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Research Article

NUTRITIONAL POTENTIAL OF AZADIRACHTA INDICA SEEDSIgwenyi I. O¹, Nchi, P. O¹, Ugwu Okechukwu¹, P. C., Igwenyi, I. P², Obasi D. C³, Edwin N¹, Uraku A. J¹, AND Ze, A. C¹.¹Department of Biochemistry, ²Department of Human Kinetics and Health Education, Ebonyi State University, Abakaliki Ebonyi State, Nigeria.³Department of Chemical Science, Evangel University, Akaeze, Ebonyi State Nigeria.**Received:** 28 December 2016**Accepted:** 28 January 2017**Published:** 28 February 2017**Abstract:**

Azadirachta indica seeds have since remained unexploited as a possible source of nutrient probably due to its irritating odour, bitter taste and insufficient scientific data. Its application has majorly been in the treatment of diseases due to its great medicinal properties. The fresh seeds of *Azadirachta indica* (neem) fruit were analyzed for their proximate and mineral compositions using Standard Official Methods. The seeds were harvested, dried, the hard seed coat removed and the cotyledons ground to reduce particle size so as to expose larger surface area. The investigation for proximate composition revealed that the seeds contained 16.81 ± 0.65 % crude protein, 3.53 ± 0.46 % ash, 2.67 ± 0.58 % moisture, 35.13 ± 0.12 % crude lipid, 3.87 ± 0.29 % crude fibre and 37.99 ± 1.88 % carbohydrate. Analysis of the mineral composition yielded the following values in $\mu\text{g/g}$ of nitrate 7.17 ± 0.08 , calcium 26.20 ± 9.41 , magnesium 0.08 ± 0.03 , phosphate 40.45 ± 2.54 and iron 2.70 ± 0.16 . The result revealed that the seeds were very rich in crude protein which is usually low in plant materials, crude lipid and carbohydrate while fibre, ash and moisture occurred at lower amounts. The mineral analysis further revealed that fresh seeds of *Azadirachta indica* are potentially rich in mineral composition. Phosphate has the highest concentration of $40.45\mu\text{g/ml}$ followed by calcium, while the values of nitrate, iron and magnesium were relatively low with magnesium having the least concentration. These minerals are needed for the proper functioning of the body system. Phosphorus is an important constituent of adenosine triphosphate (ATP) and nucleic acids and is also essential for acid-base balance, bone and tooth formation. Calcium is important in construction and maintenance of bone and normal function of nerves and muscles. This seed therefore can be useful for nutritional purposes in food/feed formulation and a valuable source of scarce plant protein.

Keywords: *Azadirachta indica*, proximate, plant protein, minerals, seeds, feed, neem**Corresponding Author:****Igwenyi I. O,**

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INTRODUCTION:

All living organisms require energy to carry out their different life activities. This energy is provided by the oxidation of food such as carbohydrate, fats and proteins (Gupta and Gupta, 2005). The capture of solar energy by photosynthetic organisms and its conversion to the chemical energy of reduced organic compounds is the ultimate source of nearly all biological energy (Nelson and Cox, 2008). Thus all energy used by most organisms comes directly or indirectly from the sun and is gradually used up as it passes in one direction through the ecosystems. The first stage of energy journey is its capture by green plants and algae in photosynthesis, making plants to be the sole source of life driving energy for animals that eat them. Other animals may then eat the plant eaters and the energy continues to flow through the ecosystem to higher animals and man (George, 2000).

Several plants however exist with very high nutritive value and yet remain unexploited for both man and animal benefits (Oladele and Oshodi, 2008). Fruits of plant on their own have high vitamin, mineral, fibre, phytochemical and antioxidant in their pulps and seeds of which most times are discarded due to ignorance of their nutritive value (Fila *et al.*, 2013). These include several wild medicinal plants like *Azadirachta indica* - a fast growing tree that can reach a height of 15-20 metres. This popular plant (also called Neem) is in the Mahogany family Meliaceae and a native to India, Pakistan and Bangladesh. The tree also grows in tropical and semi-tropical regions of the world. The fruit, as shown in figure 1 is a smooth olive-like drupe and varies in shape from elongate oval to nearly roundish. The exocarp is thin and the bitter-sweet pulp (mesocarp) is yellowish-white and fibrous. The white, hard endocarp (inner shell) of the fruit encloses elongated seeds with brown seed coat (Igwenyi *et al.*, 2014).



