



Published by SET Publisher

Journal of Pharmacy and Nutrition Sciences

ISSN (online): 1927-5951



Evaluation of Nutrients in Leaves and Seeds of *Calotropis Procera* (linn); a Multipurpose Plant

A.F. Ogundola¹, T.A. Yekeen², R.A. Arotayo², A.O. Akintola^{3,*}, A.O. Ibrahim^{2,*}, H.O. Adedosu³ and M.O. Bello²

¹Department of Pure and Applied Biology, Ladoke Akintola University of Technology, Ogbomoso, Oyo State, Nigeria

²Department of Pure and Applied Chemistry, Ladoke Akintola University of Technology, Ogbomoso, Oyo State, Nigeria

³Department of Science Laboratory Technology, Ladoke Akintola University of Technology, Ogbomoso, Oyo State, Nigeria

Article Info:

Keywords:

Calotropis procera plant, proximate composition, micronutrients, fatty acids.

Timeline:

Received: March 05, 2021

Accepted: May 25, 2021

Published: June 02, 2021

Citation: Ogundola AF, Yekeen TA, Arotayo RA, Akintola AO, Ibrahim AO, Adedosu HO, Bello MO. Evaluation of Nutrients in Leaves and Seeds of *Calotropis Procera* (linn); a Multipurpose Plant. J Pharm Nutr Sci 2021; 11(1): 33-39.

Abstract:

Calotropis procera has been widely explored in ethnomedicine to cure several ailments such as leprosy, fever, elephantiasis, menorrhagia, and snakebite. It is also used as a purgative, anthelmintic, anticoagulant, anticancer, antipyretic, analgesic, and carminative. In addition to its traditional use as coagulants, the leaves and seeds of *Calotropis procera* could be used in food fortifications to combat nutrient deficiencies as reflected in its bioactive components. The increase in its use might be associated with the level of many bioactive components, which provide nutritional and health benefits. Thus, the leaves and seeds were analyzed for their bioactive components and characterized for nutrient values using the procedures of the Association of Official Analytical Chemists.

The chemical analyses results showed that the leaf and the seed contained (g/100 g dry weight) moisture (8.11g, 9.53g), crude protein (26.69g, 14.48g), crude fiber (7.54, 15.73), crude fat (21.70, 6.29), ash (5.32, 3.69) and carbohydrate (30.64, 50.29), respectively. The leaves and seeds contained zinc (1.20, 0.60 mg/100 g), potassium (33.60, 30.30 mg/100 g) and iron (36.90, 12.90 mg/100g), respectively. The fatty acids profile revealed that the leaves and the seed oils contained a low level of saturated palmitic acid (3.01, 7.70 g/100g) and a high level of monounsaturated oleic acid (10.31, 27.90 g/100g) and polyunsaturated acids (11.63, 18.53 g/100g), respectively.

It is established that the chemical compounds in the *Calotropis procera* seeds and leaves could be beneficial for therapeutic and dietary purposes. Thus, it can be accepted that the *Calotropis procera* plant may be used as medicine and food fortificants.

DOI: <https://doi.org/10.29169/1927-5951.2021.11.05>

*Corresponding Author

E-mail: aoakintola@lautech.edu.ng, aoibrahim@lautech.edu.ng

Tel: +2348023807230, +2348035746722

© 2021 Ogundola *et al.*; Licensee SET Publisher.

This is an open access article licensed under the terms of the Creative Commons Attribution Non-Commercial License (<http://creativecommons.org/licenses/by-nc/3.0/>) which permits unrestricted, non-commercial use, distribution and reproduction in any medium, provided the work is properly cited.

