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# Proximate Analysis, Vitamins, and Mineral Compositions of *Zingiber officinale, Ocimum gratissimum* and their Herbal Blend

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**Abstract**

The nutritional composition of the aqueous extract of the leaves of *Ocimum gratissimum*, *Zingiber* officinale roots and their mixture were evaluated by investigating their proximate composition, vitamin, and mineral composition following standard biochemical methods. Proximate analysis of the herbal blend revealed the percentage moisture, crude protein, crude fiber, crude fat, and ash, as 15.84%, 13.62%, 0.36%, 1.84%, 2.92%, respectively surpassing the content from individual extracts. However, the carbohydrate content and total energy ranked in descending order of magnitude; aqueous extract of ginger (76.30%; 350.78 kCal) > scent leaf (70.03%; 345.29 kCal) > ginger -scent leaf blend (65.41%; 332.66 kCal). The vitamin and mineral content in the herbal mixture investigated showed higher concentrations of Vitamins (A, $B_1$, $B_2$, $B_3$, C, E) and minerals followed the same pattern. Nevertheless, aqueous extract of ginger showed a higher content of calcium. These findings contribute to a better understanding of the nutritional composition of these popular culinary ingredients and highlight their potential health benefits.

***Keywords:*** *Medicinal plants, Nutrient composition, Secondary metabolites, Ocimum gratissimum, Zingiber officinale, herbal mixtures*

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## Introduction

The traditional practice of extracting crude plant extracts through methods such as decoction, infusion, and tincture are prevalent worldwide. However, scientific scrutiny is ongoing to determine their effectiveness and mechanisms of action. Studies in ethnopharmacology and medical ethnobotany emphasize the importance of phytotherapy across different regions, regardless of civilization. It was estimated that over two billion people globally (34% of the world's population) rely on medicinal plants as their primary treatment, but there is paucity of exact appraisals of their use for treating ailments worldwide. Although there are no records, quantitative estimations of herbal plant usage through folklore medicine could be useful in extrapolating the consumption of medicinal plant resources. Researchers in their bid to discover therapeutically effective drugs, have targeted several floras traditionally used for medicinal purposes. The medicinal properties of plants depend on both nutrient and non-nutrient constituents. In West Africa, *Ocimum gratissimum* (OG) and *Zingiber officinale* (ZO) are well-known medicinal plants with various biological activities and therapeutic efficacy, as reported in ethnobotanical studies. These medicinal plants can be used as a" stand alone" medication, or complexed with other medicinal plants as an herbal mixture. For example, Ocimum gratissimum has been investigated by some researchers as a single herb (Nweze, 2009; Gupta *et al*., 2011; Chun-Ching Chiu *et al*., 2012; Olamilosoye *et al*., 2018) or as polyherbal mixtures (Ogbo, 2006; Okparaeke, 2007; Ojewumi, 2021; Guleria, 2022; Oghenetekevwe & Orororo, 2022).

The plant (OG) is frequently employed in traditional medicine to address a range of conditions, including respiratory infections, skin ailments, headaches, conjunctivitis, diarrhea, pneumonia, fever, and cough. Its flowers and leaves contain valuable oils, which are utilized in making teas and infusions (Prabhu *et al*., 2009). In Nigeria's coastal areas, it is used to manage high fever, epilepsy, and diarrhea (Imosemi, 2020), while in savannah areas, decoctions of the leaves are utilized for mental illnesses (Effraim *et al*., 2003; Imosemi, 2020). In Southeastern Nigeria, the Ibos use OG to manage the baby's cord and fungal infections (Prabhu *et al*., 2009). In India, the plant has been used to treat headaches, sunstroke, influenza, inflammation, and as an antipyretic and diaphoretic. The roots of OG are used as a sedative for children in Brazilian tropical forests (Agarwal & Varma, 2014), while in Kenyan and sub-Saharan African communities, the leaves are rubbed and sniffed to treat blocked nostrils, coughs, sore eyes, abdominal pains, ear infections, and fever. Additionally, the plant is employed as a tooth gargle, for regulating menstruation, and as a remedy for rectal prolapse (Naluwuge, 2013). The OG leaves' infusion is utilized as a pulmonary antiseptic, antitussive, and antispasmodic agent (Ngassoum *et al*., 2003; Bhavani *et al*., 2019), and it can be utilized alone or combined with other medicinal plants in herbal mixtures. *O. gratissimum* to also exhibit ovicidal activity (Pessoa *et al*., 2002),

leishmanicidal activity (Ueda-Nakamura *et al*., 2006), antidiarrhoeal effect (Owulade *et al*., 2004) , cytotoxic activity (Mahapatra *et al*., 2009) , cardiovascular effect (Lahlou *et al*., 2004), neuroprotective effect (Bora *et al*., 2011), antidiabetic effect (Okoduwa *et al*., 2017; Awwad *et al*., 2021) , nephroprotective (Ogundipe *et al*., 2017; Akara *et al*., 2021), hepatoprotective effect (Farombi, 2014; Chigozie *et al*., 2016; Huang *et al*., 2020). Treatment of hair loss, suspending activity, central nervous system activity, anticonvulsant activity, nematocidal activity, disintegrating activity, acne management (Prabhu *et al*., 2009).

Ginger (*Zingiber officinale* -ZO) is an important tropical valued medicinal plant, over the world as a spice and for its therapeutic properties, The plant is sterile in nature (produce no seed) and only propagated by rhizomes (Ashraf *et al*., 2017). Different members of the family have been distributed in the tropics of the south and south-eastern Asia (Mintah *et al*., 2019). This plant is also cultivated throughout the tropical and sub-tropical region and is thought to be first vegetative cultivated plant among them (Mans *et al*., 2019). These plants contain a wide variety of biologically active, non-nutritive compounds known as phytochemicals. Ginger is widely used around the world in foods as a spice. For centuries, it has been an important ingredient in Chinese, Ayurvedic and Tibb-Unani herbal medicines for the treatment of catarrh, rheumatism, nervous diseases, gingivitis, toothache, asthma, stroke, constipation and diabetes (Mintah *et al*., 2019). Ginger is used in three different forms: (i) fresh ginger; (ii) dried and ground ginger; and (iii) preserved ginger. Ginger is now grown as a commercial crop in Africa, Latin America and South-east Asia (Elzebroek, 2008; da Silveira Vasconcelos *et al*., 2019).

