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Estimation of Proximate, Phytochemical, Vitamin and Mineral Compositions of *Tetracarpidium conophorum* (African Walnut) Seed and its potential in Traditional Medicine

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ABSTRACT

Tetracarpidium conophorum (African walnut) seed is commonly eaten because of its distinct flavor and alleged health advantages. This study's goal was to evaluate the seed of Tetracarpidium conophorum for its proximate, phytochemical, vitamin, and mineral contents. A botanist identified cooked T. conophorum seeds that were bought at the "Oja-Oba" market in Ibadan, Nigeria. Before being ground into a coarse powder, the nuts' shells were removed and they were air-dried for seven days. Using accepted techniques, the proximate, phytochemical, vitamin, and mineral components were determined. According to the proximate analysis's findings, the largest and lowest nutritional classes in T. conophorum seed were crude fat (36.06%) and fiber (3.64%), respectively. The seed's phytochemical makeup showed that it contains a variety of secondary metabolites, with the highest and lowest quantities being saponin (7.95 mg/100g) and alkaloid (0.44 mg/100g), respectively. Vitamins were found to be abundant in T. conophorum seed, with vitamin E having the highest concentration (58.58 mg/100g) and vitamin B12 having the lowest (0.16 mg/100g). The highest and lowest mineral concentrations found in T. conophorum seeds were 57.57 mg/100g of magnesium and 0.41 mg/100g of zinc. The findings of this study demonstrated the nutritional value of cooked T. conophorum seed is high. It might be added to food as a supplement to lessen malnutrition. The seed's potential as a therapeutic agent should be investigated.

Keywords: Food supplement, Nutrients, Tetracarpidium conophorum seed, Therapeutic potential

INTRODUCTION

The African walnut, (Tetracarpidium conophorum), is a member of the Plukenetia genus of the Euphorbiaceae family. Other names for it include Conophor, Black walnut, and Nigerian walnut. It is a 10–20 foot long perennial climbing shrub that grows in moist areas of Eastern and Western Nigeria as well as Western Africa in general. They are primarily grown for their nuts, which are frequently roasted and eaten as snacks [1]. Despite numerous studies on the nutritional value and therapeutic potential of African walnuts it has has not yet been fully developed for industrial use in Nigeria due to a lack of storage facilities, which has seriously hampered full-scale production and the investigation of its inherent potential [1].

Figure 1: T. *conophorum* Plant

When inter-planted with African pears, it thrives [2]. It has a flimsy stem and long internodes that resemble ropes. When manual harvesting is not possible, the pod is allowed to fully develop before being selected, separated from the rotting pods, cleaned, and then sold in the market. They are often planted beneath an indigenous tree that can hold the climber's heavy weight when it is completely established on the tree's crown. Walnuts are edible even when they are uncooked, and their flavor is stimulating and bitter. To thicken soups, the roasted seeds can be mashed up like melon seeds. They may be sun-dried, roasted, or cooked. The herb is considered to have antimicrobial properties [3]. Additionally, a beverage that lowers fever and stomachaches can be made from its leaves and seeds [4].

In Nigeria, T. conophorum is widespread. The ideal soil conditions for black walnut growth are moist, deep, fertile, and loamy. African walnut is also known as "ukpa" (lgbo) in south Eastern Nigeria, "awusa" or "asala" (Yoruba) in western Nigeria, "gawudi bairi" in northern Nigeria (Hausa) and “okhoya” in Uzebba (Edo state) dialect [5]. The nut has a high dietary energy value and is a good source of protein [6]. Between the two halves of the nut is a thin coating [7]. It is customarily consumed as a nut after boiling in Nigeria [8].

Figure 2: T. *conophorum Seed*

Walnuts are known to reduce the endothelium dysfunction brought on by high-fat diets, according to studies [9]. Another study has suggested that eating walnuts may lower the lipids in overweight people by increasing fat oxidation and decreasing carbohydrate oxidation without changing total intake [10]. Therefore, the purpose of this study is to assess the phytochemical, vitamin, and mineral composition of T. conophorum seed.

