statistically analyzed using analysis of variance (ANOVA) at a significance probability of P = .05. Comparison between sample treatment and heat treatment methods was done using a two-way ANOVA at 95% confidence level. The means of the consumer ratings was analyzed using one-way ANOVA and LSD. All Experiments were repeated three times and results expressed as mean ± standard deviation.

3. RESULTS AND DISCUSSION

3.1 Sensory Acceptability by Mothers

The highest mean consumer sensory acceptability score was 2.19 on the 5-point hedonic scale where 1= like very much 3= neither like nor dislike 5= dislike very much (Table 2). The average rating for steam blanched and non-steam blanched porridges were not significantly different for all attributes.

3.1.1 Colour

Colour is one of the attributes that is known to influence the acceptability of a product. Blends that were steam blanched appeared brownish while those that were not steam blanched were relatively white. The non-fermented blends were most preferred in terms of colour and the Non-Fermented Steam Blanched (NFSB) were scored the highest; 1.66. The fermented non-steam blanched had the lowest score of 1.84 as shown in Table 2. There was no significant difference among all the blends in terms of colour. The mothers explained that sensory attributes which mostly influence the child's acceptability of food are the taste and flavour. This could be due to the fact that children before 12 months may not appreciate food colours.

3.1.2 Flavour

The mean score for flavour of the blends were ≤ 2.16 with the highest score being 1.76 for Non-fermented steam blanched (NFSB) and the lowest being Non-Fermented Non-Steam Blanched (NFNSB) as shown in Table 2. Most mothers ranked the flavour of the steam blanched blends higher than the non-steam blanched. This may mean steam blanching improved the flavour of the products [16]. No significant difference (P = .05) was observed among the blends in terms of flavour.

3.1.3 Taste

The tastes of the formulated blends were liked slightly on a 5-point hedonic scale. The taste of FSB was most preferred and the least preferred was FNSB. Blends that were steam blanched had the highest scores as compared to the non-steam blanched. Most mothers preferred the steam blanched blends. There was no significant difference between the blends except for FSB and FNSB which were significantly different at (P = .05).

3.1.4 Smoothness

Steam blanching significantly affected the smoothness of the blends. The smoothness of the non-steam blanched blends was most preferred. This could be due to the fact that children below 1 year do not have a well-established digestive system, hence mothers prefer serving children with complementary foods which have a smoother texture to aid in easy digestion and absorption of nutrient [17]. There was a significant difference between the smoothness of the NFSB to FNSB and NFNSB. The most preferred blend in terms of smoothness was the NFNSB. Acceptability of the blends in terms of smoothness was liked slightly as shown in Table 2.

Mothers rated steam blanched porridges higher for taste and flavour with significant difference (P = .05) in taste only. Smoothness of the non-steam blanched porridges was most preferred. Fermented Steam Blanched (FSB) porridge was the most preferred porridge as shown in Table 2. The mean scores for the overall acceptability of the formulated porridges were between 2.02 ± 0.73^a and 2.12 ± 0.83^a. The overall acceptability of the formulated porridges were higher than those done by Muoki et al. [10] (3 and below).

3.2 Impact of Processing on Sensory Attributes of Porridge

From Table 3, processing method (Fermentation and Non-fermentation) had no significant effect on all the attributes of the formulated porridges. This was because fermentation was done at a shorter duration (below 48 h). Oyewole and Ogundele [18] reported that fermentation below 48 h had no significant effect on cassava flour. There was no significant effect of the heat treatment (Steam blanching and non-steam blanching) on the colour of the porridges. In terms of flavour and taste, porridges that were steam blanched were liked significantly (P = .05) than those non-steam blanched. In contrast to the latter, non-steam blanched porridges were liked significantly (P = .05) in terms of their smoothness to those steam blanched. From research it is shown that steam blanching affects smoothness, taste and flavour of products [19]. The non-significant effect on colour of the porridges could be due to the fact that most babies are mostly influenced by the flavour and taste of foods as compared to colour. Hence most mothers did not have any problem with the colour of the products. In conclusion, results from this work confirms the fact that steam blanching for 15 min can make acceptable instant foods as proposed by Adeyemi et al. [11].