The soil type, texture and exposure of a plant to environmental hazard could influence the nutritional compositions, and growth (Khan *et al*., 2015). Sorrenti *et al*. (2016) confirmed and supported by Paetsch *et al*. (2018) that environmental conditions can lead to modifications of the physicochemical properties of soil, and influences plants nutritional and phytochemical composition. Differences in the report of concentrations of chemical constituents of plants may be greatly dependent on the cultivar and region (An *et al*., 2016). Therefore, the objectives of this study were to identify and compare the total proximate, vitamins, and mineral composition of extracts from these medicinal plants cultivated in the southern part of Nigeria.

## Materials and Methods

### Collection and Identification of Plant Samples

Fresh roots and leaves of ginger (Zingiber officinale) and scent leaf (Ocimum gratissimum) respectively, were collected from a garden at Okuzu Mbana Village Oba, Anambra State and transported to Plant Science and Biotechnology Department, University of Port Harcourt for taxonomical identification. After which, documentation of the got tests was finished and recorded by assigning a reference number: UPH/PSB/ 2023/014, and herbarium numbers: UPH/P/373 and UPH/P/374 for later referring purposes.

### Sample preparation

The plant samples were coarsely powdered after being air dried until constant weights were achieved. According to the procedures described by Onakurhefe *et al*. (2020), El-Borm *et al*. (2018), and Badawy *et al*. (2019), the root and leaves' aqueous extracts were prepared. In the extraction, water served as the solvent. When the soluble materials had completely dissolved, the sample was placed in a stoppered container with the solvent and left to stand at room temperature for 72 hours (3 days). After straining the mixture, the Marc (damp solid material) was compressed. After that, Whatman's No. 1 filter was used to clarify the mixed liquid. The filtrate was mounted on the water bath at $100^0$C to evaporate the liquid part of the extract. Temperature was set based on the solvent boiling point to avoid denaturing of the extracts.

### Reagents Used

The chemicals used in this study were of standard grade, sourced from Sigma-Aldrich and Merck (Johannesburg, South Africa). Chemical Safety Precautions were taken during the assays and the following reagents were used; diethyl ether, sodium sulfite ($Na_2SO_3$), octanol, acetone, sulfuric acid ($H_2SO_4$), NaOH, boric acid, hydrochloric acid, KMnO4, $FeCl_3$ solution, oxalic acid, 2,6-dichlorophenolindophenol, ∝-∝ 0 -dipyridyl reagent, ethanol, ∝-tocopherol,

### Proximate Composition

The proximate analysis (moisture, protein, fats, fiber, ash, and carbohydrate content) of the plant samples were determined by using Association of Official Analytical Chemists (AOAC, 2016) methods. All the proximate values were reported in percentage (Adegbe *et al*., 2016).

Determination of Moisture Content

Moisture content was determined using the method as described by (Adegbe *et al*., 2016). An empty crucible was dried to a constant weight in an oven at 105ºC, allowed to cool in a desiccator and weighed ($W_1$). The pulverized plant sample (2.0 g) was weighed ($W_2$) in the crucible and dried at 105ºC until it attained a constant weight. The crucible containing the plant sample was allowed to cool in a desiccator and the weight ($W_3$) was measured. The moisture content was calculated in percentage thus as:

$$\%\ Moisture\ content = \frac{W_2 - W_3}{W_2 - W_1} x100$$

Determination of Crude Protein and Nitrogen

The pulverized plant sample (2 g) was weighed in a 300 mL Kjeldahl flask and digested by a volume of 20 mL concentrated sulfuric acid ($H_2SO_4$). The process was aided with a catalyst until a clear solution was obtained. The digest was allowed to cool, diluted with 250 mL distilled water and transferred into a 500 mL Kjeldahl flask, containing anti-bumping chips and 40 mL of 40% NaOH. The distillate from the solution was transferred in a collecting liquid (250 mL of 2% boric acid and a few drops of mixed indicator) by immersing the end of the condenser inside the liquid to trap the gaseous ammonia being liberated. The resultant liquid was then back titrated against 0.01 M hydrochloric acid until the endpoint violet color was reached and percentage nitrogen content was calculated as:

$$\%\ W_{n2} = \frac{14\ x\ M\ x\ Vt\ x\ V100}{Weight\ of\ sample\ (mg)\ x\ Va}\ x\ 100$$

Percentage crude protein was expressed as: % Wp = % $Wn_2$ × 6.25; Where M is actual molarity of acid (HCl), $V_{100}$ is the titre value ($Cm^3$) of HCl used, Vt is the total volume of the diluted digest, Va is the aliquot volume distilled, Wp is the crude protein content, $Wn_2$ is the Nitrogen content.

Determination of Crude Fat

The crude lipid content of the sample was determined by Soxhlet extraction method as described by A pulverized sample of 5 g was measured in a 500 mL round bottom flask, containing a few grams of anti-bumping granules and was Weighed ($W_1$) all together. The fat content of the pulverized plant samples was extracted in 100 mL of diethyl ether at 40–60ºC for 6 h in the flask attached to the Soxhlet extractor, at reflux. The filtrate was concentrated, diethyl ether was recovered and the oil in the round bottom flask was dried in an oven. The oil and the round bottom flask were thereafter Weighed ($W_2$). The percentage of crude fat content was calculated thus as:

$$\%\ Crude\ fat = \frac{W_2 - W_1}{Weight\ of\ sample} x100$$

Determination of Neutral Detergent Fibre

The Neutral detergent fibre (NDF) of the samples was determined using the Van Soest *et al*. (1991) fibre analysis. To do this, a pulverized, air-dried sample weighing 1 g was placed in an empty crucible ($W_1$). Then, 100 mL of neutral detergent solution and 0.5 g of sodium sulfite ($Na_2SO_3$) were added to the crucible at room temperature, along with a few drops of octanol. The mixture was boiled for an hour, filtered, and the residue was washed twice in boiling water and then in cold acetone. After drying in an oven at 105ºC for 8 hours, the residue was cooled in a desiccator and weighed (W2). To calculate the percentage of NDF in the sample, the following formula was used:

$$\%\ NDF = \frac{(W_1 + W_2) - W_1}{Weight\ of\ sample} x100$$

Where, percentage Neutral detergent soluble (NDS): % NDS = (100 − % NDF).