2. METHODS

2.1 Collection of T. *conophorum Seed*

A botanist identified the boiled nuts of T. conophorum that were obtained from the "Oja-Oba" market in Ibadan, Nigeria. Before being ground into a coarse powder and stored for future analysis, the nuts' shells were removed and they were allowed to air dry for seven days.

2.2 Determination of Proximate and Energy Composition of T. *conophorum Seed*

Using techniques recommended by the Association of Official Analytical Chemists [11], the sample's proximate components were identified. The seed's moisture content was calculated gravimetrically. Using the nitrogen conversion factor of 6.25, the protein level was ascertained using the micro Kjeldahl method. Using the Soxhlet extraction method and petroleum ether, the fat content was ascertained. The crude fiber content was calculated using the acid-base technique. By burning the samples at 600 °C in a muffle furnace, the amount of ash in each sample was calculated. The amount of carbohydrates was determined by difference, and gross energy (KJ and Kcal per 100 g) was estimated using the Onabanjo and Airaodion [12]'s formula. Crude protein and carbohydrate percentages were multiplied by 4 while fat percentages were multiplied by 9 to get the amount of calories. Following that, the value was translated to calories for every 100 grams of each sample.

Energy = (carbohydrate 4) + (crude protein 4) + (crude fat 9)

2.3 Quantitative Determination of Phytochemical Composition of T. *conophorum Seed*

The phytochemical makeup of T. *conophorum seed* was determined using the AOAC's recommended procedures [11].

2.4 Determination of Vitamin Composition of T. *conophorum Seed*

The vitamin content of T. conophorum seed was assessed using the AOAC's recommended techniques [11].

2.5 Determination of Mineral Composition of T. *conophorum Seed*

For the purpose of determining various nutrients, the wet-acid digestion method described by Airaodion and Onabanjo [13] was used to determine mineral elements. Briefly, the sample substance was weighed into a 150 mL Pyrex conical flask at a weight of about 0.2 g. The sample was then given 5 ml of the extraction solution (H2SO4-Sodium salicylic acid). For 16 hours, the mixture was allowed to stand. The mixture was then put on a hot plate that was set to 30°C and heated for roughly two hours. The sample was heated vigorously with 5 mL of pure perchloric acid until it was digested into a clear solution. A minute or so later, 20 cc of distilled water was added and thoroughly mixed. The digest was put into a 50 ml volumetric flask after being given time to cool, and the required volume of distilled water was added. The digest was used to determine the amounts of calcium (Ca) and magnesium (Mg) using the Versanate Complexiometric Ethylenediamine Tetraacetic Acid Titration Method. Using a flame photometer, sodium (Na) and potassium (K) concentrations were measured according to the AOAC (2006) technique (model PFP7 Digital, Jenway, UK). A spectrophotometer using atomic absorption was used to identify all other minerals (model 3030, Perkin Elmer, Norwalk USA).

2.6 Statistical Analysis

The calculations were performed using Microsoft Excel 2013 program. The results of a triple analysis were provided as means with standard deviations (n = 3).

3. RESULTS

The findings of this investigation are shown as mean±standard deviation, with n = 3. Table 1 shows the proximate analysis of T. conophorum seed, with crude fat (36.06%) ranking highest and fiber (3.64%) ranking lowest. The phytochemical content of the seed is shown in Table 2, with the largest and lowest quantities being saponin (7.95 mg/100g) and alkaloid (0.44 mg/100g), respectively. In Table 3, which summarizes the vitamin content of T. conophorum seed, vitamin E (58.58 mg/100g) and vitamin B12 (0.16) are shown to have the greatest and lowest values, respectively. The highest and lowest mineral concentrations were found in T. conophorum seed, with magnesium at 57.57 mg/100g and zinc at 0.41 mg/100g, respectively (Table 4).