3.2.1 Bulk density

The bulk densities of the formulated blends were between 0.5 and 0.7 g/cm^3 as shown in Table 3. Porridges which were not steam blanched had significantly (P = .05) lower densities as compared to those steam blanched. Bhattacharya and Prakash [20] reported that bulk density of foods increase with increase in starch content. Meanwhile Okezie and Bello [21] maintained that high bulk density of food material is important in relation to its packaging. There was no significant difference between porridges that were fermented and those non-fermented. According to Oyewole and Ogundele [18], fermentation below 48 hours does not have any significant effect on the bulk density of foods but fermentation above 48 h resulted in foods with increased bulk densities due to the increase in the fibre content. The bulk density of the Fermented Steam Blanched (FSB) and Non-Fermented Steam Blanched (NFSB) were close to those stated by Makinde and Ladipo [22] and Ojinnaka et al. [14] (0.71 g/cm3). Research has shown that steam blanching affects the bulk density of foods. Work done by Amankwah et al. [23] confirms that steam blanching increases bulk density of foods. Complementary foods are expected to have low bulk densities. The low B.D values implies that more of the samples could be prepared using a small amount of water and yet give the desired energy nutrient density and semi-solid consistency which can easily be fed to an infant [24,14]. According to Akubor and Ukwuni, [25] cassava-soybean composite usually have low bulk density which could be an advantage in the formulation of supplementary foods.

3.2.2 Swelling power

The swelling power of the cassava-soybean complementary food ranged from 2.000 to 2.792 ml/ml as shown in Table 3. Steam blanched porridges had a significantly (P = .05) higher swelling power compared to non-steam blanched porridges. This may be due to fact that steam blanching causes starch gelatinization which improves upon the swelling and water absorption of the starch/flour. Fermentation on the other hand may even breakdown some of the starches and result in lower swelling properties Bainbridge et al. [26] stated that food products with high starch content and paste viscosity, will have high swelling power. Soni et al. [27] also attributed high swelling power to the highly ordered internal arrangement of starch granules as found in yam with a swelling capacity of 9%. Thus, steam blanching increases the swelling power of foods [23]; which confirms the higher values in porridges that were steam blanched. There was no significant difference between fermented and non-fermented blends in relation to their swelling power. This may be due to breakdown of some of the starches in the porridge resulting in lower swelling properties. The lower values of the fermented blends according to Muekatete et al. [28] could be due to their low viscosity. Muekatete et al. [28] reported that fermentation reduces the viscosity (pasting property) of flours hence more of the flour will be needed during porridge making hence giving a food with a high nutrient density. Complementary foods with high swelling power absorb more water and have less solids resulting in low nutrient density for the infant [14]. From the results, the swelling powers of the samples are similar to that stated by Ojinnaka et al. [14] (2.56 ±0.05). According to Nelson and Cox [29], high swelling power is due to the water binding capacity of the legume protein.

3.3 Proximate Composition of the Most Preferred Complementary Food Formulation (Fermented Steam Blanched (FSB) Complementary Food)

The moisture content of the most preferred sample (Fermented Steam Blanched blend) was 6.20%. The moisture content was within the normal moisture contents of dried foods (flour blends), that is below 12.5% for shelf stable storage [30]. Materials such as flour and starch containing more than 12.5% moisture have less storage stability than those with lower moisture content [31]. For this reason, a water content of not more than 12.5% is generally specified for flours and other related products. Moisture content is known to have influence on general energy and nutrient density. Low moisture content has been reported to influence the energy and nutrient density of foods; the lower the moisture content, the greater the energy content due to the high carbohydrate content [32].

The ash content of the blend also recorded a low value of 2%. The value is comparable to the value reported by Adedeji et al. [33] from the production of soy-sorghum-roselle complementary food. The fat content of the blend was 8% and the protein was 16.32%. The fat content of the blend was within stipulated standard fat content for complementary foods by Codex [34]. Fat content of 11 g in 100 g of the sample is preferred as it is reported to provide 20-25 % energy [35].

