Vol. 13(4), pp. 107-112, April 2019
DOI: 10.5897/AJPS2019.1763
Article Number: 52474DB60698
ISSN 1996-0824

http://www.academicjournals.org/AJPS

African Journal of Plant Science

Full Length Research Paper

Nutrient and antinutrient constituents in seeds of *Sphenostylis stenocarpa* (Hochst. Ex A. Rich.) Harms

Sam S. M.

Department of Biological Sciences, Faculty of Natural and Applied Science, Akwa Ibom State Universty, Ikot Akpaden, Nigeria.

Received 10 January, 2019; Accepted 14 March, 2019

Nutrient and antinutrient constituents in seeds of *Sphenostylis stenocarpa* were determined. The proximate composition revealed that *S. stenocarpa* seed contains 12.44% moisture, 18.55% protein, 2.41% lipid, 2.93% ash, 1.95% fibre, 74.16% carbohydrate and 392.50 kcal caloric value. The antinutrients analysis showed that the seed contains 15.25 mg/100 g hydrocyanide, 144.14 mg/100 g tannins, 1.01 mg/100 g phytate and 61.60 mg/100 g oxalate. It may be concluded that the seeds of *S. stenocarpa* contribute to nutrient intake by the consuming populations in Nigeria and contain some pharmacological evidence for the treatment of stomach aches and acute drunkenness can serve as an antimalarial, antidiabetic, fertility agent, anti-cancer, anti-ulcer and cardioprotective agent.

Key words: Nutrient, antinutrient, *Sphenostylis stenocarpa.*

INTRODUCTION

The African yam bean (*Sphenostylis stenocarpa* Hochst. ex. A. Rich) is a leguminous crop belonging to the family Fabaceae, sub-family papilonoidae, tribe Phaseoleae, sub-tribe Phaseolionae and genus *Sphenostylis* (Okigbo, 1973; Allen and Allen, 1987). It is a minor crop cultivated together with cassava and yam. Being a minor crop shows it is highly not exploited (Klu et al., 2001). It is cultivated in in West Africa, specifically Cameroon, Cote d'Ivoire, Ghana, Nigeria and Togo (Porter, 1992). In Nigeria, it is seen in local places in the southern part of Nigeria, where it is cultivated by poor farmers as a security crop. It has risk of disappearing due to the high payment on the major legumes enumerated earlier and others like Soya bean.

The economic importance of African yam bean is immense. High population, high prices of staple food items, policy restrictions on importation of food worsen food security in developing nations with predominantly protein deficiency and malnutrition (Weaver, 1994; FAO, 1994, 2008). To fill the high gap in the balanced food provision for developing nations' increasing population, lesser –known crops are given attention, those that play great roles in the economy of peasant farmers (Ezeagu et al., 2002). These crops include African yam beans *S. stenocarpa (*Hochst. ex A. Rich.) Harms and pigeon pea (*Cajanus cajan* L. Mill Sp.). They are planted to be consumed at home and for sale in Nigeria (Saka et al., 2004) irrespective of their abilities to give enough require nutrients. Plants like these are called under-exploited, under-utilized, orphan or abandoned (Jaenicke et al., 2009). The nutritious seeds are sweet, and many places of Nigeria people prefer it to other leguminous seeds.

E-mail: sundaysam@aksu.edu.ng. Tel: +2348028706841.

Besides its palatable leaves and pods, the tubers can be cooked as vegetable (Rice et al., 1986).

Grain legumes constitute the main source of protein in the diets of the average Nigerian home. The most important ones are cowpea (*Vigna unguiculata*), groundnut (*Arachis hypogea*) and lima bean (*Phaseolus lunatus*). However, there are other pulses that could help meet dietary needs but are cultivated only in localized areas and used less (Klu et al., 2001). These underexploited legumes include African yam bean (*S. stenocarpa*), Bambara groundnut (*Vigna subterranea*) and pigeon pea (*C. cajan*).

The current unpredictability in the supply of food globally and the increased demand expected demands searching for other food sources that everyone can access. A lot of researchers like Fetuga et al. (1973), Aletor and Aladetimi (1989) and Fowomola and Akindahunsi (2007) have investigated the nutritional potentials of plant seeds less known as other food sources. Developing nations' desire to advance in achieving the Millennium Development Goals (MDGs), mostly to eradicate severe destitution and famine specifically necessitates doing great study in certain less used native crops and tree plants.

