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A Comparative Study Between Vitamins and Amino Acid Profile of Sun-Dried Red and Yellow Cashew Pulp

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Abstract

An experiment was conducted to evaluate the comparative study between the amino acid profile and vitamin of sun-dried red and yellow cashew pulp. Kogi state is one of the largest (if not the largest) cashew producing state in Nigeria. Pulps of both red and yellow cashew were collected from cashew plantations in Anyigba and its environs. These pulps were washed, sliced (without pressing out the juice) and sun-dried using a glass house. Dried cashew pulp was milled and samples of the two varieties were taken to two (2) different laboratories for both amino acid and vitamin analysis. Amino acids analysed include: Lysine, Histidine, Arginine, Aspartic acid, Threonine, Serine, Glutamic acid, Proline, Glycine, Alanine, Cystine, Valine, Methionine, Isoleucine, Leucine, Tyrosine, Phenylalanine while vitamins A, B complex, C, D and E were analysed. Results as presented in Tables 1 and 2 for amino acid and vitamins respectively, shows that the red variety of cashew is higher in protein quality, when compared to the yellow variety since the red variety recorded values higher than the yellow variety for all the seventeen (17) amino acids presented. Vitamins A, B, C and E are present in both varieties but vitamin D is not present. Values for vitamins A and C were highly significant ($P < 0.01$), while values for vitamins B and E were not significant ($P > 0.05$). It is therefore recommended that the production of the red variety should be encouraged if amino acid profile is to be considered while the yellow should be encouraged if vitamins are to be considered. Agronomist and cashew farmers should give more emphasis to the production of the red variety of cashew since the yellow variety currently dominates cashew production in Nigeria.

Keywords

Vitamins, Amino Acid Profile, Red Cashew Pulp, Yellow Cashew Pulp, Livestock

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1. Introduction

Cashew pulp which is an important product of this utility tree is regarded as a pseudo fruit because it is a swollen stalk to which the cashew nut is attached (Deckers *et al.,* 2001). The apple is often bright red, orange or yellow in colour and has a spongy, fibrous and very juicy yellow pulp from which a refreshing juice is made. The cashew pulp is an accessory fruit which appears to be an oval or pear-shaped structure, a hypocarpium that develops from the pedicel and receptacle of the cashew flower. It ripens into a yellow or red structure about 5-11cm long with sweet taste and smell (El-Nouby, 1991). The pulp of cashew apple is very juicy, but the skin is fragile. When these fruits are dried, they turn brown due to effect of heat on them and these can be incorporated in feed to be fed to animals such as cattle and goats. It is rich in Vitamin C than oranges and contains high amount of mineral salts (Deckers *et al.,* 2001; Denise *et al.,* 2002). The cashew apple is very rich in vitamin C (262 mg/100 ml of juice) and contains five times more vitamin C than orange. A glass of

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cashew apple juice meets an adult individual's daily vitamin C (30 mg) requirement (Azam-Ali and Judge, 2001). The cashew apple or pulp is also a rich source of minerals and other essential nutrients (Deckers *et al.,* 2001). The cashew apple is also rich in sugars and contains considerable amounts of tannins and minerals, mainly calcium, iron and phosphorous. Furthermore, the fruit has medicinal properties. It is used for curing scurvy and diarrhoea and it is effective in preventing cholera. It is applied for the cure of neurological pain and rheumatism. It is also regarded as a first-class source of energy. When fermented with appropriate enzymes, it produces very valuable beverage drinks. Besides its kernel and pulp, other alternative end use to process cashew into include cashew nut shell liquid (CNSL) from which many products can be derived such as paints, plastics, printing ink, wood preservative, insecticide, aviation fuels, water-proof compounds, and anti fade agent in brake-lining (Azam-Ali and Jugde, 2001).

