Journal of Biological Sciences and Bioconservation
Volume 8, Number 1, 2016
ISSN: 2277-0143

CHEMICAL AND SENSORY PROPERTIES OF MILK DEVELOPED FROM TWO VARIETIES OF BAMBARA GROUNDNUT (*Vigna subterranean*)

[1*]Okudu, H. O., [2]Ojinnaka, M. C. & [3] Iloh C.
[1,3]Department of Human Nutrition and Dietetics Michael Okpara University of Agriculture Umudike, Abia State
[2] Department of Food Science and Technology Michael Okpara University of Agriculture Umudike, Abia State
E-mail: helenokudu@yahoo.com

ABSTRACT

Two varieties of bambara groundnut (white and mixed coloured) were purchased from five randomly selected vendors in Ubani Market Umuahia, Abia State; the bambara groundnut bought were pooled to obtain samples for milk production. Standard method was used to prepare the milk. The proximate and vitamin content of the samples were determined using standard AOAC methods. Mineral elements were determined using wet-acid digestion method for multiple nutrients determination. All tests were carried out in duplicates and the data generated were analysed using standard methods. The fat and energy values of white variety bambara groundnut milk (3.7% and 250kj respectively) were significantly higher than those of mixed coloured bambara groundnut milk (2.8% and 225kj respectively), while the protein content of mixed coloured bambara groundnut milk (4.5%) was significantly higher than that of white variety bambara groundnut milk (4.3%). Calcium, potassium, sodium, zinc, and copper contents of mixed coloured bambara groundnut milk (39.81mg/100g, 10.31mg/100g, 6.21mg/100g, 3.86mg/100g, 0.45mg/100g) were significantly higher than those of white variety bambara groundnut milk (3.85mg/100g, 8.79mg/100g, 5.46mg/100g, 3.60mg/100g. 0.32mg/100g), while iron was in white variety bambara groundnut milk (2.27mg/100g) was significantly higher than that of mixed coloured bambara groundnut milk (2.46mg/100g). There were no significant differences in most of their vitamins and phytochemial values. The colour attribute of white variety bambara groundnut milk (6.8) was comparable to that of soymilk (6.5). Texture, taste and general acceptability attributes of white variety bambara groundnut milk (5.9, 5.8, 6.2) and those of mixed coloured bambara groundnut milk (5.7, 5.9, 6.1) were comparable to those of soymilk (6.3, 5.9, 6.4). The study showed that white variety bambara groundnut had higher amount of fat, iron, vitamin C and vitamin E

while mixed coloured bambara groundnut milk had higher amount of protein, potassium, sodium, zinc and copper. The antinutrient (phytic acid, oxalate) were within permissible limit. The study showed that both products developed form bambara groundnut can be used as alternative for soybean milk.

Keywords: *Vigna subterranean*, Milk, Nutrients, Varietal Difference

INTRODUCTION

Legume is known as a source of cheap protein in developing countries (Adebayo, 2014); its protein content is an average of twice as much as that of cereals (Vijaykumarri *et al.*, 1997; Udensi *et al.*, 2010). However like most food crop produced in Nigeria legume is also faced with post harvest wastage due poor handling and storage facility (CTA, 2012). Bambara groundnut (*Vigna subterranean*) a legume crop, of the family fabaceae is commonly grown for its seeds by subsistence farmers in many parts of Africa (National Research Council, 2006; Basu *et al.*, 2007). The nuts are known as Jugo Beans (South Africa), Ntoyo Cibemba (Republic of Zambia), Gurjiya or Kwaruru (Hausa, Nigeria), Okpa (Ibo, Nigeria), Epa-Roro (Yoruba, Nigeria) and Nyimo beans (Zimbabwe) (Bamishaiye e*t al.,* 2011).

