Original Research Article

The Phytochemical and Nutritional Constituents of Leaf Extracts of Two Edible Medicinal Plants in Nigeria: A Comparative Appraisal

Comment [BL1]: Title should not start with the Definite article "The"

ABSTRACT

Comment [BL2]: Structure of the abstract lacks research problem, research methodology and conclusion.

Botanicals derived from plants with medicinal attributes are an indispensable component of existence today. They enhance good health, particularly for residents in remote areas where access to appropriate nutrition and healthcare is often a challenge. In the present investigation, the phytochemical and nutritional constituents of ethanol leaf extracts of two significant plants with nutritional and therapeutic relevance, *Dennettia tripetala*, and *Aframomum melegueta*, were comparatively examined through the exploration of established protocols. In the phytochemical investigation, *D. tripetala* has a predominance of alkaloids (4.91 %), terpenes (3.03 %), saponins (3.76 %), flavonoids (6.10 %), and tannins (5.89 %). Contrarily, no significant difference ($p > 0.05$) was observed in the cardiac glycoside contents of *D. tripetala* (2.25 %), and *A. melegueta* (2.38 %). The proximate data shows a greater proportion of moisture (13.11%), protein (10.54%), fibre (5.01 %) and carbohydrate (59.36 %) contents in *D. tripetala*. However, *A. melegueta* had a greater quantity of ash, and lipids (11.76 %, and 7.46%) than *D. tripetala* (6.52 %, and 5.42 %). The elemental assessment of the leaves shows that the concentrations of calcium, magnesium, sodium, potassium, iron, manganese, and phosphorous in *A. melegueta* were significantly higher ($p<0.05$) than those of *D. tripetala*. The opposite results were obtained for the levels of Zinc and Copper in *A. melegueta* and *D. tripetala* respectively. Therefore, the differential compositions of the chemical components present in leaf extracts of the two plants have given an insight into the best source of active principles and nutrients among them, to exploit in medicinal preparations and diet formulations for combating diseased conditions induced by pathogenic organisms and nutritional inadequacies respectively.

KEYWORDS: *Dennettia tripetala*; *Aframomum melegueta*, Medicinal plants; Phytochemicals; Nutrient composition; Leaf extract

1. INTRODUCTION

Comment [BL3]: Provide a factual background, clearly defined problem, proposed solution, a brief literature survey and the scope and justification of the work done.

The widespread recognition of the therapeutic and nutritional efficacies of plants in the management of a diversity of pathologies and malnourishment in populations is due in great measure to the presence of an extensive repertoire of biologically active phytoconstituents [1]. Moreover, the primary sources of remedies utilized by prehistoric man to treat sicknesses were plants' seeds, leaves, roots, and bark [2]. Additionally, several medications used in contemporary

medicine to treat an array of disorders emanated from botanicals that have gone through several stages of analytical technique-based refinements [3, 4]. The theory behind plant-derived medications is that they are naturally occurring compounds that are capable of improving health and treating diseases, and they are also substantially economical [5]. When these plant-based constituents are utilized for the purposes of healthcare and nourishment, their potency is a consequence of the chemical makeup of their individual components [6].

Dennetia tripetala also known as *pepper fruit*, belongs to the family, Annonaceae. It is a significant native plant of West Africa and is widely distributed in Cameroon, Ivory Coast, and Nigeria. The tree's height and girth are approximately 12 to 15 metres and 0.6 metres, respectively. The fruits, which are initially green before turning red when they ripen, have a spicy, strong, and sharp flavour [7, 8].

Information gathered from folklore medicine indicated that the seeds are employed for treating rheumatism, diarrhoea, fever, and cough. It also stated that locals brewed tea from the leaves of the plant [9]. They are also used to stop nausea, soothe sore throats, increase appetite, reduce tongue coating, and check excessive salivation. As food condiments, fruits and leaves of the plant are frequently added to prepared foods including vegetables, sausages, soups, meat, and stew [10]. The seeds also play a significant role in postpartum diets for women in the eastern part of Nigeria [11].

Several biological activities, such as anti-inflammatory, anti-snake venom, anticonvulsant, antitrypanosomal, antimalarial, antioxidant, antidiarrheal, antibacterial, and antiparasitic attributes have also been associated with the plant [12]. Furthermore, a plethora of investigations have shown that *D. tripetala* contains considerable levels of nutrients and plant-based products which contribute to its therapeutic properties [13–15].