Antinutrients are found at some level in almost all foods for a variety of reasons. However, their levels are reduced in modern crops, probably as an outcome of the process of domestication. Nevertheless, the large fraction of modern diets that come from a few crops, particularly cereals, has raised concerns about the effects of the antinutrients in these crops on human health (Cordian, 1999). The possibility now exists to eliminate antinutrients entirely using genetic engineering; but since these compounds may also have beneficial effects (such as polyphenols which reduce the risk of cancer, heart disease or diabetes), such genetic modifications could make the foods more nutritious but not improve people's health (Welch and Graham, 2004).

Many traditional methods of food preparation such as fermentation, cooking and malting increase the nutritive quality of plant foods though reducing certain antinutrients such as phytic acid, polyphenols and oxalic acid (Hotz and Gibson, 2007). Such processing methods are widely-used in societies where cereals and legumes form a major part of the diet (Chavan and Kadam, 1989; Phillips, 1993). Other antinutrients found in crops include saponins and hydrocyanide. These anti-nutrients when subjected to cooking are denatured thus making them to be non toxic.

Unlike animals, plants lack teeth, claws and legs that would enable to get out of trouble. Many plants stay on in a place and they depend on chemical defences to drive enemies not wanted. For this reason, plants store a great number of chemicals that are harmful to bacteria, fungi, insects, herbivores, and man. Luckily these different chemicals contain a lot of compounds useful to man; vitamins, nutrients, antioxidants, anticarcinogens, and a lot of other compounds that are important medically (Novak and Haslberger, 2000).

A lot of plants such as food plants have certain levels of natural plant pollutants. The levels of pollutants in plant tissues are measured by a chemist to analyze their safety for animal feed and drug. The impact of natural plant pollutants seen at reduced levels in a lot of drugs and foods and drugs consumed by us, on man and animals, is due to laboratory tests that use very high amounts of toxin than usually seen in food and drug. Each edible plant species has its own nutrient content apart from its phytochemicals that are useful pharmacologically. These nutrients needed for the physiological functions of man body. Such nutrients and biochemicals such as carbohydrates, fats and proteins satisfy man's needs for life and energy (Hoffman et al., 1998; Dingman, 2002).

Due to the transformations all over Africa, wild plants are at risk of going into extinction and might affect the nutrition of the local people (Herzog et al., 1994). Numerous scientific data indicate that the consumption of grains is associated with a lower risk of several chronic diseases, such as cancers and cardiovascular diseases. The preventive effect is often associated to naturally occurring antioxidant components, such as anthocyanins, flavonoids, and other phytochemicals that are predominantly present in the seed coat (Bomser et al., 1996; Wang and Mazza, 2002).

All legumes contain phytate (also known as phytic acid). Phytate works in the gastro-intestinal tract to tightly bind minerals such as zinc, copper, iron, magnesium and calcium. It has a particularly strong affinity for zinc, a mineral that supports wound healing, protein synthesis, reproductive health, nerve functions, and brain development. It is believed that people living in developing countries are shorter than those in developed countries because of zinc deficiency caused by eating too many legumes. There is also evidence that mental development can be negatively impacted by a diet high in phytate (Minton, 2009). In most legumes such as other varieties of beans, soaking is enough to break down most of the phytate content. However, soybean requires that the enzymes be released during the fermentation process to reduce its phytate content to the point where it becomes fit for consumption.

Antinutrients are natural or synthetic compounds that interfere with the absorption of nutrients. One common example is phytic acid, which forms insoluble complexes with calcium, zinc, iron and copper (Cheryan, 1980). Proteins can also be antinutrients, such as trypsin inhibitors and lactins found in legumes (Gilani et al., 2005). These enzyme inhibitors interfere with digestion. Another particularly wide-spread form of anti-nutrient is flavonoids, which are a group of polyphenolic compounds that include tannins (Beecher, 2003). These compounds chelate metals such as iron and zinc and reduce the absorption of these nutrients, but they also inhibit digestive enzymes and may also percipitate proteins.

Table 1. Proximate composition (%) of *S. stenocarpa*.

