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Growth Performance, Survival and Nutrient Utilization of *Clarias Gariepinus* (burchell, 1822) Fingerlings fed with Processed House Fly (*musca Domestica*) Maggot Meal

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Abstract

Growth performance, survival and nutrient utilization of Clarias gariepinus (Burchell, 1822) fingerlings fed with processed house fly (Musca domestica) maggot meal were evaluated for twelve weeks. A commercial diet (D1), five diets containing 100% fish meal (D2) and maggot meal 25%(D3), 50%(D4), 75%(D5), and 100% maggot meal (D6) inclusion levels were tested for the experiment. A commercial diet is used as the reference (D1) while 100% fish meal (D2) was used as the control. Diet 1 has the best growth indices and nutrient utilisation. Diet 4 had better growth indices and nutrient utilization than Diet 2. All these diets were tested on triplicate groups of ten fish (initial body weight; 6g) culture in 200 litres plastic tanks. There were significant differences (p≤0.05) in the growth parameters and nutrient utilization of the experimental diets on the fingerlings. The results of this study shows that maggot meal has relatively high protein level and 25% - 50% inclusion level is recommended because it gave a better growth than 100% fish meal.

Keywords: Growth, Nutrient, Maggot Meal, *Clarias gariepinus,* unconventional protein source,

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Introduction

The cost of fish meal is on the increase as a result of its competing use for feed ingredient by other livestock. This has resulted to the increasing interest in the use of inexpensive non-conventional feed ingredient to completely or partially replace fish meal in aquaculture which will not have a deleterious effect on the growth of fish (Jimoh *et al.,* 2022).

Some researchers have made effort to use locally accessible cheap protein sources such as termites (Olaniyi *et al.,* 2016), and Grasshoppers (Michael & Kolapo, 2017) with favourable results in some cases.

In order to increase the growth of pisciculture business in the aquaculture industry, it is important to completely or partially substitute fishmeal to maggot meal as a dietary protein ingredient in the fish feed production. The cost of fish feed accounts for 60-70% of the total costs of aquaculture production (Daniel, 2018).

Materials And Methods

Culturing of Maggot

Fresh chicken manure was bought from a private poultry farm and oven dried to constant weight and divided into equal halves. One part of the half (25kg) was wet with 25 liter of water and 1kg rotten fish offal was added to act as flies' attractant. The dung was placed in open containers, exposed to flies to lay their eggs on the dung and maggots were generated on the second day. The collection and processing procedure was done as described by Sogbesan *et al.* (2007). The maggots were washed, blanched with hot water, oven dried for 6 hours at 80^{o}C, pulverized and stored in a closed vessel at room temperature until required for use. Proximate analysis of the feed ingredients was done using the AOAC (1990).

Feed Ingredient and Formulation

The entire ingredients were thoroughly sorted and milled separately into fine particle size. Other ingredients that were included into the diets were salt, vitamins premix, vegetable oil, lysine, and methionine.
Apart from the commercial feed which is the reference diet, Pearson's

square method was used in formulating five isonitrogenous diets (Diet 2: contained 100% of fish meal as control; Diet 3: 25% maggot meal; Diet 4: 50% maggot meal; Diet 5: 75% maggot meal and Diet 6: 100% maggot meal) for this research at 40% crude protein. Each diet was made into pellets using a locally fabricated pelletizer which produced pellets that were about 2mm in size. The pelleted feeds were sun-dried. Each sample was analyzed in the laboratory for proximate composition following standard methods of analysis (AOAC, 1990). Table 1 below displays the composition of each ingredient used.