INTRODUCTION

As rightly reported by Steven [1], the *Calotropis procera* (Ait.) F. belongs to sub-family Apocynaceae and family Asclepiadaceae. This plant has many common names among which some are popular; giant swallow wart or milkweed, auricula tree, giant milkweed, madar, mudar, rooster tree, rubber bush, small crown flower, Sodom's milkweed, Sodom apple, and locally called "bomubomu" by the Yoruba speaking populace of Southwestern Nigeria. The family contains 280 genera and 2000 plant species of worldwide distribution, abundantly found in the tropics and subtropics, but rare in cold countries [2]. It was reported to have spread fast on space with little competition, such as overgrazed pastures and rangelands [3]. This factor has dramatically assisted its spread from its primary source Afro-Asian monsoonal regions to North-western Africa (Mauritania, Senegal), through Arabian Peninsula, commonly grow most abundantly in Bangladesh, India, Burma, Pakistan, and in the sub-Himalayan tract [4]. Its floral presence was noticed in subtropical America, the Mascarene Islands, and drier parts of Australia. Its natural plantation occurs from sea level up to 1300 m in semi-arid conditions where annual rainfall is between 150 and 1000 mm. The plant grows in sandy and excessively drained soils, derelict lands and can withstand a wide range of soil texture and eco-climatic changes, which made it a good tolerant of soil salinity, drought, heat, and beachfront salt spray. The plant's ability to thrive in different ecosystems makes it a highly adapting plant, which can withstand 2000-mm annual precipitation, and it establishes very fast in open habitat with little competition. It shows excellent adaptability to biological structures and grows along degraded roadsides, lagoon edges, and overgrazed native pastures and rangelands [3]. *Calotropis procera* grows up to 3-6' high. Its leaves arrangement is opposite, flower size 2" and color is white to purple, and the fruit is follicle [4]. The dispersal means vis a vis wind, floodwater, livestock, and animals on long distances was greatly assisted by the white silky floss seeds bore by the plant [5, 6]. *Calotropis procera* is drought-resistant and salt-tolerant to a relatively high degree. It quickly becomes established as a weed along degraded roadsides, lagoon edges, and in overgrazed native pastures. It has a preference for and often dominant in areas of abandoned cultivation especially sandy soils in low rainfall areas. It is assumed to be an indicator of over-cultivation, a native to India, Pakistan, Afghanistan, Algeria, Iraq, Israel, Kenya, Niger, Nigeria, Saudi

Arabia, United Arab Emirate, and Zimbabwe [7, 8]. *Calotropis procera* has recorded its efficacies in ethnopharmacology in time memorial, its uses in the preparation of many traditional medicines to cure the patients was documented [9]. The plant has been widely explored in ethnomedicine in the treatment of leprosy, fever, elephantiasis, menorrhagia, and snakebite. It is also used as purgative, anthelmintic, anticoagulant, anticancer, antipyretic, analgesic, and a carminative [10]. All parts of the plant, viz root, stem, leaf, and flower, are commonly involved in folkloric use as indigenous medicine [11]. Even though the latex was recognized as a toxic substance to mammals, it is not left out for its outstanding potential in use [12, 13].

The leaf of *Calotropis procera* contains an enzyme called calotropain, which induces cow or goat milk coagulation and on which milk production method is based [14]. The process of coagulation with the leaves of *C. procera* after heating, draining, and molding made the curd available on the market in different forms and sizes [15]. The leaf and latex of *C. procera* possess antimicrobial and antioxidant properties, which lend scientific credence for its use as natural agents in food preservation and pharmaceutical systems [10]. The nutritional and medicinal properties of the plant may be linked to both its nutrient and phytochemicals composition. Thus, both the leaves and seeds were characterized by some nutrient indicators.



Plate 1: *Calotropis procera* plant.

Source: Study field October 2020.

MATERIALS AND METHODS

The fresh leaves and seeds of *Calotropis procera* were collected in front of Igbon police station along

Ogbomoso-Ilorin road. The samples were identified and authenticated by Prof. A.T.J. Ogunkunle, Department of Pure and Applied Biology, LAUTECH, with the voucher number 438. The samples were dried under laboratory shade, grounded to a fine powder, and stored in an airtight container prior to analyses.