Aframomum melegueta often referred to as *Alligator pepper* (family: Zingiberaceae), is a famous plant with dietary and therapeutic benefits. It is extensively distributed throughout tropical Africa, notably in Nigeria, Ghana, Cameroon, Togo, Liberia, Sierra Leone, and Cote d'Ivoire [16]. This plant is capable of growing to a height of 1.5 metres. The leaves are roughly 12 centimetres long and 30 centimetres wide with narrow venation on the underside [17]. The fruit is ovoid, reddish in colour and contains several tiny, pointed brown-coloured seeds that taste like cardamom. The fruit pulp is consumed in West Africa as a revitalising stimulant, and the seeds as well as the leaves are employed as food condiments and in traditional herbal remedies.

Aframomum melegueta is additionally employed as a curative agent for a wide range of illnesses, including diabetes, cardiovascular disease, snakebite, diarrhoea, chickenpox, smallpox, wounds, cough, anaemia, rheumatism, measles, malaria, toothache, and birth control [18, 19]. With this plant, beneficial pharmacological properties including antibacterial, anti-inflammatory, hepatoprotective, anti-cancer, antinociceptive, and anti-diabetic activities, have also been documented [20, 21]. The presence of various secondary metabolites in *A. melegueta* such as flavonoids, alkaloids, tannins, terpenoids, saponins, steroids, cardiac glycosides and phenol have been reportedly linked to its therapeutic benefits just as is the case with other medicinal plants [15, 22].

In view of the foregoing, the seeds of *D. tripetala* and *A. melegueta* have been employed as food condiments in the preparation of certain cuisines and as a cure for a myriad of illnesses in several regions of Nigeria. In addition, a considerable amount of research has been done on the fruits and seeds of both plants. However, relatively little information exists in the literature regarding the phytochemical and nutritional constituents of their leaves and their distinctive efficacies. Thus, the present study was necessary to examine the phytochemical and nutritional constituents of the leaf extracts of *D. tripetala* and *A. melegueta* for greater exploitation of their therapeutic and nutritional properties.

2. MATERIALS AND METHODS

2.1. Collection and identification of Plant samples

The leaves of the two plants utilized in this study, *Aframonum melegueta* and *Dennettia tripetala* were freshly obtained from their native environment in Ibeleberi town, Ogbia Local Government Area, Bayelsa State, Nigeria. A certified taxonomist from the Department of Plant Science and Biotechnology of the University of Port Harcourt, Rivers State, Nigeria, did the identification and certification of the samples. Thereafter, specimens of the leaves were maintained in the herbarium unit of the said department and voucher numbers UPH/P/128 and UPH/V/1282 were assigned to *A. melegueta* and *D. tripetala* respectively.

Comment [BL4]: English need improvement.

2.2. Sample preparation and extraction

Sequel to the proper cleaning of the leaves of *A. melegueta* and *D. tripetala* of any earthy impurities, they underwent drying at room temperature for two weeks. Thereafter, pulverization of the leaves was done with the aid of an electric blender. Subsequently, 100 g of each triturated plant material was subjected to a soxhlet extraction procedure with 500 mL of 80 % ethanol. The solution obtained was left to evaporate in a water bath maintained at 40 ^{o}C. The resultant extracts were then stored in airtight containers until required for further utilization.

Comment [BL5]: Don't use pronoun like they

2.3 Quantitative Phytochemical Screening of Leaf Extracts of *D.tripetala* and *A. melegueta*

2.3.1 Determination of tannins

The tannin content of the samples was determined by Folin Denis colourimetric method [23]. A measured weight of the sample (5.0g) was mixed with distilled water in a 1:10 (w/v) ratio. The mixture was shaken for 30 minutes at room temperature and filtered to obtain the extract. A standard tannic acid solution was made, and two millilitres (2 mL) of it and a similar amount of distilled water were combined in a 50-millilitre (50 mL) volumetric flask. Both solutions were employed as the standard and the reagent blank, respectively. Thereafter, two millilitres (2 mL) of each of the sample extracts were put in their respective labelled Flask. One millilitre (1 mL) of the Folin Denis reagent was added to each flask after each had its contents combined with 35 mL of distilled water. Two and a half millilitres (2.5 mL) of saturated Na_2CO_3 solution were added after that. Subsequently, each flask was diluted with distilled water to the 50 mL mark and let sit at room temperature for 90 minutes. In a spectrophotometer, their absorbance was calculated at 760 nm with the reagent blank set to zero. The calculation for the tannin content is displayed below:

