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NUTRITIONAL COMPOSITION AND PHYTOCHEMICAL SCREENING OF AFRICAN ELEMI (*Canarium Shweinfurthii*) SEED

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Abstract
Research on nutritional composition and phytochemical screening of African elemi (Canarium scheinfurthii) seed was carried out to determine the nutritional contents and anti-nutritional factors for possible inclusion in diets for fish. Proximate composition, minerals, amino acid profile and phytochemical screenings were carried out at the Biological Science Laboratory, Federal University of Lafia, Nasarawa State. The result of the study shows that Africa elemi seed contains 7.29%CP, 33.64%CF and 38.23%NFE. Phytochemical screening revealed moderate values for tannin (0.261mg/100g) and flavonoids (0.236 mg/100g) while saponin (0.016 mg/100g), alkaloid (0.078 mg/100g) and phenols (0.030 mg/100g) were in minute quantities. High content of leucine (1.20mgg-[1]) was recorded hence, it could be recommended that African elemi seed meal be supplemented with enzymes to reduce the fibre content of the seed and to aid digestion. African elemi seed may be utilized in fish feed production based on the high content of carbohydrate. African elemi may be supplemented with other ingredients rich in amino acids during incorporation in fish diet.
Key words: Proximate, Minerals, Antinutrient, African catfish, African elemi.

Introduction

In animal production system, nutrition is a key factor to produce an economically healthy and high-quality product. One of the major inputs in aquaculture production is feed and there is also an increasing demand for quality feeds (Pootholathil and Sanal, 2021). The cost of feeds is the most expensive operating cost in fish farming, accounting for over 50% of the total cost of production. This is due to the cost of conventional feed resources such as fishmeal, soyabeans and groundnut (Aderonke, 2020). High cost of fish feed ingredients is observed as one of the problems militating against aquaculture development in Nigeria (Fadlussah *et al*., 2022). Amandeep (2016) reported that a possible way to reduce fish feed costs is finding alternatives to conventional protein and energy sources that are inexpensive, efficient and locally available. Example of such seed is African elemi (*Canarium schweinfurthii)*, which belongs to the family *Burseraceae* and the genus *Canarium* (Wikipedia, 2007). The seeds are embedded in a purplish green pulp which is oily and edible, with a desirable sweet but not too sugary taste similar to that of avocado pear. It can be eaten raw or softened in warm water to improve palatability (Maduelosi and Anyaye, 2015). The seed contained appreciable amount of nutritionally valuable minerals such as calcium, potassium, magnesium, sodium, phosphorous, iron, zinc and copper. The seed has the following proximate composition (%) 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, and energy Kcal/100g 433.14 ± 8.15 respectively (Ayoade *et al.,* 2017).

Mathew *et al.* (2020) reported the proximate composition of the seed as: protein, 6.90%, moisture, 6.00%, fats, 61%, ash, 3.40%, fibre, 7.90% and carbohydrates, 14.80%. The seed-kernel of African elemi (*Canarium schweinfurthii*) contains natural flavours high fat content, pigments, moisture, nutritionally valuable minerals, vitamins and naturally occurring antioxidants (Ayoade, *et al*., 2015). Ayoade *et al.* (2017) reported non-essential amino acids present in African elemi (*Canarium*

schweinfurthii) seeds as 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), glutamin and aspartic acids dominates the amino acid profile of the seed. Phenylalanine is the most abundant (8.63g/100g protein) essential amino acid in the seed followed by Isoleucine (7.28), arginine (6.09), histidine (5.21 g/100g protein) and leucine (5.30g/100g protein). Anti-nutritional factors present in African elemi (*Canarium schweinfurthii*) seed are: saponin, alkaloids, cyanogenic glycosides, oxalate, tannins, phytate and flavonoids (Anyalogbu and Ezejiofor, 2017; Mathew, 2020). Though anti-nutrients present in African elemi *(Canarium schweinfurthii*) are not necessarily toxic per se, through their action, they reduce nutrient intake, digestion, absorption, utilization and may produce other adverse effects in fish (McMeaty, 2013). Therefore, this study was aimed at determining the proximate composition, phytochemical, and amino acids profile of African elemi that can be used to produce diets for fish.

