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Response of Substituting Fish Meal with Maggot Meal on the Growth Performance and Nutrient Utilization of *Heterobranchus bidorsalis* (Geoffrey Saint – Hilaire 1809) Fingerlings

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ABSTRACT

Maggot meal produced from maggots grown on poultry manure was used in substituting fish meal in African Catfish, *Heterobranchus bidorsalis* diet. The study lasted for a period of 8 weeks. Growth and nutrient utilization of catfish fingerlings were evaluated as fish meal was substituted maggot meal at the following levels, 0%, 25%, 50%, 75% and 100% respectively. Proximate analysis carried out indicated that maggot meal had 32.66% crude protein, 12.5% crude fat, 7.50 crude fiber, 11.16 % ash and 34.60% moisture content. Maggot meal based diets compared favourably with fish meal based diets at an inclusion level of 25% as there were no significant differences (p>0.05) in the growth and nutrient utilization indices. It was concluded that maggot meal is a viable alternative protein source to fish meal in the diet of *Heterobranchus bidorsalis*. Its utilization is expected to reduce feed cost drastically, thus leading to a viable and sustainable aquaculture industry.

INTRODUCTION

Feed is the single most expensive factor in aquaculture production and where the protein component of fish diet constitutes the highest cost (Ezeafulukwe *et al.,* 2015; Ugwumba and Ugwumba, 2003). The proportion of protein in fish diets is higher than those of other cultured or reared animals thus making feed very expensive (Cadag *et al.,* 1981). Consequently, fish demand has been on the increase, growing at variance with its supplies but systematically with human population, industrial and growth (Njoku, 2015). One way to meet the high economic demand for fish is to culture fish species which can be cultured with prospects for fast growth under a short period of time, when given the right feed in the right proportions of nutrient (Ezeafulukwe *et al.,* 2017).

The replacement of fish meal in fish feed either commercially or locally with maggot meal was carried out since fish meal being the major component in fish feeds are exorbitant. Studies have shown that the African catfish, *Heterobranchus bidorsalis* requires about 40% crude protein in their diets and best results had been achieved with crude protein values ranging from 35 to 50% for all African catfish species (Fagbenro *et al.,* 1992).

The bulk of feeds used in fish production, especially for catfish are imported and this has led to a high production of farmed fish. The rising cost of diet ingredients especially fish meal worldwide is expected as its cost will continue to rise in world market. In order to stem this trend, researches are carried out to determine cheaper alternative with comparable nutritional qualities.

Maggot meal has been reported to be a possible alternative (Makinde, 2015). Maggot meal has good nutritional value, cheaper and less tedious to produce than other animal protein sources. It is also produced from wastes which otherwise would constitute nuisance, especially in integrated farming like and poultry. The production system thus served the dual purpose of providing a nutrient rich resource as well as a source of wastes reduction and transformation. However, the production system is yet to be commercialized (Teguia and Beynen, 2005) probably because its utility and value in aqua feeds have not been evaluated. The reported crude protein values of maggot meal range from 43 to 62% (Olaoye, 1998).

Therefore, maggot meal can be used to replace fish meal for the production of locally formulated feed for *Heterobranchus bidorsalis* fingerlings to consume. Objectives assessed are determination of growth performance, nutrient utilization and the inclusion level that elicits optimum growth of *Heterobranchus bidorsalis* fingerlings while replacing fish meal with maggot meal.

MATERIALS AND METHOD

Study area

Owerri the capital city of Imo State, Nigeria lies within latitude 06^0 29 06s and longitude 07^0 02 06s. The area experiences a longer wert season which lasts from April to November than dry season which last for the rest of the year. It has mean daily maximum temperature range of 28^0C to 35^0C, while daily minimum values ranges from 19^0C to 24^0C, with average humidity of 80%. The vegetation is dominated by semi-deciduous forest that has already been altered by agricultural and other anthropogenic activities and the dominant topsoil is moderately humus in composition.

The study was carried out in the Fisheries and Aquaculture Research Farm of the Federal University of Technology Owerri, Nigeria which provided the farm-raised specimens used for the study. It is bounded by longitudes of 65^0 8''E- 7^0 03E and latitudes of 5^0 20'N – 5^0 28'N. The institution has an annual rainfall between 192-194cm and temperature of 32.18^0C.

Experimental Procedure

Diets with different inclusion levels of maggot meal at 0%, 25%, 50%, 75% and 100% were formulated. A total of 180 *Heterobranchus bidorsalis* fingerlings purchased from a commercial hatchery with a mean weight 10.00±44.93 were used for the study. The fish were held inside 15 (fifteen) plastic containers each having 10 (ten) *Heterobranchus bidorsalis* fingerlings which were randomly distributed into each of the plastic container. Fish were allowed to acclimatize for a period of 7 days before the commencement of the experiment and were starved for 24 hours to empty their gastro intestinal tract.

