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Nutritional Value of *Cassa occidentalis* and its Potential Contribution to Aquaculture Feed

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Abstract: This study was carried out to assess the nutrient composition of *Cassa occidentalis* as a protein supplement source in the diets of fish to enhance their productivity. Proximate composition results showed high dry matter (95.65%), crude fiber (11.92%), nitrogen free extract (61.88%) and calorific value (1483.26 kcal/100 g), but low ether extract (3.69%) and crude protein (18.74%). The amino acid profile reveals a high concentration of leucine (6.23 g/100 g protein), histidine (2.27 g/100 g protein), proline (3.36 g/100 g protein) and glycine (3.51 g/100 g protein), Arginine (4.83 g/100 g protein) while the rest of the amino acids were low concentration in the raw seed. The concentration of anti-nutrients in the legume seeds recorded low values (0.99 and 0.14% and 0.28 mg/100 g) for Phytic acid, tannin and phytate respectively, while oxalate and cyanogenic glycoside levels were high. *C. occidentalis* seed is a good source of amino acid but it contained some antinutritional factors that must be deactivated for effective utilization in fish feed and also processing of the seeds will definitely improve the crude protein content.

Key words: *Cassa occidentalis*, nutrient composition, amino acid, antinutritional factor

INTRODUCTION

Aquaculture is increasingly becoming one of the fastest growing aspect of the agricultural industry worldwide (FAO, 2004). It aims at attaining sustainable fish production at a minimum possible cost in the shortest possible time (Eruvbetine *et al*., 2002). Aquaculture production has proved to be difficult in developing countries due to the dependence on imported feeds which is expensive and local feeds made from some conventional feedstuff are equally expensive because of the high demand of conventional feed ingredients by both man and other livestock and also by agro allied industries (Ogunlade, 2007). The fact that feed is one of the factors in aquacultural enterprise that determines its profitability and viability, accounts for about 60 and 70% of its operations (Gabriel *et al*., 2007). This has motivated the research for cheap and locally available or improvised feed ingredients that are unsuitable for direct human consumption but can serve as alternative energy feed for fish with the aim of reducing the cost of production without compromising feed quality.

With the advent of non-conventional feed resources found abundantly and relatively cheaper that can meet the nutrient requirements of fish, this problem can be addressed (Ferouz *et al*., 2012). Non Conventional Feed Resources (NCFRs) are feeds that are not usually common in the market and are not the traditional ingredients for commercial fish feed production (Devendra, 1988; Madu *et al*., 2003) and these include host of plants and animals by-products. NCFRs are credited for being non competitive in terms of human consumption, very cheap to purchase, by-products or waste products from agriculture, farm made feeds and processing industries and are able to serve as a form of waste management in enhancing good sanitation. Example of some non-conventional feed resources that has been researched on include feedstuffs from animal (maggot, silkworm, earthworm, termite, tadpoles, snail etc.), plant wastes (brewers waste, jack bean, soybean meal, groundnut cake, cottonseed meal, cajanus, duckweed, rice bran, maize bran, palm kernel cake, etc.) and wastes from animal sources and processing of food for human consumption such as feathers, blood, animal dung, offal, fish silage, bone, visceral) (Devendra, 1988; Omitoyin and Faturoti, 2000). However there is still need for more effort on some of the less demanded legumes, legumes commonly regarded as weed on their possible use in fish feed production. Recently some legume grains which were tested in livestock and poultry and monogastrics such as fish were faba beans (*Vicia faba*) (Gous, 2011); green peas (*Pisum sativum*) (Ganzon-Naret, 2013); sunflower seed meals (*Helianthus annuus*) (Olivera-Novoa *et al*., 2002; Akintayo *et al*., 2008); kidney beans-*Phaseolus vulgaris* (Absalom *et al*., 1999) and Pigeon pea (*Cajanus cajan*) (Obasa *et al*., 2003; Ganzon-Naret, 2014).