$$\textbf{\% Tannin} = \frac{\mathbf{100}}{\boldsymbol{W}} \times \frac{\boldsymbol{au}}{\boldsymbol{as}} \times \boldsymbol{C} \times \frac{\boldsymbol{vt}}{\boldsymbol{va}}$$

Where:

W = weight of the sample

au = absorbance of the test sample

as = absorbance of standard tannin solution

C = concentration of standard tannin solution

vt = total volume of the assay mixture

va = volume of extract analyzed.

2.3.2 Determination of alkaloids

This was done using a modified version of the Harborne method [24] developed by Biradar and Rachetti [25]. Two hundred millilitres (200 mL) of 10% acetic acid in methanol was added to 5 g of the sample, which was then placed in a 250 mL beaker, capped, and let to stand. It was filtered after 4 hours, and the filtrate was then concentrated to around 25% of its initial volume in a water bath. The extract received dropwise additions of concentrated NH_4OH till precipitation was stopped. The mixture was allowed to settle, and the precipitate was then collected, purified with dilute NH_4OH, and finally filtered. The residual material was dried and weighed in percentage as follows:

$$\textbf{\% alkaloid} = \frac{\boldsymbol{weight\ of\ alkaloid}}{\boldsymbol{weight\ of\ sample}} \times \mathbf{100}$$

Comment [BL6]: Sentence structure need improvement. Don't start sentence with "This was done"

2.3.3 Determination of flavonoids

The flavonoid content of the leaf extracts of the plants was determined in accordance with the method of Boham & Kocipai [26]. A 250 cm^3 beaker containing 50 cm3 of 80% aqueous methanol was added 2.50 g, of each sample, and then left to stand for 24 hours at room temperature. Three further extractions using the same volume of ethanol were performed on the residue after the supernatant was discarded. The entire solution of each leaf sample was filtered using Whatman filter paper No. 42 (125 mm). The filtrate from each solution was then put into a crucible and dried over a water bath. In a desiccator, the crucible and its contents were cooled before being weighed repeatedly to get a constant weight. The mathematical representation of the flavonoid content is as follows:

$$\textbf{\% flavonoid} = \frac{\boldsymbol{weight\ of\ flavonoid}}{\boldsymbol{weight\ of\ sample}} \times \mathbf{100}$$

2.3.4 Determination of saponins

With a few minor adjustments, the methodology of Obadoni and Ochuko [27] was employed for the quantitative estimation of the saponin contents of the leaf extracts of the plants. Ten grammes (10 g) of each of the plant material was placed in a conical flask along with 50 mL of 20% aqueous methanol. This mixture was heated to a temperature of 55 °C for 4 hours while being continuously stirred. Following filtration, 100 mL of 20% aqueous methanol was used to re-extract the residue. In a water bath set to 90 °C, the extracts were then mixed and diluted to 40 mL. Subsequently, ten millilitres (10 mL) of diethyl ether was added to the concentrate in a separating funnel, and it was steadily agitated. The aqueous layer was retrieved, the ether layer was disposed off, and the process of purification was carried out once more. After adding 30 mL of n-butanol, the n-butanol extracts underwent two separate washings with 10 mL of 5% aqueous NaCl. Sequel to the evaporation of the residual solution, the samples were further dried in the oven to a constant mass and then the saponin content was expressed in percentage as indicated below:

$$\textbf{\% saponin} = \frac{\boldsymbol{weight\ of\ saponin}}{\boldsymbol{weight\ of\ sample}} \times \mathbf{100}$$

