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Nutritional characterization of *Detarium microcarpum* Guill. & Perr., seeds used as a soup thickener in Bayelsa State.

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ABSTRACT:

Background: This research was carried out to determine the nutritional and phytochemical constituent of *Detarium microcarpum* seeds commonly known as 'ofor' used in Otuoke, Bayelsa State and Environs.

Methods: Fresh fruits of *Detarium microcarpum* were collected from secondary forest in Otuoke and identified. Dry ground seeds were analyzed for mineral elements, proximate composition and phytochemical constituent. Mean and standard error were calculated for the data collected.

Results: Data collected revealed that seeds of *D. microcarpum* are a rich source of essential minerals like magnesium (57.20 mg/100 g) and potassium (46.30 mg/100 g), which are vital for health and functionality of human heart. However, the content of manganese was relatively low (0.16 mg/100 g). Values for proximate content showed high carbohydrate content (63.37%), crude proteins (17.21%) and crude ash (2.81%) which make the seeds a source of balance meal. Furthermore, low water content (8.64%) was observed, which is essential for storage. The results obtain for phytochemical analysis revealed the presence of alkaloids (1.50 mg/ 100 g), tannins (2.97 mg/100 g), flavonoids (1.22 mg/100 g), saponins (1.02 mg/100 g), oxalates (0.53 mg/100 g) and phytates (0.74 mg/100 g).

Conclusion: The result obtained in this study demonstrated that seeds of *Detarium microcarpum* are a good source of vital nutrients and bioactive compounds which can enhance planetary health.

Keywords: *Detarium microcarpum;* nutritional component; phytochemicals; proximate constituent.

1. INTRODUCTION

The world`s population is growing fast, and sufficient food is needed to create a balance between economic development and poverty eradication for a healthy and sustainable ecosystem [1]. Plants have been used in the past decades for nutritional and medicinal purposes in both developing and developed countries. Majority of the World's populations depend mainly on plant and their products for there survival [2]. Humans consume food for different purposes, either for therapeutic, nutritional or for pleasure. Certain food eaten by humans might have toxic effect on the body [3]. Insufficient consumption of proteins and micronutrient has been identified as the main cause of infant malnourishment and other diet-related diseases in under developed countries of the world [4,5]. There has been a global increase in food supply from increased agricultural yield in the past few decades [6]. Despite the increase in dietary supply, the nutritional value of food we consume is inadequate. Indigenous trees has been used in sub sahara Africa for the past decades for food, nutrition and traditional medicinal. They are prospect for income generation if their potentials are maximize [7,8,9]. There has been a dearth of information concerning the nutritional and therapeutic component of many native trees, which has resulted in poor documentation in science and often not acknowledged in

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sustainable development strategies for poverty alleviation [10, 11]. As a result, the nutritional and therapeutic capacity of most traditional trees consumed as food are underestimated and underutilized [12]. It is therefore vital to evaluate the nutritional constituent of the food we consume to estimate sufficient nutrient intake for nourishing individuals at all levels [13]. Adequate information will help facilitate the selection of priority tree food species for domestication programs aimed to foster food security, economic advancement, biodiversity management and conservation. [9]. *Detarium microcarpum* seeds commonly known as 'ofor' by the Ibos; 'ogbogbo' by the Yorubas and 'taura' by the Hausas is a legume native to tropical and Sub tropical Africa regions of the world [14, 15,]. *D. microcarpum* belongs to the family leguminosae and sub-family caesalpiniacea with three main species; *D. microcarpum; D. senegalense* and *D. hendelotianium* [16]. Flours from 'ofor' seeds have been found to be used in most Eastern regions of Nigeria including Imo, Anambra, Akwa Ibom and Ondo States. They are used as thickeners, emulsifiers and flavouring agents in traditional soups due to their gum content (for eating garri, pounded yam or semo and fufu). These gums are hydrocolliods in nature. [17,18]. flours from the seeds of these legumes have been termed 'unexploited'. The edible fruits of *D. microcarpum* are a rich source of vitamins C, the root stems, bark are medicinal [19]. Foods, fruits, vegetables are vital immune boosters that help the body fight sicknesses [20]. Phytochemicals have proven to be potent immuno-modulators for therapeutic purposes. The phenolic acids, flavonoids and tannins are the major group of plant secondary metabolites exhibiting immuno-modulating activity and they are frequently found in vegetable and fruits. Phytochemicals contain high antioxidant which have anti-inflammatory properties and thus recommended to mitigate hyper-reacted immune responses which damage tissues through oxidative stress [21]. Immuno-modulators have been utilized for the treatment of various allergic diseases including asthma and allergic rhinitis [22]. Hence, dietary approach is a new model recommended to boost immune and reduce risk of many diseases such as COVID-19. [23]. The consumption of these soup thickeners made it necessary for more research to provide information on their mineral, phytochemical compositions and properties of their constituents so as to determine their actual nutritional benefit, health and other medicinal importance. Also the growing need of the Nigerian Populace calls for immediate analysis on the functionality of locally consume foods so as to increase their utilization. The objective of this study is to determine the mineral nutrients, Proximate and phytochemical composition of *D. microcarpum* seeds in order to maximize and develop strategies for sustainable utilization as a dietary resource. *D. microcarpum* is a shrub with an irregular top with a height of 5-10 m. The tree is easily identified by its leaves which is about 15 cm long, paripinnate or imparipinnate [24,25], with translucent ones. The fruit of *D. microcarpum* is a globular, flattened drupe of 3 to 8 cm in diameter. [26], which is made up of three main parts: the epicarp, mesocarp or pulp, which is intermingled with fibers inserted on the stone (edible pulp) and the stone.