	Graded	Levels of	Maggot	Meal	
Ingredients	$D_{2(0\%MM)}$	$D_{3(8.19\%MM)}$	$D_{4(16.38\%MM)}$	$D_{5(24\%MM)}$	$D_{6(32\%MM)}$
Maggot meal	0	8.19	16.38	24.56	32.75
Fish meal	32.75	24.56	16.38	8.19	0
Soyabean meal	14.04	14.04	14.04	14.04	14.04
Groundnut cake	15.21	15.21	15.21	15.21	15.21
Yellow maize	37.00	37.00	37.00	37.00	37.00
Vegetable oil	0.3	0.3	0.3	0.3	0.3
Salt	0.1	0.1	0.1	0.1	0.1
Vitamin premix	0.1	0.1	0.1	0.1	0.1
Lysine	0.1	0.1	0.1	0.1	0.1
Methionine	0.1	0.1	0.1	0.1	0.1
Bone meal	0.3	0.3	0.3	0.3	0.3
Total	100	100	100	100	100
Calculated crude protein %	40.0	40.01	40.0	40.0	40.0

Fish Sources and Management

A total of one hundred and eighty (180) fingerlings of *Clarias gariepinus* of average weight of 6g and average initial length of 7cm were acquired from Layolat fish farmhouse Mando, Kaduna State, Nigeria. The fish were transported using two fifty (50) litre aquaria tanks to Kaduna state university Zoological Garden and were acclimatized for two weeks in six 200 liters capacity plastic tanks.

During the acclimatization period, the fingerlings were fed twice daily between 8.00-9.00 a.m and 4.00- 5.00 p.m at 5% body weight with a commercial diet. The fish were randomly distributed into six groups replicated thrice using 18 experimental plastic tanks of 200 liters capacity stocked at 10 fingerlings per plastic tank. Each tank was labeled alongside its replicates. All the fingerlings were fed at 5% body weight morning and evening.

Experimental Set Up

The 18 experimental tanks were thoroughly washed and labelled as, D_1 (commercial foreign feed which is the reference diet), D_2 (100% FM which is the control), D_3(25% MM), D_4 (50% MM), D_5 (75% MM) and D_6 (100% MM) respectively. The water levels of each tank were maintained at 0.9m throughout the experimental period and 70% of the water in each tank were changed every other week. The water were completely drained and washed every other week. Also, the standard weight and standard length of the experimental fingerlings were documented. Water quality parameters such as temperature and pH were monitored twice per week using a HANNA model (HI 9812-5). Dissolved oxygen was measured using DO meter (Hanna model DI9146).

Growth Performance and Survival of *Clarias gariepinus* Fingerlings

The initial body weight of each batch of fish was weighed using a top-loading Mettler balance (model PB 3002) before they were stocked. In addition, the body length of each set of fish was measured using graduated meter rule before they were introduced into the experimental tanks. Thereafter, the lengths and the weights of the fish were measured every 2 weeks (14 days) and the total feed consumed was adjusted accordingly. The following growth indices and nutrient utilized were calculated for all the treatments and their replicates including the control diets:

i. Mean Weight Gain (MWG) = Final mean weight (g) – initial mean weight (g)

ii. Mean Length Gain (MLG) = Final mean length (cm) – initial mean length (cm)

iii. Specific Growth Rate (SGR %) $= \frac{LnW2 - LnW1}{t} X100$

Where: Ln = the natural log, W1 = initial fish weight (g), W2 = the final fish weight in "grams" and t = number of days of the experimental period.

iv. Percentage Fish Survival $= \frac{(\text{Nunber of fish} - \text{Number of fish died})}{\text{Initial number of fish stocked}} X\ 100$

Nutrient Utilization

i. Feed Conversion Ratio (FCR) $= \frac{\text{Weight of dry feed ingested(g)}}{\text{Weight gain in gram(g)}}$

ii. Gross Food Conversion Efficiency(GFCE %) $= \frac{1}{FCR} X\ 100$

iii. Protein Efficiency Ratio (PER)= $\frac{\text{Weight gain(g)}}{\text{Weight of crude protein ingested (g)}}$

iv. Net Protein Utilization (NPU %)= $\frac{Nb - Na}{N1} X100$

Where Nb = Body protein at the end of feeding trial
Na = Body protein at the beginning of feeding trial Similar number of days of the experiment for all the treatments.
N1 = Protein fed

Data Analysis

Data generated from growth and nutrient consumption parameter were subjected to one way Analysis of Variance (ANOVA) to test the significance among diet means using S.A.S V.9.2 (2007). Where there was significant difference, Duncan multiple range Analysis 2007 was used to rank diet mean. Statistical significance was set at $p<0.05$.

