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Research Article

The Nutritive Values of the Leaf Meal and Leaf Protein Concentrate of Some Tropical Weeds

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ABSTRACT

The nutritional contents of *Gliricidia sepium, Ipomoea aquatica, Lantana camara, Pistia stratiotes, Luffa aegyptiaca, Leucaena leucocephala* and *Centrosema pubescens* were investigated. The crude protein, ash, ether extract, crude fibre, dry matter, nitrogen free extract and minerals in leaf meal (LM) and leaf protein concentrate (LPC) were determined using standard methods. The results of LM were; crude protein (17.50±0.01 - 38.15±0.02%), ash (4.40±0.01 - 7.50±0.02%), ether extract (2.20±0.01 - 2.70±0.03 %), crude fibre (11.50±0.12 - 15.90±0.11%), dry matter (87.30±0.21 - 88.41±0.25 %) and nitrogen free extract (42.45±0.23 - 61.40±0.22%). Also, the results of LPC were; crude protein (35.70±0.23 - 47.24±0.22%), ash (3.90±0.02 - 7.90±0.02%), ether extract (2.10±0.01 - 2.70±0.03%), crude fibre (8.50±0.03 - 12.30±0.02%), dry matter (88.64±0.23 - 90.03±0.24 %) and nitrogen free extract (35.46±0.22 - 47.40±0.25%). The LM mineral analysis were; P (10.0±0.01 - 78.3±0.03 %), Mg (28.3±0.01- 66.6±0.02 %) and K (20.0±0.01 - 51.6±0.02 %). The LPC mineral analysis were; P (6.62±0.02 - 9.41±0.02 %), Mg (18.35±0.01 - 31.45±0.01 %) and K (38.27 ±0.01 - 78.01 ±0.02 %). Therefore, the above weeds could be the panacea for the much needed alternative feed ingredients especially crude protein (35.7 - 47.24%) for sustainable animal production including fish.

Keywords: Leaf meal, Leaf protein concentrate, Nutrients, Proximate analysis, Tropical weeds
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INTRODUCTION

The importance of fish meal in the making of feeds for animals cannot be disputed though, it constitutes the highest cost among the ingredients, thereby making the price of feed to be very high (Olaniyi & Salau, 2013). Fish meal is used as the main dietary protein source when compounding diet for fish breeding, because of its quality and palatability (Hardy & Tacon, 2002). Also, the convectional groundnut and soybean meals are over-competed by man and his animals making the cost of producing animal feed exorbitant. Therefore, to reduce the cost of feed in fish production it is imperative to replace the aforementioned convectional sources of protein with suitable alternatives (De-Silva & Hasan, 2007; Hung *et al*., 2007; Monebi & Ugwumba, 2013).

Considerable interest has been shown on the use of aquatic macro organisms such as single-cell protein and protein hydrolysates (El-Sayed & Tacon, 1997) as alternative protein sources. Also, substantial emphases have been on the use of conventional plant oilseed meals; cotton seed, soybean, rapeseed and groundnut (Agbede, 2005; Toko *et al*., 2008; Liu *et al*., 2011). Lately, the aquaculture industry has been on the search for protein source alternatives that are cheaper and more environmentally friendly. Among those alternative sources are the microbe and plant-based feedstuffs (Sanderson & Jolly, 1994; Anupama & Ravindra, 2000).

The inclusion of plant based ingredients in fish feed has increased markedly over the years and the convectional sources are legumes and oil-bearing seeds (Krogdahl *et al*., 2010). In the tropics, legumes are valuable feed source in aquaculture because of their abundance. In addition, their leaves are also rich in protein and minerals (Edelman & Colt, 2016). Also, oil-bearing seeds and oil cakes which are by-products of the vegetable and oil industry are equally sources of plant protein (Gatlin *et al*., 2007). They are high in

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protein and low in carbohydrate. However, their high fibre and cellulose contents limit their nutritional value in the feed of monogastric animals (Ghaly *et al*., 2012).

