International Journal of Innovative Biochemistry & Microbiology Research 13(4):39-45, Oct-Dec., 2025

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doi:10.5281/zenodo.17811518

Proximate And Phytochemical Characterization Of *Bambusa vulgaris* For Strategic Integration Into Aquafeed Formulation

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ABSTRACT

The study investigates the proximate and phytochemical properties of *Bambusa vulgaris* leave in the production of fish feed. Due to the high cost of fish feed in the market, it is necessary to look for alternative ingredients that are available in large quantity, have high nutritional value, less or no cost to purchase and have the presence of vital phytochemicals such as flavonoids, alkaloids etc for disease prevention. Fish malnutrition which in turn causes deficiency of protein and other nutrients in human mostly individuals that feed mainly on fish is due mostlyto excessive cost of the constituents used in the production of the conventional fish feed found in the market and also diseases cases in fish.The results of the proximate analyses that was conducted on the fine grinded leaves of *bambusa vulgaris*revealedthe crude protein (19.10 ± 0.15%), fats and oil as (9.00± 0.10%),carbohydrate level (24.60 ± 0.0257%), and crude fibre (25.60 ± 0.07%). The protein content in the compounded fish meal across the control, D1, D2, D3, and D4 with 38.1 %, 46.5 %, 45.7 %, 42.8 % and 44.4 % respectivelydrastically increase when compared with the protein content in the fine grinded *B. vulgaris*leave. The increase in protein content shows that the formulated fish meal can adequately give the fish the required growth needed for human consumption. Likewise, the presence of flavonoids, phenolics, alkaloids, saponins, terpenoids and tannin in the plant have the ability to protect the fish and in turn human against diseases. *B. vulgaris* is a source of effective bioactive ingredients, including flavones, phenolic acids, and micronutrients. High concentrations of these compounds provide the basis for traditional and modern therapeutic uses, offering potential against fever, epilepsy, and pain. The definitive recommendation for commercial implementation is the mandatory shift toward producing a detoxified functional extract or concentrate. This product must be manufactured using a hybrid processing model.

Keywords: *Bambusa vulgaris*; Plants; Proximate; Phytochemicals

INTRODUCTION

Bambusa vulgaris Leaves commonly known as bamboo leaves, is a member of the grass family *Poaceae* that is widely distributed in tropical and subtropical regions. Bamboo is a versatile plant that has various uses in different fields such as construction, furniture, handicrafts, papermaking, textiles, medicine, etc. Bamboo also has nutritional and medicinal value for humans and animals. The leaves of bamboo are rich in nutrients such as protein, fiber, carbohydrates, minerals, and vitamins, as well as bioactive compounds such as alkaloids, saponins, flavonoids, tannins, and phenols (Hua *et al*., 2019; Dorothy *et al*., 2018). These compounds may have antioxidant, anti-inflammatory, antimicrobial, antidiabetic, antihyperlipidemic, and antitumor activities. Therefore, bamboo leaves may have potential applications as complements in fish feed production.

However, there is limited information on the proximate composition and phytochemical profile of *B. vulgaris* leaves and their potential as complements in fish feed production. Therefore, this study aims to fill this gap by conducting a comprehensive analysis of *B. vulgaris* leaves as nutrient for Catfish (*Clarias gariepinus*).

The taxonomy of *Bambusa vulgaris* has been debated and refined over the years, but it is generally classified under the genus *Bambusa* within the grass family *Poaceae* (Gibson and Johnson, 2018). *Bambusa vulgaris* is one of the largest bamboo species and can be distinguished by its relatively thick culms and large size, which can reach up to 20 meters in height under optimal growing conditions (Thomas *et al.,* 2020). The species is widely accepted to have originated in Southeast Asia, but it has since spread to numerous tropical and subtropical regions around the world (Ren and Wang, 2021).

Taxonomically, *Bambusa vulgaris* belongs to the subfamily *Bambusoideae*, which encompasses more than 1,400 species of bamboo. The species is often confused with *Bambusa oldhamii*, a closely related species that also shares similar ecological and morphological features (Zhang and Liu, 2019).

