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NUTRITIONAL CHARACTERIZATION OF *GMELINA ARBOREA*R oxb LEAF AND SEED MEAL AS POTENTIAL AQUACULTURE FEED INGREDIENT

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ABSTRACT
Competition between human and lower animals for available energy and protein supply especially during the dry season has led to shortage of necessary food materials such as maize, sorghum, millet, groundnut, soya beans, and wheat among others. This problem is probably due to the continuous human population increase, to mitigate this challenge, *Gmelinaarborea* leaf and seed meal were nutritionally characterized. The leaves and seeds were collected from the field, sorted, washed, shed-dried and milled separately, and divided into several portions for analysis. Anti-nutrient, proximate, mineral and amino acid content of leaves and seeds were evaluated. The results showed anti-nutritional content were found to be significantly higher in leaf than in seed ($P<0.05$) with Saponin value 99.95±30.00 in leave and 91.63±0.02 in seed. The crude protein content in the leaf (12.59±0.22) differed significantly ($P<0.05$) than in the seed (7.92±0.17). The carbohydrate content was found to be higher in leaf (51.80±0.18) than in seed (27.67±0.23). The mineral content of the leaf and seed contain high level of potassium 11600.00±0.00ppm and 1700.00±0.00 ppm, respectively, there was significant difference mineral contents between both parts, essential and non-essential amino acids were found to be higher in seed than in the leaf with no significant difference ($P>0.05$). Conclusively, Leaves and seeds of *Gmelinaarborea* were good sources of energy characterized by high saponin, flavonoid and carbohydrate (NFE); and also present in the leaf and seed were essential minerals and amino acids. The study, therefore, recommended that anti-nutrient removal processes should be used to reduce anti-nutrient content to a tolerable amount for fish feed formulation.

Keywords: Aquaculture, Characterization, Feed Ingredients, *Gmelinaarborea*, Nutrient.

INTRODUCTION
Aquaculture is rapidly growing globally, approximately half of global aquaculture production is from species that rely on feed input National Research Council [NRC] (NRC, 2011), and aquaculture has become a major global industry and an important source of income and food in many countries. Development of nutritious, efficient and cost-effective driven diets is a major challenge in aquaculture because the major animal protein (fishmeal) used in feed industries is very expensive for fish farmers to purchase, attention is now on grains, nuts and bean seeds and as led to over dependence on them as conventional ingredient of plant origin.

Over the years, competition between higher and lower animals for available energy and protein supply especially during the dry season has led to shortage of necessary food materials such as maize, sorghum, millet, groundnut, soya beans, and wheat among others. This problem is probably due to the continuous human population increase, resulting in great demand for food, particularly foods of animal origin and products as well as subsequent high cost of conventional livestock feeding materials (Smith, 1998). This constitutes shortage in supply, not only of the stable food but also of the animal products leading to mal-nutrition.

In order to control these challenges militating against animal production in Nigeria, several attempts have been made with novel crops and shrubs to produce feed materials for fish and livestock, thus, potentials of non-conventional feed resources need to be explored to address this issues (Amata and Okorodudu, 2013). *Gmelinaarborea*is one of the unconventional materials being explored for the production of feedstuff. *Gmelinaarborea* is an unarmed, moderately sized to large deciduous tree with a straight trunk. It is wide spreading with numerous branches forming a large shady crown, attains a height of 30 m or more and a diameter of up to 4.5 m. Bark smooth, pale ashy-grey or grey to yellow with black patches and conspicuous corky circular lenticels. Inside surface of bark rapidly turns brown on exposure and exfoliates into thick woody plates or scurfy flakes (Orwa *et al*. 2009).

Gmelinaarborea leaf is a non-conventional feedstuffs and it is available all year round. The leaves remain green to larger part of dry season and have been fed to ruminants with appreciable results (Lamidi *et al*., 2009). It is rich in protein and the protein content fall within the range of 10.01-38.4% as reported by Osakwe and Udeogu (2007). Studies have shown that *Gmelinaarborea* leaf can be used as cheap protein supplements which can improve voluntary intake, digestibility and the general performance of animals fed low quality feeds (Kakengi *et al*., 2001).

