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Proximate, Mineral, and Amino Acid Compositions of *Dacryodes edulis* (African Pear) Seeds gotten From the Same Parent Tree in Ekpoma in Esan Central Local Government Area of Edo State, Nigeria

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ABSTRACT: The objective of this paper was to investigate the proximate, mineral, and amino acid compositions of Dacryodes edulis (African Pear fruit) Seeds gotten from the same parent tree in Ekpoma in Esan Central Local Government Area of Edo State, Nigeria using appropriate standard methods. The proximate analysis results of *D. edulis* seeds showed varied values ranging from 39.03±1.16 (%) for carbohydrate to 3.16±0.26 for ash. The amino acid profile of *D. edulis* seeds showed the presence of eight amino acids (Alanine, glutamine, leucine, lysine, phenylalanine, proline, threonine and tryptophan) with different concentrations, which ranged from 6.18 Pmol/g for threonine to 29.21 Pmol/g for proline. Similarly, the mineral analysis results showed the presence of twelve elements (Cadmium, cobalt, copper, iron, manganese, nickel, zinc, calcium, magnesium, potassium, sodium, and phosphorus) with the lowest mineral value of 20.00±0.97 mg/kg given by copper and the highest value of 17316.31±46.06 mg/kg obtained from potassium. Therefore, this study has shown that *D. edulis* seeds are rich in nutrients, containing both essential and non-essential amino acids, and their similarity to other poultry diets will allow for their substitution.

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Dacryodes edulis, commonly known as African plum, African pear, or Safou, is a fruit tree that is native to the humid lowlands and plateau regions of West, Central African, and Gulf of Guinea countries. *Dacryodes edulis* belong to the Burseraceae family. This tree is native to the central Africa and Gulf of Guinea regions, and it remains green all year round. The genus name is derived from the Greek word 'Dakruon' (a tear) in reference to the resin droplets that appear on the bark surface of its species. The scientific name edulis indicates that the species is apposite for consumption. The Dacryodes genus consists of approximately 40 species that can be found in the tropical regions of the Americas, Asia, and Africa (Swana *et al*., 2023). In Africa, approximately 20 species have been identified. It is referred to as 'Olumu' by the Esan / Bini people of Edo State and 'Ube' by the Igbos in the southeastern part of Nigeria. *D. edulis* is a fruit tree that originates from Africa. In southern Nigeria, the trees are cultivated near homes and bloom occurs between January and April. The primary fruiting season occurs from May to October. This fruit is a yearly occurrence, measuring approximately 3 cm in diameter. It consists of a tough outer shell encasing

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a juicy layer that is approximately 5 mm thick. The pericarp has a texture similar to butter. This part of the pear is consumed, whether it's eaten raw or cooked, creating a kind of "butter." In addition, the pulp contains 48% oil and a plantation has the potential to produce 7-8 tonnes of oil per hectare (Ogunsuyi, 2015). The fruits of *D. edulis* can be eaten, while the bark, leaves, stem, and roots have various uses. In Nigeria, *D. edulis* is primarily consumed for its fruit, which can be enjoyed in various ways such as raw, cooked, boiled, or roasted.

The cooked flesh of the fruit has a smooth and creamy texture. The oil derived from *D. edulis* fruit is abundant in amino acids and triglycerides, making it a valuable addition to our existing oil sources for human consumption (Nyong, 2023). Various components of the plant, including the leaf, stem, root, and fruit, have been found to generate essential oils of different types, such as monoterpene, sesquiterpene, diterpene, and triterpene (Swana *et al*., 2023). Additional studies on the plant have explored various aspects such as the antibacterial activities of the essential oil (Obame *et al*., 2008), levels of heavy metals (Akinola and Adenuga, 2008), nutritional composition and microbial spoilage (Omogbai and Ojeaburu, 2010), and the antibacterial components found in the leaves (Swana *et al*., 2023). According to a study by Okolo *et al*. (2016), the African Pear seed has been found to possess unique qualities that can be utilized for human nutrition. However, there has been minimal effort to capitalize on the unique activities of the seed in order to enhance human nutrition.

Typically, the seeds of numerous African fruits are often thrown away once the tasty pulp has been consumed (Okolo *et al*., 2016). According to Iyawe (2009), *D. edulis* seeds pose a significant environmental waste issue during the fruit's peak season. A substantial rise has occured in research interest in exploring the valuable potentials that plants and plant seeds possess. Consequently, many plant materials have become increasingly valuable and useful to humans. However, there are numerous plant materials that have yet to be fully utilized, and *D. edulis* seeds serve as a prime example, as highlighted by Iyawe *et al*. (2007).

The African Pear fruit holds significant value in terms of its nutritional and economic importance. Unfortunately, there hasn't been much progress in exploring the possibilities of its seeds. Thus, when the fruit of *D. edulis* is in season, the seeds become a notable environmental waste issue (Iyawe, 2009). The African Pear fruit holds great importance both in terms of nutrition and economic value. Unfortunately, not much has been done to tap into the seeds' full potential.

