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Full Length Research

Effect of processing methods on the amino acid profile of sorghum, soya beans and cashew nuts complementary food blends

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ABSTRACT: Sorghum, soya beans and cashew nuts are nutritious foods that can help combat malnutrition. Various processing methods are used to enhance the nutritional value and palatability of these foods. The objective of this study was to determine the amino acid profile of sorghum, soya beans and cashew nut complementary food blends. In this study, the complementary food blends were compared with checkers' custard. Sorghum was subjected to sprouting and fermentation processing techniques, while soya beans and cashew nuts were roasted. The complementary food blends were blended in different ratios to give six formulations. They include: RSVM: 65 parts raw sorghum: 35 parts vitamin and mineral supplements, PSVM: 65 parts processed sorghum: 35 parts vitamin and mineral supplement, PSC: 85 parts processed sorghum: 15 parts cashew nuts, PSSB: 52 parts processed sorghum: 48 parts soya beans, PSSBC: 45 parts processed sorghum: 45 parts soya beans: 10 parts cashew nuts and PSCSBVM: 45 parts processed sorghum: 10 parts cashew nuts: 30 parts soya beans: 15 parts mineral and vitamin supplements. Data obtained were subjected to Analysis of Variance (ANOVA) and Duncan's multiple range test was used to separate the means. The amino acid profile results revealed that the lysine and methionine content of the complementary food blend PSCSBVM was favourable compared with the RDA for infants aged 6-12 months. The histidine content of the six complementary food blends was above the RDA for infants, while the commercial complementary food was below the RDA.

Keywords: Amino acids, cashew nut, processing, sorghum, soya beans.

INTRODUCTION

Protein quality is a critical determinant of the nutritional value of foods, particularly in developing countries where plant-based diets dominate. The amino acid profile of food proteins, especially essential amino acids such as lysine, methionine, and tryptophan, plays a vital role in growth, tissue repair, and overall metabolic functions. However, many staple foods, including cereals and legumes, exhibit imbalanced amino acid compositions, which may contribute to protein-energy malnutrition if not properly processed or complemented (FAO, 2007).

Processing methods significantly influence the amino acid composition, digestibility, and bioavailability of nutrients in food materials. Traditional and modern processing techniques such as soaking, fermentation, germination, roasting and extrusion are widely applied to improve the nutritional quality of plant-based foods. These methods can either enhance or reduce amino acid availability depending on the intensity and nature of processing (Hotz and Gibson, 2007).

Fermentation, for instance, has been reported to improve protein quality by increasing the availability of essential amino acids. During fermentation, microbial activity leads to the breakdown of complex proteins into simpler peptides and free amino acids, thereby enhancing digestibility (Nkhata et al., 2018). Studies have shown that fermentation of cereals like sorghum significantly increases lysine content, which is typically limiting in cereals (Adeyemo and Onilude, 2013). Similarly, germination activates endogenous enzymes that hydrolyse storage proteins, resulting in improved amino acid profiles and reduced anti-nutritional factors (Ejigui *et al*., 2005).

Conversely, thermal processing methods such as roasting, boiling, and extrusion can have both positive and negative effects. Moderate heat treatment can denature proteins, making them more accessible to digestive enzymes. However, excessive heat may lead to the destruction of heat-sensitive amino acids, particularly lysine, through reactions such as the Maillard reaction (Rutherfurd and Moughan, 2007). This reaction reduces lysine availability by forming complexes with reducing sugars, thereby lowering protein quality.

The combination of different plant protein sources, such as cereals (e.g., sorghum), legumes (e.g., soya bean), and nuts (e.g., cashew nut), is a strategic approach to achieving a balanced amino acid profile. Cereals are generally deficient in lysine but rich in sulfur-containing amino acids, while legumes provide lysine but are limited in methionine. Nuts contribute additional essential amino acids and healthy lipids, thereby improving overall nutritional quality (Millward, 1999). Processing these ingredients appropriately further enhances their complementary effects and nutritional value.

