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Compositional Studies and Physicochemical Characteristics of Cashew Nut (*Anarcadium occidentale*) Flour

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Abstract: Proximate, mineral and amino acids composition of cashew nut (*Anarcaduim occidentale*) flour were determined using standard analytical techniques. The physicochemical characteristics of the oil were also investigated. The mean values of various parameters for proximate composition (%) were: moisture (5.7±0.2), ash (4.4±0.1), ether extract (36.7±0.1), crude protein (25.3±0.2), crude fibre (1.2±0.3) and carbohydrate (by difference) (26.80).The calculated fatty acids were noted to be 29.4% and energy was 2242.8KJ / 100g. Minerals (mg / 100g) included: Na (22.8±0.2), K (38.2±0.1), Ca (21.9±0.3), Mg (36.4±0.2), Mn (1.6±0.2), Cu (0.4±0.1), Zn (0.8±0.1), Fe (0.8±0.1) and P (18.6±0.2) while Pb, Cd and Hg were not detected. The relationship between Na and K as well as between Ca and P; are desirable with the respective ratios of Na/K (0.6) and Ca/P(1.2). Amino acid analysis revealed that cashew nut flour contained nutritionally useful quantities of most of the essential amino acids. The first and second limiting amino acids are Lys (0.58) and Met + Cys (TSAA) (0.66). The results of physicochemical properties of cashew nut oil with the mean values of the following parameters:- colour (yellow), refractive index (1.465), specific gravity (0.964), acid value (0.82 ± 0.4 mg KOH/g, saponification value (168.3 ± 0.3mg KOH/g), iodine value (44.4 ± 0.1mg Iodine/g), peroxide value (3.1±0.2) and free fatly acids (28.4±0.1 mg/g) indicated that cashew nut oil is edible, non-drying and may not be suitable for soap making.

Key words: Cashew nut flour, chemical composition, cashew oil, physico-chemical characteristics

Introduction

Many plant proteins usually in the form of proteins extracts or seed flours are being investigated and tested for new products such as low cost fabricated foods which are nutritious, attractive and acceptable to consumers just like conventional foods from meat, fish and dairy products (Lawhom and Cater, 1971; Lin *et al*., 1974; and McWalters and Cherry, 1977). Research attention that has been directed towards increasing utilization of plant protein sources for food use includes pumpkin (Olaofe *et al*., 1994; and Giamin and Bekebain, 1992) peanut Khan *et al.*, 1975 and McWalters *et al*., 1976) pigean pea (Oshodi and Ekperigin, 1989); African yam bean (Adeyeye *et al*., 1994) and akee apple Akintayo *et al.*, 2002). The ultimate success of utilizing plan proteins as ingredients depends largely upon the beneficial qualities they impact to foods, which depend largely on their functional and physicochemical properties (Aluko and Yada, 1995; and Shadrach and Oyebiodun, 1999).

Cashew nut (Anarcadium occidentale) is a heart like shaped fruit widely grown in Africa and West Indies. In Nigeria about 5000 - 7000 tones are produced annually mainly as an export crop. There are limited information in the nutritional composition, utilization and physicochemical properties of the cashew nut flowers.

The study is aimed at investigating the proximate, mineral and amino acid composition as well as the physicochemical characteristics of cashew nut flour producing in Nasarawa State, Nigeria. Such information may expand the scope of knowledge on the utilization and nutritional qualities of cashew nut flour.

Materials and Methods

Collection and preparation of samples: The cashew nuts that served as sample for analysis were obtained from Sabo Farm near Nasarawa State Polytechnics, Lafia. The nuts were thoroughly screened to remove the bad ones and stones. The nuts were cut into two halves using the manual cashew kernel cutter. After cutting, the nuts were pull out, dried in a forced air oven at 40^{o}C for 6 hours to make it bone dry. The covering testa were removed by squeezing and then winnowed to obtain cream colour nuts. Dried clean nuts were milled using Moulinex blender. The powdered sample was stored in polythene bags and kept in a refrigerator at 4^{o}C until used for proximate analysis.

