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# CHEMICAL COMPOSITION AND PHYSICOCHEMICAL CHARACTERISTICS OF TROPICAL ALMOND NUTS (TERMINALIA CATAPPIA L) CULTIVATED IN SOUTH WEST NIGERIA.

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## ABSTRACT

Proximate, mineral and functional properties of flour and physicochemical properties of oil of tropical almond (*Terminalia catappa*) nut were investigated using standard methods. Fresh almond nut were screened, cut into two halves and then dried in forced air oven at $40^0$C for 6hrs, milled and stored for analysis. The mean values of various parameters for proximate composition (%) were: moisture (9.3±0.2), ash (4.8±0.1), ether extract (3.3±0.1), crude protein (32.6±0.2), crude fibre (0.4±0.3) and carbohydrate (by difference) (49.90).The calculated fatty acids were noted to be 29.4% and energy was 1531.04KJ/100g. Minerals (mg/100g) included: Na (27.72±0.2), K (42.17±0.1), Ca (27.17±0.3), Mg (35.92±0.2), Mn (1.6±0.2), Cu (0.4±0.1), Zn (0.8±0.1), Fe (6.38±0.1) and P (24.26±0.2) while Pb, Cd and Hg were not detected. The relationship between Na and K and Ca and P; are desirable with the respective ratios of Na/K (0.66) and Ca/P (1.12). The physicochemical properties of almond nut oil were:- colour (yellow), refractive index (1.465), specific gravity (0.981), acid value (1.3±0.4mgKOH/g, saponification value (128.0±0.3mg KOH/g), iodine value (65±0.1mg Iodine/g), peroxide value (2.8±0.2) and free fatly acids (0.64±0.1mg/g). The physico-chemical properties of the oil indicated that it is edible, non-drying and may not be suitable for soap making. The data obtained from the study clearly show the nutritional potentials of the nut as alternative food ingredient for protein supplementation and its reliability as a good source of amino acids for school children and adults.

**Key words:** Almond nut flour, Almond oil, chemical composition, physicochemical properties, seed flour

## INTRODUCTION

Edible nuts are cultivated and grown in a variety of growing conditions and climates, are globally popular, and are valued for their sensory, nutritional, and health attributes. They are rich sources of lipids and proteins, edible nuts also contain certain vitamins and minerals in appreciable amounts. Nut seeds with skins can also be a good source of fiber and are used as a snack food or as an ingredient in the manufacture of a variety of food products such as peanut butter and peanut brittle. Nuts have been the food of man from the earliest times in many parts of the world [1]. Their significance in the nutrition of man is based on their nutritive value as they contain a significant amount of high quality proteins and vital minerals [2]. The superior quality of nut proteins makes them good substitutes for animal food and good sources of edible oils and fats. Weight

for weight, oils and fats furnish 2.25 times more energy than proteins and carbohydrates.

Tropical almond (*Terminalia catappa*) is a large, spreading tree now distributed throughout the tropics in coastal environments. The tree is tolerant of strong winds, salt spray, and moderately high salinity in the root zone. It grows principally in freely drained, well aerated, sandy soils. The species has traditionally been very important for coastal communities, providing a wide range of non-wood products and services. It has a spreading, fibrous root system and plays a vital role in coastline stabilization. It is widely planted throughout the tropics, especially along sandy seashores, for shade, ornamental purposes, and edible nuts. The timber makes a useful and decorative general-purpose hardwood and is well suited for conversion into furniture and interior building timbers. Fruits are produced from about 3 years of age, and the nutritious, tasty seed kernels may be eaten immediately after extraction. Tropical almond is easily propagated from seed, and is fast growing and flourishes with minimal maintenance in suitable environments. Selected cultivars of the species warrant wider commercial planting for joint production of timber and nuts. The tree has a demonstrated potential to naturalize in coastal plant communities, but not to adversely dominate such communities. The productivity and marketing of cultivars with large and/ or soft-shelled nuts needs to be assessed. There is also a need for experimental work to develop vegetative propagation techniques and more efficient techniques for processing fully mature fruits including drying, storage, and cracking of nuts. Information abounds on the nutritional content of common nut such as groundnut, cashew nut, walnut. However, there are limited information in the nutritional composition, utilization and physicochemical properties of the almond nut flours. The study is aimed at investigating the proximate, mineral and functional as well as the physicochemical characteristics of almond nut flour produce in Nigeria. Such information will expand the scope of knowledge on the utilization of almond oils in various food applications and nutritional qualities of almond nut flour.