Fig 1: A Typical Fresh Ripe Yellowish-Ellipsoidal Drupe (Fruit) of *Azadirachta indica* (Neem).

Fruits indeed are generally acceptable as good source of nutrients and supplement for food in a world faced with problem of food scarcity. They are known to be excellent source of nutrients such as minerals and vitamins; and also contain carbohydrates in form of soluble sugars, cellulose and starch (Adepoju *et al.*, 2006). Fruits thus are very vital portion of an adequate diet and they serve as food supplement, and an appetizer. The fruits, seeds and leaves of many wild plants already form common ingredients in a variety of traditional native dishes for the rural populace in developing countries (Humphrey *et al.*, 1993). The fruit juice of *Azadirachta indica* is today known to be rich in nutrients and unusually high in protein content, which can satisfy the nitrogen balance of humans and animals (Igwenyi and Akubugwo, 2010; Igwenyi *et al.*, 2014). Presently, there is no published report on the use of the seed, de-oiled Neem seed cake or its products in human nutrition, probably due to the repulsive and astringent taste and inadequate data from scientific research conducted on these seeds and the suspected anti-nutrients composition. Some of these secondary metabolites are naturally occurring substances found in fruits, vegetables and grains. They can influence various body processes and protect the body against diseases, slow down the aging process and reduce the risk of many diseases such as cancer, stroke, high blood pressure, osteoporosis and urinary tract infection (Igwenyi *et al.*, 2011b). However, it is possible to utilize the seeds of *Azadirachta indica* for food by either removing the anti-nutrients and/or isolate the nutrients such as protein and subsequently use them in food processing industries (Usman *et al.*, 2005). It becomes imperative therefore that scientific investigation needed to be conducted on these promising Neem seeds to expose its nutritional potentials and to present these seeds as potential improvise that will serve as alternative sources for scarce plant/animal nutrients, thereby alleviating the present global food crises ravaging the world due to pressure on known or conventional sources of food materials.

Proximate analysis of plants samples, gives valuable information about the nutritional composition of such sample and help to access the quality of the sample. It provides information on moisture content, ash content, volatile matter content, ash, fixed carbon etc. Ash is the inorganic residue remaining after water and organic matter has been removed by heating, which provides a measure of total amount of minerals within the food (Lee, 2005). Studies have shown that fruits (seeds) and vegetables contain among other vital nutrients an appreciable quantity of carbohydrate, proteins, fats, fibers and phytochemicals (Liu, 2004).

MATERIALS AND METHODS:

Sample Collection and Preparation:

Fresh ripped fruits of *Azadirachta indica* were harvested from 2nd Baze Bar and Restaurant located at No. 47 Afikpo Road in Abakaliki, Ebonyi State, Nigeria where it is planted as shade tree for relaxation and aesthetic appeal between the months of March and April. The fruits were thoroughly washed with distilled water and the juice extracted using an extractor. The seeds were further dried and seed coat removed manually. The cotyledons were ground to reduce particle size and to increase the surface area. All the reagents used were of analytical grade from May and Baker Ltd., England and BDH Chem. Ltd., England.

Determination of proximate compositions

The sample was analyzed for proximate composition which includes moisture content, crude fat/oil, ash, protein, fibre and carbohydrate contents. Official

methods of (AOAC, 2000) were used in carrying out the proximate analysis. The method of (AOAC, 2000) was employed for the determination of the proximate composition. The soxhlet method was also employed in the determination of the crude fat/oil content in the sample using petroleum ether (40-60°C). The Kjeldhal method was used for protein estimation while the crude fiber and ash contents were also determined (AOAC, 2000).

Determination of Mineral compositions

The concentrations of the minerals were determined in the sample. The minerals include iron (Fe), magnesium (Mg), calcium (Ca), phosphorus (P) and nitrates. The minerals analyzed in this work were determined using spectrophotometric methods (AOAC, 1980) except calcium which was determined by precipitation as oxalate by titrating with potassium permanganate solution.