Studies by Annongu and Folorunso (2003) reported that *G. Arborea* fruit meal when processed and at 30% dietary inclusion in pigs ration has no adverse effects on the haematology and serum biochemical analyses of the animals. In the dry season and to some extent during the raining season, livestock farmers mostly cut and carry *Gmelinaarborea* leaf and tender stem/twig for their animals while other fractions such as: bark, pod and flower are also relished by free roaming ruminants. Earlier studies identified *G. arborea*as one of the most preferred browse species by sheep during the dry season in a part of sub-humid Nigeria (Omokanye *et al*., 2001), but detailed examination of *Gmelina*plant parts, which are readily consumed by livestock, is limited. This study was aimed at nutritionally characterizing (anti-nutrient, proximate, mineral, and amino acid composition) *Gmelinaarborea* leaf and seed meal.

MATERIALS AND METHODS

The Study Area

Leaf and seeds of *G. arborea* were collected from plants growing around Faculty of Social Sciences located at the main Campus, Ahmadu Bello University, Zaria, Nigeria. The plants were identified by a taxonomist at the Herbarium Unit, Department of Botany, Ahmadu Bello University, Zaria, Nigeria.

Sample Preparation

The leaves and seeds from the field were washed, weighed and oven dried at 80°C in a paper bag for 24 hours according to the method described by Ingweye *et al.* (2010a). The dry seeds were ground to powder using a laboratory blender and sieved using a 0.5mm mesh sieve. The flour was stored in screw-capped bottles at room temperature for further analyses (Ingweye *et al.*, 2010a).

Anti-nutrient Determination

The phytate composition was determined using the Reddy and Love (1999) method, Tannins were analysed using the modified Vanidlin-HCl method of (Price *et al.,* 1978). Saponins were extracted and estimated according to the methods of (Shukla and Thakur, 1986), Alkaloid using Harborne (1973) method and flavonoid was determined by gravimetric method (Allen *et al*, 1973).

Proximate Composition Determination

Pulverised samples of leaves and seeds were used for the analyses of crude protein (CP), crude fibre (CF), ether extract (EE), nitrogen free extract (NFE), ash and moisture content were determined according to the standard method of Association of Official Analytical [AOAC] (1999).

Mineral Composition Determination

The ash residues were digested in HNO_3 with 50g/l of $LaCl_3$ (Larrauri *et al*., 1996; Ingweye *et al*., 2010a). Mineral contents were determined using Air/Acetylene Flame Atomic Absorption Spectrophotometer (UNICAM 696 AA Spectrometer),

Amino Acid profile Determination

The Amino Acid profiles in the samples were determined using methods described by Benitez (1989) and AOAC (2006). The known sample were dried to constant weight, defatted, hydrolyzed, evaporated in a rotary evaporator and loaded into the Technicon sequential Multi-Sample Amino Acid Analyser (TSM).

Data analysis

The data for the study were obtained and subjected to statistical analysis using student independent T-test to compare the differences in the mean values of anti-nutrient, proximate, minerals and amino acid profile of leaf and seed using Statistical Analysis System 9.1.3 software

RESULTS AND DISCUSSION

The anti-nutrient content of the leaf and seed of *Gmelinaarborea* is presented in Table 1. Phytate, tannin, alkanoid, saponin, and flavonoid in leaf were 0.37 ± 0.00, 4.45 ± 0.00, 1.66 ± 0.01, 99.95±0.02 and 98.61 ± 0.02%, respectively, in seed, were 0.19 ± 0.00, 2.60 ± 0.03, 2.17 ±0.01, 91.63±0.02 and 85.57±0.02%, respectively. Phytate, tannin and flavonoid were significantly ($P<0.05$) higher in leaf than in seed, while alkaloid content was significantly higher in seed, there was no significant difference in saponin content in leaf and seed, however saponin content was higher in leaf. This present study nutritionally characterised *Gmelinaaeborea* leaf and seed, nutritional evaluation of less important plant materials are imperative to source for alternative and beneficial protein or energy plant source candidate to solve the scourge of hunger, malnutrition in humans and reduce the over dependence on crop product as feed ingredient in the feed industries.