Cassa occidentalis (Syn. Senna occidentalis (L.) is also one of the legume grain which can be tested as feed ingredient for fish feed. It belongs to the family Fabaceae (Leguminosae) and sub-family Caesalpinioideae (Arora

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and Kaur, 2007). Having the following common names Coffee senna, ant bush, arsenic bush, negro coffee, Nigerian senna, septicweed, sickle pod, stink weed, stinking pea, stinkingweed. And also called Kasmard in Sanskrit, Kasondi in Hindi. It is a small, erect, annual herb that can be up to 2 m tall and is found abundantly in the rain forest and tropical areas of the world. Its seeds, found in long seed pods, are sometimes roasted and made into coffee-like beverage. *C. occidentalis* has a rich history in natural medicine and the parts of the plant used include roots, leaves and seeds (Saraf, 1994). Leaves of *C. occidentalis* plant have ethno medicinal importance. The paste of the leaves is externally applied on healing wounds, sores, itch, bone fracture, ringworm, skin diseases and throat infection (Jain *et al*., 1998; Burkill, 1995).

The present study, therefore, evaluated the nutritional potential of *C. occidentalis* to be used as fish feed ingredients. The justification of this work is that the seeds of *C. occidentalis* are locally available, found in abundance and are not directly consumed by humans. Therefore, it is envisaged that transformation of *C. occidentalis* into high quality fish feed in low-input pond culture systems can make a significant contribution to improving fish production.

MATERIALS AND METHODS

Location of the study area and collection of seeds: The matured seeds of *C. occidentalis* were harvested from wild plants growing in Dutsin-Ma Local Government Area, Katsina State in North-Eastern Nigeria. Dutsin-ma Local Government Area is located on Latitude 12° 27'18"N and longitude 7° 29'29"E. The plants were previously identified by a plant taxonomist at the Botany Unit, Department of Biological Sciences of the Federal University, Dutsin-Ma, Nigeria.

Preparation of the seeds: Fresh pods of *C. occidentalis* was collected and air dried before it was de-husked and the seeds ground to powder using a laboratory blender and sieved using a 1 mm mesh sieve then taken to the laboratory for amino acid analysis, proximate composition and anti nutrients. Each analysis was done in duplicate and the mean of the two values was presented as the result.

Proximate composition determination: The sieved powder was used for the analysis of Crude Protein (CP), Crude Fibre (CF), Ether Extract (EE), Nitrogen Free Extract (NFE), moisture content and ash. This was done according to the methods of Association of Official Analytical Chemist (AOAC, 2006).

Amino acid profile determination: Amino Acid Profile of the sample was determined using methods described by Shahidi *et al.* (1999). The sample was dried to constant weight, defatted, hydrolyzed, evaporated in a rotary evaporator and loaded into the Technicon Sequential Multi-sample Amino Acid Analyzer (TSM) using ion-exchange chromatography.

Anti nutritional factors determination: Phytates were determined according to the methods described by Muhammad *et al.* (1986) using chromatophore reagent. Tannins were analyzed using the modified Vanidlin-HCl method as described by Zia-ul-Haq *et al.* (2007). One gram of test sample was treated with methanol (28°C, 12 h) with occasional shaking. Decanted methanol was made up to 25 mL and filtered (Whatman No. 1). One milliliter of the extract was treated with 5 mL of the reagent mixture (1:1, 4% vanillin in methanol and 8% concentrated HCl in methanol). The colour developed was read at 500 nm after 20 min, using catechin as a standard, with a spectrophotometer. The tannin contents were then determined from standard curves. Estimation of oxalates was by the procedures described by Tuleun and Patrick (2007).

RESULTS

The dry matter content of the dried seeds was 95.65% while the percentage crude protein, Ether extract, Crude Fibre, Nitrogen Free Extract and ash contents of *C.occidentalis* were 18.74, 3.69, 11.92, 61.88 and 3.78% dry matter, respectively. The calorific value of *C. occidentalis* was 1485.28 kcal/100 g (Table 1).