Determination of Ash Content

The AOAC (2016) method (Adegbe *et al*., 2016), was used for the ash content assay. To determine the ash content of a pulverized plant sample, a heat-resistant porcelain crucible was used. The crucible was dried in an oven at 105ºC for 10 minutes, allowed to cool in a desiccator, and then weighed to obtain the dry weight ($W_1$). Next, 2 g of the pulverized plant sample was measured into the crucible, and the combined weight was measured ($W_2$). The crucible with the sample was then incinerated in a furnace (Furnace 62700, Barnstead-Thermolyne, USA) at 250 ◦C for 1 hour and at 550ºC for 7 hours to ensure proper ashing. After cooling the crucible in a desiccator, its weight was measured again ($W_3$). The percentage of ash content in the sample was determined using the following formula:

$$\%\ Ash\ content = \frac{W_3 - W_1}{W_2 - W_1} x100$$

Non-Fibre Carbohydrates
The Non-Fibre Carbohydrates (NFC) content of the plant sample was evaluated by the method described by (Unuofin *et al*., 2017). The carbohydrate content was calculated by the difference of the total dry matter and the addition of the percentage ash, crude fat, crude protein and Neutral detergent fibre (NDF) using the formula:

%NFC = 100 − (%Ash + %Crude fat + %Crude protein + %NDF)
A high value of NFC indicates more digestible carbohydrates and lesser fibre in the sample.

Determination of Energy Content
The value of energy in the samples was estimated in kilojoule per hundred gram and calculated by adding up the values for carbohydrate, crude lipid and crude protein using the factors; 16.736 KJ, 37.656 KJ and 16.736 KJ respectively as shown below:

Energy value (K J/100g) = (%Crude protein × 16.736) + (%crude fat × 37.656) + (%carbohydrate × 16.736).

**Vitamin composition**
The spectrophotometric estimation of vitamins A, E, C, $B_1$, $B_2$ and $B_3$ present in the ginger, scent leaf and the blend of plant mixture extract was done following standard spectrophotometric procedures. Vitamin A was estimated by the method of Bayfield and Cole (1980), based on the reaction between vitamin A acetate or palmitate with TCA (trichloroacetic acid). The absorbance of the colour developed is now estimated by spectrophotometry.
The concentration of vitamin E in the plant extract was measured using the Emmerie-Engel reaction described by Rosenberg and Miller (1992). This reaction relies on vitamin E's ability to reduce ferric to ferrous ions, which results in a red color formation upon reaction with 2,2'-dipyridyl. Initially, vitamin E and carotenes were determined together using xylene and the absorbance was measured at 460nm to determine carotenes. A correction was made by adding ferric chloride and measuring again at 520nm. To assess Vitamin C levels, 1ml of standard ascorbate, supernatant, and blank were set aside, and the volume was made up to 2ml with 4% TCA. DNPH reagent (0.5ml) was added to the tubes, followed by 2 drops of 10% thiourea solution. The mixtures were kept at 25ºC for 3 hours, resulting in the production of osazane crystals. These crystals were dissolved in 2.5ml of 85% sulfuric acid, and the absorbance was read at 540nm by spectrophotometry after cooling. A standard graph was drawn with an electronic calculator set to the linear regression mode to determine the concentration of ascorbate in the sample (expressed in mg/100g of sample). Vitamins $B_1$, $B_2$, and $B_3$ were also measured spectrophotometrically at different absorbances.

**Minerals analysis**
Minerals assay was done with the use of an Agilent FS240AA Atomic Absorption Spectrophometer according to the method of American Public Health Association [APHA] (1995) (Rahmanian *et al*., 2015)

Sample digestion
To digest the sample, 2 g of the dried extract was added into a digestion flask, to which 20 ml of the acid mixture (650 ml concentrated $HNO_3$; 80ml perchloric acid; 20ml concentrated $H_2SO_4$) were added. The flask was heated until the solution was clear, and then it was made up to the 100ml mark using distilled water.

Determination of Minerals
The method described by (Abdou Bouba *et al*., 2012) , with modification was adopted. The pulverized plant samples (2.5 g) were weighed and ashed at 550ºC. The resulting residue (white ash) was dissolved in 4 mL of concentrated HCl acid, filtered and the filtrate was diluted in a volumetric flask with distilled water. The resulting solution of the extract was then subjected for the analysis of specific major minerals. The analyses were performed in triplicates. The elements; Calcium Ca, Sodium Na, Magnesium Mg, Phosphorus P, Potassium K, Zinc Zn and Iron Fe, were determined by atomic absorption spectrophotometer (Varian Spectra AA-220, USA).

## Results

**Proximate composition**
This section presents the results of the proximate analysis of the plant extract. The proximate analysis was conducted to determine the moisture content, crude protein, crude fibre, fat, ash, carbohydrate, and energy content of the extracts. The values presented are the average of three readings (Table 1).

**Vitamins**
Figure 1 presents the vitamin composition of the plant extracts. The results show that all three samples contain varying amounts of vitamins $B_1$, $B_2$, $B_3$, E, A, and C. The GN/SL extract had the highest vitamin $B_1$ and $B_2$ content at 0.52 mg/100g and 0.19 mg/100g, respectively, followed by the scent leaf (SL) extract at 0.35 mg/100g and 0.13 mg/100g, respectively. The ginger (GN) extract had the lowest vitamin $B_1$ and $B_2$ content at 0.30 mg/100g and 0.11 mg/100g, respectively. In terms of vitamin $B_3$ content, the scent leaf (SL) extract had the lowest amount at 0.02 mg/100g, followed by the ginger (GN) extract at 0.03 mg/100g, and the GN/SL extract had the highest amount at 0.04 mg/100g.

The vitamin A content of the GN/SL extract was the highest among the samples at 39.21 µg/100g, followed by the scent leaf (SL) extract at 37.42 µg/100g, and the ginger (GN) extract at 31.01 µg/100g. Finally, the GN/SL extract had the highest vitamin C content at 2.94 mg/100g, followed by the ginger (GN) extract at 2.83 mg/100g, and the scent leaf (SL) extract at 2.15 mg/100g.