## MATERIALS AND METHODS

**Collection and preparation of samples:** The almond nuts used for this study were obtained from farm near Federal college of Agriculture, IAR&T, Ibadan, Oyo state. The nuts were thoroughly screened to remove the bad ones and stones. The nuts were cut into two halves using the manual kernel cutter. After cutting, the nuts were then removed and dried in a forced air oven at $40^0$C for 6 hours to make it bone dry. The covering testa were removed by squeezing and then winnowed to obtain cream colour nuts. Dried clean nuts were milled using Moulinex blender. The powdered sample was stored in polythene bags and kept in a refrigerator at $4^0$C until used for proximate analysis.

**Chemical analysis**: The proximate analyses of the samples for moisture, total ash and crude fibre were carried out in triplicate using the methods described by [3]. The nitrogen was determined by the micro Kjeldahl method described by [4] and the nitrogen content was converted to protein by multiplying by a factor of 6.25 and

Carbohydrate content was determined by difference. All the proximate values were reported in %.

**Mineral analysis:** The minerals were analyzed by dry ashing the samples at $550^0$C to constant weight and dissolving the ash in volumetric flask using distilled, deionized water with a few drops of concentrated hydrochloric acid. Sodium and potassium were determined by using a flame photometer (Model, 405, Corning, UK) using NaCl and KCl to prepare the standards. All other metals were determined by Atomic Absorption Spectrophotometer (Perkin-Elmer Model 403, Norwalk CT, USA). All determinations were done in triplicate. All chemical used were of analytical grade (BDH, London). Earlier, the detection limits of the metals had been determined according to Techtron (1975). The optimum analytical grade was 0.1 to 0.5 absorbance units with a coefficient of variation of (0.87 - 2.20) %. The minerals were reported as mg/100g.

**Extraction of oil:** The oil sample was extracted from the seed flours by soxhlet extractor using petroleum ether of Analar grade (British Drug Houses, London), boiling range 60-$80^0$C for 8hrs[5].

**Determination of physicochemical properties of oil:** The physicochemical properties of almond nut oil for acid value, iodine value, saponification value, peroxide value, free fatty acid( as oleic acid) and specific gravity were carried out according to the methods of [3]. Refraction index at $29^0$C was determined using Abbe refractometer.

**Determination of the functional properties of almond nut meal:** The water absorption capacity (WAC) and fat emulsion stability were also determined [6]. The fat absorption capacity (FAC) was determined as described [7] (Solsulki, 1962) and the lowest gelation concentration (LGC), foaming capacity (FC) and foaming stability (FS) were determined using a standard technique described elsewhere [8].

## RESULTS AND DISCUSSION

Table 1 presents results of the proximate composition of almond nut flour. The moisture mean value of almond nut flour which was 9.3 ± 0.2% dry weight is high when compared with the mean value of moisture of legumes ranging between 7.0% and 11.0% reported by [9] and 5.7% reported for cashew nut flour by [10. This value is also higher than the study reported by [11] and [12] for fluted pumpkins seed of 5.0% and 5.50% respectively and groundnut [13]. This indicates that the nut will not have good keeping properties. Ash content mean value of almond in this present study was 4.9 ± 0.1%. It has been recommended by [14] that ash contents of nuts, seed and tubers should fall in the range 1.5-2.5% in order to be suitable for animal feeds. The ash content of almond nut does not fall within this range hence it cannot be recommended for animal feeds. This value is in close agreement with those reported by [10] for cashew nut flour of 4.4%. The ether extract (crude fat) with a mean value of 3.3±0.1% is low compared to the values for varieties of melon oil seeds ranging between 47.9-51.1% reported by[11]; for pumpkin seed (49.2% and 47. 01%) by[15] and[12] respectively. It is also low when compared to soybean seed, which has only

23.5% fat [16] and cashew nut which has 36.7% fat. Fat is important in diets because it promotes fat soluble vitamin absorption [17]. It is a high energy nutrient and does not add to the bulk of the diet. The crude protein of 32.6% is highly comparable to protein rich foods such as soybeans, cowpeas, pigean peas, melon, pumpkin and gourd seeds ranging between 23.1- 33.0 % [18]; chick beans 19.4% and lima bean, 19.8% [19]; Jack bean, 30.8% [20] and cashew nut, 25.25±0.2% [10].