Analytical Methods

Proximate Composition

Procedures of Association of Official Analytical Chemists [16] were adopted. Moisture content was determined by heating 2.0 g of each sample to a constant weight in a crucible placed in an oven maintained at 105⁰C. Crude fat was obtained by exhaustively extracting 5.0 g of the dried sample in a Soxhlet apparatus using petroleum ether (40-60⁰C) as the extractant. Crude protein (% total nitrogen x 6.25) was determined by the Khejhal method, using 2.0 g of dried, defatted samples. Ash was determined by the incineration of 1.0 g dried defatted samples placed in a muffle furnace maintained at 550⁰C for 5 hours, and the carbohydrate was determined by the refractometry method.

Determination of Mineral Elements

The sample (1.0 g) was weighed; nitric: (30 mL) perchloric acids in a 2:1 ratio were added to the sample. The mixture was heated and digested. The resultant digestate was washed into a standard 50mL standard flask with deionized water and made up to the mark. This solution was analyzed in triplicate for its elemental composition using Buck Scientific Model 210 VGP (American specification) Atomic Absorption Spectrophotometer.

Fatty Acid Composition and Analysis

Fatty acid methyl esters (FAME) were prepared as per the method of [17]. The fatty acid composition was determined by GC using a flame ionization detector operated under the following conditions: capillary column Elite FFAP (30 m × 0.25 mm × 0.25 μm); Nitrogen flow 40 mL/min; Hydrogen flow 40 mL/min; airflow 400 mL/min; column temperature 100⁰C held for 5 minutes then increased at the rate 3 ml/min up to 240⁰C which was then held for 15 minutes; injector temperature 210⁰C and FID temperature 280⁰C. The fatty acids were identified using authentic standards and reported as a relative percentage.

RESULTS AND DISCUSSION

The results of proximate constituents were reported in Table 1. The moisture content of 8.11 % in the leaf of *Calotropis procera* was lower compared to 9.53 % in the seed. The moisture content of *Calotropis procera* leaf was observed to be low when compared with a range of 55.76 ± 0.05 to 91.83 ± 0.04 g/100 g moisture reported for some conventional leafy vegetables [18]. The low level of moisture would hinder the growth of microorganisms, and the shelf-life could be high [19, 20, 21]. Ash is an indication of the level of mineral elements; thus, the quantity in the leaf might be higher than the level in the seed. The level of ash in the leaf and seed of *Calotropis procera* were 5.32 and 3.67 %, respectively. Fat is a lipid component, and the energy derived from it could be utilized for body maintenance. The quantity of crude fat in the leaf was higher than that in the seed; 21.70% fat was observed in the *Calotropis procera* leaf compared to 6.29 % in the seed. The oil in the *Calotropis procera* leaf was higher than 15.42 % reported in *Croton zambesicus* leaf [22], but it compared favorably with 20 g/100 g in soya bean, 23g/100 g in rice bran, and 25g/100 g in cottonseed [23]. The leaf could be a good source of fixed oil, thus complementing the conventional sources; they could also be a good source of essential fatty acids and fat-soluble vitamins. The level of fiber was, however, higher in the seed compared to the leaf of *Calotropis procera*. Fiber is nutraceutical for its health benefit effects. Though man cannot digest dietary fiber, it provides roughage that aids digestion. Fibers could slow down glucose absorption and reduce insulin secretion, which can be beneficial to diabetic patients [24]. The seeds, when ground to fine powder, can be incorporated into some other low fiber flour meals to prevent constipation. A high fiber diet has been reported to lower cholesterol levels in the blood, reduce the risk of various cancers, bowel diseases and improve general health and well-being [20]. The crude protein content of the leaf of *Calotropis procera* was more than that in the seed. Both values were higher than 8.26g/100g dry matter in the fruit pulp of *Carica papaya*. The protein content in the leaves compared favorably with the protein content of 12.8% in cabbage and 14% in lettuce [25]. Thus, the leaf and seed could be a dietary source of protein in combating protein-energy malnutrition. Carbohydrates are one of the most important components in foods; digestible carbohydrates are considered an essential source of energy. The level of carbohydrates in the leaf and seed of *Calotropis procera* could be a good energy source.