Materials and Methods

Collection of Experimental Materials and Processing

The experimental material African elemi (*Canarium schweinfurthii*) seeds were collected at Jiplik in Pankshin L.G.A. of Plateau State. Sand and roasting pan was used for the roasting of the seed heated to 120^0C thermocouples instrument. Subsequently, roasted African elemi (*Canarium schweinfurthii)* seeds were crushed using hammer mill at the Feed Processing Unit, Faculty of Agriculture, Shabu-Lafia Campus, Nasarawa state.

Nutritional Analysis and Phytochemical Screening

Proximate composition, minerals, amino acid profile and phytochemical screening were carried out at the Biological Science Laboratory, Federal University of Lafia, Nasarawa state. The analysis was conducted for percentage moisture content, crude protein, fats, crude fibre and ash contents was determined using the conventional methods of AOAC (2006).

Phytochemical Screening of African elemi (*Canarium schweinfurthii*) Seed meal.

The powder obtained from the African elemi (*Canarium schweinfurthii*) seed meal was sent to the Federal University of Lafia, Biological Science Laboratory for phytochemical screening for the following parameters: Tannin, alkaloid, saponin, flavonoid and phenol.

Determination of Tannin

To 2 mL of aqueous extract, 2 mL of 5% $FeCl_3$ was added and observed for the formation of yellow brown precipitate (Parekh and Chanda, 2007).

Determination of Alkaloid

1.25 g of the sample was weighed into 250 ml beaker and 50ml of 10% acetic acid was added. It was covered and allowed to stand for 4 hours. This was filtered and the extract was concentrated using a water bath to one quarter of the original volume. Concentrated ammonium hydroxide was added drop wise to the extract until the precipitation was complete. The whole solution was allowed to settle and the precipitate was collected and washed with dilute ammonium hydroxide and then filtered. The residue suspected to be alkaloid was dried and weighed using the method described by Singh, *et al.* (2007).

Determination of saponin

About 5 g of the sample was put in a conical flask, 25 ml of 20% aqueous ethanol were added. The sample was heated over a hot water bath for 4 hours with continuous stirring at about 55˚C. The mixture was filtered and the residue re-extracted with another 50 ml 20% ethanol. The combined extracts were reduced to 10ml 20% ethanol over water bath at about 90˚C. The concentrate was

transferred into a 250ml 20% ethanol separatory funnel and 5 ml 20% ethanol was added and shaken vigorously. The aqueous layer was recovered while the ether layer was discarded. The purification process was repeated and 15 ml of ethanol was added. The combined ethanol extracts were washed twice with 2.5ml of 5% aqueous sodium chloride. The remaining solution was heated in a water bath. After evaporation, the sample was dried in the oven to a constant weight and the saponin content was calculated as percentage as described by Singh *et al*. (2007).

Determination of flavonoid

Two grams of the sample was put in 10 ml alcohol or water. To 2 mL filtrate, few drops of concentrated HCl followed by 0.5 g of zinc or magnesium turnings were added. The solution was observed for the appearance of magenta red or pink colour after 3 min (Parekh and Chanda, 2007).

Determination of Total Phenols

The fat free sample was boiled with 50 ml of ether for the extraction of the phenolic component for 15 minutes, 5ml of the extract was pipetted into 50ml flask and 10 ml of distilled water was added. 2 ml of ammonium hydroxide solution and 5ml of ethanol were added. The samples were made up to the mark and left to react for 30 minutes for colour development. The absorbance of the solution was read using spectrophotometer at 505 nm wave length (Singh *et al.,* 2007).

Statistical Analysis

The results were expressed as mean ± Standard Deviation (SD) of three replicates using STAR software package.

