Original Research Article

Changes in Amino Acid Profile of African Yam Bean (*Sphenostylis sternocarpa*): The Effect of Different Processing Methods.

ABSTRACT: The effect of different processing methods namely conventional cooking, microwave cooking and roasting compared with fresh samples on the amino acid profile to determine protein quality of *Sphenostylis sternocarpa* (African yam bean) flour was investigated. Results indicated that processing had various effects which were in this order: roasting > microwave cooking > conventional cooking. Total amino acid values were 78.25, 67.57, 72.25 and 80.0 g/100g protein for flour from raw, conventionally cooked, microwave cooked and roasted samples respectively. Essential amino acids namely valine, methionine and phenylalanine in both raw and processed samples were not sufficient to meet human nutritional needs based on FAO/WHO (1991) reference pattern for amino acids. The predicted protein efficiency ratio (P-PER) was 2.26 for flour from the raw sample while P-PER of flour from conventionally cooked, microwave cooked and roasted samples were 2.05, 2.19 and 2.31 respectively.

Keywords: African yam bean, Amino acids, processing, predicted protein efficiency ratio

1. INTRODUCTION

Leguminous seeds are good sources of plant proteins [1]. They are nutritious foods and a substitute for an animal protein which arises from the knowledge of the functional properties of the seed flour and other products [2]. Due to malnutrition in Africa as a result of insufficient animal protein, there is an intensive search for alternative sources of protein from minor proteins [3]. Their nutritional and functional properties dramatically affect the overall quality and its technological performance [4].

Foods are processed by various means to get them to a state the body can absorb nutrients maximally. For the legumes, they contain anti-nutritional factors like protease inhibitors, phytates, oxalates, saponins which inhibit or limit maximum absorption of amino acids from them. However, there is a remarkable improvement in the nutritive value and quality of legume seeds which have been achieved through dehulling, heat treatment, germination, fermentation, soaking and partial hydrolysis by proteolytic enzymes [5]. Heat treatments employed in food processing include roasting, grilling, boiling/cooking, microwave cooking, ohmic heating, baking, toasting, frying, etc. These processing methods may have the potentials of reducing antinutritional factors which interfere with protein digestibility and amino acid absorption. The reason stems from the fact that protein quality is defined by its amino acid composition and this influences nutrients derived from them [6].

Sphenostylis sternocarpa (African yam bean) is a legume found in the tropics. It is called ‘odudu’, ‘Ukpodudu’, ‘Okpodua’ [1], ‘Azuma’ by some Igbo clans 'Bebe' by the Yorubas and in Northern states of Nigeria 'Kashin kaji' [7]. It is a leguminous crop of the family Leguminosae and sub-family Papilionaceae [1,8]. It is a herbaceous climbing vine which produces ellipsoid, round or truncated seeds which vary in size and colour ranging from creamy-white or brownish yellow to dark brown [1]. This work was aimed at studying the changes effected by various heating methods on amino acid composition of *S. sternocarpa* seeds which were used in producing flour respectively.

2. MATERIALS AND METHODS

2.1 Sourcing and Preparation of Materials

Sphenostylis sternocarpa (African yam bean) seeds used for this study was purchased from Ohafia and Umuahia in Abia State, Nigeria. The seeds used was a mixture of coloured cultivars of brown, red and white. They were winnowed, and extraneous materials were removed. The cleaned seeds were divided into four portions of 150g each. Three out of the four portions were heat processed by conventional cooking for 120 minutes, microwave cooking (Sonic 5mw-70017, Japan) for 810 minutes and roasting at 150^0C for 20 minutes respectively. The fourth portion was raw, this was used as a control. After heat processing, the various samples, the conventionally cooked and microwave prepared samples were oven dried (Ocean Med., Mode DHG- 9053A, England) at 65^0C for 6h. The individual seed samples were milled and sieved to obtain flour samples. Powder (i.e flour) samples generated were microwave cooked, conventionally cooked, roasted and raw African yam bean flour. Amino acid compositions to determine protein quality of the respective powder samples were investigated.

