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Amino Acid Composition of Cassava Seed Protein Concentrate

Blessing K Gana[1*], Olufunmilayo H Akanya[2] and Evans C Egwim[2,3]

[1]*Department of Science Laboratory Technology, School of Applied Sciences, Federal Polytechnic Ile-Oluji, Nigeria.*

[2]*Department of Biochemistry, School of Life Sciences, Federal University of Technology, Minna, Nigeria.*

[3]*Global Institute of Bio-Exploration (GIBEX), Federal University of Technology, Minna, Nigeria.*

Corresponding Author: Blessing K Gana, Department of Science Laboratory Technology, School of Applied Sciences, Federal Polytechnic Ile-Oluji, Nigeria.

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Abstract

The aim of this study was to determine the amino acid composition of cassava seed protein concentrate. Preparation of the protein concentrate from defatted cassava seed flour was carried out by isoelectric precipitation extraction method. Amino acid analysis was carried out using automated amino acid analyzer. The amino acid score was calculated using WHO provisional scoring pattern for preschool children (1-2years). The obtained result showed that a total of 18 amino acids were identified in cassava seeds protein concentrate consisting of 9 essential amino acids and 9 non-essential amino acids. The total amino acid content was 79.88 ± 7.99 g/100g.Generally, glutamic acid (13.78 ± 2.15 g/100g) was the highest amino acid while tryptophan (0.83 ± 0.99 g/100g) was found to be the least amino acid. The concentration of the total non-essential amino acid was 48.75 ± 3.49 g/100g, for essential amino acids, the total essential amino acids was 29.76 ± 2.56 g/100g. The concentration of total sulphur-containing amino acid was 2.90 ± 0.85 g/100g while concentration of total aromatic amino acid was 7.22 ± 0.02 g/100g. Lysine was the limiting amino acid (amino acid score = 0.88). The findings suggest that cassava seed protein concentrate could be a rich source of amino acids for human and animal diet and could be incorporated into food therefore improving protein quality in diets and alleviating protein energy malnutrition.

Keywords: Cassava Seed, Protein Concentrate, Amino Acid, Amino Acid Score, Diet

1. Introduction

Cassava is a major staple food in developing world and many sub-Saharan African countries [1]. Cassava can be multiplied vegetatively from stem, meristem, leaf-bud and root-tip cuttings, or sexually from botanical seed [2]. Cassava seeds have been given less attention and are underutilized due to poor consumer awareness. However, they are good source of proteins thus; protein concentrates can be obtained from them. Protein concentrates are made from defatted protein-containing flour after non-protein dietary components are eliminated from food [3,4]. They are dietary supplements for humans and animals that are extracted or produced from plant or animal matter and have a high protein concentration. The Proteins in this form are required ingredients in many food processes because they improve nutritional quality without affecting other properties significantly, and in some cases, the addition of protein concentrate appears to extend final product shelf life [5]. In many developing countries, the supply of animal protein cannot adequately meet the protein needs of the rapidly growing population. Increase in cost of animal protein sources has accelerated research on potential utilization of alternative plant protein from locally available crops at a lower cost of production [6]. Since the values of cassava seeds are unknown, this research was carried out to investigate the potential of cassava seed protein concentrate as a food supplement through analysis of its amino acid profile.

2. Materials and Methods

2.1. Source of Material

Cassava seeds were purchased from IITA Ibadan, Oyo State, Nigeria.

2.2. Reagents and Chemicals

All chemicals and reagents used were of GPR grade (General Purpose Reagent).

2.3. Preparation of Seeds

Cassava seeds were weighed, cleaned, sorted to remove stones and extraneous materials. The seeds were oven dried at 450C until constant weight was obtained, then, they were cooled in a desiccator. Dried seeds were milled to powder using analytical mill (Cole Parmar, IL, USA) at high speed (20,000 rpm) and were stored in an air tight container for

further analysis.

2.4. Defatting of Cassava Seed Flour

The sample was defatted using petroleum ether. Exactly 4g of the sample was put in extraction thimble and extracted for 15 hours in Soxhlet extraction apparatus according to AOAC method (2006) [7].

