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Research Article

Preliminary Assessment of Growth Performance and Nutrient utilization of *Clarias gariepinus* (Burchell, 1822) Fingerlings fed *Cirina forda* (Westwood, 1849) as Protein Source

Abstract

The potentials of *Cirina forda* as a replacement for fishmeal in the diets of *Clarias gariepinus* fingerlings were evaluated in 56 days. Five diets namely diets A (100% fishmeal and 0% Cirina *forda*), B (75% fishmeal and 25% *Cirina forda*), C (50% fishmeal and 50% *Cirina forda*), D (25% fishmeal and 75% *Cirina forda*), and E (0% fishmeal and 100% *Cirina forda*) were compounded and given to the fingerlings at 5% body weight. Growth performance traits and nutrient compositions were measured, recorded and analysed. The highest final mean weight and mean weight gain were obtained in diet E containing 100% Cirina *forda* while the least values were recorded in diet C at 50% inclusion of *Cirina forda*. This indicates that *Clarias gariepinus* can tolerate 100% *Cirina forda* as a protein source without any inclusion of fishmeal. This will subsequently reduce the cost of feed production in the culture of *Clarias gariepinus.*

Introduction

Human beings need protein to be healthy as reported by [1,2]. The catfish, *Clarias gariepinus* which is a good source of protein and other nutrients for human health also needs protein in its diet. Culture of *Clarias gariepinus* is one of the preferred means of survival among Nigerians, especially the fresh graduates and pensioners. However [3], reported that the culture of catfish has faced a lot of challenges. One of these is availability of cheap and quality feed as the price of imported fish feed has escalated because of the present economy of the country. Fish feed can be prepared locally but the common protein sources used which include fishmeal are either expensive following the present market survey or according to [4], the plant sources such as soybean and some vegetables are needed to be given with caution to avoid negative effects such as retarded growths and deaths of the fish [5]. Also added that the prices of fishmeal will remain high in the long term because of constant demand and limited supply. It was further reported that in 2015, the major exporters which are both Peru and Chile had the lowest export volumes in the past six years. Therefore, the use of insects such as *Cirina forda* (a lepidoptera) as feed or feed supplement for cultured fish like *Clarias gariepinus* is inevitable, especially in this period of economic recession in Nigeria where people can hardly eat balanced diet daily [6], also emphasised that hunger causes bad health, low energy levels, reductions in growth and mental functioning and it can consequently lead to greater poverty by limiting people's ability to work and learn, thus leading to greater hunger.

Fish biologists have worked on organisms like *Moringa olifera* [7]. *Macrotermes subhyalinus* [8], maggot of *Musca domestica* [9], *Zonocerus variegatus* [10], to replace fishmeal in fish culture. [11] listed *Cirina forda* as one of the edible insects in Nigeria which according to [12], contains a level of crude protein ranging between 46.5 and 79.6%. As a result of its high crude protein content, *C. forda* is being used to replace fish meal in the diet of fish and poultry animals [13]. This research is aimed at investigating the potentials of *Cirina forda* larvae, as an alternative to fishmeal in fish culture by assessing the growth performance of *Clarias gariepinus* using *C. forda* as protein source with a view to determining its suitability in replacing fish meal in the feed ration of fish.

Materials and Methods

Dried larvae of *Cirina forda* were purchased from the Oja Oba, Ado-Ekiti while all the other feed ingredients such as maize, groundnut cake, soyabean, fishmeal, premix, bonemeal, palm oil, starch and salt were purchased from (Metrovet) feed mill, Ado-Ekiti in Ekiti State of Nigeria. These were transported to

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the Department of Zoology laboratory in Ekiti State University where the experiment was carried out.

Fingerlings of average weight of 1.8 g were bought at the Ondo State Sunshine Fishery Akure, and transported to the laboratory. The experimental plastic tanks used for the experiments were 25 l capacity plastic bowls filled with water of about 15 l. After 48 h of acclimatization, the 56-day feeding trials commenced. The catfish were fed twice daily between 08:00 a.m. to 09:00 a.m. and 05:00 p.m. to 06:00 p.m. at 5% of their body weight. The weight of the fish in each tank was taken once every week and feeding rate adjusted accordingly. Cleaning of the tank was done daily to remove unconsumed food particles to prevent poor water quality.

Feed formulation

The larvae of *Cirina forda* was totally dried in an oven for about 30 minutes and milled into powder form using grinding machine. The feed ingredients, were used to prepare the experimental feed, in which *Cirina forda* was used to replace fishmeal at five inclusion levels tagged diets A, B, C, D and E by varying the concentrations of the *C. forda* in each diet. Diet A (control) contained 100% fishmeal and 0% *C. forda* larvae, diet B contained 25% *C. forda* larvae, diet C contained 50% *C. forda* larvae, diet D contained 75% *C. forda* larvae, diet E contained 100% *C. forda* larvae with the diets having three replicates each. After preparing the ingredients, they were weighed and mixed in appropriate proportions to give the desired protein level required by the fish.