RESULTS:

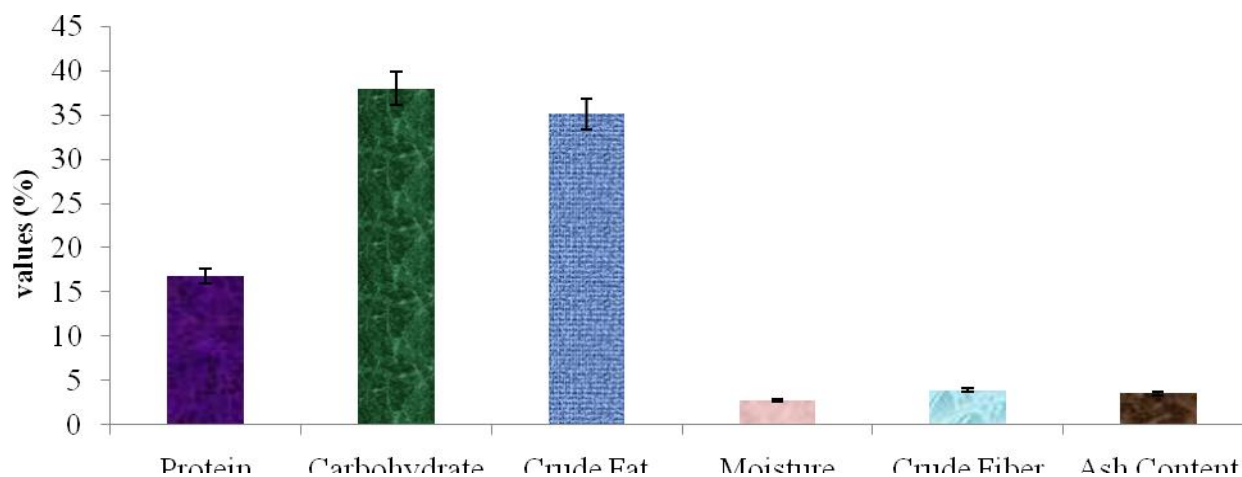


Fig 1: Proximate composition of fresh seeds of *Azadirachta indica*

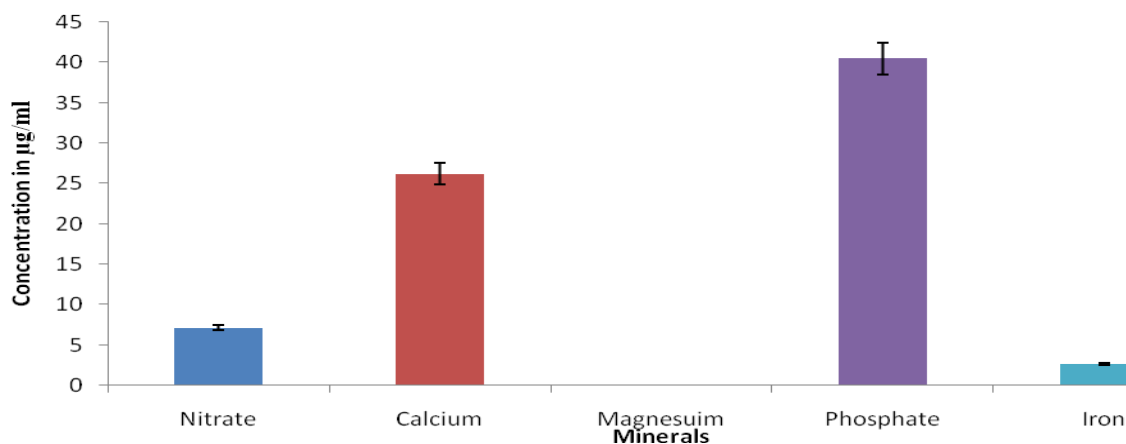


Fig 2. Mineral Composition of Fresh Seed of *Azadirachta indica* in µg/ml

DISCUSSION:

The fresh seeds of *Azadirachta indica* (neem) fruit were analyzed for proximate composition. The results of the proximate analysis shown in figure 2 revealed that the seeds contained 16.81 ± 0.65 % crude protein, 3.53 ± 0.46 % ash, 2.67 ± 0.58 % moisture, 35.13 ± 0.12 % crude lipid, 3.87 ± 0.29 % crude fibre and 37.99 ± 1.88 % carbohydrate.

