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Amino acids profile and health attributes of Bambara groundnut (*Vigna subteranea* L.) and sesame (*Sesamum indicum* L.): a comparative study

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Abstract

Healthy seeds samples of Bambara groundnut (*Vigna subteranea* L.) and sesame (*Sesamum indicum* L.) commonly found in Nasarawa State, Nigeria were studied for comparative nutritional evaluation with respect to proximate and amino acid compositions using standard analytical techniques. The respective proximate composition values (%) for the Bambara groundnut (*Vigna subteranea L.*) and Sesame (*Sesamum indicum L.)* samples were: (10.39 and 3.53), crude protein (25.68 and 9.67), crude fat (25.67 and 3.44), ash (7.12 and 2.42) and crude fibre (10.39 and 3.53). The calculated nitrogen-free extract (NFE) was 26.10 and 71.07% respectively. The results showed that Bambara groundnut gives appreciable values of crude protein, fat and fibre which are twice the values obtained for sesame. The anti-nutritional composition phytate, for the two samples Bambara groundnut and sesame, recorded a triple digit's values (mg/100g) of 188.74 and 186.77, tannins double digits value of 14.91 in Bambara while a single digit value of 8.91 in sesame respectively. The amino acid profile revealed that both samples contained useful quantities of most essential amino acid. Glutamic acid had the highest value in both samples 18.31 and 18.67 g/100g crude protein while cystine recorded the lowest value of 0.60 g/100g cp in Bambara and tryptophan 1.36 g/100g cp in sesame. By comparison with the FAO/WHO standards, the EAA score value of the samples based on white hen's egg profile, showed that both samples are mostly greater than 1.0 g/100g except for Ile, Lys, Met + Cys (TSAA) and Thr in Bambara and Ile, Lys, Thr and Val in sesame which may require supplementation based on the provisional amino acid scoring pattern. The incorporation of the seeds into diets has the capacity of enhancing its health applications due to the presence of some important nutrients containing health-protecting and disease-preventing abilities.

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1. Introduction

It has been discovered that plant nutrients are essential to human and animal survival. Many deadly disorders can arise from inadequate or inadequate amounts of certain plant components [1]. Legumes are the most suitable source of nutrients for healthy

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Figure 1: Plate 1 – Bambara groundnuts (*Vigna subteranea* L.).

Figure 2: Plate 2 – Sesame seeds (*Sesamum indicum* L.).

growth, however, the majority of these legumes are grossly underutilized in the global food chain [2]. Sesame and Bambara seeds are among these legumes, and they have a variety of nutritional benefits [1, 3, 4]. As seen in Figure 1, the underappreciated Bambara groundnut (*Vigna subterranea*) is a member of the Fabaceae family that is mostly grown in Asia and Africa. After groundnut and cowpea, it is the third most significant member of the family of leguminous crops [1]. It is a highly nutritious legume with an excellent ratio of necessary amino acids. Additionally, it is seen as a complete meal, particularly by the underprivileged in developing nations [4]. As a result, those who cannot afford pricey animal protein are starting to include it in their diets [5].

There are 60 species and 16 genera in the Pedaliaceae family, which includes sesame (*Sesamum indicum* L.). Due to its economic and industrial appeal, sesame seed has become more and more in demand every year. Sesame is grown in tropical and subtropical climates, and it has a mellow flavour and highly aromatic aroma [3]. Sesame is used to make a variety of goods, including sesame oil, paste, and food decorations. After the oil is extracted, the defatted sesame cake is a great source of high-quality protein and a variety of beneficial phytochemicals, which are plant-based bioactive nutrients that may enhance basic nutrition and lower the risk of serious diseases. For this reason, sesame is regarded as an unusual source of protein because it is mostly employed in the production of oil [6, 7]. Both pharmacological and nutraceutical benefits can be obtained from sesame seeds and their constituents, among other health benefits. It has been demonstrated that sesame seeds contain anticancer, antioxidant, and cholesterol-lowering qualities [7]. Due to its ability to grow in regions with relatively low growth requirements, *Sesamum indicum* L. is a crop that is essential to the provision of food in underprivileged areas of tropical Africa.