**Table 1:** Proximate Analysis of the Plant Extracts

| Sample | Moisture Content (%) | Crude Protein (%) | Crude Fibre (%) | Fat (%) | Ash (%) | Carbohydrate (%) | Energy (kCal) |
|---|---|---|---|---|---|---|---|
| Ginger (GN) | 11.42 | 9.19 | 0.28 | 0.98 | 1.83 | 76.30 | 350.78 |
| Scent Leaf (SL) | 12.74 | 12.82 | 0.23 | 1.54 | 2.64 | 70.03 | 345.29 |
| GN/SL | 15.84 | 13.62 | 0.36 | 1.84 | 2.92 | 65.41 | 332.66 |

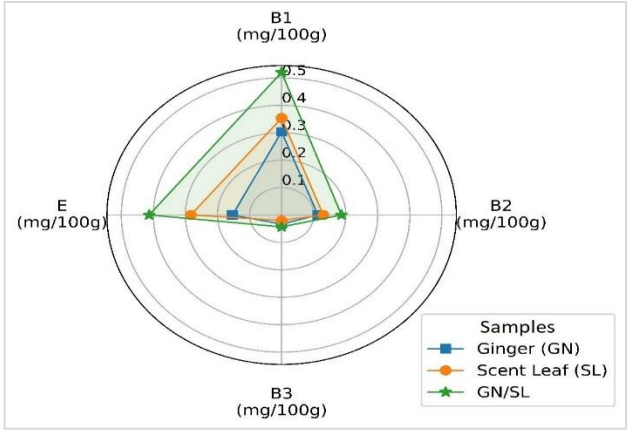


**Figure 1:** Radar plot showing the Vitamins Composition of the plant extract

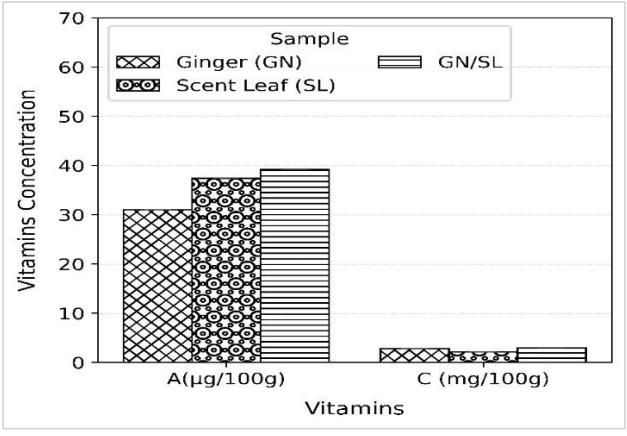


**Figure 2:** Bar plot showing the Vitamins Composition of the plant extract

**Mineral Composition**

Minerals are important nutrients that are essential for many physiological functions in the body. The mineral composition of the plant extract is presented in Figures 3 and 4.

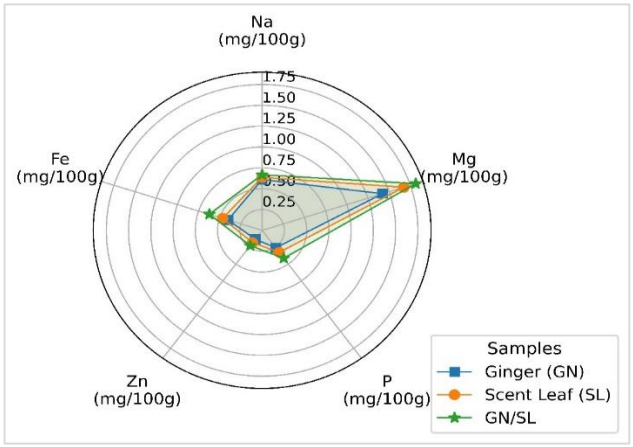


**Figure 3:** Radar plot showing the Minerals Composition of the plant extract

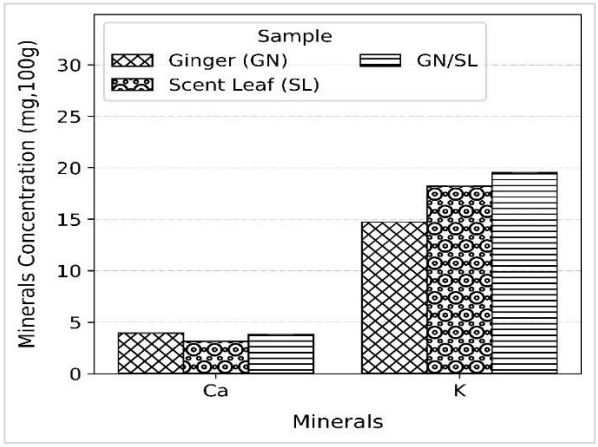


**Figure 4:** Bar plot showing the Minerals Composition of the plant extract

**Statistical Analysis**

All experiments were performed in triplicate and the outcomes expressed as mean ± standard deviation. The obtained data were subjected to statistical analysis using XLSTAT 2016. A one-way ANOVA was used to compare mean values among the various extracts. P-values less than 0.05 ($P \leq 0.05$) were considered statistically significant using Tukey's Multiple Comparison Test.