Vitamins are defined as organic compounds that are required in small amount for normal growth and maintenance of Animal life. They are also mediators of the biochemical pathways. Vitamin A, chemically known as (retinol) does not exist as such in plant, but is present as precursors or provitamins in the form of certain carotenoids which can be converted into the vitamin. It is a fat-soluble vitamin. It helps in the continual renewing of the light sensitivity of the retina and also helps regulate cellular differentiation. It assists to form and protect the epithelial tissues and mucous membranes. Vitamin B-complex is all soluble in water and most of them are components of co-enzymes. Components of vitamin B-complex are B_1 (Thiamin) B_2 (Riboflavin) Nicotinamide, B_6 (Pyridoxine, Pantothenic acid, Biotin, Folic acid, Choline) B_{12} (Cyanocobalamin). Apart from Cyanocobalamin, other members of vitamin B-complex are not stored in the tissues in appreciable amount and a regular exogenous supply is essential (especially in monogastric feeds) Like vitamin B, vitamin C (Ascorbic acid) is water soluble with an acidic and strong reducing properties. It is heat-stable in acid solution but is readily decomposed in the presence of Alkali. It plays an important role in various oxidation-reduction mechanisms in living cells (McDonald *et al*., 2002).

Amino Acids (which are nitrogen-containing compounds that are the building blocks from which proteins are made) are produced when proteins are hydrolysed by enzymes, acids or alkalis. Babington (2006) defined limiting amino acid as the first amino-acid to be exhausted in making or synthesis of a particular protein. Plants and many microorganisms are able to synthesise proteins from simple nitrogenous compounds such as nitrates. Certain amino acids can be produced from others by a process known as transamination (McDonald *et al*., 2002). Aduku (2004) reported the following protein sources to be deficient in these amino acids: soyabean (methionine), groundnut cake (lysine, methionine), beniseed (lysine), cotton seed meal (lysine, methionine), palm kernel meal (lysine, methionine), sunflower (lysine), Lablab (methionine) and cowpea (methionine).

This study is necessitated due to the limited information on the nutritive value of cashew pulp (especially if the two major varieties- yellow and red are to be compared).

2. Materials and Methods

2.1. Procurement and Preparation of Varieties of Cashew Pulp

Samples of the 2 main varieties of cashew pulp (red and yellow) were obtained from Anyigba and its environs. Anyigba is in Kogi State, Nigeria. They were washed, sliced with the aid of knives and chopping boards into bits, air-dried and moved to the glass house where they were properly dried. The dried cashew pulp were packaged, weighed and stored in a safe place. The dried cashew pulp was later milled and sent to the laboratories for analysis.

2.2. Vitamin Analysis

Both varieties of cashew pulp were analysed for vitamins A, B complex, C, D and E using the methods described by AOAC (1990).

2.3. Amino Acid Profile Determination

The Amino Acid profile in the known sample was determined using methods described by Benitez (1984). The known sample as dried constant weight, defatted, hydrolyzed, evaporated in a rotary evaporator and loaded into the Technicon sequential Multi-Sample Amino Acid Analyzer (TSM).

Defatting Sample:

The sample was defatted using chloroform/methanol mixture of ratio 2:1. About 4g of the sample was put in extraction thimble and extracted for 15 hours in soxhlet extraction apparatus (AOAC, 2006).

Nitrogen Determination:

A small amount (200mg) of ground sample was weighed, wrapped in whatman filter paper (No.1) and put in the Kjelcihal digestion flask. Concentrated sulphuric acid (10ml) was added. Catalyst mixture (0.5g) containing sodium sulphate (Na_2SO_4), copper sulphate ($CuSO_4$) and selenium oxide (SeO_2) 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 digested sample was colled and diluted with distilled water to 100ml in standard volumetric flask. Aliquot (10m1) of the diluted solution with 10ml of 45% sodium hydroxide was put into the Markham distillation apparatus and distilled into 10ml of 2% boric acid containing 4 drops of bromocresol green/methyl red indicator until about 70ml of distillate was collected.