Sorghum, soya beans, and cashew nuts are widely used as ingredients in complementary food blends due to their nutritional properties. These ingredients are rich sources of amino acids (Amankwah et al., 2009), which are essential for growth and development, especially in young children. The processing methods used to prepare these ingredients can affect their amino acid profiles, potentially impacting the overall nutritional quality of the complementary food blends (Mohapatra et al., 2019). Sorghum is a gluten-free grain that is commonly used in complementary food blends. The processing methods used to prepare sorghum, such as grinding and cooking, can affect its amino acid profile. For example, grinding sorghum into flour can increase its digestibility and the availability of amino acids (Mohapatra et al., 2019). Additionally, cooking sorghum can help break down anti-nutritional factors, which can interfere with amino acid absorption.

Soya beans are a rich source of protein and essential amino acids, making them a popular ingredient in complementary food blends. The processing methods used to prepare soya beans, such as soaking, roasting and cooking, can impact their amino acid profile (Ketnawa and Ogawa, 2019). Soaking soya beans can help reduce anti-nutritional factors and improve amino acid availability. Cooking soya beans can also enhance digestibility and amino acid absorption.

Cashew nuts are high in protein and essential amino acids, making them a nutritious addition to complementary food blends. The processing methods used to prepare cashew nuts, such as roasting, can affect their amino acid profile. Roasting cashew nuts can help improve their digestibility and enhance the availability of amino acids (Olatidoye et al., 2020).

The processing methods used to prepare sorghum, soya beans, and cashew nuts can have a significant impact on the amino acid profiles of these ingredients. By understanding how different processing methods affect amino acid availability and digestibility, food manufacturers and nutritionists can optimise the nutritional quality of complementary food blends for young children (Medina-Vera et al., 2024)

MATERIALS AND METHODS

Sources of raw materials

The cashew nut, soya beans, and sorghum were obtained at Maiduguri Monday Market and were identified and authenticated by seed breeders at the Lake Chad Research Institute, Maiduguri, Borno State, Nigeria. The commercial complementary food, Checkers' custard®, was purchased from a supermarket (Gumalti store) in Maiduguri, Borno State.

Preparation of cashew nut

Healthy, dry nuts were steamed in a 115°C cooker for 45 minutes. Once pre-cooked, the nuts were allowed to cool for 48 hours at room temperature and separated into two equal halves using a manually controlled dehuller. The almonds inside the hulls were removed using small knives and oven-dried in hot air at 85 °C for 2 hours. The nuts were dried at 65 °C for 6 hours to reduce the moisture content to 5-6 %, cooled, milled and sieved to obtain a fine flour as described by AOAC (2012).

Preparation of soya beans

Soya beans were sorted to get rid of foreign matter. It was weighed and then soaked in tap water for about 30 seconds, this is to facilitate dehulling of the grain, and this was done using a mortar and pestle. The dehulled soya beans were roasted in a frying pan for 3-4 minutes and subsequently milled and sieved to obtain a fine flour.

Preparation of sorghum

Sorghum grain was sorted to get rid of foreign matter and damaged grains. The sorghum was divided into two portions. The first portion was washed, dried, milled and sieved to obtain fine flour. The second portion of the sorghum was soaked in water, and the water was decanted. The sorghum was placed in a plastic bucket and allowed to sprout for 72 hours by spreading it in a clean, grease-free tray. The sprout was dried for three days in a clean tray. The sprout was soaked in water, about three times its weight by volume, for 72 hours. The fermented grain was washed and sun-dried for three days, then milled and sieved to obtain fine flour (Kulkarni *et al.,*1991).

Formulation of the complementary food blends

The complementary food blends were formulated using Cashew nut, Soya beans, and Sorghum in the following ratios as shown below;

1. 65 parts of Unprocessed (raw) Sorghum and 35 parts of vitamin and mineral supplement, i.e., 65:35 RSVM.
2. 65 parts of Processed Sorghum and 35 parts of vitamin and mineral supplement. i.e., 65:35 PSVM.
3. 85 parts of Processed Sorghum and 15 parts of Cashew Nuts, i.e., 85:15 PSC
4. 52parts of Processed Sorghum and 48 parts Soya Beans, i.e., 52:48 PSSB
5. 45 parts of Processed Sorghum, 45 parts of Soya Beans and 10 parts of Cashew Nuts, i.e., 45:45:10 PSSBC
6. 45 parts of Processed Sorghum, 10 parts of Cashew Nuts, 30 parts of Soya Beans and 15 parts of vitamin and mineral supplement, i.e., 45:10:30:15 PSCSBVM.