2.5. Preparation of Protein Concentrate

Cassava seed protein concentrate (PC) was prepared by a method modified by [8]. One hundred grams of defatted flour was dispersed in 1 L distilled water to give final flour to water ratio of 1:10. The dispersion was then gently stirred on a magnetic stirrer for 10 min to form a suspension, after which the pH of the resultant slurry was adjusted with 1.0 M HCl to the point at which the protein was least soluble (pH 4; a value obtained from preliminary solubility results of the defatted flour) to precipitate the proteins. The precipitation process was allowed to proceed with gentle stirring for 4 h, keeping the pH constant. Soluble carbohydrates (oligosaccharides) and minerals was removed by centrifugation at 3500×g for 30 min. The precipitate (concentrate) was afterward washed twice with distilled water to remove the residual minerals and soluble carbohydrates and the pH was adjusted with 1.0 M NaOH to 7.0 for neutralization and then centrifuged at 3500×g for 10 min. The resultant precipitate (concentrate) was collected and dried in an oven at 45 °C for 8 h and kept for further analysis.

2.6. Amino Acid Determination

The Amino Acid profile in the known sample was determined using methods described by AOAC (2005) [9]. The known sample was dried to constant weight, defatted, hydrolyzed, evaporated in a rotary evaporator and loaded into the PTH Amino Acid Analyzer.

2.7. Determination of Essential Amino Acid Scores

The essential amino acid scores of cassava seed protein concentrates were calculated using the FAO/WHO (2007) provisional scoring pattern for preschool children (1-2years) as the ratio of the actual amount (mg) of each essential amino acid per gram of protein to the required amount (mg) of that essential amino acid per gram of a reference protein, as described by Nielsen (2001) [10].

3. Results and Discussion

3.1. Results

Amino Acid	Concentration (g/100g protein)
Alanine	5.38±0.08
Arginine	5.26±0.26
Aspartic Acid	9.40±0.44
Cystine	1.58±0.48
Glycine	3.67±0.48
Glutamic Acid	13.78±1.52
Histidine	2.21±0.04
Isoleucine	3.79±0.22
Leucine	6.57±0.44
Lysine	4.60±0.97
Methionine	1.32±0.12
Phenylalanine	3.46±0.09
Proline	4.23±0.77
Serine	3.92±0.30
Threonine	2.92±0.09
Tryptophan	0.83±0.07
Tyrosine	2.93±0.18
Valine	4.08±0.22

Table 1: Total Amino acid Composition of Cassava Seed Protein Concentrate

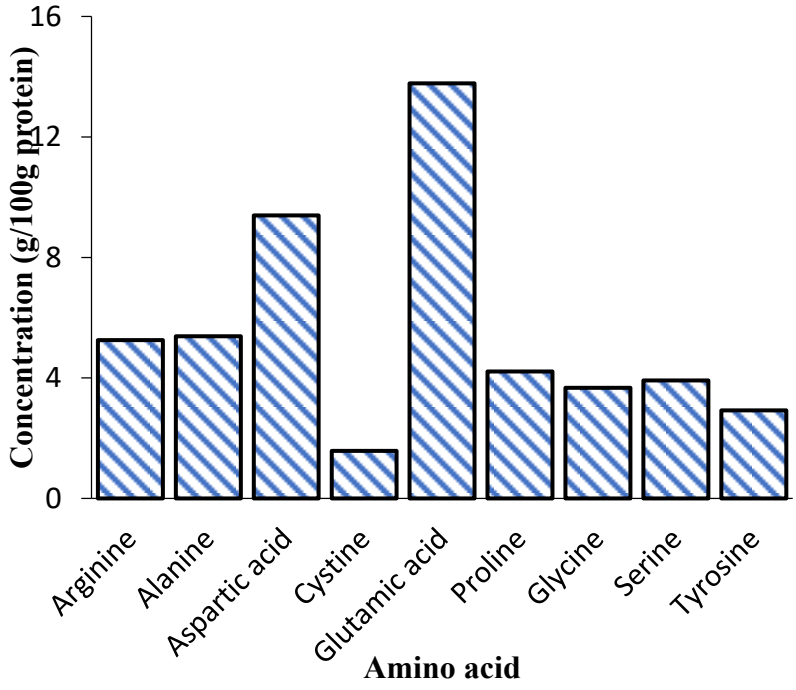

Figure 1: Non-essential Amino acid Composition of Cassava Seed Protein Concentrate