## DISCUSSION

**Proximate Analysis**

The outcome of the proximate analysis of the plant extract show that the ginger extract (GN) had a lower moisture content (11.42 ± 0.03%,) than the scent leaf extract (SL: 12.74± 0.03%) and the GN/SL extract (15.85 ± 0.04%). The moisture content of a substance is an important parameter to consider because it affects the stability and shelf life of the substance. The lower moisture content of the GN extract may indicate that it may have a longer shelf life than the SL extract and the GN/SL extract. The crude protein content of these aqueous extracts (SL, GN, GNSL) was expressed using organic nitrogen, with the GNSL combination containing the highest values at 13.62 ± 0.02%, in comparison to the GN protein content of 9.19 ± 0.01% and the SL protein content of 12.82 ± 0.02%. Although the recommended daily intake of protein for humans is 0.8 g/kg BW/d, regardless of age or gender, these guidelines do not account for variations in hormone levels, metabolism, immunity, or health issues (Bauer *et al*., 2013). As such, these extracts (herbal mixture and individual extracts) could be suggested as an excellent protein source in complementary diets. The crude fibre content expresses the level of food digestibility The crude fibre content of the GN extract was 0.28%, while that of the SL extract was 0.23%. The GN/SL extract had a crude fibre content of 0.36%. The quantification of fat and oil extracted from the plant revealed that GN/SL extract had a higher fat content than the GN extract and the SL extract. Fat is a major component that contributes to differences in the gross energy of various food substances, as it yields over 9 Kcal/g compared to carbohydrates and proteins that yield about 5 Kcal/g. Nagao and Yanagita (2010) reported that medium-chain triglycerides (MCTs) and medium-chain fatty acids (MCFAs) have therapeutic benefits in preserving insulin sensitivity, as observed in animal models and patients with type 2 diabetes. Therefore, the level of oil present in SL, GN and GNSL could contribute to its medicinal potency. This may be because both ginger and scent leaf are rich sources of essential oils. The fat content of a substance is also an important parameter as it affects the sensory properties of the substance, such as the texture and flavor. The ash content of the plant indicated the presence of inorganic constituents. Our results showed that the percentage of ash in the GNSL extract (2.90 ± 0.03 %) was higher than that of the extract from GN root (1.83 ± 0.02%) and SL 2.64 ± 0.02). The ash content strongly suggests that the mineral level in the mixture is higher than that of the individual extracts, except for the calcium composition in the ginger root which was significantly higher. Therefore, in terms of mineral composition, the GNSL combination is a better source. Overall, minerals are known to be essential for human nutrition, contributing to physical and mental wellbeing. Carbohydrate content is an important parameter to consider because it is an indicator of the energy content of the substance. The carbohydrate content of the GN extract was higher than that of the SL and the GN/SL extract, the higher carbohydrate content of the GN extract compared to the other extracts may be attributed to the higher sugar content present in ginger. Additionally, the lower carbohydrate content in the GN/SL extract may be due to the dilution effect caused by the mixture of the two extracts. The energy content of the GN extract was higher than that of the SL extract and the GN/SL extract, which may be attributed to the higher carbohydrate content. The energy content of the GN extract was 350.78 kCal, while that of the SL extract and GN/SL extract were 345.29 kCal and 332.66 kCal, respectively. Elhayany *et al*. (2010) concluded in their research that a low carbohydrate diet could reduce the risk of cardiovascular diseases and control diabetes among obese patients. GNSL could be advantageous in this regard as the, likewise SL which is predominantly being consumed as a vegetable.

**Vitamin Quantification**

The fat-soluble vitamins A and E content of the plant extracts were evaluated using retinol equivalent. The GNSL sample (39.21 ± 0.01mg retinol/100g) has the highest retinol followed by SL sample (37.42 ± 0.02 mg retinol/100g) and the GN sample (31.01 ± 0.02 mg retinol/100g) has the lowest value of vitamin A which is also commensurable to the recommended Average Requirement (AR) of vitamin A, by European Union (EU) for average body weight adult men (68.1 kg) and women (58.5 kg) with an established ARs values of 0.57 mg retinol equivalent (RE)/day and 0.49 mg RE/day respectively (Idris *et al*., 2019). The high vitamin A content even in the individual extracts may explain the reason for improved vision with scent leaf and ginger. Vitamin B and C are water soluble vitamins which are also essential micronutrient that was quantified in this research. Vitamin B (B1, B2, and B3) are important vitamins which aid in conversion of food into energy and are vital for healthy skin, muscles, brain, and nerve functionality. Vitamin C is a strong aqueous-phase antioxidant that scavenges free radicals and reduces oxidative stress (Pandithavidana & Jayawardana, 2019). The GNSL extract (0.41 ± 0.02mg AA/100g) has higher ascorbic acid content compared to the SL extract (0.28 ± 0.01mg AA/100g) and GN extract (0.15 ± 0.01mg AA/100g). Vitamin C which aids in collagen formation and key to absorbing and metabolizing other nutrients, is less stable to heat, hence this might result in the lesser values of the ascorbic acid content of the samples (pulverized aqueous extracts) as shown in fig. 3. According to Frei *et al.* (2012), the recommended dietary allowance (RDA) of vitamin C for adults (≥19 years) is 75 mg/day for a female and 90 mg/day for a male. Ginger and scent leaf are usually not eaten as a whole meal, rather as spices and herbs but should be supplemented with food containing appreciable amount of vitamin C to achieve a balanced diet.

**Mineral Elements**

Mineral elements are essential constituents in human nutrition. They are skeletal structures and serves as essential components of many enzymes, vitamins, hormones and respiratory pigments or as cofactors in metabolism, catalysts and enzyme activators (Soetan *et al*., 2010; Fox & Zimba, 2018). The macro and micro elements of these plants contain very important nutrients relevant to the human wellbeing. Adequate calcium (Ca) is needed alongside with vitamin D and K to the development and maintenance of healthy bones and teeth. It also plays a vital role in many systems including intracellular signaling to enable the integration and regulation of metabolic processes (Klimecka & Muszyńska, 2007; Krebs *et al*., 2015). The values of Ca in the aqueous extracts were GNSL (3.82 ± 0.02%), SL (3.11 ± 0.01%), and GN (3.93 ± 0.02%). This result shows that consumption of ginger extract provides

more calcium .This value was also higher than that reported by (Ogbuewu *et al*., 2014). However, the values recorded for the SL and GNSL mixture are comparable to that exhibited by GN sample, suggesting that scent leaf may have performed a suppressive action with regards to calcium content in the herbal blend. Sodium (Na) is responsible for regulating body water content and electrolyte balance. It is also required for the absorption of certain nutrients and water from the gut. The control of blood sodium levels depends on a balance between sodium excretion and absorption at the kidney which is regulated by nerves and hormones (Pohl *et al*., 2013; Afsar *et al*., 2016; Shrimanker & Bhattarai, 2019). The values of sodium in the samples were (0.61 ± 0.01, 0.64 ± 0.01, and 0.67 ± 0.02) mg/100g for GN,SL and GNSL respectively. Magnesium (Mg) is an essential mineral present in all human tissues, especially in bone. It has both physiological and biological function such as muscle and nerves functioning, activation of many enzymes and for parathyroid hormone secretion (Gröber *et al*., 2015; McEwen, 2021). It also has important interrelationships with Ca, K and Na. The values of Mg in the studied aqueous ginger sample GN (1.42 ± 0.01) was higher than those reported by (Osabor *et al*., 2015) in the same plants, but (Okunlola *et al*., 2019) reported a value of 261.93 ± 0.29mg/100g , higher than that in our studied SL sample. The reasons for the variations could be because of the extraction process and solvents used. The major role of phosphorus is in the formation with calcium, of the bone component. It is essential for healthy bone and tooth structures. It is also important for the structure of cell membrane and contributes to several processes associated with energy metabolism (Settembre *et al*., 2013). Phosphorus concentrations in studied samples ranges from (0.26 ± 0.01, 0.33 ± 0.02, and 0.41 ± 0.02) mg/100g% respectively for GN, SL and GNSL. Potassium (K) is essential for water and electrolyte balance and the normal functioning of cells, including nerves. It also decreases blood pressure by promoting the loss of sodium in the urine (McLean & Wang, 2021). It helps to protect cardiovascular health. Concentrations of K in the studied extracts were (14.72 ± 0.01, 18.22 ± 0,02, and 19.54 ± 0.02mg/100g.) for GN.SL and GNSL respectively. This value are agreement with the findings of and (Osuagwu & Edeoga, 2013) for SL but higher than those reported for ginger by (Ogbuewu *et al*., 2014).