Table 1. Proximate and Energy Composition of T. *conophorum Seed*

Parameters	Concentration
Protein (%)	16.73±1.22
Crude Fat (%)	36.06±8.12
Crude Fibre (%)	3.64±0.35
Ash (%)	4.01±0.91
Moisture (%)	20.05±3.51
Carbohydrate (%)	19.49±1.16
Energy (KJ/100g)	469.41±9.54

Results are presented as means ± standard deviation (SD) of triplicate analysis (n = 3)

Table 2. Phytochemical Composition of T. *conophorum* *Seed*

Phytochemical	Concentration (mg/100g)
Alkaloid	0.44±0.06
Flavonoid	1.69±0.03
Saponin	7.95±1.11
Tannin	0.89±0.02
Phytate	2.67±0.06
Phenol	2.76±0.39

Results are presented as means ± standard deviation (SD) of triplicate analysis (n = 3)

Table 3. Vitamin Composition of T. *conophorum Seed*

Vitamin	Concentration (mg/100g)
Vitamin A (Retinol)	4.00±0.28
Vitamin B_1 (Thiamine)	0.64±0.01
Vitamin B_2 (Riboflavin)	0.24±0.10
Vitamin B_3 (Niacin)	1.04±0.07
Vitamin B_{12} (Cobalamin)	0.16±0.02
Vitamin C (Ascorbic Acid)	9.15±0.83
Vitamin E (Tocopherol)	8.58±1.07

Results are presented as means ± standard deviation (SD) of triplicate analysis (n = 3)

Table 4. Mineral Composition of T. *conophorum Seed*

Mineral	Concentration (mg/100g)
Potassium (K)	25.14±2.36
Magnesium (Mg)	57.57±8.27
Calcium (Ca)	44.89±6.09
Phosphorus (P)	99.45±8.91
Iron (Fe)	18.49±1.33
Sodium (Na)	7.97±0.86
Zinc (Zn)	0.41±0.05
Na/K	0.32±0.04
Ca/P	0.45±0.03

Results are presented as means ± standard deviation (SD) of triplicate analysis (n = 3)

4. DISCUSSION

4.1 Proximate Composition of T. conophorum Seed

Rural residents rely on wild fruits for both income-generating and everyday dietary needs [14]. The profitability of a certain plant as a prospective supply of nutrients can be predicted by determining the close composition of the plant. This study's proximate analysis revealed that T. conophorum seed contains a significant number of nutrients (Table 1). There was a significant amount of crude protein (16.73%). This is comparable to the 16.04% and 17.90% reported in the corresponding investigations by Akin-Osanaiye and Ahmad [14] and Chikezie [10]. It is nevertheless less than the figures of 28.85% and 23.03%, respectively, published by Chijioke et al. [15] and Eromosele et al. [16]. Additionally, this study's observation of crude protein concentration is a little bit higher than the 14.92% reported by Ekwe and Ihemeje [17]. Protein intake will rise with the use of T. conophorum seed and other food sources that are high in protein because protein has been identified as one of the nutrients that are deficient in developing nations. One of the major issues facing the African continent, particularly Nigeria, is protein malnutrition [18].

The amount of crude fat (36.06%) found in this study is comparable to the 32.21% found in the examination of a raw, dry sample of T. conophorum seeds reported by Nwaoguikpe et study suggests that T. *conophorum* seeds cannot be kept for an extended amount of time without developing color changes or unpleasant odors.

Digestion is said to be improved by fiber [19]. T. *conophorum* seed may therefore be essential for the digestion of food and prevent constipation in consumers. This study has a 3.64% crude fiber concentration. This figure exceeds the 1.14% and 1.24% that Ekwe and Ihemeje [17] and Chikezie [10] recorded. It falls short of the 7.11% and 8.66% reported by Akin-Osanaiye and Ahmad [14] and Chijioke et al. [15], respectively.

Ash value has been used as a gauge for assessing food quality [18]. While reporting the nutritional and anti-nutritional evaluation of garri prepared by conventional and instant mechanical processes, Airaodion et al. [19] emphasized that ash content is a measure of the total minerals present inside a product. The ash percentage of the T. *conophorum* seed utilized in this investigation was found to be 4.01%, which is lower than the 6.01% reported by Chijioke et al. [15] but equivalent to the 3.52% and 4.89% reported by Ekwe and Ihemeje [17] and Akin-Osanaiye and Ahmad [14]. Nevertheless, it is larger than the 2.66% noted by Chikezie [10].