The recommended daily allowance for protein for children ranges from 23.0-36.0g and for adult, 44-56g [21]. However, it can be evaluated that almond nut can supply the recommended daily intake of protein for children. Apart from the nutritional significance of protein as a source of amino acids, they also play apart in the organoleptic properties of foods [22]. The present study investigated only the crude protein content of the nut. [23] suggests a daily intake of 0.88g of protein per kg body weight for children in the age range of 1-10 years. As many people who inhabit the developing nations rely almost exclusively on plant proteins, an adequate serving of tropical almond nuts should be encouraged in the diets of this people. The present study shows that the nut contains some amount of protein that can supplement other dietary sources. The crude fibre of almond nut (0.43%) was very low compared with legumes, mean values ranging between 5-6% [10] and [20]. Maintenance of internal distention for a normal peristaltic movement of the intestinal tract is the physiological role which crude fibre plays. Other authors [22] reported that a diet low in fibre is undesirable as it could cause constipation and that such diets have been associated with diseases of colon like piles, appendicitis and cancer. The value obtained for carbohydrate (by difference), 49.9% is comparable with an acceptable range mean

Table 1: Proximate composition (%) of Almond nut flour

| Composition | % |
|---|---|
| Moisture | 9.3±0.2 |
| Ash | 4.8±0.1 |
| Ether extracts | 3.3±0.2 |
| Crude protein | 32.6±0.1 |
| Crude fibre | 0.4±0.2 |
| Carbohydrate (by difference) | 49.9±0.3 |
| [a]Fatty acids | 0.64±0.1 |
| [b]Energy KJ/100g | 1531.04±0.2 |

Values are mean ± standard deviation of triplicate determinations. [a]calculated fatty acids (0.86× crude fat). [b]calculated metabolizable energy (KJ/100g)(Protein ×17+ Fat ×37+carbohydrate×17) values of legumes, 20-60% of dry weight [9]. This result thus gave an indication that the almond nut flour is a rich source of energy and capable of supplying the daily energy requirements of the body. Carbohydrates are easily digested, provide the necessary calories in the diets of most people of the world promote the utilization of dietary fats and reduce wastage of proteins. The calculated metabolizable energy value (1531.04KJ/100g) showed that almond nut flour was concentrated source of energy. The energy from cereals ranged from 1.3-1.6 MJ/100g

reported by [16] indicating that almond nut flour has energy concentration favourably comparable to cereals. In human diets, protein quality and quantity are major concerns.

The mineral content (mg/100g) of almond nut flour is shown in Table 2. They serve as cofactors for many physiologic and metabolic functions. The least abundant minerals were Cr (1.14), Zn (1.18) and Ni (0.3) while K was found to be the most abundant mineral (42.17±0.1mg/100g). This is in close agreement with the observation of [24] and [25] that K was the most predominate mineral in Nigerian Agricultural Products. Mg was found to be next highest mineral component. It has been reported that magnesium is an activator of many enzymes systems and maintains the electrical potential in nerves [26]. The body contains 20-28g of magnesium, more than half of which is stored in the bones. Tropical almond nut contains large amounts of magnesium and an adequate serving would satisfy Recommended Daily Allowance (RDA). Calcium mean value (27.17±0.3mg/100g) of the present study is lower than melon, pumpkin and gourd seeds of 130.7, 72.3 and 54.9mg/100g respectively reported by [18] and higher than cashew nut (21.9mg/100g) reported by [10]. Calcium in conjunction with phosphorus, magnesium, manganese, vitamins A, C and D, chlorine and protein are all involved in bone formation [27]. Calcium is also important in blood clothing muscle contraction and in certain enzymes in metabolic processes. Calcium, an important mineral required for bone formation and neurological function, was found to be present at significant levels. Considering that WHO/FAO recommends an intake of 400–500 mg per day of calcium for adults and 1200 mg per day until the age of 24 years [23] a modest serving of approximately 100g of tropical almond per day would satisfy half an adult daily calcium need and one-fourth of the daily requirement for children. This shows that tropical almond can supplement other sources of dietary calcium since it is consumed mainly as snack. The mean value of phosphorus (22.6±0.2mg/100g) is very close to that of calcium. Phosphorus is always found with calcium in the body both contributing to the blood. Sodium is a macronutrient and constitutes 2 percent of the total mineral content of the body. The mineral is vital in maintaining the body fluid volume, osmotic equilibrium and acid-base balance.