There is the need for a detailed comparative analysis of the proximate, amino acid, and phytochemical properties of *Bambara groundnut* (*Vigna subterranea L.*) – Figure 1, and *sesame seeds* (*Sesamum indicum L.*) – Figure 2, which remains relatively unexplored. While existing studies have highlighted the nutritional and medicinal benefits of Bambara groundnut and sesame seeds individually, there has been limited research on a direct comparative evaluation of these legumes in terms of their nutrient density and health-promoting bioactive compounds.

This study advances current knowledge by providing a systematic comparison of the two legumes, focusing on their potential to serve as affordable and sustainable protein and nutrient sources, particularly for underprivileged populations in developing regions. By analyzing their proximate composition (protein, fat, carbohydrate, etc.), amino acid profiles, and phytochemical content, this study seeks to determine which legume offers superior nutritional and health benefits. Additionally, it highlights the potential for these crops to address nutritional deficiencies and serve as functional foods, thereby expanding their role in global food security and health promotion.

Such a comparative analysis can guide food scientists, policymakers, and agricultural stakeholders in promoting the use of Bambara groundnut and sesame seeds in food systems, optimizing their production, and creating nutritionally enhanced food products tailored to meet dietary needs in resource-limited settings [3]. In order to determine which is better for nutrition, this study will look into the proximate, amino acid, and phytochemical properties of *Sesamum indicum L* and *Vigna subteranea L.*

2. Materials and methods

2.1. Sample collection and preparation

The samples were bought in Nasarawa State, Nigeria, at the Lafia Modern Market. The samples were completely cleared of any undesired material, stones, and broken seeds. Balarabe *et al.* [1] provided the method that was utilised to prepare bambara groundnut. The cleaned bambara groundnut was dehulled after soaking in boiling water for one hour at 100 degrees Celsius. For 96 hours, the dehulled seeds were dried at 35°C. An attrition milling machine (Thomas Wiley Model ED-5) was used to grind the dry bambara groundnut to flour, using a 5 mm sieve size. On the other hand, the sesame was made according to Sabiha *et al.* [8] instructions. When the milling samples were brought to the lab for chemical analysis, they were each kept in a separate airtight container.

2.2. Proximate composition

Following established procedures, the following parameters were measured: moisture, ash, crude protein (N x 6.25), crude fat, crude fibre, and carbohydrate (by difference) [9]. Every one of the sample flours' proximate analysis was done in triplicate and given in percentages. Every chemical was of Analar quality. Every result was calculated using dry weight (dw).

2.3. Anti–nutritient content determination

Using techniques outlined in standard procedure [10], the levels of oxalate, saponins, alkaloids, flavonoids, tannins, cyanide, phytate, and total phenols were assessed in each of the sample flours.

2.4. Amino acid analysis

Using the Technico Sequential Multisample (TSM) Amino Acid Analyser (Technicon Instruments Corporation, New York), the amino acid analysis was performed using Ion Exchange Chromatography (IEC) [11]. For every sample, the analytical time lasted for 76 minutes. At 60 degrees Celsius, the gas flow rate was 0.50 mLmin-1, and the repeatability was consistent within 3%. Every peak that the TSM's chart recorder created, each of which represented an amino acid, had its net height measured and computed. The reported values of amino acids were the means of two measurements. Within, nor-leucine served as the benchmark. Following alkali (NaOH) hydrolysis, tryptophan was measured using the colorimetric technique.

2.5. Calculating the projected protein efficiency ratio (P–PER), the isoelectric point (pI), and the quality of the protein in food

The method of Olaofe and Akintayo [12] was used to analyze the projected isoelectric point. The isoelectric point (pI) of a molecule, typically a protein or an amino acid, is the pH at which the molecule carries no net electrical charge. At this point, the number of positive charges equals the number of negative charges, making the molecule neutral overall) [12]:

$$pI_m = \sum_{i=1}^{n=1} pI_i X_i, \tag{1}$$

where pI_m is the amino acid mixture's isoelectric point, X_i is the mass or mole fraction of the mixture's amino acids, and pI_i is the isoelectric point of the mixture's ith amino acid.