Bambusa vulgaris is native to the tropical regions of Southeast Asia, particularly in countries like India, China, Myanmar, Thailand, and Malaysia (Zhang and Liu, 2020). Its distribution has expanded significantly due to human cultivation and trade, and it is now found in many tropical and subtropical regions across the globe, including parts of Africa, Latin America, and the Caribbean (Legrand *et al*., 2021). The species thrives in warm, moist environments and is commonly found along riverbanks, in forests, and in disturbed areas that provide adequate sunlight and moisture (Kumar *et al*., 2022).

The nutritional and chemical composition of *Bambusa vulgaris* varies according to the age of the culms, the environmental conditions in which the plant grows, and the specific cultivar. However, research has identified several key nutrients and bioactive compounds that contribute to its potential use as food and medicinal resources.

The young shoots of *B. vulgaris* are edible and are considered a nutritious food source in many parts of Asia and Africa. They are rich in carbohydrates, dietary fiber, and proteins, making them a valuable resource for communities where other food sources may be scarce (Zhou *et al*., 2019). According to studies, the nutritional profile of B. vulgaris shoots includes significant amounts of protein (about 2-3% of fresh weight), a variety of amino acids, and dietary fiber, which contributes to digestive health (Mao *et al*., 2020). In addition to macronutrients, *B. vulgaris* is also a good source of vitamins such as Vitamin C and Vitamin A, as well as several essential minerals like calcium, iron, and magnesium (Zhou *et al*., 2019).

Bambusa vulgaris contains a range of chemical compounds with bioactive properties. Phytochemical analysis has revealed the presence of flavonoids, alkaloids, terpenoids, and phenolic compounds, which are associated with antioxidant, anti-inflammatory, and antimicrobial properties (Qin et al., 2022). These compounds have potential therapeutic applications, including in the treatment of inflammatory diseases, infections, and oxidative stress-related conditions (Wang *et al.,* 2016).

Studies have demonstrated the presence of lignin and cellulose in the woody parts of the culms, making *B. vulgaris* a valuable source of raw material for the paper and pulp industry (Xue*et al.,* 2020). The cellulose content of the bamboo is typically around 45-50%, while lignin content can range from 20-30%, depending on the plant's age and the environmental conditions (Zhao *et al.*, 2016).

Fish is an important source of both food and income to many people in developing countries. In Africa, as much as 5% of the population, some 35 million people depends wholly or partly on the fisheries sector for their livelihood (FAO, 1996a). It is estimated that by 2050, when world population is projected to be over 9 billion, Africa will have to increase food production by 300%, Latin America by 80% and Asia 70% to provide minimally adequate diets for the projected population of 2 billion, 810 million and 5.4 billion people in the respective regions (Anon, 1997). The consumption and demand for fish as a cheap source of protein is on the increase in Africa, because of the level of poverty in the land. The vast majority of the fish

Supply in most cases comes from the rivers in the continent. While capture fisheries based on species that are presently exploited seem to have reached their natural limits (FAO, 1996c), there is considerable potential to expand aquaculture in Africa in order to improve food security (Kapetsy, 1994; Engle 1997, Jamu and Ayinla, 2003). Although potentials abound in the continent for the development of viable fish farming, one of the major hindrances to the development of aquaculture industry in Africa is the lack of locally produced high-quality fish feed. Fish requires high quality nutritionally balanced diet for growth and attainment of market size within the shortest possible time. Therefore local production of fish feed is very crucial to the development and sustainability of aquaculture in Africa especially, in the rural areas. For aquaculture to thrive and bridge the already existing wide gap between fish demand and supply especially in the Sub-Saharan Africa, the vital role of locally produced fish feed in reducing production cost, thereby making fish farming attractive to both private and commercial investors and ultimately boost fish production cannot be overemphasized.

MATERIALS AND METHODS

All the reagents and chemicals used in the study were either B.P grade or U.S.P grade and were procured from the University of Port Harcourt Teaching Hospitals Complex Port Harcourt. All the reagents and chemicals including [Ammonium SulphateNH_4SO_4), Copper Sulphate ($CuSO_4$), Sodium Sulphate (Na_2SO_4), Hydrogen Sulphate (H_2SO_4), Ethanol, Hydrogen peroxideetc] used were of analytical grade and were obtained from either Sigma or BDH and Randox Laboratory Limited County Antrim,UK.