Moisture content calculates both the sample's direct water content and its indirect dry matter content. It also serves as a measure of the flour samples' storage stability. In order to combat microbial growth, materials having moisture contents above 14% are less storable [18]. Unfortunately, this study's findings showed that T. *conophorum* seeds have a moisture content of 20.05%, which makes them less able to withstand microbial growth and reduces their capacity to be stored. This outcome is consistent with the 19.20% reported by Ekwe and Ihemeje [17], but it is lower than the 31.40% and 40.19% reported by Chijioke et al. [15] and Eromosele et al. [16] for the moisture content of T. *conophorum* seed in their respective investigations. However, the mean moisture content value found in this investigation was lower than the 2.36% and 5.46% found in the corresponding studies of Akin-Osanaiye and Ahmad [14] and Chikezie [10].

T. *conophorum* seed yielded 19.49% carbohydrate and 469.41 KJ/100g of energy, respectively. The sample had low carbohydrate content but a high calorific content. At rest, the human body uses a lot of energy. The amount needed has been calculated to be between 1,500 and 2,000 Kcal per day, or around 1 Kcal per kilogram of body weight each hour depending on the metabolism of the individual. The majority of the energy that people consume from their food is utilized to maintain their body temperature and other vital functions [17]. The quantity of energy obtained by the body from food is less than that obtained when food is totally oxidized or burned in a bomb calorimeter. This is because the body does not fully digest, absorb, or oxidize the components that produce calories, primarily protein, lipids, and carbohydrates [20]. According to Chikezie [10], Eromosele et al. [16], and Chijioke et al. [15], respectively, the concentration of carbohydrates in this study is equivalent to the 19.28%, 19.59%, and 21.30% reported in those works. The outcome is significantly higher than the 15.38% that Ekwe and Ihemeje [17] were able to achieve, but slightly lower than the 27.17% that Akin-Osanaiye and Ahmad [14] reported. Similarly, this study's energy is higher than the 234.57 KJ/100g reported by Chijioke et al. [15]. According to the recommended daily intake of 1,500–2,000 Kcal [21], T. *conophorum* seed may only provide a portion of the energy needed each day when taken, but it would significantly help to meet that need. Inconsistencies between the published values of the proximate composition of T. *conophorum* seed and certain earlier research may be caused by variations in the soil, climatic conditions, harvesting procedures, location, and relative humidity of the local environment [22].

4.2 Phytochemical Composition of T. *conophorum Seed*

Bioactive substances known as phytochemicals can be found in fruits, vegetables, seeds, cereals of all kinds, and plant-based beverages like tea and wine. They are substances that plants create through either their primary or secondary metabolism. They have been employed in traditional medicine and as poison [23]. Table 2 displays the findings of the phytochemical content of the T. *conophorum* seed. The outcome revealed that the seed has an alkaloid content of 0.44 mg/100g. This finding is comparable to the 0.41 mg/100g found in T. *conophorum* seed as reported by Eromosele et al. [16]. Both Ayoola et al. [7] and Nwaoguikpe et al. [6] showed that the alkaloid concentration in T. *conophorum* root and its dry seed was 0.41 mg/100g. The 2.24 mg/100g reported by Chijioke et al. [15] for alkaloid in T. *conophorum* seed oil is much lower than the mean value obtained for the concentration of alkaloid in this investigation. Numerous indole alkaloids have antihypertensive effects, quinidine and spareien have antiarrhythmic effects, quinine has antimalarial properties, and dimeric indoles, vincristine, and vinblastine have anticancer properties [24]. Caffeine, nicotine, and morphine are examples of alkaloids with stimulant qualities that are also employed as analgesics [25]. T. *conophorum* seed will therefore be a powerful medicinal ingredient. Since ancient times, alkaloids have been used medicinally, and one of their characteristic biological traits is cytotoxicity [26]. Alkaloids are known to have analgesic, antispasmodic, and bactericidal effects [27]. Because of this, the seed is recommended to be taken between asthma attacks rather than for acute asthma because it is thought to stop asthma. The elderly might also use it to treat constipation [28]. Alkaloids are thought to have antihypertensive and detoxifying effects [29,30].