The proximate analyses of the samples for moisture, total ash and crude fibre were carried out in triplicate using the methods described in AOAC. The nitrogen was determined by the micro Kjeldahl method described by Pearson (1976) and the nitrogen content was converted to protein by multiplying by a factor of 6.25. Carbohydrate was determined by difference. All the proximate values were reported in %.

Extraction of oil: The oil sample was extracted from the seed flours by soxhlet extractor using petroleum ether of

Analar grade (British Drug Houses, London), boiling range 60-80°C for 8 hours (James, 1996).

Mineral analysis: The minerals were analyzed by dry-ashing the samples at 550°C to constant weight and dissolving the ash in volumetric flask using distilled, deionized water with a few drops of concentrated hydrochloric acid. Sodium and potassium were determined by using a flame photometer (Model, 405, Corning, UK) using NaCl and KCl to prepare the standards. All other metals were determined by Atomic Absorption Spectrophotometer (Perkin - Elmer Model 403, Norwalk CT, USA). All determinations were done in triplicate. All chemical used were of analytical grade (BDH, London). Earlier, the detection limits of the metals had been determined according to Techtron (1975). The optimum analytical grade was 0.1 to 0.5 absorbance units with a coefficient of variation of (0.87 - 2.20) %. The minerals were reported as mg / 100g.

Amino acid analysis: 2.0g of cashew nut flour was defatted with chloroform/methanol mixture using soxhlet extraction apparatus while the extraction lasted for 15 hours. Between 30-50mg of defatted sample was weighed into glass ampoule. 7ml of 6MHCl was added and oxygen expelled by passing nitrogen into the ampoule. The Sealed ampoule was put is an oven at 105 ±50°C for 22 hours and later allowed to cool before the content was filtered. The filtrate was then evaporated to dryness at 40°C under vacuum in a rotary evaporation. Residue was dissolved with 5ml acetate buffer (pH 2.0). The method of amino acid analysis was by ion exchange chromatography (IEC) (FAO/WHO, 1991) using the Technicon Sequential Multi sample Amino Acid Analyzer (TSM) (Technicon Instruments Corporation, New York).

Physicochemical properties determination: The physicochemical determination of the cashew nut oil for acid value, iodine value, saponification value, peroxide value, free fatly acid and specific gravity were carried out according to the methods of AOAC (1990).

Results and Discussion

Table 1 presents results of the proximate composition of cashew nut flour. The moisture mean value cashew nut flour which was 5.7 ± 0.2% dry weight is some how low when compared with the mean value of moisture of legumes ranging between 7.0% and 11.0% reported by Arkroyed and Doughty (1964). However this value is in close agreement with those reported by Ige *et al.* (1984) and Fagbemi and Oshodi (1991) for fluted pumpkins seed of 5.0% and 5.50% respectively. Ash content mean value of cashew nut in this present study was 4.4 ± 0.1%. It has been recommended by Pomeranz and Clifton (1981) that ash contents of nuts, seed and tubers

Table 1: Proximate composition (%) of cashew nut flour

Composition	%
Moisture	5.7±0.2
Ash	4.4±0.1
Ether extract	36.7±0.1
Crude Protein	25.3±0.2
Crude Fibre	1.2±0.3
Carbohydrate (by difference	26.8
[a]Fatty acids	29.4
[b]Energy KJ / 100g	2242.8

Values are mean ± standard deviation of triplicate determinations. [a]calculated fatly acids (0.8 x crude fat). [b]calculated metabolizable energy (KJ/100g)(Protein x 17 + Fat x 37+ carbohydrate x 17)