A flow chart for the production and formulation of the complementary food blends was presented in Figure 1.

Determination of amino acid profile

The amino acid profile in the known sample was determined using methods described by AOAC (2012). The known sample was dried to constant weight, defatted, hydrolysed, and evaporated in a rotary evaporator and loaded into the Technicon sequential Multi-Sample Amino Analyser (TSM).

Defatting sample

The sample was defatted using a chloroform/methanol mixture of ratio 2:1. About 4 g of the sample was placed in an extraction thimble and extracted for 15 hours in a Soxhlet extraction apparatus (AOAC, 2012).

Hydrolysis of the sample

Two grams (2 g) of the defatted sample was weighed into a glass ampoule. About 7 ml of 6N HCL was added, and oxygen was expelled by passing nitrogen into the ampoule (this is to avoid possible oxidation of some amino acids during hydrolysis, e.g. methionine and cystine). The glass ampoule was scaled with a Bunsen burner flame and put in an oven preset at 105°C± 5°C for 22 hours. The ampoule was allowed to cool before being broken open at the tip, and the contents filtered to remove the humins. The filtrate was evaporated to dryness in a hot air oven. The residue was dissolved with 5 ml of acetate buffer (pH 2.0) and stored in plastic specimen bottles, which were kept in the freezer.

Loading of the hydrolysate into the TSM analyser

The amount loaded is between 5 to 10 microlitres. This was dispensed into the cartridge of the analyser. The TSM analyser is designed to separate and analyse free acidic, neutral and basic amino acids of the hydrolysate. The period of the analysis would last for 76 minutes.

Method of calculating amino acid values from the chromatogram peaks

An integrator attached to the analyser calculates the peak area proportional to the concentration of each of the amino acids. Alternatively, the net height of each peak produced by the chart recorder of TSM (each representing an amino acid) was measured. The approximate area of each peak was obtained by multiplying the height by the width at half-height.

The norcleucine equivalent (NE) for each amino acid in the standard mixture was calculated using the formula:

$$\mathrm{NE} = \frac{Area\ of\ Norceucine\ Peak}{Area\ of\ each\ Acid}$$

A constant S was calculated for each amino acid in the standard mixture: where $S_{std} = NE_{std}$ x Molecular weight x μMAA_{std}.

Finally, the amount of each amino acid present in the sample was calculated in g/16gN of g/100g protein using the following formula:

Concentration (g/100g protein) = NH x W@NH/2 x S_{std} x C

Where $\mathrm{C} = \frac{\text{Dilution x 16} \div \text{NH x W (nleu)}}{\text{Sample Wt (g) x N\% x 10 x Vol.loaded}}$