The colour of the seeds vary from white, cream, red, black and in some cases mottled with colours such as brown, red or black (Amarteifio *et al.*, 2010). The crop is known for its tolerance to drought, relative resistance to pests, diseases and the ability to produce yield in poor soils too poor to support the growth of other legumes (Brough and Azam-Ali, 1992). The seed of ripe or immature Bambara groundnut (*Vigna subterranean*) contains about 20% protein, 60% carbohydrates and 7% oil (Goli, 1995; National Research Council, 2006). Lysine and Leucine are the predominant essential amino acids found in *Vigna subterranean* (Mune *et al.*, 2011; Mazahib *et al.*, 2013). While the predominant fatty acids found in Bambara groundnut are linoleic, palmitic and linolenic acids (Minks and Bruneteau, 2000).

In Nigeria mature fresh bambara groundnut is usually boiled and consumed as snack while mature dried ones are either toasted and consumed as snack or prepare into ukpa. The hard nature of the roasted nut and also the peppery taste of okpa are factors that reduce intake of bambara groundnut and its products in some individuals (particularly the aged and children). There is

therefore need to diversify the use of bambara groundnut by developing it into product that will make it available all year round; and also enhance its consumption among children and the aged who are grouped as vulnerable. This study was therefore designed to develop and carryout chemical and sensory test on milk from two varieties of bambara groundnut (white and mixed cloured varieties).

MATERIALS AND METHODS

Collection/ Cleaning of Bambara Groundnut (*Vigna subterranean*)

Two varieties of bambara groundnut (white and mixed coloured) were purchased from five randomly selected vendors in Ubani Market Umuahia, Abia State; the bambara groundnut bought were pooled to obtain samples for milk production. The samples were cleaned by winnowing, and removing of extraneous objects and immature seeds. One kilogram of whole seeds was soaked in potable water at room temperature (29-32°C in a 1: 30 (bean: water) ratio for 6hr. The soaked seeds were drained, rinsed, dehulled and ground in a ratio of 1liter of water to each 300gram of bambara groundnut. The mixture was left to macerate for 10 minutes. It was then pressed and filtered using a muslin cloth. One hundred and fifty (150ml) millilitter of potable water was added to the residue in order to extract the remaining milk and then six hundred and fifty (650ml) millilitter of potable water was added to the extract and allowed to boil for 20 minutes. Sugar syrup made up of 300ml of potable water and 20 cubes of sugar was added to the boiling milk and allowed to further boil for another five minutes. The samples for chemical analysis were poured into clean sample bottles and immediately taken for analysis while the remaining milk was evaluated for its sensory attributes at a temperature of 12°C.

Chemical Analyses

The proximate compositions of the sample were determined using standard A.O.A.C. (2006) methods. Moisture content of the jam was determined gravimetrically. The crude protein content was determined by micro-Kjeldahl method, using 6.25 as the nitrogen conversion factor. The crude fat content was determined by Soxhlet extraction method using petroleum ether. The ash content was determined by incinerating the samples at 600°C in a muffle furnace. Carbohydrate was obtained by difference, while energy was calculated using the Atwater Conversion factors in KJ and Kcal (17KJ/4Kcal, 17KJ/4Kcal, and 37KJ/9Kcal, for protein, carbohydrate and lipid respectively. Mineral elements were determined using wet-acid digestion method for multiple nutrients determination as described by the method of A.O.A.C (2006). About

0.2g of the processed sample material was weighed into a 150ml Pyrex conical flask. Five (5.0) ml of the extracting mixture (H_2SO_4 – Sodium Salicylic acid) was added to the sample. The mixture was allowed to stand for 16 hours. The mixture was then placed on a hot plate set at 30°C and allowed to heat for about 2hours. Five (5.0) ml of concentrated perchloric acid was introduced to the sample and heated vigorously until the sample was digested to a clear solution. Twenty (20) milliliters of distilled H_2O was added and heated to mix thoroughly for about a minute.

The digest was allowed to cool and was transferred into a 50ml volumetric flask and made up to the mark with distilled water. The digest was used for the determinations of calcium (Ca) and magnesium (Mg) by the ethylamine ditetra acetic acid (EDTA) versanate complexiometric titration method. Potassium (K) and sodium (Na) were evaluated by flame photometry method and phosphorus (P) by the vanadomolybdate method using the spectrophotometer. The trace metals (zinc, iron, copper, selenium, manganese and iodine) were determined using the atomic absorption spectrophotometer 969 instrument. The appropriate cathode lamp was fixed for each element. The sample was introduced to the atomizer and the value concentration of the element printed out as mgX/liter.

