# Amino Acid Content Analysis of Four Varieties of African Yam Bean at Afikpo Town of Ebonyi State in Nigeria

Peter Anyigor Okorie

Lecturer, Department of Food Science and Technology, Ebonyi State University, Abakaliki, Nigeria
paokorie@yahoo.com

## ABSTRACT

The amino acid content analysis of white, brown, spotted and black coat coloured African yam bean varieties that are cultivated in the Afikpo town of Ebonyi State in Nigeria was determined in this study. The results showed that methionine and cystine were low among the varieties of the African yam bean, with the values of 1.14 % and 1.09 % respectively for the spotted variety.

The most of the essential amino acid, especially lysine and methionine levels in the African yam bean are higher than some other legumes like pigeon pea, cowpea, bambara groundnut and soybean. The brown variety had the lowest histidine content while the black variety had the highest content of histidine. Alanine was lowest and highest in the brown and black varieties with 3.19 % and 4.14 % values. The total non-essential amino acid ranged from 40.3 g/100cp to 41.9 g/100cp with a significant difference among the varieties. The findings suggest that the African yam bean is essential for adequate functioning of the human body, because it contains the required proportion of amino acid needed for in the human body.

**Keywords/ Index Term**— Amino acids, African yam bean, Yam bean analysis, Afikpo-indigenous yam bean.

## 1. INTRODUCTION

African yam bean (sphenostylis stenocarpa) is among the most common legumes found in tropical regions of the world. It is one of the lesser known legumes that is now coming into prominence in nutritional and agronomic research as an emerging food legume [1]. The nutritional quality of the grains and tubers of the African yam bean is immense. The protein content in both the tuber and seed is comparatively higher than what is obtainable in most tuberous legumes [2]. The relevance of the African yam bean in human nutrition has attracted numerous research attention [3-15]. Onyenekwe et al. [16] stated that the proportion of the essential amino acid in the protein of African yam bean is over 32 % with cystine and leucine being predominant. The amino acid spectrum indicated that the most essential amino acid, especially lysine and methionine levels is higher in African yam bean than those in other legumes including soybean [17].

Nwodo and Nwinyi conducted proximate analyses of African yam beans that are consumed in Eastern Nigeria. The results showed that the African yam beans contained 1.96± 0.02 % moisture, 37.21±0.02 % proteins, 9.49±0.02 % fat, 5.35±0.02 % Ash, 3.55±0.02 % crude fibre and 44.4±0.02 % total carbohydrates. The bean has high protein content. The findings indicated that the African yam bean is an important food sources that can be exploited, particularly in the developing countries where there is shortage of animal protein and under nutrition facing many families.

Ojuederie and Balogun [19] examine the genetic variability in the mineral and proximate compositions of four accessions of African yam bean. Crude protein in the African yam bean ranged from 15.1 % to 15.9 %. Magnesium and potassium were prominent in the yam bean 166.7 mg $100g^{-1}$ and 1010.1 mg $100g^{-1}$ respectively. The findings showed that African yam

  

bean could be used as an alternative source of protein, energy and food supplement for human and livestock nutrition.

Inyang et al. [20] evaluated the effect of steeping time in 0.50 % solution of unripe plantain peel ash prior to autoclaving on the amino acids of African yam bean flour. The results showed that the total amino acids and total essential amino acids increased from 75.52 g/100 g and 30.07 g/100g in the flour from unsteeped seeds to 80.29 g/100g and 32.87 g/100g respectively in the flour from the seeds that were steeped for 72 hours.

Although researchers have carried out studies on African yam bean in the past, there is little literature on the chemical composition of the African yam bean that is grown in Afikpo, Ebonyi State, Nigeria. Therefore, the present study seeks to determine the amino acid content of four varieties of African yam bean that are cultivated in the Afikpo town of Ebonyi State, Nigeria.

