Journal of Fisheries
Volume 2 Issue 3 Pages: 151–156 December 2014
Peer Reviewed | Open Access | Online First

eISSN 2311-3111
pISSN 2311-729X

DOI: https://doi.org/10.17017/j.fish.83

Original article

Nutritional and anti-nutrient composition of Karaya gum tree (*Sterculia setigera*) seed: a potential fish feed ingredient

Kehinde Moruff Adelakun[1] • Moshood Keke Mustapha[2] • Damilare Ibukun Ogundiwin[3] • Ambrose A Ihidero[1]

[1] *Federal College of Wildlife Management, P.M.B. 268, New Bussa, Nigeria*

[2] *Department of Zoology, University of Ilorin, Ilorin, Nigeria*

[3] *Department of International Fisheries Management, Arctic University of Tromsø, Norway*

Correspondence: Kehinde Moruff Adelakun, Federal College of Wildlife Management; Email: adelakunkehinde@gmail.com

Received: 02 Jul 2014, Received in revised form: 02 Sep 2014, Accepted: 12 Sep 2014, Published online: 09 Nov 2014

Citation: Adelakun KM, Mustapha MK, Ogundiwin DI and Ihidero AA (2014) Nutritional and anti-nutrient composition of Karaya gum tree (*Sterculia setigera*) seed: a potential fish feed ingredient. Journal of Fisheries 2(3): 151-156. DOI: 10.17017/j.fish.83

Abstract

The nutritional and anti-nutritive composition of Karaya gum tree (*Sterculia setigera*) seed collected from Federal College of Wildlife Management estate, New Bussa, Nigeria was evaluated from October to December, 2013 with the aim of providing data that will guide the effective utilization and inclusion of this under exploited tropical plant seed in fish feed formulation. The seeds were washed, dried, grounded and analyzed for the proximate composition, vitamin and mineral contents as well as the anti-nutritive factors using standard procedures. The result showed that the mean values for the proximate composition were: moisture 5.20%, ash 3.95%, fat 26.03%, fiber 6.15%, protein 13.39% and carbohydrate 45.27%. The plant also contained vitamins and relatively adequate essential mineral elements of nutritional importance of macro elements such as calcium, potassium, sodium, magnesium and micro elements of iron, manganese, zinc and copper. Some anti-nutritional factor such as; alkaloids, phytate, cardiac glycosides, flavonoids, steroids and trace of oxalate were also found in the plant, but their composition will pose no serious nutritional problem if well processed before its inclusion in fish diet and could therefore be a cheap source of raw materials for the fortification applications in various fish feed formulations.

Keywords: Anti-nutrient, fish feed, *Karaya* gum tree, *Sterculia setigera*

INTRODUCTION

Fish is often the cheapest source of animal protein and is, therefore, important in the diets of the lowest income group (Allison 2001). In the late 20th century, a "blue revolution" (Coull 1993) has been witnessed with aquaculture regarded as the world's fastest growing food production system (Kureshy *et al.* 2000). However, high quality feed is required to meet the expanding aquaculture production system. Conversely, energy feedstuffs such as maize, cassava, millets are scarce; thereby limiting the availability of the energy based feed ingredients. Thus, there is competition for these feed ingredients between animals and humans, making them more expensive and their inclusion in fish diet also increases the cost of fish production.

To meet the protein demand in developing countries where animal protein intake is also grossly inadequate and relatively expensive, intensive research effort is geared towards finding alternative sources of protein from underutilized grain legume seeds (Adaparusi 1994, Fagbenro 1999, Osuigwe 1999). Although grains and grain products are the main nutrients sources in the diets of cultivated fishes and other livestock (Durunma *et al.* 2000), an attempt at fulfilling the energy requirement of these animals through the use of wild plant seed could probably ameliorate the stiff competition with cereals and grains. One of these plants is *Sterculia setigera*.