Zinc (Zn) is a trace mineral which plays a role in the formation of enzymes, Zn improves immune function, helps blood clotting, maintain seen of taste and smell, keep skin healthy and enable normal growth and development (Chasapis *et al*., 2020). Zinc concentrations in samples studied had the values of (0.13 ± 0.01, 0.18 ± 0.01, 0.23 ± 0.02) mg/100g for GN, SL and GNSL respectively. But lower values of zinc in ginger was reported by Ogbuewu *et al*. (2014) and Okunlola *et al*. (2019) in scent leaf. The difference may be attributed to the soil types and environmental factors associated to the different location of the studies. As important medicinal trace minerals in human body, Zn provides a natural protective mechanism against virus especially those causing respiratory tract infections (Cai *et al*., 2005). Also according to these studies (Kupka & Fawzi, 2002; Maier *et al*., 2013) , Zn is used extensively in the fight against HIV by delaying the integration of HIV virus in the blood. Its immunomodulatory role also buttresses the traditional usage of these medicinal plants to cure cold and mange HIV. Zinc is important in the development and functioning of pituitary gland, the gonads and the reproductive organs. Iron is another trace mineral that was evaluated in this study. It is a component of hemoglobin in the blood, and it transports oxygen from the lungs to different parts of the body. It is also part of many enzymes and essential for growth, healing, immune function, and synthesis of DNA (Wild *et al*., 2010; Musallam & Taher, 2018). Iron concentration in the studied samples had GNSL higher than the values from the individual samples. GN and SL.

## Conclusion

The chemical composition determines the physiological properties and medicinal value of a plant. The medicinal potential of GN, SL and the herbal mixture GNSL could have been due to the chemical composition and nutritional value as studied in this research. The present study, which investigated the nutritional composition of ginger, scent leaf and their mixtures established that these medicinal plants cultivated in the southern part of Nigeria are powerhouses of nutrients; and there may be more potent outcomes when used as a herbal mixture. The above results indicate that these extracts can form part of a complementary diet for total wellbeing.

## Declarations

### Competing Interest

The authors declare no competing interest.

### Authors' Contributions

CGI designed and performed the experiments, interpreted the results, drafted the manuscript. JOA characterized the antioxidant activities of the extracts, drafted the manuscript, and participated in the design of the study. KPI performed the statistical analysis and revised the manuscript. ENO supervised the work. All authors read and approved the final manuscript.

## References


Abdou Bouba, A., Njintang Yanou, N., Foyet, H., Scher, J., Montet, D., & Mbofung, C. M. (2012). Proximate composition, mineral and vitamin content of some wild plants used as spices in Cameroon.

Adegbe, A., Larayetan, R., & Omojuwa, T. (2016). Proximate analysis, physicochemical properties and chemical constituents characterization of Moringa oleifera (Moringaceae) seed oil using GC-MS analysis. *American Journal of Chemistry*, *6*(2), 23-28.

Afsar, B., Vaziri, N. D., Aslan, G., Tarim, K., & Kanbay, M. (2016). Gut hormones and gut microbiota: implications for kidney function and hypertension. *Journal of the American Society of Hypertension*, *10*(12), 954-961.

Agarwal, K., & Varma, R. (2014). Ocimum gratissimum L.: A medicinal plant with promising antiurolithiatic activity. *International Journal of Pharmaceutical Sciences and Drug Research*, *6*(1), 78-81.

Akara, E. U., Emmanuel, O., Ude, V. C., Uche-Ikonne, C., Eke, G., & Ugbogu, E. A. (2021). Ocimum gratissimum leaf extract ameliorates phenylhydrazine-induced anaemia and toxicity in Wistar rats. *Drug metabolism and personalized therapy*, *36*(4), 311-320.

An, K., Zhao, D., Wang, Z., Wu, J., Xu, Y., & Xiao, G. (2016). Comparison of different drying methods on Chinese ginger (Zingiber officinale Roscoe): Changes in volatiles, chemical profile, antioxidant properties, and microstructure. *Food chemistry*, *197*, 1292-1300.

Ashraf, K., Sultan, S., & Shah, S. (2017). Phychemistry, phytochemical, pharmacological and molecular study of Zingiber officinale Roscoe: a review. *Int J Pharm Pharm Sci*, *9*(11), 8-16.

Awwad, A., Poucheret, P., Idres, Y. A., Tshibangu, D. S., Servent, A., Ferrare, K., Lazennec, F., Bidel, L. P., Cazals, G., & Tousch, D. (2021). In vitro tests for a rapid evaluation of antidiabetic potential of plant species containing caffeic acid derivatives: A validation by two well-known antidiabetic plants, Ocimum gratissimum L. leaf and Musanga cecropioides R. Br. ex Tedlie (Mu) Stem Bark. *Molecules*, *26*(18), 5566.

Bauer, J., Biolo, G., Cederholm, T., Cesari, M., Cruz-Jentoft, A. J., Morley, J. E., Phillips, S., Sieber, C., Stehle, P., & Teta, D. (2013). Evidence-based recommendations for optimal dietary protein intake in older people: a position paper from the PROT-AGE Study Group. *Journal of the american Medical Directors association*, *14*(8), 542-559.

Bayfield, R., & Cole, E. (1980). [24] Colorimetric estimation of vitamin A with trichloroacetic acid. In *Methods in enzymology* (Vol. 67, pp. 189-195). Elsevier.

Bhavani, T., Mohan, R. R., Mounica, C., Nyamisha, J., Krishna, A. G., Prabhavathi, P., Raja, R. R., & Baba, K. H. (2019). Phytochemical screening & antimicrobial activity of Ocimum gratissimum review. *Journal of Pharmacognosy and Phytochemistry*, *8*(2), 76-79.

Bora, K. S., Shri, R., & Monga, J. (2011). Cerebroprotective effect of Ocimum gratissimum against focal ischemia and reperfusion-induced cerebral injury. *Pharmaceutical biology*, *49*(2), 175-181.

