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SHORT COMMUNICATION article

Physicochemical analysis of *Terminalia catappa* (Almond) seed nuts grown in Benin City, Nigeria

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Abstract: The need for natural medicine and nutrients from natural product sources cannot be overstressed. Plant parts like leaves, stems, roots, seeds, nut and flowers supply enormous minerals, phytochemicals and other bioactive constituents apart from the primary metabolites. *Terminalia Catappa* (*T. catappa*) is a combretaceous plant often found in tropical and subtropical regions. The plant has many uses as an ingredient of various drugs such as anti-oxidants, anti-inflammatory, anti-cancer, and anti-diarrheal. Thus, the main objective of this study was to determine the proximate, mineral and physicochemical analysis of *T. catappa* seed nuts. The proximate composition was determined according to the previous standard methods and elemental analysis by Atomic Absorption Spectrophotometry and Flame Photometer. Proximate composition revealed a moisture content of 2.34%, ash 3.89%, fibre content of 8.50%, crude protein of 29.66%, fat of 21.98% and carbohydrate of 33.63%. Elemental analysis of the plant has indicated the presence of iron, zinc, calcium, magnesium, potassium, sodium, copper and chromium in the aqueous extract. Physicochemical parameters of the plant revealed a specific gravity of 0.9182, viscosity of 33.62 mm^2/s, refractive index of 1.4642, acid value of 0.102 mg KOH/g, saponification value of 151.28 mg KOH/g, iodine value 47.19 g I_2/100 g and peroxide value 8.93 meq/kg. In conclusion, the findings from this study confirmed that almond nut oil has a long shelf life which may explain its applications in pharmaceutical, non-pharmaceutical and personal care industries.

Introduction

Worldwide, fruits and sometimes fruit nuts of many plants have been consumed for their nutritional benefits but, apart from that, they could be of medical and pharmaceutical importance use to humans. *T. catappa (Terminalia catappa*, almond plant) from *Combretaceae* family is a large tree in the Leadwood tree family that grows mainly in tropical regions of Africa, Asia and Australia [1]. In Southern Nigeria, it is referred to as "Ebelebo" among the Binis, "Baushe" in Hausa and "Igi-furutu" in Yoruba [2]. The juice obtained from its fresh leaves has been used in the preparation of medicinal lotion which is effective against scabies, leprosy, stomach aches and headaches [3]. The tree provides several other dyes, tannins, timbers, carbohydrates, fuel plants and many other medicinal

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purposes [2]. *T. catappa* is a well-known herb in Ayurveda traditions in India. The ethno-medical uses of *T. catappa* include the modulatory activity of the methanol extract of the leaves, wound healing activity of the chloroform extract of the bark [4], anticancer potency of the ethanol extract of the leaves [5] and anti-oxidant, hepato-protective, anti-microbial, analgesic, anti-inflammatory, anti-diabetic and anti-aging activity [3]. Recent scientific investigations revealed that the methanol extract of *T. catappa* leaf extract exhibits a dosage-dependent increase in inhibitory effect on α-glucosidase enzyme and α-amylase enzyme [6]. *T. catappa* exhibits anti-tumor activity with high anti-oxidant levels and the anti-oxidant defense may be due to the presence of phenolic and flavonoid components [5]. Phytochemical screening of the tree bark and leaves contains saponins, alkaloids, glycoside, terpenes, volatile oils, steroids and phenols. While, the seeds are rich in oleic-linoleic acid group, steroids, glycosides, phenolics and terpenes [7]. *T. catappa* has been observed to possess anti-oxidant activity in a dose-dependent manner by DPPH assay, nitric oxide assay, reducing power assay and H_2O_2 assay [8]. The plant also reverses the lipid levels to normal range and this shows anti-tumor and anti-lipidemic activities [9]. The leaf extract also inhibits the expression and activities of matrix metallo-proteinase-9 (MMP-9) by the assessment of mRNA levels in hepato-cellular carcinoma [10]. This research is aimed at determining the proximate composition, mineral elements and physicochemical parameters of *T. catappa* seed extract.