2.3.5 Determination of terpenoids

To calculate the levels of total terpenoids in the leaves, Ferguson's method [28] was applied. The powdered leaves (2 g) were combined with 50 mL of 95% ethanol for 24 hours. Using Whatman No. 42 filter paper, the mixture was filtered before being collected. Thereafter, petroleum ether was used to extract the filtrate between 60 to 80 °C before being dried in a water bath at 65°C. Below is a formula used to determine the percentage of all terpenoid content:

$$\textbf{\% } \boldsymbol{total\ terpenoid} = \frac{\boldsymbol{weight\ of\ residue}}{\boldsymbol{weight\ of\ the\ sample}} \times \mathbf{100}$$

2.3.6 Determination of cardiac glycosides

The technique adopted by El-Olemy *et al.* [29] was employed. Each test tube containing about 1 g of the plant leaves was filled with 10 mL of ethanol (70%). At room temperature (25 °C), the test tube was covered, put in a shaker, and shaken for 6 hours at 300 rpm. Following that, the mixture was filtered using Whatman No. 42 filter paper. To precipitate tannins, resins, and pigments, the filtrate was treated with 5 mL of distilled water and 1 mL of 12.5% lead acetate. After adding distilled water up to 8 mL, the mixture was shaken for 10 minutes at 300 rpm in a

shaker. To precipitate the extra phosphorus ions, 2 mL of 4.77% disodium hydrogen phosphate (Na_2HPO_4) solution was added. The resulting solution was filtered using Whatman No. 42 filter paper to get a clean filtrate. The filtrate was then dried by evaporation in an oven at 40 °C. Below are the calculations used to determine the percentage cardiac glycoside content:

$$\% \text{ cardiac glycosides} = \frac{weight\ of\ residue}{weight\ of\ the\ sample} \times 100$$

2.4 Proximate Analysis of Leaf Extracts of *D.tripetala* and *A. melegueta*

2.4.1 Moisture content determination

The moisture content of the samples was ascertained using the method of the Association of Analytical Chemists [30]. At 105°C, a clean, flat plate was dried for 15 minutes. After 15 minutes of cooling in the desiccator, it was weighed (W_1). A 2 g sample that had been thoroughly mixed was added to the dish (W_2). The dish was cleaned and heated for 4 hours at 105˚C in an oven. After 15 minutes of cooling, the dish was taken from the desiccator, covered, and weighed as soon as feasible (W_3).

$$\% \text{ moisture} = \frac{(W_2 - W_3)}{(W_2 - W_1)} \times 100$$

2.4.2 Ash content determination

The moisture content of the samples was evaluated by employing the method of the Association of Analytical Chemists [30]. Crucibles are heated for at least 15 minutes in a muffle furnace. They are then taken out, given 30 minutes to cool in a desiccator, and weighed. Two grammes (2 g) of each sample are measured into several dishes (crucibles). The plates are set on a hot plate inside a fume chamber, and the temperature is gradually raised until smoking stops and the sample is completely charred. The dishes are then placed in the middle of the muffle furnace and heated until thoroughly ashed (when the ash turns a noticeable grey hue). The ash-filled dishes were then placed in desiccators, allowed to cool, and weighed.

Comment [BL7]: Spelling mistake

Let W_1 be the sample weight.

Let W_2 be the ash's weight.

$$\% \text{ ash} = \frac{W_2}{W_1} \times 100$$

2.4.3 Lipid content determination

The lipid composition of the leaf samples was determined using the Soxhlet extraction method as adopted by Nwachoko *et al.* [31]. Following the assessment of the sample's moisture content, 5 g of dry samples were weighed and placed in the thimble. 250 mL of a round bottom flask were cleaned, dried at 105 °C for 30 minutes, cooled to room temperature in a desiccator, and then weighed. Each thimble containing a sample was put into the extractor, and 150 mL of ethyl ether was measured into the round bottom flask. The condenser was linked to a water tap and the heating mantel was turned on, setting up the extractor. The lipids were extracted for 6 hours, and the solvent (ethyl ether) was recovered. The round bottom flask was heated to 105°C for 30 minutes, and subsequently transferred to a desiccator to cool, with the weight documented. The percentage lipid composition was calculated as follows:

$$\% \text{ lipid composition} = \frac{\text{Weight of lipid}}{Weight\ of\ sample} \times 100$$