Feed evaluation parameters

Performance characteristics were determined according to the method of [14] as follows:

Mean Weight Gain (MWG) = Final mean weight (g) - Initial mean weight (g);

Percentage Weight Gain (PWG) = Mean weight gain (g) / Final mean weight X 100;

Specific growth rate (SGR % /day) = 100[(LogeW2 – LogeW1)/No of days;

Feed conversion ratio (FCR) = Total feed fed (g) / Net weight gain (g).

Statistical analysis

Evaluation of the growth performance and nutrient utilization parameters were assessed by one-way analysis (ANOVA) of variance using SPSS 15.0. Significant differences among means were determined using Duncan's Multiple Range Test (DMRT).

Results

Tables 1 and 2 show the mean proximate composition of *Cirina forda* larvae and composition of experimental diets.

Table 3 shows the growth performance and nutrient utilization of *C. gariepinus* fingerlings fed diets A (control), B (25%), C (50%), D (75%), and E (100%). Fish fed diet E had the highest (17.89±1.99) initial mean weight while those fed diet B had the least (14.80±0.74). For the final mean weight, fish fed diet E had the highest (33.77±14.75) while fish fed diet C had the least (22.34±5.23). Fish fed diet E had the highest mean weight gain of 18.01±13.54 while the fish fed diet C had the lowest mean weight gain of 5.31±4.95. For the percentage mean weight gain, fish fed diet E had the highest (53.33±89.69) while those fed diet C had the least (23.77±28.25). Fish fed diet D had the highest specific growth rate (0.59±0.21) while fish fed diet C had the least (0.20±0.15). Feed conversation was mostly efficient in catfish fed diet D (1.06±0.76) while it was least efficient in the catfish fed diet C (7.92±6.28). The results from the table also showed that the final mean weight (g) of specimens fed diets A, B, D and E did not show any significant differences among themselves but significantly different ($P<0.05$) from diet C. Furthermore, whereas the mean weight gain followed the same pattern with the final mean weight, the percentage weight gain showed significant differences ($P<0.05$) among the diets. The specific growth rate showed no significant differences among the diets while in the feed conversion ratio, there were significant differences ($P<0.05$) among the diets.

Table 4 shows the mean proximate composition of the experimental diets. The moisture content was highest in diet E (9.30±0.78) and least in diet D (8.41±0.61) while the % ash was highest in diet D (12.67±0.69) and least in diet C (4.88±0.08). The percentage fat was highest (11.24±0.48) in diet D and least (5.14±0.06) in diet B. The crude protein was highest (61.55±2.42) in diet C and lowest (24.29±2.45) in diet A. The

Table 1: Mean proximate composition of *Cirina forda* larvae.

Components	Percentage (%) of components
Moisture content	5.25
Fibre content	7.69
Ash content	6.49
Protein content	45.1
Fat content	18.03
Carbohydrate	17.44

Table 2: Composition of experimental diets

Ingredients	Diet A	Diet B	Diet C	Diet D	Diet E
	0%	25%	50%	75%	100%
Fish meal	24.72	18.54	12.36	6.18	-
Maize	21.85	21.85	21.85	21.85	21.85
Cirina forda	-	6.18	12.36	18.54	24.72
Groundnut	24.72	24.72	24.72	24.72	24.72
Soya bean	24.72	24.72	24.72	24.72	24.72
Palm oil	01	01	01	01	01
Bone meal	01	01	01	01	01
Premix	01	01	01	01	01
Salt	0.50	0.50	0.50	0.50	0.50
Starch	0.50	0.50	0.50	0.50	0.50
Total	100	100	100	100	100

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percentage fibre was highest (3.32±0.17) in diet C and lowest (1.06±0.04) in diet D.

Table 5 shows the result of the proximate composition of the flesh of *C. gariepinus* fingerlings fed diets A-E after the experiment. Fish fed with diet B had the highest moisture content (12.98±1.06) while diet C had the lowest (9.19±0.81). The ash content was highest in control diet A (17.48±0.13) and lowest in diet B(12.02±0.50). The % fat was highest (8.97±0.06) in diet C and lowest (7.30±0.12) in diet A. The % crude protein was highest in diet B (75.14±2.41) and lowest in diet E (31.05±2.44). Crude fibre was not detected in the fish specimens.

Discussion and Conclusion

The moisture content of *C. forda* larvae was 5.25% which [15], considered low and could make them resistant to microorganism attack thereby increasing their shelf life. Also, the protein content of 45.10% is within the range of 15 to 60% reported for different Lepidopterans [16] and can be compared with protein content of 55.50%±1.20% obtained by [17]. At 25%, 75% and 100% levels of diets, the fingerlings gave comparable growth values as in the conventional fishmeal diet although the highest values of all growth performances were recorded for the fish fed the experimental diets. This suggests that the compounded larval diets contained a protein level which is comparable and even higher in quality to that present in the conventional fishmeal. This result agreed with the findings of [13], who reported that there were no significant differences between the growth performances of broiler chicks fed the compounded *C. forda* larvae and those fed the conventional fishmeal. At either the starter or finisher phase, the larvae diets gave comparable growth values in the broiler chicks like the conventional fishmeal diet. *C. forda* showed higher specific growth rates comparable to fishmeal. *C. forda* larvae in dried form had been confirmed to contain 57.96% crude protein and also able to cause higher growth rate comparable to that observed in the fishmeal probably because of its high protein content and presence of essential minerals and vitamins like sodium, potassium, zinc and manganese [18].

