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Phytochemical and Nutritional Composition of Partial Replacement of *Ipomoea batatas* Leaf Inclusion Fish Diet

Beauty Nwakaku* and Comfort Chinaza Monago-Ighorodge

Department of Biochemistry, Faculty of Science, University of Port Harcourt, P. M. B. 5323 Port Harcourt, Rivers state.
*Corresponding author's email: beautynwakaku@gmail.com

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Abstract

Fish farming is a very indispensable component of modern society, especially in Nigeria where fish occupies a central position in the diet of the average Nigerian. Production of quality fish is a function of good quality feed containing the right proportion of protein and other micronutrients. *Ipomoea batatas* (sweet potato) is a herbaceous creeping plant which is commonly found in the wild and its leaf may be included in fish feed production. This present study aimed to investigate the phytochemical, proximate and amino acids composition of partial replacement of *I batatas* leaf inclusion fish diet. Fresh *I. batatas* leaves were harvested from Aluu community in Ikwerre LGA. of Rivers State, Nigeria and prepared for analysis by soaking ten grams (10 g) of the sample in 100 ml of distilled water in a beaker and left for about 8hrs followed by filtration of the solution; the filtrate was subsequently used for phytochemical screening. All chemicals and reagents used were of analytical grade. *I. batatas* leaf inclusion feeds were formulated using the Pearson's square standard method. Phytochemicals, proximate, nitrogen-free extract and amino acids concentration were determined by standard methods. The results indicate that in *I. batatas* leaves cardiac glycosides and tannins were highly present while alkaloids, steroids, terpenoids and phenols were moderately present. Proximate composition of the formulated fish feeds showed the following ranges: protein (35.16±0.23% to 43.75±0.30%), lipid (6.18±0.60% to 11.93±0.13%), moisture (6.04±2.13% to 9.33±0.82), ash (5.39±0.36% to 9.44±0.12%), NFE (19.41±0.87% to 34.23±0.40%) and fibre (2.15±0.76% to 7.98±0.14%). A total of nineteen amino acids were found in varying proportions including essential amino acids such as histidine, lysine, valine, leucine, arginine, methionine, phenylalanine and isoleucine were present. Thus, *I. batatas* has good potential for inclusion in fish diet due to its rich proximate content (especially protein) and amino acids which are indispensable for fish growth and development.

Keywords: Fish, feed, *I. batatas*, phytochemicals, proximate, protein

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Introduction

Aquaculture is an essential source of livelihood and income for millions of people all over the world. During the production of fish feed, fish meal is one of the main ingredients required, bearing in mind the high significance of fish as a source of protein. The swift growth and development of the aquaculture industry combined with the high cost of fish meal, encourages the search for the replacement of fish meal with locally available protein rich materials sacrosanct (Oluwarotimi *et al*., 2022). Numerous plants derived products have been proposed as possible agents for aqua feeds to support the viable production of different fish species in captivity (Akpabio *et al.* 2019). No one feed ingredient can supply all of the nutrients and energy fishes need for best growth thus, commercial fish feeds contain a mixture of feedstuffs and vitamin and mineral premixes that provide the right essential nutrients as well as the energy necessary to use the nutrients. The amount of each feed ingredient depends on several factors, including nutrient requirements, ingredient cost, availability of each ingredient, and processing characteristics. Protein consumption by fish is very essential because it provides the amino acids needed for the synthesis of novel tissues or to replace worn protein. The traditional ingredients used in fish feed production include sunflower, rapeseed, groundnut, soybean and cottonseed however, most of these products are difficult to find, costly due to demand for the production of alternative products and requires high labour and material input to cultivate (Olaniyan *et al*., 2022). Owing to these, they are largely out of reach from the poor and most time does not sustain the immediate need.

Ipomoea batatas (sweet potato) (Fig. 1) is a herbaceous creeping plant with smooth, lightly moderate green leaves sometimes with a considerable amount of purple pigmentation especially along its veins (Alam, *et al.*, 2016). *I. batatas* leaves are known to have anti-oxidant effects, antidiabetic effects, anticancer effects, cardiovascular effects, effects on immune system, anti-microbial effects, anti-inflammatory effects etc (Ayeleso *et al.*, 2016; Elgabry *et al.*, 2023). This study therefore aimed to determine the phytochemical and nutritional composition of diets formulated using varying concentrations of *I. batatas* leaf.