In order to address these aforementioned challenges, concentrates of leaves are being used as sources of protein in fish feed (Sodamode *et al*., 2013). Leaf protein concentrate (LPC) found in the leaves of plants, has been examined as a human and animal food source because, it is very cheap and also abundant (Adeyemi & Osubor, 2016). The LPC is tremendously nutritious, made by mechanically separating indigestible fibre and soluble anti-nutrients from much of the protein, vitamins, and minerals in some fresh green plant leaves (Adeyemi & Osubor, 2016).

Over the years, several attempts have been made to substitute fishmeal with plant protein and when amino acid composition of plant protein was compared with that of fish meal, it was relatively unbalanced probably, due to excessive heating during industrial drying of plant feedstuffs. Therefore, the main objective of this study was to evaluate the nutritional composition of the leaf meal, leaf protein concentrate and macro elements of some tropical weeds in Nigeria.

MATERIALS AND METHODS

Collection of Plant Samples

Gliricidia sepium (Quick stick), *Lantana camara* (Big-sage) and *Luffa aegyptiaca* (Sponge gourd) were collected from the Botanical garden, University of Lagos, Akoka, Nigeria, while *Ipomea aquatica* (Morning glory) and *Pistia stratiotes* (Water cabbage) were collected from Lagos lagoon, Lagos, Nigeria. *Centrosema pubescens* (Butterfly pea) and *Leucaena leucocephala* (White lead tree) were collected from University of Ibadan botanical garden, Nigeria. These weeds were authenticated at the Herbarium of the Department of Botany, University of Lagos, Nigeria.

Preparation of Leaf Meal (LM)

One hundred (100) g leaf from each of the freshly sampled weed was put in a tray to sun-dry for about four days, milled and kept in an airtight container prior to analysis for leaf meal (Fellow, 1987; Agbede & Aletor, 2004; Agbede, 2005).

Preparation of Leaf Protein Concentrate (LPC)

100g leaf from each of the freshly sampled weed was washed and pounded which ruptured the plant cell wall. The residue was squeezed to release leaf juice which contained protein. The separated leaf juice was heated at 80-90 °C for 10 minutes to coagulate the leaf protein. A rubber hose was used to siphon the coagulated protein from the whey, the protein coagulum was further filtered through muslin cloth and screw-pressed to remove the entire whey. The leaf protein was washed with water, repressed and sun-dried to get the leaf protein concentrate (Fellow, 1987; Agbede & Aletor, 2004; Agbede, 2005).

Proximate Analysis of Plants

The proximate composition (crude protein, ether extract, crude fibre, ash, dry matter and nitrogen free extract) of the leaf meal and leaf protein concentrate of some tropical weeds were carried out using atomic absorption spectrophotometer as described by the Association of Official Analytical Chemist (AOAC., 2005).

RESULTS

The Percentage Leaf Meal (LM) Proximate Composition of Some Tropical Weeds

The percentage leaf meal proximate composition of *G. sepium, L. camara, L. aegyptiaca, I. aquatica, P. stratiotes, C. pubescens* and *L. leucocephala* is presented in Table 1. The crude protein ranged between 21.10±0.01 (*I. aquatica*) and 38.15±0.02 % (*P. stratiotes*), the ash content varied between 4.40±0.01 (*G. sepium*) and 7.50±0.02 % (*C. pubescens*), ether extract ranged between 2.20±0.01 (*G. sepium*) and 2.70±0.03 % (*L. aegyptiaca*), crude fibre varied between 11.50±0.12 (*L. leucocephala*) and 15.90±0.11 % (*C. pubescens*), dry matter varied between 87.30±0.21 (*I. aquatica*) and 88.41±0.25 % (*G. sepium*) while the values of nitrogen free extract ranged between 42.45±0.23 (*P. stratiotes*) and 61.40±0.22 % (*I. aquatica*).