Several findings have indicated the potentials of vegetable protein sources in providing fish with essential protein needed for them [7,19,20]. However, the occurrence of high amounts of fibre, carbohydrate and other organic molecules like cyclopropenes, glucosides and phytates in these vegetable sources give some problems that are usually not encountered with animal origin sources [21].

The fingerlings fed diet D (75%) showed superior feed conversion ratio (1.06±0.76) in general followed by the fingerlings fed diet A (1.11±0.65) and diet E (1.57±1.66) compared to the fish fed diet C (7.92±6.28) whose diet had the highest protein. The observation shows that the fingerlings were able to utilize the *C. forda* larvae diet efficiently like the

Table 3: Growth performance and nutrient utilization of *Clarias gariepinus* fingerlings fed *Cirina forda* larvae as protein source

Parameters	Diet A 0%	Diet B 25%	Diet C 50%	Diet D 75%	Diet E 100%
Initial mean weight(g)	17.31±0.97[a]	14. 80±0.74[b]	17.03±0.38[a]	15.64±1.51[b]	17.89±1.99[a]
Final mean weight (g)	33.57±8.33 [a]	30.83±10.96[a]	22.34±5.23[b]	33.44±5.98[a]	33.77±14.75[a]
Mean weight gain (g)	16.27±7.44 [a]	16.03±11.59[a]	5.31±4.95[b]	17.80±7.44[a]	18.01±13.54[a]
% mean weight gain (g)	48.47±37.22[a]	51.99±81.26[b]	23.77±28.25[c]	53.23±39.77[b]	53.33±89.69[b]
Specific growth rate (g)	0.49±0.14[a]	0.52±0.34[a]	0.20±0.15[a]	0.59±0.21[a]	0.51±0.17[a]
Feed conversion rate	1.10±0.65[a]	3.07±4.23[b]	7.92±6.28[c]	1.06±0.76[a]	1.57±1.66[a]

Means with same superscript in the same row are not significantly different at (P<0.05).

Table 4: Mean proximate composition of experimental diets.

Parameters	Diet A 0%	Diet B 25%	Diet C 50%	Diet D 75%	Diet E 100%
% moisture content	8.92±0.64[a]	8.77±0.67[a]	8.85±0.70[a]	8.41±0.61[a]	9.30±0.78[a]
% ash	8.11±0.02[b]	8.66±0.06[b]	4.88±0.08[d]	12.67±0.69[a]	6.88±0.04[c]
% fat	6.69±0.08[b]	5.14±0.06[c]	5.44±0.09[c]	11.24±0.48[a]	6.18±0.06[b]
% crude protein	24.29±2.45[c]	39.14±1.23[b]	61.55±2.42[a]	37.14±2.40[b]	39.80±2.45[b]
% fibre	1.77±0.08[a]	2.14±0.04[b]	3.32±0.17[c]	1.06±0.04[a]	2.08±0.04[b]

Means with same superscript in the same row are not significantly different at (P<0.05).

Table 5: Proximate compositions of flesh of *Clarias gariepinus* fed experimental diets.

Parameters	Diet A 0%	Diet B 25%	Diet C 50%	Diet D 75%	Diet E 100%
% moisture content	10.73±0.86[c]	12.98±1.06[a]	9.19±0.81[b]	12.76±0.80[a]	10.41±0.37[c]
% ash	17.48±0.13[a]	12.02±0.50[b]	12.91±0.85[b]	16.75±1.34[a]	12.39±0.66[b]
% fat	7.30±0.12[b]	8.37±0.04[a]	8.97±0.06[a]	8.16±0.08[a]	7.91±0.07[b]
% crude protein	74.64±2.45[a]	75.14±2.41[a]	69.80±2.47[b]	71.96±2.42[c]	31.05±2.44[d]

Means with same superscript in the same row are not significantly different at (P<0.05).

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conventional fishmeal as the diets brought about a considerable weight gain within a short period of 56 days. Hence, the fishery industry can utilize the advantages of the insect's availability and protein potentials in enhancing the productivity of *Clarias gariepinus*. In addition, the cost effectiveness in the usage of the larvae as compared to conventional fishmeal is cheaper. Therefore, *C. forda* as a protein source can efficiently replace fishmeal up to 100%. This will eventually reduce the cost of production of fish feed and sustain the Nigerian catfish farmers in their businesses. Since this is a preliminary research, further studies may be done using recombinant DNA technology to determine, isolate and transfer the genes of *Cirina forda* that may be responsible for high growth traits in some *Clarias gariepinus* parentals so that better growth performance can be expressed in subsequent generations. This will curtail the incidence of extinction in *Cirina forda* in the future because they are also eaten by human beings

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