Plant Material was gotten at the University of Port Harcourt Abuja Campus, Aluuand was identity at the by a taxonomist at department of Plant Science and Biotechnology laboratory at the University of Port Harcourt. The leaves were carefully plucked, washed, chopped and sun dried. Furthermore, the samples were oven-dried, macerated to powder and stored until used for the formulation of fish feed at different concentration of the *Bambusa vulgaris* leave meal (BVLM) with other constituents which include wheat bran, soya bean mill, fish mill, vitamin C, lysin, salt etc. The proximate analysis was done according to the procedures below:

Determination of Fats and Oil

The use of Cold method of extraction was adopted in the determination fats and oils in the sample. A clean and dried empty beaker was heated to dryness and transferred into a desiccator to cool. After cooling, the flask was weighed and was recorded as the initial weight (W1). 10g of the sample was accurately weighed into round bottom flask and then 50ml of n-hexane was added into it and covered for 24hours for proper extraction of oil, after which, the flask and its content was reweighed and new weights taken (W2). Percentage fats were calculated thus:

% Fats or oil = ((W2 - W1)/ weight of sample used ×100

Determination of Moisture Content

In this determination, a clean, dry glass petri-dish was initially weighed and the weight was recorded (W1). 1.0 g of sample was added into the accurately weighed glass petri-dish. This was kept in a vacuum oven for 1hour at 105 °C. The dish was removed from the oven, cooled and re-weighed and recorded as

(W2). This process was repeated until a constant weight was attained. This process was repeated for all the samples and the moisture content was calculated in percentage as follows:

% moisture = ((W1-W2)/weight of sample used) ×100.

Protein Determination

The protein nitrogen in 0.5g dried sample was converted to NH_4SO_4 by digestion with concentrated H_2SO_4 and in presence of $CuSO_4$ and Na_2SO_4. This was heated and the ammonia involved was steam distilled in 4% boric acid solution, the nitrogen from ammonia was deduced from the titration of the trapped ammonia with 0. 1N H_2SO_4 with methyl red indicator until a pink coloration was observed indicating the end point of titration. Protein was calculated by multiplying the deduced value of nitrogen by a protein constant of 6.25 mg.

Crude Fibre Determination

2.0 g of sample was added into a beaker and was digested in 200 ml of 1.25% H_2SO_4. The mixture was boiled for 30 minutes and was filtered and washed with hot water to reduce acidity. This was tested with pH paper; the residue was again digested in 200 ml of 1.25% Na0H. The mixture was heated for 30 minutes, filtered and washed with hot water and dried in an oven. This was transferred to a platinum crucible and weighed (W1), then heated in a furnace of 550°C to ash and reweighed again (W2). Percentage fibre was calculated as:

% crude fibre = (W1-W2/weight of sample used) ×100.

Determination of Ash Content

1.0g of sample was accurately weighed in a platinum crucible and recorded as W1, was transferred to muffle furnace at the temperature of 5500° for 8 hours until a white ash was obtained. The platinum crucible was removed and placed in a desiccator to cool and weighed, the value was recorded as W2. Percentage was calculated as:

% ash = (W1-W2)/weight of sample used) ×100.

Carbohydrate Determination

The carbohydrate content of the samples was estimated as the difference obtained after subtracting the values of organic protein, ash content, fat or oil, crude fibre, and moisture content from 100, that is:

100 - (Protein + Ash + Crude fiber + Moisture content).

Phytochemical analysis

The alkaline precipitation gravimetric method by Harborne (1973) was used for the determination of alkaloids. Flavonoids and phenolic acids as well as terpenoids were also determined using the method described by Harborne(1973). Tannin content was determined by Folin-denis colorimetric method described by Kirk & Sawyer (1998). Saponin was determined by double solvent extraction gravimetric method. The phytochemical analysis was done in triplicate.