Table 1: Proximate Composition of the Leaf and Seed of *C. procera* (g/100g Dry Weight)

Constituents	LEAF	SEED
Moisture	8.11 ± 0.00	9.53 ± 0.30
Ash	5.32 ± 0.00	3.69 ± 0.00
Crude fat	21.70 ± 0.31	6.29 ± 0.46
Crude fibre	7.54 ± 0.00	15.73 ± 0.54
Crude protein	26.69 ± 0.62	14.48 ± 0.56
Carbohydrate	30.64 ± 0.32	50.29 ± 0.94

± Standard deviation of triplicate determinations.

Table 2 reported the level of some nutritionally important mineral elements in the leaf and seed of *C. procera*. The concentration of iron was highest in the leaf; iron is an essential mineral and a vital component of proteins involved in oxygen transport and metabolism. Deficiency of iron limits oxygen delivery to cells resulting in fatigue, poor work performance, and decrease immunity and physical activities [26]. Manganese was detected in both the leaf and seed; deficiency of manganese could cause skeletal deformation in animals and inhibit collagen production in wound healing. Low levels of manganese were reported to lead to many health problems, including joint pain, arthritis, inflammation, and other diseases such as Parkinson's, schizophrenia, osteoporosis, and epilepsy [27]. Potassium also regulates osmosis and aqueous equilibrium, impacting nerve transmission, muscle tone, renal function, and heart muscle contraction. Occasional potassium deficiencies are diagnosed by symptoms including renal disorder, diabetic acidosis, vomiting, diarrhea, and excessive sweating [28].

All the mineral elements quantified in both the leaf and the seed are of nutritional health benefits. The higher level of the mineral elements in the leaves of *C. procera* might be an added advantage in its use as a coagulant in cheese processing. *C. procera* processed cheese was reported to have higher nutrient

compositions compared to *Carica papaya* processed cheese [29].

Sixteen fatty acids were identified in both the leaf and fruit oils of *C. procera* (Table 3). The leaf had 20.87% saturated fatty acids, 10.63% monounsaturated fatty acids, and 11.63% polyunsaturated fatty acids, while the seed had 30.44% saturated fatty acids, 28.11% monounsaturated fatty acids, and 18.53% polyunsaturated fatty acids (Figure 2). The seed had higher percentages of saturated, monounsaturated, and polyunsaturated fatty acids. Among the saturated fatty acids, palmitic acid (7.70%) was highest in the seed oil, while stearic acid (6.10%) was highest in the leaf. Consumption of high saturated fatty acids has been implicated in heart-related diseases [30, 31]. Oleic acid, a monounsaturated fatty acid, had the highest percentage in both the leaf (10.31%) and seed (27.90%) relative to other fatty acids in the plant parts. The proportion of oleic acid in *C. procera* leaf and seed was higher than 7.0 % and 8% oleic acid in castor seed oil and coconut oil, respectively [32]. Oleic acid is an omega-9 fatty acid that is considered to be one of the healthiest sources of fat in diets, helps to lower cholesterol level, high blood pressure, chest pain, and also helps in the production of antioxidants [33]. The quantity of linoleic acid was highest among the polyunsaturated fatty acids in both the leaf (11.54%) and seed (18.31%). Linoleic acid is an important

Table 2: Concentrations of Mineral Elements in the Seed and Leaf of *Calotropis procera* (mg/100g)

Elements	Leaf	Seed
Copper	1.80 ± 0.10	5.70 ± 0.10
Zinc	1.20 ± 0.02	0.60 ± 0.02
Iron	36.90 ± 0.20	12.90 ± 0.33
Manganese	26.40 ± 0.15	22.50 ± 2.30
Potassium	33.60 ± 0.04	30.30 ± 0.56

± Standard deviation of triplicate determinations.