The β – carotene, riboflavin, niacin and thiamin of the products were determined spectrophotometrically as described by AOAC (2006). While ascorbic acid was determined as described by AOAC (2006) using titration method. Gravimetric method (Harborne, 1973) was used to determine alkaloids. Saponin was determined by gravimetric oven drying method as described by the method of A.O.A.C (2006). Tannin content of the sample was determined spectrophometrically as described by Kirk and Sawyer (1991). Phenol was determined by the folin-ciocatean spectrophotometry method (AOAC 2006). Flavonoid was determined by gravimetric oven drying method as described by Harborne (1973).

Sensory Evaluation

Sensory evaluation of the milk produced was carried out by a group of 20 panelists. The panelist consisted of randomly selected staff and students (both males and females) from College of Applied Food Sciences and Tourism. Commercial soymilk used as the control. The judges evaluated the products using a nine point hedonic scale where 7 = like very much and 1 = dislike very

much. Panelists scored the sample for four sensory attributes – flavour, colour, consistency and over all acceptability. A cup of potable water was given to the panelist to rinse his/her mouth after each tasting.

Statistical Analysis

All determinations were done in duplicates. The data generated were entered into the computer and analyzed using Statistical Package for Social Sciences (SPSS version 16.0) Means and standard deviation obtained from the chemical analysis and sensory evaluation scores were calculated.

RESULTS

Energy and Proximate Composition of Milk Developed from Two Varieties of *Vigna subterranean*

The energy and proximate composition (Table 1) of the milk as consumed is presented. Moisture content of white variety bambara groundnut milk (89.7%) was not significantly different from that of mixed coloured bambara groundnut milk (89.4%). The fat and energy values of white variety bambara groundnut milk (3.7% and 250KJ respectively) were significantly higher than those of mixed coloured bambara groundnut milk (2.8% and 225KJ respectively), while the protein content of mixed coloured bambara groundnut milk (4.5%) was significantly higher than that of white variety bambara groundnut milk (4.3%). There were no significant differences their crude fibre, ash and carbohydrate contents.

Mineral Composition of Milk Developed from Two Varieties of *Vigna subterranean*

The mineral content of the milk produced from two varieties of bambara ground nut are presented in Table 2. Calcium, potassium, sodium, zinc, and copper contents of mixed coloured bambara groundnut milk (39.81mg/100g, 10.31mg/100g, 6.21mg/100g, 3.86mg/100g, 0.45mg/100g) were significantly higher than those of white variety bambara groundnut milk (3.85mg/100g, 8.79mg/100g, 5.46mg/100g, 3.60mg/100g. 0.32mg/100g), while iron in white variety bambara groundnut milk (2.27mg/100g) was significantly higher than that of mixed coloured bambara groundnut milk (2.46mg/100g). There was no significant difference in the magnesium content of mixed coloured bambara groundnut milk (18.79mg/100g) and that of white variety bambara groundnut milk (19.55mg/100g). The potassium: sodium (K: Na) ratio for white variety bambara groundnut milk was 1.6 while that of mixed coloured bambara groundnut milk was 1.66.

Vitamin Composition of Milk Developed from Two Varieties of *Vigna subterranean*

The values of β-carotene, vitamin B_1 vitamin B_2 vitamin B_3 of white variety bambara groundnut milk (2.87mg/100g, 0.01mg/100g, 0.02mg/100g, 0.04mg/100g) were not significantly higher than those of mixed coloured bambara groundnut milk (2.78mg/100g, 0.02mg/100g, 0.03mg/100g, 0.04mg/100g). The vitamin C and vitamin E values of white variety bambara groundnut milk (0.79mg/100g and 1.62mg/100g respectively) were however higher than those of mixed coloured bambara groundnut milk (0.32mg/100g and 1.32mg/100g respectively).