The available amino acid ratio in the sample protein was compared to the demands represented as a ratio in order to determine the quality of dietary protein. The formula FAO/WHO [13] was then used to estimate the amino acid score (AAS):

$$\text{AAS} = \frac{\text{mg of amino acid in 1g of test protein}}{\text{mg of amino acid in reference protein}} \times \frac{100}{1}. \tag{2}$$

Using the formula created by Alsmeyer *et al.* [14], the anticipated protein efficiency ratio (P–PER) of the seed sample was determined from its amino acid content as follows:

$$P - PER = -0.468 + 0.454(LeU) - 0.105(Tyr). \tag{3}$$

The chosen analytical techniques were selected for their reliability, precision, and established use in food science. For proximate composition, standard AOAC methods ensured accurate measurements of moisture, ash, crude protein, fat, fibre, and carbohydrate content, with results reported on a dry weight basis to eliminate moisture variability. Anti-nutritional factors like oxalates, tannins, and phytates were assessed using widely accepted methods, critical for evaluating nutrient bioavailability and safety.

Amino acid analysis employed Ion Exchange Chromatography (IEC), a gold standard for precise quantification, with tryptophan determined calorimetrically to avoid degradation. Protein quality was assessed using the isoelectric point (pI), amino acid score (AAS), and predicted protein efficiency ratio (P–PER) – a computational method to estimate the protein quality based on its amino acid composition. It predicts how efficiently a protein can support growth, particularly in young animals, which is a traditional measure of protein quality in nutrition science, providing insights into protein functionality and dietary adequacy. These methods offer a balance of accuracy and practicality, ensuring robust and comparable results while addressing the nutritional and functional characteristics of *Sesamum indicum L.* and *Vigna subterranea L.* samples.

2.6. Statistical analysis of the samples

For each sample, the amounts of crude protein (17 kJ), crude fat (37 kJ), and carbohydrates (17 kJ) were added to determine the energy values. The values of fatty acids were calculated by multiplying the crude fat value of each sample by a factor of 0.8, meaning that the value of fatty acids is equal to crude fat x 0.8. For the proximate composition, errors of three determinations were calculated as standard deviations (SD). Additionally, the samples' standard deviation and percentage coefficient of variation were calculated. The use of SD and %CV ensures the accuracy and consistency of proximate composition measurements, helping to assess the reproducibility of the experimental methods. Including significance testing provides a robust framework for determining whether observed differences are statistically meaningful. Confidence intervals enhance the interpretability of results by quantifying the range within which true values are likely to lie. By integrating these statistical methods, this study provides a thorough evaluation of the nutritional properties of *Sesamum indicum L.* and *Vigna subterranea L.*, enabling more reliable comparisons. These statistical approaches also strengthen the validity of findings, paving the way for future research into these underutilized legumes' nutritional and industrial potential.

3. Results and discussion

The proximate composition of dehulled Bambara groundnut and sesame seed are presented in Table 1. Moisture content is a major factor as it determines the shelf life and storage of seeds. Moisture content of samples ranged between 3.53 and 10.39%. Highest values were recorded for Bambara groundnut, this indicative that sesame has lower moisture content compare to Bambara groundnut. Similar result (8.05%) of Bambara groundnut was reported by Aliyu *et al.* [1]. However, Okudu *et al.* [15] reported higher moisture value (8.68%) for sesame. It has been observed that a moisture content of less than a tenth (10%) is what keeps seeds from deteriorating over an extended length of time. A lengthy shelf life is indicated by the seed flour's low moisture content [16]. Bambara groundnut gives higher value of 25.68% crude protein comparable to 9.67% crude protein of sesame. From the data obtained, in order to combat protein energy malnutrition and to supplement other sources of protein and fat, Bambara groundnuts may be considered a superior supply of essential fat and protein. Bambara groundnut, on the other hand, offers greater energy, helps with the transport of soluble vitamins, and preserves internal tissues considerably more than sesame seed [4]. A fair agreement can be observed from the value of 21.78% given for sesame [17].