2.4.4 Crude Protein Determination

The procedure outlined by Chang [32] in accordance with Kjeldahl's method was utilized. To calculate the protein content, the amount of nitrogen in the sample was calculated and multiplied by 6.25. In a digestion flask, the sample (0.5 g) and 10 mL of concentrated H_2SO_4 were combined. Prior to heating it under a fume cupboard until a clear solution (the digest) was obtained, a selenium catalyst tablet was introduced to it. The digest was further diluted to a volume of 100 mL in a volumetric flask. In a Kjeldahl distillation apparatus, 10 mL of the digest and an equivalent amount of 45% NaOH solution were combined. Following that, three drops of mixed indicator (bromo cresol green/methyl red) were added to 10 mL of 40% boric acid after the mixture was distilled. Distillates were collected in a total of 50 mL, and they were titrated against 0.02 N EDTA from a green colour to a deep red colour as the endpoint. Also digested, distilled, and titrated was the reagent blank. According to the following formula, the nitrogen content and consequently the protein content were determined:

1 mL of 1 N H_2SO_4 = 14 mg

Nitrogen (%) = $\frac{100}{W} \times \frac{N \times 14}{1000} \times \frac{V_t}{V_a} \times T \times B$

Protein (%) = Nitrogen (%) x 6.25

2.4.5 Crude Fibre Determination

The method of James [33] was used to determine the crude fibre. The sample (5.0 g) was heated to a boil in 150 mL of 1.25% H2SO4 solution over reflux for 30 minutes. The sample was cooked and then purified multiple times in hot water using a two-fold cloth to retain the particles. It was re-introduced to the flask and heated for a further 30 minutes in 150 mL of 1.25% NaOH under the same conditions. The sample was washed several times in hot water and left to drain dry before a known quantity is transferred to a weighted crucible and dried at 105°C to a consistent weight. After that, it was brought to a muffle furnace where it was burned, leaving nothing but ash. The difference was used to determine the weight of the fibre, which was then expressed as a percentage of the sample weight:

Crude fibre (%) = $\frac{W_2 - W_1}{Weight\ of\ sample} \times 100$

2.4.6 Carbohydrate Determination

The total percentages of moisture, ash, crude fat, crude protein, and crude fibre was deducted from 100 [34] to obtain the total amount of carbohydrates:

% Total Carbohydrate = 100 - (% Moisture + % Ash + % Fat + % Protein + % Fibre

2.5 Elemental Determination

Atomic Absorption Spectroscopy (AAS) was used for the elemental analysis in accordance with the procedure outlined by the Association of Official Analytical Chemists [35]. Two grammes (2g) of each of the samples were digested in a hot plate for 20 minutes at 110°C using 20 mL of HCl and 2 mL of perchloric acid. The samples were evaporated to almost dryness, diluted with 20 mL of 2% (v/v with water) nitric acid, filtered through Whatman No. 42 paper, and then diluted to 100 mL with deionized distilled water. The metals' appropriate salts were employed to create their standards, and lamps were fixed. Thereafter, the air-acetylene burner was adjusted

for flame and the AAS machine was calibrated for the element's wavelength. The test sample digest was introduced into the AAS machine, and the absorbance was measured. The concentration of each element in the samples was calculated from the calibration curve using the absorbance readings for each element of the sample.

2.6 Data Analysis

The one-way analysis of variance (ANOVA) and Tukey post hoc test were employed to analyze the data using the Statistical Package for the Social Sciences (Version 21). Results were given as the mean of three replicates ± standard error of the mean (S.E.M). At 95% (p<0.05), a statistical significance was deemed to exist.

3. RESULTS

Comment [BL8]: Results lacks statistical analysis. Provide results in graphs, images, ANOVA and correlation

3.1 Phytochemical Constituents of *A. melegueta* and *D. tripetala* Leaves

The quantitative phytochemical components of the leaves of *A. melegueta* and *D. tripetala* are shown in Table 1 below. D*ennettia tripetala* had considerably higher levels (p<0.05) of tannin, flavonoid, saponin, alkaloid, and terpenoid than *Aframomum melegueta*. However, the cardiac glycoside content of *A. melegueta* and *D. tripetala* did not differ significantly (p>0.05).