should fall in the range 1.5-2.5% in order to be suitable for animal feeds. The ash content of cashew nut does not fall within this range hence it cannot be recommended for animal feeds. The ether extract (crude fat) with a mean value of 36.7 ± 0.1% is low compared to the values for varieties of melon oil seeds ranging between 47.9 - 51. 1% reported by Ige *et al.* (1984); for pumpkin seed (49.2% and 47. 01%) by Aisegbu (1987) and Fagbemi and Oshodi (1991) respectively but is high compared to soybean seed, which has only 23.5% fat (Paul and Southgate, 1980). Fat is important in diets because it promotes fat soluble Vitamin absorption (Bogert *et al*., 1994) It is a high energy nutrient and does not add to the bulk of the diet. The crude protein of 25.25±0.2% is highly comparable to protein rich foods such as soybeans, cowpeas, pigean peas, melon, pumpkin and gourd seeds ranging between 23.1- 33.0% (Olaofe *et al.*, 1994); chick beans 19.4% and lima bean, 19.8% (FAO 1982); and Jack bean, 30.8% (Anonymous, 1972). The recommended daily allowance for protein for children ranges from 23.0-36.0g and for adult, 44-56g (NRC, 1989). However, it can be evaluated that cashew nut can supply the recommended daily intake of protein for children. Apart from the nutritional significance of protein as a source of amino acids, they also play a part in the organoleptic properties of foods (Okon, 1983). The crude fibre of cashew nut was very low compared with legumes, mean values ranging between 5-6% (Anonymous, 1972 and Aremu *et al*., 2006). Maintenance of internal distention for a normal peristaltic movement of the intestinal tract is the physiological role which crude fibre plays. Okon (1983) reported that a diet low in fibre is undesirable as it could cause constipation and that such diets have been associated with diseases of colon like piles, appendicitis and cancer. The value obtained for carbohydrate (by difference), 26.8% is comparable with an acceptable range mean values of legumes, 20-60% of dry weight (Arkroyed and Doughty, 1964). This result thus gave an indication that the cashew nut flour is a rich source of energy and capable of supplying the daily energy requirements of the body. The calculated metabolizable energy value

Table 2: Mineral content (mg/100g) of cashew nut flour

Mineral	mg/100g
Na	22.8±0.2
K	38.2±0.1
Ca	21.9±0.3
Mg	36.4±0.2
Pb	ND
Mn	1.6±0.2
Cu	0.4±0.1
Zn	0.8±0.1
Fe	0.8±0.1
P	18.6±0.2
Cd	ND
Hg	ND
Na/K	0.60
Ca/P	1.18

Values are mean ± standard deviation of triplicate determinations. ND = Not detected.

(2242.8KJ/100g) showed that cashew nut flour was concentrated source of energy. The energy from cereals ranged from 1.3-1.6 MJ/100g reported by Paul and Southgate (1980) indicating that cashew nut flour has energy concentration favourably comparable to cereals. The mineral content (mg/100g) of cashew nut flour is shown in Table 2. The least abundant minerals were Cu, Zn and Fe while K was found to be the most abundant mineral (38.2 ± 0.1mg/100g). This is in close agreement with the observation of Olaofe and Sanni, (1988) and Aremu *et al*. (2005) that K was the most predominate mineral in Nigerian Agricultural Products. Mg was found to be next highest mineral component. It has been reported that magnesium is an activator of many enzymes systems and maintains the electrical potential in nerves (Ferrao *et al.*, 1987). Calcium mean value (21.9 ± 0.3mg/100g) of the present study is lower than melon, pumpkin and gourd seeds of 130.7, 72.3 and 54.9mg/100g respectively reported by Olaofe *et al*. (1994). Calcium in conjunction with phosphorus, magnesium, manganese, vitamins A, C and D, chlorine and protein are all involved in bone formation (Fleck, 1976) Calcium is also important in blood clothing muscle contraction and in certain enzymes in metabolic processes. The mean value of phosphorus (18.6± 0.2mg/100g) is very close to that of calcium. Phosphorus is always found with calcium in the body both contributing to the blood. Low Ca/P ratio facilitates calcinations of calcium in the bone while Ca/P ratio above two helps to increase the absorption of calcium in the small intestine (Nieman *et al*., 1992). Ca/P ratio of cashew nut flour is greater than 1, indicating that it would serve as good source of mineral for bone formation. The ratio of sodium to potassium in the body is of great concern for prevention of high blood pressure. Na/K ratio less than one is recommended (Nieman *et al*., 1992). The Na/K ratio for cashew nut flour under consideration though less than one. This is an indication that consumption of cashew nut would probably reduced high blood pressure disease.