The Percentage Leaf Protein Concentrate (LPC) Proximate Composition of Some Tropical Weeds

The percentage leaf protein concentrate proximate composition of *G. sepium, L. camara, L. aegyptiaca, I. aquatica, P. stratiotes, C. pubescens* and *L. leucocephala* is presented in Table 2. The crude protein of leaf protein concentrate varied between 35.70±0.23 (*L. camara*) and 47.24±0.22 % (*I. aquatica*), the ash content ranged between 3.90±0.02 (*L. camara*) and 7.90±0.02 % (*C. pubescens*), the ether extract varied between 2.10±0.01 (*G. sepium*) and 2.70±0.03 % (*I. aquatica*), the crude fibre ranged between 8.50±0.03 (*G. sepium*) and 12.30±0.02 % (*P.

Table 1: Proximate composition (%) of leaf meal from some tropical weeds

Plant	Crude protein	Ash	Ether extract	Crude fiber	Dry matter	Nitrogen free extract
G. sepium	27.30±0.02	4.40±0.01	2.20±0.01	15.10±0.12	88.41±0.25	51.00±0.21
I. aquatica	21.10±0.01	4.90±0.02	2.50±0.02	13.70±0.12	87.30±0.21	61.40±0.22
L. camara	21.70±0.12	6.40±0.01	2.50±0.02	14.60±0.11	87.72±0.22	54.80±0.21
P. stratiotes	38.15±0.02	5.10±0.03	2.40±0.01	11.90±0.12	88.30±0.24	42.45±0.23
L. aegyptiaca	28.35±0.02	6.80±0.01	2.70±0.03	13.20±0.13	87.61±0.25	48.95±0.22
L. leucocephala	29.40±0.21	6.10±0.01	2.30±0.01	11.50±0.12	87.59±0.22	50.70±0.23
C. pubescens	22.40±0.10	7.50±0.02	2.60±0.03	15.90±0.11	88.16±0.23	51.60±0.24

Table 2: Proximate composition (%) of leaf protein concentrate (LPC) from some tropical weeds

Plant	Crude protein	Ash	Ether extract	Crude fiber	Dry matter	Nitrogen free extract
G. sepium	42.35±0.21	3.92±0.01	2.10±0.01	8.50±0.03	89.20±0.22	43.15±0.24
I. aquatica	47.24±0.22	4.40±0.03	2.70±0.03	10.20±0.01	89.46±0.25	35.46±0.22
L. camara	35.70±0.23	3.90±0.02	2.12±0.02	10.90±0.03	88.64±0.23	47.40±0.25
P. stratiotes	41.30±0.21	5.80±0.01	2.20±0.02	12.30±0.02	89.27±0.22	38.40±0.21
L. aegyptiaca	45.85±0.21	6.30±0.01	2.50±0.03	9.80±0.02	90.03±0.24	35.55±0.23
L. leucocephala	41.65±0.22	6.30±0.02	2.20±0.02	10.60±0.03	88.75±0.25	39.25±0.20
C. pubescens	41.50±0.23	7.90±0.02	2.40±0.03	12.10±0.04	89.38±0.22	36.1±0.22

stratiotes), the dry matter was between 88.64±0.23 (*L. camara*) and 90.03±0.24 % (*L. aegyptiaca*) while the nitrogen free extract ranged between 35.46±0.22 (*I. aquatica*) and 47.40±0.25 % (*L. camara*).

The Percentage Mineral Analysis from Leaf Meal of Some Tropical Weeds

The percentage mineral analysis from leaf meal of *G. sepium, L. camara, L. aegyptiaca, I. aquatica, P. stratiotes, C. pubescens* and *L. leucocephala* is presented in Figure 1. The highest value for phosphorus was recorded for *L. aegyptiaca* (78.3±0.03 %) while the least value was recorded for *C. pubescens* (10.0±0.01 %). Also, the highest (66.6±0.02 %) and lowest (28.3±0.01 %) values for magnesium were recorded for *L. leucocephala* and *L. camara* respectively. Furthermore, *L. leucocephala* recorded the highest value (51.6±0.02 %) and *G. sepium* recorded the least value (20.0±0.01 %) for potassium.