Table 1: Phytochemical constituents of *A. melegueta* and *D. tripetala* Leaves

Phytochemicals	*A. melegueta*	*D. tripetala*
Tannins (%)	4.34± 0.02	5.89 ± 0.18*
Alkaloids (%)	3.01 ± 0.01	4.91 ± 0.02*
Saponins (%)	2.31 ± 0.03	3.76 ± 0.02*
Flavonoids (%)	4.87 ± 0.01	6.10 ± 0.03*
Terpenoids (%)	0.87 ± 0.16	3.03 ± 0.05*
Cardiac Glycosides (%)	2.38 ± 0.03	2. 23 ± 0.10

Values are represented as Mean ± Standard Error of Mean (S.E.M) in triplicate.
(*****) = Mean values along the same row are significantly different ($p \leq 0.05$).

3.2 Proximate Composition of *A. melegueta* and *D. tripetala* Leaves

Table 2 gives an overview of the relative composition of nutrients in *A. melegueta* and *D. tripetala* leaf extracts. The findings demonstrated that *D. tripetala* had considerably higher quantities (p<0.05) of carbohydrates, moisture, crude protein and crude fibre than *A. melegueta*. However, *A. melegueta* had more ash and lipids.

Table 2: Proximate Composition of *A. melegueta* and *D. tripetala* Leaves

Parameters	*A. melegueta*	*D. tripetala*
Moisture (%)	10.30± 0.01	13.11 ± 0.01*
Ash (%)	9.76 ± 0.07	6.52 ± 0.03*
Lipid (%)	7.46 ± 0.02	5.42 ± 0.01*
Crude Protein (%)	8.28 ± 0.01	10.54 ± 0.03*
Crude Fibre (%)	7.35 ± 0.09	5.01 ± 0.01*
Carbohydrate (%)	52.82 ± 0.02	59.36 ± 0.10*

Values are represented as Mean ± Standard Error of Mean (S.E.M) in triplicate.
(*****) = Mean values along the same row are significantly different ($p \leq 0.05$)

3.3 Elemental Composition of *A. melegueta* and *D. tripetala* Leaves

Table 3 displays the mineral constitution of *A. melegueta* and *D. tripetala* leaf extracts. *Aframomum melegueta* had considerably greater percentage compositions (p<0.05) of calcium, sodium, magnesium, potassium, manganese, potassium, and phosphorous than *Dinnetia tripetala*. In contrast to *A. melegueta, D. tripetala* had considerably greater (p<0.05) quantities of the mineral elements, zinc and copper.

Table 3: Elemental Composition (mg/100g) of *A. melegueta* and *D. tripetala* Leaves

Mineral Elements	*A. melegueta*	*D. tripetala*
Calcium	23.44± 0.01	13.57 ± 0.08*
Magnesium	18.57 ± 0.01	8.06 ± 0.02*
Sodium	19.20 ± 0.02	15.73 ± 0.01*
Potassium	26.72 ± 0.01	23.22 ± 0.10*
Iron	4.58 ± 0.01	2.01 ± 0.03*
Manganese	4.36 ± 0.01	1. 79 ± 0.01*
Copper	0.01± 0.01	0.09 ± 0.01*
Zinc	0.07 ± 0.02	0.55 ± 0.01*
Phosphorous	1.72 ± 0.01	0.51 ± 0.02*

Values are represented as Mean ± Standard Error of Mean (S.E.M) in triplicate.
(*) = Mean values along the same row are significantly different ($p \leq 0.05$)

4. DISCUSSION

Comment [BL9]: Discussion needs improvement

Today, the universe has given us access to a vast range of plants that can be utilized both as nourishment and healthcare. The phytochemical makeup of these plants is a noteworthy characteristic. Accordingly, their tremendous advantages have caused researchers to continually discover additional benefits of plants to mankind. In the current investigation, tannins, flavonoids, alkaloids, terpenoids, saponins and cardiac glycosides were present in *D. tripetala* and *A. melegueta* leaves in varying quantities. This outcome is in tune with previously published informations on *D. tripetala* leaves [12, 15, 36, 37]. The proportions of some of these phytochemicals, however, are inconsistent with those of the current study. This is exemplified in

the tannin (0.68%), flavonoid (21.00%) and alkaloid (26.14%), contents of *D. tripetala* reported by Okoronkwo *et al.* [36] and the tannin (3.18%), flavonoid and alkaloid (1.18%) saponin (0.04%) and cyanogenic glycoside (0.61%) contents of *D. tripetala* reported by Odoh and Emechebe [37] which do not conform with the tannin (5.89%), flavonoid (6.10%) and alkaloid (6.00%), saponin (3.76%) and cyanogenic glycoside (2.25%) contents of the said plant obtained in this study. The techniques employed, the timing of harvest, variations in the extraction solvent, and local edaphic, environmental and meteorological variables could be contributory to the discrepancies that were detected. Notwithstanding, the saponin content (3.77%) reported by Okoronkwo *et al.* [36] coupled with the flavonoid (6.09%) and alkaloid (4.84%) contents reported by Mordi *et al.*[13] are consistent with the findings of this study.