The values obtained are fairly high compared to the Bambara groundnut value (5.83%) as reported by Aliyu *et al.* [1]. When an organic substance in a food sample is completely oxidized or ignited, the inorganic residue that remains is referred to as ash. Most of the minerals found in the food sample make up the inorganic residue) [18]. The ash contents recorded were 7.12 and 2.42 % for Bambara groundnut and sesame respectively. The obtained, ash content result of sesame 2.42 % is in contrast to the 8.46% reported for seeds of *Sesamum indicum* L. grown in Southeastern Nigeria, as reported by Christian *et al.* [19]. These differences may be a result of geographical location and the various oil activities carried out in the southern part of Nigeria. Toros and Guzmán-Alvarez [3] also reported higher ash values of sesame ranging from 9.70 – 10.11% for three varieties of sesame which is also higher compared to the work of Okudu, *et al.* [15]. The inorganic residue left over after organic matter is destroyed is known as crude fibre. Due to potential volatilization or constituent interaction, it could not always be precisely comparable to the mineral matter [20], from the data obtained the crude fibre value of Bambara groundnut is superior to that of sesame and to the Bambara groundnut value as recorded by Aliyu *et al.* [1]. The calculated carbohydrate by difference of Bambara groundnut and sesame was 26.10% and 71.07% respectively. The sharp distinction in carbohydrate values of the samples agrees that sesame seed can provide more energy in the form of glucose than Bambara groundnut which is important for metabolic processes and fueling bodily functions. The fatty acid value of Bambara groundnut (20.54) indicates that Bambara groundnut seed oil is not suitable for use as cooking oil as opine by Aremu *et al.* [21], an oil's high fatty acid content suggests that it might not be edible for cooking but could be valuable for industrial uses. On the other hand, sesame (2.75) has shown benefits in both industrial and medical applications as well as culinary use. Both samples'

Table 1: Proximate composition of *Vigna subteranea*L. and *Sesamum indicum* L.

Parameters	*Vigna subteranea L*	*Sesamum indicum L*	Mean	SD	CV (%)
Moisture	10.39±0.01	3.53±0.18	7.08	3.98	55.93
Crude protein	25.68±0.09	9.67±0.25	17.68	11.32	64.03
Crude fat	25.67±0.05	3.44±0.18	14.56	15.72	39.29
Ash	7.12±0.08	2.42±0.02	4.77	3.20	67.09
Crude fibre	10.39±0.01	3.53±0.18	6.96	4.85	69.68
Carbohydrate	26.10±0.33	71.07±0.04	48.59	31.80	65.45
*Fatty acids	20.54	2.75	11.65	12.58	31.43
^{a}Energy (KJ/100g)	1830.05	1499.86	1665.31	1314.68	3654.89

All values are the mean ± standard deviation of three determinations expressed in dry weight basis; *Calculated fatty acids; ^{a}Calculated metabolizable energy; SD = Standard Deviation; CV = Coefficient of Variation.

Table 2: Antinutritional composition of *Vigna subteranea* L. and *Sesamum indicum* L.

Parameters	*Vigna subteranea L*	*Sesamum indicum L*	Mean	SD	CV
Oxalate (%)	4.36±0.63	1.29±0.04	11.64	2.18	18.72
Saponins (%)	0.24±0.02	0.62±0.02	0.43	0.27	62.79
Alkaloids (%)	6.35±0.07	0.62±0.02	3.49	2.57	73.64
Flavonoids (%)	6.35±0.04	2.71±0.20	4.53	2.55	29.02
Tannins (mg/100g)	14.91±0.13	8.91±0.09	11.91	4.42	59.93
Cyanide (mg/100g)	0.61±0.34	0.23±0.03	0.42	0.27	64.29
Phytate (mg/100g)	188.74±0.72	186.77±0.80	187.76	1.39	0.74
Total Phenol (%)	0.51±0.02	0.71±0.02	0.61	0.14	22.95

SD = Standard Deviation; CV = Coefficient of Variance.

metabolizable energy values are fairly high, suggesting that their energy concentration was preferable to that of various dietary grains [21, 22]. The findings, however, are consistent with those found for other legumes, including the red kidney bean (1678.4 kJ/100g) [23], the Bambara groundnut (1691.3 kJ/100g)[16], the Kersting's groundnut (1692.9 kJ/100g), and the cranberry beans (1651.7 kJ/100g). In terms of fatty acids, the coefficient of variation (CV%) ranges from 31.43 to 3654.89 in computed metabolizable energy.

Anti-nutrients are harmful compounds that impede the body's ability to absorb vital nutrients, particularly minerals, when ingested in food form. They also interfere with digestive processes. Since these anti-nutrients combine with minerals including iron, zinc, and calcium, they primarily damage minerals [24, 25]. Anti-nutrients thus have the adverse effect of lowering food intake and/or decreasing the effective utilisation of nutrients, which in turn lowers their bioavailability [26]. Amino acid bioavailability can be impacted by anti-nutrients by up to 50% [25].

