

Evaluation of Proximate Composition, Mineral Element and Anti-Nutrient in Almond (*Terminalia catappa*) Seeds

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Abstract: Proximate composition, mineral elements, anti-nutrients (toxicants) and lipid characteristics were determined for almond (*Terminalia catappa*) seeds. The results obtained showed the proximate composition of 25.23% moisture; 5.00% ash; 32.73% lipid; 33.66% crude fibre; 3.11% crude protein; 25.47% carbohydrate and caloric value 534.200 kcal. Mineral elements determined were P, Na, K, Fe, Mg and Ca while the anti-nutrients evaluated were hydrogen cyanide, oxalate and tannin. Almond seed oil was also characterized. The chemical properties of the oil showed that the oil contain high saponification value with low iodine value hence the oil is not recommended for soap making but is recommended for cosmetics industries.

Key words: Almond seed, proximate composition, mineral elements, anti-nutrients, oil characteristic

INTRODUCTION

The almond tree (*Terminalia catappa*) grows to a height of 3-8 m and bears a fruit that is ellipsoid in shape with a bluntly pointed apex and the fruit is about 7.51 cm long and 5.05 cm thick. On ripening, it turns from green to purplish yellow and contains a hard shell or nut which covers the delicate edible seed. The ripe mesocarp of the fruit is mostly consumed by children neglecting the seed which contains oil. The major countries growing this plant include Italy, Spain, Morocco, France, Greece and Iran. It flowers appear between April and May and between September and October. The fruiting season is from October to April (Salvo *et al.*, 1983).

Many varieties of almond tree are grown but they can broadly be divided into two types, bitter and sweet. Sweet almonds tree seeds do not contain amygdalin and are widely used as edible nuts and food ingredients. Bitter almonds contain amygdalin an enzyme which causes its hydrolysis to glucose, benzaldehyde and hydrocyanic acid (Salvo *et al.*, 1983). Fixed oil is obtained from sweet almond while volatile oil is obtained from sweet almond tree seeds. However, this does not imply however that sweet almond oil is made from sweet almonds. Bitter almonds are thus used for both fixed and volatile oil extractions (Eckey, 1954). The oil content of dried sweet almond kernel is 50-60%. That is bitter almonds has oil with lower yield 40-45% and sometimes as low as 20% (Eckey, 1954).

Sweet almond oil is used in many cosmetic products. Due to its high value, sweet almond oil is subject to

adulteration particularly by the far cheaper peach oil which has very similar fatty acid characteristics. In one survey in Brazil it was found that 77% of almond oil samples had been adulterated (Badolato *et al.*, 1983), much research has been carried out on analytical method to detect such adulteration (Salvo *et al.*, 1983).

The cake of sweet almond remaining after oil extraction contains 39-47% protein and 10-18% oil. It is used in animal feed and also ground to a fine powder which finds use in toilet preparations. Bitter almond press cake due to its toxic component cannot be used for feed (Etokakpan, 1983).

The Indian almond (*Terminalia catappa*) finds wide use amongst tribals. The kernel is eaten and the tree provides medicines and dyes, the wood is used for construction (Sen and Halder, 1987). The chemical composition of some seeds and nuts such as the African oil bean (*Pentacethra macropohylla*), melon (*citrullus vulgaris*), groundnut (*Arachies hypogea*), cashew nut (*Anacardium occidentale*) oil palm nut (*Elears guineensis*) and seeds of *Senna siamea* has been analysed by scientist (Ingweye *et al.*, 2010). Physico-chemical properties of seed oil have also been reported, these include; Castor seed oil (Bagali *et al.*, 2010), Shea butter oil (Asuquo *et al.*, 2010), *Dennettia tripetala* fruit oil (Pepper fruit) (Nwinuka and Barine, 2009). Physico-chemical studies of oil from *Irvingia gabonensis*, *Telfairia occidentalis*, *Treulia Africana*, *Peralima nitida*, *Lageneria siceraria*, *Sesamum orientale*, *Dacryodes edulis* and *Parkia biglobosa* have been reported (Dawodu, 2009), characterization of Avocado pear

(*Persea americana*) and native pear (*Dacryodes edulis*) fruits oil have been reported in the earlier research (Akpabio *et al.*, 2011).