Figure 1: *Ipomoea batatas* leaves (Dawson, 2018)

Methodology

Materials

Fresh *I. batatas* leaves were harvested from Aluu community in Ikwerre LGA. of Rivers State, Nigeria in April 2020 and identified at the Department of Plant Science and Biotechnology herbarium, University of Port Harcourt by Mr. Ekeke. All chemicals and reagents used were of analytical grade

Methods

Phytochemical screening

Preparation of *I. batatas* leaf extract: Ten grams (10 g) of the sample was soaked in 100 ml of water in a beaker and left for about 8hrs. The solution obtained was filtered using filter paper, and the filtrate used for phytochemical screening.

Qualitative determination of phytochemicals

The methods of Sofowora (1980) and Harbone (1973) was deployed for the qualitative determination of alkaloids, flavonoids, cardiac glycosides, phlobatannins, tannins, steroids, terpenoids, diterpenes, triterpenes, quinones and phenols.

Proximate analysis of *I. batatas* leaves and compounded fish feed

Proximate composition of samples (moisture, ash, lipid, crude fiber and crude protein) were determined by standard procedures (AOAC, 2000).

Determination of Nitrogen free extract

The method of Hodge & Hofreiter (1962) was adopted. Some quantity (100 mg) of the sample was weighed into a boiling tube and hydrolysed through addition of 1.3ml 62% per chloric acid with continuous shaking vigorously to ensure proper mixing. The set-up is allowed to stand for about 20 min to cool and the volume made up to 100 ml before centrifuging. Aliquot 0.5 ml of the supernatant was measured into test tubes and made up to the mark with distilled water. A blank correction was made by addition of 0, 0.2, 0.4, 0.6, 0.8 and 1 mL of working standard into different test tubes with corresponding addition of distilled water to make up the mark. Exactly 4.0 ml of anthrone reagent was added and heated in boiling water bath for 8 min. finally, the set-ups were allowed to stand and their absorbances read-off as the green colouration became thicker at 630 nm. A standard graph was obtained by plotting absorbance against concentration of standard while the quantity of nitrogen free extracts (NFE) carbohydrate was obtained using the below formula:

$$\text{NFE } in\ 100mg\ of\ the\ sample = \frac{\text{mg of glucose}}{\text{Volume of test sample}} \times 100$$

Amino acid and protein content determinations

The amino acid profile was analysed by standard methods (AOAC, 2000). Each of the sample was dried to obtain a constant weight, evaporated, defatted and loaded into the techno sequential multi-sample analyser (TSM) that was premeditated to separate as well as analyse free, neutral, basic and acidic amino acids of the hydrolysate.

Composition of compounded feeds

The feeds were formulated using the Pearson's square standard method. The following tables (table 1-3) show the formulation of the feeds in this study.

Table 1: At 10% partial replacement with *I. batatas* leaf

Ingredients	%	Weight(kg)	*I. batatas* leaf (kg)
Wheat bran	9.81	1.47	
Soyabean meal	39.845	5.98	
Fishmeal	39.845	5.38	0.6
Palm oil	5	0.75	
Garri	5	0.75	
Premix	0.25	0.04	
Methionine	0.15	0.02	
Vitamin C	0.1	0.015	
Total	**100%**	**15kg**	

Table 2: At 20% partial replacement with *I. batatas leaf*

Ingredients	%	Weight (kg)	*I. batatas* leaf(kg)
Wheat bran	9.81	1.47	
Soya bean meal	39.845	5.98	
Fishmeal	39.845	4.78	1.2
Palm oil	5	0.75	
Garri	5	0.75	
Premix	0.25	0.04	
Methionine	0.15	0.02	
Vitamin C	0.1	0.015	
Total	**100%**	**15kg**	

Table 3: At 30% partial replacement with *I. batatas leaf*

Ingredients	%	Weight (kg)	*I. batatas* leaf(kg)
Wheat bran	9.81	1.47	
Soya bean meal	39.845	5.98	
Fishmeal	39.845	4.19	1.8
Palm oil	5	0.75	
Garri	5	0.75	
Premix	0.25	0.04	
Methionine	0.15	0.02	
Vitamin C	0.1	0.015	
Total	**100%**	**15kg**	

Statistical analysis

Data obtained was analyzed using Statistical Package for Biological and Social Sciences (SPSS) (version 26.0). Mean values M±SD were calculated and one-way analysis of variance (ANOVA) test was done for comparison of related variables. Probability that was less than 0.05 ($p<0.05$) was considered statistically significant.