The value for moisture content though high was relatively lower than 11.75 ± 0.25 % for *Tamarindus indica* seeds, (Yusuf *et al.*, 2007) and also lower than value for *Azzeria africana* seeds 9.13 ± 0.02 by (Ogunlade *et al.*, 2011) which are close species and families respectively. Notwithstanding the relative low moisture content, storage of the seeds will require careful reduction in moisture to discourage microbial growth and spoilage (Igwenyi *et al.*, 2011a).

The ash content of the seeds (3.38 ± 0.29 %) falls within the range of 1.63-8.53% reported for commonly consumed fruits (Oluyemi *et al.*, 2006) and compares favourably with the value for castor seeds (3.5 %) (Aisha *et al.*, 2013). Samples with high ash contents are expected to have high concentration of various mineral elements, which helps in speeding up metabolic processes, improve growth and development (Elinge *et al.*, 2012).

The value for fibre is comparable to that of *Tamarindus indica* 3.82 ± 0.005 (Yusuf *et al.*, 2007) and that of *Jatropha curcas* seeds 3.8 ± 3.96 (Azza and Ferial, 2010), this value however is higher than (1%) for pumpkin seeds (Elinge *et al.*, 2012). This therefore suggests that the seeds are good source of fibre which is important in diet and helps in lowering serum cholesterol levels, risk of coronary heart disease, hypertension, diabetes, colon and breast cancer (Ishida *et al.*, 2000).

The crude proteins value compares favourably with values from *Azzeria africana* seeds 16.52 ± 0.70 % (Ogunlade *et al.*, 2011), value gotten from analysis of the *Azadirachta indica* fruit juice 19.37 ± 0.58 % (Igwenyi *et al.*, 2014) and cashew nuts (18%) by (Egwu *et al.*, 2011). The value for the protein content of the fruit juice by Igwenyi *et al.*, (2014) indicates that the fruit of *Azadirachta indica* is the plant material with probably the highest content of protein. This protein content is higher than known plant and most animal sources of protein. The value however is higher than that for *Annona muricata* (8.5%) by (Nzikou *et al.*, 2010), 11.11% for castor seeds (Aisha *et al.*, 2013) and it exceeded the range of value 1.28-11.90% obtained for seeds of 15 species of plants used in nutrition as protein sources at Umudike Nigeria by (Dike, 2009). Thus the seeds are good sources of scarce plant protein. Several attempts have

been made to find solutions to nutritional problems in Africa in relation to protein intake and interest in newer sources of protein has grown due to protein shortage in developing countries especially Nigeria (Ameen *et al.*, 2012). In Nigeria in particular, locally available but unusual proteins containing food stuffs have been evaluated for their nutritional potentials aiming at reducing dependence and competition between livestock and man for the consumable sources (Mba *et al.*, 1974). Thus this is one of the giant strides in the discovery of novel sources of protein especially as plants are not previously known for their good protein sources.

The value obtained for crude lipid was higher than values for both *Tamarindus indica* seeds 11.43 ± 0.07 % (Yusuf *et al.*, 2007) and *Azzeria africana* seeds 16.35 ± 0.02 (Ogunlade *et al.*, 2011). In fact the value exceeds most common oil seeds e.g. *Jatropha* seeds 29.95 ± 0.05 obtained by (Inekwe *et al.*, 2012). It favourably compares with other popular oil seeds 35.27 ± 0.94 for fermented Africa locust beans (*Parkia biglobosa*) (Odebumni *et al.*, 2009), 38.00% for Pumpkin seeds (Elinge *et al.*, 2012) and groundnut (45%) (Okaka *et al.*, 2006). Neem oil also known as Margosa oil is already popular oil serving as a raw material used in production of soap amongst other industrial uses. This means that it can be classified as oil seeds, having more yield than common seeds known as oil seeds and comparable with industrial ones like groundnut. Lipids also are essential because they provide the body with maximum energy and structural support (Oluyemi *et al.*, 2006).

The carbohydrate content indicates a very high value (37.99 ± 1.88 %) higher than values for other oil seeds like *Annona muricata* (34.1%) (Nzikou *et al.*, 2009) and comparable to the range of some conventional sources of carbohydrate, like cereals, with 72-90g/100g carbohydrate content (Adewusi *et al.*, 1995). Following the recent decline in the yields of cereals, tubers and root crops which are the major sources of carbohydrate by many African countries (Paarlberg, 1996), this seeds therefore may be a very good source of energy for metabolic processes for both man and animals if properly processed.