Flavonoids have been shown to have a variety of biological effects, including antibacterial, cytotoxic, anti-inflammatory, and anticancer effects, but the ability of practically all flavonoid groups to operate as antioxidants, which can shield the human body from free radicals, has been well documented [31]. The concentration of flavonoid in the current study is 1.69 mg/100g, a value that is significantly higher than the 0.02 mg/100g alkaloid concentration in T. *conophorum* seed oil reported by Chijioke et al. [15] but lower than the 2.78 mg/100g flavonoid concentration in T. *conophorum* seed reported by Eromosele et al. [16]. The molecular makeup of flavonoids determines how effective they are as antioxidants. For flavonoids to have antioxidant and free radical scavenging properties, certain characteristics in their chemical structure are crucial [29]. According to studies, flavonoids offer a variety of beneficial effects, including anti-inflammatory, enzyme-inhibiting, antibacterial, oestrogenic, anti-allergic, antioxidant, vascular, and cytotoxic anticancer activity [32]. Flavonoids are a group of secondary plant metabolites that have been shown to have positive impacts on health [24]. A variety of compounds known as flavonoids play a significant role in defending biological systems from the damaging effects of oxidative processes on macromolecules like carbohydrates, proteins, lipids, and DNA. Due to the presence of flavonoids, several studies have suggested that various plant extracts may have the ability to prevent peptic ulcers [33-35].

Saponin possesses a variety of biological actions that may have positive effects on health, including the prevention of dental cavities and platelet aggregation [36]. It is also hypocholesterolemic, anti-coagulant, anti-carcinogenic, hepatoprotective, hypoglycemic, immunomodulatory, and neuroprotective. In this investigation, it was shown that T. *conophorum* seeds contained 7.95 mg/100g of saponin, which is comparable to the 8.07 mg/100g level reported by Chijioke et al. [15]. This number is considerably lower than the 10.71 mg/100g reported by Ayoola et al. [7], but significantly higher than the 1.69 mg/100g reported by Eromosele et al. [16]. In addition to being found to considerably improve animal growth, feed intake, and reproduction, saponin may be used to treat hypercalciuria. Additionally, protozoans and mollusks have been seen to die from saponins, which also act as antifungal and antiviral agents [7].

Tannin-containing plant extracts are used as astringents and diuretics, to treat stomach and duodenal cancers, as astringents, and as medicines that are anti-inflammatory, antiseptic, antioxidant, and hemostatic [37]. In this investigation, tannin concentration in T. *conophorum* seed was found to be 0.89 mg/100g, greater than the 0.55 mg/100g found in T. *conophorum* root by Ayoola et al. [7], but similar to the 0.89 and 0.92 mg/100g reported by Chijioke et al. [15] and Eromosele et al. [16]. The seeds of T. *conophorum* contain tannins, which support the plant's anti-inflammatory qualities and its usage in herbal medicine to treat varicose ulcers, frost bite, and hemorrhoids [38]. Because tannins are present, it is possible that this plant has antidiarrheal and antihaemorrhagic properties. According to Han et al. [26], Parekh and Chanda [39], and Senchina et al. [40], proteins and tannins interact to produce the usual tanning effect, which is crucial for the treatment of inflamed or ulcerated tissues. Tannins attach to proline-rich proteins and prevent the creation of new proteins. Herbs that mostly consist of tannins are astringent in nature and used to treat gastrointestinal conditions like diarrhea and dysentery [41].

Food phytate levels must be understood because a high concentration might adversely affect digestion [42]. Due to its negative consequences, phytate has been classified as an anti-nutrient. Growth was inhibited and the bioavailability of micronutrients was decreased. Phytate can cause nutritional deficiencies by chelating divalent cationic minerals such as calcium, iron, magnesium, and zinc [43,44]. According to Wise [45], dietary calcium intake affects both the amount of minerals bound to the complex and the solubility of phytate. T. *conophorum* seed used in this investigation had a phytate concentration of 2.67 mg/100g, which is comparable to the 2.37 mg/100g found by Eromosele et al. [16].

