ISSN: 2754-4958

Journal of Aquaculture & Livestock Production

SCIENTIFIC Research and Community

Research Article

Open Access

Growth Performance and Carcass Analysis of African Catfish (*Clarias Gariepinus*) Juveniles Fed Varying Inclusion Levels Of Butterfly Pea (*Clitoria Ternatea*) Seed Meal

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ABSTRACT

High cost of qualitative fish feed is one of problems hampering the development and profitability of fish farming and consequently leads to food insecurity in terms of food availability and accessibility. The study was conducted to determine growth parameters and carcass composition of *Clarias gariepinus* juveniles of mean weight 21.74g+0.54g fed with varying levels of dietary inclusion of *Clitoria ternatea* seed meal substituted for soybean meal over a period of eight weeks. Four iso-nitrogenous experimental diets were formulated at 0% (control), 25%, 50% and 100% inclusion levels of *C. ternatea* seed meal. The 8-week feeding experiment was conducted in rectangular plastic tanks, each treatment having three replicates with two feeding regime at 5% body weight and weighed every week. At the end of the intensive feeding period, samples from each treatment were oven dried for nutritive analysis of the fish carcass. The values of mean weight gain for diets I and III were 27.7+1.11 and 27.23+0.94 respectively. Comparatively, the growth parameters values; FI(g), SGR(%), FCR(g), PER(%) and NPU(%) for control diet and diet III were the best with no significant difference ($p>0.05$). The Carcass evaluation revealed that Diet I had the highest crude protein which was not significantly different ($p>0.05$) from diet III. It was established that fish fed 50% inclusion level of *C. ternatea* seed meal had effective comparable biological values with the control diet in terms of growth performance and feed utilization. The total fish production (kg) showed no significant difference ($p>0.05$) between diets I and III.

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Received: August 20, 2021; **Accepted:** August 26, 2021; **Published:** August 30, 2021

Keywords: Growth Performance, Carcass, Juveniles, *Clitoria Ternatea*, *Clarias Gariepinus*, Food Security.

Introduction

Fish continues to make substantial contributions to animal protein requirements. There has been a steady increase in aquaculture produce (inland and marine) from about 55.7 million tons in 2009 to 167.2 million tons in 2014. Fish is very important in developed and developing countries as it serves as source of food (animal protein for both man and livestock), income, employment, and recreation for people. In Africa, it is one of the cheapest and direct sources of protein and micro nutrients for millions of people. *Clarias gariepinus*, also known as African mud catfish, is the most popularly cultured fish in Nigeria. It has the ability to feed on variety of food items ranging from zooplankton to fish. Catfish has been credited for being hardy, resistant to handling stress and possessing better growth and feed conversion abilities. The high quality and better taste of its flesh makes it a highly demanded fish, hence there is a need to increase the local production of this species while reducing production cost [1-4].

Feed is one of the major inputs in aquaculture production, however fish feed technology is one of the least developed sectors of aquaculture particularly in Africa and other developing countries of the World [5]. In Nigeria, high cost of fish feed has been observed as one of the problems hampering the development of aquaculture has noted that expensive feeds will marginalized or even nullify the profitability of fish farming thereby incapacitating the expansion of farms to increase production and consequently low yield in terms of quality and quantity, resulting in the scarcity of the commodity (fish) and eventually high cost of the few available ones to the disadvantage of the populace [5,6].

In a bid to reduce the cost of fish production and maximize profit, many researches are being conducted to identify non- conventional feed resources that are less expensive and readily available. A number of plants continue to be investigated for their potential in supplementing or even replacing fish meal, and. They are known as non-conventional plant feedstuff. According to, they are many and abundant almost in every locality in Africa. Their potential and utilization in aquaculture have been reviewed with their levels of inclusion in aqua feed depending on their availability, nutrient level, processing, techniques, species of fish and cultural farming pattern prevalent in the locality [7-10].