**Table 2: Concentration of macro and microelement of Almond nut flour (mg/100g)**

| Mineral | mg/100g |
|---|---|
| Ca | 27.17±0.2 |
| Na | 27.72±0.1 |
| K | 42.17±0.2 |
| Mg | 35.92±0.3 |
| P | 24.26±0.2 |
| Fe | 6.38±0.2 |
| Zn | 1.83±0.1 |
| Cr | 1.14±0.1 |
| Ni | 0.30±0.1 |
| Pb | ND |
| Hg | ND |
| Cd | ND |
| Na/K | 0.66 |
| Ca/P | 1.12 |

Values are mean ± standard deviation of triplicate determinations. ND= Not detected

Deficiency of sodium occurs during hot weather or as a result of heavy work in hot climate. A significant consumption of tropical almond nut will provide the RDA of sodium as 1.37g is an adequate daily intake [21]. Low Ca/P ratio facilitates calcinations of calcium in the bone while Ca/P ratio above two helps to increase the absorption of calcium in the small intestine [28]. Ca/P ratio of almond nut flour is greater than 1, indicating that it would serve as good source of mineral for bone formation. The ratio of sodium to potassium in the body is of great concern for prevention of high blood pressure. Na/K ratio less than one is recommended [28]. The Na/K ratio for almond nut flour under consideration though less than one. This is an indication that consumption of almond nut would probably reduced high blood pressure disease. Iron is a constituent of hemoglobin, myoglobin, and a number of enzymes, which catalyzes oxidation, and reduction processes in the cell. Anaemia is causes due to diet deficient in iron, protein and the vitamins folate, B-1, B-6 and C, or poor absorption over long periods. The present study on tropical almond nut shows that the nut contains some levels of iron which can supplement other sources of dietary iron. Phosphorus a macronutrient comprises 22 percent of the total minerals of the body. Dietary deficiency of phosphorus is extremely unlikely as nearly all food content this mineral. The study shows that tropical almond nut is a rich source of dietary phosphorus. The study also shows the present of zinc and chromium.

The physicochemical properties of almond nut oil are shown in Table 3. The yellowish colour oil had specific gravity of 0.964 indicating that it is less dense than water with refractive index of 1.465, which is in agreement with the value of 1.462 for B. Sapida oil [29] and 1.654 for cashew nut oil [10]. This showed that the oil is less thick when compared with most drying oils whose refractive indices were between 1.475 and 1.485[30]. Saponification value is used in checking adulteration. The saponification value of the oil was 128 mgKOH/g which is below the values obtained for some vegetables oil ranging from 188-196 mgKOH/g. Also the value is lower than the values for cashew nut oil (168.3mgKOH/g) [10], coconut oil (253mgKOH/g), palm oil (247 mgKOH/g), butter fat (225 mgKOH/g). Pearson [4] reported that oils with higher saponification values contain higher proportion of lower fatty acids.

**Table 3. Physicochemical Properties of oil Almond nut flour**

| Parameters | Values |
|---|---|
| Colour | yellow |
| pH | 5.51 |
| Acid value (mg KOH/g)* | 1.3 |
| Free fatty acid (as oleic acid) (mg/g)* | 0.64 |
| Iodine value (mg Iodine/g)* | 65.0 |
| Peroxide value (meg/kg)* | 2.8 |
| Saponification value (mg KOH/g)* | 128.0 |
| Specific gravity ($20^0$C) | 0.981 |
| Refractive index ($29^0$C) | 1.48 |
| State at room temperature | Liquid |