Phytochemicel and Antinutrient Composition of Milk Developed from Two Varieties of *Vigna subterranean*

The phytochemical and antinutrient contents of the samples are shown in Table 4. The milk from the two varieties of *Vigna subterranean* had the amounts of alkaloid and tannins (5.0mg/100g and 2.0mg/100g respectively). The oxalate and phytic acid values of mixed coloured bambara groundnut milk (9.0mg/00g and 7.0mg/100g) were significantly higher than those of white variety bambara groundnut milk (8.0mg/100g and 6.0mg/100g respectively) but saponin in white variety bambara groundnut milk (11.0g/100g) was higher than that of mixed coloured bambara groundnut milk (10.0mg/100g).

Sensory Attributes of Milk Developed from Two Varieties of *Vigna subterranean*

The sensory attributes of milk developed from two varieties *Vigna subterranean* is shown in Table 5. The colour attribute of white variety bambara groundnut milk (6.8) was comparable to that of soymilk (6.5) while that of mixed coloured bambara groundnut milk (4.9) was not. The flavor of soymilk (6.5) was significantly ($p<0.05$) higher than those of white variety bambara groundnut milk and mixed coloured bambara groundnut milk (5.5 and 5.6 respectively); texture, taste and general acceptability attributes of white variety bambara groundnut milk (5.9, 5.8, 6.2 respectively) and those of mixed coloured bambara groundnut milk (5.7, 5.9, 6.1 respectively) were comparable to those of soymilk (6.3, 5.9, 6.4).

DISCUSSION

The moisture contents of the products fell within values reported for most plant milk. Moisture in food is a function of its shelf-life stability; this implies

that the products may have a short shelf-life. Protein values in both samples were higher than the one (3.15-3.85%) reported for *Treculia africana* seed milk (Nnam, 2003). The difference in their protein contents could be attributed to varietal difference. The ash values of the products were comparable to the ash content (0.89%) of *Treculia africana* seed milk (Onweluzo and Nwakalor, 2009) but lower than 1.5% reported for soymilk (Ukwuru, 2008). The ash content of any food is an index of its mineral composition (Gemah *et al*., 2012). White variety of bambara groundnut milk appeared to have higher values of crude fat and energy than mixed coloured variety. The difference in their fat content can be attributable to varietal difference while the difference in energy content could be a function of their composition (Ene-Obong *et al*., 2014). Low energy, high moisture, low fat and low protein make the milk suitable for patients with some physiological conditions.

Mixed coloured bambara groundnut milk appears to be a better source of calcium, potassium, sodium, zinc and iron, while white variety bambara groundnut milk was a better source of iron (Fe). The calcium, potassium and zinc in this study were higher those reported by Onweluzo and Nwakalor (2009) on a similar work done on bambara groundnut milk. Calcium and potassium are important element in the body; they play essential role in health of bone as well as regulating blood pressure (Elamin and Tureno, 1990). Zinc is also known for its role in physiological processes (King and Cousins, 2006).

Other minerals found in considerable quantity include magnesium and potassium. It is worth noting that the K/Na ratio of both products (1.6 and 1.66 respectively) fell within current recommended potassium and sodium molar ratios (Dietary Guideline Advisory Committee, 2011). This implies that potassium and sodium are in the right proportion in the products. The β-carotene values of the products were not significantly different from each other, but the vitamin E content of white variety bambara groundnut milk was significantly higher than that of mixed coloured bambara groundnut milk. The difference in vitamin E values could be attributable to varietal difference. Apart from been sources of nutrients β-carotene and vitamin E act also as antioxidants. β-carotene protects the body against free radicals (Rao and Rao, 2007), while vitamin E is known for its ability to terminate action of free radicals (Gropper *et al*., 2006). Water soluble vitamins in this study were low; however consumption of the products alongside other dietary source of water soluble vitamin could contribute to cumulative intake.

Alkaloid and tannin values found in the two products were not significantly different from each other, but saponin value of white variety bambara groundnut milk was significantly higher than that of mixed coloured bambara groundnut milk. Saponin in food has been proven to be of health benefit (Shi *et al.*, 2004); this implies that products from bambara groundnut will be of health benefit to individuals that will consumes it. Oxalate and Phytic acid were found in both products but in quantity within permissible level (Erdman, 1979; Anigo *et al.*, 2010). Sensory attribute is the measure and interpret reaction to characteristics of food as perceived by senses of sight, taste, touch and hearing. Score for colour for white variety bambara groundnut was comparable to that of the control (commercial soymilk; vita milk brand), while score for colour for mixed coloured variety was significantly lower.