2.2 Amino Acid Determination

Amino acid composition of the individual powder samples was determined by the method described by [9] using Ion Exchange chromatography (Technicon Sequential Multisample (TSM) amino acid analyser , Technicon Instruments Cooperation, New York, USA). Each flour sample was hydrolyzed while 10µl of the hydrolyzed sample was loaded into the TSM amino acid analyser. The analysis lasted for 76minutes. The net height of each peak produced by the chart record of TSM (each representing an amino acid) was measured and calculated. Norleucine was used as internal standard. Tryptophan was not determined. Amino acid values from the chromatogram peaks were calculated whereby the half height of each peak on the chart was found and width of the peak on the half height was accurately measured and recorded. Area of each peak was then obtained by multiplying the height by the width at the half height the Norleucine equivalent (NE) for each amino acid in the mixture.

$$NE = \frac{\text{Area of Norleucine Peak}}{\text{Area of each amino acid}}$$

A constant 'S' was calculated for each amino acid in the standard mixture as:

$$S_{std} = NE_{std} \times \text{molecular weight} \times \mu AA_{std}$$

The amount of each amino acid present in each sample was calculated in g/100g protein =

NH x W@ NH/2 x Sstd x C

$$C = \frac{\text{Dilution x 16}}{\text{Sample Wt(g) x N\% x 10 x Vol Loaded.}}$$

Where NH = Net Height

W = Width at half height

Nleu = Norleucine

2.3 Estimation of Amino Acid Score and Predicted Protein Efficiency Ratio (P-PER)

Amino acid score of each flour sample was determined based on whole Hen's egg [10]. In this method, essential amino acids were scored methionine + cysteine, and phenylalanine + tyrosine was taken as two distinct units. Amino acid scores (AMSS) were estimated by [11] formula:

$$\text{AMSS} = \frac{\text{mg of amino acid /g of test protein}}{\text{mg of amino acid /g of reference protein}} \times \frac{100}{1}$$

The predicted protein efficiency ratio (P-PER) was calculated from the amino acid composition using the equation developed by [12] stated thus:

P-PER = - 0.468 + 0.454 (Leu) - 0.105 (Tyr)

3. RESULTS AND DISCUSSION

The effect of different processing methods on amino acid composition of African yam bean flour (*Sphenostylis sternocarpa)* flour is shown in Table 1. Results revealed that glutamic acid had the highest concentration in both raw and processed samples with values 12.79, 11.30, 11.94, 12.58 g/100g protein for the fresh, conventionally cooked, microwave cooked and roasted samples respectively. Methionine had the least concentration in all the flour samples which ranged between 0.69 to 0.96 g/100g protein. Roasting slightly increased methionine content while conventional and microwave cooking decreased it when compared with its value in the raw flour sample. The low-methionine content in the various powder samples agrees with findings that methionine is the most limiting essential amino acid in leguminous seeds [13]. The most abundant essential amino acids were lysine and leucine which ranged between 5.88 to 6.82 g/100g protein and 6.16 to 6.86g/100g protein respectively.

All the processing methods resulted in a decrease in lysine content of *Sphenostylis sternocarpa* flour while leucine content slightly increased to 6.86g/100g protein as a result of roasting with a slight decline being induced by conventional and microwave cooking. The reason could be as a consequence of the hydrophobicity of leucine which makes it be located in hydrophobic regions of polypeptides and so may not be easily lost by roasting which does not involve a water medium. Nutrients most times get solubilized in water medium during processing resulting in a decrease. Lysine is the most sensitive amino acid and prone to processing damage [14]. A different observation was reported by [15] indicating that cooking and roasting resulted in a slight increase in both leucine and lysine content of black turtle bean. However, [16] reported that boiling led to a small decrease in lysine while leucine increased slightly in *Artocarpus heterophyllus* seeds.

Other hydrophobic amino acids include isoleucine, valine, methionine, phenylalanine, tryptophan [17]. It was observed that these amino acids increased slightly by roasting. This could be as a result of the unfolding of the polypeptide chain when compared with the effect of both conventional and microwave cooking except for phenylalanine. Tryptophan was not determined. Lysine content of *Sphenostylis sternocarpa* flour from the raw seeds (6.82g/100g crude protein) was comparable to lysine content of raw *Phaseolus vulgaris* (black turtle bean) (6.50g/100g crude protein) [15] but higher than lysine content of cream coated Bambara nut (3.0g/100g crude protein), dark coated Bambara nut (2.9 g/100g crude protein), cranberry beans (3.1g/100g crude protein), kcresting's groundnut (3.0 g/100g crude protein), brown coated cowpea (2.8 g/100g crude protein), white coated cowpea (2.9 g/100g crude protein) [18]. It entails that *Sphenostylis sternocarpa* is a good leguminous seed with appreciable lysine content needed in human nutrition. Lysine is essential for children as it is critical for bone formation, is involved in hormone production, lowers serum triglyceride levels [19].