Phytic Acid, tannin, oxalate, Cyanogenic glycoside and phytate contents were 0.985, 0.14 and 3.715%, 7.215 and 0.28 mg/100 g Dry Matter, respectively (Table 2).

The concentration of non essential amino acid (NEAA) content of *C. occidentalis* shows that Asp, Ser, Glu, Pro, Gly and Ala contents were 8.63, 3.31, 13.10, 3.36, 3.51 and 4.03 g/100 g protein. The total non-essential amino acids (TNEAA) content was 35.94. This was 54.54% of the total amino acid concentration in a 100 g of protein. The essential amino acids (EAA) was 3.40, 3.20, 0.53, 3.01, 1.04, 2.54, 6.23, 2.70, 3.54 g/100 g protein for Lysine, Threonine, Cystine, Valine, Methionine, Isoleucine, leucine, Tyrosine, Phenylalanine, respectively (Table 3). The Total essential amino acid (TEAA) content was 26.19. This was 35.76% of the total amino acid concentration in 100 g of the protein. The semi-essential amino acid content shows that histidine and arginine were 2.27 and 4.83 g/100 g protein, respectively while the total semi-essential amino acid content was 7.10. This value was 9.70% of the total. Among all the amino acids detected, glutamic acid was predominant while cystine was the least abundant.

DISCUSSION

The ether extract was low compared to values reported for *Senna obtusifolia* (8.00%), *Lablab purpuresus* (9.13%), *M. utilis* (5.90%) and other African bean seeds

Table 1: Proximate composition of raw *C. occidentalis* seeds

Parameters	Concentration (%)
Crude protein	18.74
Ether extract	3.69
Crude fibre	11.92
Ash	3.78
Dry matter	95.65
Nitrogen free extract	61.88
Metabolic energy (kj/100 g)	1485.23

Table 2: Anti-nutrient composition of raw *C. occidentalis* seeds

Parameters	Concentration
Phytic acid (%)	0.99
Tannin (%)	0.14
Oxalate (%)	3.72
Cyanogenic glycoside (mg/100 g)	7.22
Phytate (mg/100 g)	0.28

Table 3: Amino composition of raw *C. occidentalis* seeds

Parameters	Concentration (g/100 g protein)
Aspartic acid	8.63
Serine	3.31
Glutamic acid	13.10
Proline	3.36
Glycine	3.51
Alanine	4.03
Total non-essential amino acid	35.94
Total non-essential amino acid (%)	54.54
Lysine	3.40
Threonine	3.20
Cystine	0.53
Valine	3.01
Methionine	1.04
Isoleucine	2.54
Leucine	6.23
Tyrosine	2.70
Phenylalanine	3.54
Total essential amino acid	26.19
Total essential amino acid (%)	35.76
Histidine	2.27
Arginine	4.83
Total semi essential amino acid	7.1
Total semi essential amino acid (%)	9.70

Table 4: Recommended FAO/WHO essential amino acids provisional pattern

EAA	FAO	*C. occidentalis*
Arg	2.0	4.83
His	2.4	2.27
Ile	4.2	2.54
Leu	4.8	6.23
Lys	4.2	3.40
Met	2.2	1.04
Phe	2.8	3.54
Thre	2.6	3.20
Try	1.4	nd
Val	4.2	3.01

EAA: Essential amino acid, ND: Not determined.
Source: Belschant *et al.* (1975)

(Awawu *et al*, 2014; Abeke *et al.*, 2003; Tuleun and Patrick, 2007; Ajah and Madubuike, 1997) and higher than the ether extract content (2.10 and 1.41%) of pigeon pea reported by Ogundipe *et al.* (2003), Iorgyer (2010), respectively. This could be attributed to the genetic differences as they affect the composition of seeds. Low ether extract value of foods contributes to poor energy content of such material compared to soybean that is an oil bean seed. The low fat content will also help in increasing the shelf life by decreasing the chances of rancidity and will also contribute to the low energy value. The low oil content, *C. occidentalis* may not be suitable as a commercial source of oil, reducing the competition of *C. occidentalis* from vegetable oil industries.