The Percentage Mineral Analysis from Leaf Protein Concentrate of Some Tropical Weeds

The percentage mineral analysis from leaf protein concentrate of *G. sepium, L. camara, L. aegyptiaca, I. aquatica, P. stratiotes, C. pubescens* and *L. leucocephala* is presented in Figure 2. The highest (9.41±0.02 %) and lowest (6.62±0.02 %) values for phosphorus were recorded for *C. pubescens* and L. *leucocephala* respectively. The highest value (31.45±0.01 %) for magnesium was exhibited in *G. sepium* while the least value (18.35±0.01 %) was found in *I. aquatica.* Also, the value of *I. aquatica* (78.01±0.02 %) was the highest for potassium while *L. leucocephala* (38.27±0.01 %) exhibited the lowest value.

DISCUSSION

The results from the nutritional compositions of the weeds studied, showed appreciable nutrients content in both the leaf meal and leaf protein concentrate from the sampled plants. The results of proximate analyses for leaf meal of all the sampled plants recorded crude protein level above 20 % (21.10±0.12 - 38.15±0.02). Similarly, the results of

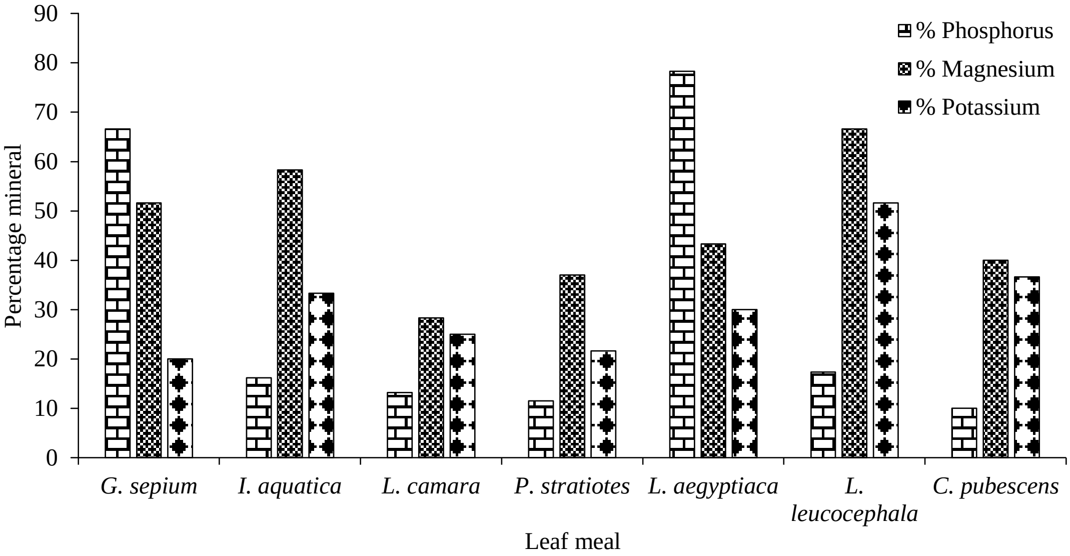

Figure 1: Percentage mineral analysis of leaf meal from some tropical weeds

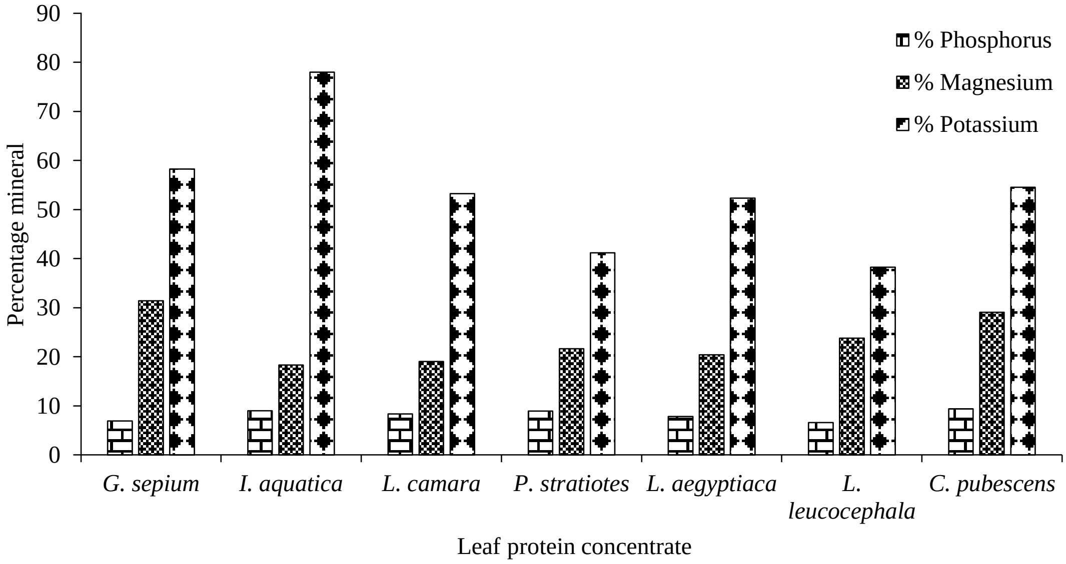

Figure 2: Percentage mineral analysis of leaf protein concentrate from some tropical weeds

proximate analyses for leaf protein concentrate of all the tested plants recorded crude protein level above 20 % (35.70±0.23 - 47.24±0.22).

The levels of crude protein recorded in the studied weeds compared favourably with some plants in previous studies, such as cowpea (25 %) (Gallup & Reder, 1943), Lima bean (23.11 %) (Oshodi *et al*., 1998) and Bambara groundnut (11.60 %) (Aremu *et al*., 2006). However, Wasagu *et al*. (2013) analysed the nutritional levels of *P. stratiotes* and found that the weed had 6.96 % crude protein in contrary to a higher value of 38.15 % observed in this study. The variation in the value of CP for *P. stratiotes* could be due to the different methods of processing of the weed for analysis.