Materials and methods

Materials: All the chemicals and materials used in this work were of analytical grade and were obtained from the brand company of Merck and Sigma Aldrich, Modderfontein Johannesburg 1645, South Africa.

Sample collection and treatment: The fruits of *T. catappa* were collected from trees grown in Benin City, Edo State, Nigeria. The fresh epicarps of the *T. catappa* fruit were peeled to expose the seeds. The exposed seeds were then air dried for seven days and cracked open to collect the nuts. The seed nuts were air-dried under normal laboratory conditions for four weeks and finally pulverized. The powder seed nuts were then used for the proximate analysis and the determination of mineral composition [11].

Proximate analysis: The proximate composition of the seed kernel was analyzed following standard methods [11], crude fat by the Soxhlet method and moisture by vacuum oven, crude protein by Kjeldahl method and ash by ignition. Carbohydrate content was calculated by subtracting the values of all the other proximate analyses from 100 [11].

Mineral element determination: For the elemental analysis of the powder seeds, one gram of the sample was digested with concentrated HNO_3 and $HClO_4$. The sample was then filtered and made up to 50 ml with distilled water [11]. The metal concentrations were determined using an Atomic Absorption Spectrophotometer (Buck Scientific model 210) and a Flame Spectrophotometer (Sherwood, model 410). The mineral elements investigated were Iron (Fe), Zinc (Zn), Calcium (Ca), Magnesium (Mg), Potassium (K), Nickel (Ni), Sodium (Na), Cadmium (Cd), Cupper (Cu), Chromium (Cr) and Lead (Pb).

Physico-chemical analysis: The physicochemical analysis including acid value, saponification value, peroxide value and iodine value was determined according to standard methods [1].

Results

The results of the proximate analysis, mineral elements and physicochemical analysis of the seed oil extract of *T. catappa* seed nut are shown in **Tables 1**, **2** and **3**, respectively. Thus, a wide range of percentages among the

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constituents of *T. catappa* seed nut was found as shown in **Table 1**. Thus, carbohydrate, fat and crude protein were found in a high percentage (33.3%, 21.9%, and 29.6% respectively), whereas, fibre, ash and moisture contents were found in very low percentages (8.5%, 3.8%, and 2.3%, respectively).

Table 1: Results of proximate composition of *T. catappa* seed nut

Parameter	Value (%)
Moisture	02.34±0.2
Ash	03.89±0.1
Fibre content	08.50±0.1
Crude protein	29.66±0.3
Fat	21.98±0.1
Carbohydrate	33.63±0.2

In **Table 2**, different contents of mineral elements of the extract are given. Potassium, magnesium and zinc contents represent the highest, whereas, other elements are presented in a very low content. However, lead (Pb) content was not detected in this extract.

Table 2: Mineral elements detected in hexane extract of *T. catappa* seed nut

Element	Content (mg/kg)
Fe	06.40±0.00
Zn	39.00±0.42
Ca	29.00±2.60
Mg	30.00±3.13
K	54.70±1.50
Ni	00.00±0.00
Na	02.10±0.18
Cd	00.00±0.00
Cu	00.30±0.01
Cr	00.18±0.01
Pb	00.00±0.00

Table 3 shows acid, saponification, iodine and peroxide values of the crude oil hexane extract of *T. catappa* seed nut. A large variation was found among them with saponification value representing the high value and the acid value being the lowest value.

Table 3: Chemical parameters of the crude oil hexane extract of *T. catappa* seed nut

Parameter	Mean±S.E.
Acid value [mg KOH/g of oil]	0.102±0.01
Saponification value [mg KOH/g of oil]	151.28±2.63
Iodine value [g I_2/100 g of oil]	47.19±1.44
Peroxide value [meq/kg of oil]	8.93±0.86