*Values are mean standard deviation of triplicate determinations

Therefore, the value for almond nut oil indicated that the oil contained high proportion of higher fatty acids and may be useful industrially. The low saponification value and low acid value indicated that the oil may not be suitable for soap making. Acid value is used as an indicator for edibility of oil and suitability for use in the paint industry. The acid value of the nut is 1.2±0.4 mgKOH/g which is low when compared with plukenetia conophoria (11.5mgKOH/g) as reported by[31], benissed (47.6%)[32] but higher than cashew nut oil (0.82mgKOH/g)[10], Hura crepitan seed oil (19.04mgKOH/g) [33], C. albidum (3.56mgKOH/g), L. owaronsis (15.33mgKOH/g), palm oil (14.04mgKOH/g) [34]. Pearson [4] reported acid values of sesame, soybean, sunflower and rape seed of 7 mg KOH/g. The iodine value of the oil was 65mgiodine/g. This is a measure of the degree of unsaturation in oil and it is an identity characteristics nature of oil. It indicates the degree of unsaturation in the fatty acid of triacyglycerol**.** This value could be used to quantify the amount of double bond present in the oil which reflects the susceptibility of oil to oxidation.

The iodine value obtained is low suggesting the presence of saturated fatty acid and this places the oil in the non drying groups as drying oil have an iodine value above 100[30]. The oil may be used as a raw material in industries for the manufacture of vegetables oil based ice cream. The iodine value is higher than value obtained for cashew nut (44.4mg Iodine/g) [10], citrullus vulgaris (38.1mgIodine/g) [35] and Hausa melon seed, 38.50±0.67% [36]. In view of the fact that drying oils have an iodine value above 100 [30] almond nut oil could only be categorized as non-drying oil. The oil has free fatty acid value of 0.64 which is less than 3 obtained for C. albidum, 2.78 for D.edulis, 7.06 for Eguinensis, 7.70 for L. owaronsis, 2.60 N. imperialis [34]. This value is within the allowable limit for edible oil 0-3 [37]. This oil could therefore be used as edible oil. However, the peroxide value obtained for the oil (2.8) is lower than the recommended standard (codex alimentarius commission, 1970) for all edible oils. Fresh oils have values less than 10mEqKg-1. The value is lower than the value obtained for whole cashew nut [34]. The peroxide value is lower than that expected of rancid oil which ranges from 20.00 to 40.00mg/g oil [33]. This shows that the oil is not rancid and considered stable [38]. The peroxide value is used as an indicator of deterioration of oil. Fresh oils have peroxide values less than 10mEq/kg. The value of the functional properties of the almond nut flour from this study suggest that its usefulness in the development of different food products. The water absorption capacity (WAC) is 128.2 which is lower than 130% reported for soybean [39] 134% reported for African yam bean [40] but comparable with values reported for melon [11]. The value is also lower than 139.5 279.0 ± reported for cashew nut respectively [41].

**Table 4. Functional properties of Almond nut flour**

| Parameters | Values |
|---|---|
| Swelling capacity (%) | 1.2 |
| Foaming capacity (30 min) % | 14.5 |
| Foam stability (%) | 10.7 |
| Bulk density (loose) (g/10cm$^3$) | 0.3248 |
| Bulk density (Packed) (g/10cm$^3$) | 0.5366 |
| Least gelation concentration (%) | >20 |
| Emulsion capacity (%) | 5.7 |

| | |
|---|---|
| Water Absorption capacity (%) | 128.2 |
| Oil Absorption capacity (%) | 107.6 |

The value is lower than 138 and 187.5 reported for talinum triangulare and Amaranthus cruentus respectively reported by [42]. The water absorption capacity is a critical property of protein in viscous food such as gravies soups dough and baked products [41], their incorporation in food formulation such as maize gruel, cassava flour will enhance their nutritive values. The observed fat absorption capacity (FAC) is 108.7 is lower than 167.4 reported for undefatted cashew nut flour [41], but higher than 84.4% reported for soy bean flour [39] and higher than 207% reported for sunflower flour [39] and 89.7% pigeon pea flour [32]. This indicates the nutritional potential of almond nut as flavour retainers. The foaming capacity (FC) and foaming stability for almond nut flour after 30minutes are 14.8 and 12% respectively when compared with the values reported for dehulled varieties of lema beans flour by [43] was 8.8 to 15.2%. This indicates that almond nut flour may be a suitable whipping agent in food system higher than the value reported by [41] cashew nut (2%).but lower than soy bean flour (7%) and sun flower flour (230%) reported by [41]. The foaming stability values of almond nut are lower than values reported for legumes product and talinum triangulare (22.1) Amaranthus cruentus (18.9) Telfaria occidentalis (19.2) reported by [42]. The emulsion capacity (6.0) (Table 4) is lower than 28.7 and 32.7 and 30.1 reported for talinum triangulare, amaranthus cruentus and Telfaria occidentalis [43]. The least gelation concentration (20%) is higher than values reported for pigeon pea (12%) lupin flour (14%) and cassava leaf meal and cassava leaf protein concentrate (9.04 and 12.5% respectively) previously reported by [44]. This value is lower than values reported for fluted pumpkin (36%) [45].This result obtained shows that almond nut flour may be useful in the production of curd or as an additive for other materials for gel formation in food products.

