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The Growth and Body Composition of *Clarias gariepinus* Fingerlings Fed Combined Different Sources of Lipid

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Abstract

Attempt in reducing the high cost of feeding in aquaculture through the use of energy rich oils was taken as a means of protein sparing in a feeding trial. Fingerlings of *Clarias gariepinus* with an average weight of 3.28 ± 0.72g fed three formulated diets and a control (commercial feed -Multifeed), Diet 2 (45% Lipid and 50%CP), Diet 3 (45%Lipid and 40%CP) and Diet 4 (45% Lipid and 30%CP). Results obtained showed significant difference ($P<0.05$) in the mean weight gain, feed conversion ratio, and specific growth rate compared with control diet (commercial catfish diet). However, diet 4 exhibited highest mortality rate which rendered it inefficient. Diet 4 also gave significantly high ($P<0.05$) body lipid and correspondingly low body crude protein than diets 2 and 3. Diets 2 and 3 moreover, demonstrated significantly ($P<0.05$) good growth performances and body compositions than the control. Inferences from this study recommended inclusion of combined varying levels of palm oil, groundnut oil and fish oil in the diets of *Clarias gariepinus* fingerlings for efficient growth at 45:40 Lipid: Protein ratio (diet3) beyond which there is adverse effects on the growth and survival of *Clarias gariepinus* fingerlings.

Keywords: Length-Weight; Relationships; Male; Female; *T. jarbua*

Introduction

Nigeria has a population of over one hundred and forty million people and has her national fish demand at over 2.66 million metric tones. The current annual aquaculture production hovers around 0.62 million metric tones (FDF, 2008) [1]. These combined with ever decreasing catch (due to over exploitation) from the capture fisheries have not been able to meet the ever-increasing protein demand of the country. Whereas small scale fish farming supplies the greatest percentage of the Nigerian's annual fish production output (FDF, 2008) [1]. However, the production level has been hampered due to high cost of feeding fish coupled with the expensiveness of protein as feed ingredient.

Clarias gariepinus, also known as African mud catfish, is the most popularly cultured fish in Nigeria [2-6]. It has the ability to feed on variety of food items ranging from Zooplankton to fish [7]. Fish with omnivorous feeding habits may be able to use dietary vegetable oils in more efficient manner than the counterpart carnivorous species [8]. Catfish has been credited for been hardy, resistance to handling stress; it has 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 specie at cheaper production cost [9]. Lipids are an extremely diverse group of compounds, many of which functions as important sources of metabolic energy. Among the various types of lipids, it is the simple, glycerol based fats and oils that are of most interest in terms of general nutrition [10]. Lipids normally occur in food stuffs and in the fat deposits of most animals in the form of triglycerides, which are esters of fatty acids and glycerol [11]. Thus, dietary lipids provide a source of indispensable nutrients, the essential fatty acids. In addition, they also act as carriers of certain non-fat nutrients, notable the fat soluble vitamins A, D, E and K. They are also an important source of energy [12]. Lipid contains more energy per unit weight than any biological compound. Example, One gram of lipid contains about twice as much total energy as either one gram of carbohydrate or one gram of protein [13].

Several authors have researched into inclusion of various oils in the fish diets [14-17]. However, inclusion of different sources of lipid in appropriate combination in the diet of *Clarias gariepinus* has not been fully exploited. Therefore, the study will investigate the effect of combining different sources of lipid on the growth and body composition of *Clarias gariepinus*.

Materials and Methods

Experimental location

The experiment was carried out at Water resources, Aquaculture and Fisheries Technology STEP-B laboratory, of Federal University of Technology Minna, Gidan kwano campus.

Experimental design

A complete randomized design was used in all the experiment, where treatments were of one variable; ingredient incorporates being the variable. The fishes and treatments were randomly assigned to tanks in triplicate.

Experimental fish

The experimental fish was *Clarias gariepinus* fingerlings which were purchased from TJ farm Ilorin Kwara State. The fishes were acclimatized in a 500 litres rubber tank for one week before the commencement of the feeding trial, during which period fishes were placed on commercial catfish diets (Multifeed).

Experimental diets

Feedstuffs used for the research work include Fish oil, Palm oil and Groundnut oil. They were purchased from Minna market while Vitamin

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premix, Multifeed and fish meal were obtained from Makholo stores Minna. Three diets formulated to contain to contain varying levels of Crude protein (CP) (50%, 40%, and 30%) respectively. The lipids inclusion levels were at 10%, 15% and 20% of the total lipid required by *Clarias gariepinus* for Fish oil, Palm oil and Groundnut oil respectively , Diets formulated were as presented in Table 1, and commercial diets (Multifeed) was used as control diet [18]. Equation method of two (2) unknown was used to formulate the diets [19].

x+y=95; x+y=A

Where x=Protein source (Fishmeal), y=Energy source (Oil), A=% Crude protein and 95=Bulk.

