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The Growth response of *Clarias gariepinus* (Burchell, 1822) Fingerlings Fed Tadpole Meal Replacing Fish Meal

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ABSTRACT
This study evaluates the growth performance of *Clarias gariepinus* fingerlings fed tadpole meal partially replacing fish. Five iso-nitrogenous (crude protein 42 %) diets were prepared and designated as TP1 (0 %, control), TP2 (10 %), TP3 (30 %), TP4 (45 %) and TP5 (60 %) of tadpole meal as replacement for fish meal. The diets were fed to fingerlings of *Clarias gariepinus* for 56 days. Fish were stocked into five glass aquarium tanks at 20 fish per glass aquarium (0.6m × 0.3m × 0.3m). The tadpole-based diets were allotted to fish in the aquarium each replicated thrice. The result showed final weight, weight gain, specific growth rate and fed intake were significantly ($p<0.05$) better in fish fed 30% tadpole replacing fish meal. *Clarias gariepinus* fingerlings accepted diets containing tadpole meal as fishmeal replacer. Tadpole meal can replace 30% of fish meal in the diet of *C. gariepinus* fingerlings.

Key words: Growth response, tadpole meal, fishmeal *Clarias gariepinus*, fingerlings

INTRODUCTION

Fish farming involves raising of fish commercially in tanks, enclosures or confinement such as a fish pond, usually for food (Funge-Smith and Phillips, 2001). The exponential growth of this sector throughout the past two decades is the outcomes of the progressive intensification of production systems (FAO, 2006). A major contributor to this intensive production system is the use of manufactured feeds formulated to meet the nutritional requirements with balanced diet formulations and appropriate feeding practices (Gatlin, 2010). For many fish species, feeds account for about 70 % variable cost of commercial fish farming operation (Webster *et al.*, 1999). The hike in the price of fish feed due to the high cost of fishmeal called for researches into a suitable substitution for this essential animal protein which will be used to produce feeds with high nutrient and preserved quality. Thus, fishmeal is a high-protein, nutrient-rich and high digestible feed ingredient that can be stored easily and is used primarily in diets for domestic animals. Among the animal protein sources, fishmeal is particularly suited to meet the nutrient requirements of animals (Karimi, 2006). The global demand for fish diet ingredients becomes limited in supply and highly-priced, and thus, a sustainable alternative must be sourced. The high cost and shortage of fish meal in compounded feeds has led to the use of other alternative protein sources such as toad meal (Annune, 1990), fermented fish silage (Fagbenro and Jauncey, 1995), poultry dung meal (Fasakin *et al.*, 2000), maggot meal (Sogbesan *et al.*, 2005), and garden snail meal (Sogbesan and Ugwumba, 2006). The continued expansion of fish farming will not be sustainable if fishmeal is exclusively depended upon as the primary source of protein in aqua diets (Abolude and Abdullahi, 2005).

The usage of tadpole meal as fish feed ingredients is limited in the study area. However, tadpole meal has been tested as protein sources in a feeding trial with different fish species (Anunne, 1990; Ayinla *et al.*, 1994; Sogbesan and Ugwumba, 2007; Sogbesan *et al.*, 2007; Sogbesan *et al.*, 2009; Hindatu and

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Solomon, 2017). Though none of these researchers investigated on growth performance of *Clarias gariepinus* fingerlings at different replacement levels as indicated in this study. Tadpoles are free-living aquatic larva of either a frog or a toad (Zug *et al*., 2001; Michal *et al*., 2015). As a larva, it is non-reproductive and obliged to go through a change in form (metamorphosis) in order to reach the reproductive condition (Richard, 1975). A toad is a group of froglike amphibians that are usually well-known from frogs by the roughness of the skin, having a large number of glandular tubercles, and by their shorter hind legs. Toads are very prolific (Wells, 2007; Liedtke *et al*., 2017) and do breed during the rainy season alone in the wild and any standing water. Tadpole graze upon rotting materials in the pond using their hundreds of teeth and use the gills to filter microscopic particles out of the water. They get most of their nutrition by ingesting planktonic items, mosquito larva, organic sediments from the water bottom, graze on the periphyton leaves and animal remains in decomposition, and even consume macro-invertebrates (Arias *et al*., 2002; Dutra and Allisto, 2005). Proper utilization of this natural resource and limitation of its annual nuisance, could be diverted as fishmeal supplement in the fish feed (Sogbesan and Ugwumba, 2007).