S. setigera Del. (Family: Sterculiaceae) is known by different indigenous cultural communities in Nigeria: Hausa– "Kukuki"; Nupe– "Kokongiga"; Fulani– "Bo'boli"; Kanuri– "Sugubo"; Yoruba– "Ose-awere", "eso funfun"; Etulo– "Idafu"; Idoma– "Ompla", "Upula"; Igede– "Upuru"; Igala– "Ufia"; Tiv– "Kume-ndul", "Kumenduur" (Adjanahoun *et al.* 1991; Igoli *et al.* 2002, 2003, 2005; Tor-Anyiin *et al.* 2003; Keay 1989; Keay *et al.* 1964; Agishi 2004). It is a savannah tree, widespread in savannah areas of tropical Africa. The seeds are with yellow aril and the tree is found in open savannah woodlands, often characterized by stony hills (Adjanahoun *et al*. 1991, Keay *et al*. 1964, Agishi 2004).

The quality of a food depends upon the presence of relative concentrations of various nutrients such as proteins, fat, carbohydrate, vitamins and minerals (Gopalan *et al*. 2004). However, the availability of these nutrients after ingestion also depends on the anti-nutritional factors present in the seeds (Ladeji *et al.* 2004). Though, Ighodalo *et al.* (1993) and Idu *et al.* (2008) investigated nutritional content of *S. setigera,* but their reports are contradictory. This and lack of data on both their vitamin composition and the anti-nutritional factors has limited the prospect of it utilization as fish feed. Therefore, the need to evaluate the proximate, mineral, vitamins and anti-nutrient composition of *S. setigera* seed is worthy of investigation for its potential ingredient for fish feed production.

METHODOLOGY

Collection of sample plant: Dried seed of Karaya gum tree were collected bi-monthly from October to December, 2013 from Federal College of Wildlife Management Estate in New Bussa, Niger State, Nigeria. The plant was identified with the aid of keys compiled by Sacande *et al.* (2007) and registered in the herbarium of Forestry Research Institute of Nigeria (FRIN), Ibadan. The seeds were cleaned to remove dirt, sun-dried for three days and finally ground in an electric mill (National Food Grinder, Model MK308, Japan). It was then passed through a 40 mesh sieve and stored in a plastic container at a room temperature. The proximate and phytochemical analysis were carried out in the laboratory of National Institute for Freshwater Fisheries Research (NIFFR), New Bussa, Niger State, Nigeria while the mineral and vitamins analysis were carried out in the laboratory of Institute for Agriculture Research and Training (IAR&T), Moor plantation, Ibadan, Oyo State, Nigeria.

Proximate analysis: The chemical analysis of percentage crude protein, crude fiber, moisture, ash, fat and carbohydrate were carried out using methods described by AOAC (1990). All determinations were done in triplicates.

Mineral analysis: The mineral contents namely, calcium, magnesium, copper, manganese, iron, zinc, were determined using dry ashing procedure and Atomic Absorption Spectroscopy (AAS) (AA 800, Perkin-Elmer Germany) as described by AOAC (1990). Sodium and potassium were determined by flame emission techniques.

Vitamins analysis: Different vitamins such as: Vitamin A, Vitamin B_1, B_2, B_3, B_{12}, Vitamin C, Vitamin E and Vitamin K; were also analyzed according to the Methods of Vitamin Assay (FEFANA 2006).

Anti-nutritional analysis: Anti-nutritional evaluation were carried out and the percentage proportion of the respective anti-nutritive factors such as tannins, saponins, oxalate, alkaloids, flavonoids, steroids and cardiac glycosides were evaluated according to the standard chemicals procedures (Harbornes 1984).

Statistical analysis: All data generated were analyzed using descriptive statistic as described by Olawuyi (1996).