RESULTS

Proximate composition of roasted African elemi (*Canarium schweinfurthii*) seed meal

The results of the proximate composition of roasted African elemi seed meal revealed 4.77±0.11%moisture content, 7.29±0.21crude protein, 33.64±1.32 crude fibre, and 13.21±0.89 ether extract, 2.86±0.01 ash, and 38.23±2.56 Nitrogen Free Extract respectively as shown in Table 1.

Table 1: Proximate composition of the roasted African elemi *Canarium schweinfurthii* Seed (%)

TRT	Content
MC	4.77±0.11
CP	7.29±0.21
CF	33.64±1.32
EE	13.21±0.89
ASH	2.86±0.01
NFE	38.23±2.56

MC, moisture content; CP, crude protein; E.E, ether extract; CF, crude fibre; NFE, nitrogen free extract, %; percent and TRT=treatment.

Phytochemicals of roasted African elemi (*Canarium schweinfurthii)* seed meal

The results of qualitative and quantitative analysis of African elemi seed meal is presented in Table 2. It showed the presence of various constituents such as tannin, alkaloids, flavonoids, saponins and phenol. The results of quantitative analysis show highest content in tannin (0.261±0.02) and flavonoids (0.236±0.02), followed by Alkaloids (0.078±0.01), phenol (0.030±0.00), while Saponins (0.016±0.00) was the lowest respectively. The results of qualitative analysis revealed that tannin and flavonoids were moderately present, while alkaloids, saponins and phenols were present in minute quantities.

Table 2: Phytochemicals of roasted African elemi (*Canarium schweinfurthii)* seed meal

Parameters	Observation	Quantity (mg/100g)
Tannin	XX	0.261±0.02
Alkaloids	X	0.078±0.01
Flavonoids	XX	0.236±0.02
Saponins	X	0.016±0.00
Phenol	X	0.030±0.00

XX=present in a moderate amount, X=present in a minute amount.

Mineral Constituents of Roasted African Elemi (*Canarium schweinfurthii*) Seed Meal

The results of the mineral constituents of the roasted African elemi seed meal is presented in Table 3. The content of copper (25.10±2.56) in the study was the highest, followed by Zinc (18.90±2.34), potassium (5.97±0.11), phosphorus (5.91±0.13) while magnesium was the lowest (3.17±0.02) respectively.

Table 3: Mineral constituents of roasted African elemi (*Canarium schweinfurthii*) seed

Parameters	Quantity
	(mg/100g)
Phosphorus	5.91±0.13
Potassium	5.97±0.11
Magnesium	3.17±0.02
Copper	25.10±2.56
Zinc	18.90\±2.34

Essential and non-essential amino acids in roasted *Canarium schweinfurthii* seeds

The results of amino acid profile of Africa elemi seed meal are presented in Table 4. The essential amino acids show the present of leucine (1.20±0.05), cysteine (0.08±0.01), phenylalanine (0.06±0.01), and valine (0.34±0.00) respectively. However, non-essential amino acids revealed alanine (0.76±0.01) as the highest followed by proline (0.55±0.01), Histine (0.45±0.01) while glycine (0.43±0.01) was the lowest respectively.

Table 4: Essential and non-essential amino acids in roasted *Canarium schweinfurthii* seeds.

Nutrients	**Concentration**
	mg/100g **Protein**
Essential amino acids	
Leucine	1.20±0.05
Cystine	0.08±0.01
Phenylalanine	0.06±0.01
Valine	0.34±0.00
Non-essential amino acids	
Glycine	0.43±0.01
Alanine	0.76±0.01
Proline	0.55±0.01
Histidine	0.45±0.01

Discussion

Proximate Composition of Processed African Elemi Seed Meal

The proximate constituent of feedstuffs provides detail nutrients that make up the material and is an indication of the quality of nutrients from which conclusions may be made as to its usefulness. Moisture content recorded for African elemi seed meal in the study was an indication that it can be stored for a long time without the development of moulds as suggested by Umar *et al.* (2007).