Three diets containing varying inclusion levels of lipid protein ratios are diet 2 45% Lipid and 50% protein (45L:50P), diet 3 45% lipid 40% crude protein (45L:40P), and diet 4 which consist of 45% lipid 30% crude protein (45L:30P) while diet 1 (control diet) was commercial catfish feed Multifeed). All the ingredients were mixed together in adequate proportion and were preserved in a refrigeration 4°C.

Experimental procedure

The experimental work was carried out in the Water Resources, Aquaculture and Fisheries Technology Step B Laboratory of Federal University of Technology Minna, Gidan-Kwano Campus using the recirculatory system. Fishes were randomly stocked in triplicate, in 25 litres capacity round plastic bowls at a stocking density of 20 fishes per bowl in the department of Water Resources, Aquaculture and Fisheries Technology laboratory. The bowls were arranged in a randomized block and were covered with Mosquito nets to prevent fishes from jumping out.

The fish were fed the test diets to satiation twice daily (9.00 and 17.00). The uneaten diets were siphoned 30 minutes post feeding for adjustment for feed fed at the end of the feeding trial. The feeding trial lasted for 8 weeks while the water exchange was carried out mechanically by the recirculatory system.

The water quality parameters were monitored on a weekly bases for temperature using clinical thermometer; dissolved oxygen according to the method of Wrinker's [20,21]; Hydrogen iron concentration (pH) were measured using a EIL 7045/46 pH meter in the laboratory at room temperature while conductivity was monitored using conductivity meter.

Diets Composition (%)	*Diet 1 (control) 50%	Diet 2 45L:50P	Diet 3 45L:40P	Diet 4 45L:30P
Fish meal		59.24	47.39	35.55
Fish oil		7.95	10.58	13.21
Palm oil		11.92	15.87	19.82
Groundnut oil		15.89	21.16	26.42
Premix		5.0	5.0	5.0
Total		100	100	100
Proximate composition of Diets (%)				
Crude protein	50.00	51.47	39.89	33.03
Crude Lipid	12	30.60	39.64	52.41
Crude fibre	2.5	1.84	1.52	1.23
Ash	8.5	7.57	9.23	8.19
Moisture content	12.00	8.39	9.17	4.67
Total	85	99.78	99.45	99.53

*Manufacturer data

Table 1: Formulated diets based on various lipids sources and their proximate Composition.

Statistical analysis

Growth responses and feeds utilization obtained from the different treatments and their replicates were subjected to statistical analysis using Minitab release 14 package. Data were subjected to analysis of variance (ANOVA) using Turke's test at 5% probability level. Multiple parameters means comparison of treatments was according to Duncan multiple range tests [22,23]. Graphical analyses were plotted with Microsoft Excel window 2010.

Biological evaluation

The parameters measured were in accordance to Halver (1989) Maynard et al. as explained below [24,25]

i. Mortality

This measure the death rate in the fishes as expressed below

$$\%\text{Mortality} = \frac{\text{No of dead fish}}{\text{No of fishes stocked}} \times \frac{100}{1}$$

ii. Specific Growth Rate (SGR)

This is expressed as

$$\text{SGR} = \frac{\text{Ln MFW}(\text{Mean finalweight}) - \text{Ln MIW}(\text{Mean initial weight})}{\text{Time in days}} \times 100$$

iii. Food Convertion Ratio

This is expressed as

$$\text{FCR} = \frac{\text{Weight of food fed}(\text{Dry gram weight})}{\text{Weight gain of fish}(\text{Wetgram weight})}$$

iv. Protien Efficiency Ratio

This measure the protein efficiency ratio

$$\text{PER} = \frac{\text{Weight gain of fish}}{\text{Protein feed}}$$

$$\text{Where Protein feed} = \frac{\text{Total feed intake}}{\text{Protein content of feed}}$$

v. $\text{Mortality}(\%)\frac{\text{Total no dead}}{\text{Total no stocked}} \times 100$

Results

From the result in Table 2 there was significant difference in the mean weight gain of the fishes between diets 2, 4 and 1, 3 (P<0.05). Diet 2 and 4 recorded significantly high (P<0.05) mean weight gain (MWG) of 11.61 and 11.19 respectively which were not significantly different (P>0.05) from each other but significantly different (P<0.05) from diets 1 and 3 (8.51 and 9.81 respectively) which were not significantly different (P>0.05) from each other. The feed conversion ratio (FCR) of the diets differed significantly (P>0.05) from each other. There was no significant difference between diets 2 and 3 (1.67 and 1.78 respectively). Diet 1 and 4 differed significantly from other diets (P<0.05) with FCR values of 2.06, however, diet 4 apparently recorded the lowest FCR of 0.91 which was significantly lower (P<0.05) than other diets. However, it is apparent in Figure 1, that diet 4 is indeed a very poor diet.