Results indicated that lysine, histidine, glycine, isoleucine, leucine and tyrosine were sufficient to meet nutritional needs of man based on [11] reference pattern for amino acids in both raw and processed flour samples from *Sphenostylis sternocarpa* seeds. Microwave cooking and roasting did not cause any reduction in arginine in all the flour samples with a value of 5.44g/100g protein. Leucine, isoleucine are components of branched chain amino acids the other being valine. Tyrosine is a non-essential aromatic amino acid.

Predicted protein efficiency ratio (P-PER) is one quality parameter used for protein evaluation [11]. Results indicated that roasting resulted to an increased P-PER with a value of 2.31 while conventional cooking and microwave cooking resulted in a decrease in P-PER with values of 2.05 and 2.19 respectively. P-PER of flour from raw seed samples of *Sphenostylis sternocarpa* was 2.26. P-PER of flour from raw, roasted, microwave cooked and conventionally cooked *Sphenostylis sternocarpa* seeds were slightly lower than P-PER of raw, cooked, boiled and roasted *Phaseolus vulgaris* [15] as well as raw, cooked and roasted groundnut [20] but higher than cooked and raw *Cyperus esculentus* seeds [21], cooked and raw *Artocarpus heterophyllus* seeds [16]. Much of proteins benefits may be attributed to leucine due to its ability to stimulate protein synthesis; help turns on the body's switch to build muscle and spare muscle when dieting [22,23]. Protein sparing effects are primarily derived from leucine (Layman and Walker, 2006). A protein efficiency ratio below 1.5 appropriately describes a protein of low or poor quality [24]. Leucine content of 5.0g/100g protein often results to appreciable P-PER [25]. It entails that roasted *Sphenostylis sternocarpa* seeds will be more beneficial in contributing proteins for human nutrition than conventionally and microwave cooked seeds.

Table1: Effect of Different Processing Methods on Amino Acid Profile of *Sphenostylis. Sternocarpa* seeds.

Amino acid (g/100g protein)	Raw	Conventionally cooked	Microwave cooked	Roasted	FAO/WHO (1991 Reference Pattern). (g/100g protein)
Lysine*	6.82	5.88	6.65	6.49	5.80
Histidine*	3.49	3.05	3.43	2.98	2.80
Arginine*	5.44	4.93	5.44	5.44	5.20
Aspartic acid	8.71	7.51	7.89	8.90	7.70
Threonine*	3.63	3.06	3.29	4.09	3.40
Serine	4.20	3.46	3.82	4.23	7.00
Glutamic acid	12.79	11.30	11.94	12.58	14.70
Proline	3.59	3.01	3.01	4.17	10.70
Glycine	3.20	2.79	2.89	3.99	2.20
Alanine	3.44	2.81	2.98	3.89	6.10
Cyst(e)ine	1.52	1.24	1.31	1.31	3.00
Valine*	4.01	3.25	3.01	4.32	5.00
Methionine*	0.80	0.69	0.75	0.96	2.50
Isoleucine*	3.16	2.74	3.00	3.46	2.80
Leucine*	6.69	6.16	6.51	6.86	1.10
Tyrosine	2.98	2.65	2.81	3.14	1.10
Phenylalanine*	3.78	3.34	3.52	3.19	6.30
Tryptophan*	ND	ND	ND	ND	1.10
P-PER	2.26	2.05	2.19	2.31	-

*- Essential Amino Acid, ND – Not Determined, P-PER – Predicted Protein Efficiency Ratio.

Differences in amino acid concentration of flour from raw and processed *Sphenostylis sternocarpa* seeds is shown in Table 2. Data showed that the various processing methods caused a decrease in lysine, histidine, glutamic acid, cyst(e)ine and phenylalanine. The effect of these processing methods on amino acid decrease was in this order: Conventional cooking > microwave cooking > Roasting. Roasting resulted to enhancement of aspartic acid (2.18%), Threonine (12.67%), Serine (0.71%), proline (16.16%), glycine (24.69%), alanine (13.08%), valine (7.73%), methionine (20%), isoleucine (9.49%), Leucine (2.54%) and Tyrosine (5.37%). Conventional cooking and microwave cooking resulted in a decrease in all the amino acids except in arginine for flour from the microwave cooked seed samples. The drastic reduction in amino acids by conventional cooking more than microwave cooking could be as a result of much solubilization of amino acids in higher water volume employed in conventional cooking than in microwave cooking. Roasting enhanced the concentration of some amino acids which could be as a result of non-exposure to the fluid-like environment rather it caused an unfolding of the polypeptide chain, exposing the hydrophobic amino acids which were located in the interior part of the polypeptide. It made them more available, and the exposed amino acids were not solubilized in water medium employed in conventional cooking and microwave cooking.