Phenols have been linked to a variety of biological functions [46,47]. Some of the biological functions of phenol include an increase in bile production, a decrease in blood cholesterol and lipid levels, and antibacterial activity against some bacterial strains including staphylococcus aureus. Phenolics have a variety of biological effects, including antiulcer, anti-inflammatory, antioxidant, cytotoxic and anticancer, antispasmodic, and antidepressant properties [46,47]. In this investigation, it was discovered that T. *conophorum* seed contained 2.76 mg/100g of tannin, a concentration greater than the 1.90 and 1.51 found in wet and dry raw T. *conophorum* seed by Nwaoguikpe et al. [6]. It is also higher than the 0.22 mg/100g of phenol in T. *conophorum* root that Ayoola et al. [7] found.

4.3 Vitamin Composition of T. *conophorum Seed*

Vitamins are essential nutrients but are typically only needed in extremely small amounts. Vitamins A, D, E, and K are examples of fat-soluble vitamins, whereas B and C are examples of water-soluble vitamins [31]. The liver and adipose tissues contain fat-soluble vitamins, while the water-soluble vitamins are often excreted from the body. Vitamin C is an antioxidant with the ability to support connective tissue health, speed up wound healing, and aid in dietary iron absorption from the intestine [48]. The amount of vitamins A and C is sufficient to support other dietary sources. Scurvy and gingivitis are brought on by a lack of vitamin C, whereas eye problems can be treated with vitamin A. Important antioxidants like vitamins E and C shield the outer membranes from oxidative stress and damage [49]. For adults, a daily intake of 45 mg of vitamin C is recommended [50]. One of the main components of T. *conophorum* seed is vitamin C. Ascorbic acid (Vitamin C), tocopherol (Vitamin E), retinol (Vitamin A), thiamine (Vitamin B1), riboflavin (Vitamin B2), niacin (Vitamin B3), and cyanocobalamin (Vitamin B12) are all found in T. *conophorum* seeds, which make them good dietary supplements, antioxidants, and necessary for healthy

Due to the preservation of epithelial cell processes, vitamin A is crucial for healthy vision, gene expression, growth, and immunological function [46]. The amount of vitamin A found in this study was 4.00 mg/100g, which is more than the 2.24 mg/100g found in the study by Chijioke et al. [15]. However, it is less than the 1283.33 and 285.60 mg/100g of raw T. *conophorum* seed found by Nwaoguikpe et al. [6] for wet and dry seed, respectively. This may indicate that heating the T. *conophorum* seed used in this study greatly decreased its vitamin A concentration. Adults should consume between 0.8 and 10 mg of vitamin A per day, according to the recommended dietary allowance [51]. Thus, eating cooked T. *conophorum*m seed could provide an adult with the recommended daily allowance of vitamin A.

The B-vitamins are well known for their functions in vivo in energy metabolism [18]. Thiamin (0.64 mg/100 g), riboflavin (0.24 mg/100 g), niacin (1.04 mg/100 g), and cyanocobalamin (0.16 mg/100 g) are the B vitamins found in T. *conophorum* seed. In comparison to Chijioke et al. [15]'s result of 0.20 and 0.14 mg/100g, respectively, the riboflavin and niacin values in this study is significantly greater. Thiamine and cyanocobalamin concentrations in this investigation were lower than those reported by Chijioke et al. [15] at 0.89 and 0.38 mg/100g, respectively. The niacin concentration found in this study is lower than the 2.81 and 2.91 mg/100g of T. *conophorum* wet and dry raw seed found by Nwaoguikpe et al. [6]. Contrarily, the levels of thiamin and riboflavin found in this study are higher than those found in the wet and dry raw T. *conophorum* seed as reported by Nwaoguikpe et al. [6]. The mean B-vitamin values found in this study are higher than those previously reported for T. *conophorum* root by Ayoola et al. [7]. Vitamin B12 is crucial for the development of red blood cells, healthy nervous system function, and methyl group translocation during DNA synthesis. It also plays a significant role in boosting glucose, protein, and appropriate fat metabolism [31].