Almond seed is an edible seed and is eaten by both young and old people in Nigeria but the report of its physicochemical properties is scanty hence the aim of this research is to determine the chemical composition, mineral elements, anti-nutrient and lipid characteristics of the almond seed in order to ascertain the industrial application of its seeds, seed oil and the kernel cake.

MATERIALS AND METHODS

Samples collection and preparation: Mature fruits of the samples were collected from the University of Uyo convocation grounds and Law Park in the Annex Campus. The fruits were sun dried for 7 days and cracked open to remove the seeds. The seed coat of almond seed was removed and the moisture content of the seed determined. The seeds were then oven dried at 60°C for 24 h and ground into fine powder using mortar and pestle. The powdered samples were stored in plastic container for laboratory analysis when needed. Most of the methods adopted in this research are those recommended by AOAC except otherwise stated.

Proximate composition

Moisture content: The wet sample obtained immediately after collection was oven dried at 60°C for 24 h with the weight of the wet sample and the weight after drying noted. The drying was repeated until a constant weight was obtained. The moisture content was expressed in terms of loss in weight of the wet sample.

Ash content: About 1 g of the oven-dried sample in powder form was placed in crucible of known weight. This was ignited in a muffle furnace for 5 h at 550°C. The crucible was cooled and weighed and the ash content was expressed in terms of the oven-dried weight of the sample.

Crude protein: The protein nitrogen in 1 g of the dried sample was converted to ammonium sulphate by digestion with concentrated H₂SO₄ and in the presence of CuSO₄ and Na₂SO₄. This was heated and the ammonia evolved was steam distilled into boric acid solution. The nitrogen from ammonia was deduced from the titration of the trapped ammonia with 0.1M HCl with Tashirus indicator (double indicator) until a purplish pink colour was obtained. Crude protein was calculated by multiplying the value of the deduced nitrogen by the factor 6.25 mg.

Crude fibre: About 2 g of the ground sample was digested in 50 mL of 1.25% H₂SO₄. The solution was boiled for 30 min after which it was filtered and washed with hot water. The filtrate was also digested in 50 mL of 1.25% NaOH. The solution was heated for 30 min, filtered and washed with hot water and oven dried. Finally, the oven-dried residue was ignited in a furnace at 550°C. The fibre content was measured by the weight of the left after ignition and was expressed in term of the weight of the sample before ignition.

Oil (Lipid) content: The lipid content was determined by extracting the fat from 5 g of the sample using petroleum ether in a soxhlet apparatus. The weight of the lipid obtained after evaporating off the petroleum ether from the extract gave the weight of the crude fat in the sample.

Carbohydrate content: The carbohydrate content of the sample was estimated as the difference obtained after subtracting the values of organic protein, lipid, ash and fibre from the total dry matter.

Caloric value: The caloric value of the sample was obtained by multiplying the values of the crude protein, lipid and carbohydrate by the factors 4, 9 and 4, respectively and taking the sum of the products.

Oil (Lipid) characteristics: Lipid characteristics (saponification value, free fatty acid, iodine value and acid value) were determined using AOAC Standard Method.

Mineral elements: Sodium and potassium was determined by Flame Photometry Method. Calcium and magnesium were determined by Versenate Titration Method (Cheng and Bray, 1951). Phosphorous concentration in the sample was measured colorimetrically using the Molybdovanadate Method recommended by AOAC. Iron concentration in sample digest was determined using Orthophenathroline Colometric Method.

Anti-nutrients (Toxicants): The dried sample was analysed for the presence of toxicants using different method as described.

Hydrogen cyanide: About 5 g of the sample were soaked in distilled water for 4 h for the liberation cyanide. The liberated cyanide was steam distilled into 5 mL of 2.5% w/v 4 mL of 6N NH₄OH and 5% w/v KI were added to the distillate portion before titration with 0.02N AgNO₃ to a faint but permanent turbidity (mL of 0.02 N AgNO₃ = 1.08 mg HCN).

Oxalate: This was determined using Dye Method (Dye, 1956). About 2.5 g of the sample was extracted with dilute HCl, 5 mL of concentrated ammonia and precipitated with CaCl₂ as calcium oxalate. The precipitate was washed with 20 mL of 25% H₂SO₄ and dissolved in hot water before titrating with 0.05N KMnO₄ to determine the concentration of oxalate.