The *Clarias gariepinus* belong to the family Clariidae and it commands high aquaculture importance in Nigeria (Ndome *et al*., 2011). *Clarias gariepinus* takes a unique position in the commercial fisheries in Nigeria because it is tasty, hardy, tolerating pathetic water quality conditions and growing to a size of 7.0 kg (Idodo-Umeh, 2003). It has an effective feed conversion especially in the males and so attracts high sales price (Nweke and Ogwumba, 2005).

As a result of the growing world population, the request for food is growing, therefore more food will be needed to meet the demand especially with higher animal protein. The major growth is anticipated in developing nations where fish is the primary source of animal protein. Hence, there is need to intensify fish production in these developing nations. However, these could be affected by the high cost of feed ingredients and fish feed. The quest to research for non-conventional feedstuff could reduce the high cost of feed ingredients and fish feed in the aquaculture industry. The annual availability of tadpoles and limited competition by the man in this part of the study area could be utilized by fish farmers as protein supplement in aqua diets. Therefore, the fish growth performance was investigated to evaluate tadpole meal as fishmeal alternative in diets for *Clarias gariepinus* fingerlings.

MATERIALS AND METHODS

Study area

This experiment was conducted in the hatchery unit of Department of Water Resources Aquaculture and Fisheries Technology, Federal University of Technology Minna, Bosso Campus, for 8 weeks. Minna is located at latitude 9^{o} 40' N and longitude 6^{o} 30' E in the Southern Guinea Savanna region of Nigeria. The area experiences two seasons, rainy beginning from April to October, and dry starting from November and stops in March. The vegetation cover is mostly grasses and shrubs with scattered trees, and also the soil is sandy loam in composition (Ibrahim *et al*., 2018).

Collection and processing of tadpole

Tadpole was harvested from Tagwai Dam and other surrounding standing water in Chanchaga Local Government Area of Niger State, Nigeria using a net and a container. Harvested tadpoles were oven-dried at 80^{o}C for 6 hours and processed into a meal as described by Akpodiete and Okagbare (1999). Other ingredients (Fishmeal, maize meal, millet meal, starch, cellulose, vegetable oil, vitamins and minerals premix) were purchased from Kure Ultra-Modern market in Bosso local government area of Niger State, Nigeria. The processed tadpole meal was then analysed for moisture, ash, ether extract, crude fibre and crude protein using Association of Official Analytical Chemist Methods (AOAC, 2005).

Experimental fish

A total of three hundred (300) pieces of *Clarias gariepinus* fingerlings (2.34 – 2.38g) were collected from the outdoor tank of the Department of Water Resources, Aquaculture and Fisheries Technology

Minna, Bosso Campus. The fingerlings were acclimatized for 7 days in 1.2m × 1.2m × 1m deep tank concrete tank and fed 2 mm vital commercial diet.

Experimental diet

The feed ingredients (Fishmeal, maize meal, millet meal, starch, cellulose, vegetable oil, vitamins and minerals premix) were purchased from Kure Ultra-Modern market in Bosso local government area of Niger State, Nigeria. The ingredients were ground into the mill and stored in an airtight plastic container until needed. Five iso-nitrogenous (Crude Protein 42 %) diets were formulated using a linear programming method (Ghosh *et al*., 2011) as shown in Table 1

Table 1: Gross composition of the experimental diets

Ingredients (g)	Tadpole replacement levels (%)				
	0	10	30	45	60
Tadpole meal	0.00	100.00	300.00	450.00	604.60
Fishmeal	563.10	470.00	383.70	144.00	0.00
Maize meal	150.00	150.00	150.00	150.00	150.00
Starch	105.00	105.00	105.00	105.00	105.00
Cellulose	27.90	51.70	47.20	7.30	0.00
Mineral premix	50.00	50.00	50.00	50.00	50.00
Vitamin premix	50.00	50.00	50.00	50.00	50.00
Vegetable oil	54.00	23.30	14.10	43.70	40.40
Total	1000.00	1000.00	1000.00	1000.00	1000.00
Chemical composition (%)					
Crude protein	41.38	41.61	42.33	40.98	42.08
Ether extract	10.71	10.59	10.87	10.22	10.64
Ash content	11.86	12.03	12.61	12.75	13.47
Crude fibre	1.26	1.72	2.25	2.77	2.98
Moisture content	4.39	4.53	4.11	4.85	4.42
Nitrogen free extract	30.40	29.52	27.38	28.43	26.41
Digestible energy (MJ/kg)	406.11	404.83	403.91	400.10	399.32