Mineral composition in food helps in the maintenance of the body system for healthy growth and development. The fresh seed of *Azadirachta indica* showed varied concentration of minerals. The following values were obtained: nitrate 7.17 ± 0.08 µg/ml, calcium 26.20 ± 9.41 µg/ml, magnesium 0.08 ± 0.03 µg/ml, phosphate 40.45 ± 2.54 µg/ml and iron 2.70 ± 0.16 µg/ml. The result reveals that fresh seed of *Azadirachta indica* is potentially rich in minerals. Phosphate showed the highest value while magnesium showed the least.

Phosphate has the highest value of $40.45 \pm 2.54 \mu\text{g/ml}$. Phosphorus compounds are major constituents in the tissue and cell of the body and is vitally concerned with many metabolic processes, including those involving the buffers in body fluids. It is an important constituent of bones, teeth, the energy currency of the cell (adenosine triphosphate - ATP), phosphorylated metabolic intermediates and nucleic acids. Deficiency disease or symptoms in children causes rickets and in adults, it causes osteomalacia. The value of calcium is significant about $26.20 \pm 9.41 \mu\text{g/ml}$. Calcium functions as a constituent of bones and teeth, regulation of nerve and muscle function. In blood coagulation, calcium activates the conversion of prothrombin to thrombin and also takes part in milk clotting. Calcium deficiency causes rickets due to insufficient calcification by calcium phosphate of the bones in growing children. The bones therefore remain soft and deformed by the body weight. In adults, it causes osteomalacia, a generalized demineralization of bones. It may also contribute to osteoporosis, a metabolic disorder resulting in decalcification of bone with a high incidence of fracture, that is, a condition where calcium is withdrawn from the bones and the bones become weak and porous and then breaks (Murray *et al.*, 2000).

The primary biological function of iron with significant value of $2.70 \pm 0.16 \mu\text{g/ml}$, is the transport of electron in the respiratory chain events that terminates in the oxidation of metabolic hydrogen ion (H^+). Iron is very important component of hemoglobin and myoglobin. Many of the iron deficiency results to anemia. Symptoms including fatigue, headache, and parasthesia which may be as a result of malfunction of intracellular enzymes.

Magnesium had the lowest concentration of $0.08 \pm 0.03 \mu\text{g/ml}$ among the minerals determined. However, it is an essential constituent of bones, teeth, enzyme cofactor, kinases etc. The health status of the digestive system and the kidneys significantly influence magnesium status. Magnesium is absorbed in the intestines and then transported through the blood to cells and tissues. Toxicity disease or symptoms of magnesium deficiency in humans include depressed deep tendon reflexes and respiration (Murray *et al.*, 2000).

Nitrate showed $7.17 \pm 0.08 \mu\text{g/ml}$. Nitrates are always present in the blood stream at levels normally ranging from between 1 and 2 mg/liter before meals. In normal conditions, two sources of nitrates exist: the exogenous source from food and water and endogenous sources from cell activity. Each of the sources provides about 70-75mg/day (Bartholomew and Hill, 1984). The result of the analysis revealed that *Azadirachta indica* is potentially rich in

proximate composition in addition to its mineral composition compared to other seeds mostly used for nutritional and medicinal purposes such as soya bean, palm kernel, cotton seed meals etc.

CONCLUSION:

Azadirachta indica (neem) thus has great nutritional potential and quality higher than most wild medicinal plants and favorably comparable with other oil seeds. Thus as countries continue to suffer from drought and other weather related calamities, which tend to decrease the yields of their traditional grain staples such as millet, maize and sorghum, leading to a greater hike in global food prices with consequent escalation of hunger and increase in world food crises, *Azadirachta indica* seeds has remained a waiting antidote to this ugly trend. However, further researches should be conducted on the area of its phytochemical and antinutrient/alnutrient compositions to ensure its palatability to both animals and humans.