Nutrient	Sample composition %
Moisture contents	12.44
Crude protein	18.55
Crude lipid	2.41
Ash	2.93
Crude fibre	1.95
Carbohydrate	74.16
Caloric value (Kcal)	392.50

However, polyphenols such as tannins have anticancer properties, so foods such as green tea that contain large amounts of these compounds might be good for the health of some people despite their antinutrient properties (Chung et al., 1998). Locally, very little is known about the economic and nutritional value of *S. stenocarpa*, this studies aim to add to the existing information the nutritional and antinutritional value of the said seed crop.

MATERIALS AND METHODS

Sources and collection of seeds

The seeds of African yam bean *S. stenocarpa* (Hochst. ex.A. Rich) Harms were collected from local farmers in Use Offot, and Nsukara Offot in Uyo Local Government Area of Akwa Ibom State. The seeds were identified by a taxonomist in the Department of Biological Sciences, Akwa Ibom State University. The seeds were extracted from the dried pods. Observation showed that two sizes of seeds and two colours were present, a small size (SS) and a large size (LS), brown and white. The weight of each seed was also determined. Premature and infected seeds were discarded, and selected seeds were taken to the laboratory for analysis. Seeds from both sources (Use Offot and Nsukara Offot) were pooled together and the brown colour seeds were used for the studies.

Proximate analysis

Analysis of the nutrient content of *S. stenocarpa* was carried out using the method of AOAC (1984).

Analysis of anti-nutrients

The method of AOAC (1984) was employed to determine the level of Hydrocyanide, Oxalate, phytate and tannins.

RESULTS

The results of the proximate analysis of *S. stenocarpa* seeds are presented in Table 1. The results show that the seed contains (12.44%) moisture, (18.55%) protein, (2.41%) lipid, (2.93%) Ash, (1.95%) fibre, (74.16%) carbohydrate and (392.50 kcal) caloric value. Table 2 shows the antinutrients content of *S. stenocarpa* seeds. The results indicate that the seed contains hydrocyanide (15.256 mg/100 g), tannins (144.144 mg/100 g), phytate (1.006 mg/100 g) and oxalate (961.60 mg/100 g).

DISCUSSION

The results of the proximate composition of the seed of *S. sternocarpa* as shown in Table 1 show that the moisture contents (12.44%) was within the range obtained for red kidney bean (12.39 ±4.60) (Sasanam et al., 2011) but was more than 4.85 as in gourd seed (9.13 ±8.0%) (Ogungbenie, 2006), pumpkin seed (5.02%) (Aisegbu, 1987), pumpkin seed (5.5%) (Fagbemi and Oshodi, 2005) and shelled lima bean (4.42%) (Oyenuga, 1968). This observed variation might have resulted from genetic geographic, climate and season variations.

The protein content value (18.55%) was comparable to that of *Afzelia africana* seed (16:52 ± 0.79%) (Ogunlale et al., 2011) and low in comparison to other palatable leguminous seed flours like pigeon peas, cowpeas and soybeans (Olaofe et al., 1994), certain lima bean varieties (Oshodi, 1993), some cowpea varieties (Aletor and Aladetimi, 1989) and related less used legumes (*Caesalpinia pulcherima*) (Olaofe et al., 2004). Its protein content makes it nutritionally a good source of plant protein; this validates its use in diet as a plant protein which can supplement animal protein thereby alleviating kwashiorkor and marasmus. Its palatability however, depends on handling when prepared as meal.

The value for the lipids content (2.41%) was similar to the fruit pulp of *Spondias mombin* (2.0 ± 0.05) (Adepoju, 2009) and were low when compared with 43.2% for calabash kernel (Olaofe et al., 2009) and 23.5% for soybean seed (Paul and Southgate, 1985). The seed of *S. stenocarpa* recorded ash content of 2.93%. This value was lower than (3.00 to 3.8%) in certain varieties of cowpea (Aletor and Aladetimi, 1989) and (3.1 ± 3.6%) for various lima bean flours (Oshodi and Adeladun, 1993), but comparable favaourbaly with values (2.62 ± 0.025%) reported for mango seed (Fowomola, 2010). This suggests that the seeds of this plant might be mineral sources the body needs to develop well. The crude fibre

Table 2. Antinutrients contents (mg/100 g) of *S. stenocarpa* seeds.