Where: NH = Net Height, W = Width @ half height and nleu = Norleucine

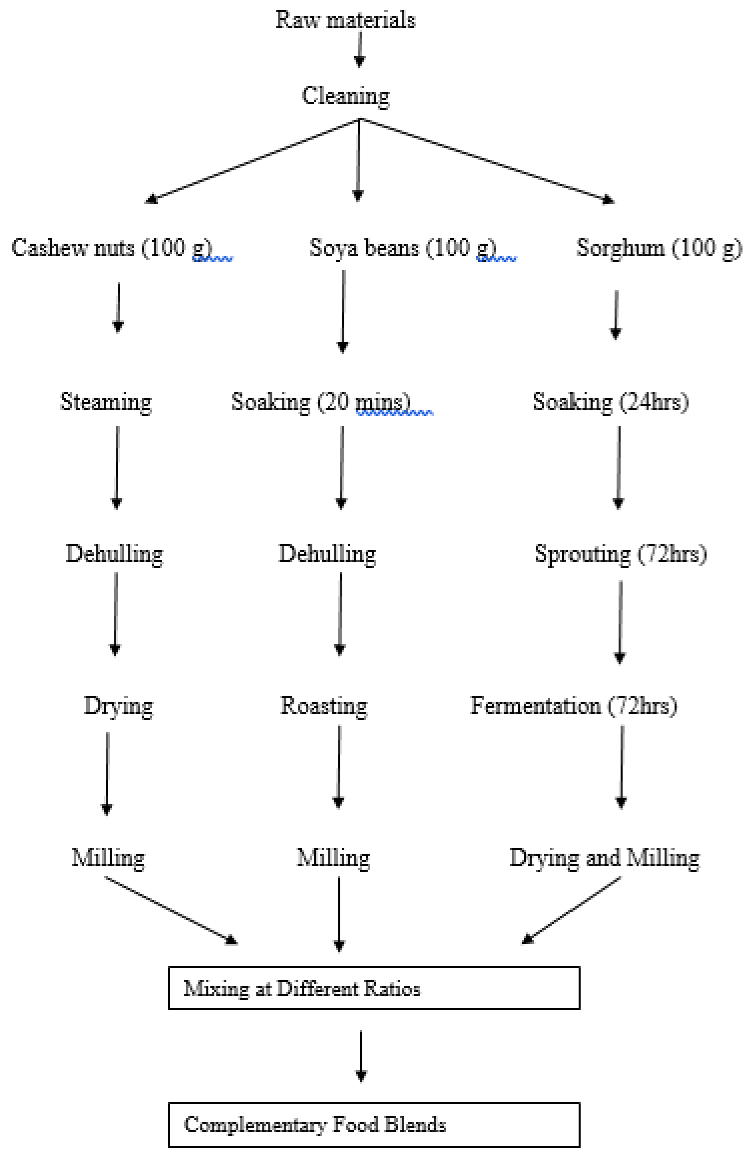

Figure 1. Flow chart for production and formulation of complementary food blends (Source: Kulkarni *et al.,* 1991).

RESULTS AND DISCUSSION

The results obtained from this study provide important insights into the effect of processing on the amino acid composition of sorghum, soya beans, and cashew nuts, as well as their suitability for use in complementary food formulations for infants.

Table 1 shows the Amino acid profile of raw and processed sorghum, soya beans and cashew nuts. The absence of significant differences in the histidine content of unprocessed and processed sorghum, soya beans, and cashew nuts suggests that the processing methods used did not adversely affect this amino acid. Histidine is relatively stable during moderate heat processing, which may explain the minimal change observed. This finding agrees with the report of Adeyeye (2011), who observed that some essential amino acids, such as histidine, remain relatively stable during common food processing techniques. The implication is that processing did not reduce the nutritional contribution of histidine in the formulated complementary foods.

The significant decrease in isoleucine observed in processed sorghum and cashew nuts may be attributed to the effect of heat and leaching during processing. Heat treatment and soaking processes can lead to partial degradation or loss of certain amino acids, particularly

Table 1. Amino acid profile of raw and processed sorghum, soya beans and cashew nuts.