REFERENCES:

- 1.A.O.A.C. (2000). Official Method of Analysis. 17th Edition. Association of Official Analytical Chemists, Washington, D.C., 1: 12 - 20.
- 2.Adepoju O. T, Onasanya L. O, Ogunfuwa A. O. and Ayoade S. O. (2006). Nutrient composition and acceptability test of juice and ice cream from *Spondias mombin* (Hog plum) fruit pulp extract. *Journal of Tropical Forest Research*, **22**: 25 – 32.
- 3.Adewusi, S. R. A., Udio, A. J. and Osuntogun, B. A. (1995). Studies on the Carbohydrate Content of Bread Fruit (*Artocarpus commmunis* forst) from South Western Nigerian. *Starch Nutrition*, **85**: 285 - 294.
- 4.Aisha, U., Aleiro, B. L., Shehu, K., Hauwa, B. and Sumayya B. I. (2013). Seed Characteristics and Proximate Analysis of Wild Castor Plant from Sokoto State. *Journal of Environmental Science, Toxicology and food Technology*. **3**(4): 59 - 63.
- 5.Ameen, O. M., Belewu, A. M., Usman, A. L. and Onifade, O. O. (2012). Toxicity and Antimetabolic Properties of Biologically Treated Neem Seed (*Azadirachta indica*) Kernel Cake. *American Journal of Chemistry*, **2**(3): 112 - 114.
- 6.Azza, A. A. and Ferial, M. A. (2010). Nutritional Quality of *Jatropha curcas* Seeds and Effect of Some Physical and Chemical Treatments on their Anti-Nutritional Factors. *African Journal of Food Science*. **4**(3): 23 - 103.
- 7.Bartholomew, B. and Hill, M. J. (1984). The pharmacology of dietary nitrate and the origin of urinary nitrate. *Food Chemistry*, **22**: 789.
- 8.Dike, M. C. (2010). Proximate, phytochemical and nutrient compositions of some fruits, seeds and leaves of some plant Species at Umudike, Nigeria. *ARPN Journal of Agricultural and Biological Science*, **5**(1): 7 - 11.