The non-conventional plant feedstuff have so many factors which limit higher level of incorporation in the diet. These include;

low protein content, amino acid imbalance and presence of antinutritional factors [11-13]. The plant source of feed that are already in use are; Soybean, Corn grain, Rice bran sunflower, sorghum. *Clitoria ternatea* commonly known as Butterfly pea belonging to the family *Fabaceae* and sub-family *Papilionaceae* is a perennial leguminous twiner. *Clitoria* Linn. Comprises 60 species distributed mostly within the tropical belt with a few species found in temperate areas. It is found in low and medium altitudes of the settled areas. The mostly frequently reported species is *Clitoria ternatea*. It is a strongly persistent, sparsely pubescent, legume. It is a perennial climber with slender downy stem, found throughout the tropical regions of the country being cultivated in gardens everywhere and often also found growing over hedges and thickets. *Clitoria ternatea* seeds are mainly used as a forage as it is highly palatable for live-stock and it is well adapted to various climates [14]. *Clitoria ternatea* seeds meal has nutrient density that is comparable to any other protein sources. It has a good amino acid profile with its essential amino acids level (except lysine) higher than soybean meal [15]. The use of *Clitoria ternatea* seed meal in fish diets is not well documented compared to other forage crops; used detoxified *Jatropha kernel* meal for rainbow trout; used detoxified *Jatropha curcas* meal for carp; and also used boiled *Jatropha kernel* meal for *Clarias gariepinus* [16-18].

Soybean meal is one of the major feed ingredients used in fish feed production. The ever increasing price of this feed resource has necessitated the need for a search of replacement which could be an ideal nutritional source of dietary protein for fish. Lot of studies have been on the utilization of some non- conventional plant protein source as replacements for soybean in order to reduce feed cost and contribute to feed security. The importance of the development of non-human food grade feed resources whose growth can cope with the projected and fast growth of the sub-sector has been stressed by [19-21]. There is a dearth of knowledge specifically for the replacement of soybean meal with *Clitoria ternatea* in the diet of *Clarias gariepinus*. *Clitoria ternatea* is a high-quality protein rich legume, which is often referred to as a protein bank that can be grown at low cost [22]. This study therefore investigated the growth response and carcass composition of *Clarias gariepinus* juvenile fed *Clitoria ternatea* seed meal.

Methodology

Study Location

The experiment was carried out in the Fish Biology Laboratory of Oyo State College of Agriculture and Technology, Igboora, Oyo State Nigeria.

Source of Ingredients, Diet formulation and Preparation

Fishmeal, Groundnut Cake, Soybean meal and Maize were obtained from the market while Butterfly pea seed (*Clitoria ternatea* seed) was freshly plucked from the pasture and ranch Department of Animal Health and Production of Oyo State College of Agriculture and Technology, Igboora Oyo State. Nigeria and was identified from a herbarium in the department. The diets used in the experiment were formulated and iso-nitrogenous (40% CP) containing 0%, 25%, 50% and 100% inclusion levels of Butterfly pea seed (*Clitoria ternatea*) meal. The seed was extracted from the cob, processed and was oven dried at 70°C using electric oven. All ingredients were grinded into powdery form using burr mill and mixed thoroughly with the use of hand. Warm water was added to the premixed ingredients and homogenized to a dough-like paste. This was then pelletized using a 2mm pellet press. The pelletized feed was later sun-dried for 4 days, stored in airtight containers.

Table 1: Gross Composition of Fed Ingredients in Test Diets (Iso-nitrogenous)

Ingredients	Diet I	Diet II	Diet III	Diet IV
Replacement level Variable ingredients	0%	25%	50%	100%
Fishmeal (kg)	24	24	24	24
Maize (kg)	30	30	30	30
GNC (kg)	20	20	20	20
Soybean (kg)	25	18.75	12.5	0
Clitoria seed meal (kg)	0	6.25	12.5	25
Lysine (kg)	0.1	0.1	0.1	0.1
Methionine (kg)	0.1	0.1	0.1	0.1
Vitamin C (kg)	0.1	0.1	0.1	0.1
Salt (kg)	0.1	0.1	0.1	0.1
Bone meal (kg)	0.1	0.1	0.1	0.1
Premix (kg)	0.5	0.5	0.5	0.5
Total (kg)	100	100	100	100