2. MATERIALS AND METHODS

2.1. Materials

The materials used in this experiment were sourced from Biology Laboratory, Federal University Otuoke, Bayelsa State, in alliance with the Laboratories in the environ. Analysis of mineral elements was determined using a drying oven, electric blender, porcelain crucible, a muffle furnace, Hot plate, volumetric Flask Water bath, and atomic absorption spectrophotometer. Proximate analysis required the following materials to determine the nutritional constituent of seeds; a beaker, desiccators, Lenton furnace, cotton wool, extraction flask, porous thimble, soxhlet, Whatmann No. 1 filter paper, Water bath and spatula. Gem filter paper, electronic weighing balance, test tubes, Bunsen burner, burette stand, burette, pipette, funnel, weighing bottle, glaze tile, wire guaze, spectrophotometer, chemical balance were used to determine the phytochemical analysis. Sack bags were used collection of plant samples.

2.1.1. Biological materials

D. microcarpum fruits were collected from the secondary forest in Otuoke, Bayelsa State, Nigeria.

2.1.2. Chemicals and reagents

Chemical reagents in the University Laboratories were used while other were purchased. $HNO_3/HCL/H_2O$, deionized water were needed for determination of mineral element. Petroleum ether ($600cm^3$) was used for analysis of crude fat, 100 cm^3 of 1.25% H_2SO_4, 100 cm^3 of 1.25% NaOH, 1:1ethanol and acetone were used for crude fibre content. Conc. H_2SO_4, $NAOH/NA_2SO_3$, 4% boric acid, indicators, HCL were required for determination of crude proteins. 10% acetic acid, absolute ethanol, diethyl ether, n-butanol, sodium chloride, conc. Ammonium hydroxide, for alkaloid. aqueous methanol for flavonoids, oxalic acid, potassium permanganate solution,1.0M Sulphuric acid, Folin -Denis reagent, sodium carbonate solution for phytochemical analysis.

2.1.3. Equipment and Apparatus
Kjeldhal Apparatus,

2.2. Methods
2.2.1. Analysis for mineral composition of Detarium microcarpum seeds.
Mineral composition was determined according to method of Shahidi *et al.* [27]. Air dried seeds were macerated into small component. The samples were dried in an oven at 100^0C for 4 hours and then milled with an electric blender to powder form. 2 g each of samples were weighed into a cleaned porcelain crucible and subjected at 450°C in a muffle furnace to dry ash. The resultant ash was dissolved in 5ml of $HNO_3/HCL/H_2O$ (1:2:3) and heated gently on a hot plate until brown fumes disappeared. To the remaining materials in each crucible, 5 ml of deionized water was added and heated until a colourless solution was obtained. The mineral solution in each crucible was filtered into a 100 ml volumetric and the volume made to the mark with distilled water. This solution was used for elemental analysis by atomic absorption spectrophotometer. A 10 cm long cell was used and concentration of each element in the sample was calculated on percentage of dry matter.

2.2.2. Proximate Analysis:
Air dried seeds were ground to powdered form and analyzed for their proximate compositions using the Official methods as described by AOAC, [28].

2.2.3. Determination of Phytochemical content:
Alkaloids were determined by the method described by Harbone [29]. Tannins were determined by the method of Pearson [30]. Method of Obadoni and Onyeka [31] was used to determine the saponin content while the flavonoids were determine by methods of Boham and Kocipal-Abyazam [32]. Similarly, methods of Oberlease *et al.*, [33] was adopted for Phytates composition and Oxalates was determine by the titration method.