The low score in colour for mixed coloured bambara groundnut maybe because individuals that consume plant milk are more familiar to creamed coloured plant milk. The low score for flavor in both products was not surprising because both products exhibit slight beany smell. The values for texture, taste and general acceptability for both products were comparable with those of the control (soymilk); this implies that bambara ground milk irrespective of its variety can be used as alternative for soybean milk.

CONCLUSION

The study showed that white variety bambara groundnut had high amount of fat, iron, vitamin C and vitamin E while mixed coloured bambara groundnut milk had higher amount of protein, potassium, sodium, zinc and copper. Phytochemical such as alkaloid, saponin, and tannin were present in both products. The antinutrient (phytic acid, oxalate) were within permissible limit. Both products developed competed favourably with the control (soybean milk) in terms of texture, taste and general acceptability. Sensory scores showed that milk from bambara groundnut (particularly the milk from the white variety) was acceptable.

RESULTS

Table 1: ENERGY AND PROXIMATE COMPOSITION OF MILK DEVELOPED FROM TWO VARIETIES *Vigna subterranean*

Nutrient	White cloured bambara groundnut milk	Mixed cloured bambara groundnut milk
Moisture (%)	89.7^{a}±0.03	89.4^{a}±0.24
Protein (%)	4.3^{b}±0.01	4.5^{a}±0.05
Crude fat (%)	3.7^{a}±0.01	2.8^{b}±0.01
Crude fibre (%)	0.04^{a}±0.01	0.04^{a}±0.01
Ash (%)	0.84^{a}±0.01	0.85^{a}±0.01
CHD (%)	2.2^{a}±0.29	2.3^{a}±0.01
Energy (kcal/kJ)	60/250	50/221

Values with the same superscript on the same row are not significantly different (p>0, 05) from other

Table 2: MINERAL COMPOSITION OF MILK DEVELOPED FROM TWO VARIETIES *Vigna subterranean*

Nutrient	White cloured bambara groundnut milk	Mixed cloured bambara groundnut milk
Calcium	$36.55b^{\pm}0.25$	$39.81a^{\pm}0.02$
Magnesium	$19.55a^{\pm}0.08$	$18.79a^{\pm}0.09$
Potassium	$8.79b^{\pm}0.05$	$10.31a^{\pm}0.02$
Sodium	$5.46b^{\pm}0.02$	$6.21a^{\pm}0.02$
Zinc	$3.60b^{\pm}0.01$	$3.86a^{\pm}0.03$
Iron	$2.77a^{\pm}0.02$	$2.46b^{\pm}0.02$
Copper	$0.32b^{\pm}0.01$	$0.45a^{\pm}0.01$
K/Na	1.6	1.66

Values with the same superscript on the same row are not significantly different (p>0, 05) from other

Table 3: VITAMIN COMPOSITION OF MILK DEVELOPED FROM TWO VARIETIES *Vigna subterranean*

Nutrient	white cloured bambara groundnut milk	Mixed cloured bambara groundnut milk
β-carotene (mcg/100g)	2.87^{a}±0.02	2.78^{a}±0.07
Vitamin B_1(mg/100g)	0.01a±0.00	0.02^{a}±0.01
vitaminB_2(mg/100g)	0.02^{a}±0.01	0.03^{a}±0.01
Vitamin B_3(mg/100g)	0.04^{a}±0.01	0.04^{a}±0.01
Vitamin C(mg/100g)	0.79^{a}±0.01	0.34^{b}±0.02
Vitamin E(mg/100g)	1.62^{a}±0.56	1.36^{b}±0.02

Values with the same superscript on the same row are not significantly different (p>0, 05) from other

Table 4: PHYTOCHEMICAL/ANTINUTRIENT COMPOSITION OF MILK DEVELOPED FROM TWO VARIETIES *Vigna subterranean* (mg/100g)

Nutrient	white cloured bambara groundnut milk	Mixed cloured bambara groundnut milk
Alkaloid	5.0^{a}±0.01	5.0^{a}±0.01
Saponin	11.0^{a}±0.01	10.0^{b}±0.01
Tannin	2.0^{a}±0.01	2.0^{a}±0.01
Phytic acid	6.0^{a}±0.01	7.0^{a}±0.01
Oxalate	8.0^{b}±0.01	9.0^{a}±0.01
Phenol	0.0±0.0	0.0±0.0

Values with the same superscript on the same row are not significantly different (p>0, 05) from other.