MATERIALS AND METHODS

Plant Sample Collection and Preparation: Fresh, matured and ripe *D.edulis* (Olumu/ Ube) seed were gotten from the same parent tree in Ekpoma in Esan Central Local Government Area of Edo State and identified at the Botany Department of Ambrose Alli University by Prof. O.O. Obaduni. The seeds were carefully removed, cut into pieces for easier drying and air dried. The dried seeds were ground by mortar and pestle, and filtered through a 40 mm sieve to obtain a fine powder and used for the assays.

Proximate and Mineral Analyses: The proximate analysis on the dried *D. edulis* seed sample was done by the AOAC method (1995), while the analysis for the trace metals and essential minerals were done using atomic absorption spectrophotometer (AAS) model 210/211 VGP Buck scientific, while Na and K were analyzed using Flame photometer model Jenway PFP-7, UK.

Amino acid analysis: Amino acid composition of the raw *D.edulis* (Olumu/ Ube) seed were done using HPLC (Shida *et al*., 1981).

Statistical Analysis: Data obtained from this experiment were subjected to analysis of variance (ANOVA) using the computer software (Graphpad Prism 6.0 software, SanDiego, CA). $p<0.05$ was considered significant and differences between means were separated by Tukey-Kramer multiple comparison test.

RESULTS AND DISCUSSION

Table 1 shows the proximate analysis results of *D. edulis* seeds with varied values. The highest proximate value of 39.03±1.16 (%) was obtained from carbohydrate, while the lowest proximate content was given by Ash (3.16±0.26). Proximate evaluation is essential for assessing the nutritional content of plants since it offers a fundamental comprehension of a sample's composition. It offers information that aids in the categorization and comparison of a sample with established data (Okoro *et al.*, 2019; Okoro, 2023). Although the proximate and nutritional constitution of the African pear fruits, largely the pulp and to a lesser extent the seed have been mentioned by some authors, but it has also been widely reported that the geographical locations where plants are grown have significant impact on their dietary profile (Okeke *et al*., 2021; Bouzid *et al*., 2022). Thus, the proximate makeup of plants is said to vary among different

varieties and impacted by the geographical positioning and meteorological circumstances (Akporido and Okoro, 2022). Hence, in this study, the proximate examination of the raw sample was done to determine the nutritional constitution of the *D. edulis* seeds.

Table 1: Proximate Analysis Results of *D. edulis* seeds.

S/N	Parameters	Values
1	Moisture Content (%)	9.55±0.66
2	Crude Fibre (%)	36.95±0.36
3	Crude Fat (%)	9.28±0.78
4	Protein (%)	3.81±0.40
5	Ash (%)	3.16±0.26
6	Carbohydrate (%)	39.03±1.16

** Values are presented as Mean ±SD*

The results for the proximate examination of *D. edulis* seeds showed varied values with the highest proximate value being obtained for carbohydrate, while the lowest proximate content was seen in Ash. The results of proximate and mineral makeup of *D. edulis* seed agrees with earlier reports on the Proximate and Mineral Elements Compositions in the African pear (Ogboru *et al*., 2016; Oluwaniyi *et al*., 2017; Lekpoabari *et al*., 2021). According to Bratte *et al.* (2010), *D. edulis* seed contains only trace amount of the essential and non-essential amino acids and can act as a close substitute for maize in poultry diets because of its similarity to maize in terms of its soluble carbohydrate and protein contents.

Table 2: Amino acid composition of D. edulis seeds

S/N	Amino Acids	Conc. (Pmol/g)
1	ALA	18.7261
2	ARG	-
3	ASN	-
4	ASP	-
5	CYS	-
6	GLN	-
7	GLU	15.3275
8	GLY	-
9	HIS	-
10	ILE	-
11	LEU	16.4182
12	LYS	7.9533
13	MET	-
14	PHE	28.2147
15	PRO	29.2136
16	SER	-
17	THR	6.17629
18	TRP	19.2381
19	TYR	-
20	VAL	-

**-: not detected*

Oluwaniyi *et al*. (2017) reported that crude fibre (46.33%) and carbohydrate (54.23%) were more abundant in the *D. edulis* seed than the fruit pulp. Also, Lekpoabari *et al*. (2021) reported that the highest percentage of (44.0%) for carbohydrates relative to other proximate analysis parameters in *Dacryodes edulis* seeds.

The amino acid profile of *D. edulis* seeds (Table 2) shows eight amino acids detected with different concentrations, which ranged from 6.17629 Pmol/g for threonine to 29.2136 Pmol/g for proline.