The specific growth rate (SGR) differed significantly among the Diets (P<0.05). Moreover there was no significant difference (P<0.05)

Treatments	Diet 1 50P	Diet 2 45L:50P	Diet 3 45L:40P	Diet 4 45L:30P	STD
Initial weight gain (g)	2.27^{a} ± 1.11	3.28^{a} ± 0.72	3.30^{a} ± 1.34	2.78^{a} ± 0.83	1.03
Final weight gain (g)	11.27^{ab} ± 5.18	14.99^{a} ± 9.86	13.12^{b} ± 8.13	13.96^{b} ± 4.82	7.30
Mean weight gain (g)	8.51^{b} ± 4.09	11.61^{a} ± 9.78	9.81^{b} ± 6.79	11.19^{a} ± 5.59	6.89
Mean Feed Fed (g)	17.58^{b} ± 0.01	19.55^{a} ± 0.01	17.45^{b} ± 0.02	10.14^{c} ± 0.01	0.01
FCR	2.06^{c} ± 0.01	1.67^{b} ± 0.02	1.78^{b} ± 0.02	0.91^{a} ± 0.01	0.012
SGR (%/Day)	2.51^{c} ± 0.01	2.70^{b} ± 0.01	2.46^{c} ± 0.01	2.89^{a} ± 0.01	0.01
PER	0.99^{b} ± 0.01	1.41^{b} ± 0.01	1.41^{b} ± 0.01	3.70^{a} ± 0.01	0.01
Mortality (%)	3.49^{c} ± 0.01	31.65^{b} ± 0.01	31.65^{b} ± 0.01	76.65^{a} ± 0.01	0.01

Table 2: Mean Growth performance of Clarias gariepinus fingerlings feed with various Lipid/protein Ratio for 8 weeks.

Body Composition Parameters (%)	Initial Carcass	Final Carcass				SD
		Diet 1 50P	Diet 2 45L:50P	Diet 3 45L:40P	Diet 4 45L:30P	
Crude protein	47.06^{c} ± 0.01	52.50^{a} ± 0.01	48.41^{b} ± 0.01	52.60^{a} ± 0.01	48.45^{b} ± 0.01	0.01
Crude lipid	18.35^{c} ± 0.01	23.52^{b} ± 0.01	22.33^{b} ± 0.58	24.80b^{c} ± 0.01	28.42^{a} ± 0.01	0.26
Ash content	3.12^{d} ± 0.01	16.15^{a} ± 0.01	12.29^{b} ± 0.01	9.35^{c} ± 0.01	9.46^{c} ± 0.01	0.01
Moisture content	7.55^{b} ± 0.01	8.03^{a} ± 0.06	8.40^{a} ± 0.01	6.90c ± 0.01	8.30^{a} ± 0.01	0.03

Means with the same superscript along the row do not differ significantly (P<0.05)

Table 3: Body Composition of Experimental Fishes.

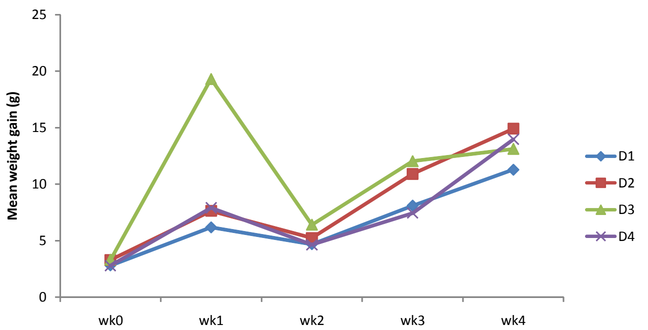

Figure 1: Growth Response of Clarias gariepinus fingerlings fed combined lipid sources for 8 weeks.

between the values of diet 1 and 3 (2.51and 2.46 respectively) Table 2. Moreover, diet 4 recorded significantly high (P<0.05) SGR value 2.89 followed by diet 2 (2.70) which differed significantly (P<0.05) from other diets Table 2.

The protein efficiency ratio (PER) differed significantly (P<0.05) from each other. Diet 4 recorded significantly high PER value of 3.7 which differed significantly from other diets. This was followed by diets 2 and 3 with PER of 1.41 and 1.41 respectively. The percentage mortality recorded in the experiment differed significantly from each other (P<0.05). Diet 1 recorded the lowest mortality of 3.49% being the control diet, diet 2 and 3 had moderate mortality rate of 31.65 each while diet 4 exhibited the highest mortality rate of 76.65% Table 2.