RESULTS AND DISCUSSION

Proximate composition of S. setigera seed: The result of the proximate composition of the Karaya gum tree (*S. setigera*) seed is presented in Table 1. The proximate composition in the study is in consonance with report of Ighodalo *et al.* (1993), though it contradict the proximate composition of 21.40% protein, 11.58% fat, 7.73% crude fiber, 21.03% carbohydrate and 16.42% moisture reported by Idu *et al.* (2008) on the same species. The moisture and fiber content are comparable to (7.50%, 4.51%, 6.00%, and 5.26%) and (6.57%, 5.21%, 6.27%, and 5.41%) recorded for *Cassipourea congoensis* (Tunti), *Nuclea latifolia* (Luzzi), *Detarium macrocarpum* (Tallow), and *Gmelina arborea* (Gmelina) in the same order as indicated by Nkafamiya *et al.* (2007).

Table 1: Proximate composition of Karaya gum tree (*Sterculia setigera*) seed

Nutrients	*Mean composition±SD (%)*
Moisture content	05.20±0.15
Ash content	03.95±0.30
Crude fiber	06.15±0.13
Crude protein	13.39±0.23
Crude fat	26.03±0.15
Carbohydrate	45.27±0.05

The values are mean±standard deviation of triplicate determination expressed in dry weight basis

Vitamins composition of S. setigera seed: The result in Table 2 shows that the sample contains different types of essential vitamins needed for fish growth (Halver 2002) in different proportion. Among vitamins found in the study

sample analysis are: vitamin A, B_1, B_2, B_6, B_{12}, and E. The result revealed that vitamin B_{12} has the highest of 5.09g/100g and vitamin A has the lowest value of 0.708µg/100mg. However, the presence of these essential vitamins means that Karaya gum tree seed could be used as a nutritionally valuable ingredient to improve fish health and growth performance.

Table 2: Vitamins composition of Karaya gum tree (*Sterculia setigera*) seed

Vitamin	*Mean composition±SD*
Vitamin A (µg/g)	0.71±0.01
Vitamin B_1 (g/100g)	1.28±0.14
Vitamin B_2 (g/100g)	3.17±0.16
Vitamin B_6 (g/100g)	3.99±0.23
Vitamin B_{12} (g/100g)	5.09±1.03
Vitamin E (µg/g)	1.08±0.12

The values are mean±standard deviation of triplicate determination expressed in dry weight basis

Minerals composition of Karaya gum tree (Sterculia setigera) seed: The results of mineral analysis revealed the presence of macro nutrients such as Calcium, Magnesium, Potassium and Sodium in $mgg^{-1}$are shown in Table 3a. Other minerals (micro nutrients) detected includes; iron, manganese, zinc and copper in parts per million (ppm) are shown in (Table 3b).

Table 3a: Macro-mineral Composition of Karaya gum tree (*Sterculia setigera*) seed

Elements	*Mean composition±SD (mg/g)*
Calcium	150.21±9.39
Magnesium	35.10±2.10
Potassium	21.00±0.44
Sodium	73.00±1.45

The values are mean±standard deviation of triplicate determination expressed in dry weight basis

Table 3b: Micro-mineral Composition of Karaya gum tree (*Sterculia setigera*) seed

Elements	*Mean composition±SD (mg/kg)*
Iron	2.31±0.01
Manganese	0.62±0.60
Zinc	1.21±1.20
Copper	1.01±0.07

The values are mean±standard deviation of triplicate determination expressed in dry weight basis