Table 4: At 100% partial replacement with *I. batatas leaf*

Ingredients	%	Weight (kg)	*I. batatas* leaf(kg)
Wheat bran	9.81	1.47	
Soya bean meal	39.845	5.98	
Fishmeal	39.845	0	5.98
Palm oil	5	0.75	
Garri	5	0.75	
Premix	0.25	0.04	
Methionine	0.15	0.02	
Vitamin C	0.1	0.015	
Total	**100%**	**15kg**	

Results and Discussion

The result of the qualitative phytochemical screen of *I. batatas* leaf revealed cardiac glycosides and tannins were highly present while alkaloids, steroids, terpenoids and phenols were moderately present (Table 5). Tannins, cardiac glycosides, steroids, alkaloids, phenols and terpenoids possess a wide array of pharmacological and other functions (Awoyinka *et al*., 2007; Al-Bayati and Sulaiman; 2008; Aberoumand, 2012). According to Pandey *et al.,* (2012), the antimicrobial potentials of plants used in fish nutritional studies helps in averting mass death of fishes in the aquarium and improve their marketability, hence this supports the usage of this leaf as components of fish diet. The proximate analysis of the *I. batatas* leaf revealed substantial amounts of proximate contents particularly moisture, carbohydrate, protein, crude fibre and ash (table 6). Awol (2014) and Alam *et al*., (2016) had earlier revealed the proximate content of *I. batatas* leaves and results obtained here correspond with their findings. The protein content recorded in the four concentrations of *I. batatas* leaf fish compounded diets were higher than 15.0%, 21.0%, 20.72% and 24.0% obtained in *Heinsia crinata* (Effiong, *et al.* 2009). The presence of high protein implies that *I. batatas* leaf is capable of serving as sole source of protein in fish diet formulation, hence supplementing the daily recommended values in man. Lipid enhances the palatability and flavor of diets (Fagbohun, *et al.* 2012). The percentages obtained in the four concentrations of compounded fish diets (table 7) are higher when compared with similar studies (Ikewuchi *et al*., 2010; Igboh, *et al.* 2009). This implies amendment of fish diet with *I. batatas* leaves will improve the palatability of their diet.

Table 5: Phytochemical screening of *I. batatas* leaf

Phytochemical	Result
Alkaloids	+
Flavonoids	-
Cardiac glycosides	++
Phlobatannins	-
Tannins	++
Steroids	+
Terpenoids	+
Diterpenes	-
Triterpenes	-
Quinones	-
Phenols	+

Key: -=absent; + = moderately present; ++ = highly present

Table 6: Proximate analysis of *I. batatas leaf*

Parameter	Composition
Crude protein	16.60±2.13
Crude fats	0.16±0.00
Moisture	40.62±3.16
Ash	11.92±0.54
Crude fibre	12.28±1.22
Carbohydrate	18.42±2.17

Data are Mean ± standard deviation (n=3).

Table 7: Proximate analysis of compounded fish feed

Parameter	**Compounded feeds (% *I. batatas* leaf)**			
	10%	**20%**	**30%**	**100%**
Protein	42.55 ± 0.41^{b}	35.16 ± 0.23^{a}	39.32 ± 0.15^{a}	37.86 ± 0.52^{a}
Lipid	6.88 ± 2.02^{a}	7.02 ± 0.47^{b}	6.18 ± 0.60^{b}	8.23 ± 1.40^{b}
Moisture	7.25 ± 0.29^{a}	9.33 ± 0.82^{b}	7.19 ± 0.31^{a}	6.04 ± 2.13^{b}
Ash	5.39 ± 0.36^{b}	6.28 ± 0.38^{b}	8.77 ± 0.01^{a}	7.99 ± 0.53^{b}
NFE	30.08 ± 0.70^{b}	34.23 ± 0.40^{b}	31.48 ± 0.30^{b}	33.72 ± 0.65^{b}
Fibre	7.85 ± 1.27^{b}	7.98 ± 0.14^{b}	7.06 ± 0.53^{b}	6.16 ± 0.22^{b}

NFE-Nitrogen Free Extract; Values are presented as mean ± standard deviation (n=3); Values with different superscript letters in same row differ significantly ($p<0.05$)