Experimental procedure

The experiment was laid out in a Simple Randomized Design (SRD) which was replicated three times. The total number of 144 *Clarias gariepinus* juveniles with average weight 21.74g+0.54g were randomly distributed across a total of twelve plastics tanks at stocking density of 12 juveniles per tank. The fish were acclimatized for two days before the start of the feeding trials. The feeding trial was conducted in an experimental unit containing a set of 12 rectangular plastic tanks, each with a capacity of 55 L of water. The 35 L of water was maintained in each tank and changed at 3-day intervals at 60: 40 (stale and fresh water ratio). This was done to avoid incessant seemingly environmental shock as a result of the new environment when the whole water is changed. The four treatments (0%, 25%, 50%, and 100% concentration of *Clitoria ternatea* seed meal) were administered to the fish in triplicates. Experimental fishes were fed twice daily at a fixed feeding rate of 5% body weight day-1. Feeding were done in the mornings at 09.00 and 15.00

h except on sampling day when they were fed after weighing for 8 weeks.

Data collection for growth parameters and feed utilization evaluations

Data on fish growth characteristics were measured weekly and at the end of the experiment. The following parameters were measured;

- Weight gained = final weight- initial weight
- Specific growth rate (SGR) = $\frac{\text{Final Weight – Initial weight}}{\text{Duration of the Experiment (Days)}}$
- Feed conversion ratio (FCR) = $\frac{\text{Feed intake}}{\text{Body weight gain}}$
- Survival rate = $\frac{\text{Total number of dead fish}}{\text{Total number of stocked}} \times 100$
- Protein efficiency ratio = $\frac{\text{Mean weight gain}}{\text{Average crude protein feed}}$
- Net protein utilization = $\frac{\text{Net protein in carcass}}{\text{Protein feed}} \times 100$
- Percentage weight gain = $\frac{\text{Mean final weight gain – Mean initial weight}}{\text{Mean Initial weight}} \times 100$
- Total fish production (kg/m^3) = $\frac{\text{Final weight X Survival rate}}{1000\ (L)}$

Carcass Analysis

The fish samples of each treatment were dried and taken to Animal Sciences Laboratory University of Ibadan to analyse the Crude protein, Ash, Fibre, Ether Extract and Dry matter content of the carcass following standard methods [23].

Proximate composition of Butterfly pea seed (*Clitoria ternatea*) The seed was processed, dried and taken to Animal Sciences Laboratory of University of Ibadan to analyze the crude protein, ether extract, ash content and dry matter according to the standard methods [23].

Statistical analysis of data

All the data obtained were statistically analysed using analysis of variance (ANOVA) for significant differences in the treatment means, and the mean separation was achieved by using Duncan Multiple Range Test using the SAS software.

Results

Chemical composition of feed ingredient (*Clitoria ternatea*)

The feedstuff for fish diet formulation and preparation can be best evaluated on the basis of its nutritive analysis. The proximate composition of *Clitoria ternatea* seed meal is presented in Table 2. The results showed that the leguminous seed plant was protein based as its had 40% CP, 9.5% CF, 13.7% C fat, 2.9% ash contents and 10% moisture contents.

Table 2: Proximate Composition of Butterfly pea seed (*Clitoria ternatea*) Fed to *Clarias gariepinus* Juveniles

Crude protein%	Crude Fibre %	Ether extract %	Ash content %	Dry matter %
40	9.5	13.7	2.9	90.01

Table 3 shows the growth performance and feed utilization of juveniles in each treatment. Diet 1 (27.7+1.11g) and III (27.23+0.94g) recorded the highest weight gain followed by Diet II (25.3+0.71g) while fish fed Diet IV (22.2+1.73g) has the lowest weight gain. Although Diet I had the highest values for Percentage Weight Gain, Protein Efficiency Ratio, and Survival Rate, the analysis of variance showed that there was no significant difference ($p>0.05$) in the Weight Gain, Protein Efficiency Ratio, Food Conversion Ratio and Net Protein Utilization of Diets I and III. The specific growth rate of Diet I, II and III also showed no significant difference ($p>0.05$) with Diet IV recording the least specific growth rate (0.4%). The survival rate across the diets differed significantly ($p>0.05$) and subsequent fish produced (kg) varied between 0.42kg-0.55kg in diets II and I respectively.