Table 3: Amino acid composition of cashew nut flour (g/100g) protein

Amino acid	Concentration (g/100g protein)
Lysine[a] (Lys)	3.2
Histidine[a] (His)	2.4
Arginine[a] (Arg)	4.4
Aspartic acid (Asp)	5.6
Threonine[a] (Thre)	2.5
Serine (Ser)	3.7
Glutamic acid (Glu)	19.1
Proline (Pro)	4.1
Glycine (Gly)	3.0
Alamine (Ala)	3.5
Cystine (Cys)	0.3
Valine[a] (Val)	3.7
Methionine[a] (Met)	2.0
Isoleucine[a] (Ile)	4.0
Leucie[a] (Leu)	6.9
Tyrosine (Tyr)	3.3
Phenylalanine[a] (Phe)	4.1

[a]Essential amino acids.

Table 3 present the amino acid analysis of cashew nut flour (g/100g protein). The major abundant amino acids were Glutamic acid (Glu), Leucine (Leu) and Aspartic acid (Asp) with the values of 19.11, 6.87 and 5.59-g/100g proteins respectively. This observation is in close agreement with the report of Olaofe *et al.* (1993), Oshodi *et al.* (1998) and Adeyeye (2004) and Aremu *et al.* (2006). The sum of the Asp and Glu amino acids was 24.7g/100g protein (32.6%) this value is higher than the values obtained from selected oil seeds (melon, pumpkin and gourd seeds) ranging between 24.2 - 29.5 (Olaofe *et al.*, 1994) and Ige *et al.* (1984). Tryptophan was not determined.

Table 4 depicts many parameters. The total amino acid (TAA) of 75.8g/100g protein indicated that cashew nut will contribute significantly to the supply of amino acid in diet. This value is higher than that of melon, pumpkins and gourd seed of 53.4,38.3 and 53.6g/100g protein respectively reported by Olaofe *et al.* (1994); soybean, 44.4g/100g protein (Kuri *et al.*, 1991), pigeon peas, 45.2g/100g protein (Nwokolo, 1987). This is an indication that cashew nut is very rich in proteins. The % total amino acid (% TEAA) of 43.7 (with His) was an indication that cashew nut flour is a good source of essential amino acids. The leucine (Leu) (6.9g/100g) protein) and phenylalanine (Phe) (4.1g/100g) protein values are higher than that of the reference values of 4.2 and 2.8g/16g of N protein respectively. However lysine (Lys), methionine (Met) and valine (Val) values of 3.2, 2.0 and 3.7g/100 protein are lower than the reference values

Table 4: Essential, non-essential, acidic, neutral and basic amino acids (g/100g protein) of cashew nut flour

Amino acid Classification	Concentration (g/100g protein)
Total Amino Acid (TAA)	75.7
Total Non-Essential Amino Acid (TNEAA)	42.7
% TNEAA	56.3
Total Essential Amino Acid (TEAA)	
-4 With Histidine	33.1
-5 Without Histidine	30.7
% TEAA	43.7
-6 With Histidine	40.6
-7 Without Histidine	17.1
Essential Aliphatic Amino Acids (EAAA)	4.1
Total Neutral Amino Acid (TNAA)	43.5
% TNAA	57.4
Total Acidic Amino Acid (TAAA)	24.7
% TAAA	32.6
Total Basic Amino Acid (TBAA)	10.0
% TBAA	13.18
% of Cystine in Total Sulphur Amino Acid (TSAA)	13.9

Table 5: Amino acid scores of the cashew nut flour

Amino acid	Provisional amino acid scoring pattern[a] (g/100g protein)	Current result (mg/100g protein)	Amino acid scores
Ile	4.0	4.0	1.0
Leu	7.0	6.9	0.98
Lys	5.5	3.2	0.58
Met + Cys (TSAA)	3.5	2.3	0.66
Phe + Tyr	6.0	7.4	1.24
Thre	4.0	3.3	0.83
Try	1.0	ND	ND
Val	5.0	3.7	0.74
Total	36.0	30.8	6.03

[a] Source: Belschant *et al.* (1975). ND = Not Detected.