Antinutrient content	Sample composition (mg/100 g)
Hydrocyanide	15.256
Tannins	144.144
Phytate	1.006
Oxalate	61.60

value 1.95% was low in comparison to the 2.8 and 4.28% for gourd seeds (Ogungbenle, 2006) and soybean (Temple et al., 1991). The low fibre composition can reduce the taking in of bile (Marfo et al., 1990). The content of carbohydrate (74.16%) was high as compared with values reported for *Pachira glabra* and *Afzelia africana* seeds (52.32 ± 0.8) and (45.92 ± 0.72) respectively (Ogunlade et al., 2011). This shows that *S. Stenocarpa* seed is a good source of carbohydrate with protein and the gross energy value qualify it as a good energy source.

Food analysts are greatly concerned about oxalate due to its adverse effect on the availability of minerals. Food having high level of oxalate can result in kidney stones as its high levels tantamount to increased absorption of calcium in the kidneys (Chai and Liebman, 2004). The levels of oxalate in *S. stenocarpa seeds* were higher than 0.23 to 1. 10 g/100 g (Bello et al., 2008) and 0.4% (Amoo and Agunbiade, 2010) found in certain Nigerian fruits and full seed flour of *Pterygota macrocarpa*. Oxatate builds complex if taken by animals and also great amount of oxalate diets can increase the risk of absorping renal calcium (Osagie and Eka, 1988). Also, dietary oxalate can form complex with calcium, magnesium and iron resulting in insoluble oxalate salts and oxalate stone.

Tannins are responsible for the formation of insoluble complexes with proteins leading to low digestibility of food proteins. Tannin values got (61.60) were lower than 13.3% cashew nut, 19.1% fluted pumpkin (Fagbemi et al., 2005) and 7.0% hulled seed of *P. macrocarpa* (Amoo and Agunbiade, 2010). Tannins are pleasant compounds that contain groups of phenols. They mingle with salivary proteins and glycoproteins in the mouth and make the tissues bitter. The bitterness makes tannin valueable medically for the prevention of diarrhea and dysentery and to control haemorrhage (Jones, 1965). Also, tannins save plants from dryness, rot, destruction from animals and pathogens. Their polymerization forms insoluble protective barrier which stops attack of microbes (Stumpf and Conn, 1981). Thus they can be used on wounds as defence coating. Bichel and Bach (1968) said that continued absorption of tannin has symptoms like gastritis, irritation and edema of the intestine. Glick and Joshyn (1970) said that intake of 0.5% of tannic acid reduced the retaining of nitrogen and led to 5% death in rats. Bressani et al. (1983) reported that tannins show their adverse impacts by building protein tannin complexes via multiple hydrogen binding between their hydroxyl groups and carboxyl groups of protein peptide bounds of proteolytic enzymes in the gastrointestinal tract.

Phytate reduce the growth of chicks given phytate-casein diet by forming complex with zinc making the later not available. Phytate value got (1.006 mg/100 g) was low. Omosaiye and Cheryan (1979) noted that, phytate formed complex with protein via the activity of cations, normally calcium, zinc or magnesium acting as a bridge between the negatively charged protein carboxyl groups and former. The content of the hydrocyanide was 15.256 mg/100 g. Chen et al. (1934) reported that the lowest harmful dose of hydrogen cyanide taken by mouth was between 0.5 and 3.5 mg/kg body weight. The hydrogen cyanide signs are peripheral numbness, light-headedness, mental confusion, stupor, cyanosis and convulsion (Halstrom and Moller, 1945).

The outputs of plant normally have higher levels of antinutritional features than those of animals. The values of the antinutritional factors that are slightly high might be because the seeds are not processed. The availabilityof some of these antinutrients can be decreased by different processing methods (Elegbede, 1998). Farag (2001) and Agunbiade and Olanlokun (2006) showed that soaking and boiling, autoclaving for 30 min and irradiation up to 20 KGY and roasting and boiling terribly decreased the antinutritional factors seen in mango seed kernels, leading to improvement in their features nutritionally. It is clear in this work that *S. stenocarpa* had high levels of antinutrients apart from phytate. All the antinutritional parameters levels were lower than what can make up the health risk or wrong intake of other nutrients in high amount.