Results

Proximate Composition of Experimental Diets

Table 2 shows the proximate composition of the experimental diet of all inclusions fed *Clarias gariepinus*. The result showed that the crude protein was in the range of 41.56 to 45.01 g/100g. D2 had a higher percentage crude protein (44.01) than D1(42.10) while D6 had the lowest percentage crude protein (41.56). There was no significant difference ($p \geq 0.05$) between the crude protein of diets 2 and 5. However, diets 1, 3, 4 and 6 were significantly different ($p \leq 0.05$). The lowest CP level was observed in D6. The ash content was in the range of 3.20 to 10.00 g/100g, D1 had the highest ash content (10.01) while Diet 6 had the lowest ash content (3.2). D1 had a higher ash content compared to D2, D3, D4 and D5. The crude fibre ranges from 3.83 to

6.27 g/100g while the gross energy is between 1813.13kJ/100g to 2110.95 kJ/100g. The lipid, crude fiber and NFE increased as the percentage of maggots increased while the ash content decreased as the percentage of maggot increased. Although there was significant difference ($p \leq 0.05$) between the moisture content, crude lipid, ash content, NFE, crude protein and gross energy of all the experimental diets, they all satisfied the target requirement for catfish fingerlings.

Table 2: Proximate composition of Experimental Diets (g/100g dry matter)

Comp. (g/100g)	Diet 1 (RD)	Diet 2(Ctl.) (100%FM)	Diet3 (25%M)	Diet 4 (50%M)	Diet5 (75%M)	Diet 6 (100%M)
DM	92.93 ± 0.06^{a}	90.20 ± 0.23^{b}	92.14 ± 0.32^{a}	91.74 ± 0.15^{a}	91.51 ± 0.99^{a}	92.66 ± 0.23^{a}
MC	7.07 ± 0.06^{f}	9.80 ± 0.23^{a}	7.86 ± 0.23^{c}	8.26 ± 0.23^{b}	7.15 ± 0.18^{e}	7.34 ± 0.23^{d}
CP	42.10 ± 0.02^{d}	44.01 ± 0.18^{a}	43.92 ± 0.10^{b}	43.10 ± 0.01^{c}	43.98 ± 0.01^{a}	41.56 ± 0.04^{e}
CF	3.83 ± 0.17^{e}	4.50 ± 0.35^{d}	5.07 ± 0.02^{c}	5.23 ± 0.08^{c}	5.70 ± 0.26^{b}	6.27 ± 0.26^{a}
Lipid	8.33 ± 0.12^{d}	7.20 ± 0.07^{f}	8.05 ± 0.05^{e}	8.99 ± 0.08^{c}	10.04 ± 0.01^{b}	11.23 ± 0.02^{a}
Ash	10.00 ± 0.01^{a}	9.82 ± 0.02^{b}	9.02 ± 0.02^{c}	6.68 ± 0.22^{d}	3.80 ± 0.44^{e}	3.20 ± 0.44^{f}
NFE	28.68 ± 0.02^{c}	24.68 ± 0.01^{f}	26.09 ± 0.43^{e}	27.75 ± 0.04^{d}	29.33 ± 0.06^{b}	30.40 ± 0.5^{a}
GE	1856 ± 6.2^{e}	1813 ± 0.5^{f}	1909 ± 0.51^{d}	1984 ± 11.1^{c}	2080 ± 11.2^{b}	2110 ± 0.7^{a}

Means with the same superscript along the same row were not significantly different ($p \geq 0.05$) while those with different superscript were significantly different ($p \leq 0.05$).