Table 5: SENSORY ATTRIBUTES OF MILK DEVELOPED FROM TWO VARIETIES *Vigna subterranean*

Sample	Colour	flavour	Texture	Taste	General acceptability
201	6.8^{a}±0.41	5.5^{b}±1.00	5.9^{a}±1.00	5.8^{a}±1.23	6.2^{a}±0.77
202	6.5^{a}±0.89	6.5^{a}±0.76	6.3^{a}±0.86	5.9^{a}±1.07	6.4^{a}±0.68
203	4.9^{b}±1.61	5.6^{b}±1.14	5.7^{a}±1.12	5.9^{a}±1.12	6.1^{a}±0.88

Values with the same superscript on the same column are not significantly different (p>0, 05) from other. 201-white bambara groundnut milk; 202-soybean milk; 203-mixed coloured bambara groundnut milk

REFERENCES

ADA Reports (2003). Position of America Dietetic Association of Dietitians of Canada: *Vegetarian Diets. J. Am Assoc.* 103:748.

Adebayo, S. F. (2014). Effect of Soaking Time on the Proximate, Mineral Compositions and Anti-Nutritional Factors of Lima Bean. Food Science and Quality Management www.iiste.orgISSN 2224-6088 (Paper) ISSN 2225-0557 (Online) Vol.27.

Amarteifio, J. O., Tibe, O. and Njogu R. M. (2010). The Nutrient Composition of Bambara Groundnut Landraces (*Vigna subterreanea*) Cultivated in Southern Africa Agricultura Tropica et Subtropica.

Anigo, K. M., Ameh, D. A. Ibrahim, S. and Danbauch, S. (2010). Nutrient Composition of Commonly used Complementary Foods in North Western Nigeria. Afri. J. N-Biotech 8(17): 4211-4216.

Association of Official Analytical Chemist AOAC. (2006). Official Methods of Analysis. Association of Official Analytical Chemistry, Washington D.C.

Bamshaiye, O. M., Adegbola, J. A., E. I. and Bamishaiye, E. I. (2011). Bambara groundnut: An Under-Utilized Nut in Africa. Advances Agric. Biotechnol. 1: 60-72.

Basu, S., J. A. Roberts (2007). "Development of Microsatellite Markers for Bambara Groundnut (Vigna subterranean L. Verdc.)— An Underutilized African Legume Crop Species. "Molecular Ecology Notes 7(6): 1326-1328.

Brough, S. H. and Azam-Ali S. N. (1992): The Effect of Soil Moisture on the Proximate Composition of Bambara Groundnut (*Vigna subterranean* (L) Verdc). *J. Sci. Food Agric.* 60: 197–203.

CTA (2012). Going to Waste – Missed Opportunity in the Battle to Improve Food Security CTA Policy. Brief 7. www.cta.int/joomlatools.filesdocuman-files/policy/7 going to waste missed. Retrieved 02/04/15.

Dietary Guidelines Advisory Committee (DGAC) (2011). Report of the Dietary Guidelines. Advisory Committee on the Dietary Guidelines for Americans, 2010. Washington, .DC: U.S Department of Agriculture, Agricultural Research Service.

Elamin, A. and Tureno, T. (1990). Dependent Diabetes Mellitus 2. Diabetes Research and Clinical Practice. 10:203-209.

Ene-Obong, H. N., Okudu, H. O. and Asumugha, U. V. (2014). Nutrient and Phytochemical Composition of Two Varieties of Monkey Kola (*Cola parchycarpa* and *Cola lepidota*): An Underutilized Fruit. Food Chem. 193:154-159.