RESULTS AND DISCUSSION

The investigations on the proximate composition and phytochemicals screening of *bambusa vulgaris*; the results of the proximate analyses in **Table 1**showed the concentration of Moisture , Ash content , Crude protein, Fat and Oil, Crude fibre and Carbonhydrate as 11.20 ± 0.15 %, 10.50 ± 0.31 %, 19.10 ± 0.15 %, 9.00± 0.10 % and 25.60 ± 0.07 % respectively. The quantity of protein in the plant is adequate for an optimal growth in fish when used for fish feed formulation. Other constituent used in the formulation of *bambusa vulgaris* leave meal (BVLM) such as fish meal, red oil, soya bean mill and wheat bran contributes to addition protein and carbonhydrate content as seen in **Table 2**. The protein concentration increase in the formulated fish feed drastically when compared with the protein content in the fine grinded *bambusa vulgaris* leave. The protein concentration were 38.1 %; 46.5 %; 45.7 %; 42.8 %; and 44.4 % in D1, D2, D3 and D4 respectively. From **Table 2**, the control has the lowest concentration of protein and this is due to the exclusion of *bambusa vulgaris* leave meal (BVLM), this shows that the inclusion of BVLM at different concretion in the test group has the potential for nutritional stability and growth on the fishes. The group fed with foreign fish meal (Fo) has high concentration of protein with 73.2 % while group fed with the local conventional fish feed (Lo) has 48.2 % protein content. The protein concentration in Diet 1 can be compared with the Lo group as proof of high level protein in our test groups. The carbonhydrate content also is important in this study. Energy is vital in all living organism. The carbonhydrate content is adequate when compared with the control with 18.3 % against the test of in D1; D2; D3 and D4 with carbonhydrateconcentration of 15.4 %; 12.6 %; 15.7 % and 14.5 % respectively. The optimal carbonhydrate level were seen in the control group with 18.3 % which is a proof that our test groups has more of protein which is the main source of growth.Furthermore, the results of the phytochemicalcontents (**Table 3**) shows that flavonoids, phenolics, alkaloids, saponins, terpenoids, and tanins content are present. They neutralize harmful free radicals, reducing oxidative stress that can damage cells and DNA. This protective mechanism is key in preventing many chronic diseases. They help regulate the body's inflammatory response by modulating inflammatory enzymes and signaling pathways, which can reduce chronic inflammation associated with numerous diseases.

Table 1: Proximate composition of the fine grinded leaves of *Bambusa vulgaris* gotten from the University of Port Harcourt, Aluu

PARAMETERS	CONCENTRATION(%)
% Moisture content	11.20 ± 0.15
% Ash content	10.50 ± 0.31
% Crude Protein	19.10 ± 0.15
% Fats/Oil	9.00± 0.10
% Crude Fibre	25.60 ± 0.07
% Carbohydrates	24.60 ± 0.02

Table 2. Proximate analysis of the formulated diet of *Bambusa Vulgaris* leaves

PARAMETERS	Crtl	Diet 1	Diet 2	Diet 3	Diet 4	Foreign	Local
Moisture (%)	3.2	7.0	6.9	5.6	4.7	0.3	0.1
Ash Content (%)	6.8	6.2	5.8	7.8	8.8	2.5	1.0
Fat and Oil (%)	12.2	11.1	14.4	12.7	14.8	4.8	5.8
Protein (%)	38.1	46.5	45.7	42.8	44.4	73.2	48.2
Carbohydrate (%)	18.3	15.4	12.6	15.7	14.5	5.2	32.9
Crude Fibre (%)	11.4	13.8	14.6	15.6	12.8	14.0	12.0

Table 3: Phytochemical Properties of *Bambusa vulgaris leaves*

COMPOUND	RESULTS	
	Positive	**Negative**
Alkaloids	+	
Saponin	+	
Tanin	+	
Flavonoid	+	
Terpenoids	+	
Total Phenol	+	
Steroids	+	
Anthocyanidins-		
Phytoestrogen		-
Carotenoids		-
Glucosinolate		-

CONCLUSION

In Summary, considering the proximate and phytochemical properties of *bambusa vulgaris*on the fish feed formulation, the results obtained from the laboratory analyses proofs high nutritional and phytochemical agents in the plant for proper growth and immune functionon the fishes and in turn humans.The primary commercial value of *B. vulgaris* in aquafeeds lies in its robust phytochemical profile, which provides significant therapeutic and functional benefits. The analysis confirms that *Bambusa vulgaris* possesses a phytochemical profile that positions it as a highly promising functional ingredient for sustainable aquaculture, offering significant immunomodulatory, antioxidant, and growth-promoting benefits for key species like Nile tilapia.

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