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Discussion

In this study, the moisture content obtained for the almond seed nuts was to be 2.34%. Moisture content helps to determine storage time. Low moisture content is important for storage quality and shelf life of seeds. The moisture content indicates that almond seed can thus be kept for a long time. Furthermore, most researchers have inferred that low moisture in seeds reduces microbial activities and decreases unwarranted fermentation [1]. The lower moisture content recorded may be due to the fact that the almond seeds were air dried for 28 days. The ash content of a sample is an indication of the level of minerals present [12]. The values of ash content reported from different locations in Nigeria appear to fall within a similar range of 2.0%-5.0%. According to the previous report [13], the low ash content of seeds could be credited to the fact that during maturation, inorganic ions migrate from different parts of the plant to the region of active growth. This value was also lower than those obtained for almond seeds from other countries like Ivory Coast (4.6%) but higher than the 3.78% reported in the seeds from Malaysia [14]. The crude fiber content obtained in this work was 8.50% and higher than the 3.11% obtained by Akpabio [12]. The high amount of protein content obtained in this work suggests that almond nuts can be used to supplement other dietary sources. Therefore, it is recommended that almond nuts be added to the meals of individuals in order to increase the protein content. Another study, the seed contains carbohydrates, protein, fat, fiber, iron, ascorbic acid, arachidic acid and β-carotene in good proportion [15].

Amongst the minerals determined, the concentration of potassium was the highest (54.7 mg/kg) and Cr had the least quantity (0.18 mg/kg) while Ni, Cd and Pb were beyond the detection limit. Iron had a quantity of 6.40 mg per kg. On comparison with the work of Mandloi [15], phosphorus, potassium, niacin, riboflavin and thiamin were also detected in the seed. Therefore, almond seed could be recommended as a dietary supplement for people who need essential minerals and iron. The World Health Organization (WHO) recommended daily allowance for zinc is 11 mg. Therefore, almond nut when properly processed will be a good source of zinc due to its high value. Potassium has quantity of 54.7 mg per kg which plays a role in many body functions including transmission of nerve signals, muscle contractions, fluid balance and various chemical reactions.

The chemical parameters of the oil extract shown below in this study indicated an acid value of 0.102 mg KOH per g of oil which is attributable to its low free fatty acid value of 0.051. This value was low when compared to 0.787 mg KOH per g of almond nut oil obtained from India [12]. However, Ogbeide and others [16] reported a much higher-level acid value of 2.94 mg KOH per g. The saponification value obtained showed a value of 151.278 mg KOH per g which less than the value 326.08 mg KOH per g is obtained [16]. The saponification value obtained in this work could suggest that the almond seed has a few proportions of low molecular weight fatty acids and the difference observed could be as a result of the method of extraction of the oil from the seed. Another report, however, indicated that almond nut oil contains higher proportions of low molecular weight fatty acids [1]. Rancidity begins to occur in oil when the peroxide value ranges from 20.0 mg per g oil to 40.0 mg per g oil. The peroxide value obtained in this work was 8.93 meq per kg and these low values of peroxide value are indicative of low levels of oxidative rancidity of the oils and suggest high levels of antioxidants [1]. It has been asserted that oils with iodine value less than 100 mg I_2 per 100 g are non-drying oils, and consequently, the lesser the number of unsaturated the lower the susceptibility of such oil to oxidative rancidity [17]. The iodine value obtained in this work was 47.186 g per100 g which is less than 131.37 g per 100 g obtained by [16] and 121.19 g per 100 g obtained by [1]. The iodine value obtained was less than 100 g per 100 g, thus, almond nut oil cannot be placed in the class of drying oil.

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Conclusion: Terminalia catappa seed nuts contain essential minerals required for nutritional and medicinal purposes, and the low moisture content of the oil indicates that products or formulations from the nuts will possess a longer shelf life.

Author contribution: OI conceived, designed the study, performed the analysis and drafted the manuscript. JEU & EE collected and analyzed the data. All authors have approved the final version of the manuscript and agreed to be accountable for its contents.
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Ethical issues: Including plagiarism, informed consent, data fabrication or falsification and double publication or submission were completely observed by the authors.
Data availability statement: The raw data that support the findings of this article are available from the corresponding author upon reasonable request.

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