The distillate was then titrated with standardize 0.01 N hydrochloric acid to grey coloured

$$\text{Percentage Nitrogen} = \frac{(a-b)\text{ x }0.01\text{ x }14\text{ x V x }100}{\text{W x C}}$$

Where:

a. = Titre value of the digested sample

b. = Titre value of blank sample

v. = Volume after dilution (100ml)

W. = Weight of dried sample (mg)

C. = Aliquot of the sample used (10ml)

14. = Nitrogen constant in mg.

Hydrolysis of the sample

A known weight of the defeated sample was weighed into glass ampoule. 7ml of 6NHCL 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 then sealed with Bunsen burner flame and put in an oven preset at 105^0C± 5^0C for 22 hours. The ampoule was allowed to cool before broken open at the tip and the content was filtered to remove the humans. It should be noted that tryptophan is destroyed by 6N HCL during hydrolysis.

The filtrate was then evaporated to dryness at 40^0C under vacuum in a rotary evaporator. The residue was dissolved with 5ml to acetate buffer (pH 2.0) and stored in plastic specimen bottles, which were kept in the freezer.

Loading of the hydrolysate into TSM analyzer

The amount loaded was between 5 to 10 microlitre. This was dispended into the cartridge of the analyzer. The TSM analyzer is designed to separate and analyze free acidic, neutral and basic amino acids of the hydrolysate. The period of an Analysis lasted for 76 minutes.

Method of Calculating Amino Acid Values from the Chromatogram Peaks.

The net height of each peak produced by the chart recorder of TSM (each representing and Amino) was measured. The half-height of the peak on the chart was found and width of the peak on the half height was accurately measured and recorded. Approximately area of each peak was then obtained by multiplying the height with the width at half-height.

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

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

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 or g/100g protein using the following formula:

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

$$\text{Where C} = \frac{\text{Dilutionx16}}{\text{Sample Wt (g) x N\% x 10 x Vol.loaded}} \div \text{NH x W (nleu)}$$

Where: NH = Net height

W = Width @ half height

Nle = Norleucine

2.4. Data Collection and Statistical Analysis

Data on vitamins and amino acids were collected. Data obtained for vitamins were subjected to a one way analysis of variance (ANOVA) using SPSS, 16.0 Evaluation Version for windows in a Complete Randomized Design (CRD). Significant mean levels were separated using Least Significant Difference.

3. Results

3.1. Vitamins in Varieties of Sun-Dried Cashew Pulp

Table 1. Vitamins in Varieties of Sun-Dried Cashew Pulp.

Varieties of Cashew			
Vitamins (mg/100g)	**Yellow**	**Red**	**SEM**
A	1.477^a	0.860^b	0.138^{**}
B	0.167	0.220	0.018^{ns}
C	30.130^a	28.100^b	0.454^{**}
D	NP	NP	NP
E	0.113	0.140	0.011^{ns}

a, b = Means with different superscript on the same row are significantly different ($p < 0.01$)
SEM = Standard Error of Mean, ** = Significant at ($p < 0.01$), ns = Not Significant, NP = Not Present

Results on vitamins in varieties of sun-dried cashew pulp are presented in Table 1. Values for vitamins A and C were highly significant ($p < 0.01$). Values for vitamins B and E

were not significant ($p > 0.05$), while the result shows that vitamin D is not present in sun-dried cashew pulp. Values for vitamin A ranged from 0.860 mg/100g – 1.477 mg/100g. Vitamin B ranged from 0.167 mg/100g - 0.220 mg/100g. Vitamin C ranged from 28.100 mg/100g – 30.130 mg/100g and vitamin E ranged from 0.113 mg/100g - 0.140 mg/100g.