Table 2: Results on Differences in Concentration of Various Amino Acid (g/100g crude protein) of flours from raw and processed *Sphenostylis. Sternocarpa* seeds.

Amino acid (g/100g protein)	Raw (i)	Conventionally cooked (i-ii)	Microwave cooked (i-iii)	Roasted (i-iv)	Mean	SD	CV (%)
Lysine*	6.82	0.94(13.78%)	0.17(2.49%)	0.33(4.83%)	6.46	0.41	6.35
Histidine*	3.49	0.44(12.61%)	0.06(1.72%)	0.51(14.61%)	3.24	0.26	8.02
Arginine*	5.44	0.51(9.38%)	0.00(0.00%)	0.00(0.00%)	5.31	0.26	4.90
Aspartic acid	8.71	1.20(13.78%)	0.82(9.41%)	-0.19(-2.18%)	8.25	0.66	8.00
Threonine*	3.63	0.57(15.70%)	0.34(9.37%)	-0.46(-12.67%)	3.52	0.45	12.78
Serine	4.20	0.74(17.62%)	0.38(9.05%)	-0.03(-0.71%)	3.93	0.36	9.16
Glutamic acid	12.79	1.49(11.65%)	0.85(6.65%)	0.21(1.64%)	12.15	0.67	5.51
Proline	3.59	0.58(16.16%)	0.58(16.16%)	-0.58(-16.16%)	3.45	0.56	16.23
Glycine	3.20	0.41(12.81%)	0.31(9.69%)	-0.79(-24.69%)	3.22	0.54	16.77
Alanine	3.44	0.63(18.31%)	0.46(13.37%)	-0.45(-13.08%)	3.28	0.49	14.94
Cyst(e)ine	1.52	0.28(18.42%)	0.21(13.82%)	0.21(13.82%)	1.35	0.12	8.89
Valine*	4.01	0.76(18.95%)	1.00(24.94%)	-0.31(-7.73%)	3.65	0.62	16.99
Methionine*	0.80	0.11(13.75%)	0.05(6.25%)	-0.16(-20.0%)	0.80	0.12	15.00
Isoleucine*	3.16	0.42(13.29%)	0.16(5.06%)	-0.30(-9.49%)	3.09	0.30	9.71
Leucine*	6.69	0.53(7.92%)	0.18(2.69%)	-0.17(-2.54%)	6.56	0.30	4.57
Tyrosine	2.98	0.33(11.07%)	0.17(5.70%)	-0.16%(5.37%)	2.90	0.21	7.24
Phenylalanine*	3.78	0.44(11.64%)	0.26%(6.88%)	0.59(15.61%)	3.46	0.25	7.23
Tryptophan*	ND	ND	ND	ND	-	-	-

The results on the different classes of amino acids are shown in Table 3. Total amino acids of flour from raw *Sphenostylis sternocarpa* seeds was 78.25g/100g crude protein. This value was comparable to total amino acids of *Phaseolus vulgaris* seeds (78.3g/100g crude protein) [15] but higher than what was reported for krestings groundnut (74.2g/100g crude protein), cream coated Bambara nut (70.8g/100g crude protein), dark brown coated Bambara nut 968.5g/100g crude protein), dark brown coated Bambara nut (68.5g/100g crude protein), cranberry beans (65.9g/100g crude protein) [18]. Processing caused a change in total amino acids which varied in this order: Roasting > microwaved cooked > conventionally cooked with values of 80g/100g crude protein, 72.25g/100g crude protein and 67.87g/100g crude protein respectively. The effect of roasting in enhancing amino acids of *Sphenostylis sternocarpa* is in agreement with the findings of [15] but differ for cooking which improved amino acid concentration.