The dry matter value was high (95.65%). The high dry matter value was similar to values obtained for most raw seeds of legumes like *Lablab purpuresus* (95.97%) and *Milletia obanensis* (91.55%) (Abeke *et al.*, 2003; Umoren *et al.*, 2005). This will ensure long term storage of the seeds and also reduce the cost of handling.

The crude protein content of *C. occidentalis* seed can be regarded to be very low and it fell below the 20% crude protein content regarded by Olukunle (2004) as protein based diet. Although this was higher than that reported for its close relative *S. obtusifolia* (11.55%) (Awawu *et al.*, 2014) but when comparable to the value for *Afzelia Africana* (24.00%) (Obun and Ayanwale, 2006), Lablab purpureus (23.29%), raw African locust bean (*Parkia filicoidea*) (21.02%) and *Mucuna utilis* (26.90%) the protein content of *C. occidentalis* is low (Abeke *et al.*, 2003; Ari and Ayanwale, 2012; Tuleun *et al.*, 2008). However processing of the seeds may increase the protein content; this is in line with result obtained by Amaefule and Nwagbare (2004) who reported increase in crude protein of 27.34 and 27.12% in both boiled and toasted *Cajanus cajan*, respectively. The ash content of the seed is as low when compared to *S.obtusifolia* (4.00%) and *Cajanus cajan* (5.50%) (Awawu *et al.*, 2014; Amaefule and Nwagbare, 2004). The ash content indicates a rough estimation of the mineral content of the product. *C.occidentalis* has a high metabolizable crude fibre content of 11.92% as compared to 4.19% in *Mucuna cochinchinensu* reported by Ezeagu *et al.* (2003) and 6.30% in *Mucuna Utilis* (Ravindran and Ravindran, 1988). High crude fiber in diets in known to enhance digestibility, slow down the release of glucose into the blood stream, reduce blood cholesterol levels, prevent bowel cancer and atherosclerosis (Salvin *et al.*, 1997). The food energy value was calculated to be 1485.28 kJ 100/g DM based on crude protein, crude lipid and Nitrogen free extract (NFE). The high caloric values were due to the high value in Ether extract and Nitrogen free extract, respectively which are the major contributors to the energy value of foods. This is comparable to previous studies, in the seeds of *Canavalia gladiata* (Vadivel and Janardhanan, 2004). The investigated seed sample has lower energy than the reported value for pulses *Rhychosia fillips* (1593.37kj 100/g DM) and *R. rufescens* (1563.21 kg 100/g DM) (Kalidass and Mohan,

2012) and *Canavalia ensiformis* (1560.3 kj/100 DM) (Doss *et al*., 2011) but the calorific values of the seed sample exceeds energy values of cowpea, -1 green gram, horse gram, moth bean and peas (Rao and Deosthale, 1982), which are in the range of 1318-1394 kJ 100 g DM.

Legumes are important sources of dietary protein in many countries especially the developing ones, but acceptability and utilization has been limited due to the presence of high concentration of certain antinutritional factors (Nowacki, 1980). For this reason, in the present investigation an attempt has been made to detect the presence of certain antinutritional factors in *C. occidentalis*. The phytic acid value of investigated seed samples were found to be low when compared with that of some commonly consumed legumes such as *Dolichos lablab* var. vulgaris (Vijayakumari *et al*., 1995); tribal pulses *Mucuna pruriens* var, utilis (Janardhanan *et al*., 2003) and *Mucuna atropurpurea* (Kamatchi *et al*., 2010). Phytic acid is an important storage form of phosphorus in plant, it is insoluble and it has 12 replaceable hydrogen atoms with which it could form insoluble salts with metals such as calcium, iron, zinc and magnesium.