Table 2 gives the obtained analytical data of the anti-nutrient composition of the seeds of Bambara groundnut and sesame with observable differences within the spread. The phytate content of Bambara groundnut value (mg/100g) 188.74 (Figure 3). When Bambara groundnut was purchased from AlGenina market in the Western States of Sudan, a high value of 1478.15 mg/100 g was reported by Mazahib *et al.* [27]; similarly, when bambara groundnut was purchased from Ogige market, Nsukka, located in Enugu State, Nigeria, a high value of 255 mg/100 g was reported by Okafor *et al.* [28]. Phytate (188.74 mg/100g), tannins (14.91 mg/100g), flavonoids (6.35%), alkaloid (6.35%) and oxalate (4.36%) for Bambara groundnut gives superior values when compared with the data published by Aliyu *et al.* [1] on similar antinutritional parameters, but lower than the values of Bambara groundnut present by Ndidi *et al.* [6]. Comparing between the two samples, Bambara groundnut gives higher scores than those observed of sesame seeds. The values of sesame in this work for Phytate, oxalate, tannin are in agreement to the work of Okudu *et al.* [16]. Conclusively, the results from the finding are valid and give amplitude to the nutritional significance of the samples. High values of SD give rise to the variation observed in the data analysis.

Table 3 displays the results of the amino acid content of sesame and bambara groundnut. The non-essential amino acid with the highest concentration in both samples was glutamic acid (18.31 and 18.67 g/100 g crude protein, cp). The values found in this report for both samples are greater than the glu content of a few plant foods found in Nigeria [29–31], including *Sphenostylis stenocarpa* (7.45 g/100 g cp) reported by Oshodi [31], *Cajanus cajan* (8.40 g/100 g cp), *Phaseolus lunatus* (7.45 g/100 g cp), and *luffa* cylindrical kernel (13.0 g/100 g cp) [29], *Anarcadium occidentalis* protein (13.6 g/100 g cp) [30], *Cajanus cajan* (8.40 g/100 g cp), and *Phaseolus lunatus* (7.45 g/100 g cp) [31]. Comparable, however, to *Cyperus esculentus* (19.7 g/100 g cp) [22] and *Glycine max* (16.25 g/100 g g cp) [32]. Tryptophan (1.36 g/100 g cp) in sesame and cysteine (0.60 g/100 g cp) in *Vigna subterranea* (Bambara) are the least amount of amino acids, respectively. The most prevalent essential amino acid in both samples was leucine (Leu), with 7.38 and 7.55 g/100 g cp for sesame and Bambara groundnut, respectively. Leucine is said to play a key role in blood sugar regulation by