## CONCLUSION

The data obtained from the proximate, mineral and functional properties of almond nut clearly show the nutritional potentials of the nut as alternative food ingredient for protein supplementation when compared to some other oil seeds and nuts. The high quality protein of almond nut showed its reliability as a good source of amino acids for school children and adults. The physico-chemical properties of the oil indicated that it is edible, non-drying and may not be suitable for soap making. However, further work is in progress for the determination of fatty acid, amino acid profile and sterol composition of almond nut oil by the same authors.

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## REFERENCES

1. Shakuntala, MN and M. Shadadsharaswamy, 1987. Food, Facts and Principles. Wiley Eastern Limited, New Delhi.
2. Eley, G. E. P (1976) Publishing Ltd., Yorkshire .

3. AOAC. Official Methods of Analysis. Association of Official Analytical Chemists 15th Ed. Washington D.C. (1990)
4. Pearson, D, 1976. The Chemical Analysis of Foods. 7th ed. Churchill Livingstone, London
5. AOAC, 1990. Official Methods of Analysis, 15th edition, Washington, DC.
6. Beuchat, L.R., 1977. Functional and electrophoretic characteristic of succinylated peanut flour protein. J.Agri. Food Chem., 25: 258-261.
7. Sosulski, F.W., Garrat, M.O. & Slinkard, A.E. (1976). Functional properties of ten legume flours. Journal of Food Science and Technology, 9, 66–69.
8. Coffmann, C.W. & Garcia, V.V. (1977). Functional properties and amino acid content of a protein isolate from wing bean flour.Journal of Food Technology, 12, 473–477
9. Arkroyed, W.R. and J. Doughty, 1964: Legumes in human nutrition, Food and Agricultural Organization nutrition studies publication, 19.
10. Aremu, M.O., A. Olonisakin, D.A. Bako and P.C. Madu, 2006a. Compositional studies and physicochemical characteristics of cashew nut (*Anarcadium occidentale*) flour. Pak. J. Nutr., 5: 328-333.
11. Ige, M.N, A.O. Ogunsua, O.L. Okon, (1984) Functional properties of the protein of some Nigeria oil seeds. Casophor seeds and three varieties of some oil seeds. Food Chem., 32: 822-825.
12. Fagbemi, TN and AA. Oshodi (1991). Chemical composition and functional properties of Full fat fluted pumpkin seed flour. Nig. Food J., 9: 26-32
13. NIN, ICMR, 1984. Indian Council of Medical Research, Hyderabad, India.
14. Pomeranz and D. Clifton,1981. In food analysis theory and practices. Westport, L.T, AVI Publishing Comp.
15. Aisegbu, J.E., 1987. Some biochemical evaluation of fluted pumpkin seeds. J. Sci. Food Agri., 40: 151 -155.
16. Paul, A.A. and B. A.T Southgate, 1980. Mucance and Widdowson's Composition of Food, 4th edition Her majesty's stationary office, London. UK. pp: 227- 228.
17. Bogert, J.L., G.M. Briggs and D.H. Galloway, 1994: Nutrition and Physical fitness. Int. J. Food Sci. Nutr., 45: 223-230.
18. Olaofe, O. F.O Adeyemi, G.O. Adediran, 1994. Amino acid and Mineral composition and Functional properties of some oil seeds. J. Agric. Food Chem., 42: 878-884.
19. FAO, 1982. Food composition table for use in Africa development of health education and Welfare. Rome. Health Science and FAO Nutrition Division. P. 32.
20. Anonymous, 1972. Tropical Legumes: resources future. National Academic of Science Washington, DC, p: 24.(1972)
21. National Research Council (NRC), 1989. Recommended Dietary Allowances 10th edition. National Academic Press Washington, D.C. USA.
23. WHO/FAO, Report.1973. In: Energy and Protein Requirements. Geneva: World Health
24. Olaofe, O. and C.O. Sanni, 1988. Mineral contents of Agriculture products. Food Chem., 30: 73-79.
25. Aremu, M.O., A. Olonisakin, J.W. Otene and B.O. Atolaye, 2005. Mineral content of some agricultural products Chem., 39: 1702-1703. grown in the Middle Belt of Nigeria, Oriental J. Chem., 21: 419-426.