Table 3: Fatty Acids Profile of *C. procera*

FATTY ACIDS	LEAF VALUE (%)	SEED VALUE (%)
Caprylic acid (6:0)	2.43 ± 0.02	3.31 ± 0.05
Caproic acid (8:0)	0.14 ± 0.01	0.22 ± 0.01
Capric acid (10:0)	3.50 ± 0.01	4.04 ± 0.02
Lauric acid (12:0)	1.14 ± 0.03	6.72 ± 0.04
Myristic acid (14:0)	4.45 ± 0.02	5.91 ± 0.05
Palmitic acid (16:0)	3.01 ± 0.05	7.70 ± 0.02
Margaric acid (17:0)	0.10 ± 0.01	0.05 ± 0.01
Stearic acid (18:0)	6.10 ± 0.03	2.39 ± 0.04
Behenic acid (22:0)	ND	0.02 ± 0.01
Lignoceric acid (24:0)	ND	0.08 ± 0.02
Palmitoleic acid (16:1)	0.22 ± 0.01	0.15 ± 0.02
Oleic acid (18:1)	10.31 ± 0.01	27.90 ± 0.02
Erucic acid (22:1)	0.10 ± 0.01	0.06 ± 0.02
Linoleic acid (18:2)	1.54 ± 0.01	18.31 ± 0.03
Linolenic acid (18:3)	0.07 ± 0.02	0.14 ± 0.02
Arachidonic acid (20:4)	0.02 ± 0.02	0.08 ± 0.02

ND- not detected, ± standard deviation of triplicate determinations.

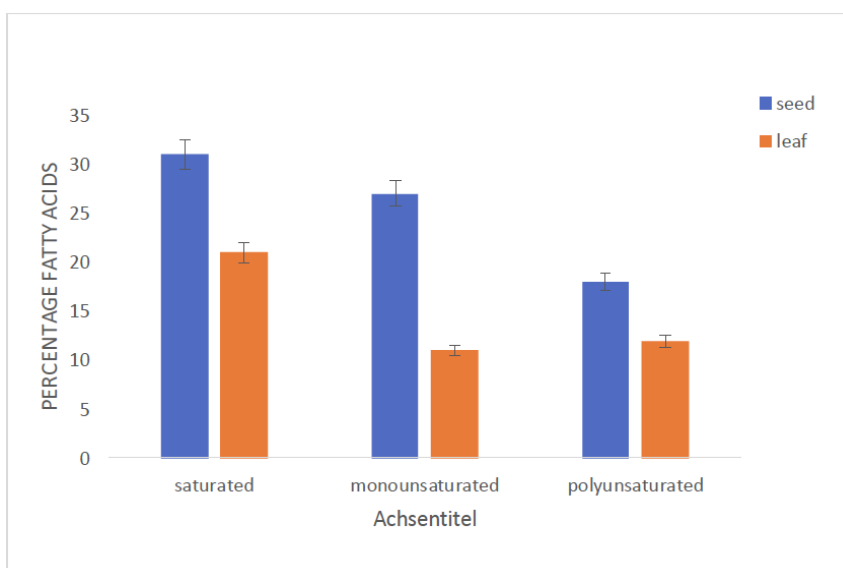


Figure 2: Levels of saturation and unsaturation of the seed and leaf oils of *Calotropis procera*.

essential fatty acid required for growth, physiological functions, and maintenance. The presence of a high level of linoleic acid in the plant parts could be beneficial as dietary supplements as it has been linked to helping in weight management, in the prevention of cancers, asthma, high blood pressure, cardiovascular diseases, gastrointestinal and immune systems dysfunction [34].

CONCLUSION

The results of this study established that *Calotropis procera* constituted reasonable quantities of mineral elements, proximate parameters (and moderate fatty acid methyl esters), which can be easily exploited as an alternative food source for human consumption and as a nutraceutical in the prevention of different

ailments. Integration of the plant leaves into Nigeria's dietary pool can go a long way to alleviate many diseases and ailments in our society. Moreover, it tolerates various edaphic factors and thus confers its availability.