Due to its astringent qualities, tannin speeds up the recovery of injuries and inflammations in mucous-secreting tissues [38]. Additionally, in an earlier report, saponins were connected with the propensity to trigger hemolysis, heal wounds, and act against fungal disease-causing organisms [39]. Furthermore, saponins have also been recently reported [40] to possess a hypocholesterolemic effect through their binding of cholesterol and ensuing prevention of cholesterol absorption. Similarly, *D. tripetala's* potential utility as a fundamental therapeutic agent is suggested by the higher amount of alkaloids detected in the leaves of the plant. Alkaloids have reportedly been used in the production of medicines. Moreover, it has been observed that the majority of plants used in ill health treatments, including analgesics, antimalarials, antibiotics, and antispasmodics, contain an alkaloid [36, 41].

Flavonoids possess antioxidant and anticancer properties [42]. Terpenoids have been associated with a number of biological characteristics, including having hypoglycemic properties, boosting transdermal absorption, and having antiviral, antitumour, anti-inflammatory, antibacterial, and antimalarial actions [43]. Thus, it is reasonable to state that the higher tannin, flavonoid, saponin, alkaloid and terpenoid contents in *D. tripetala's* leaf extract not only justifies its applications in herbal therapies but invariably suggests that it may be a preferable source of active ingredients in medicinal preparations for the treatment of hypercholesterolemia, injuries including burns, inflammations, plasmodial and other microbial infections when compared with *A. melegueta*.

The values obtained for the tannin (0.16 %), flavonoid (2.15 %), saponin (0.14 %) and alkaloid (0.29 %) contents of leaf samples of *A. melegueta* by Okwu and Njoku [44] are not in line with

those of the present study. Plausibly, differences in soil characteristics, climatic factors and analytical procedures could have influenced the outcome of their investigation. However, in their report, the flavonoid content of the leaf sample was the highest among the various phytochemicals examined. This trend is in concordance with the findings of this study. Moreover, the non-significant (p>0.05) and relatively low amounts of cardiac glycosides in *A. melegueta* and *D. tripetala* are indicative that both plants could be future therapeutic candidates for cardiac-related ailments. This is because minute quantities of cardiac glycosides have reportedly been shown to boost cardiac muscle contraction without a corresponding increase in oxygen consumption, thus enhancing the myocardium's capability to fulfil the circulatory system's demands efficiently [45].

Examination of the proximate content of a plant component is necessary to determine its nutritional relevance since its utilization depends on the variety and amount of constituents it possesses. The values reported for the proximate composition of carbohydrate (56.9 %) and ash (6.2 %) contents of *D. tripetala* by Okoronko *et al.* [36] are comparable to the values obtained for the said nutrients (59.36 % and 6.52 %) in the present study. However, the values reported for crude protein (0.7 %), lipid (18.2 %), crude fibre (8.7 %) and moisture contents (9.3%) by the same authors are not comparable to the respective values obtained (10.54 %, 5.42 %, 5.01 %, and 13.11%) in this study. Again, differences in edaphic and climatic factors and location could be responsible for the discrepancies in values.

In addition to being crucial for the upkeep and nutrition of plant and animal life, carbohydrates are a prominent class of naturally existing organic substances. The body receives the fuel and energy it requires from its expenditure for both daily tasks and exertion [46]. While carbohydrate deprivation results in the loss of bodily tissue, adequate carbohydrate is also necessary for the brain, heart, neurological system, digestive system, and immune system to function at their best [47]. Since the present study reveals that *D. tripetala* leaves have a higher carbohydrate content, they could be a better choice in terms of energy provision for the daily operations of the human system when compared with their counterpart, *A. melegueta* leaves.