Cai, L., Li, X.-K., Song, Y., & Cherian, M. G. (2005). Essentiality, toxicology and chelation therapy of zinc and copper. *Current medicinal chemistry*, *12*(23), 2753-2763.

Chasapis, C. T., Ntoupa, P.-S. A., Spiliopoulou, C. A., & Stefanidou, M. E. (2020). Recent aspects of the effects of zinc on human health. *Archives of toxicology*, *94*, 1443-1460.

Chigozie, U.-u. J., Okechukwu, M., & Ikechukwu, S. (2016). Potential hepatoprotective effect of different solvent fractions of Ocimum gratissimum (OG) in a paracetamol-induced hepatotoxicity in Wistar albino rats. *American Journal of Physiology, Biochemistry and Pharmacology*, *5*(1), 1-7.

da Silveira Vasconcelos, M., Mota, E. F., Gomes-Rochette, N. F., Nunes-Pinheiro, D. C. S., Nabavi, S. M., & de Melo, D. F. (2019). Ginger (zingiber officinale roscoe). In *Nonvitamin and nonmineral nutritional supplements* (pp. 235-239). Elsevier.

Effraim, K., Jacks, T., & Sadipo, O. (2003). Histopathological studies on the toxicity of Ocimum gratissimumleave extract on some organs of rabbit. *African Journal of Biomedical Research*, *6*(1).

Elhayany, A., Lustman, A., Abel, R., Attal-Singer, J., & Vinker, S. (2010). A low carbohydrate Mediterranean diet improves cardiovascular risk factors and diabetes control among overweight patients with type 2 diabetes mellitus: a 1-year prospective randomized intervention study. *Diabetes, Obesity and Metabolism*, *12*(3), 204-209.

Elzebroek, A. T. G. (2008). *Guide to cultivated plants*. CABI.

Farombi, E. (2014). Assessment of flavonoid content, free radical scavenging and hepatoprotective activities of Ocimum gratissimum and Spondias mombin in rats treated with dimethylnitrosamine. *Archives of Basic and Applied Medicine*, *2*(1), 47-56.

Fox, J. M., & Zimba, P. V. (2018). Minerals and trace elements in microalgae. In *Microalgae in health and disease prevention* (pp. 177-193). Elsevier.

Frei, B., Birlouez-Aragon, I., & Lykkesfeldt, J. (2012). Authors' perspective: What is the optimum intake of vitamin C in humans? *Critical reviews in food science and nutrition*, *52*(9), 815-829.

Gröber, U., Schmidt, J., & Kisters, K. (2015). Magnesium in prevention and therapy. *Nutrients*, *7*(9), 8199-8226.

Huang, C.-C., Hwang, J.-M., Tsai, J.-H., Chen, J. H., Lin, H., Lin, G.-J., Yang, H.-L., Liu, J.-Y., Yang, C.-Y., & Ye, J.-C. (2020). Aqueous Ocimum gratissimum extract induces cell apoptosis in human hepatocellular carcinoma cells. *International journal of medical sciences*, *17*(3), 338.

Idris, O. A., Wintola, O. A., & Afolayan, A. J. (2019). Comparison of the proximate composition, vitamins (ascorbic acid, α-tocopherol and retinol), anti-nutrients (phytate and oxalate) and the GC-MS analysis of the essential oil of the root and leaf of Rumex crispus L. *Plants*, *8*(3), 51.

Imosemi, I. O. (2020). A review of the medicinal values, pharmacological actions, morphological effects and toxicity of Ocimum gratissimum Linn. *Eur J Pharm Med Res*, *7*(7), 29-40.

Khan, A., Khan, S., Khan, M. A., Qamar, Z., & Waqas, M. (2015). The uptake and bioaccumulation of heavy metals by food plants, their effects on plants nutrients, and associated health risk: a review. *Environmental Science and Pollution Research*, *22*, 13772-13799.

Klimecka, M., & Muszyńska, G. (2007). Structure and functions of plant calcium-dependent protein kinases. *Acta Biochimica Polonica*, *54*(2), 219-233.

Krebs, J., Agellon, L. B., & Michalak, M. (2015). Ca2+ homeostasis and endoplasmic reticulum (ER) stress: An integrated view of calcium signaling. *Biochemical and biophysical research communications*, *460*(1), 114-121.

Kupka, R., & Fawzi, P. W. (2002). Zinc nutrition and HIV infection. *Nutrition reviews*, *60*(3), 69-79.

Lahlou, S., Interaminense, L. d. F. L., Leal-Cardoso, J. H., Morais, S. M., & Duarte, G. P. (2004). Cardiovascular effects of the essential oil of Ocimum gratissimum leaves in rats: role of the autonomic nervous system. *Clinical and Experimental Pharmacology and Physiology*, *31*(4), 219-225.

Mahapatra, S. K., Chakraborty, S. P., Das, S., & Roy, S. (2009). Methanol extract of Ocimum gratissimum protects murine peritoneal macrophages from nicotine toxicity by decreasing free radical generation, lipid and protein damage and enhances antioxidant protection. *Oxidative Medicine and Cellular Longevity*, *2*(4), 222-230.

Maier, D. A., Brennan, A. L., Jiang, S., Binder-Scholl, G. K., Lee, G., Plesa, G., Zheng, Z., Cotte, J., Carpenito, C., & Wood, T. (2013). Efficient clinical scale gene modification via zinc finger nuclease–targeted disruption of the HIV co-receptor CCR5. *Human gene therapy*, *24*(3), 245-258.

Mans, D. R., Djotaroeno, M., Friperson, P., & Pawirodihardjo, J. (2019). Phytochemical and pharmacological support for the traditional uses of Zingiberacea species in Suriname-a review of the literature. *Pharmacognosy Journal*, *11*(6s).

McEwen, B. (2021). Magnesium: The multipurpose mineral. *Journal of the Australian Traditional-Medicine Society*, *27*(3), 140-141.

McLean, R. M., & Wang, N. X. (2021). Potassium. In *Advances in Food and Nutrition Research* (Vol. 96, pp. 89-121). Elsevier.

Mintah, S. O., Asafo-Agyei, T., Archer, M.-A., Junior, P. A.-A., Boamah, D., Kumadoh, D., Appiah, A., Ocloo, A., Boakye, Y. D., & Agyare, C. (2019). Medicinal plants for treatment of prevalent diseases. *Pharmacognosy-Medicinal Plants*, 1-19.