## 2. MATERIALS AND METHODS

The four varieties, namely: white, brown, spotted and black of African yam bean that were used in this study were purchased from a farmer in Afikpo north local government area of Ebonyi State in Nigeria. The yam bean samples were prepared according to the method described by Eneche [21]. 2 g of the samples that were free from foreign particles such as stones, leaves and sticks as damaged and contaminated seeds was weighed and milled with a locally fabricated attrition mill to obtain fine flour. The samples flour produced was packaged in sealed polyethylene bags for analysis. The dried samples, ground to pass through a 1 mm mesh sieve were transferred into a crucible and ashed in a muffle furnace at 500 ℃ for 3 hours. The crucibles were removed after the ashing. After cooling, 10 ml of 2M hydrochloric acid was added and heated directly until boiling. The contents in each crucible were transferred into 50 ml volumetric flask and then diluted to 50 ml.

The Amino acid profile in the known sample was determined using methods described by Nwosu et al. [22]. The known sample was dried to constant weight, defatted using chloroform/methanol mixture of ratio 2:1, hydrolyzed, evaporated in a rotary evaporator and loaded into the Technicon sequential Multi sample Amino Acid Analyzer (TSM). About 4g of the sample was put in extraction thimble and extracted for 15 hours in soxhlet extraction apparatus.

200 mg of ground sample was weighed, wrapped in Whatman filter paper number 1 and put in the Kjeldhal digestion flask to determine the nitrogen content. Concentrated sulphuric acid (10 ml) was added. Catalyst mixture (0.5 g) containing sodium sulphate ($Na_2SO_4$) in the ratio of 10:5:1 was added into the flask to facilitate digestion. Four pieces of anti-bumping granules were added. The flask was then put in Kjeldhal digestion apparatus for 3 hours until the liquid turned light green. The sample was cooled and diluted with distilled water to 100 ml in standard volumetric flask. Aliquot (10 ml) of the diluted solution with of 45 % sodium hydroxide was put in 10 ml of 2 % boric acid containing 4 drops of bromocresol green/methyl red indicator until about 70 ml of distillate was collected.

A known weight of the defeated sample was weighed into glass ampoule. 7 ml of HCL was added and oxygen was expelled by passing nitrogen into the ampoule to avoid possible oxidation of some amino acids during hydrolysis. The glass ampoule was then sealed with Bunsen burner flame and put in an oven preset at 105 ℃ ± 5 ℃ for 22 hours. The ampoule was allowed to cool before breaking open at the tip and the content was filtered. The filtrate was then evaporated to dryness at 40 ℃ under vacuum in a rotary evaporator. The residue was dissolved with 5 ml to acetate buffer (pH 2.0) and stored in plastic specimen bottles, which were kept in the freezer.

## 3. RESULTS AND DISCUSSION

The results of the amino acid composition of the African yam bean are presented in Table 1. Methionine and cystine were low among the varieties of the African yam bean; the spotted variety had the least value of 1.14 % and 1.09 % respectively. On the same note, lysine, aspartic acid, glutamic acid and leucine contents were high among the varieties of the African yam bean. White variety had the highest value of 13.48 % for glutamic acid and 7.48 % for leucine among the varieties. The analysis of lysine content showed there was a significant difference in the mean values of the four varieties of the yam bean. The amino acid spectrum indicated that most of the

  

essential amino acid, especially lysine and methionine levels in the African yam bean are higher than some other legumes like pigeon pea, cowpea and bambara groundnut [23], including soybean [17]. The values obtained for lysine, threonine and proline in all varieties were comparable to the submission of Ekop [24] for African yam bean.