Table 1: Anti-nutritional content of the Leaf and Seed of *Gmelinaarborea* (%)

Variable	Phytate	Tannin	Alkaloid	Saponin	Flavonoid
Leave	0.37±0.00	4.45±0.00	1.66±0.01	99.95±30.00	98.61±0.02
Seed	0.19±0.00	2.60±0.03	2.17±0.01	91.63±0.02	85.57±0.02
P-value	0.00	0.00	0.00	0.51	0.00

Table 2 depicts the proximate composition of the leaf and seed of *Gmelinaarborea.* The moisture, ash, crude lipid, protein, fibre and nitrogen free extract in leaves were 5.43 ± 0.11, 5.07 ± 0.27, 6.24 ± 0.04, 12.59 ± 0.22, 19.09 ± 0.06 and 51.58 ± 0.23%, respectively, while in seed, were 4.68 ± 0.06, 0.40 ± 0.05, 7.20 ± 0.12, 7.92 ± 0.17, 52.77 ± 0.14 and 27.03 ± 0.18% respectively, all proximate contents were significantly higher in leaf with the exception of crude lipid and fibre which were higher in seed. From the results, the saponin and flavonoid concentration were found to be high in both seed and leaf but low concentration of tannin, alkaloid, and phytate. Similarly, Amata and Nwagu (2013) reported low alkaloid in the seed of same plant (*G. arborea*), Daya *et al.* (2013) also revealed high concentrations of saponin and flavonoid in the leaf but low concentrations of phenol, glycoside, alkaloid, steroid, and tannin.

Table 2: Proximate content of Leaf and Seed of *G. arborea* (g/100g)

Variable	Moisture	Ash	Crude lipid	Protein	Fibre	Nitrogen free extract
Leave	5.43±0.11	5.07±0.27	6.24±0.04	12.59±.0.22	19.09±0.06	51.58±0.23
Seed	4.68±0.06	0.40±0.05	7.20±0.12	7.92±0.17	52.77±0.14	27.03±0.18
P-value	0.04	0.00	0.00	0.00	0.00	0.00

The mineral composition of leaf and seed of *Gmelinaarborea* is presented in Table 3. The results indicates significant differences (P<0.05) in mineral contents evaluated between leaf and seed of *G. arborea,* higher value in leaf for zinc (Zn), iron (Fe), manganese (Mn), calcium (Ca), magnesium (Mg) and sodium (Na) with value 0.31 ±0.00, 0.74 ± 0.00, 0.54 ±0.00, 27.45 ± 0.00, 29.59 ± 0.00 and540.00 ± 0.00 ppm, respectively, however potassium was significantly higher in seed (1700 ± 0.00 ppm) than in leaf. The results discloses that *Gmelinaarborea* leaf and seed had reasonable crude protein content, however did not meet FAO requirement to be classified as a protein plant based source because the crude protein value in both parts were lower than 20%, however could be classified as a roughage or energy source base on their high fibre and nitrogen free extract. Amata and Nwagu (2012) also reported high crude fibre and nitrogen free extract in the seed of *G. arborea.* The leaf had higher mineral content than the seed, the leaf was found to be high in zinc, iron, manganese, calcium, magnesium and sodiumbut potassium was higher in seed, Ingweye *et al.* (2010b) reported that seeds have high concentration of potassium which this finding corroborated.