2.2.1. Study Area
This experiment was conducted in Federal University Otuoke, Bayelsa State. The location is a secondary forest habitat which is partially or completely swampy. Otuoke is located at coordinates of 4°42'23.418"N 6°19'44.472"E.

2.2.2 Sample Collection and Identification
Fresh seeds of *Detarium microcarpum* were collected from secondary forest in Otuoke, Bayelsa State, Nigeria. The samples were taken to the Department of Biology and identified by in the Herbarium before pretreatment for Laboratory analysis.

2.2.3. Sample preparation
The collected *D. microcarpum* fruits were manually dehulled with a hammer to remove the seeds from the pericarp. The obtained seeds were air dried for three days.

2.3 Statistical analysis:
Mean and standard error were calculated for the data collected. Analysis of variance (ANOVA) was done using GENSTAT (version 12). Differences between treatment means were determined at 0.05 level of probability.

3. RESULTS
The mineral element composition of *Detarium microcarpum* seeds are presented in Table 1 showed high content of calcium, Magnesium, sodium and potassium

Table 1: Mineral element composition of *Detarium microcarpum* seeds

	Mineral composition in seeds of *Detarium microcarpum*	Determined values in (mg/100 g)	Daily nutritional goals/source of goal [76,77,78]
1	Calcium	38.14 ±0.27	700-1300 (RDA) mg/day children 1000-1300(RDA) mg/day adult
2	Magnesium	57.20± 0.33	80-360(RDA) mg/day children 360-480 (RDA) mg/day adult
3	Sodium	18.21± 0.46	1200-2300 1500-2300 adult (CDRR) mg/day
4	Potassium	46.30±0.61	2000-2300 2300-3400 adult (AI) mg/day
5	Nitrogen	2.16±0.17	0.15-0.2 (RDA) g/kg/day
6	Phosphorus	4.21±0.20	460-1250 500-1250 adult (RDA) mg/day
7	Iron	0.20±0.03	7-15 children(RDA) mg/day 15-18 adult(RDA) mg/day
8	Manganese	0.16±0.05	1.8-2.3 adult (SI) mg/day
9.	Copper	0.42±0.02	1- 4 (RNI) mg/day adults
10	Zinc	0.36±0.07	3-9 (RDA) mg/day children 5-11 (RDA) mg/day adult

Values are means of triplicate analysis

Values obtain from proximate analysis of *Detarium microcarpum* seeds are presented in Table 2. The seeds have relatively low moisture content, moderate fat content and rich in proteins and carbohydrates.

Table 2: Proximate values in seeds of *Detarium microcarpum*

	Proximate parameters	Proximate values obtained from seeds(mg/100 g)	Daily nutritional goals/source of goal (78)
1	Carbohydrates	63.37± 0.32	130 g (RDA) children 130 g/d (RDA) Adults
2	Crude proteins	17.21±0.24	13-52 g/d (RDA) children 46-46 g/d (RDA) adult
3	Crude fat	5.07±0.13	25-40 g/d (AMDR) children 20-35 g/d (AMDR) adults
4	Crude ash	2.81±0.22	
5	Crude fibre	2.90±0.32	14-31 g (14g/1000k.cal) children 20-34 g (14g/1000kcal) adult
6	Moisture content	8.64±0.53	

Values are means of triplicate analysis

Results obtain from phytochemical analysis of *Detarium microcarpum* seeds are presented in Table 3. Relatively low phytochemicals were observed in this study.

Table 3. Phytochemical analysis of *Detarium microcarpum* seeds

	Phytochemicals analyzed	values obtained from (mg/100 g) of seeds
1	Alkaloids	1.50±0.36
2	Tannins	2.97±0.44
3	Flavonoids	1.22±0.67
4	Saponins	1.02±0.55
5	Oxalates	0.53±0.04
6	Phytates	0.74±0.08