Singlet oxygen and other radicals can be effectively quenched by ascorbic acid (vitamin C). It couples lipophilic and hydrophilic processes while having an antioxidant effect that doesn't deplete vitamin E [49]. Hydrogen peroxide is produced when it combines with superoxide and a proton; water is produced when it reacts with the hydroxyl radical [52]. Additionally, collagen synthesis is essential for iron intake, tissue repair, and blood vessel development. Fatigue and immunodeficiency are linked to foods low in vitamin C [53,54]. Human deficiencies may lead to scurvy. Vitamin C content was found to be 9.15 mg/100 g in this investigation, which is greater than the 5.08 mg/100 g reported by Chijioke et al. [15], but similar to the 9.11 mg/100 g reported by Ayoola et al. [7]. The content of vitamin C found in this study is lower than the 17.57 and 14.80 mg/100g of wet and dry raw T. *conophorum* seed found by Nwaoguikpe et al. [6] respectively. This may indicate that heating the T. *conophorum* seed used in this study reduced its vitamin C concentration. Because of the high ascorbic acid content, T. *conophorum* seeds can help avoid conditions such as scurvy, bleeding gums, limb pain, and blindness. According to NAS [21], 45 mg of vitamin C should be consumed daily. When ingested, the cooked T. *conophorum* seed's vitamin C content will help a person fulfill their necessary daily intake. Healthy cells are shielded from free radical damage by ascorbic acid. It aids in the body's immune system function, promotes wound healing, and aids in iron absorption. The use of the plant in herbal medicine for the treatment of skin disorders, such as eczema, pruritus, psoriasis, and parasitic conditions is supported by the presence of ascorbic acid in the seed [55]. Additionally, this vitamin can be utilized to treat conditions including prostate cancer and the common cold [56,57]. Ascorbic acid has the intriguing property of preventing, or at the very least, minimizing the development of carcinogenic chemicals from dietary material [58]. In addition to being essential for the growth and healthy operation of muscles and red blood cells, vitamin E is a potent antioxidant that aids in preventing cell damage from free radicals [59]. Vitamin E content in the T. *conophorum* seed utilized in this investigation was 8.58 mg/100g. Compared to the 70.00 mg/100g reported by Chijioke et al. [15], this is much less. Adults should consume between 8 and 10 mg of vitamin E daily, according to the recommended dietary allowance. This suggests that T. *conophorum* seed may supplement the body's requirement for vitamin E. According to Udedi et al. [60], African walnut can be utilized to maintain food security because it has a high nutritional value and excellent antioxidant activity. It plays a crucial role in the production of red blood cells and the utilization of vitamin K. (blood-clotting vitamin). Animals such as rats experience sterility due to tocopherol deficiency. The T. *conophorum* seeds' significant tocopherol content lends support to the treatment of male infertility issues [61].

4.4 Mineral Composition of T. conophorum Seed

Table 4 displays the findings of the mineral profile of T. conophorum seed. Magnesium was the mineral with the highest concentration (57.57 mg/100g), followed by calcium (44.89 mg/100g), and potassium (25.14 mg/100g), which came in third. These minerals are crucial for many biological processes and are particularly vital for health, according to Airaodion et al. [31]. The magnesium concentration of 57.57 mg/100 g in this study is significantly higher than the magnesium concentration of 0.11 mg/100 g for T. conophorum root reported by Ayoola et al. [7], which is in agreement with the magnesium concentrations of 59.77 and 60.20 mg/100 g reported by Chijioke et al. [15] and Ekwe and Ihemeje [17] respectively. Additionally, it is higher than the 0.31 and 0.36 mg/100g of raw T. conophorum seed obtained by Nwaoguikpe et al. [6] for wet and dry seeds, respectively. This may indicate that the magnesium content of the T. conophorum seed used in this investigation was raised during cooking. According to some reports, calcium and magnesium work together to help muscles contract and blood clot. For several enzymes, it serves as a co-factor [62].