- 9.Egwu, U. E., Ogbu, O., Ogunji, J., Oselebe, H. and Udu, A. A. (2011). Practicum in Entrepreneurship and Interpreneurship (A Do-It-Yourself Manual). EBSU Entrepreneurial Studies Centre, Abakaliki, Nigeria. **2**: 229.
- 10.Elinge, C. M., Muhammad, A., Atiku, F. A., Itodo, A. U., Peni, I. J., Sanni, O. M. and Mbongo, A. N. (2012). Proximate, Mineral and Anti-nutrient Composition of Pumpkin (*Cucurbita pepo* L) Seeds Extract. *International Journal of Plant Research*, **2**(5): 146-150.
- 11.Fila, W. A., Itam, E. H., Johnson, J. T., Odey, M. O., Effiong, E. E., Dasofunjo, K. and Ambo, E. E. (2013). Comparative Proximate Compositions of Water melon *Citrullus lanatus*, Squash *Cucurbita pepo* L. and Rambutan *nephelium* L. *International Journal of Science and Technology*, **2**(1): 81 - 88.
- 12.George, B. J. (2000). The Living World. 2nd Edition. The McGraw-Hill Companies Incorporated, USA. 8-10.
- 13.Gupta, N. K and Gupta, S. (2005). Plant Physiology. 1st Edition. Oxford & IBH Publishing Co., Pvt., Ltd., New Delhi. 189.
- 14.Humphrey C. M., Clegg, M. S., Keen C. L. and Grivetti, L. E. (1993). Food diversity and Drought survival: the Hausa example. *International Journal of Food Science and Nutrition*. **44**: 1 - 16.
- 15.Igwenyi, I. O. and Akubugwo, E. I. (2010). Analysis of Four Seeds Used as Soup Thickeners in the South Eastern Parts of Nigeria. *Conference Proceedings: International Conference on Chemistry and Chemical Engineering*, (ICCCE, 2010), August 1-3, 2010, Kyoto International Conference Center, Kyoto, Japan. 426 - 430.
- 16.Igwenyi, I. O., Nwigbo, J. C., Nwokike, J. C. and Awoke, J. N. (2014). Biochemical Compositions of *Azadirachta indica* Fruit Juice, *World Applied Sciences Journal*, **32**(2): 239-242.
- 17.Igwenyi, I. O., Eze, C. A., Azoro, B. N., Offor, C. E. and Nwuke, C. P. (2011a). Proximate, Mineral and Amino Acid Compositions of *Irvigna gabonensis* and *Citrullus colocynthis* used as Soup Thickener in South Eastern Nigeria, *International Journal of Biotechnology and Biochemistry*, **7**(4): 493-499.
- 18.Igwenyi, I. O., Offor, C. E., Ajah, D., Nwankwo, O.C., Ukaoma, J. I. and Aja, P. M. (2011b). Chemical Composition of *Ipomea aquatic*. *International Journal of Pharma and Bio Science*. **2**(4): 593 - 598.
- 19.Ishida, H., Suzuno, H., Sugiyama, N., Innami, S., Todokoro, T. and Maekawa, A. (2000). Nutritional Evaluation of Chemical Component of Leaves, Stalks and Stem of Sweet Potatoes (*Ipomea batatas* poir). *Food Chemistry*, **68**: 359 - 367.
- 20.Lee, S. (2005). Encyclopedia of Chemical Processing. CRC Press, Florida, USA. 280
- 21.Liu, R. H. (2004). Potential Synergy of Phytochemicals in Cancer Prevention, Mechanism of Action. *Journal of Nutrition*, **134**: 3475.
- 22.Mba, A. U., Njike, M. C. and Onyenuga, V. A. (1974). The Proximate, Chemical Composition and the Amino Acid Content of Nigerian Oil Seeds. *Journal of Science, Food and Agriculture*, **25**: 1542 - 1553.
- 23.Murray, R. K., Granner, D. K., Mayes, P. A. and Rodwell, V. W. (2000). Harper's Biochemistry, 25th Edition, McGraw-Hill, Health Profession Division, USA.
- 24.Nelson, D. L. and Cox, M. M. (2008). Lehninger Principles of Biochemistry. 5th Edition. W.H. Freeman Company, England. 741 - 743.
- 25.Nzikou, J. M., Kimbonguila, A., Matos, L., Loumouamou, B. and Ndangui, B. (2010). Proximate Composition and Physicochemical Properties on the Seeds and Oil of *Annona muricata* grown In Congo-Brazzaville. *Research Journal of Environmental and Earth Sciences*, **2**(1): 13 - 18.
- 26.Odebunmi, E. O., Oluwaniyi, O. O. and Bashiru, M. O. (2009). Comparative Proximate Analysis of Some Food Condiments. *Journal of Applied Sciences Research*, **C**: 1 - 3.
- 27.Ogunlade, I., Osadebe, A. I. and Ilugbiyin, A. (2011). A Comparative Study of Proximate Composition, Antinutrient Composition and Functional Properties of *Pachira glabra* and *Azalia africana* Seed Flours. *African Journal of Food Science*, **5**(1): 32 - 35.
- 28.Okaka, J. C., Akobundu, E. N., Okaka, A. N .C. (2006). Food & Human Nutrition: An Integrated Approach. OCJ Academic Publishers, Enugu, Nigeria. 34-310.
- 29.Oladele, E. P. and Oshodi, A. A. (2008). Effect of Fermentation on Some Chemical and Nutritive Properties of Berlandier Nettle Spurge (*Jatropha carthartica*) and Physic Nut (*Jatropha curcas*) seeds. *Pakistan Journal of Nutrition*, **7**(2): 292 - 296.
- 30.Oluyemi, E. A. Akilua, A. A., Adenya, A. A. and Adebayo, M. B. (2006). Mineral Contents of Some Commonly Consumed Nigerian Foods. *Science Focus*, **11**(1): 153 - 157.
- 31.Paarlberg, R. L. (1996). Rice Bowls and Dust Bowls. *Foreign Affairs*, **75**: 127 - 132.
- Pearson, D. (1976). The Chemical Analysis of Foods. 17th Edition. Churchill Livingstone, London. 3 - 4.
- 32.Usman, L. A., Ameen, O. M. Ibiyemi, S. A. and Muhammad, N. O. (2005). The Extraction of Proteins from the Neem Seed (*Azadirachta indica*). *African Journal of Biotechnology*, **4**(10): 1142 - 1144.
- 33.Yusuf, A. A., Mofio, B. M. and Ahmed, A. B. (2007). Proximate and Mineral Composition of *Tamarindus indica* LINN 1753 Seeds. *Science World Journal*, **2**(2): 1 - 4.