Table 6: Physicochemical characteristics of cashew nut oil

Parameter	Value
Colour	Yellow
Refracture index	1.654
Specific gravity	0.964
Acid value (mgKOH/g)[a]	0.82±0.4
Saponification Value (mgKOH/g)[a]	168.3±0.3
Iodine Value (mg Iodine/g) [a]	44.4±0.1
Peroxide Value[a]	3.1±0.2
Free fatly acids (mg/g) [a]	28.4±0.1

[a]Values are mean± standard deviation of triplicate determinations.

of 4.2, 2.2, and 4.2g/100g protein respectively. Threomine (Thre) (2.5g/100g) protein) is comparable to the reference value of 2.8g/16g of N protein (FAO, 1970). Essential aliphatic amino acid (EAAA) which constitute the hydrophobic regions of protein were more abundant in cashew nut flour (17.1g/100g protein), But essential aromatic amino acid (EArAA) which are precursions of tyrosine, episephrus and thyroxin (Robinson 1987) were not found in abundant (4.1g/100g protein).

The quality of dietary protein can be measured in various ways (FAO/ WHO, 1991) but basically it is the ratio of available amino acid in the food or diet compared with the needs expressed as a ratio Bender (1992) Using data from Table 3 together with the scoring pattern from Table 5, the values of the amino acids in the sample were found as follows:

Amino acids score = [g of amino acid per test proteins / g of amino acid per g of reference pattern]

The scoring Table reveals that first and second limiting amino acids are Lys, 0.58 and Met + Cys (TSAA), 0.66. These calculated values are in agreement with a report that the essential amino acids most often acting in a limiting capacity are Met (and Cys), Lys and Try (Bingham, 1997) Therefore in order to fulfil the day's needs for all the essential amino acids in cashew nut, 100/66 (for TSAA) or 1.52 times as much of cashew nut protein would have to be eaten when it is the sole protein in the diet. Although many vegetable proteins contain substantially more Cys than Met, this current report gave a percent Cys in TSAA as 13.9.

The physicochemical properties of cashew nut oil are shown in Table 6. The yellowish colour oil had specific gravity of 0.964 indicating that it is less dense than water with refractive index of 1.465, which is in agreement with the value of 1.462 for B. Sapida oil (Akintayo *et al.*, 2002) This showed that the oil less thick when compared with most drying oils whose refractive indices were between 1.475 and 1.485 (Duel, 1951). The saponification value of the oil was 168.3± 0.3 mgKOH/g which is below the values obtained for some vegetable oils ranging from 188-196mg KOH/g. However, there are some vegetables with higher saponification values such as coconut oil (253 mgKOH/g), palm kernel oil (247 mgKOH/g) and butter fat 225 (mgKOH/g). It has been reported by Pearson, (1976) that oils with higher saponification values contain high proportion of lower fatty acids. Therefore the value obtained for cashew nut oil indicated that the oil contained high proportion of higher fatty acids. The oil had very low acid value of 0.82±0.4 mgKOH/g when compared with plukenetia conophora (11.5mg KOH/g) as reputed by Akintayo and Bayer (2002) and benniseed (47.6%), by Ohsodi (1992). The low saponification value and low acid value indicated that the oil may not be suitable for soap making. The iodine value (44.4±0.1 mgIodine/g) of cashew nut oil is comparable with citrullus vulgaris with value 38.1±3% (Achinewhu, 1990) and Hausa melon seed, 38.50 ±0.67% (Oladimeji *et al*., 2001). In view of the fact that drying oils have an iodine value above 100 (Duel, 1951} cashew nut oil could only be categorized as non-drying oil.

Conclusion: The present study indicated that cashew nut is rich in important food properties compared to some other oil seeds and nuts. The high quality protein of cashew nut showed its reliability as a good source of

amino acids for school children and adults. The physico-chemical properties of the oil indicated that it is edible, non-drying and may not be suitable for soap making. However further work is in progress for the determination of fatty acid and sterol composition; and spectroscopic analysis of the cashew nut oil.

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