Each diets was assigned to a group of ten (10) *Heterobranchus bidorsalis* fingerlings in triplicate, fish were fed twice daily in the morning hours (8am -9.30am) and in the evening hours (4pm -5.30pm) respectively.

Fish inside the 15 plastic containers were weighed simultaneously in batches at the end of every two weeks using digital weighing balance and return to their respective enclosures. The feed were adjusted every two weeks when the new mean weight of fish for the experiment were determined, unconsumed feed were siphoned out each week, stale water were renewed in the containers after 3 days from a bore hole at the farm unit. The experimental containers were monitored daily to remove mortality while physic chemical parameters were monitored for temperature, dissolved oxygen, ammonia, P^H and hardness throughout the duration of the experiment for 56 days.

Analysis of Fish samples for nutrient composition

Samples were analyzed chemically in accordance (AOAC, 2005).

Crude protein determination

Crude protein was determined in accordance with AOAC (2005). The crude protein in the sample was determined by the routine semi micro Kjeldahl, procedure and technique. This consists of three techniques of analysis, namely, digestion, distillation and titration.

Statistical analysis

The two sets of data on nutrient composition emanating from fish were subjected to analysis in accordance with DNMRT (Gordon and Gordon, 2014).

RESULTS

Table 1-3 presents the gross composition of the experimental diet, proximate analysis of *Heterobranchus bidorsalis* fingerlings and proximate analysis of experimental diets as evaluated. A total of five parameters were considered including crude protein, crude fat, crude fibre, ash and moisture.

Table 1: Proximate Analysis of Maggot Meal.

Parameters	Maggot Meal %
Crude Protein	32.66
Crude Fat	12.46
Crude Fiber	7.50
Ash	11.16
Moisture	34.60

Table 2: Ingredient Composition of Experimental Diets

Ingredients	D_0	D_1	D_2	D_3	D_4
Fish Meal	33.94	25.47	16.97	8.47	0.00
Maggot Meal	0.00	8.47	16.97	25.47	33.94
Soya Bean Meal	29.96	29.96	29.96	29.96	29.96
Yellow Maize	15.10	15.10	15.10	15.10	15.10
Wheat Bran	5.00	5.00	5.00	5.00	5.00
Bone Meal	10.25	10.25	10.25	10.25	10.25
Fish Premix	1.50	1.50	1.50	1.50	1.50
Vitamin C	0.50	0.50	0.50	0.50	0.50
Cod Liver Oil	1.00	1.00	1.00	1.00	1.00
Palm Oil	1.00	1.00	1.00	1.00	1.00
Lysine	0.25	0.25	0.25	0.25	0.25
Methionine	0.25	0.25	0.25	0.25	0.25
Common Salt	0.25	0.25	0.25	0.25	0.25
Starch	1.00	1.00	1.00	1.00	1.00
Total	100.00	100.00	100.00	100.00	100.00

Table 3: Carcass Quality Analysis of *Heterobranchus bidorsalis* fingerlings Before Study.

Parameters	Values (%)
Crude Protein	14.05
Crude Fat	2.15
Crude Fiber	0.34
Ash	1.20
Moisture	81.74

Table 4: Proximate Analysis of Experimental Diets

Parameters (%)	Control D_0 (g) D_1(g)	D_2(g)	D_3(g)	D_4(g)	
Crude Protein	37.23	36.25	35.40	33.30	33.56
Crude Fat	13.25	13.98	14.83	16.45	16.65
Crude Fibre	2.50	3.00	2.70	2.15	2.20
Moisture	23.14	26.61	25.48	27.98	27.50
Ash	7.38	8.17	9.39	11.01	11.56
NFE	16.50	11.99	12.20	9.11	8.53

Table 5: Growth Parameters of *Heterobranchus bidorsalis* fingerlings fed with Five Different Diets.

Parameters	D_0	D_1	D_2	D_3	D_4
Initial Weight (g)	44.03±3.19[a]	44.79±2.0[a]	44.07±0.90[a]	44.39±2.62[a]	44.74±3.65[a]
Final Weight (g)	147.17±4.87[a]	144.17±8.45[ab]	127.30±10.76[b]	107.93±12.97[c]	105.38±15.11[c]
Mean Weight Gain (g)	104.13±6.99[a]	99.37±9.47[ab]	83.23±11.11[b]	65.21±8.14[c]	60.65±13.02[c]
Mean Daily Weight Gain (g)	1.86±0.12[a]	1.78±1.17[ab]	1.49±0.20[b]	1.17±0.15[c]	1.08±0.24[c]
Specific Growth Rate (%/day)	2.20±0.17[a]	2.09±0.16[ab]	1.85±0.22[b]	1.61±0.08[c]	1.52±0.19[c]
Feed Conversion Ratio	2.61±0.18[a]	2.58±0.25[a]	2.85±0.37[ab]	3.25±0.40[ab]	3.56±0.70[b]
Protein Efficiency Ratio	0.96±0.06[a]	0.97±0.10[a]	0.89±0.12[a]	0.77±0.11[a]	0.72±0.16[a]
Feed Intake	271.42±0.01[a]	254.86±0.01[a]	234.52±0.01[a]	210.01±0.01[a]	209.90±0.01[a]
Daily Feed Intake	4.85±0.01[a]	4.55±0.01[a]	4.19±0.01[a]	3.75±0.01[a]	3.75±0.01[a]
Protein Intake	108.58±0.01[a]	101.94±0.01[a]	93.81±0.01[a]	84.00±0.01[a]	83.00±0.01[a]
Survival Rate	100±0.01[a]	96.67±5.77[ab]	90±10.00[b]	100±0.01[a]	100±0.01[a]

