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Proximate, Minerals and Amino Acid Profile of (*Canarium Schweinfurthii*) Seed Pulp

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ABSTRACT

The nutritional composition and amino acid profile of matured (*Canarium schweinfurthii*) seed pulp were evaluated using standard methods. The proximate composition (%) of the seed pulp showed moisture content (30.21), ash (1.86), fat (34.83), fibre (3.19), protein (12.67) and carbohydrate (17.24). Mineral contents (mg/100g) of the seed indicated; calcium (32.0), phosphorous (16.8), iron (5.6), sodium (15.3), potassium (21.4), magnesium (24.0), copper (2.1), manganese (0.3) and zinc (6.3), lead and cadmium were below the detection limit. Amino acid profile of seed pulp showed concentration of total amino acids of (83.01 g/100g protein), total essential amino acids (45.15 g/100g protein) and total non-essential amino acids (37.86 g/100g protein). The result of proximate composition of edible part of *Canarium* fruit revealed very high moisture content which may accelerate its susceptibility to microbial infection. The fruit had very low ash and fibre contents but contained appreciable amount of lipid, protein and carbohydrate. The seed also contained appreciable amount of nutritionally valuable minerals and amino acids as a food supplement. Due to its high content of fat, *Canerium* seed is a suitable source of edible oil, alternative source of energy and could be applicable in high-lipid foods such as margarine.

Keywords: *Proximate, Canarium Seed, Minerals, Amino Acids*

1. INTRODUCTION

In most developing tropical countries the food situation is worsening owing to increasing population, shortage of fertile land, high prices of available staples and restrictions on the importation of food (Sadik, 1991; Weaver, 1994). This has resulted in a high incidence of hunger and malnutrition, a situation in which children and women, especially pregnant and lactating women are most vulnerable (Coulter et al., 1988; Pelletier, 1994). Predictions of future food needs are based on the current rates of population increase and food production emphasizes the seriousness of this problem (FAO, 1990). Indigenous fruits play a vital role in the livelihoods of many rural communities in Nigeria, especially those living in the dry-lands. Ethnobotanical records available on useful wild plants in Nigeria highlight the importance of *Canarium* sp. medicinal roles and human consumption of their edible fruits (Ayoade *et al*., 2015a). *Canerium* seed contained natural flavours, high fat content, pigments, moisture, nutritionally valuable minerals, vitamins and naturally occurring antioxidants Ayoade, *et al* (2015b). *Canarium schweinfurthii bursaraceae* is the fruit of the perennial tree plant also called "atili' tree. In Nigeria, the fruit is called 'ube okpoko' in Ibo and "atili" in Hausa. The fruit is commonly found in large quantity in Pankshin, Plateau State of Nigeria and is also produced in similar quantities in other states of the Northern and South-eastern Nigeria. The plant produces its fruits in the rainy season (usually) between the months of April and September. The flowers grow in clusters at the end of the twigs and are small and dark green in colour. The fruits which are of two varieties-long spirals and short round in shape develop from the flowers. The fruits contain single triangular-shaped seed with small projections at the three edges. The seeds are embedded in a purplish green pulp with a desirable sweet but not too sugary taste similar to that of avocado pear, the pulp is of oily consistency and edible (Ayoade *et al*., 2015a). The weight of the fruits ranges from 3.5 to 9 g with a predominant average weight of about 5.3 g. The fruit is very hard; the seed is cooked and yields oil, sometimes used as a substitute for shear butter (Kochar, 1981). The fruit store best under cold storage thus, preventing moisture loss that may result in shrinkage of the fruit surface reducing its aesthetic value and also prevent microbial growth (Looney, 1985). The research was designed to evaluate the nutritional composition and amino acid profile of the canerium seed pulp to ascertain its consumption and supplement in case of malnutrition.

2. MATERIALS AND METHODS

2.1. Sample and sample preparation

African canarium (*Canarium schweinfurthii)* seeds were purchased from a farmer in Pankshin Local Government Area of Jos, Plateau State, Nigeria. The seeds were brought to Akure and authentication was done at the Department of Crop Soil and Pest Management of The Federal University of Technology, Akure Ondo State, Nigeria. The seeds were

screened in the Laboratory by hand-picking to remove the bad ones and soaked in warm water at 65 ^{o}C for about 20 min to soften the seed coat for easy removal. Seed flesh was then removed through sterilized knife and ground using Marlex Excella mixer / grinding machine. The ground sample was packed in screwed – caped air tight plastic and refrigerated at 4 ^{o}C prior analysis.