From the result in Table 3, the values on body composition of crude protein, crude lipid, crude ash and moisture, shows significant difference (P<0.05) observed among the experimental diets.

Moreover there was no significant difference (P>0.05) between diet 1 and 3 with the values of (52.50) and (52.61) respectively. The body crude protein for diet 3 containing 40% crude protein and 45% lipid (10% Fish oil, 15% Palm oil, and 20% Groundnut oil) was significantly higher (P<0.05) (52.61) than initial carcass crude protein (47.06).

However, there was corresponding increase in the body lipid contents for diets 3 and 4 containing 40%crude protein (24.80) and 30 % crude protein (28.42) which was significantly higher (P<0.05) than other diets.

There was significant difference (P<0.05) in the crude ash content of the experimental fishes with diet 1 (16.15) recorded the highest body ash content, which was significantly higher than other diets. Moreover, all diets were of high ash values than the initial carcass with crude ash of 3.12.

There was no significance difference (P>0.05) between carcass of moisture content of diet 1 (8.00) and 4 (8.30) but there was no significant difference (P>0.05) between initial carcass composition (7.55) and other diets. Moreover diet 3 recorded significantly low (P>0.05) moisture contents of 6.90.

Discussion

The present study investigates the growth and body composition of *Clarias gariepinus* fingerlings fed combine different source of lipid. Of all the formulated diets, diet 4 apparently recorded best growth performance values as reflected in the value obtained for FCR, SGR and PER (Table 2) however, the mortality rate was the highest (76.65%). This would render the diet unfit for feeding fish. The high level of mortality can be attributed to high level of lipids in the diet which also resulted in loss of appetite and eventual mortality [17,26-28] also reported that, poor utilization of lipid could be attributed to poor feed intake, which prevented the fish from taking enough nutrients to meet the carcass nutrients requirements for the developments of tissues.

There was no significant difference (P>0.05) between FCR, SGR and PER of Diets 2 and 4 this indicates that the fish was able to digest the diets and converts the diets into body tissue with same degree of efficiency. In the first two weeks of the experiments, their growth dropped drastically (Table 2 and Figure 1). It was probably due to the fact that the fishes were getting used to acclimatizing to the formulated diets. Thereafter, all fishes picked up and started utilizing the diets better.

The PER was not significantly different between treatments, except for diet 4 which performed significantly higher than all other diets. The improvement in PER could probably be that increasing lipid level by decreasing the crude protein content has spared dietary protein

Conversion into energy utilization of lipid for growth by protein sparing has also been considered as welcome development in aquaculture [29-31]. Diet 2 expressed the second best growth performance; they expressed no significant difference in their growth parameters that is FCR, SGR, PER, ANPU and optimum Mortality. (Lim et al. ; Peres and Oliva-Teles; and Gaylord and Gatlin,) who work on European Zea bass and hybrid striped bass respectively and agreed that the muscle lipid contents of these were not affected by dietary lipid levels [32-34]. The growth improvement observed agreed with Lim et al .(2001) that up to 8% of refined, bleached, deodorized, palm olein or, crude palm oil can be included in diets for the African catfish with improved performance and protein retention of this fish [32]. Also the work of Pie et al. reported improvement in carp fed dietary lipid [35]. Ng et al. also reported that up to 90% of dietary fish oil could be replaced by crude palm oil without compromising growth or feed utilization efficiency of a tropical catfish, *Mystus nemurus* [36].

Recent studies have revealed that substantial use of vegetable oils as energy sources in fish diets have yielded positive growth response in fish [37,38]. The results gathered from the study have demonstrated that the three lipids source used are of good nutrient composition. This observation could imply that there was no palatability problem and that their utilizations were adequate, which is similar to the work of Aderolu and Akinremi in the utilization of coconut oil and peanut oil in catfish diet [38]. Sotolu recorded similar observation when he fed diets containing Benni seed oil, groundnut oil, soybean oil and palm oil to *Clarias gariepinus* fingerling [31].

Carcass analysis (Table 3) showed significant difference (P<0.05) between the control diet and other diets, in terms of crude lipid, crude protein, crude ash and moisture. The crude protein values of diet 2 and 4 of 48.42 and 48.45 respectively were significantly (P<0.05) lower than that of control diet (52.50), while diets 2 and 3 also have better growth ratio which was in agreement with Aderolu et al. that even although, the control diet had a higher crude protein value, the experimental diet performed better in terms of growth and nutrients utilization [39].

Conclusions

The results of this study showed that combination of different lipids source at appropriate ratio of lipid-protein ratio (45:40) can be fed to *Clarias gariepinus* which spares protein for growth.

Recommendation

It is recommended that diet 3 with lipid and protein ratio of approximately ratio 1:1 can be formulated for *Clarias gariepinus* that gives efficient protein utilization for growth, beyond which, there will be decline in growth.

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