The average calcium concentration found in this study was 44.89 mg/100 g, which is lower than the 53.95 mg/100 g reported by Eromosele et al. [16], but similar to the 44.99 and 45.01 mg/100 g found by Chijioke et al. [15] and Ekwe and Ihemeje, [17]. The results were much greater than the 0.004 mg/100g for T. conophorum root reported by Ayoola et al. [7]. This suggested that T. conophorum has a larger calcium concentration in its seed than in its root. The mean calcium concentration in this study is also greater than the 1.88 and 2.10 mg/100g calcium concentrations for wet and dry raw T. conophorum seeds, respectively, that were found by Nwaoguikpe et al. [6]. This may indicate that heating the T. conophorum seed used in this investigation improved its calcium content. Ossification, muscle contraction, and blood clotting all require calcium. This shows that the sample's calcium content would be sufficient for a baby's bone and tooth development. The skeleton is where calcium and magnesium mostly reside.

The potassium concentration found in this study was 25.14 mg/100 g, which is much higher than the 0.02 mg/100 g found in T. conophorum root as reported by Ayoola et al. [7] but similar to the 24.08 and 23.14 mg/100 g found by Chijioke et al. [15] and Ekwe and Ihemeje [16]. This suggested that T. conophorum has a higher potassium concentration in its seed than in its root. The mean potassium concentration in this study is also greater than the 0.87 and 1.02 mg/100g potassium concentrations for wet and dry raw T. conophorum seeds, respectively, that were found by Nwaoguikpe et al. [6]. This may be a sign that the potassium content of the T. conophorum seed used in this investigation was raised during cooking.

Additionally, the mean value of sodium is lower than the 9.59 mg/100g reported by Chijioke et al. [15] but equal to the 8.07 mg/100g obtained by Ekwe and Ihemeje [17]. The results were much greater than the 0.002 mg/100g for T. conophorum root reported by Ayoola et al. [7]. This suggested that T. conophorum has a larger salt concentration in its seed than in its root. The mean sodium level in this study is also greater than the 0.39 and 0.26 mg/100g values for wet and dry raw T. conophorum seeds, respectively, that were obtained by Nwaoguikpe et al. [6]. This may be a sign that the sodium level of the T. conophorum seed used in this investigation was raised by boiling. Both sodium and potassium play a key role in the transit of some non-electrolytes and regulate the water equilibrium level in bodily tissue [31]. The iron concentration in this study was 18.49 mg/100 g, which is comparable to the 20.83 mg/100 g reported by Eromosele et al. [16]. This concentration is considerably greater than the 2.89 and 2.92 mg/100g that Chijioke et al. [15] and Ekwe and Ihemeje [17] reported, respectively. The iron content of the seed is a useful weapon in the fight against anemia on the front lines. This study's results show that the Na/K ratio is 0.32. For intake, a ratio of 0.60 is suggested [63]. The sample's reported value was less than the suggested value. T. conophorum would not support hypertension, according to this.

The zinc content in this study was found to be 0.41 mg/100g, which is lower than the 6.78 and 5.96 mg/100g reported by Chijioke et al. [15] and Ekwe and Ihemeje [17], respectively, but similar to the 0.37 mg/100g reported by Eromosele et al. [16]. The zinc content shows that the seed may affect nerve function and male sterility in some ways. This corroborates the claims made in the works of Ajaiyeoba and Fadare [61] that T. conophorum seeds might be used to treat male infertility issues. Zinc is essential for healthy sexual development, particularly for the growth of the testes and ovaries. Additionally, it is necessary for reproduction. The activity of vitamins, the development of red and white blood cells, the healthful operation of the heart, and normal growth are all stimulated by zinc [64].

5. CONCLUSIONS

The seed of T. conophorum is a highly nutritive plant, according to the results of the analysis of its proximate, phytochemical, vitamin, and mineral composition. It might be added to food as a supplement to lessen malnutrition. The seed's potential as a therapeutic agent should be investigated.

ETHICAL APPROVAL

Not applicable

CONSENT FOR PUBLICATION

Not applicable

AVAILABILITY OF DATA

The datasets used and analyzed during the current study are available from the corresponding author on reasonable request

COMPETING INTERESTS

The authors declare that they have no competing interests in this research and publication.

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