The value of moisture content was lower than 6.0% reported by Mathew (2020) for African elemi pulp and seeds. Amoo (2005), reported 8.0 % for cashew nut and 10.99 %, 9.68 % and 5.12 % respectively were reported for raw, boiled and roasted Treculia *africana* seed by Ayoade *et al.* (2015c). Ayoade *et al.* (2017) reported that high moisture content may accelerate perishability and susceptibility to microbial infection of food product. The crude protein content in the study revealed that the seed meal is not a good source of protein. The seed meal can be used as carbohydrate source in the diets of fish. Crude protein content of 7.29% in the study was lower than 12.67% reported for *Canarium Schweinfurthii* Seed Pulp, also Anhwange *et al.,* (2004) revealed *Moringa oleifera* (40.1 %), *D. microcarpum* (35.96 %) and *B. monandra* (33.09 %) respectively. The content of NFE in the study indicate that the seed meal is rich in carbohydrate which can be used in fish feed production. Dreon *et al.* (1990) reported that carbohydrate content in most fruits and seed depend on the fruit type, maturity and environment. However, carbohydrate content in the study was higher than 24.1% reported by Amoo (2005) for cashew nut and 28.40 % for V. *doniana* reported by Vunchi et *al,* (2011). Carbohydrates is the least expensive source of dietary energy which serve as precursors for dispensable amino acids, lipids and nucleic acid necessary for growth as reported by Maduelosi and Angaye (2015). Crude fibre content obtained for *African elemi* was higher than 1.19% of *Treculia africana* seed by Ayoade *et al.* (2015). High fibre content in feed ingredient may affect digestibility in farmed animals and the result in the current study recommend African elemi seed meal to be supplemented with enzymes to reduce the fibre concentration. This finding is in agreement with Delbert (2010) who suggested amount of crude fiber in fish feeds ingredient to be less than 7 percent in order to limit the amount of undigested

materials entering the culture system. The study revealed that 13.21% of the ether extract, was lower than 34.83 % reported by Ayoade *et al.* (2017) for *Canarium Schweinfurthii* Seed Pulp; between 46.20 - 49.34 % was reported for *Mucuna sp.* by Amoo *et al.* (2009). This study suggests African elemi as source of oil ingredient in fish diet for metabolism, growth and development.
Therefore, ash content of 2.86% is similar with 2.8 % reported for cashew nut by Amoo (2005); 2.1 % reported by Amoo and Lajide (1999) for the fruit of *Nauclea latifolia*. Ash content reported in the study indicates that the seed meal is rich in minerals that can be used to strengthen bones, scales and vomera in fish. Ash content measure total mineral content of food materials (Ayoade *et al*., 2017).

Phytochemical screening and analysis of African elemi seed
In this study, it was observed that tannin and flavonoids were moderately detected while alkaloids, saponins and phenol were observed to be in minute quantities. This implies that roasting of African elemi seed has the tendency to reduce phytonutrient in the seeds. The study proved African elemi could be used as food supplement in the diet of animals especially fish. The low amounts of alkaloids and phenols apparently proved African elemi maybe less toxic but caution should be taken when including it in animals' diet due to the presence of tannin and flavonoids. This is in line with the findings of Udousoro and Akpan (2014); Omenna, *et al* (2016) who confirmed that some levels of anti-nutrients are found in almost all plant foods but are reduced by many traditional methods of food preparation.