Amino Acids	Samples					
	Sorghum		Soya beans		Cashew nut	
	Unprocessed	Processed	Unprocessed	Processed	Unprocessed	Processed
Histidine	0.85±0.01[a]	0.79±0.01[a]	1.47±0.01[a]	1.32±0.01[a]	3.98±0.00[a]	3.23±0.01[b]
Isoleucine	2.01±0.01[a]	1.65±0.00[b]	4.04±0.01[a]	4.04±0.01[a]	3.77±0.01[b]	3.97±0.01[a]
Leucine	1.74±0.00[a]	1.55±0.00[a]	4.65±0.00[a]	3.66±0.00[b]	3.30±0.01[b]	4.41±0.01[a]
Lysine	3.87±0.01[a]	3.85±0.00[a]	4.66±0.01[a]	4.26±0.01[b]	5.22±0.00[a]	5.17±0.01[a]
Methionine	2.72±0.01[a]	2.65±0.00[a]	5.86±0.01[a]	5.26±0.01[b]	6.23±0.01[a]	7.11±0.01[a]
Phenylalanine	6.25±0.01[b]	5.89±0.01[a]	8.94±0.00[a]	8.93±0.00[a]	8.11±0.00[a]	8.13±0.01[a]
Threonine	1.54±0.01[a]	1.51±0.00[a]	3.93±0.00[a]	3.86±0.00[a]	4.20±0.00[b]	4.45±0.01[a]
Tryptophan	1.54±0.01[a]	1.05±0.00[b]	4.23±0.00[a]	4.17±0.01[a]	5.01±0.00[b]	5.16±0.01[a]
Valine	2.75±0.00[a]	2.72±0.00[a]	4.17±0.01[a]	3.87±0.01[b]	3.11±0.00[b]	4.34±0.01[a]
Alanine	0.56±0.01[a]	0.55±0.00[a]	1.38±0.01[a]	0.98±0.01[b]	2.50±0.01[b]	2.97±0.01[a]
Serine	2.75±0.01[a]	2.60±0.00[a]	4.92±0.00[a]	4.71±0.13[b]	3.25±0.02[a]	3.24±0.02[a]
Tyrosine	4.43±0.01[a]	4.10±0.00[b]	11.1±0.00[a]	4.11±0.01[b]	8.43±0.00[a]	6.46±0.01[b]
Proline	1.71±0.01[a]	1.70±0.00[a]	3.30±0.00[a]	2.30±0.00[b]	4.11±0.01[a]	2.27±0.00[b]
Glutamic acid	1.77±0.01[a]	1.45±0.00[b]	4.15±0.00[a]	4.15±0.00[a]	4.12±0.01[a]	3.71±0.01[b]
Glycine	4.53±0.04[b]	3.65±0.00[a]	8.35±0.00[a]	7.34±0.00[b]	8.18±0.00[a]	7.14±0.01[b]
Aspartic acid	3.62±0.00[a]	3.60±0.00[a]	6.51±0.00[a]	6.32±0.01[b]	4.90±0.00[b]	4.98±0.01[a]
Arginine	2.80±0.01[a]	2.71±0.00[a]	3.81±0.00[a]	3.46±0.00[b]	3.01±0.00[b]	3.78±0.01[a]
Cystine	3.13±0.01[a]	3.00±0.00[a]	6.05±0.01[b]	6.06±0.01[a]	4.00±0.01[b]	4.42±0.00[a]

Values are mean ±SEM, n=3. Values with different superscript along the row are significantly different ($p<0.05$).

branched-chain amino acids. Similar observations were reported by Badau *et al*. (2009), who found that processing methods such as soaking, boiling, and fermentation could alter amino acid composition in cereals and legumes. The implication is that processing conditions must be carefully controlled to minimise nutrient losses in complementary foods (Manzanilla-Valdez *et al*., 2024).

The lack of significant difference in the isoleucine content of unprocessed and processed soya beans suggests that the processing methods used were mild enough to preserve this amino acid. Soya beans are known to contain relatively high and stable levels of essential amino acids, especially when processed under controlled conditions. This finding agrees with Friedman and Brandon (2001), who reported that soya bean proteins are generally stable during moderate processing. The implication is that soya beans remain a reliable source of essential amino acids in complementary food formulations. The absence of significant differences in the valine and leucine contents of sorghum before and after processing indicates that these amino acids were not greatly affected by the processing method used. This observation supports previous findings by Mertz *et al.* (1984), who reported that most essential amino acids in cereals are relatively stable during traditional processing methods. The implication is that sorghum can maintain its protein quality even after processing.

The observed decrease in valine and isoleucine in processed soya beans compared to the raw samples may be attributed to heat denaturation and possible Maillard reactions during processing. Heat treatment can sometimes reduce amino acid availability, particularly when proteins react with reducing sugars. This finding is consistent with Hurrell and Carpenter (1981), who reported that processing can reduce the availability of certain amino acids through chemical reactions during heating. The implication is that although processing improves digestibility and reduces antinutritional factors, it may slightly reduce some amino acid levels.

The lack of significant differences in methionine and lysine in sorghum and cashew nuts indicates that processing did not significantly affect these amino acids. However, the decrease in methionine and lysine in processed soya beans suggests that these amino acids may be sensitive to heat processing. Lysine, in particular, is known to be susceptible to the Maillard reaction during heating. Similar findings were reported by Rutherfurd and Moughan (2007), who observed reductions in lysine availability after heat processing of protein-rich foods. The implication is that careful processing is necessary to preserve lysine, which is an essential amino acid for infant growth.