The presence of these essential nutrients and minerals imply Karaya gum tree seed could be utilized as a fish feed ingredient. Calcium which was higher in the seed is an important element in bone formation, blood and extracellular fluid; it is necessary for the normal functioning of cardiac muscles, blood coagulation and the regulation of cell permeability while sodium and potassium that take part in ionic body balance and maintain moderate tissue excitability (Lall 2002). Magnesium is an essential component of bone, cartilage and the crustacean exoskeleton, and through its role in enzyme activation, magnesium (like calcium) stimulates muscle and nerve irritability (contraction), is involved in the regulation of intracellular acid-base balance, and plays an important role in carbohydrate, protein and lipid metabolism (Gafar and Itodo 2011). The micronutrients which are found in small quantities in the species are essential component of many enzyme systems such as cytochrome oxidase, lysyl oxidase and ceruloplasmin, an iron-oxidizing enzyme in blood (Mills 1981). The observation of anaemia in copper deficiency may probably be related to its role in facilitating iron absorption and in the incorporation of iron into haemoglobin (FAO/WHO 1974). Zinc is a component of many metalloenzymes, including some enzymes which play a central role in nucleic acid metabolism (Atukorala and Waidyanatha 1987). In addition, zinc is a membrane stabilizer and a stimulator of the immune response (Hambidge 1978). Its deficiency leads to impaired growth and malnutrition (Prasad 1981). Though, Manganese was comparatively lower in *S. setigera* (Karaya gum tree) seed, it is essential for hemoglobin formation (Critchley 1986), but excess is harmful. Iron was comparatively high in the seed useful in prevention of anaemia and other related diseases (Oluyemi *et al*. 2006).

Anti-nutritional composition of S. setigera seed: The result of phytochemical analysis shows that some anti-nutritive factors such as alkaloids, cardiac glycosides, phytate, flavonoids, steroids and trace of oxalate were detected (Table 4); these factors may not pose any serious nutritional problem for use of Karaya gum tree seed if processed. The germinated seeds were devoid of tannins and saponin, whereas the total alkaloids, phytate and cardiac glycosides activities can considerably decreased on cooking (D'Cunha *et al.* 2009). The anti-nutrients of flavonoids and steroids were low, while oxalate presence is trace. It is established that only high content of these anti-nutrients prevent the absorption of nutrient which are essential for metabolism of the body (Ologhobo 2004). High content of the anti-nutrients would also affect homeostasis of zinc and iron, inhibit enzymatic digestion of proteins by forming complexes with large quantities of protein and would therefore be toxic to the body (AOAC 1999, Munro and Bansir 1969).

Table 4: Anti-nutritional compositions of Karaya gum tree (*Sterculia setigera*) seed

Phytochemical/anti-nutrients	*Status*
Tannins	-
Saponin	-
Oxalate	Trace
Alkaloids	++
Flavonoids	+
Steriods	+
Cardiac glycosides	++
Phytate	++

-, absent; +, present; ++, highly present

CONCLUSION

The result of the nutrients composition of proximate and mineral analysis of the Karaya gum tree (*S. setigera*) seeds indicates that it could find be included in fish feed that requires relatively high source of carbohydrate. It has potential for use as source of energy and minerals in fish and livestock diets. The crude fat content and carbohydrate shows that the seed could provide sufficient energy thereby prevent the utilization of protein meant for growth as source of energy. The low moisture content of Karaya gum tree seed will discourage microbial growth, decrease the rate of enzymatic reaction and hence deterioration will be very low. The seed also contain essential vitamins necessary for fish growth, maintenance and reproduction. However, the value of vitamin A is relatively low, but not too low for plant based vitamins. By inference, the seed will supplement other sources of dietary minerals in fish if eaten, and since its macro nutrients content is very high, it implies that adequate inclusion of the seeds in fish diet would satisfy the needed energy daily allowance in conjunction with other sources of dietary minerals and reduce competition between man and animal for energy feedstuffs.

Some anti-nutritive factors such as alkaloids, cardiac glycosides, phytate and trace of oxalate were detected in the plant and may not pose any serious nutritional problem in consumption of the seed if well processed before is inclusion in fish diets. However, further work is needed to investigate the processing method that will reduce the anti-nutritional factors to the barest minimum before its inclusion in fish feed. The addition of *S. setigera* in fish ingredients will make fish feed to be cheaper and also add to the growing lists of plant source for fish feed.