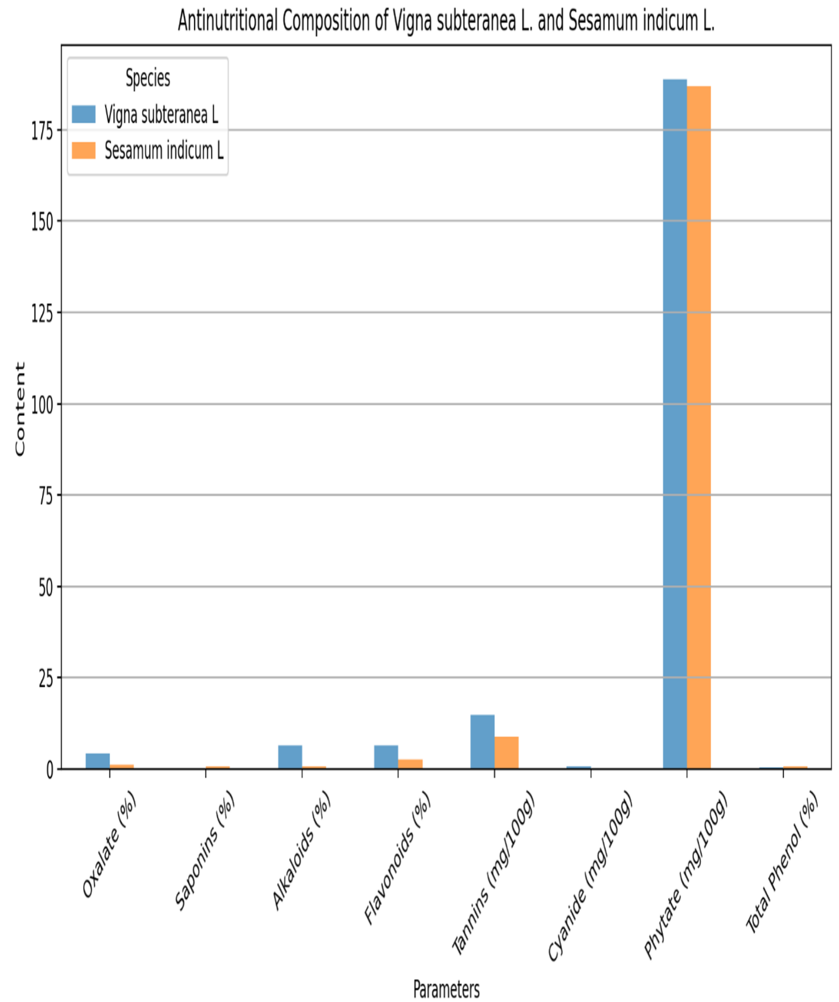

Figure 3: A bar chart showing the Antinutritional Composition of *Vigna subteranea* L. and *Sesamum indicum* L.

enhancing insulin sensitivity and facilitating glucose uptake in bodily cells, in addition to helping to maintain and grow muscle [33]. Leucine is equally important for amino acids' ability to spare proteins. Despite being prone to processing degradation, for sesame and Bambara groundnut, respectively, lysine was found in both samples at suitable levels of 4.61 and 3.11 g/100g cp, which are close to that reported by Aremu *et al.* [33]. Lysine is an important ingredient in the body anabolic activities and is important for hormone production, calcium absorption and retention, and a reduction in serum triglyceride levels, lysine is critical for osteogenesis.

The consistent superior result in analytical values of Bambara groundnut, present it, as a good nutritional source of food above sesame. This, however proven that sesame seed have appreciable values of essential nutrients fits for nutritional importance. Other non-essential amino acids of appreciable concentration include aspartic acid with values of 8.21 g/100g cp and 7.25 g/100g cp, for Bambara groundnut and sesame respectively. Arginine in Bambara groundnut (11.30 g/100g crude protein, cp) is twice higher than the data obtain for sesame (5.61 g/100g crude protein, cp). The SD shows a consistent agreement of no deviation from the mean of the data set except for arginine (4.02%). The determined isoelectric point (ρl) showed variation from 4.41 to 5.65. In order to facilitate the rapid precipitation of protein isolate from biological materials, this value can be used to forecast the ρl for proteins [12]. One of the quality metrics for evaluating proteins is the projected protein efficiency ratio (P–PER) [34]. Although the P-PER for Bambara groundnut (2.62) is higher than that of sesame (2.58), it is still comparable to the P-PER values reported for *Haematostaphis barteri* (1.37) [20], *Phaseolus coccineus* (1.91) [34], Lathyrus sativus L. (1.03) [35], but it is in line with those for *Phaseolus vulgaris*, *Prosopis africana* and *Cyperus esculentus* respectively. Ghafoorunisa and Narasinga [36], in their observations on chemical, biochemical and pathological research carried out on humans and lab animals revealed that a diet high in leucine damages the body's ability to metabolise tryptophan and niacin, which is why sorghum eaters have niacin deficit. It has also been discovered that high leucine contributes to maize's pellagra genic qualities [37]. Studies have indicated that a diet high in leucine alone may not be as essential as a diet high in isoleucine [21]. The samples have low Leu/Ile ratios (1.95 – 2.09).

Table 3: Amino acid profile of *Sesamum indicum* L. and *Vigna subteranea* L.