Table 3: Growth Performance of African Catfish (*Clarias gariepinus*) Juvenile Fed Varying Inclusions of *Clitoria ternatea* Seeds Meal

Parameters	DIET 1	DIET 2	DIET 3	DIET 4
Average Initial Weight (g)	21.90+1.54^a	21.10+2.08^a	22.57+1.03^a	21.4+0.89^a
Average Final Weight (g)	49.6+2.77^a	46.4+1.48^b	49.8+2.15^a	43.6+1.13^c
Average Weight Gain (g)	27.7+1.11^a	25.3+0.71^b	27.23+0.94^a	22.2+1.73^c
Percentage Weight Gain (%)	126.5+4.42^a	120+2.18^b	120.6+3.73^b	103.7+2.19^c
Feed intake (g)	14.8+1.08^a	13.7+0.82^b	14.6+0.91^a	13.6+0.54^b
Specific Growth Rate (%)	0.5+0.10^a	0.5+0.05^a	0.5+0.08a	0.4+0.03b
Feed Conversion Ratio (g)	0.53+0.04b	0.54+0.02b	0.53+0.02b	0.61+0.04a
Protein Efficiency Ratio (%)	0.70+ 0.02a	0.63+0.05b	0.68+0.03a	0.55+0.03c
Net Protein Utilization (%)	155+5.14c	168.5+3.89b	156.5+4.17c	200+5.14a
Survival Rate (%)	92.0+1.33a	75.0+1.67c	90.8+0.33^b	92.0+1.67a
Total fish production (kg/m^3)	4.56±0.12a	3.50±0.32c	4.52±0.21a	4.01±0.33b

* Mean values along the row with different superscripts are significantly different ($p<0.05$)

Final carcass composition is presented in table 4. Diet I had the highest crude protein value of 56.73+3.72 followed by diet III while diets II and IV had the lowest mean crude protein of 53.14+4.10, 51.75+1.89 respectively. The crude protein composition of fish fed diet I and III were not significantly different ($p>0.05$) while others differed significantly ($p>0.05$). There was also significant difference ($p>0.05$) in the moisture contents of the fish fed different diets. The test organism efficiently utilized the available fat from

the butterfly pea seed meal as a source of energy for its physiological development. While the mineral contents of Clarias gariepinus juveniles increased significantly, an indication that the butterfly pea seed meal enhanced the mineralization of the fish species.

Table 4: Final Carcass Composition of African Catfish (Clarias gariepinus) Juvenile Fed Varying Inclusions of Clitoria ternatea Seeds Meal

Parameters	DIET 1	DIET 2	DIET 3	DIET 4
Moisture	9.71+0.24^{a}	7.87+2.17^{bc}	8.19+0.47^{b}	7.17+2.18^{c}
Crude protein	56.73+3.72^{a}	53.14+4.10^{b}	56.47+3.11^{a}	51.75+1.89^{b}
Crude fibre	0.10+0.01^{a}	0.14+0.02^{a}	0.17+0.01^{a}	0.24+0.04^{a}
Ash	4.64+0.81^{b}	5.71+0.41^{a}	4.78+0.31^{b}	3.84+0.19^{c}
Esther extract	12.19+1.18^{a}	11.76+1.04^{b}	11.45+1.21^{b}	10.32+1.74^{c}
Nitrogen free extract	16.63+0.91^{d}	21.33+1.35^{b}	18.94+2.17^{c}	26.72+2.08^{a}

*Values along the row with different superscripts are significantly different $p<0.05$

Discussion

Protein requirement is given high priority in any nutritional study because it is the nutrient that is required in the largest quantity for growth and development. Protein based ingredients are also the most expensive ingredients in diet formulation [24]. Variations may occur in individual feed stuffs as a result of their variety, climatic condition and processing methods. Studies have been conducted on the replacement of the conventional protein based diet such as fishmeal, soybean meal and groundnut cake with unconventional ones for African catfish production, and. stated that anti-nutritional factors in plant based protein rich ingredients may cause irritation of digestive tract which is capable of decreasing feed intake and growth [25,26].