The moisture content of a food component determines its water activity and reflects how stable and susceptible it is to contamination by microorganisms. Thus, the moisture content is a function of how perishable an item is [47, 48]. Though the moisture content of *D.tripetala* was

greater than that of *A. melegueta*, their moisture content values agree with the report of Rishi *et al.* [50] who stated that an acceptable range of moisture in most vegetables is between 6% and 15%. Thus, the leaves of both plants may have a high resistance to food-spoiling microbes and have the capability to last longer when preserved.

The amount of ash a plant component contains is indicative of its mineral composition. It also reveals whether a plant is highly digestible or not [51]. The higher content of ash observed in *A. melegueta* leaves demonstrates how abundant the plant leaves are in dietary nutrients when compared with *D. tripetala*. Dietary fibre fosters development and safeguards healthy gut flora. Additionally, it has been suggested that increased intake of fibre improves digestion and lowers the incidence of colon cancer [52]. Moreover, plants that possess high fibre content are employed in the treatment of digestive disorders, malignant tumours diabetic conditions and obesity [53]. Apparently, *A. melegueta* leaves may serve as a better option for employment in the treatment of the aforementioned disorders.

The higher protein content of *D. tripetala* leaves suggests that they may be better repositories of enzymes, hormone precursors and components for maintaining fluid balance, growth and repair of worn-out tissues when compared with *A. melegueta* leaves [51]. Concomitantly, the higher lipid content of *A. melegueta* leaves is indicative that they may contain more essential fatty acids and fat-soluble vitamins necessary for the proper functioning of the body and a better contributor to food palatability[54] than those of *D. tripetala*.

In order to gain insight into medicinal plants and identify the range of elements that are linked to their applications and credibility, elemental analyses are conducted. This implies that these elements also have an impact on the nutritional and therapeutic properties of plants. A holistic view of the results obtained for the mineral elements of the leaves of the two plants revealed that *A. melegueta* contains higher concentrations (over 75%) of the majority of the mineral elements examined in this study. This outcome could have been a result of its higher ash content displayed in the proximate analysis of the plant.

Calcium is essential for the good formation of the bones and teeth, the healthy operation of the muscles of the heart, the blood coagulation system, regulation of cellular permeability and nerve-impulse dissemination [55]. According to Shomar [56], sodium and potassium present in human

intracellular and extracellular fluids support the maintenance of membrane fluidity and electrolyte balance. Moreover, a study carried out by the British Medical Journal Group [57] has revealed that a value of about 1.0 is acceptable for the ratio of sodium/potassium in a given food component since higher values have been linked to heart diseases. The sodium/ potassium ratio of the leaves of the two plants, *A. melegueta* (0.72) and *D. tripetala* (0.68) are within the acceptable limit.

Haemoglobin contains iron, which aids in the delivery of oxygen from the lungs to various parts of the body. Iron could also be employed in the treatment of anaemia. Hence, the leaves of *A. melegueta* having a higher haematunic property than its counterpart, may be employed as part of the components utilized in the preparation of natural remedies for anaemic conditions. Among the trace elements investigated in the two leaf samples, zinc and copper had the lowest concentrations. Though present in trace amounts, they are necessary for the basic physiological processes of the body. The cells of the immune system require zinc for its proper functioning. Zinc is also administered as a prophylactic and therapeutic component for various maladies including diarrhoea, pneumonia and respiratory infections [58]. Copper, on the other hand, is a vital mineral needed for a variety of biological processes such as enzymatic and oxidation-reduction reactions [59].

CONCLUSION

This study revealed the presence of potent phytochemicals, nutrients and mineral elements in the leaf extracts of *Aframomun. melegueta* and *Dennettia tripetala*: Higher concentrations of tannin, alkaloid, saponin, flavonoid, and terpenoid were found in *Dennettia tripetala*. On the other hand, *Aframomum melegueta* contained more ash, lipid, and fibre. With the exception of copper and zinc, the elemental analysis clearly demonstrated that *A. melegueta* possessed higher quantities of macronutrients and trace elements. The nutritional and therapeutic uses of the leaves of the two plants as food supplements and therapeutics to correct various health shortcomings have thus been reasserted by this study.

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Comment [BL10]: References should be up-to-date.

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