Parameters	*Vigna subteranea L.*	*Sesamum indicum L.*	Mean	SD	CV%
Leucine[e]	7.38	7.55	7.47	0.12	1.61
Lysine[e]	4.61	3.11	3.86	1.06	27.46
Isoleucine[e]	3.79	3.61	3.70	0.13	3.51
Phenylalanine[e]	5.16	4.20	4.68	0.68	14.53
Tryptophan[e]	1.32	1.36	1.34	0.03	2.24
Valine[e]	5.21	4.56	4.89	0.46	9.41
Methionine[e]	2.27	3.06	2.67	0.56	20.97
Proline[e]	3.30	3.09	3.20	0.15	4.69
Arginine	11.30	5.61	8.46	4.02	47.55
Tyrosine	2.47	3.64	3.06	0.83	27.12
Histidine[e]	2.89	2.86	2.89	0.02	0.69
Cystine	0.60	2.11	1.36	1.07	78.68
Alanine	4.88	7.30	6.09	1.71	28.09
Glutamic acid	18.31	18.67	18.49	0.25	1.35
Glycine	5.06	3.68	4.37	0.98	19.10
Threonine[e]	3.86	3.22	3.54	0.45	12.53
Serine	4.23	4.59	4.41	0.25	19.45
Aspartic acid	8.21	7.25	7.73	0.71	59.75
Isoelectric point	5.65	4.41	5.03	0.88	5.74
P–PER	2.62	2.58	2.60	0.50	2.58
Leu/Ile	1.95	2.09	2.02	0.92	0.46

[e] = Essential amino.

Table 4: Concentrations of essential, non-essential, neutral, sulphur, aromatics, etc of *Sesamum indicum* L. and *Vigna subteranea* L.

Amino Acid Description	*Vigna subteranea* L.	*Sesamum indicum* L.	Mean	SD	CV%
Total amino acid (TAA)	94.85	89.47	792.16	3.80	4.12
Total non-essential amino acid	46.03	50.30	48.17	3.02	6.27
%TNEAA	48.53	56.23	52.38	5.44	10.39
TEAA with Histidine	48.82	39.17	43.99	06.48	15.50
Without Histidine	45.93	36.31	41.12	06.80	16.53
%TEAA with Histidine	51.47	43.78	47.63	5.44	11.42
without Histidine	48.42	40.58	44.50	5.54	12.45
Essential aliphatic amino acid	34.41	34.51	34.46	0.07	0.20
Essential aromatic amino acid	15.14	15.15	15.15	0.01	0.07
Total neutral amino acid	49.53	51.97	50.75	1.73	3.41
%TNAA	52.23	58.09	55.16	4.14	7.51
Total acidic amino acid	26.52	25.92	26.22	0.42	1.60
%TAAA	27.96	28.97	28.47	0.71	2.49
Total basic amino acid	18.80	11.58	15.19	5.11	33.64
%TBAA	19.82	12.94	16.38	4.48	29.67
Total sulphur amino acid	2.87	5.17	4.02	1.63	40.55
%cystine in TSAA	20.90	40.81	30.86	14.10	45.69

SD = Standard Deviation; CV = Coefficient of Variation.

The results are shown for each class of amino acid in Table 4. Much of a protein's nutritional worth is determined by how well it meets demands for essential amino acids and nitrogen [31]. Total amino acids (TAA) were 89.47 and 94.85 g/100 g cp for both samples (CV% = 4.12). The total amino acid content of Bambara groundnut (94.85 g/100 g cp) in this study was found to be higher than the 72.52 and 87.57 g/100 g cp for steam Bambara groundnut paste (SBGM) and steam Bambara groundnut paste (SBGJ) reported by Aremu *et al.* [3]. For sesame, the total sulphur amino acids (TSAA) and total essential amino acids (TEAA), which include histidine, were 39.17 and 5.17 g/100 g cp and 48.82 and 2.87 g/100 g cp, for Bambara groundnut respectively.

The percentage of total equivalent amino acids (TEAA) containing histidine was 51.47% for Bambara, 43.78% for sesame, and 48.42% for Bambara, 36.31% for sesame. The proportion of essential amino acids to non-essential amino acids in Bambara and sesame, respectively, was 1.06 and 0.77, respectively, meeting the FAO/WHO reference values of 40% and 0.6% (FAO/WHO 1998)

Table 5: Essential amino acid composition and scoring pattern for *Vigna subteranea* L. and *Sesamum indicum* L.