REFERENCES

- [1] Stevens PF. Angiosperm Phylogeny 2012:Website <http://www.mobot.org/MOBOT/research/APweb/>
- [2] Perwez A, Mohammad A. Phytochemical investigation of *Calotropis procera* in roots. *Indian Journal of chemistry* 2008; Vol; 48B, pp. 443-446.
- [3] Orwa C, Mutua A, Kindt R, Jamnadass R, Anthony S. Agroforestry database: A tree reference and selection guide version 4.0. World Agroforestry Centre, Kenya Ecocrop, Ecocrop database. FAO2011; 2. Ecoport, Ecoport database. Ecopop.
- [4] Yelne MB, Sharma PC, Dennis TJ. Database on Medicinal Plants used in Ayurveda, Central Council for Research in Ayurveda & Siddha, New-Delhi, Vol.2: 69-73.
- [5] Parsons WT, Cuthbertson EG. Noxious weeds of Australia. CSIRO: Publishing 2001; p. 712
- [6] Batello C, Marzot M, Touré AH. The future is an ancient lake: Traditional knowledge, biodiversity and genetic resources for food and agriculture in Lake Chad Basin ecosystems. FAO Interdepartmental Working Group on biological diversity for food and agriculture 2004; Rom.
- [7] Sharma AK, Kharb R, Kaur R. Pharmacognostical aspects of *Calotropis procera* (Ait.) R. Br. *International Journal of Pharma and Bio Sciences* 2011; 2(3):480-8.10.
- [8] Parihar G, Sharma A, Ghule S, Sharma P, Deshmukh P, Srivastava DN. Anti-inflammatory effect of *Calotropis procera* root bark extract. *Asian Journal of Pharmacy and Life Science* 2011; 1(1):29-44.
- [9] Vadlapudi V, Naidu CK. In vitro bioactivity of Indian medicinal plant *Calotropis procera* (Ait). *Journal of Global pharma technology* 2010; 2(2) 43-45.
- [10] Rohit S, Gulab S, Thakur BS, Sanodiya AS. Therapeutic potential of *Calotropis procera*: A giant milkweed. *IOSR Journal of Pharmacy and Biological sciences* 2012; 4: 2278-3008. <https://doi.org/10.9790/3008-0424257>
- [11] Mukherjee B, Bose S, Dutta SK. Phytochemical and pharmacological investigation of fresh flower extract of *Calotropis procera* Linn. *Int. J. of Pharmaceutical Sciences and Research* 2010; 1(2):182-187
- [12] Larhsini M, Bousaid M, Lazrek HB, Jana M, Amarouch H. Evaluation of antifungal and molluscicidal properties of extracts of *Calotropis procera*. *Fitoterapia* 1997; 68: 371-373. [Links]
- [13] Haque MA, Nakakita H, Ikenaga H, Sota N. Development-inhibiting activity of some tropical plants against *Sitophilus zeamais* Motschulsky (Coleoptera: Curculionidae). *J Stored Prod Res* 2000; 36: 281-87. [Links] [https://doi.org/10.1016/S0022-474X\(99\)00048-X](https://doi.org/10.1016/S0022-474X(99)00048-X)
- [14] Zecchini M, Cantafora AFA. Produrre latte in Africa subsahariana con particolare riferimento ai paesi dell'Africa centro-occidentale 2010; SIVtro - VSF Italia. [cited 2016 Oct 12]. <http://www.dimevet.unimi.it/ecm/home/rapporti-internazionali/attivita-di-cooperazione-allo-sviluppo>.
- [15] Dossou J, Hounzangbe-Adote S, Soule H. Production et transformation du lait frais en fromage peulh au Bénin – Guide de bonnes pratiques. Groupe de Recherche et d'Echanges Technologiques (GRET) 2006; Université e d'AbomeyCalavi, Faculte des Sciences Agronomiques, Bénin. [cited 2016 Apr 12]. www.repol.info/IMG/pdf/Fiche_wagashi_VF.pdf
- [16] AOAC. Official method of analysis, 15th and. Association of Official Analytical Chemists 1990; Arlington, VA.
- [17] Kaushlesh KY, Neelima G, Anil V, Sanjay K, Mala T. Optimization and extraction of oil from mango seed kernel (*Mangifera indica*). *Indian Journal of Agricultural Sciences* 2017; 87(7):943