Values are means of triplicate analysis

4. DISCUSSION

The mineral content of *Detarium microcarpum* seeds are shown in table 1. Potassium and sodium help to regulate body hemostasis which is essential for co-regulating ATP. Potassium is a vital cellular cation that facilitates intracellular osmotic pressure [35]. The potassium contents in seeds of *D. microcarpum* was 46.30 mg/100 g and sodium, 18.21 mg/100 g. The results are in agreement with the experiment of Ndulaka *et al.* [3] who reported potassium content of 56.82 mg/100 g in *D. microcapum* and 20.62 mg/100 g in sodium. The calcium content obtained in this study was high with a value of 38.14 mg/100 g. The findings in this study is contrary to the report of [36,37,38,39] who recorded calcium content of (0.35 g.100 g-1) in raw seeds of *D. microcapum*. Calcium is a vital mineral which forms structural component of bones and teeth. It is also facilitates muscle contraction, blood coagulation and nerve impulse transmission. Iron is also an essential constituent of cellular proteins and enzymes like hemoglobin and cytochrome P450. Iron deficiency is the major clinical cause of anaemia in females of reproductive age [40]. The iron content in seeds of *D. microcarpum* was very low 0.20 mg/100 g, this observation is in confirmation with the earlier claims of [36,37,38,39] who showed relatively lower value of 0.012 g.100 g-1. Despite the low iron content, its level in seeds of *D. microcarpum* is vital as a value of 0.031 g·100 g-1, is considered the minimum nutritional intake recommended by FAO/WHO which are 0.009 g·day-1 for males to 0.027 g·day-1 for females [46]. The magnesium contents of 57.20 mg/100 g does not correspond with the findings of Umaru *et al.* [41] who reported that pulps of the plant contain 20.5 mg/100 g magnesium. Similar report from Tchatcha [42] in Benin republic recorded lower values of (0.24 g.100 g-1). The difference in mineral composition in legumes might be due to variety or location, loamy soils retained in guinea savannah might be different from the ones found in mangrove savannah in Bayelsa State [43]. Manganese is vital for bone, nerve, brain, thyroid functioning and other cellular enzymatic reactions [44]. Manganese value recorded in this report was very low 0.16 mg/100, the experiment of Nwokocha and Nwokocha [45] who found 1.7mg/kg validates the lower levels observed in this report but contradicts the report of Balogun and Fetuga [46] who showed higher value of 195mg/kg. This result also contradicts the report of Issa *et al*. [47] whose experiment in Cotonou observerd higher values of 135.54mg/kg. The variations in the contents of the different mineral elements observed in the present study, across countries could be due to the different soils compositions [47]. The low Phosphorus value of 4.21 mg/100 g obtained in this report contradicts the high value shown in the experiment of Umaru *et al*.; [41] with a value of 170 mg/100 g. The observed low Copper content of 0.42 mg/100 g validates earlier report of Oibiokpa *et al.* [48] who also observed lower values in pulp of *D. microcarpum* . Low Nitrogen content was observed in *D. microcarpum* in this research and there is a dearth of information in this regard. The proximate compositions in seeds of *D. microcarpum* revealed crude protein composition of 17.21 mg/100 g which corresponds with the report of Ndulaka *et al.* [3] who observed a protein value of 16.02% in seeds of *D. microcarpum*. The value obtained in this study was higher than that reports of Igwenyi and Akubugwo [49]. The moderate content of plant proteins in *D. microcarpum* has the potential to provide the essential amino acids required for healthy growth and repair of tissues as dietary proteins are relatively scarce [50]. Proteins are fundamental elements for metabolism of enzymes, hormones and many other molecules essential for life [51]. The crude fat content in seeds of *D.microcarpum* of 5.07 mg/100 g was close to the findings of Odenigbo and Obizoba [52]. Fats are a major source of energy and are the essential fuel for the brain and growing fetus [53]. They enhance flavour and palatability of food and make an important contribution to health. Food containing essential fatty acids that cannot be synthesized in the body are required for a range of metabolic and physiological processes to maintain the structural and functional integrity of cell membranes [54]. The percentage crude fiber in the seed 2.90 mg/100 g, contradicts the report of Akpata and Miachi [55], Barminas *et al*.,[56] who both reported higher values of crude fibre content. Fiber has many health benefits and can reduce the risk of diabetes [57] and high blood cholesterol [58]. Fiber reduces the transit time for dietary nutrients to circulate the gastrointestinal tracts, reduces low density lipoprotein and maintains gut health. Fibre rich food may modulate the digestive and absorptive process [59]. The high carbohydrate composition of the seeds 63.37 mg/100 g are comparable with the work of [60], who recorded 60.17% in *Brachystegia eurycoma* (Achi) and 51.03% in *D.microcarpum* .The result is also in line with the work of Ejiofor [61]. A high carbohydrate content is a major source of readily available energy [62, 63]. The ash content in seeds of *D. microcarpum* were also investigated and a value of 2.81 mg/100 g was recorded. The ash composition were comparable to values reported by Barminas *et al*. [56] for *Xylopia ethiopica* which is also used as a soup thickener. Similar reports for ash content were found, ranging between