Treatment means within same row with different superscript letters a, b ,c are significantly different ($p<0.05$). D = Diets.

Table 6: Physio- Chemical Parameter of Water Recorded During the 8 Weeks of Study

Parameters	D_0	D_1	D_2	D_3	D_4
Temperature	28.67±1.16[a]	28.33±1.53[a]	27.67±1.16[a]	28.67±2.31[a]	28.67±0.58[a]
pH	6.40±0.17[a]	6.40±0.10[a]	6.47±0.06[a]	6.33±0.29[a]	6.43±0.12[a]
D_0	7.47±0.81[a]	7.50±0.46[a]	8.00±0.53[a]	7.67±1.03[a]	7.60±0.60[a]
Ammonia	3.0±0.01[a]	3.0±0.01[a]	3.0±0.01[a]	3.0±0.01[a]	3.0±0.01[a]
Hardness	1323.0±4.00[a]	126±5.00[a]	133±7.00[a]	130±7.00[a]	134±4.00[a]

Mean with different superscripts on the same row are significantly different ($p<0.05$).

Table 7: Proximate Analysis (Carcass Quality Analysis) of Experimental Fish (*Heterobranchus bidorsalis* fingerlings) After Study on Dry Matter.

Components (%)	D_0 (0%)	D_1 (25%)	D_2 (50%)	D_3 (75%)	D_4 (100%)
Crude Protein	67.17	64.75	57.13	54.68	54.34
Crude Fat	4.26	4.99	5.65	6.27	6.11
Moisture	26.20	28.62	34.63	35.62	36.49
Crude Fibre	0.54	0.48	0.36	0.25	0.31
Ash	1.83	1.16	2.23	3.18	2.76

RESULTS AND DISCUSSION

From Table 5 above, no significant difference ($p>0.05$) were observed in the following parameters; initial weight, feed intake, protein intake, protein efficiency ratio, daily feed intake and survival rate. Significant difference ($p<0.05$) existed among treatment in parameters final weight, mean weight gain, weight gain, specific growth rate and feed conversion rate respectively.

Mean weight gain and specific growth rate reduced at all trial inclusion levels of maggot meal. It has been suggested that the good growth and nutrient utilization capacity of fish fed maggot based diets stem from the high biological value i.e. nutrient composition and digestibility of the ingredient (Bayandina *et al.,* 1980; Ebenso and Udo, 2003). Jhingram (1983) reported that maggots are easily digested by fish and this has been attributed to its relatively high crude fiber content, which according to Fagbenro and Arowosoge (1991) plays a significant role in feed digestion. In this study, the opposite was the case as the control diet; (treatment 1) had higher weight gain than the maggot treated diets. This may be attributable to the high fiber content of the maggot meal which makes its utilization inefficient. It is also observed that the higher the maggot inclusion, the lower the growth of the fish. This was confirmed by Ekoue and Hadzi (2000) and Sogbesan *et al.,* (2005) who worked on *Heterobranchus longifilis* and found out that the fish do not require high inclusion level of maggot meal. Utilization of maggot meal will pave way for cheaper and nutritionally rich aqua feeds in the culture of *Heterobranchus bidorsalis* fingerlings at 25% inclusion level as observed in this study as shown in Table 2.

The temperature in the water ranged from 27.67 – 28.67^{0}C, pH, and 6.3-6.4 and dissolved Oxygen 7.47ppm – 8.00ppm. These ranges fall within the acceptable limits in aquaculture (Boyd, 1979). The dietary protein concentrate in the feed is directly proportional to the ammonia produced, with higher protein levels producing more ammonia (Ebenso and Udo 2003).

Fashina-Bombata and Balogun (1997) and Ajani *et al.* (2004) showed that the nutritive value of maggot meal compared favourably with that of fish meal. They concluded that maggot meal can replace up to 100% of fish meal in the diets of Nile tilapia (*O. niloticus*).

CONCLUSION

It is concluded that based on the availability, biological value, growth and nutrient utilization, maggot meal at 25% inclusion level, is a viable alternative protein source to fish meal *Heterobranchus bidorsalis* diets. The economic efficiency so in developing countries like Nigeria where fish meal is imported at an exorbitant cost.

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