Erdman, J. W. (1979). Oilseed Phytate: Nutritional Implications. J. Am. Chem. Soc. 56: 258-264.

Gemah, D. I., Eke, M. O. and Ariahu, C.C. (2012). Chemical and Sensory Evaluation of Bread Sold in Benue and Nasarawa States of Central Nigeria. Advanced J. Food Sci. Technol. 5:547-550.

Goli, A.E. 1995. Introduction. In bambara Groundnut *Vigna subterranean* (L) *verdc*. Proceedings of the Workshop on Conservation and Improvement of Bambara Groundnut. *Vigna subterranean* (L) verdc. Heller, J, Hammer, K and Engels, J. Pp. 3-6.

Gropper, S., Smith, J. L. and Groff, J. L. (2005). Advanced Nutrition and Human Metabolism. United Kingdom. pp 355.

Harboune, J. B. (1973). Phytochemical Methods: A Guide to Modern Technique of Plants Analysis. Chapman and Hall: London. pp 60-64.

Kings, J. C. and Cousins, R. J. (2006). Zinc. In: Shils, M.E and Others (Eds): Modern Nutrition in Health and Disease. 10th Ed. Philadelphia, PA: Lippincott Williams and Wilkins.

Kirk, R. S. and Sawyer, R. (1991). Pearson' Composition and Analysis of Foods. 9th Edition, Longman Scientific and Technical. United Kingdom.

Mazahib, A. M., Nuha, M. O., Salawa I. S. and Babiker, E. E. (2013). Some Nutritional Attributes of Bambara Groundnut as Influenced by Domestic Processing. Int'l. Food Res. J. 20(3): 1165-1171 (2013)

Minka, S. R. and Brunetean, A. (2000). Partial Chemical Composition of Bambara pea (*Vigna subterranea*). Food Chem. 68: 273–276.

Mune, M. A, Minka, S. R, Lape Mbome, I. and Etoa, F. X. (2011). Nutritional Potential of Bambara Bean Protein Concentrate. Pakistan J. Nutr. 10: 112-119.

National Research Council (2006). Lost Crops of Africa, Vol. II: Vegetables (Development, Security, and Cooperation Policy and Global Affairs). The Natl. Academies Press, Washington DC. Retrieved from: http://www.nap.edu/openbook.php?record_id=11763 on 22/06/2012.

Nnam, N. M. (2003). Nutrient Composition and Acceptability of Vegetable Milk, made from Oil Seeds. J. Home Econ. Res. 5: 57-61.

Onweluzo, J. C. and Nwakalor, C. (2009). Development and Evaluation of Vegetable Milk from Decene Seed. J. Nutr. 8: 233-238.

Rao, A.V. and Rao, L.G. (2007). Carotenoids and Human Health. Pharmacol. Res: 5: 207-216.

Shi, J., Konesh, A., Yeung, D., Kakuda, Y., Miltal, G. and Jiang, Y. (2004). Saponins from Edible Legumes. Chemistry, Processing and Health Benefits. J. Med. Fd.7:67-78.

Udensi, E. A. Arisa, N.U. and Ikpa, E. (2010). Effects of Soaking and Boiling and Autoclaving on the Nutritional Quality of *Mucuna flagellipes* ("Ukpo"). *Afric. J. Biochem. Res.* 4(2): 47-50.

Ukwuru, M. U., Omachona, L. J. and Toker, C. (2008). Production and Quality Assessment of Tiger Imitation Milk during Storage. *J. Food Sci. Technol.* 45: 180-182.

Vijayakumari, K., Siddhuraji, P. Janardhanan, K. (1997). Effect of Domestic Processing the Levels of Certain Antinutrients in *Prosopis chilensis* (Molina) Stunz. Seeds. Food Chem. 59(3): 367-371.

Reference to this paper should be made as follows: Okudu, H.O., *et al*, (2016), Chemical and Sensory Properties of Milk Developed from Two Varieties of Bambara Groundnut (*vigna subterranean*). *J. of Biological Science and Bioconservation,* Vol. 8, No. 1, Pp. 1-13