2.2. Proximate Analysis: The moisture, crude protein, fibre, fat and ash contents were determined according to the method of the Association of Official Analytical Chemists (AOAC, 2005); and carbohydrate was determined by difference.

2.3. Mineral Analysis: Atomic Absorption Spectrophotometry (AAS) method was adopted for analysis of minerals i .e Ca, Mg, Zn, Fe, Cu, Pb, Mn and Cd, while Na and K were analyzed using flame photometry and P was analyzed using vanado molybdate method.

2.4. Amino acid Analysis: The amino acids were quantitatively measured by method described by spackman *et al*., (1958), using automatic amino acid analyzer (Technico TSM Sequential Multisample Analyzer).

2.5. Statistical Analysis

The results were expressed as mean ± Standard Deviation (SD) of three replicates. Data obtained were statistically analysed using one way Analysis of Variance (ANOVA), a tool in Statistical Packages for Social Sciences (SPSS 16.0).

3. RESULTS AND DISCUSSION

Table 1: Proximate Composition (%) of Canerium Seeds

Parameters	Results
Moisture	30.21 ± 1.03
Ash	1.86 ± 0.01
Crude fibre	3.19 ± 0.02
Crude fat	34.83 ± 0.05
Protein	12.67 ± 0.01
Carbohydrate	17.24 ± 0.02
Dry matter	69.79 ± 0.03
Energy Kcal/100g	433.14 ± 8.15

Mean ± standard deviation of the triplicate determinations (n = 3)

3.1. Proximate Composition of Canerium Seed Pulp

The results of proximate composition of *canerium* fruit are shown in Table 1. Moisture content is a measure of the water content in the fruit samples, generally moderate is an indication that it can be stored for a long time without the development of moulds (Umar *et al*., 2007). The moisture content of *canerium* fruit was 30.21 %, this is very high compared to 8.0 % reported for cashew nut by Amoo (2005), 10.99 %, 9.68 % and 5.12 % respectively reported for raw, boiled and roasted *Treculia Africana* seed by Ayoade *et al.,* (2015c) and 16.66 % reported for *Vitex doniana* pulp by Vunchi *et al.,* (2011). The fruit pulp was very high in moisture content and this may accelerate its perishability and susceptibility to microbial infection, the fruit should therefore be stored at low temperature to avoid moisture loss, shrinkage of the fruit surface and deterioration. Ash content is a measure of the total mineral content of a food. The sample had a value of 1.86 % which is lower than 2.8 % reported for cashew nut by Amoo (2005), 2.1 % reported for the fruit of *nauclea latifolia* (Amoo and Lajide 1999). Apart from high moisture content, the seeds dominantly contained appreciable amount of lipids, protein and carbohydrates. The fat content of seeds was 34.83 % which is lower compared with 42.8 % reported for cashew nut by Amoo (2005) and (46.20-49.34 %) reported for *Mucuna sp*., by (Amoo, *et al.,* 2009), but comparable with that of *Vitex doniana* (34.62 %) reported by Vunchi *et al.,* (2011). Because of the high content of fat, *Canerium* seed is suitable as the source of edible oils and could be applicable in high-lipid foods such as margarine. Crude protein content of canerium fruit was 12.67 % which is lower compared to the seeds of *M. oleifera* (40.1 %), *D. microcarpum* (35.96 %) and *B. monandra* (33.09 %) Anhwange *et al*., (2004), cowpea (22.7 %), chick beans (19.4 %), lima beans (19.8 %) and big brown beans (21.3 %) Amoo (1998), but higher than 8.24 % reported for *V. doniana* fruit by Vunchi *et al.*, (2011). Dreon *et al.,* (1990) claimed that most fruits have high carbohydrate content depending on the fruit type, maturity and environment. However, *Canerium* fruit has a lower value of 17.24 %, this value is also low compared to 24.1 % reported for cashew nut by Amoo (2005) and 28.40 % reported for *V. doniana* by Vunchi *et al*, (2011). The crude fibre content obtained for *Canerium* fruit (3.19 %) was slightly higher than 1.4 % reported for cashew nut by Amoo (2005), 1.44 %, 1.04 % and 1.19 % respectively reported for raw, boiled and roasted *Treculia Africana* seed by Ayoade *et al.,* 2015c. The fibre recommended dietary allowance (RDA) values foe children, adults, pregnant and breast feeding mothers are 19-25 %, 21-38 %, 28 % and 29 % respectively. Therefore, *Canerium* fruit is not a good source of dietary fibre for humans, however, it could be recommended for low fibre feed formulation or supplement. The fruit contains about seventy percent (69.79%) dry matter and high energy value (433.14 Kcal/100g) which indicates that the seed is a good alternative source of energy and could be taken when energy given food is required.