In this experiment, the amino acid constitution of *D. edulis* seed was done to be certain of the amino acids types present in the seed because, according to Abdul-Mumeen *et al.* (2024), the quality and quantity of amino acids composition of a crop is a function of its environment and region. The results of the amino acid constitution of the seeds showed eight amino acids with different concentrations. Amino acids are bifunctional molecules and the fundamental structural components of proteins. They are essential for the synthesis of bodily proteins and other significant nitrogenous substances, including creatine, peptide hormones, and some neurotransmitters. The distinctiveness of various proteins is dictated by their constituent amino acids. The interplay of enhanced genetic potential and modifications in management practices affects the nutritional requirements of chicken. Historically, nutritionists have concentrated on fulfilling amino acid requirements for optimal production performance and yield. Increasing certain amino acid concentrations can boost gastrointestinal growth and integrity, improve immune response potential, impact behavior, and promote sustainability (Okoro, 2020; Okoro, 2023). The Mineral Analysis Results of *D. edulis* seeds is presented in Table 3. The lowest mineral value of 20.00±0.97 mg/kg was given by copper and the highest value of 17316.31±46.06 mg/kg was obtained from potassium.

Table 3: Mineral Analysis Results of D. edulis seeds

S/N	Element(mg/kg)	Values
1	Cadmium	27.77±2.19
2	Cobalt	102.07±6.17
3	Copper	20.00±0.97
4	Iron	689.63±22.92
5	Manganese	40.71±0.75
6	Nickel	92.10±4.95
7	Zinc	69.65±3.54
8	Calcium	284.91±5.74
9	Magnesium	1192.00±24.38
10	Potassium	17316.31±46.06
11	Sodium	608.31±22.49
12	Phosphorus	3556.09±50.72
13	Chromium	ND

**ND= not detected; ** Values are presented as Mean ±SD*

In this study, the mineral analysis of the *D. edulis* seed was done because, according to Yao *et* al. (2024), nutritional composition of plants varies according to climatic zone. Also, minerals salts are reported to assume a significant role in the process of fermentation and are said to affect microbiological stability (Kounbesiou *et al.*, 2010). Moreover, the importance of vitamins, minerals and nitrogen in fermentation

processes have been stated (Maisonnave *et al.*, 2013; Roca-Mesa *et al*., 2022). The results of the mineral assay showed copper with the lowest value while the highest value was got for potassium. The nutritional needs of microbes utilized in industrial fermentation processes are intricate and diverse, reflecting the variety of the bacteria themselves (Kampen, 2014).

In addition to energy, organisms necessitate a supply of resources for the manufacture of cellular components and the functioning, upkeep, and reproduction of cells. These materials must supply all the elements necessary to accomplish this. Certain microbes employ elements as simple compounds, while others necessitate more complicated compounds, typically associated with the manner in which they will be integrated into cellular components. Minerals provide essential materials to cells throughout cultivation. Phosphorous occurs principally in the form of sugar-phosphates, such as the nucleotides which compose DNA, RNA, and ATP. Phosphorus is assimilated in its inorganic form where the phosphate ion is esterified. Sulfur is commonly supplied as H_2SO_4 for pH adjustment, and as ammonium sulfate and potassium bisulfate. Many of the other elements are found complexed with enzymes: e.g., Mg^{2+} with phosphohydrolase and phosphotransferase, K^+ with pyruvate phosphokinase (and Mg^{2+}), and Na^+ with plasma membrane ATP-ase (and K^+ and Mg^{2+}) (Nicholls *et al*., 2023).

Requirements for trace elements may include iron (Fe^{2+} and Fe^{3+}), zinc (Zn^{2+}), manganese (Mn^{2+}), molybdenum (Mo^{2+}), cobalt (Co^{2+}), copper (Cu^{2+}), and calcium (Ca^{2+}). The functions of each vary from serving in coenzyme functions to catalyze many reactions, vitamin synthesis, and cell wall transport. The needs are often minimal and may occasionally be met by concentrations present in water or leachates from equipment. Trace elements may facilitate the synthesis of both primary and secondary metabolites (Kampen, 2014).

Manganese can influence enzyme production. Iron and zinc have been found to influence antibiotic production. Primary metabolite production is usually not very sensitive to trace element concentration, however, this is a different matter for secondary metabolite production. Micronutrients, comprising vitamins and minerals, are vital for optimal development, growth, and disease prevention. They are crucial to practically all bodily processes, including the synthesis of enzymes and hormones, as well as the facilitation of the immune system. The influence of micronutrients on health is paramount, and a shortage in any of them can lead to serious and perhaps fatal illnesses (Kampen, 2014; Okoro *et al.*, 2019).

Conclusion: The proximate analysis results of *D. edulis* seeds showed varied macronutrient values. Also, the amino acid profile of *D. edulis* seeds showed the presence of amino acids, namely Alanine, glutamine, leucine, lysine, phenylalanine, proline, threonine, and tryptophan. Similarly, the mineral analysis results showed the presence of cadmium, cobalt, copper, iron, manganese, nickel, zinc, calcium, magnesium, potassium, sodium, and phosphorus with different concentrations. This study has therefore demonstrated that *D. edulis* seeds are rich in nutrients as they contain both essential and non-essential amino acids and can be substituted for other poultry diets because of their similarity

Conflict of Interest Declaration: The authors assert that no conflict of interest exists.

Data Availability Statement: The authors assert that the data for this research can be obtained upon request from the relevant author.

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