1 and 7% according to the experiment of [55, 36, 37, 64, 38]. Ash content can be use to evaluate food quality, high content of dry matter in food guarantees higher shelve-life thereby limiting microbial and pest spoilage during storage [65, 66]. The percentage moisture contents was relatively low, 8.64 mg/100 g and the value obtained in this study is in agreement with earlier work of Ndulaka *et al*. [3] who observed moisture content of 10.96%. Relatively low moisture content ranging from 2.2 to 16.7% was observed by [55, 36, 37, 64, 38]. However, the report of Uhegbu *et al*.; [36] and Amandikwa *et al*. [37] recorded higher values of (11.7-16.7%) which contradicts the finding in this study. *D.microcarpum* seeds contain some phytochemicals that can be removed or inactivated by different processing methods [35, 36, 37]. Phytate is a phytochemical that inhibits the absorption of iron, calcium, zinc, and other minerals, [67]. Although the toxicity dosage and effect of this antinutrient have not been well established or documented [68], Phytate level of 0.74 mg/100 g obtained in *D.microcarpum* seed in this study is not negligible. However, pre-treatments like soaking, fermentation and cooking before usage of the seeds can help reduce the negative effect and enhance quality of consumption [69, 70]. The Phytate (0.26%) contents reported earlier by Obun *et al*. [71] corresponds with the value obtained in the present study. However, our values are lower than 5.57% reported by Anhwange *et al*. [35]. The content of tannins in seeds of *D. microcarpum* in this study with a value of 2.97 mg/100 g contradicts the lower values obtain in the experiment of Peace and Adekunle [64], Michael *et al*. [38] who both reported a range of (0.67-0.74 mg·100 g-1). This observed difference between the different results could be due to environmental conditions experienced by the seeds. Similarly, the saponin value of 1.02 mg/100 g, in this study is contrary to values (0.040.4 mg·100 g-1) obtain in the work of Peace and Adekunle [64], Michael *et al*. [38]. Earlier findings by Tchatcha *et al.* [42] who document lower values of oxalates 0.18 mg.100 g-1 is in line with the values obtained in this study with a level of 0.53 mg/100 g. Oxalates content of (0.04-0.86 mg·100 g-1) according to Michael *et al*. [38] also corresponds with the findings in this report. Similarly, the flavonoids content of 1.22 mg/100 g in this report is close to the record of Peace and Adekunle [64] who recorded (0.13-1.82 mg·100 g-1). Flavonoids are termed "nature's biological response modifiers" because they have been established experimentally to have the capacity to modify the body's reaction to foreign bodies. They show anti-allergic, anti-inflammatory, anti-cancerous and anti-microbial activity [72, 73]. Flavonoids are antioxidants which help to protect cells from lethal effects, free radicals and their derivatives [74]. A diet rich in phenols and flavonoids helps to boost the innate antioxidant-based defense system in the human body [74]. Alkaloids have been used as analgesics in the treatment of diseases and during surgery due to their therapeutic and pharmacological potency [75]. The alkaloids content (0.2-1.05 mg·100 g-1) reported by Anhwange *et al.* [35], Uhegbu *et al.* [36], Amandikwa *et al*. [37], Peace and Adekunle [64], Michael *et al*. [44] is in agreement with the value of 1.50 mg/100 g obtained in this study. Processing methods have been known to influence the phytochemical composition of these seeds as demonstrated by Peace and Adekunle [64] and Michael *et al*. [38] on the effects of some processing methods on the phytochemical composition of *D. microcarpum* seeds, and found that roasting, soaking and boiling treatments reduced the anti-nutrients concentration in *D. microcarpum* kernels significantly.

5. CONCLUSION

The result obtained in this study reveals that *D. microcarpum* seeds have some vital nutritional components that can improve human health and thereby create a balance between economic development and poverty eradication for a healthy and sustainable ecosystem. More research is needed to bring to light the mechanism behind the physiological and biochemical effects of this legume and other crops on human health, especially in our present day where we truly need an increase in dietary supply and adequate nutritional value of food we consume.

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Conflict of Interest

No conflict of interest was observed between the three Authors.

Contribution of the Authors

Mrs. Esther Omone Akhigbe and Prof. Mbosowo Etukudo were fully in charge of the sample/data analysis while Kelechi Joe-Ezeoke was in charge of sample collection and preparation. The Compilation of this paper was organized collectively by the three authors.

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