Table 2: Mineral Composition (mg/100g) of Canerium Seeds

Minerals	Results
Potassium	21.4 ± 0.02
Calcium	32.0 ± 0.03
Sodium	15.3 ± 0.01
Iron	5.6 ± 0.01
Magnesium	24.0 ± 0.02
Zinc	6.3 ± 0.01
Copper	2.1 ± 0.00
Lead	BDL
Manganese	0.3 ± 0.00
Phosphorous	16.8 ± 0.04
Cadmium	BDL

Mean ± standard deviation of the triplicate determinations (n = 3)

BDL = Below Detection Limit

3.1. Mineral Composition of Canerium Seed Pulp

Table 2 shows the mineral composition of *Canerium* fruit pulp. Calcium which forms component of bones and teeth, necessary for blood clotting and muscle contraction was found to be 32.0 mg/100g in *canerium* which is lower than 160 mg/100g for *D. microcarpum* pulp (Umar *et al*, 2007) and higher than 30.0 mg/100g reported by Eromosele *et al*, (2001) for the same species. Phosphorus is related to calcium for bone, teeth and muscles growth and maintenance (Umar *et al.*, 2007). 16.8 mg/100g obtained for phosphorus in *canerium* fruit is comparable to 16.5mg/100g that was obtained for V. doniana fruit by Vunchi *et al.*, (2011). The availability of calcium in the body depends on calcium to phosphorus ratio and presence of antinutritional factors. For good calcium intestinal absorption, Ca:P ratio of 1:1 is required (Umar *et al.*, 2007). Ca:P ratio obtained for the edible part of *canerium* seed was 2:1 which indicates that the seed required to be supplemented with phosphorus rich diet to maintain Ca/P balance. Iron is essential micro nutrient for haemoglobin formation, normal functioning of central nervous system (CNS) and in oxidation of carbohydrate, protein and fat (Adeyeye and Otoketi, 1999). The iron content of seed is 5.6 mg/100g and is higher than 0.191 mg/g reported for *V. doniana* pulp (Robert *et al.*, 1997) and 2.11-2.53 mg/100g for *D.* m*icrocarpum* (Umar *et al*, 2007). The seed had appreciable amount of iron, its consumption could be encouraged for menstruating and lactating women. Sodium content in combination with potassium is involved in proper acid-base balance maintenance and nerve transmission in the body system. The value obtained for sodium and potassium in this study were 15.3 mg/100g and 21.4 mg/100g respectively. The variation of sodium to potassium in this work is of significant importance particularly to hypertensive patient (Umar *et al.*, 2007). A high intake of potassium has been reported to protect against increasing blood pressure and other cardiovascular risks (Langford, 1983). Na/K ratio of less than one is recommended and 0.715 was obtained in this study. Magnesium is an element in connection with circulatory diseases and calcium metabolism in bone (Ishida *et al.*, 2000), it also involved in bone mineralization, the building of protein, enzyme action, normal muscular contraction and transmission of nerve impulses. The magnesium value (24.0 mg/100g) obtained in this study was lower compared to 33.6 mg/100g reported for *D. microcarpum by* Umar *et al.*, (2007) and 90.7 mg/100g reported by Lockeett *et al.*, (2000) for the same species. The concentration of copper in *canerium* seed (2.1 mg/100g) is lower than 2.7 mg/100g reported for *V. doniana* pulp by Vunchi *et al*, (2011). This value is within the recommended dietary allowance (RDA) of 1.5-3.0 mg/day for copper, therefore 100 g of *Canerium* fruit consumed could provide the required value. Manganese which involved in bone formation, as well as in enzymes involved in amino acid, cholesterol and carbohydrate metabolism was found in trace (0.3 mg/100g). However, the concentration of zinc was 6.3 mg/100g while lead and cadmium were below detectable limit.