Table 2 shows the Amino acid composition of complementary food blends. The amino acid composition of the complementary food blends showed that lysine and methionine in the PSCSBVM blend compared favourably

Table 2. Amino acid composition of complementary food blends (g/100g).

Aino acids	Complementary food blends							
	RSVM	**PSVM**	PSC	**PSSB**	**PSSBC**	**PSCSBVM**	**RDA**	STD
Histidine	2.75±0.01^{d}	3.28±.0.01^{c}	2.70±0.00^{d}	3.86±0.00^{b}	4.04±0.01^{a}	4.54±0.01^{a}	1.13±0.01^{e}	1.90
Isoleucine	4.00±0.00^{c}	4.00±0.00^{c}	2.01±0.01^{e}	4.04±0.01^{c}	4.13±0.01^{b}	4.78±0.01^{a}	2.85±0.00^{d}	2.80
Leucine	7.78±0.01^{d}	8.26±0.01^{c}	6.78±0.01^{e}	8.93±0.01^{c}	9.32±0.01^{b}	9.41±0.00^{a}	2.25±0.01^{f}	6.60
Lysine	3.78±0.01^{d}	4.00±0.00^{c}	2.06±0.01^{e}	4.17±0.00^{c}	4.83±0.00^{b}	5.83±0.00^{a}	4.01±0.01^{c}	5.80
Methionine	1.67±0.00^{d}	1.93±0.00^{c}	1.34±0.01^{e}	2.12±0.01^{c}	2.76±0.01^{b}	2.65±0.01^{b}	3.78±0.01^{a}	2.60
Phenylalanine	3.95±0.00^{d}	3.96±0.00^{d}	3.87±0.01^{e}	4.96±0.01^{c}	5.60±0.00^{b}	5.81±0.01^{b}	7.34±0.01^{a}	6.30
Threonine	1.95±0.00^{e}	2.87±0.01^{d}	2.84±0.01^{d}	4.66±0.00^{c}	5.13±0.01^{b}	5.83±0.01^{a}	1.87±0.01^{e}	3.40
Tryptophan	3.66±0.01^{d}	4.45±0.00^{c}	3.71±0.01^{d}	5.26±0.01^{b}	5.63±0.01^{a}	5.89±0.01^{a}	2.62±0.01^{e}	-
Valine	4.22±0.01^{c}	4.32±0.01^{c}	2.74±0.00^{e}	4.96±0.01^{b}	5.52±0.00^{a}	5.58±0.00^{a}	3.84±0.01^{d}	3.50
Alanine	2.44±0.00^{d}	2.65±0.01^{d}	1.72±0.00^{e}	4.15±0.00^{c}	6.54±0.01^{b}	7.56±0.00^{a}	0.70±0.00^{f}	-
Serine	4.00±0.00^{c}	4.15±0.00^{c}	3.92±0.00^{d}	5.45±0.00^{b}	7.23±0.01^{a}	7.26±0.00^{a}	3.12±0.00^{e}	-
Tyrosine	4.11±0.00^{e}	5.17±0.01^{d}	5.14±0.00^{d}	6.82±0.00^{c}	7.37±0.01^{b}	8.13±0.00^{a}	3.14±0.00^{f}	-
Proline	2.00±0.00^{d}	3.04±0.01^{c}	1.75±0.00^{e}	4.28±0.01^{b}	4.35±0.01^{b}	5.55±0.00^{a}	1.82±0.01^{e}	-
Glutamic acid	5.81±0.01^{d}	6.17±0.01^{d}	4.62±0.01^{e}	9.11±0.01^{c}	9.39±0.01^{b}	10.46±0.0^{a}	2.72±0.01^{f}	-
Glycine	3.95±0.00^{d}	4.12±0.01^{d}	2.13±0.00^{e}	6.05±0.01^{c}	5.99±0.01^{c}	9.26±0.01^{a}	6.52±0.00^{b}	-
Aspartic acid	6.85±0.00^{d}	7.28±0.01^{c}	6.83±0.01^{d}	8.35±0.00^{b}	8.82±0.00^{b}	9.65±0.00^{a}	4.62±0.01^{e}	-
Arginine	4.32±0.00^{d}	4.52±0.00^{c}	4.62±0.01^{c}	6.32±0.01^{b}	4.04±0.01^{e}	7.13±0.01^{a}	3.13±0.01^{f}	2.00
Cystine	1.45±0.00^{e}	2.34±0.00^{d}	1.52±0.00^{e}	2.98±0.00^{c}	3.77±0.01^{a}	3.96±0.00^{a}	3.14±0.01^{b}	2.50