The level of moisture in any food sample determines it storage duration and resistance to microbial attack (Olutiola, *et al.* 1991). The moisture percentage in all the fish compounded diets are less than 10% and significantly lower than values obtained in *Sansevieria liberica* (Ikewuchi *et al*., 2010) and *Pennisetum purpureum* (Okaraonye & Ikewuchi, 2009). This makes strong statement for the longevity fish feed with high resistance to bacterial and fungal attack.The ash content was higher at greater concentrations (30% and 100%) than lower concentrations. Similarly, the ash content in the four fish compounded samples are higher than values obtained in dry weight of *Pennisetum purpureum* but lower than wet weight of the leaf sample (Okaraonye & Ikewuchi, 2009), however, they are lower than 9.68%, 15.86% and 15.09% obtained in pumpkin leaf, bitter leaf and moringa leaf respectively (Effiong *et al*., 2009). The percentage of ash in the fish compounded diet provides strong backing for mineral supplements. Nitrogen free extract (NFE) expresses the percentage of water-soluble polysaccharides in the sample. The study revealed substantial quantity of NFE to provide the fishes with the needed sugars for development.

The percentages of crude fibre in the four compounded diets were when compared with the findings of Udosen *et al*., (1998) and Isong and Idiong (1997) on crude fibre content of dry mass *Heinsia crinata* and *Lasianthera africana* leaves respectively. This implies that the fibre content in the compounded diet may not have any great impact on the availability of other nutrients to the fish.

Amino acid analysis of the compounded feed showed presence of essential and non-essential amino acid (table 8), making the formulated diet a rich source of nutrients for fish growth, this study is in line with the study of Ndamitso *et al.* (2019) who did proximate and amino acid composition of red sweet potato.

Table 8: Amino acids composition of *I. batatas* leaf fish feeds

Amino acid	Compounded feeds (% *I. batatas* leaf)			
	10%	**20%**	**30%**	**100%**
Lysine	2.15±0.30^{b}	2.16±0.07^{a}	2.32±0.00^{a}	2.06±0.00^{a}
Histidine	0.88±1.03^{b}	0.89±0.17^{b}	0.87±0.90^{b}	0.83±0.50^{b}
Arginine	7.02±1.69	6.80±0.66^{b}	6.70±0.34^{b}	6.12±.98^{b}
Aspartic Acid	2.81±0.67	2.72±0.43	2.79±0.40^{b}	2,64±0.60^{b}
Threonine	3.16±1.03	2.98±0.07^{b}	2.77±0.19^{a}	2.19±0.40^{b}
Serine	2.74±0.16	2.23±0.07	2.48±0.30^{b}	2.22±1.03^{b}
Glutamic Acid	8.79±0.16^{b}	9.20±0.82	9.06±0.16	8.48±0.05
Proline	6.15±0.78	6.23±0.45	6.03±0.13	6.01±0.18
Glycine	6.05±0.79	6.11±0.12	6.01±0.04	5.35±1.07
Alanine	8.22±0.15	8.80±1.01	8.13±0.66^{b}	8.17±0.04^{b}
Cysteine	1.92±0.94	1.87±1.04	1.99±1.01	1.06±0.56
Valine	2.91±0.83	2.60±0+13	2.12±0.75	2.31±0.99
Methionine	0.89±1.14	0.84±0.05	0.86±0.77	0.80±0.14
Isoleucine	7.22±0.71	7.18±0.10	7.04±0.66	7.34±0.86
Leucine	2.37±0.80	2.19±0.93	2.50±0.72	2.01±0.05
Tyrosine	1.97±0.78	2.20±0.61	2.46±0.10	2.17±1.03
Phenylalanine	0.14±0.95	0.20±0.64	0.18±0.12	0.15±0.85
Tryptophan	0.41±0.97	0.40±1.07	0.38±0.07	0.41±0.65

Values are presented as mean ± standard deviation (n=3); Values with different superscript letters in same row differ significantly (p<0.05)

Conclusion

The results obtained from the present study showed that *I. batatas* has good potentials for inclusion in the fish diet. It is rich in protein, phytochemicals and amino acids. The results also indicated that *I. batatas*, which is readily available all-year-round in most parts of Nigeria, can profitably replace scarce and expensive commercial protein ingredients without reducing feed quality and may improve fish farming.

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