Table - 1: Amino acid composition of four varieties of African yam bean

| Amino acids | White variety (%) | Brown variety (%) | Spotted variety (%) | Black variety (%) |
|---|---|---|---|---|
| Lysine | 6.37±0.01$^{b}$ | 6.21±0.01$^{c}$ | 6.75±0.01$^{a}$ | 6.60±0.01$^{a}$ |
| Histidine | 2.87±0.01$^{c}$ | 2.64±0.01$^{d}$ | 3.03±0.00$^{b}$ | 3.17±0.01$^{a}$ |
| Arginine | 6.04±0.01$^{c}$ | 6.47±0.01$^{a}$ | 5.87±0.01$^{d}$ | 6.30±0.01$^{d}$ |
| Aspartic acid | 8.84±0.01$^{d}$ | 9.55±0.01$^{a}$ | 9.00±0.01$^{c}$ | 9.53±0.01$^{b}$ |
| Threonine | 3.14±0.01$^{d}$ | 4.00±0.01$^{a}$ | 3.50±0.01$^{b}$ | 3.29±0.01$^{c}$ |
| Serine | 3.61±0.01$^{b}$ | 3.90±0.01$^{a}$ | 3.20±0.01$^{c}$ | 3.00±0.02$^{d}$ |
| Glutamic acid | 13.48±0.01$^{a}$ | 12.19±0.01$^{d}$ | 12.65±0.01$^{c}$ | 13.36±0.01$^{b}$ |
| Proline | 2.01±0.01$^{d}$ | 3.46±0.01$^{a}$ | 3.25±0.01$^{b}$ | 3.13±0.01$^{c}$ |
| Glycine | 4.15±0.01$^{a}$ | 3.57±0.01$^{c}$ | 3.58±0.01$^{c}$ | 3.89±0.01$^{b}$ |
| Cystine | 1.25±1.01$^{b}$ | 1.32±0.01$^{a}$ | 1.09±0.01$^{c}$ | 1.24±0.01$^{b}$ |
| Alanine | 3.42±0.01$^{c}$ | 3.19±0.01$^{d}$ | 4.02±0.01$^{b}$ | 4.14±0.01$^{a}$ |
| Valine | 4.63±0.01$^{a}$ | 3.61±0.01$^{d}$ | 3.88±0.01$^{c}$ | 4.20±0.01$^{b}$ |
| Methionine | 1.27±0.01$^{a}$ | 1.16±0.03$^{c}$ | 1.14±0.01$^{c}$ | 1.23±0.01$^{b}$ |
| Isoleucine | 4.18±0.01$^{a}$ | 3.23±0.01$^{c}$ | 3.48±0.01$^{b}$ | 3.26±0.01$^{c}$ |
| Leucine | 7.48±0.01$^{a}$ | 6.44±0.01$^{d}$ | 6.82±0.01$^{c}$ | 7.28±0.01$^{b}$ |
| Tryosine | 3.49±0.01$^{b}$ | 3.17±0.01$^{c}$ | 3.49±0.01$^{b}$ | 3.56±0.01$^{a}$ |
| Pheylalanine | 5.06±0.01$^{a}$ | 4.05±0.01$^{d}$ | 4.30±0.01$^{c}$ | 4.93±0.01$^{b}$ |

Values with the same superscript in the same row are not significantly different ($p<0.05$)

The histidine content ranged from 2.64 % to 3.17 %. The brown variety had the lowest histidine content while the black variety had the highest content of histidine. According to Okaka et al. [25], the high histidine in African yam beans makes it better source for infants in preparing weaning foods.

Arginine had a minimum value as 5.87 % in spotted variety and maximum of 6.47 % in brown variety with a significant difference among the varieties. The African yam bean compares well with some other tropical legumes in terms of arginine. This basic amino acid is used in muscle contraction and in the control of cartilage [24].

Aspartic acid content was found to be high in all the samples examined. The values ranged from 8.84 % in white variety to 9.55 % in brown variety with a significant difference among the varieties. The percentage values of Aspartic acid corresponded to the range of 7.41 % to 10.0 % reported by Oshodi et al. [12] for some varieties of African yam bean.