3.2. Amino Acid Profile of Sun-Dried Cashew Pulp Varieties

The results of amino acids contained in both red and yellow cashew pulp are presented in Table 2. Data on amino acids in varieties of sun-dried cashew pulp were not analysed. Values for lysine ranged from 1.84 – 2.22; histidine values ranged from 0.76 – 1.04; arginine ranged from 1.47 – 1.90; aspartic acid ranged from 3.32 – 3.97; threonine ranged from 1.41-1.93; serine ranged from 1.52 – 1.79; glutamic acid ranged from 3.64 – 4.24; proline ranged from 2.24 – 2.65; glycine ranged from 1.83 – 2.09; alanine ranged from 1.99 – 2.28; cystine ranged from 0.40 – 0.66; valine ranged from 2.20 - 2.61; methionine ranged from 0.49 – 0.63; isoleucine ranged from 1.65 – 1.97; leucine ranged from 2.79 -3.11; tyrosine ranged from 1.11 – 1.27 and phenylalanine ranged from 1.87 – 1.94.

Table 2. Amino Acid Profile of Varieties of Sun-Dried Cashew Pulp.

Amino Acids	Concentration g/100g protein (%)		
	Red	Yellow	Difference
Lysine	2.22	1.84	0.38
Histidine	1.04	0.76	0.28
Arginine	1.90	1.47	0.43
Aspartic acid	3.97	3.32	0.65
Threonine	1.93	1.41	0.52
Serine	1.79	1.52	0.27
Glutamic acid	4.24	3.64	0.60
Proline	2.65	2.24	0.41
Glycine	2.09	1.83	0.26
Alanine	2.28	1.99	0.29
Cystine	0.66	0.40	0.26
Valine	2.61	2.20	0.41
Methionine	0.63	0.49	0.14
Isoleucine	1.97	1.65	0.32
Leucine	3.11	2.79	0.32
Tyrosine	1.27	1.11	0.16
Phenylalanine	1.94	1.87	0.07

Difference = Value of Red - Value of Yellow.

4. Discussion

4.1. Vitamins in Varieties of Sun-Dried Cashew Pulp

Results on vitamins in varieties of sun-dried cashew pulp as presented in Table 2 shows that values for vitamins A and C were highly significant ($p < 0.01$) while values for vitamins B and E were not significant ($p > 0.05$). The result also shows that vitamin D is not present in sun-dried cashew pulp. The value of vitamin A for yellow sun-dried cashew pulp was significantly higher ($p < 0.01$) than that of the red variety. Adegbenro *et al*. (2013) studied the proximate composition, vitamins, and anti-nutritional factors of some selected vegetables grown in Nigeria and reported 5.48mg/100g, 5.71 mg/100g, 8.24mg/100g, 6.50mg/100g and 2.96 mg/100g as values of vitamin A for cassava leaf, moringa leaf, fluted pumpkin leaf, bitter leaf and African basil leaf respectively. Values for vitamin B in this study ranged from 0.167mg/100g - 0.220mg/100g. The value of vitamin C for yellow sun-dried cashew pulp was significantly higher ($p < 0.01$) than that of the red variety. Values for vitamin C in this study for sun-dried cashew pulp ranged from 28.100 mg/100g – 30.130 mg/100g. Azam-Ali and Judge (2001) reported that the vitamin C in cashew juice is 262 mg/100 ml. Oliveira *et al*. (1999) reported 162.89mg/100g as ascorbic acid in cashew juice. Adegbenro *et al*. (2013) reported 141.60 mg/100g, 145.15 mg/100g, 154.41 mg/100g, 150.48 mg/100g and 87.21 mg/100g as values of vitamin C for cassava leaf, moringa leaf, fluted pumpkin leaf, bitter leaf and African basil leaf respectively. Values of vitamin E in this study ranged from 0.113 mg/100g - 0.140 mg/100g. Adegbenro *et al*. (2013) reported 1.30 mg/100g, 1.39 mg/100g, 1.35 mg/100g 1.75 mg/100g and 1.62 mg/100g as values of vitamin E for cassava leaf, moringa leaf, fluted pumpkin leaf, bitter leaf and African basil leaf respectively. This result shows that the value of vitamin in cashew juice is higher than that in the sun-dried cashew pulp. The low vitamin content in the sun-dried pulp as compared to the juice could be due to extraction of juice from the pulp before drying and also due to the effect of sun-drying. The result of this study agrees with the study of Deckers *et al.* (2001) and Denise *et al.* (2002) that cashew is rich in Vitamin C than oranges since the margin between vitamin C and the other vitamins analysed are very far apart (Table 1). Azam-Ali and Judge (2001) also reported that cashew is very rich and contains five times more vitamin C than orange. They further reported that a glass of cashew juice meets an adult individual's daily vitamin C (30 mg) requirement. The value (30.130 mg/100g) of vitamin C from the yellow sun-dried cashew pulp is higher than 28.100 mg/100g obtained for the red sun-dried cashew pulp. This agrees with the study of Adou *et al.* (2012) who rather worked on cashew juice and reported the values of 478.3 mg/100g and 406.8 as vitamin C for juice from yellow and red cashew respectively. The biological functions of vitamin C are numerous in the body. Vitamin C plays a relative role in the immune system, the biosynthesis of collagen, iron absorption and inhibition of the formation of nitrosamines (Vannuchi and Jordao, 1998). Its antioxidant property is associated with reduced cancer incidence in the