Conclusion

The seed of *S. sternocarpa* can be seen as a potential source of useful items for food and drugs formulation. Further research work is ongoing to confirm some of the ethno-pharmacological claims on *S. stenocarpa*.

CONFLICT OF INTERESTS

The author has not declared any conflict of interests.

REFERENCES

Adepoju OT (2009). Proximate Composition and Micronutrient Potentials of Three Locally available Wild Fruits in Nigeria. African Journal of Agricultural Research Research 5(14):2952-2955.

Agunbiade SO, Olanlokun JO (2006). Studies on the Nutritive Values of the Seed Kernels of Exotic and Local Mangoes (*Magnifera indica).* Asian Journal of Bioscience and Biotechnology Research 3(1A):81-86.

Aisegbu JE (1987). Some Biochemical Evaluation of Fluted Pumpkin Seed. Journal of the Science of Food and Agriculture 40:151-155.

Aletor VA, Aladetimin OO (1989). Compositional Evaluation of Some Cowpea Varieties and Some Underutilized Legumes in Nigeria. Nahrung 10:999-1007.

Allen ON, Allen EK (1987). The Leguminous. A Source Book of characterization, uses and Nodulation, London: Macmillan Publishers' Ltd P 620.

Amoo IA, Agunbiade FO (2010). Some Nutrients and Antinutrient Components of *Pterygota macrocarpa* Seed Flour. Journal of Environmental, Agricultural and Food Chemistry 9(2):293-300.

Association of official Analytical Chemists (AOAC) (1984). Official Method of Analysis of the Association of official Analytical Chemists*.* Washington D. C. USA. pp. 832-860.

Beecher GR (2003). Overview of Dietary Flavonoid: Nomenclature, Occurrence and Intake. Journal of Nutrition 133(10):3248-3254.

Bello MO, Falade OS, Adewusi SRA, Olawore NO (2008). Studies on The Chemical Compositions and Anti-nutients of Some Leser Known Nigerian Fruits. African Journal of Biotechnology 7(21) 3972-3979.

Bichel J, Bach A (1968). Investigation on the Toxicity of Small Chronic Doses of Tannis Acid with Special Reference to possible Carcinogenicity. Acta Pharmacology Toxicology 36:41-45.

Bomser J, Madhavi DL, Siggnletetary, Smith MAL (1996). Invitro Anticancer Acrtivity of Fruit Extracts From Vaccinium Species. Journal of Planta Medica 41:212- 216.

Bressani R, Elias LG, Wolzak HAAE, Buder LG (1983). Tannin in Common Beans. Methods of Analysis and Effects on Protein Quality. Journal of Food Science 48:1000-1001.

Chai W, Liebman M (2004). Assessment of Oxalate Absorption from Almonds and Black Beans With and without the Use of an Extrinsic Lable*.* Journal of Urology 172:953-957.

Chavan JK, Kadam SS (1989). Nutritional Improvement of Cereals by Fermentation. Critical Reviews in Food Science and Nutrition 28(5):349-400.

Chen KK, Rose CL, Cloves GHA (1934). Comparative Values of Several Antidotes in Cyanide Poisoning. American Journal of the Medical Science 188:767-781.

Cheryan M (1980). Phytic Acid Interactions in Foods Systems. Critical Reviews in Food Science and Nutrition 13(4):297-335.

Chung KT, Wei CI, Johnson MG (1998). Are Tannins a Double –Edged Sword in Biology and Health. Trends in Food Science and Technology 9(4):168-175.

Cordian L (1999). Cereal Grains: Humanity's Double-Edged Sword, World Review of Nutrition and Dietetics 84:19-73.

Dingman SL (2002). Water in Soils: Infilteration and Redistribution. Physical Hydrology, 2nd Edn, Upper Saddle River, New Jersey, Prentice Hall, Inc. P 646.

Elegbede JA (1998). Legumes *In*: Osagie, A. U. and Eka, O. U. (Eds). Post Harvest Research Unit, University of Benin pp. 53-83.

Ezeagu IE, Devi S, Haridas PR, Nath H, Rao AG, Gowda L, Tarawali G (2002). Prospects for Incorporation of Defatted Mucuna Flour in Biscuits Formation. Journal of Food Science and Technology 39:435-438.