Key: Comp. (Composition), DM(Dry Matter), MC (Moisture Content), Crude Protein(CP), Crude Fibre(CF), Crude Lipid(CL), Nitrogen Free Extract(NFE), Gross Energy(GE),kilo Joules(kJ), Maggot meal(M), Reference Diet(RD), Control(Ctl.), Fish meal(FM)

Physicochemical Parameter of Experimental Tank Water

The water quality parameters monitored during the experimental feeding trial are presented in Table 3. The result showed that there were no significant differences ($p \geq 0.05$) in temperature (27.63 ± 0.15 - 28.08 ± 0.15°C), Dissolved Oxygen (5.20 ± 0.04 - 5.65 ± 0.08 mg/L) and Hydrogen ion concentration (pH) values (7.27 ± 0.05 to 7.41 ± 0.03) between the experimental tanks water documented during experimental period.

Table 3: Physicochemical Parameter of Experimental Tanks

Parameter	Diet 1 (RD)	Diet 2(Ctl.) (100%FM)	Diet 3 (25%M)	Diet 4 (50%M)	Diet 5 (75%M)	Diet 6 (100%M)
Temp.(^{0}C)	28.08 ±0.15[a]	28.03±0.02[a]	28.03±0.01[a]	27.9±0.01[a]	28.03±0.02[a]	27.63±0.15[a]
DO(mg/L)	5.37±0.03[a]	5.47±0.027[a]	5.20±0.04[a]	5.65±0.08[a]	5.34±0.01[a]	5.41±0.03[a]
pH	7.32±0.06[a]	7.41±0.03[a]	7.36±0.06[a]	7.27±0.05[a]	7.36±0.06[a]	7.28±0.05[a]

Means with the same superscript along the same row are not significantly different ($p \geq 0.05$) while those with different superscript are significantly different ($p \leq 0.05$).
Key:
Temp. (Temperature), DO (Dissolved Oxygen), pH (Hydrogen ion concentration), Reference Diet(RD), Control(Ctl.), FM (fish meal), M (Maggot meal).

Growth Performance and Survival of *Clarias gariepinus* Fingerlings fed Experimental Diets

The results recorded for the growth parameters and survival of *Clarias gariepinus* fingerlings fed Experimental Diets are presented in Table 4. Final mean weight increased with increase of maggot up to 75% level of meal inclusion in the experimental fish diet. Fish in all the experimental groups increased significantly over the twelve weeks feeding trial. The highest mean weight in this study was observed in the reference diet which is the commercial diet (57.77g). Fish fed commercial diet had a higher weight gain than fish fed solely maggot meal. Furthermore, fish fed 25%, 50% and 75% inclusion levels of maggot meal gave a higher final mean weight (46.61g, 55.84g and 44.04g respectively) than 100% fish meal (43.72g). The least weight gain was seen in fish fed 100% inclusion levels of maggot meal (35.95g). There were significant differences ($p \leq 0.05$) in weight gain among experimental diets. Similarly, 25%, and 50% inclusion of maggot meal gave higher specific growth rates than 100% fish meal. Apart from 0% and 75% (2.20/day) inclusion levels of maggot meal which has no significant differences ($p \geq 0.05$) in specific growth rate between them, there were significant differences ($p \leq 0.05$) in specific growth rate among the other experimental diets.

The highest survival rate (90%) of fish was recorded in fish fed (diet 1). Diets containing 25%, 50%, 75%, 100% inclusion level of maggot and

100% fish meal gave the same survival rate of fish. There were significant differences (p≤0.05) between the inclusion levels of maggot meal and the reference diet. However, there was no significant difference (p≥0.05) between inclusion levels of maggot meal.