Tannin: This was determined using Burn Method (Burns, 1971). About 5 g of the dried sample was treated with 50 mL methanol and kept for 24 h before filtration. The 5 mL of freshly prepared vanalin hydrochloric acid was added and the solution was allowed to stand for 20 min for colour development. The absorbance was measured at 550 nm using spectronic 20 and the machine value was used in calculating the tannin content.

RESULTS AND DISCUSSION

Proximate composition: The moisture content of almond seed was 25.229%. This result therefore shows that almond seed has high moisture content hence cannot be preserved for a long time. This value is high when compared to 5.5 and 5.1% for cashew nut (Fetuga *et al.*, 1974) and African oil bean (Osagie *et al.*, 1986) (Table 1).

The ash content of almond seed was 5%. Ash content signifies the level of mineral present in the sample. The ash content of almond seed is high when compared to 3.3% recorded for cashew nut (Fetuga *et al.*, 1974); it is also higher than the value of 2.7% obtained for African oil bean (Osagie *et al.*, 1986).

The protein content was 33.69% in almond seed. The value is high when compared to that of melon seed which is 30.8% (Ige *et al.*, 1984), African oil bean with 28.1% (Osagie *et al.*, 1986) and cashew nuts with 21.2% (Fetuga *et al.*, 1974). The dietary allowance for protein is 56 g for a 70 kg man (NRC, 1989). For the fact that the protein content for almond seed is high, it could be used as a dietary supplement for people who need a lot of protein and most importantly for those who require plant protein e.g., people suffering from hypertension. It can also be incorporated into animal feed to increase the protein content.

The fibre content of almond seed was 3.11%. This is significantly high when compared to 0.8% obtained from

cashew nut (Fetuga *et al.*, 1974) and 2.5% for African oil bean and melon seed (Isichei and Achienwhu, 1988). The high fibre content can act better on the digestive system without giving much problem of constipation. The fibre content of almond seed is low when compared to the value of 8.2% obtained for African mango (Oke and Umoh, 1978).

The carbohydrate content of almond seed was 25.47%. This value is high when compared to the values of other seeds and nut such as melon seed with 7.3% (Achiewhu, 1983), African mango 19.2% and African oil bean with 15.3% (Isichei and Achienwhu, 1988).

The caloric value of almond seed was 534.20 kcal. This value is high and as such could be recommended as a dietary supplement for people who require a lot of energy, example the athletes.

Almond seed has a lipid content of 32.73%. The lipid content of the seed is low when compared to melon seed which contain 51.1% lipid (Ige *et al.*, 1984) and African mango with 55% (Isichei and Achienwhu, 1988), Cashew nut with 48.1% (Fetuga *et al.*, 1974) and African oil bean with 34.9% (Osagie *et al.*, 1986).

Mineral elements: The value of phosphorus obtained from almond seed was 10.0 mg/100 g. The value is very low when compared to 4000 mg/100 g obtained for Benni seeds (Dashak and Fali, 1993). The dietary allowance for phosphorus is 800 mg/100 g (NRC, 1989). Therefore almond seed is not useful as phosphorus supplements (Table 2).

The value of sodium in almond seed was 5.0 mg/100 g. This value is high when compared to 1.96 mg/100 g obtained for cocoa bean (Olaefe, 1987). The dietary allowance for sodium is 110-3300 mg for adults, (NRC, 1989). The value obtained for almond seed is quite low and so cannot serve as dietary supplement for sodium.

The value of potassium in almond seed was 350.00 mg/100 g. This value is high when compared to 330 mg/100 g obtained for cocoa bean (Olaefe, 1987). The dietary allowance for potassium is (1875-5625 mg) for adults (NRC, 1989). The seed could not be recommended as source of dietary supplement for potassium. The

Table 1: Proximate composition

Compositions	Values
Moisture (%)	25.229
Ash (%)	5.000
Lipid (%)	32.730
Crude protein (%)	33.690
Crude fibre (%)	3.110
Carbohydrate (%)	25.470
Caloric value (kcal)	534.200

Table 2: Mineral element composition (mg/100 g)

Elements	Values
Phosphorus	10.0
Sodium	5.0
Potassium	350.0
Iron	375.0
Magnesium	26.4
Calcium	36.1

magnesium content was 26.4 mg/100 g. This value is low when compared to 520 mg/100 g obtained for cocoa bean (Olaefe, 1987). The value is also low when compared to 300 mg/100 g reported for Benni seed (Dashak and Fali, 1993).