The protein content was also a little higher than that recommended (15%) in complementary foods. The fibre content was 3.34%. The fibre content was within the accepted range for home-made complementary food but higher than that for commercially processed complementary food which is 2% [34]. It is recommended that the fibre content of complementary food be low since high fibre content increases the bulk and satiety as well as reduce the nutrient digestibility and energy density. It has been reported that dehulling legumes removes phytate to some extent [36]. Completely removing phytate in soybean is difficult since it is located in the cotyledon and not the hull [35]. Milling has also been reported to reduce fibre and antinutrients in whole grains [37]. The carbohydrate content was 64.15.

The apparent energy was 393.86 kcal and the available energy was 374.167 kcal. The blend is therefore suitable for infants within 9-23 months of age who are breast fed (Table 5).

Table 2. Sensory evaluation of cassava-soybean complementary food

Sample	Colour	Flavour	Taste	Smoothness	Overall acceptability
FSB	1.68±0.89[a]	1.92±1.05[a]	2.08±1.21[a]	2.38±1.31[a]	2.02±0.73[a]
NFSB	1.66±0.82[a]	1.76±0.92[a]	2.14±1.37[a]	2.64±1.35[a]	2.05±0.85[a]
FNSB	1.84±0.87[a]	2.12±0.92[a]	2.66±1.39[b]	2.14±1.14[ab]	2.19±0.74[a]
NFNSB	1.68±0.89[a]	2.16±1.18[a]	2.58±1.49[a]	2.04±1.18[b]	2.12±0.83[a]

Values are mean±standard deviation of fifty scores. Colum means with different superscripts are significantly different at 95% probability level (P = .05). Key: FSB (Fermented steam blanched), NFSB (Non-fermented steam blanched), FNSB (Fermented non-steam blanched), NFNSB (Non-fermented non-steam blanched)

Table 3. Effect of fermentation and steam blanching on the sensory attributes of the porridge

Factor	Colour	Flavour	Taste	smoothness
Fermentation	.464	.679	.959	.651
Heat treatment	.464	**.039**	**.009**	**.018**
Fermentation * Heat treatment	.569	.490	.718	.309

Values are p scores at 95% probability level

Table 4. Functional properties of cassava-complementary food

Sample	Bulk density (g/cm^3)	Swelling power (ml/ml)
FSB	0.70±0.02[a]	2.63±0.13[a]
NFSB	0.73±0.05[a]	2.79±0.19[a]
FNSB	0.62±0.02[b]	2.00±0.13[b]
NFNSB	0.59±0.01[b]	2.08±0.07[b]

Values are mean±standard deviation of triplicate scores. Column means with different superscripts are significantly different at 95% probability level (P = .05). Key: FSB (Fermented steam blanched), NFSB (Non-fermented steam blanched), FNSB (Fermented non-steam blanched), NFNSB (Non-fermented non-steam blanched)

Table 5. Proximate composition (%) of the most preferred complementary food formulation fermented steam blanched (FSB) blend

Sample	Moisture	Ash	Fat	Crude protein	Crude fibre	Carbohydrate
FSB	6.20±0.00	2.00±0.00	8.00±0.00	16.32±0.45	3.34±0.48	64.15±0.92

Table 6. Energy needed from complementary foods for breastfed and non-breastfed older infants and young children in developing countries and estimated gastric capacity

Age of child (mo.)	Recommended daily feeding frequency (meals/snacks)		Energy needs from complementary foods		Gastric capacity (ml)	
	Breastfed	**Not breastfed**	**Breastfed (kcal/day)**	**Not breastfed (kcal/day)**	**Average child ml/meal**	**Growth retarded child ml/meal**
6-8	2-3	4-5	200	600	249	192
9-11	3-4	4-5	300	700	285	228
12-23	3-4	4-5	550	900	345	273

Source: [38]

4. CONCLUSION

The study revealed that steam blanching for 15 minutes could be employed in developing cassava-based instant complementary food. Sensory analysis showed that Fermented Steam Blanched (FSB) blend was the most preferred in terms of the attributes assessed. The bulk density and swelling power of the FSB blend was low making it an ideal complementary food. The proximate composition of the most preferred sample (FSB) showed that the blend can be used to improve the nutritional needs of children from 9-11 months of age. However, the fat content could be increased to the recommended level which is 11%.

CONSENT

As per international standard or university standard, patient's written consent has been collected and preserved by the authors.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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