Fagbemi TN, Oshodiu AA, Pinmoroti KO (2005). Processing Effects on some Anti-Nutritinal Factors and in Vitro Multi Enzyme Protein Digestibility (IVPD) of Three Tropical Seeds:Breadnut (*Artocarpus altilis*),Cashewnut (*Anarcardium occidentale*) and Fluted Pumpkin (*Telfairia occidentalis*). Pakistan Journal of Nutrition 4(4):250-256.

Food and Agriculture Organization (FAO) (2008). Markets, Prices, Food Situation and Prospects for Benin, Niger and Nigeria. Available at: http://www.fao.org/docrep/010ai464e/ai464eoo.htm

Food and Agriculture Organization (FAO) (1994). The State of Food and Agriculture. FAO Agriculture Series No. 27. FAO, Rome.

Farag MD (2001). The Enhancement of the Nutritive Value of Mango Seed Kernels for Poultry by Thermal Treatment and Radiation Processing. Archiv For Tierernahrung 54(1):61-79.

Fetuga BL, Babatunder GM, Oyenuga VA (1973*).* Protein Quality of Some Nigerian food Stuffs*,* IbadanL Ibadan University Press pp. 1505-1514.

Fowomola MA (2010). Some Nutrients and Antinutrients Contents of Mango (*Magniferea indica*) Seed. African Journal of Food Science 4(8):472-476.

Fowomola MA, Akindahunsi AA (2007). Nutritional Quality of Sandbox Tree (*Hura Crepitans Linn.)* Journal of Medical Food 10(1):159-164.

Gilani GS, Cockell KA, Sepehr E (2005). Effects of Antinutrtional Factors on Protein Digestibility and Amino Acid Availability in Foods. Journal of AOAC International 88(3):967-987.

Glick Z, Joslyn MA (1970). Food Intake Depression and Other Metabolic Effects of Tannic Acid in the Rat. Journal of Nutrition 100:509-515.

Halstrom F, Moller KD (1945). Content of Cyanide in Human Organs from Cases of Poisoing with Cyanide Taken by Mouth with Contribution to Toxicology Cyanides. Acta Pharmacol and Toxicology 1:18-28.

Herzog F, Farah z, Amado R (1994). Compostion and Consumption of Gathered Fruits in the V-Babule, Cote D'Ivoire. Ecological Food Nutrition 32:161-194.

Hoffman PC, Combs DK, Casler MD (1998). Performace of Lactating Dairy Cows fed alfaifa Silage and Perennial Rye Grass Silage. Journal of Dairy Science 81:162-168.

Hotz C, Gibson RS (2007). Traditional Food Processing and Preparation Practices to Enhance the Bioavailability of Micronutrients in Plant–based Diets. Journal of Nutrition 137(4):1097-1100.

Jaenicke HJ, Gemmy I, Zeledon H, Kahanne R (2009). International Symposium on Underutilized Plants for Food Security Nutrition, Income and Sustainable Development. Vol. 2, International Society for Horticultural Science, Arussha, Tanzania.

Jones L (1965). Veterinary Pharmacology and Therapeutics. 3rd Ed., Lowa: Lowa State University Press pp. 5-15.

Klu GYP, Amoatey HM, Bansa D, Kumaga FK (2001). Cultivation and Use of African Yam Bean (*Sphenostylis stenocarpa*) in the Volta Region of Ghana. Journal of Food Technology in Africa 6(3):74-77.

Marfo EK, Simpson BK, Idowu JS, Oke OL (1990). Effect of Local Food Processing on Phylate Level in Cassava, Cocoyam, Yam, Maize, Sorghum, Rice, Cowpea and Soya Beans. Journal of Agriculture and Food Chemistry 38:1580-1585.

Minton BL (2009). Fermented Soybean is only Soybean Food fit for Human Consumption. Natural News, February 3rd, P 2.

Novak WK, Haslberger AG (2000). Substanting Equivalence of Antinutrients and Inherent Plant Toxins in Genetically Modified Foods. Food and Chemical Toxicology 38:473-483.

Ogungbenle HN (2006). Chemical Compostion, Functional Properties and Amino Acid Composition of Some Edible Seeds. La Rivista Italiana Delle Sostanze Marso 83:81-84.