Calcium content in almond seed was 36.1 mg/100 g. This value is high when compared to 2.17 mg/100 g obtained for cocoa bean (Olaefe, 1987) but low when compared to 900 mg/100 g obtained for Benni seed (Dashak and Fali, 1993). The dietary allowance for calcium is 800 mg for 70 kg man (National Research Council, 1989).

The value of 37.5 mg/100 g was obtained for iron. The iron content is high when compared to 1.94 mg/100 g obtained for cocoa bean (Olaefe, 1987). However, iron content of almond seed is low when compared to 50 mg/100 g obtained for Benni seeds (Dashak and Fali, 1993). The dietary allowance for iron is 10 g for 70 kg (NRC, 1989). Therefore, almond seed could be recommended as a dietary supplement for people who need iron.

Anti-nutrients (Toxicants): Hydrogen cyanide of 21.6 mg/100 g was obtained from almond seed. The value is low when compared to 28.4 mg/100 g for *Vigana unguiculata* (Etokakpan, 1983). The lethal dose for this toxicant is 50-60 mg kg⁻¹ (Rention *et al.*, 1971). The seed may be consumed without any hydrogen cyanide related problem arising since the value is low.

The total oxalate content of almond seed was 26.4 mg/100 g. This value is low when compared to 51.4 mg/100 g obtained for *Vigana unguiculata* (Etokakpan, 1983) (Table 3). Almond seed was found to contain 39.40 mg/100 g of tannin. The value is low when compared 73.1 mg/100 g obtained for *Vigana unguiculata* (Etokakpan, 1983). Low value of tannins has less effect in the body as high quantity is not good in the body.

Oil (lipid) characteristics: The saponification value of almond seed oil was 95.37. This value is low when compared to 163.6 obtained by Kalu (1988) for calabash seed oil. Low saponification value is ideal for soap making (Akpabio *et al.*, 2011) (Table 4).

The acid value of almond seed oil was 1.68. This value is low when compared to 2.15 obtained for melon seed oil (Ige *et al.*, 1984), 2.37 for coconut oil (Peter, 1956) and 4.30 for camphor seed oil (Osagie *et al.*, 1986). For soap making higher values is required, therefore the oil is not useful for soap making with regard to acid values (Devine and Williams, 1961). The free fatty acid value of the oil obtained was 16.92. This value is high when compared to 3.45 obtained for melon seed (Ige *et al.*, 1984)

Table 3: Anti-nutrients (mg/100 g)

Toxicants	Values
Hydrogen cyanide	21.60
Oxalate	26.40
Tannin	39.40

Table 4: Oil characteristics

Lipid characteristics	Values
Saponification (mg KOH/g)	95.37
Free fatty acid (mg KOH/g)	16.92
Acid value (mg/KOH 100 g)	1.68
Iodine value (g I ₂ /100 g)	1.27

for soap making, oil with 2-5% free fatty acid value could be used. Thus, the oil from almond would not perform very well in soap making with regard to the free fatty acid values.

The iodine value of almond seed oil was found to be 1.27. Oils with iodine value <1.30 are non drying oil and are not suitable for paint making (Hilditch and Seavell, 1950), therefore almond seed oil is not suitable for paint making.

CONCLUSION

From the results of the study, it can be concluded that almond tree seed has a higher level of most of the chemical components. It is therefore a very promising raw material for various industries. Also, it would serve as useful dietary supplements. Therefore, this seed must not be overlooked anymore. The high protein value of the seeds and low level of anti-nutrient indicates its potentials usefulness in animal and poultry feed supplements. The chemical properties of the almond seeds oil showed that the oil contain high saponification value with low iodine value, low saponification value is ideal for soap making, hence the oil is not recommended for soap industry. Almond seed oil can also be considered as non drying oil hence it is not good for paint making but is recommended for cosmetics industries.

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