Table 3 shows parameters examined and recorded in the growth performance and nutrient utilization of C. gariepinus at inclusion levels of 0%, 25%, 50% and 100% of Clitoria ternatea seed meal in the diets. The mean weight gain (MWG) result showed the weight of the fish increased across the diets after 8 weeks of feeding trials. Also, feed intake across the diets indicated that the diets were accepted because of their palatability which is a function of handling methods. The processing technique might have ameliorated the effects of embedded anti nutritional factors of Butterfly seed pea. The observation agrees with the reports of the authors reported that reduction in anti-nutritional factors by different processing methods resulted in better palatability and growth in fish [27-29]. The feeding trial shows that the soyabean-based diet (control) performed best in terms of growth; feed intake, weight gain, percentage weight gain and specific growth rate. But contrary to the opinion of [17]. This is an evidence that protein quality of Clitoria ternatea was effectively utilized by Clarias gariepinus juveniles. This result agrees with growth performance of Clarias gariepinus and Tilapia (O. niloticus) as reported by who reveals that 30% boiled jatropha kernel meal as a substitute for soya bean meal in diet of African mud fish Catfish fingerlings showed best growth indices. reported that the inclusion of hydrolyzed feather meal in the diet of O. niloticus could replace 30% of the expensive fish meal without deleterious effects on fish growth and feed conversion efficiency. Processing method used may have contributed significantly to the suitability of the diets for feeding of Clarias gariepinus. Feed utilization was higher in the control diet (Diet 1) which is closely followed by Diet III with 50:50% soybean meal and Clitoria ternatea seed meal. The analysis of variance showed that the weights gain of the diet I (27.7g) and diets III (27.23g) were not significantly different ($p > 0.05$) [30].

Feed conversion ratio (FCR) is the quantity of feed required to produce one unit weight of fish. Treatment IV recorded the highest (0.61) FCR which was significantly higher than ($p<0.05$) other treatments observed. Thereby making other diets (I, II and III) more efficient which is evidenced in comparative total fish produced. reported that a lower FCR indicated a more efficient feed or feeding strategy [31]. The protein efficiency ratio (PER) is based on the weight gain of the test organism divided by the protein consumed for a particular diet during the period of the experiment. It is the measure of growth using the dietary protein as an index [24]. The variation of Protein efficiency ratio of the various diets suggests the bulk of the protein consumed and converted to weight gain. However, from the result, diet III recorded the closest value (0.68) to the control treatment which had the highest (0.70) PER. The analysis of variance revealed that there was no significant difference ($p<0.05$) in the PER for both diets I and III.

Carcass analysis of the juveniles fed all the various diets showed that the fish retained considerable high crude protein after the experiment. This is similar to the findings of who recorded a correspondingly high crude protein retained in the carcass of Clarias gariepinus fed varying dietary protein levels. This revealed that the protein to energy ratio in the used diets was at the right proportion. The analysis of variance showed that the crude protein content of fish fed the diet I (56.73) and diet III (56.47) were not significantly different ($p<0.05$). The carcass evaluation showed variations in fat content of the test organism across the diets. It is observed that, the higher the inclusion level of butterfly pea seed meal the lower the fat contents. An indication that, the non-conventional feed stuff was able to meet the energy requirement of the test animal. Though carcass fat contents were significantly high in fish across the diets, thus sparing protein to be utterly geared towards growth and development. This result agrees with the opinion of who reported that high level of fat does not pose any concern, rather it has curative heart diseases. Ash is a measure of the mineral content of food item. The consequential residual balance after organic matter has been burnt off. The observed range of ash content in the test organism across the diets indicates that the test feed ingredient was a good source of minerals. The ash values were significantly different ($P>0.05$) across the diets [32,33].

Conclusion

From the experiment and the results obtained, Diet III with 50% inclusion of Clitoria ternatea seeds meal can efficiently replace soybean meal as its showed favourable growth indices comparatively with the control diet in terms of weight gain, specific growth rate, feed conversion ratio, protein efficiency ratio and in feed intake. The Carcass analysis showed that the fish retained considerable high crude protein after the experiment.

This showed that the protein to energy ratio used in the feed was at the right proportion. Hence, the different nutrient compositions of the experimental diets had considerable effects (variations and similarities) on the growth response and feed utilization of the Clarias gariepinus (African Catfish) juveniles.

Recommendation

Due to the high cost of conventional fish feed ingredients; it is therefore advisable for fish farmers to introduce non-conventional fish feedstuff like Clitoria ternatea seed meal to reduce the high cost of fish production. Hence, Clitoria ternatea seed meal can be used to replace soybean meal in the diet of cat fish at 50% inclusion level to reduce mortality rate, enhance growth, high yields and profits of the aqua-business.

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