With regards to the potential utilization of the leaf meal and leaf protein concentrate as fish feed ingredients for the most cultured fish species in Nigeria, the results of the present study indicated that LM and LPC from these weeds could serve as suitable alternatives for plant protein in the diets of cultured fish species. Previous studies, had shown that catfish grow-out requires crude protein levels between 40 and 42 % (Wilson & Moreau, 1996), this range of values was met by the leaf protein concentrate of *G. sepium, I. aquatica, P. stratiotes, L. aegyptica, L. leucocephala* and *C. pubescence* with the exception of *L. camara*. Furthermore, *I. aquatica* with crude protein level of 47 % would be a good source of plant protein for fingerling feed ingredient for *C. gariepinus.*

Fiber is an inherent dietary component and serves as a source of bulk that facilitates the passage of feed through the digestive tract of animals (Ensminger *et al*., 1990; Li *et al*., 2012). The levels (8.50 – 12.30) of crude fibre for the leaf protein concentrate were relatively lower to the previous studies; 8.80 % for *C. pubescens (*Nworgu & Egbunike, 2013), 16.41 % for *L. camara* (Haruna *et al*., 2015), 14.30 % for *P. stratiotes* and 18.38 % for *I. aquatica* (Adelakun *et al.*, 2016), while the range 13-30 % was recorded for *G. sepium* (Glover, 1989). According to Li *et al*. (2012), channel catfish fed 2%-fiber feed had weight of 3,132 kg/hectare, which was significantly ($P < 0.05$) more than fish fed the 14%-fiber feed (2,468 kg/hectare) and 20%-fiber feed (2,532 kg/hectare), but not the 8%-fiber feed (2,705 kg/hectare). Hence, the crude fibre from *G. sepium* at 8.50% could favourably be tolerated in practical catfish diet.