Table 4: Growth Performance and Survival of *Clarias gariepinus* Fingerlings Fed Experimental Diets

Parameter	Diet 1 (RD)	Diet 2(Ctl.) (100%FM)	Diet 3 (25%M)	Diet 4 (50%M)	Diet 5 (75%M)	Diet 6 (100%M)
IMW (g/fish)	6.05	6.06	6.06	6.08	6.07	6.07
FMW(g/fish)	57.77±0.13^{a}	43.72±0.21^{e}	46.61± 0.12^{c}	55.84± 0.48^{b}	44.04± 0.53 ^{d}	35.95± 0.47^{f}
MWG(g/fish)	51.72 ±0.13^{a}	37.66±0.27^{e}	40.56±0.06^{c}	49.76±0.44^{b}	38.00±0.50^{d}	29.88±0.41^{f}
IML (cm)	7.19±0.02^{a}	7.17±0.02^{a}	7.16±0.01^{a}	7.17±0.01^{a}	7.16±0.02^{a}	7.17±0.01^{a}
FML (cm)	17.21±0.22^{a}	15.56±0.03^{b}	16.0±0.01^{d}	16.62±0.10^{c}	14.90±0.08^{d}	13.60±0.03^{e}
MLG (cm)	10.02±0.24^{a}	8.39±0.05^{d}	8.84±0.01^{c}	9.45±0.10^{b}	7.74±0.09^{e}	6.43±0.03^{f}
SGR (%/day)	2.51±0.00^{a}	2.20±0.00^{d}	2.27±0.00^{c}	2.46±0.00^{b}	2.20±0.00^{d}	1.98±0.00^{e}
Survival (%)	90^{a}	80^{b}	80^{b}	80^{b}	80^{b}	80^{b}

Means with the same superscript along the same row are not significantly different (p≥0.05) while those with different superscript are significantly different (p≤0.05).

Key:

Initial Mean Weight(IMW), Final Mean Weight(FMW),, Mean Weight Gain (MWG), Initial Mean Length (IML), Final Mean length (FML), Mean Length Gain(MLG), Specific Growth Rate(SGR), Reference Diet(RD), Control(Ctl.), M(maggot meal), FM(Fish Meal).

Nutrient Utilization of *Clarias gariepinus* Fingerlings Fed Experimental Diets

The results recorded for the nutrient utilization by *Clarias gariepinus* Fingerlings fed Experimental diets are presented in Table 5. Feed conversion ratio, Gross Feed conversion efficiency, Protein intake, protein efficiency ratio and Net Protein Utilization were higher (1.50, 66.90%, 32.55g/100g, 1.59 and 79.71%, respectively) in fish fed Diet 1 followed by fish fed Diet 4(1.52, 65.78%, 32.58g/100g,1.53 and 70.52%). Values of feed conversion ratio, gross feed conversion efficiency, protein efficiency ratio and Net Protein Utilization in diets 3, 4, and 5 where better than diet 2. There were significant differences (p≤0.05) observed between Feed conversion ratio, Gross Feed conversion efficiency, Protein intake, protein efficiency ratio and Net

Protein Utilization values of each fish fed experimental diets.

Table 5: Nutrient Utilization of Catfish Fed Experimental Diets

	Diet 1 (RD)	**Diet 2(Ctl.) (100%FM)**	**Diet 3 (25%M)**	**Diet 4 (50%)**	**Diet 5 (75%M)**	**Diet 6 (100%M)**
FCR	1.50±0.00^{f}	1.89±0.00^{b}	1.79±0.00^{d}	1.52±0.00^{e}	1.88±0.00^{c}	2.09±0.00^{a}
GFCE	66.9±0.02^{a}	52.84±0.04^{e}	55.85±0.01^{c}	65.78±0.04^{b}	53.2±0.05^{d}	47.85±0.07^{f}
PI	32.55±0.41^{a}	32.08±0.18^{c}	31.89±0.16^{d}	32.58±0.17^{b}	31.39±0.17^{cd}	25.95±0.06^{f}
PER	1.59±0.01^{a}	1.17±0.01^{e}	1.27±0.01^{c}	1.53±0.00^{b}	1.21±0.01^{d}	1.15±0.00^{f}
NPU	79.71±0.83^{a}	64.86±0.30^{c}	68.10±0.15^{c}	70.52±0.97^{b}	65.91±0.64^{d}	66.32±0.4^{d}