Value are mean ± SEM, n=3. Values with different superscript along the row are significantly different ($p<0.05$). **Keys:** RSVM- 65 parts of unprocessed (raw) sorghum and 35 parts of vitamin and mineral supplements; PSVM- 65 parts of processed sorghum and 35 parts of vitamin and mineral supplements; PSC- 85 parts of processed sorghum and 15 parts of cashew nut; PSSB- 52 parts of processed sorghum and 48 parts of soya beans; PSSBC- 45parts of processed sorghum, 45 parts of soya beans and 10 parts of cashew nuts; PSCSBVM- 45 parts of processed sorghum, 10 parts cashew nut, 30 soya beans and 15 parts vitamin and mineral supplement; STD- Checkers' Custard®.

with the recommended dietary allowance (RDA) for infants. This indicates that combining cereals, legumes, and nuts improved the overall amino acid balance of the food blends. This result supports the concept of protein complementation, where cereals deficient in lysine are combined with legumes that are rich in lysine. Similar findings were reported by FAO/WHO (2007) and Ijarotimi and Keshinro (2012), who noted that combining cereals and legumes significantly improves protein quality in complementary foods. The implication is that the formulated blends could effectively support the protein needs of infants.

The histidine levels of the complementary food blends being higher than the RDA for infants suggests that the formulations provide adequate amounts of this essential amino acid for growth and tissue repair. The lower histidine value observed in the standard diet compared to the RDA may indicate poorer protein quality relative to the formulated blends.

The arginine, valine, and isoleucine contents of the complementary food blends exceeding the RDA for infants indicate that the formulated products have the potential to support growth, immune function, and muscle development in infants aged 6–12 months. This finding agrees with WHO (2009), which emphasises the importance of adequate essential amino acid intake during infancy for optimal growth and development.

However, the phenylalanine content of the complementary food blends being below the RDA suggests that the blends may require further optimisation to fully meet infant amino acid requirements. Similar observations have been reported in cereal-based complementary foods, which sometimes lack adequate levels of certain essential amino acids (Gibson et al., 2010).

The significant increase in threonine content in the formulated blends indicates improved protein quality compared with the standard diet. Threonine is important for immune function and protein synthesis in infants. The lower threonine level observed in the standard diet compared with the RDA suggests that it may not adequately meet the nutritional needs of infants. This supports the importance of formulating complementary foods from diverse food sources to improve nutritional adequacy. Overall, the results demonstrate that processing and blending sorghum, soya beans, and cashew nuts can significantly improve the amino acid quality of complementary foods, making them suitable for infant nutrition. The combination of cereal, legume, and nut ingredients helps to overcome the amino acid limitations of individual food sources and contributes to better protein quality.

Conclusion and Recommendations

Fortification of sprouted and fermented sorghum with roasted soya beans, cashew nuts, vitamins, and mineral supplements increased the amino acid content of the complementary food blends. The lysine and methionine content of PSCSBVM (5.83 g/100g, 2.65 g/mg) met the RDA for infants. The lysine content of RSVM, PSVM, PSC, PSSB, PSSBC and commercial complementary food was below the RDA for infants. The methionine content of RSVM, PSVM, PSC and PSSB was below the RDA. PSSBC and the commercial complementary food were above the RDA for infants 6-12months. Therefore, it was recommended from this study that;

1. Fermentation and germination are preferred processing methods to improve amino acid quality and protein digestibility.
2. Control heat processing conditions (time and temperature) may be used to prevent loss of essential amino acids like lysine.
3. Cereal–legume–nut blends (e.g., sorghum, soya bean, cashew nut) should be promoted for a balanced amino acid profile.
4. Encourage further research on amino acid bioavailability and improved processing technologies.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

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