body (Lupulescu, 1990; Lupulescu, 1993). Moreover, these high levels are an important asset for the preservation of vitamin C during the heat treatments such as pasteurization, despite his state of thermolability (Walingo, 2005). In summary, vitamin C is a very important component for the metabolism of the organism and the inventory of these functions is very broad.

4.2. Amino Acids Profile of Sun-Dried Cashew Pulp Varieties

As observed from Table 2, the red variety recorded the highest values for amino acids. Values for most of the amino acids such as lysine (1.84-2.22) %, Aspartic acid (3.32-3.97) %, Glutamic acid (3.64-4.24) %, Proline (2.24-2.65) %, Valine (2.2-2.61) % and Leucine (2.79-3.11) % are high when compared to some other feedstuffs. For instance, the value of Lysine (1.84-2.22)% for cashew in this study is higher than 1.73%, 0.26%, 0.90%, 0.23%, 1.52%, 0.14, 0.30% (Aduku, 2005) and 1.6%, 0.24%, 0.70%, 0.45%, 0.76%, 0.35%, 0.28% (Obioha, 1992) reported for groundnut cake, maize, brewers dried grain, millet, sun flower seed cake, guinea corn and wheat respectively, but lower than 2.70%, 4.40%, 5.30% (Aduku, 2005) and 2.80%, 4.50%, 7.00% (Obioha, 1992) reported for soyabean, fish meal and blood meal respectively. Likewise the value of methionine (0.49-0.63) % in this study is higher than 0.15%, 0.23%, 0.21%, 0.14% (Aduku, 2005) and 0.40%, 0.40%, 0.34%, 0.60% (Obioha, 1992) reported for millet, guinea corn, maize and wheat respectively. It was not possible to compare the values of amino acids obtained for sun-dried cashew pulp in this study with other studies on cashew pulp because of paucity of information on amino acid composition in dried cashew pulp.

5. Conclusion and Recommendations

Results of this study showed that values of vitamins A and C for the yellow cashew variety were significantly higher ($P < 0.01$) than those for the red variety. Vitamin D is not present in the two varieties. The result of this study supports those of some authors' who also found out that cashew pulp is very rich in vitamin C.

The red sun-dried cashew pulp meal is higher in all the amino acids analysed.

It is recommended that agronomist should be encouraged to produce more of the red variety since it is in short supply when compared to the yellow variety. The utilization of sun-dried cashew apple pulp in the diets of both monogastrics and ruminants in areas where cashew pulp is considered a waste (as it is in most part of Nigeria- Kogi, Benue and some other highly cashew producing states in Nigeria) is encouraged since cashew pulp is high in both vitamins and amino acids.

Sun-dried cashew pulp can also be used as an anti-stress since it is very rich in vitamin C.

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