Ogunlade I, Iiugbiyin A, Osasona AI (2011). A. Comparative Study of Proximate Composition, Antinutrient Composition and Functional Properties of *Pachira glabra* and *Afzelia africana* Seed Flours. African Journal of Food Science 5(1):32-35.

Okigbo BN (1973). Introducing the Yam Bean (*Sphenostylis stenocarpa)* (Hochst ex. A. Rich) Harms. *In:* Processing of the 1st 11TA Grain Legume Improvement Workshop 29 October – 2 November, Ibadan pp. 224-238.

Olaofe O, Adeyemi FO, Adediran GO (1994). Amino Acid, Chemical Composition and Functional Properties of Some Oil Seeds*.* Journal of the Agricultural and Food Chemistry 42(4):879-881.

Olaofe O, Ekuagbere AO, Ogunlade I (2009). Chemical, Amino Acid Composition and Functional Properties of Calabash Seed's Kernel. Bulletin of Pure and Applied Science 28(1-2):13-24.

Olaofe O, Ogunlade I, Jibuah N (2004). Proximate, Mineral Composition and Functional Properties of Pride of Babados (*Caesalpinia pulcherrima*) Seed Flour. *In:* Proceeding of The 27th International Conference of the Chemical Society of Nigeria pp. 130-135.

Omosaiye O, Cheryani M (1979). Low Phylate, Full-Fat Soy Protein Products by Ultra Filatration Aqueous Extracts of Whole Soybeans*.* Cereal Chemistry 56:58-62.

Oshodi AA, Adeladun MOA (1993). Proximate Composition, Nutritionally

Valuable Minerals and Functional Properties of Three Varieties of Lima Bean (*Phaseolus lunatus*) Flour, International Journal of Food Science and Nutrition 43:181-185.

Oyenuga V (1968). Nigeria's Food And Feeding Stuffs, their Chemistry and Nutritive Value. 3rd Ed., Ibadan: Ibadan University Press, Nigeria P 99.

Paul AA, Southgate DAT (1985). Mccane and Widdowsen's. The Compostion of Foods. HMSO/Royal Society of Chemistry, London. pp. 5-7.

Phillips RD (1993). Starchy Legumes in Human Nutrition, Health and Culture. Plants Foods for Human Nutrition 44(3):195-211.

Porter D (1992). Economic Botany of *Sphenostylis* (Leguminosae). Economic Botany 46(3):262-275.

Rice RF, Rice LW, Tindall HD (1986). Fruits and Vegetables Production in Africa*.* Hongkong: Macmillan Publishers. India pp. 264-265.

Saka JO, Afibade SR, Adeniyan ON, Oluwoyo RB, Ogunbodede BA (2004). Survey of Underutilized Grain Legume Production Systems in the Southwest Agricultural Zone of Nigeria. Journal of Agricultural and Food Science 6:93-108.

Sasanam S, Paseephol J, Moongngarm A (2011). Comparison of Proximate Compositins Resistant Starch Content, and Pasting Properties of Different Colored Cowpea (*Vigna unguiculata*) and Red Kidney Bean (*Phaseolus vulagaris*). World Academy of Science, Engineering and Technology 81:525-529.

Stumpf PK, Conn EE (1981). Secondary Plant Products. In: The Biochemitry of Plants (Conn. Ed). New York: Academic Press pp. 33-40.

Temple VJ, Odewumi L, Joseph K (1991). Soybeans and Soybeans based iets. *In:* Proceedings of the 3rd Regional Workshop on Rural Development, Jos. pp. 45-50.

Wang J, Mazza G (2002). Effects of Authocaynins and other Phenolic Compounds on the Production of Tumor Necrosis Factor Alpha in LPS/IFN–gamma-activated RAW 264.7 Macrophages. Journal of Agriculture and Food Chemistry 50:4183-4189.

Weaver LT (1994). Feeding the Weanling in the Developing World Problems and Solutions. International Journal of Food Science and Nutrition 45:127-134.

Welch RM, Graham RD (2004). Breeding for Micronutrients in Staple Food Crops from a Human Nutrition Perspective. Journal of Experimental Botany 55(396):353-364.