Alanine was lowest in brown variety (3.19 %) and highest in black variety (4.14 %) with a significant difference among the four varieties. It is a factor in regulating the adrenal glands, ensuring healthy skin, particularly the scalp [26]. Valine ranged from 3.61 % to 4.63 % in brown and white varieties respectively, with a significant difference among the varieties. The tyrosine content ranged from 3.17 % to 3.56 %. The brown and white varieties had the lowest and highest tyrosine content respectively. Values obtained for phenylalanine content ranged from 4.05 % to 5.06 % in brown and white varieties respectively. Values obtained in valine, tyrosine and phenylalanine are relatively close to that obtained by Adeyeye [27] for groundnuts.

Amino acids are important components for healing and protein synthesis processes: any deficiency in these essential components will hinder the recovery process [28]. According to Whittle et al. [29], glycine together with other essential amino acids forms a polypeptide that promotes growth and tissue healing. The amino acid composition of African yam bean is consistent with that previously reported by other researchers [30]. It contains all the essential amino acids in good proportion [31].

The concentration of total, essential, non-essential, acidic, neutral sulphur aromatic and basic amino acid of African yam bean is presented in Table 2.

Table - 2: Concentration of amino acid (g/100 g crude protein) of African yam bean samples

| Amino acids | White variety | Brown variety | Spotted variety | Black variety |
|---|---|---|---|---|
| Total Amino Acid (TAA) | 81.3±0.1$^{b}$ | 78.2±0.1$^{d}$ | 79.1±0.1$^{c}$ | 82.1± 0.1$^{a}$ |
| Total Non-Essential Amino Acid (TNEAA) | 40.3±0.1$^{a}$ | 40.4±0.1$^{b}$ | 40.3±0.1$^{b}$ | 41.9±0.1$^{a}$ |
| Total essential amino acid with histidine | 40.7±0.7$^{a}$ | 37.8 ±0.1$^{c}$ | 38.8±0.1$^{b}$ | 40.3±0.1$^{a}$ |
| Total essential amino acid without histidine | 38.1±0.1$^{a}$ | 35.2±0.1$^{d}$ | 35.7±0.1$^{c}$ | 37.0±0.1$^{a}$ |
| %TNAA | 49.5±0.1$^{c}$ | 51.6±0.1$^{a}$ | 51.0± 0.1$^{b}$ | 51.0±0.1$^{b}$ |
| %TEAA with Histidine | 50.5±0.1$^{a}$ | 48.4±0.1$^{c}$ | 49.0±0.1$^{b}$ | 49.0±0.1$^{b}$ |
| %TEAA without histidine | 47.0±0.1$^{a}$ | 45.0±0.1$^{c}$ | 45.1±0.1$^{c}$ | 45.2±0.1$^{b}$ |
| Total Neutral Amino Acid(TNAA) | 43.7±0.1$^{a}$ | 41.1±0.1$^{d}$ | 41.7±0.1$^{c}$ | 43.2±0.1$^{b}$ |
| %TNAA | 53.8±0.1$^{a}$ | 52.6±0.1$^{c}$ | 52.8±0.1$^{b}$ | 52.6±0.1$^{c}$ |
| Total Acidic Amino Acid (TAAA) | 22.3±0.01$^{b}$ | 21.7±0.1$^{c}$ | 21.7±0.1$^{c}$ | 27.9±0.1$^{a}$ |
| %TAAA | 27.5±0.1$^{b}$ | 27.8±0.1$^{c}$ | 27.4±0.1$^{b}$ | 27.9±0.1$^{a}$ |
| Total Basic Amino Acid (TBAA) | 15.3± 0.1$^{c}$ | 15.3±0.1$^{c}$ | 15.7±0.1$^{b}$ | 16.1±0.1$^{a}$ |
| %TBAA | 18.8±0.1$^{c}$ | 19.6±0.1$^{b}$ | 19.8±0.1$^{a}$ | 19.6±0.1$^{b}$ |
| Total Sulphur Amino Acid (TSAA) | 2.5±0.1$^{a}$ | 2.5±0.1$^{a}$ | 2.3±0.1$^{a}$ | 2.5±0.1$^{a}$ |
| %TSAA | 3.2±0.1$^{a}$ | 3.2±0.1$^{a}$ | 2.8±0.1$^{c}$ | 3.0±0.1$^{b}$ |
| %Cystine | 49.6±0.1$^{c}$ | 52.6±0.1$^{a}$ | 48.9±0.1$^{d}$ | 50.2±0.1$^{b}$ |
| Total Aromatic Amino Acid (TAr AA) | 8.6±0.1$^{b}$ | 7.2±0.1$^{c}$ | 8.6±0.1$^{b}$ | 10.5±0.1$^{a}$ |
| %TArAA | 10.5±0.1$^{a}$ | 9.2±0.1$^{c}$ | 9.2±0.1$^{c}$ | 10.3±0.1$^{b}$ |