Experimental design

Five different replacement levels of tadpole meal; 0 (control), 10, 30, 45 and 60 % of tadpole meal, designated as TP1, TP2, TP3, TP4 and TP5 respectively, were incorporated into the experimental diet to make up 42 % crude protein diet. The experiment was replicated into three in completely randomized design (CRD) manner. The tadpole-based diet was allotted to 15 well-aerated glass aquaria (0.6m × 0.3m × 0.3m), using a total of 300 pieces of *Clarias gariepinus* (2.34 – 2.38g weight and xx –xx mm or cm length) fingerlings stocked at 20 fingerlings per the glass aquarium. The tadpole-based diets were fed at 5 % of their body weight for a period of 56 days. Uneaten feed and faecal materials were siphoned every morning from the aquaria using a rubber hose (7.5 mm). Fish sampled to adjust feeding. At the end of the rearing, final weight, final length, feed applied and fish mortality were recorded. The following growth indices for each treatment were estimated using the following formulae:

i. Weight gain/fish (g/fish) = Wf – Wi, where: Wi = initial weight at the beginning of the experiment, Wf = final weight at the end of the experiment.

ii. Specific growth rate (%) = $(\log W_f - \log W_i)/t \times 100$. Where, $\log W_i$ = logarithm of initial weight, log W_f = logarithm of final weight, t = experimental period.

iii. Feed efficiency (%) = (weight gained/feed intake) × 100.

iv. Feed Intake (mg/fish/day) = (feed fed/number of fish)/feed intake.

v. Protein retention (%) = (protein gain/ protein fed) × 100.

vi. Feed conversion ratio = feed dispensed/weight gain.

vii. Protein efficiency ratio = (body weight gain/protein intake) × 100.

viii. Survival rate (%) = (Nf/Ni) × 100, where: Nf = number alive at the end of the experiment, Ni = number stocked at the beginning of the experiment.

Water quality parameters

The water temperature, conductivity and pH were recorded using mercury thermometer, conductivity meter (Model: Jenway, 4010) and pH meter (pHS-25) respectively. Alkalinity, hardness, dissolved oxygen and biological oxygen demand were determined using the method described in AOAC (2005).

Data analysis

All the data collected were subjected to one-way analysis of variance (ANOVA). Differences between the means were determined using Turkey's HSD with the aid of SPSS 22.0 at 5 % level of probability ($P \leq 0.05$).

RESULTS

The growth performance of *Clarias gariepinus* fingerlings fed graded levels of tadpole meal is shown in Table 2. Final weight, weight gain, specific growth rate and feed intake were significantly ($p<0.05$) better in fish fed 30% tadpole replacement level compared to the other treatment. However, there was a declined in the final weight, weight gain, specific weigh gain and fed intake with an increase in fishmeal replacement levels increases above 45 %.

The feed conversion ratio of fish fed TP1 and TP4 were not significantly ($P>0.05$) different from each other. Similarly, no significant variation ($P>0.05$) were observed between the feed conversion ratio of TP2 compared to TP5. However, the feed conversion value of TP3 was significantly different from those of TP1, TP2, TP4 and TP5, respectively. There were no significant differences ($p>0.05$) between feed efficiency and protein efficiency ratio values of the fish fed TP1, TP2, TP4 and TP5 tadpole replacement levels compared to that of TP3. However, TP3 significantly different existed among fingerling fed TP1, TP2, TP4 and TP5.

The protein retention was significantly ($p<0.05$) higher (40.51±0.67%) in fish fed 30% tadpole-based diet, followed by (39.41±0.30%) those fed 10% tadpole-based diet. There were no significant differences ($p>0.05$) between the protein retention of control diet compare to those fed 45 and 60% inclusion levels. Survival of fish were between 88 – 90 % across all the treatment. No significance variation ($p>0.05$) was observed in survival rates fish among the entire treatment.

Table 2: Mean (±SD) growth response of *Clarias gariepinus* fingerlings tadpole Meal replacing fishmeal