REFERENCES

Adeparusi EO (1994) Evaluation of the nutritive potential of cooked pigeon pea (*Cajanus cajan*) meal as a protein source for *Clarias gariepinus* fingerlings. Journal Agricultural Science Technology 1: 48-57.

Adjanahoun EM, Ahyi RA, Ake-assi L, Dramane K, Elewede JE, Fadoju SO, Gbile ZO, Goudote E, Johnson CLA, Eita A, Morakinyo O, Ojewole JAO, Olatunji AO, and Sofowora EA (1991) Traditional Medicine and Pharmacopoeia: Contribution to Ethnobotanical Floristic Studies in Western Nigeria. Organization of African Unity Scientific, Technical and Research Commission, OAU/STRC Pub. Lagos, Nigeria. 420 pp.

Agishi EC (2004) Etulo, Idoma, Igede, Tiv and Hausa names of plants. AGITAB Pub. Ltd., Makurdi, Nigeria. 188 pp.

Allison EH (2001) Big laws, small catches: global ocean governance and the fisheries crisis. Journal of International Development 13(7): 933-950. DOI: 10.1002/jid.834

AOAC (Association of Official Analytical Chemists) (1990) Official methods of analysis of AOAC International, Gatithersburg, MD, USA. pp. 205-228.

AOAC (Association of Official Analytical Chemists) (1999) Official Method of Analysis. 2nd edition, Association of Official Analytical Chemists, Washington D.C., pp. 807-928.

Atukorala TMS and Waidyanatha U de (1987) SZinc and copper content of some common foods. Journal of the National Science Council of Sri Lanka 15(1): 61-69.

Coull JR (1993) Will a blue revolution follow the green revolution? The modern upsurge of aquaculture. Area 25(4): 350-357.

Critchley M (1986) In Butterworths Medical Dictionary, (Editor-in-Chief) ELBS, UK, p. 1035.

D'Cunha M, Sridhar KR, Young CC and Arun AB (2009) Nutritional evaluation of germinated seeds of coastal sand dune wild legume *Canavalia cathartica*. International Food Research Journal 16: 249-260.

Durunma CS, Udebibie ABI and Anyanwu GA (2000) Combination of maize/sorghum and cassava tuber meal as a substitute for maize in diet of laying hens. In: Proceedings of the 25th Annual Conference of the Nig. Soc. Anim. Prod. Umudike.

EU Feed Additives and Premixtures Association (Fefana) (2006). Method of Analysis of Vitamins, Provitamins and Chemically well defined substances having a similar biological effect, Part 1 "*Tel Quel*". pp. 6-45. www fefana.org.

Fagbenro OA (1999) Equi-protein replacement of soybean meal with winged bean meals in diets for the African clariid catfish, *Clarias gariepinus* (Burchell). Journal of Aquaculture in the Tropics 14: 93-99.

FAO/WHO (1974) Hand Book on Human Nutritional Requirements, Food Agric. Organisation of United Nation Nutritional Studies 28: 63-64.

Gafar MK and Itodo AU (2011) Proximate and mineral composition of hairy indigo leaves. Electronic Journal of Environmental, Agricultural and Food Chemistry 10(3): 2007-2018.

Gopalan C, Sastri BVR, and Balasubramanian SC, (2004) Nutritive Value of Indian Foods. National Institute of Nutrition, Indian Council of Medical Research, Hyderabad, India. pp. 2-58.

Halver JE (2002) The vitamins. In: Fish Nutrition. JE Halver and RW Hardy (eds.), 3rd edition. London. Academic Press. pp. 61-141

Hambidge KM (1978) Zinc as membrane stabilizer. Journal of Human Nutrition 32: 99-100.

Harborne JB (1984) Phytochemical Methods. A guide to modern techniques of plant analysis. 2nd edn. Chapman and Hall, London. pp. 49-288.