Table 3: Mineral content of the Leaf and seed of *G. Arborea* (ppm)

Mineral content	**Leave**	**SEEED**	**P –value**
Zinc	0.31±0.00	0.27±0.00	0.00
Iron	0.74±0.00	0.65±0.00	0.00
Manganese	0.54±0.00	0.29±0.00	0.00
Calcium	27.45±.0.00	5.62±0.00	0.00
Magnesium	29.59±0.00	4.35±0.00	0.00
Sodium	540.00±0.00	450.00±0.67	0.00
Potassium	11600.00±0.00	1700.00±0.00	0.00

The essential amino acid content in the leave and seed of *Gmelinaarborea* (Table 4). lysine, histidine, arginine, methionine, valine, threonine, phenylalanine and isoleucine content in g/100g protein of leaf were 2.17±0.14, 1.13±0.11, 5.41±0.73, 0.62±0.08, 2.09±0.13, 2.91±0.09 and 2.09±0.13, respectively while the seed were 4.10±0.20, 2.23±0.07, 5.62±0.34, 0.98±0.12, 2.13±0.18, 0.50±0.10, 3.39±0.13 and 2.44±0.17, respectively showing no significant difference (P>0.05) with the seed having higher content than the leaves, with the exception of leucine (6.50 ± 0.37g/100g) and tyrosine (2.49 ± 0.17) amino acid which were significantly higher in seed, for non-essential amino acids, asparagine, serine, glutamic acid, proline, glysine, alanine, and cystine content in g/100g in leaf were 3.08±0.59, 1.06±0.18, 6.43±1.17, 2.73±0.53, 2.21±0.21, 2.57±0.42 and 0.52±0.04, respectively while in seed were 8.41±0.30, 3.07±0.13, 12.76±0.76, 3.14±0.12, 3.33±0.18, 3.05±0.15 and 1.04±0.07 with no significant difference between the leave and the seed and the seed having higher content than the leaf. From the results, both leaf and seed were promising, showing potentials that they could be used as non-conventional feed materials in animal feed production. This findings agree with Zengin *et al*. (2012) that amino acids are the building block of protein, and further asserted that quality protein source should have high concentration of essential amino acid. Generally, amino acids (essential amino acid: lysine, histidine, arginine, threonine, valine, methionine, isoleucine, leucine, tyrosine and phenylalanine and non-essential amino acid: asparagine, serine, glutamic acid, prolline, and cystine) were found to be higher in seed than in leaf. The amino acid composition were similar to that reported by Zengin *et al*. (2012) for leaves of eleven asphodeline species (*liliaceae*), It has been suggested that the amino acid composition of the leaves of most terrestrial plants is very similar due to the very low variability in the amino acid composition of ribulose 1, 5-biphospahte carboxylase/ oxygenase (rubisco), which accounts for a very large portion of the total leaf protein (Byers, 1983; Zengin *et al*., 2012) and were within Food and Agriculture Organization (FAO) recommended range for animal feed production.

Table 4: Amino Acid composition of Leaf and Seed of *G. Arborea*

Essential amino acids	Leaf	Seed	Pvalue
Lysine	2.17±0.14	4.10±0.20	0.15
Histidine	1.13±0.11	2.23±0.07	0.13
Arginine	5.41±0.73	5.62±0.34	0.81
Threonine	0.50±0.10	3.20±0.16	0.05
Valine	2.13±0.18	3.10±0.12	0.05
Methionine	0.62±0.08	0.98±0.12	0.13
Isoleucine	2.09±0.13	2.44±0.17	0.23
Leucine	3.49±0.35	6.50±0.37	0.03
Tyrosine	1.41±0.09	2.49±0.17	0.03
Phenylalamine	2.91±0.09	3.39±0.13	0.09
Non-essential amino acid			
Asparagine	3.08±0.59	8.41±0.30	0.15
Serine	1.06±0.18	3.07±0.13	0.12
Glutamic acid	6.43±1.17	12.76±0.76	0.39
Prolline	2.73±0.53	3.14±0.12	0.53
Glysine	2.21±0.21	3.33±0.18	0.54
Alanine	2.57±0.42	3.05±0.15	0.39
Cystine	0.52±0.04	1.04±0.07	0.22

CONCLUSION AND RECOMMENDATION

Leaves and seeds of *Gmelinaarborea* are good sources of energy, they are characterised by high saponin, flavonoid and carbohydrate (NFE), also present in the leaf and seed are essential minerals and amino acids. Therefore, the study recommended that anti-nutrient removal processes should be used to reduce anti-nutrient content to a tolerable amount in fish feed formulation.

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