Table 3: Amino Acid Profile (g/100g protein) of Canerium Seeds

Amino acid	Results
Lysine*	3.51 ± 0.02
Histidine*	5.21 ± 0.01
Arginine*	6.09 ± 0.01
Aspartic acid	13.19 ± 0.03
Threonine*	2.70 ± 0.00
Serine	2.17 ± 0.00
Glutamic acid	11.67 ± 0.01
Proline	2.03 ± 0.01
Glycine	3.08 ± 0.02
Alanine	3.50 ± 0.02
Cysteine*	0.80 ± 0.00
Valine*	4.00 ± 0.05
Methionine*	1.63 ± 0.01
Isoleucine*	7.28 ± 0.03
Leucine*	5.30 ± 0.00
Tyrosine	2.22 ± 0.01
Phenylalanine*	8.63 ± 0.02
Total amino acids	**83.01** ± 0.21

Mean ± standard deviation of the triplicate determinations (n = 3)
Essential amino acids*

Table 4: Classification of Amino Acid Composition of Canerium Seeds

CLASSIFICATIONS	RESULTS
Total amino acid (TAA)	83.01
% (TAA)	100.0
Total essential amino acid (TEAA)	45.15
% (TEAA)	54.39
Total non-essential amino acid (TNEAA)	37.86
% (TNEAA)	45.61

3.2. Amino Acid Profile (g/100g protein) of *Canarium* seeds

Table 3 shows the amino acid profile (g/100g protein) of *Canarium* seeds. Glutamic acid and aspartic acid dominates (13.19 and 11.67) the amino acid profile of the sample. This could be because these two amino acids are the precursors from which the backbones of amino acids are formed and they are storage forms of nitrogen (Onwuliri and Anekwe, 1993). It was observed that the concentration of both glutamic and aspartic acids (together make up 24.86 g/100g protein) are the most abundant amino acids in the plant food sample, this was close to (23.8 g /100g protein) reported for cashew nut by Aremu *et al.*, (2007). Some researchers (Olaofe *et al.*, 1994; Adeyeye, 2004;

Aremu *et al*, 2006a, 2006b; Oshodi *et al.*, 1998) had made similar observation. Other non-essential amino acids detected in sample were serine (2.17 g/100g protein), proline (2.03 g/100g protein), glycine (3.08 g/100g protein), alanine (3.50 g/100g protein) and tyrosine (2.22 g/100g protein). Phenylalanine was the most abundant (8.63g/100g protein) essential amino acid in the sample followed by Isoleucine (7.28), Arginine (6.09), Histidine (5.21 g/100g protein) and Leucine (5.30g/100g protein) which is lower than (6.2g/100g protein) reported for cashew nut by Aremu *et a.l*, (2007) and leucine content of protein concentrate of some Nigerian legumes; liman bean (7.59 g/100g protein), pigeon pea (8.40 g/100g protein) and African yam bean (7.45 g/100g protein) reported by Oshodi *et al.*, (1998). Other essential amino acids detected were Valine (4.0 g/100g protein), Lysine (3.51 g/100g protein), Threonine (2.70 g/100g protein) and Cysteine (0.80 g/100g protein) which was detected at lowest concentration. Both Histidine and Arginine are particularly essential for children (FAO/WHO/UNU, 1985). Result showed that the sample contained all essential amino acids at moderate concentration except tryphtophan which was not detected. The classification of amino acids composition in the sample was shown in Table 4. It revealed that the total amino acids concentration in *canarium* fruit was 83.01 g/100g protein) and the total essential amino acids was (45.15 g/100g protein) at 54.39 % of total while total nonessential amino acids concentration was (37.86 g/100g protein) at 45.61 %. This indicates that the sample contained more than 50 % concentration of nutritionally useful essential amino acids and is also an indication that the fruit could be useful as supplement where essential amino acids are required.

4. CONCLUSION

The result of proximate composition of edible part of *Canarium* fruit revealed that the moisture content was very high and this may accelerate its susceptibility to microbial infection. The fruit had very low ash and fibre contents but contained appreciable amount of lipids, protein and carbohydrates. Due to its high content of fat, *Canerium* seed is suitable as the source of edible oils, alternative source of energy and could be applicable in high-lipid foods such as margarine. The seed also contained appreciable amount of nutritionally valuable minerals such as calcium, potassium, magnesium, sodium, phosphorous, iron, zinc and copper. Glutamic and aspartic acids dominated the amino acid profile of canarium seed, it contained appreciable amount of essential amino acids which was more than fifty percent of total amino acid contents. The study recommended that the seed should be refrigerated at low temperature because of its high moisture content to prevent it against microbial infection and shrinkage of fruit outer surface and the fruit pulp could also be applicable in feed formulation as a supplement where essential amino acids are required.

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