Musallam, K. M., & Taher, A. T. (2018). Iron deficiency beyond erythropoiesis: should we be concerned? *Current medical research and opinion*, *34*(1), 81-93.

Nagao, K., & Yanagita, T. (2010). Medium-chain fatty acids: functional lipids for the prevention and treatment of the metabolic syndrome. *Pharmacological Research*, *61*(3), 208-212.

Naluwuge, A. (2013). Comparative physicochemical, phytochemical and acute toxicity studies of Ocimum Gratissimum and Ocimum Suave Species in Western Uganda.

Ngassoum, M., Essia-Ngang, J., Tatsadjieu, L., Jirovetz, L., Buchbauer, G., & Adjoudji, O. (2003). Antimicrobial study of essential oils of Ocimum gratissimum leaves and Zanthoxylum xanthoxyloides fruits from Cameroon. *Fitoterapia*, *74*(3), 284-287.

Ogbuewu, I., Jiwuba, P., Ezeokeke, C., Uchegbu, M., Okoli, I., & Iloeje, M. (2014). Evaluation of phytochemical and nutritional composition of ginger rhizome powder. *International Journal of Agriculture and Rural Development*, *17*(1), 1663-1670.

Ogundipe, D. J., Akomolafe, R. O., Sanusi, A. A., Imafidon, C. E., Olukiran, O. S., & Oladele, A. A. (2017). Ocimum gratissimum ameliorates gentamicin-induced kidney injury but decreases creatinine clearance following sub-chronic administration in rats. *Journal of Evidence-Based Complementary & Alternative Medicine*, *22*(4), 592-602.

Okoduwa, S. I., Umar, I. A., James, D. B., & Inuwa, H. M. (2017). Anti-diabetic potential of Ocimum gratissimum leaf fractions in fortified diet-fed streptozotocin treated rat model of type-2 diabetes. *Medicines*, *4*(4), 73.

Okunlola, G. O., Jimoh, M. A., Olatunji, O. A., Rufai, A. B., & Omidiran, A. O. (2019). Proximate analysis, mineral composition, and antioxidant properties of bitter leaf and scent leaf. *International journal of vegetable science*, *25*(4), 346-354.

Osabor, V., Bassey, F., & Umoh, U. (2015). Phytochemical screening and quantitative evaluation of nutritional values of Zingiber officinale (Ginger). *American Chemical Science Journal*, *8*(4), 1-6.

Osuagwu, G., & Edeoga, H. (2013). The effect of water stress (drought) on the proximate composition of the leaves of Ocimum gratissimum (L) and Gongronema latifolium (Benth). *International Journal of Medicinal and Aromatic Plants*, *3*(2), 293-299.

Owulade, M., Eghianruwa, K., & Daramola, F. (2004). Effects of aqueous extracts of Hibiscus sabdariffa calyces and ocimun gratissimumleaves on interstinal transit in rats. *African Journal of Biomedical Research*, *7*(1).

Paetsch, L., Mueller, C. W., Kögel-Knabner, I., Von Lützow, M., Girardin, C., & Rumpel, C. (2018). Effect of in-situ aged and fresh biochar on soil hydraulic conditions and microbial C use under drought conditions. *Scientific Reports*, *8*(1), 6852.

Pandithavidana, D. R., & Jayawardana, S. B. (2019). Comparative study of antioxidant potential of selected dietary vitamins; computational insights. *Molecules*, *24*(9), 1646.

Pessoa, L., Morais, S., Bevilaqua, C., & Luciano, J. (2002). Anthelmintic activity of essential oil of Ocimum gratissimum Linn. and eugenol against Haemonchus contortus. *Veterinary parasitology*, *109*(1-2), 59-63.

Pohl, H. R., Wheeler, J. S., & Murray, H. E. (2013). Sodium and potassium in health and disease. *Interrelations between essential metal ions and human diseases*, 29-47.

Prabhu, K., Lobo, R., Shirwaikar, A., & Shirwaikar, A. (2009). Ocimum gratissimum: A review of its chemical, pharmacological and ethnomedicinal properties. *The open Complementary medicine journal*, *1*(1).

Rahmanian, N., Ali, S. H. B., Homayoonfard, M., Ali, N., Rehan, M., Sadef, Y., & Nizami, A. (2015). Analysis of physiochemical parameters to evaluate the drinking water quality in the State of Perak, Malaysia. *Journal of Chemistry*, *2015*, 1-10.

Rosenberg, I. H., & Miller, J. W. (1992). Nutritional factors in physical and cognitive functions of elderly people. *The American journal of clinical nutrition*, *55*(6), 1237S-1243S.

Settembre, C., Fraldi, A., Medina, D. L., & Ballabio, A. (2013). Signals from the lysosome: a control centre for cellular clearance and energy metabolism. *Nature reviews Molecular cell biology*, *14*(5), 283-296.

Shrimanker, I., & Bhattarai, S. (2019). Electrolytes.

Soetan, K., Olaiya, C., & Oyewole, O. (2010). The importance of mineral elements for humans, domestic animals and plants: A review. *African journal of food science*, *4*(5), 200-222.

Sorrenti, G., Masiello, C. A., Dugan, B., & Toselli, M. (2016). Biochar physico-chemical properties as affected by environmental exposure. *Science of the Total Environment*, *563*, 237-246.

Ueda-Nakamura, T., Mendonça-Filho, R. R., Morgado-Díaz, J. A., Maza, P. K., Dias Filho, B. P., Cortez, D. A. G., Alviano, D. S., Maria do Socorro, S. R., Lopes, A. H. C., & Alviano, C. S. (2006). Antileishmanial activity of Eugenol-rich essential oil from Ocimum gratissimum. *Parasitology international*, *55*(2), 99-105.

Unuofin, J. O., Otunola, G. A., & Afolayan, A. J. (2017). Research Article Essential Oil Composition, Nutrient and Anti-nutrient Analysis of Vernonia mespilifolia Less. *Res J Bot*, *12*, 38-45.

Van Soest, P. v., Robertson, J. B., & Lewis, B. A. (1991). Methods for dietary fiber, neutral detergent fiber, and nonstarch polysaccharides in relation to animal nutrition. *Journal of dairy science*, *74*(10), 3583-3597.

Wild, T., Rahbarnia, A., Kellner, M., Sobotka, L., & Eberlein, T. (2010). Basics in nutrition and wound healing. *Nutrition*, *26*(9), 862-866.

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