Growth parameters	Tadpole Replacement Level (%)				
	0	10	30	45	60
Initial weight (g)	$2.38±0.04^{a}$	$2.34±0.03^{a}$	$2.34±0.05^{a}$	$2.37±0.20^{a}$	$2.35±0.01^{a}$
Final weight (g)	$21.68±0.14^{c}$	$22.88±0.09^{b}$	$24.88±0.09^{a}$	$21.65±0.26^{c}$	$20.85±0.07^{d}$
Weight gain (g)	$19.30±0.14^{c}$	$20.54±0.08^{b}$	$22.54±0.08^{a}$	$19.28±0.26^{c}$	$18.50±0.08^{d}$
Specific growth rate (%)	$3.95±0.01^{c}$	$4.07±0.01^{b}$	$4.22±0.01^{a}$	$3.95±0.02^{c}$	$3.90±0.02^{d}$
Feed intake (g)	$22.82±0.12^{c}$	$23.80±0.12^{b}$	$25.36±0.38^{a}$	$22.66±0.17^{c}$	$22.39±0.00^{c}$
Feed conversion ratio	$1.93±0.02^{a}$	$1.17±0.01^{b}$	$1.12±0.01^{c}$	$1.79±0.01^{a}$	$1.22±0.01^{b}$
Feed efficiency	$0.85±0.01^{bc}$	$0.86±0.00^{b}$	$0.89±0.01^{a}$	$0.85±0.01^{b}$	$0.83±0.00^{c}$
Protein efficiency ratio	$2.20±0.02^{b}$	$2.19±0.01^{b}$	$2.25±0.04^{a}$	$2.16±0.01^{b}$	$2.18±0.01^{b}$
Protein retention (%)	$36.97±0.40^{c}$	$39.41±0.30^{b}$	$40.51±0.67^{a}$	$36.95±0.07^{c}$	$36.25±0.15^{c}$
Survival rate (%)	$89.45±6.64^{a}$	$90.00±0.01^{a}$	$88.77±5.08^{a}$	$90.00±0.00^{a}$	$88.44±3.54^{a}$

Means in the same row with the same superscript are not significantly different ($P>0.05$)

Water quality parameters

The mean water quality parameters recorded during the experiment is shown in Table 3.
The was no significant differences ($P>0.05$) among the water qualities across the entire treatments.

Table 3: Mean (±SD) water quality parameters monitored during the experiment

Parameters	Tadpole Replacement Level (%)				
	0	10	30	45	60
T (^{0}C)	27.77±0.23	27.58±0.45	27.66±0.29	27.53±0.36	27.57±0.38
pH	7.33±0.40	7.33±0.15	7.40±0.44	7.30±0.26	7.23±0.15
Alk (mg/l)	92.55±0.13	89.30±0.29	77.47±0.27	94.13±0.07	95.67±0.05
Hrd (mg/l)	109.74±0.11	133.64±0.10	89.11±0.11	84.18±0.16	82.46±0.14
C (μ^s/cm)	414.47±0.06	394.73±0.08	367.72±0.05	413.20±0.18	398.40±0.07
DO (mg/l)	6.94±0.03	8.18±0.17	7.06±0.06	7.52±0.19	7.92±0.05
BOD (mg/l)	3.81±0.07	4.80±0.06	3.87±0.12	4.50±0.13	5.22±0.14

Key: T = Temperature, Alk = Alkalinity, Hrd = Hardness, C = Conductivity, DO = Dissolved oxygen, BOD = Biological oxygen demand

DISCUSSION

The best final weight, weight gain and Specific growth rate at 30% replacement observed in this study were higher (5.85g, 3.05g/fish and 0.58%/day, respectively) than those reported by Sogbesan *et al.* (2006) after replacing fish meal with 100% tadpole meat and 8.21g final weight and 0.67%/day specific growth rate observed by Hindatu and Solomon (2017) in the diet of similar fish species. The variation from these previous findings may be attributed to different feed ingredient, environmental conditions and different fish species. The least growth response observed in *Clarias gariepinus* fingerlings fed 60 % replacement level could be as a result of low feed intake. The weight gain of fingerlings is usually a reliable indicator of nutritional adequacy of the diet (Cho and Watanabe, 1998; Adewole and Olaleye, 2014). Adequate and right processing of ingredients has been reported to have an effect on the texture and palatability and of experimental diets (Francis *et al*., 2001; Sogbesan and Ugwumba 2008a). The protein efficiency ratio observed in this study is not in accordance with the findings of Sogbesan and Ugwumba (2008b). De-Silva and Anderson (1995) reported that the protein efficiency ratio is a measurement of how well the protein sources in the diet provide essential amino acids requirement of the fish fed.

The low feed conversion ratio obtained from fish fed diet TP3 could be attributed to diet unpalatability as suggested by Rodriguez *et al*. (1996) when animal by-products were used to replace fish meal in the diet of *Oreochromis niloticus*. Sogbesan *et al*. (2006) had earlier observed that lower feed conversion ratio indicates better utilization of the feed by the fish fed the diet.

The mean water quality variables monitored were within the desirable range for fish culture as suggested by Viveen *et al*. (1985). The DO level recorded in this study is in line with the suggestion of Bhatnagar *et al*. (2004) who stated that DO level of 5 and above is desirable for fish culture. The pH levels were in accordance with the report of Santhosh and Singh (2007).

Conclusion

This study concludes that *Clarias gariepinus* fingerlings accepted diets containing tadpole meal as fishmeal replacer. Tadpole meal can replace 30% of fish meal in the diet of *C. gariepinus* fingerlings.

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