The total non-essential amino acids in flour (TNEAA) for both raw and processed *Sphenostylis sternocarpa* indicated that flour from roasted seeds had the highest value of 42.21g/100g crude protein while flour from raw seeds had a value of 40.43g/100g. Total non-essential amino acids in flour from conventionally cooked seeds had the least value of 34.77g/100g crude protein. Total non-essential amino acids of flour from raw *Sphenostylis sternocarpa* was higher than what was reported for raw *Phaseolus vulgaris* (37.2g/100g crude protein) [15], cream coated Bambara nut (38.5g/100g crude protein), brown cowpea (36.19/100g crude protein), white cowpea (35.4g/100g crude protein), cranberry bean (34.1g/100g crude protein) [18]. However, TNEAA in flour from raw *Sphenostylis sternocarpa* seeds was comparable to that of krestings groundnut (41.4g/100g crude protein) and brown coated Bambara nut (40.10g/100g crude protein) [18].

Total essential amino acids (TEAA) with and without histidine in flour from raw and roasted seeds were quite comparable. Results indicated that processing had varying effects on essential amino acids in the various powder samples in this order: Roasting>Microwave>Conventional cooking. Total essential amino acids of flour from raw *S. sternocarpa* seeds was lower than that of flour from *Phaseolus vulgaris* seeds with and without histidine [15], but higher than what was observed as total essential amino acids with and without histidine in flour made from raw seeds of cream and brown coated Bambara nut, krestings groundnut, cranberry beans, brown and white coated cowpea reported by [18]. Arginine is thought to be conditionally essential for children up to 5years old and the elderly 60 and up while histidine is essential for children up to 5years of age [26].

Results indicated that roasting slightly enhanced essential aliphatic amino acids with a value of 18.73g/100 which compared with flour produced from raw seed sample which had a value of 17.49g/100g crude protein. Conventional and microwave cooking caused a decrease in values of 15.21 and 15.81g/100g crude protein respectively. Aliphatic amino acids have a large hydrophobic side chain with the branched-chain amino acids (BCAAs) making up the bulk of it. BCAAs include leucine, isoleucine and valine. Their molecules are rigid, and their mutual hydrophobic interactions are important for correct folding of proteins as these chains tend to be located inside the protein molecule [6]. These BCAAs had values of 6.69, 3.16 and 4.01g/100g crude protein in flour made from raw seeds (Table 1). Processing caused different changes with roasting enhancing them while conventional cooking and microwave cooking slightly reduced them. BCAAs make up a high proportion of amino acids burned by the muscles as fuel with leucine being the most abundant of the three [22]. Leucine tends to modulate insulin signalling and glucose use by skeletal muscle through stimulation of glucose cycling via alanine cycle [23] while isoleucine induces glucose uptake by cells [27].

Total acidic amino acids (TAAAs) was higher than total basic amino acids (TBAAs) in flours made from both raw and processed *Sphenostylis sternocarpa* seeds. Variations in TAAAs in flour samples was in this order: Raw = Roasted > microwave cooked > conventionally cooked while differences in TBAAs in flours from the various samples was in this order Raw = microwave cooked > roasted >conventionally cooked.

Total sulphur amino acids (TSAAs) consists of the cyst(e)ine and methionine. It had values of 2.32g/100g crude protein in flour made from raw seeds while processing resulted in a slight decrease in values of 1.93, 2.06 and 2.26g/100g crude protein in flours made from conventionally cooked, microwave cooked and roasted *Sphenostylis sternocarpa* seeds respectively. TSAAs of flour from raw seeds was comparable to what was reported as TSAAs of *P. Vulgaris*, Bambara nut, cowpea, cranberry beans, krestings groundnut [15,18,], raw groundnut [20] but lower than TSAAs of flour from processed raw and cooked *Artocarpus heterophyllus* seeds which had values of 9.94 and 9.59g/100g crude protein respectively [16]. Sulphur amino acids provide sulphur for sulfation reactions in the body with cyst(e)ine having sparing effect for methionine [28]. Cyst(e)ine had a high percentage of TSAAs in flours from both raw and processed *Sphenostylis sternocarpa* seeds. Therefore implies that the available cyst(e)ine may have the potentials of sparing methionine which is an essential amino acid.

Table 3: Evaluation of Amino Acid Classes of flour from Raw and Processed *Sphenostylis. sternocarpa* seeds.