- [18] Kwenin WKJ, Wollu M, Dzomeku BM. Assessing the nutritional value of some Africa indigenous green leafy vegetables in Ghana. *Journal of Animal and Plants Sciences* 2011; 10 (2):1300-1305.
- [19] Amarteifio JO, Mosase MO. The Chemical Composition of Selected Indigenous Fruits of Botswana. *Journal . Appl.Sci. Environ. Manage* 2006; 10, 43-47. [CrossRef] <https://doi.org/10.4314/iasem.v10i2.43659>
- [20] Murray S, Schoeninger MJ, Bunn, HT, Pickering TR, Marlett JA. Nutritional composition of some wildplant foods and honey used by Hadza foragers of Tanzania. *Journal of Food Compos. Anal* 2001; 14, 3-13. [CrossRef] <https://doi.org/10.1006/jfca.2000.0960>
- [21] Bello MO, Falade OS, Adewusi SRA, Olowore NO. Studies on the chemical compositions and antinutrients of some lesser known Nigeria fruits. *African J. of Biotech* 2008; 7(1): 3972-3979. <https://doi.org/10.19026/ajfst.6.44>
- [22] Bello MO, Abdul-Hammed M, Abolanle SA, Fasogbon OT. Nutrient Contents and Fatty Acids Profiles of Leaves and Seeds of *Croton zambesicus*. *Advance Journal of Food Science and Technology* 2014; 6(3): 398-402.
- [23] Abayeh OJ, Aina EA, Okoungbae CO. Oil content and oil quality characteristics of some Nigeria oil seeds. *Sci. Forum J. Pure Appl. Sci* 1998; 1(1): 17-23.
- [24] Ijeomah AU, Ugwuona FU, Ibrahim Y. Nutrient composition of three commonly consumed indigenous vegetables of North-central Nigeria. *Nigerian Journal of Agriculture, Food and Environment* 2012; 8(1):17-21.
- [25] USDA. National Nutrient Database for Standard Reference. U.S. Department of Agriculture, Agricultural Research Service 2005; Retrieved form: <http://www.nal.usda>.
- [26] Emoyan OO, Agbaire PO, Otoberise C, Okube UN, Ojomah FI. Effects of Preservation on the Concentration of Iron, Iodine and Ascorbic acid in selected Fishes. *Proceedings of the 34th annual conference Proceedings of Chemical Society of Nigeria, Kwara* 2011.
- [27] Keen CL, Zidenberg-Cherr S. Manganese. In: Ziegler EE and LJ Filer (Eds.), *Present Knowledge in Nutrition*. 7th Edn, ILSI Press, Washington, D.C. 1996; pp 334-343.
- [28] Michael A. *National Kidney Foundation Primer on Kidney Diseases* 2014; (Sixth Edition)
- [29] Adetunji VO, Salawu OT. West African soft cheese "wara" processed with *Calotropis procera* and *Carica papaya*: A comparative assessment of nutritional values. *African Journal of Biotechnology* 2008; 7(18): 3360-3362.
- [30] Frank BH, JoAnn EM, Walter CW. Types of dietary fat and risk of coronary heart disease: A critical review. *Journal of American College of Nutrition* 2011; 20(1): 5-19. <https://doi.org/10.1080/07315724.2001.10719008>
- [31] Griffin BA. How relevant is the ratio of dietary n-6 to n-3 polyunsaturated fatty acids to cardiovascular disease risk? Evidence from the OPTILIP study. *Current Opinion in Lipidology* 2008; 19: 57-62. <https://doi.org/10.1097/MOL.0b013e3282f2e2a8>
- [32] Sahari MA, Ataii D, Hamed M. Characteristic of seed oil in comparison with sunflower and olive oils and its effect as a natural anti-oxidant. *American Oil Chem. Soc.* 2004; 81:585-588. <https://doi.org/10.1007/s11746-006-0945-0>

- [33] Marlene A. Oleic acid benefits. Downloaded from www.buzzle.com/articles/oleic-acidbenefits.html on 16/1/2012.
- [34] Dupont J, White PJ. Food uses and Health effects of Corn oil. *J. Am. College of Nutr* 1990; 9(5): 438-470.
<https://doi.org/10.1080/07315724.1990.10720403>