The ash content is a reflection of the mineral content preserved in the leaf. The results (4.40±0.01 – 7.50±0.02 %) from the present study differed from previous studies; Adelakun *et al.* (2016) recorded 16.20 % for *P. stratiotes* and 10 % for *I. aquatica* however, Aye and Adegun (2013) reported 8.93 % for *L. leucocephala and* 6.67 % for *G. sepium* which are relatively similar to the results of this study. The ash contents are relatively high which mean that inorganic elements are substantial in the weeds (McClements & Decker., 2009).

Crude fats are very concentrated sources of energy and can play an important role in the diets of highly productive animals. The results (2.20 – 2.70 %) from the present study was within the range 1.18 to 5.42 % crude fat for *P. stratiotes* reported by Boyd (1968). Also, Nworgu and Egbunike (2013) recorded 3.32 % for *C. pubescens*. These findings were corroborated by Haruna *et al.* (2015) who reported 2.99 % crude fat for *L. camara.* However, Aye and Adigun (2013) reported high values (12.40 %) and 12.29 %) for *L. leucocephala and G. sepium* respectively. Furthermore, Wasagu *et al*. (2013) also reported lower ether extract value (2.17 %) for *P. stratiotes.* Markedly, the crude fat content of the weeds in this study would help provide additional source of energy in the feed.

The results (42.45 – 61.40 %) of nitrogen free extract in the leaves meals were relatively high when compared with values of *P. stratiotes* (25.62 %) and *I. aquatica* (22.12 %) (Adelakun *et al.,* 2016). Also, the values reported by Aye and Adigun (2013) for *L. leucocephala* (34.64 %) and *G. sepium* (40.21 %) were considerably lower when compared with the findings of this study. Evidently, these findings were validated by Nworgu and Egbunike (2013) who recorded 55.5 % for *C. pubescens*.

Principally, the fraction that contains the sugars and starches plus small amounts of other materials are nitrogen-free extract fraction, which vary greatly with different plant species and also with different methods of determining the crude fiber fraction, however this fraction would serve as supplementary energy in animal feed.

The range (87.30 – 88.41 %) of dry matter content of the leaves meals in the present study was comparatively high when compared with report of Banerjee and Matai (1990) who reported 5.3 % for *P. stratiotes* while Aye and Adigun (2013) reported higher values (92.75 %*)* and 92.85 %) for *L. leucocephala and G. sepium* respectively. These findings were confirmed by Nworgu and Egbunike (2013) who recorded 88.99 % for *C. pubescens*. The dry matter (DM) is what remains when moisture is removed from a feed. The high DM recorded in this study showed that the moisture content is low, which implies that the feed ingredients that would be produced from these weeds are loaded with nutrients with long shelf life.

The macro elements are required in large quantity in animal diets for a great diversity of uses. Hence, the importance of these elements cannot be over emphasized; these elements (P, Mg, K) participate in several biochemical reactions (Dato-Cajegas & Yakupitiyage, 1996; NRC, 2011). Magnesium and phosphorus are crucial in the formation of bones and teeth. Additionally, phosphorus is involved in the formation of phosphoproteins (Adeyemi & Osubor, 2016), while potassium helps in the transmission of nerve impulses and keeping electrolyte balance. The results of mineral analysis of the weeds in the present study showed the presence of phosphorus (6.62±0.02 - 78.3±0.03 %) magnesium (18.35±0.01- 66.6±0.02 %) and potassium (20.0±0.01 - 78.01±0.02 %). These could be deployed at graded levels to meet the requirements in the diets of different categories of cultured animals including fish, which unlike several terrestrial animals can absorb most of the minerals from their diets and environment (Paul & Giri, 2009).

The nutritional composition of seven tropical weeds was determined. All the sampled plants are potentially rich in crude protein and mineral elements which could either be used as leaf meal or leaf protein concentrate in the production of animal feed. The alternative feed ingredients could be incorporated in a regulated manner in animal feed to provide some of the nutrients required at very low cost. Therefore, this could be the panacea for the much needed alternative feed ingredients especially crude protein (35.7 - 47.24 %) for sustainable animal production including fish.

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