Idu M, Uzoekwe S and Onyibe HI (2008) Nutritional Evaluation of *Sterculia setigera* seeds and pod. Pakistan Journal of Biological Sciences 11(1): 139-141. DOI: 10.3923/pjbs.2008.139.141

Ighodalo C, Eromosele C and Eromosele O (1993) Studies on the chemical composition and physico-chemical properties of seeds of some wild plants. Plant Foods Human Nutrition 43: 251-258.

Igoli JO, Igwue IC and Igoli NP (2003) Traditional Medicinal Practices amongst the Igede people of Nigeria. Journal of Herbs, Spices and Medicinal Plants 10(4): 1-10.

Igoli JO, Ogaji OG, Tor-Anyiin TA, Igoli NP (2005) Traditional Medicine Practice amongst the Igede people of Nigeria. Part II. African Journal of Traditional, Complementary and Alternative Medicine 2(2): 134-152.

Igoli JO, Tor-Anyiin TA, Usman SS, Oluma HOA and Igoli NP (2002) Folk medicines of the lower Benue Valley of Nigeria. In: Series Recent Progress in medicinal Plants vol. 7-Ethnomedicine and Pharmacognosy II. Eds. V. K. Singh, J. N. Govil, Shamima Hashmi and Gurdeep Singh. Sci. TECH. Pub., USA. (Chap). 23: 327-338.

Keay RWJ (1989). Trees of Nigeria. Clarendon Press Oxford 476 pp.

Keay RWJ, Onochie CFA and Stanfield DP (1964) Nigerian Trees vol. II. Department of Forest Res. Ibadan, Nigeria. 495 pp.

Kureshy N, Davis DA and Arnold CR (2000) Partial replacement of fish–and bone-meal in practical diets for juvenile red drum. North American Journal of Aquaculture 62(4): 266-272. DOI: 10.1577/1548-8454(2000)062<0266:PROFMW>2.0.CO;2

Ladeji O, Akin CU and Umaru HA (2004) Level of antinutritional factors in vegetables commonly eaten in Nigeria. African Journal Natural Science 7: 71-73.

Lall SP (2002) The minerals. In: Fish nutrition. JE Halver and RW Hardy (eds.), 3rd edition. London. Academic Press. pp. 259-308.

Mills CF (1981) Symposia from the XII International Congress on Nutrition. Progress in Clinical and Biological Research 77: 165-171.

Munro A and Bansir O (1969) Oxalate in Nigerian vegetables. West African Journal of Biological and Applied Chemistry 12: 14-18.

Nkafamiya II, Modibbo UU, Manji AJ and Haggai D (2007) Nutrient content of seeds of some wild plants. African Journal of Biotechnology 6(14): 1665-1669.

Olawuyi JF (1996) Biostatistics: A foundation course in health sciences. 1st Edition. University College Hospital, Published by Tunji Alabi Printing Co. Total Garden, Ibadan, Nigeria, pp. 1-221.

Ologhobo DA (2004) Anti-nutritional factors in feeds and feed stuffs and effect of processing. Report of the study at the Institute of Animal Nutrition, University of Hohenheim Stuttgart, Germany.

Oluyemi EA, Akilua AA, Adenuya AA and Adebayo MB (2006) Mineral contents of some commonly consumed Nigerian foods. Science Focus (11): 153-157.

Osuigwe DI (1999) Growth responses and nutrient utilization of *Oreochromis niloticus* (L) fed on diets containing *Mucuna* seed meal. Journal Agriculture, Biotechnology and Environment 1(2): 47-52.

Prasad AS (1981) Symposia from the XII International Congress on Nutrition. Progress in Clinical and Biological Research 77: 172–177.

Sacande M, Sanon M and Schmidt L (Ed.) (2007) *Sterculia setigera* Delile. Seed Leaflet (134).

Tor-Anyiin TA, Sha-'Ato R, and Oluma HOA (2003) Ethnobotanical survey of anti-malarial medicinal plants amongst the Tiv people of Nigeria. Journal of Herbs, Spices and Medicinal Plants 10(3): 61-74.