Amino Acid Description	Raw	Conventionally Cooked	Microwave Cooked	Roasted
Total Amino Acids (TAA)g/100g	78.25	67.87	72.25	80.00
Total non-essential amino acids (TNEAA)	40.43	34.77	36.65	42.21
%TNEAA	51.67	51.23	50.73	51.48
Total essential amino acids (TEAA)				
With Histidine	37.82	33.1	35.60	37.79
Without Histidine	34.33	30.05	32.17	34.81
% TEAA				
With histidine	48.33	48.77	49.27	47.24
Without histidine	43.87	44.28	44.53	43.51
Essential Aliphatic Amino Acid (EAAA)	17.49	15.21	15.81	18.73
%EAAA	22.35	22.41	21.88	23.41
Total neutral amino acids (TNAA)	41.00	35.20	36.90	43.61
%TNAA	52.39	51.86	51.07	54.51
Total Acidic Amino Acids (TAAA)	21.50	18.81	19.83	21.48
%TAAA	27.48	27.72	27.45	26.85
Total Basic Amino Acids (TBAA)	15.75	13.86	15.52	14.91
%TBAA	20.13	20.42	21.48	18.64
Total Sulfur Amino Acids (TSAA)	2.32	1.93	2.06	2.26
% Cyst(e)ine in TSAA	65.52	64.25	63.59	57.71

The essential amino acid scores (EAAS) based on provisional amino acid scoring pattern stated by FAO/WHO (1991) is shown in Table 4. Amino acid scores (AAS) indicated that flour from roasted seeds was sufficient in lysine, phenylalanine + tyrosine and threonine while flours made from raw, conventionally and microwave cooked seeds were sufficient in lysine and phenylalanine + tyrosine. Tyrosine is a non-essential amino acid but can spare phenylalanine [29]. It is a ring containing amino acid referred to aromatic amino acid, the other two being phenylalanine and tryptophan with these being essential in human nutrition [6]. Phenylalanine has been reported to have antisickling potency [30].

The most limiting amino acids in both raw and processed flour samples were methionine + cyst(e)ine. Results also indicated that roasting slightly increased total amino acid scores (AAS) with a value of 6.95 while flour from raw seed sample had an AAS of 6.49. Microwave cooking had better effects on AAS than conventional cooking with values of 5.96 and 5.54 respectively. The most limiting amino acids were in this order: methionine + cysteine > valine > isoleucine in all the flour samples.

Table 4: Amino Acid Scores of flour from raw and processed *Sphenostylis sternocarpa* seeds.

EAA	**PAAESPA[a]** **(g/100g protein)**	**RAW**		**Conventionally cooked**		**Microwave cooked**		**Roasted**	
		EAAC	AAS	EAAC	AAS	EAAC	AAS	EAAC	AAS
Ile	4.0	3.16	0.79	2.74	0.69	3.00	0.75	3.46	0.87
Leu	7.0	6.69	0.96	6.16	0.88	6.51	0.93	6.86	0.98
Lys	5.5	6.82	1.24	5.88	1.07	6.65	1.21	6.49	1.18
Met + Cys (TSAA)	3.5	2.32	0.66	1.93	0.55	2.06	0.59	2.27	0.65
Phe+Tyr	6.0	6.76	1.13	5.99	1.00	6.33	1.06	6.33	1.06
Thr	4.0	3.63	0.91	3.06	0.77	3.29	0.82	4.09	1.02
Try	1.0	ND	ND	ND	ND	ND	ND	ND	ND
Val	5.0	4.01	0.80	3.25	0.65	3.01	0.6	4.32	0.86
Total	36	33.39	6.49	29.01	5.54	30.85	5.96	35.82	6.95

EAA – Essential amino acid, PAAESP – Provisional amino acid (egg) scoring pattern, EAAC – Essential amino acid concentration, AAS – Amino acid scores, ND – Not Determined , [a][31].

4.CONCLUSION

It is therefore concluded that processing had different effects on the amino acid composition of flour from *Sphenostylis sternocarpa* seeds. All the essential amino acids were sufficient to meet human nutritional needs based on FAO/WHO (1991) reference pattern for amino acids except valine, methionine and phenylalanine. Amino acid scores indicated that the most limiting amino acids were methionine + cysteine in both raw and processed flour samples while valine and isoleucine ranked second and third limiting amino acids in flour samples produced from raw and processed *S. sternocarpa* seeds. This study indicated that roasting enhanced amino acids more than conventional and microwave cooking. Therefore, the processing method which is most recommended for *S. sternocarpa* seeds for maximum nutrients to be derived from it is roasting.

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