Values with the same superscript in the same row are not significantly different ($p<0.05$)

  

The content of Total Essential Amino Acid (TEAA) with histdine ranged from 37.8 g/100cp to 40.7 g/100cp in brown and white varieties respectively. The TEAA without histidine amounted to 35.2 g/100cp and 38.1 g/100cp. There were significant differences in the mean value of the African yam bean for the content of histidine. The percentage ratios of TEAA to Total Amino Acid (TAA) in the four varieties of the African yam bean ranged between 48.4 g/100cp to 50.5 g/100cp, which were well above the 39 g/100cp considered to be adequate for ideal protein food for infants, 26 g/100cp for children and 11 g/100cp for adults [32].

Total Non-Essential Amino Acid (TNEAA) ranged from 40.3 g/100cp to 41.9 g/100cp with a significant difference among the varieties. The white and spotted varieties were lower in TNEAA, while the black variety had the highest content. The percentage TNEAA values were between 49.5 g/100cp in white variety and 51.6 g/100cp in brown variety with a significant difference among the varieties. Total Neutral Amino Acid (TNAA) had the minimum value of 41.1 g/100cp in brown variety and maximum value of 43.7 g/100cp in the white variety with significant differences among the samples. The value of percentage TNAA ranged from 52.6 g/100cp to 53.9 g/100cp with a significant difference among the varieties.

Total Acidic Amino Acid (TAAA) includes aspartic acid and glutamic acid, which had values of 21.7 g/100cp to 22.9 g/100cp with a significant difference among the varieties, On the other hand, the percentage TAAA ranged from 27.4 g/100cp to 27.9 g/100cp in spotted and black varieties respectively.

Total Basic Amino Acid (TBAA) comprises of histidine, lysine and arginine. This ranged from 15.3 g/100cp to 16.1 g/100cp, while the percentage TBAA fell within the range of 18.8 g/100cp to 19.8 g/100cp with a significant difference among the varieties.

The ratio of Total Sulphur Amino Acid (TSAA) and percentage TSAA were 2.3 g/100cp to 2.5 g/100cp and 2.8 g/100cp to 3.2 g/100cp respectively. Methionine and cystine were the amino acids that made up TSAA. These amino acids were the limiting amino acids in African yam bean [33].

Total Aromatic Amino Acid (TArAA) comprises of phenylalanine and tyrosine. The value of TArAA ranged from 7.2 g/100cp to 10.5 g/100cp in brown and black varieties respectively. They differed significantly among the mean values of the four varieties. The percentage TArAA ranged from 9.2 g/100cp to 10.5 g/100cp with significant difference as well.

## 4. CONCLUSIONS

The amino content analysis of four varieties of the African yam bean that are cultivated in the Afikpo town of Ebonyi State in Nigeria was carried out. The results showed that most of the essential amino acid, especially lysine and methionine levels in the African yam bean are higher than some other legumes like pigeon pea, cowpea, bambara groundnut and soybean. The findings indicate that the African yam bean is essential for adequate functioning of the human body, since it contains the required proportion of amino acid needed for human survival.

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