Means with the same superscript along the same row are not significantly different ($p \geq 0.05$) while those with different superscript are significantly different ($p \leq 0.05$).

Key:

Feed Conversion Ratio (FCR), Gross Feed Conversion Efficiency (GFCE), Protein Intake (PI), Protein Efficiency Ratio (PER), Net Protein Utilization (NPU), Reference Diet(RD), Control(Ctl.), M (maggot meal), and FM (Fish Meal).

Discussion

The crude protein of maggot meal obtained in this work was higher than 48.7% reported by Hezron, *et al.* (2019) and lower than 64.30% reported by Jimoh *et al.* (2022). The variation in crude protein contents of maggot meal could be attributed to the method of processing, geographical location, quality of protein used to produce the maggot meal and time of harvesting. The crude protein values of the experimental diets were in conformity with the values recommended by Bolorunduro (2002) as crude protein requirement for *C. gariepinus* fingerlings. The variation in crude protein may be related to the different inclusion level of maggot meal in the diets. Although all the diets contained percentage crude protein required for *C. gariepinus* fingerlings growth, they may not necessarily contain percentage crude fibre in the right proportion as high percentage crude fibre can hinder growth. Therefore, it is not only the recommended percentage crude protein that determines the optimum growth pattern of the fish but also

the amount of percentage crude fibre (Robinson, *et al.*, 2001). However, the crude fibre was equally good and capable of aiding the digestion of nutrients. Compared to older maggots, younger maggots seemed to be tender and had less fiber. (Hezron *et al*. 2019).
The crude lipid was 12.68g/100g was high which could be related to the accumulation of fat through the active feeding process with larval growth (Hezron *et al*. 2019).
The current study shows that the values for growth performance and nutrient utilization of the diet of all the experimental groups were positive and this implies that all the experimental diets contain the adequate crude protein composition necessary for the growth of fingerlings.
The replacement of fish meal in the diet of *Clarias gariepinus* fingerling with a maggot meal at 50% inclusion level could be incorporated without a deleterious effect on growth and nutrient utilization. This is in accordance with the findings of Jimoh *et al.* (2022). The reference diet gave the highest growth and feed utilization performance. This could be attributed to the good odour, colour and stability of the feed in water.
The negative effects of growth indices and nutrient utilization with 75% and 100% of maggot meal inclusion in spite of the conducive physico-chemical parameters of water recorded might be related to decreased feed intake, digestibility of feed, mineral deficiencies and high percentage crude fibre content of the diets. Similar studies recorded depression in growth performance and nutrient utilization when different insects were fed to *C. gariepinus* (Olaniyi, *et al.*, 2016; Michael & Kolapo, 2017).

The high survival rate (80%) of fingerlings fed 25%, 50%, 75% and 100% inclusion level of maggot meal showed that maggot diets provided nutrition to *Clarias. gariepinus* fingerlings. Similarly, they were harmless with no deleterious effect on percentage survival since it was comparable with 100% fish meal. Also, low mortality was thought to be the consequence of handling stress and water quality deterioration due to high levels of nitrogenous wastes in the water. The survival rate correlates with the study of Okore *et al.* (2016).

Conclusion

It is concluded that based on growth parameter and nutrient indices of the experimental diets, the control, diet 3 and diet 4 gave a better result than diet 2. It may be stated that local and inexpensive aquafeeds can partially replace fish meal where fish meal is imported at an exorbitant cost.

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