The tannin content of the investigated sample was relatively lower than the other domesticated legumes like black gram, chick pea, cow pea and green gram (Rao and Deosthale, 1982). Tannins are known to inhibit activities of digestive enzymes and hence, the presence of even low levels of tannins is not desirable from a nutritional point of view. However, in legumes the soaking and cooking process is known to reduce tannins significantly (Vadivel and Pugalenthi, 2008).

Oxalates can bind to calcium present in food thereby rendering calcium unavailable for normal physiological and biochemical role such as the maintenance of strong bone, teeth and as clotting factor in the blood (Ladeji *et al*., 2004). Oxalate may be present as oxalic acid or as insoluble Calcium oxalate which when present in high concentration in diet may increase the risk of renal calcium absorption (Osagie, 1998). The value of 3.72% oxalates obtained for *C. occidentalis* in the present study with an average of 0.55% is above the established toxic level (Umaru *et al*., 2007). The Oxalate content of the investigated seed sample was low when compared to locust bean seeds (4.96%). Also the level of oxalate obtained in the present work was higher compared with the range (0.54 to 0.82%) reported by Ologhobo (2012) for forage legumes in Nigeria. Cyanogenic glycoside on hydrolysis yield toxic hydrocyanide acid (HCN). The cyanide ions inhibit several enzyme systems; depress growth through interference with certain essential amino acids and utilization of associated nutrients. *C.occidentalis* was found with the presence of cyanogenic glycoside but having lesser quantity far below the fatal does (50 mg/kg) (Sarjekar *et al*., 1994). The phytate molecule forms insoluble complexes; thereby making minerals unavailable for absorption. It is also negatively charged at physiological pH and is reported to bind with essential, nutritionally important divalent cations such a Fe, Zn, Mg and Ca etc. (Rimbach *et al*., 1994). Phytate molecule inhibits the digestion of protein and starch and formed complexes with them. (Oatway *et al*., 2001). The phytate level of *C.occidentalis* was low (0.28 mg/100) compared to 3.98 mg/100 g reported for *M. obanensis* (Umoren *et al*., 2005) and 5.0 mg/100 g recorded for raw mung bean seeds (Mubarak, 2005).

The Lysine, Cystine, Valine, Leucine, Methionine, Tyrosine and Phenylalanine contents were low but within the range of most legumes compared to the values reported for Kidney beans, cowpea and many other legumes (Yagoub *et al*., 2008; Khattab *et al*., 2009; Mubarak, 2005; Yanez-Ruiz *et al*., 2009). The essential amino acid needs to be supplemented in aquatic diet for optimum performance when fed with *C. occidentalis* seed meal.

The Total Essential Amino Acid was same as the Food and Agriculture Organization/World Health Organization (1973) reference protein value of 36. Suggesting that no supplementation with other sources especially for fish is needed for it to realize their full potential.

It is observed that glutamic and aspartic acids are the most abundant amino acid in *C. occidentalis,* similar observation has been reported by Olaofe and Akintayo (2000) and Adeyeye (2004). Leucine was the most concentrated Essential Acid (6.23%). *C. occidentalis* has a high amount of Methionine (1.04%) which is greater than that of soyabean (0.54%) (Temple and Aliyu, 1994). Tryptophan was not determined. The total Essential Amino Acid is 35.76%. This is comparable with values obtained from selected oil seeds (gourd seeds, melon and pumpkin) which ranged between 33.3 and 53.6% (Olaofe *et al*., 1993). The amino acid profile of the studied legume suggests that the protein have moderate nutritive value.

When comparing the essential amino acids in this legume flows with the recommended FAO/WHO provisional pattern, the legume was superior with respect to arginine, leucine, phenylalanine and threonine and also adequate in histidine, methionine and threonine. It is only for isoleucine, lysine and valine that supplementation may be required.

Conclusion: *C. occidentalis* could serve as valuable feed ingredient that can be used in the developing countries where feed is a very important limiting factor in aquaculture production. It could serve as a substitute for soyabean, though with lower crude protein and higher crude fibre levels. *C. occidentalis* seed is a good source of amino acid but it contained some antinutritional factors that must be deactivated for effective utilization in fish feed.

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