Minerals
Minerals are essential chemical elements involved in the normal metabolism of fish. They are required only in trace amounts. In the study, the concentration of copper in African elemi seed meal (2.1 mg/100g) is lower than 2.7 mg/100g reported for *V. doniana* pulp by Vunchi *et al.* (2011). this implies that copper has the ability to make cofactor of some proteins and enzymes when ingested by animals. Copper also helps to keep the blood vessels, nerves, immune system, keeps the bones healthy and also aids in iron absorption (Edwin and Menghe, 2015). Phosphorus helps to initiate enzymes and retain blood pH within a standard range and Lawrence *et al.* (2009) stated 6.70–8.20 g/kg of phosphorus requirement for catfish. The current study recorded values of phosphorus lower than the report of Lawrence *et al.* (2009) for catfish. Availability of dietary phosphorus must therefore be at a level that will neither compromise fish growth nor cause environmental pollution (Mgbenka and Ugwu, 2005). Magnesium which is essential for reproduction, growth and development in farm animals particularly fish. The current study recorded similar value of magnesium as those reported by Mathew *et al.* (2020) who evaluated the chemical and nutritional composition of African elemi pulp and seeds. Deficiency of magnesium in the diet of catfish results to reduced growth, sluggishness and mortality (Sathosh and Sadasivam, 2021). The value of zinc recorded in the study is in accordance with the report of Anyalogbu and Ezejiofor (2017) for African walnut (*Plukenetia conophora*). Zinc recorded in the study was higher than the report of Ayoade *et al.* (2017) of 6.3 mg/100g for *Canarium Schweinfurthii*. Zinc plays a significant role in building protein and healing of damaged tissues (Anyalogbu and Ezejiofor, 2017). Zinc is considered the most abundant trace element after Fe which is essential for cell development in most living organism and its requirement for fish ranged from 33.5-64.6mg/kg (Sathosh and Sadasivam, 2021).

Essential and non-essential amino acids
Amino acids are the building blocks for proteins and substrates for synthesis of low-molecular-weight substances. With the values of amino acids recorded in the study, African elemi shows poor content of amino elements which should be supplemented with other ingredients rich in amino acid during inclusion in animal's diet (Ayoade *et al.,* 2017). Leucine in this study was lower than

6.2g/100g reported for cashew nut by Aremu *et al.* (2007); liman bean (7.59 g/100g), pigeon pea (8.40 g/100g) and African yam bean (7.45 g/100g) reported by Oshodi *et al.* (1998). In the study, the value of leucine suggests that African elemi seed could be rich in leucine and seemingly deficient in phenylalanine. Leucine was reported by Umar *et al.* (2007) to plays important role in the growth and health of animals and its requirement for fish falls between 1.61 – 2.55%. The value of phenylalanine in a study conducted by Ayoade *et al.* (2017) for proximate, minerals and amino acid profile of *Canarium Schweinfurthii* Seed Pulp was 8.63 g/100g higher than the value recorded in this study. Shabihul and Imtiaz (2022) suggested that ingredients deficient in phenylalanine should be supplemented with alternative sources rich in amino acid for phenylalanine. The content of leucine can stimulate muscle protein synthesis and also inhibit protein degradation in skeletal muscle as well as in liver. It was observed that African elemi seed are low in concentration of valine, cysteine, histidine, proline, glycine and alanine than the report of Ayoade *et al.* (2017) for *Canarium Schweinfurthii* Seed Pulp who recorded valine (4.0 g/100g) cysteine (0.80 g/100g), histidine (5.21g/100g) proline (2.03g/100g), glycine (3.08g/100g) and alanine (3.50g/100g) respectively.

Conclusion and Recommendation

In conclusion, African seed meal was found to contain protein content (7.29%) which can be used to replace maize (7.71%) and other sources of energy in animal diets. The roasting of African elemi seed may reduce the content of phytochemicals. Yet contain high amounts of copper and zinc. Meanwhile, it was observed that African elemi seed was apparently poor in amino acids. However, it could be recommended that African elemi seed meal be supplemented with enzymes to reduce the fibre content of the seed and to aid digestion. African elemi seed may be utilized in fish feed production based on the high content of carbohydrate. African elemi seed could be supplemented with other ingredients rich in amino acids during incorporation in animal's diet.

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