EAA	PAAESP g/100g protein	*Vigna subteranea* L. EAAC	*Vigna subteranea* L. AAS	*Sesamum indicum* L. EAAC	*Sesamum indicum* L. AAS
Ile	4.0	3.76	0.9	3.61	0.90
Leu	7.0	7.70	1.05	7.55	1.08
Lys	5.5	4.61	0.84	3.11	0.57
Met + cys (TSAA)	3.5	2.87	0.82	5.71	1.48
Phe + Tyr	6.0	7.63	1.27	7.84	1.31
Thr	4.0	3.86	0.97	3.22	0.81
Try	1.0	1.32	1.32	1.36	1.36
Val	5.0	5.21	1.04	4.56	0.91
Total	36.0	36.64	8.25	39.96	8.42

EAA =Essential Amino Acid; PAAESP = Provisional Amino Acid (Egg) Scoring Pattern; EAAC = Essential Amino Acid Composition; AAS = Amino Acid Score.

[38]. The hydrophobic portion of protein, comprising essential aliphatic amino acids (EAAA) Ile, Leu, and Val, was shown to be somewhat greater in sesame (34.51 g/100 g cp) and Bambara groundnut (34.41 g/100 g cp). It was discovered that the essential aromatic amino acid (EArAA) value fell between 15.15 and 15.14 g/100 g, respectively. The ranges for the percentages of TNAA, TAAA, and TBAA in the two samples are 52.23-58.09%, 27.96–28.97%, and 19.82–12.95%, respectively. The results attempt to predict that the samples are acidic in nature and in agreement with Balarabe *et al.* [1].

Based on the tentative amino acid scoring pattern [11], Table 5 displays the samples' EAA scores. The dietary formula based on this analysis indicated that all the analyzed samples will need to have some necessary amino acid supplements, like Lys and Ile. Ile, Lys, and Met + Cys for Bambara groundnut and Val for sesame were the limiting AAs. Every other amino acid score obtained from the different seed samples falls within the FAO/WHO provisional pattern reference criteria.

The study's findings emphasize Bambara groundnut's dual role as a source of protein and energy and its potential to mitigate protein-energy malnutrition [39, 40]. Sesame, on the other hand, stands out for its carbohydrate-rich profile, which is critical for quick energy release [41–44]. Unique to this study is the relatively low ash and fatty acid content of sesame, contrary to higher values often reported in other regions, which underscores the impact of environmental and agronomic factors. The distinct differences in anti-nutritional factors between the two seeds call for tailored processing techniques. For example, the higher phytate and oxalate levels in Bambara groundnut require more extensive processing, such as soaking, fermentation, and enzymatic treatments, to improve mineral absorption and protein digestibility. In contrast, sesame's lower anti-nutritional factor levels allow for simpler processing methods. Together, these findings underscore the importance of tailored processing and optimized agricultural practices in maximizing the nutritional benefits of these seeds to address global dietary challenges.

4. Conclusion

The results of this study showed the proximate, amino acid, and anti-nutrient compositions of two common plants found in Lafia, Nasarawa State, Nigeria: sesame (*Sesamum indicum* L.) and Bambara groundnut (*Vigna subteranea* L.). Both samples included acceptable levels of essential amino acids, moderate amounts of protein, and fat—all vital nutrients for developing children and nursing moms. Incorporation of the seeds into diets has the capacity of enhancing its health applications due to the presence of some important nutrients containing health-protecting and disease-preventing abilities. Hence, it's recommended for its usage as a good source of nutrients. The results of this study add to the increasing amount of information about the nutrition of these seeds in the larger context of sustainable and health-conscious eating choices. Future research might focus on particular bioactive chemicals. While this study provides valuable insights into the nutritional and anti-nutritional properties of *Sesamum indicum* L. and *Vigna subterranea* L., it has several limitations that should guide future research. First, the analysis was limited to proximate composition, amino acid profile, and anti-nutritional factors, overlooking bioavailability studies assessing nutrient absorption and utilization. Additionally, the study did not consider the influence of environmental factors, such as soil quality and climate, which can significantly affect nutrient content. The research also relied on chemical methods that may not fully mimic in vivo conditions, leaving gaps in understanding the physiological impacts of these seeds when consumed. Moreover, functional properties like digestibility, protein solubility, and thermal stability were not explored, which are crucial for food application. Future studies should include advanced techniques, such as metabolomics and bio-accessibility assays, to provide a more comprehensive understanding of these underutilized legumes.

Data availability

The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

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