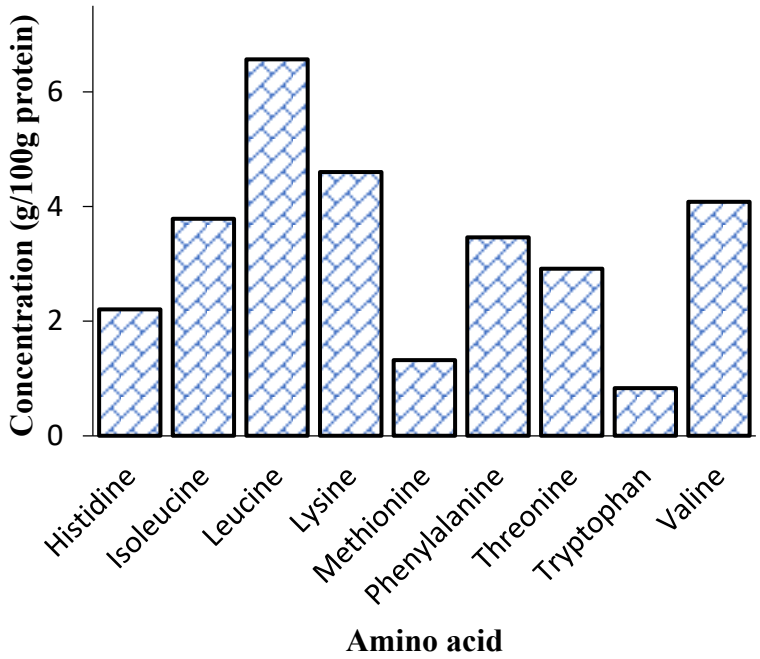

Figure 2: Essential Amino acid Composition of Cassava Seed Protein Concentrate

Essential Amino Acid	Concentration (g/100g protein)	FAO/WHO (2007) Pre-school(1-2years) in g/100g protein	**Amino acid score
Histidine	2.21	1.80	1.23
Isoleucine	3.79	3.10	1.22
Leucine	6.57	6.30	1.04
Lysine	4.60	5.20	*0.88

Methionine + Cysteine	2.90	2.50	1.16
Phenylalanine + Tyrosine	6.39	4.60	1.39
Threonine	2.92	2.70	1.08
Tryptophan	0.83	0.70	1.19
Valine	4.08	4.10	1.00
Total	34.29	31.0	

Table 2: Amino acid Score of Essential Amino acids in Cassava Seed Protein Concentrate

* Lysine is limiting amino acid (Amino acid score = 0.88)

**Calculated based on FAO/WHO (2007) [10]. Suggested Pattern of amino acid requirements for preschool children (Age 1-2 years)

4. Discussion

Amino acid composition of cassava seed protein concentrate (CSCP) is an important chemical property of proteins, as it determines the principal nutritional value of the protein concentrate. Cassava seed protein concentrate contains 18 out of 20 naturally occurring amino acids (Table 1), therefore, it can be a source of essential and non-essential amino acids (Figure 1 and Figure 2). The quality of a dietary protein is determined by how well it can supply the essential amino acids needed for tissue upkeep and growth, this is necessary since the body is unable to produce essential amino acids [11]. The total essential amino acids in CSCP (29.76 g/100g) (Figure 2) was found to meet the FAO/WHO (1991) requirements (23.20 g/100g) [12]. When comparing the amino acid composition of CSPC with the FAO/WHO (2007) recommended pattern, it appeared that the CSPC essential amino acids concentration are in agreement with the values recommended for a pre-school child (1-2 years old) (Table 2), therefore cassava seed protein concentrate contained sufficient amounts of essential amino acids needed to meet the essential amino acid requirement of preschool children. Furthermore, the concentrate can be a good source of leucine as this amino acid was found to be the highest essential amino acid in the concentrate. The limiting amino acid in the protein concentrate was found to be lysine with amino acid score of 0.88 (Table 2). This is in agreement with the findings which showed that lysine is generally low in cereal proteins and also, it is the limiting amino acids in most diets [13-16]. Lysine, in addition to being a protein building block, is a precursor for glutamate, an important signaling amino acid that regulates plant growth and responses to the environment. Lysine levels in plants are regulated by a variety of mechanisms, including intracellular compartmentalization of enzymes and metabolites, complex transcriptional and posttranscriptional controls of genes encoding enzymes involved in lysine metabolism during plant growth and development, and interactions between different metabolic fluxes [17].

Conclusion

Cassava seed protein concentrate contained appreciable amount of amino acids including essential and non-essential amino acids making it a potential good source of protein that could be used as food and food supplement to remedy protein energy malnutrition (PEM).

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This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Conflicts of Interest

The authors declare that there is no conflict of interest regarding the publication of this paper.

Data Availability

The authors confirm that the data supporting the findings of this study are available within the article.

Authors Contributions

Conceptualization, EEC.; Methodology BKG.; Validation, OAH.; Formal Analysis, BKG.; Investigation, BKG.; Resources, BKG.; Data Curation, BKG.; Writing Original Draft Preparation, BKG.; Writing-Review and Editing, OAH and EEC.; Supervision, OAH and EEC.; Project Administration, OAH.; Funding Acquisition, BKG. All authors have read and agreed to the published version.

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