26. Ferrao, J.E.M, A.M.B.C Ferro and A.M.G. Antures, 1987 Bambara groundnut {Vigna subterranean) Aspect of its nutritive value. Gracia deorta seriede Estudos Agronomics,14: 35-39.
27. Fleck, H., 1976. Introduction to Nutrition, 3rd edition Macmillan, New York, USA, pp: 207-219.
28. Nieman, D.C., D.E. Butter Worth and C.N. Nieman, 1992. Nutritions: Wm. C. Brown Publisher Dubugue pp: 9,540.
29. Akintayo, E.T., E.A. Adebayo and L.A. Arogundade, 2002. Chemical composition, physico-chemical and functional Properties of Akee (B. Sapida) pulp and seed flours; Food Chem.,77: 333-336.
30. Duel, H.J., Tr, 1951; The lipids: their Chemistry and Biochemistry Vol. 1 New York Inter Science Publishers pp: 53-57.
31. Akintayo, E.T. and E. Bayer, 2002. Characterization and some possible uses of Plukenetia conophora and Adenopus breviflorus seeds and seed oils; Bioresource Technology, 85: 95-97.
32. Oshodi, A.A. and N.M. Ekperigin, 1989. Functional properties of pigeon pea flour (cajanus cajan). Food Chem, 34: 187-191.
33. Oderinde. R.A. Ajayi. I.A and Adewuyi, A. 2009. Characterization of Seed and Seed oil of Hura Crepitans and The Kinetics of Degradation of the oil during Heating. EJEAFChe, Vol. 8 No.3.pp 201-208.
34. Akubugwo. I.E, and Ugbogu, A.E., 2007. Physicochemical studies on oils from five selected Nigerian plant seeds. Pak. J. Nutr. 6: pp.75-78.
35. Achinewhu, S.C., 1990. Composition and food potential of melon seed (C. vulgaris). Nig. Food J., 8: 130-133.
36. Oladimeji, M.O., A.O. Adebayo and A.H. Adegbesan, 2001. Physico-chemical properties of Hausa melon seed flour, Ultra Sci., 13: 374-377
37. Eckey, E.W., 1954. Vegetable fats and oils; Reinhold: New York
38. Ajayi.A. and Oderinde. R.A., 2002. Studies on the oil Characteristics of *Dacryodes edulis* pulp and seed. Discov Innov. Vol. 14: pp.20-24.
39. Lin, M.J.Y., E.S. Humbert and F.W. Sosulski, 1974. Certain functional properties of sunflower meal products Food Sci., 42: 368-370.
40. Adeyeye, E.I., A.A. Oshodi and K.O. Ipinmoroti, 1994. Functional properties of some varieties of African Yam Sean (Sphenostylis stenocarpa) flour. Int. J. Food Sci. Nutr., 45: 115-126.
41. Aletor, V.A. and O.O. Aladetimi, 1989. Compositional evaluation of some cowpea varieties and some under-utilized edible legumes in Nigeria. Die Nahrung, 33: 99-107.
42. Fasuyi AO. Nutritional potentials of some tropical vegetables leaf meals; chemical characterization and functional properties. African Journal of Biotechnology Vol. 5 (1), pp. 49-53, (2006)
43. Oshodi, A.A. and M.O.A. Adeladun, 1993. Proximate composition, some nutritional valuable minerals and functional properties of three varieties of Lima bean (*Phaselous lunatus* Linn) flour. Int. J. Food Sci. Nutr., 43: 181-185.
44. Fasuyi AO, Aletor VA 2005.Varietal composition and functional properties of cassava leaf meal and leaf protein concentrate. Pak. J. Nutr. 4(1): 43-49.