GROWTH AND SURVIVAL RATE OF *CLARIAS GARIEPINUS* FINGERLINGS FED WITH BLACK SOLDIER FLY (*HERMETIA ILLUCENS*) LARVAE MEAL.

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Abstract

This study reports four-weeks feeding trial to access the survival and growth parameters of Clarias gariepinus fingerlings fed with black soldier fly larvae meal. Black soldier fly larvae meal was substituted for fishmeal, with black soldier meal at 0% for Treatment 0 (T_0) (control), 25% (T1), 50% (T2), 75% (T3) and 100% (T4) in five different feeding diets. The result of the feed utilization and survival rate indicate that fishes fed with the second diet (T1) had the highest Mean Weight Gain (MWG), while those served with treatment T4 had the least. There was no significant difference ($p>0.05$) in the specific growth rate (SGR) between the fishes fed with the second diet (T1) and those fishes fed with T2. The treatment with the highest feed conversion ratio (FCR) was T1, T2 and T_0 (the control) while the lowest was diets T4 and T3. The present study revealed that black soldier fly larvae meal has a good potential for use as a fishmeal substitute in C. gariepinus diet up to 75% inclusion level without compromising growth.

Keywords: Black soldier fly meal, *Clarias gariepinus*, Growth rate and Survival rate

Introduction

Aquaculture is an enterprise that is growing rapidly and improving the economy worldwide. Fish are cultivated for food and source of revenue for the growing human population, restocking streams, lakes, and rivers to curb the shortage due to the decline in wild capture and sport fishing (FAO, 2000). While agriculture is predominantly based on the use of freshwater, aquaculture occurs in both inland (freshwater) and coastal (brackish water, seawater) areas. Aquaculture is one of the fastest growing, food-producing sectors in agriculture and fish is among the most traded food commodities worldwide, accounting for 17 percent of the global intake of animal protein(FAO, 2014).

Fish is also an important source of micronutrients such as vitamins, minerals, and polyunsaturated omega-3 fatty acids (FAO, 2012). Fish farming (Aquaculture) is one of the fastest growing agriculture enterprises in Nigeria with a gross domestic product (GDP) of 5.4% (Federal Department of Fisheries, 2005). Fishmeal is considered a viable source of amino acids and protein while fishery products such as fats provide polyunsaturated fatty acids such omega-3 fatty acids are desirable for their excellent antioxidant properties in human and animal nutrition (Olsen and Hasan, 2012).

Catfish (*Clariasgariepinus*)is a remarkable fish species in Nigeria where it is the leading aquatic crop. It has the credentials of fast growth, resistance to disease, and handling stress. It has an air-breathing structure and can, therefore, tolerate very low oxygen levels in any aquatic environment as well as on land. Nigeria is presently the largest producer of catfish (FAO, 2005).

The black soldier fly, *Hermetia illucens* (Linnaeus)**,** is a sleek-looking fly that many confuse with a wasp. However, like most flies, the black soldier flies only have two wings (wasps have four) and do not possess a stinger. Although the loud buzzing they create when flying is enough to concern many people, adult soldier flies pose no danger.
Feed is pertinent to the success of aquaculture development. It will account for 60 to 70% of the total cost of production (FAO, 2012).With increasing demand for fish and the decline of capture fisheries,fish production in Nigeria is shifting to commercial high-intensive fish farming. This means that the demand for commercially formulated feed is rising.

However, the continuous use of fish meal in aquaculture production is currently unsustainable currently since water bodies are heavily exploited to feed the fish meal industry (FAO,2012). In recent times due to increasing pressure on water bodies and tightened controls, (FAO,2012) this has resulted in the expensive production of fish feed. For

instance, the cost of fish feed on the international market increased by 73% from 2005 to 2008 due to increase in fish meal prices (FAO,2012).

The implication of the high cost of feed for fish farmers is that fish feed is less accessible and aquaculture production is unsustainable. A locally manufactured feed will use a more cost-effective supplement with sustainable supply and socially acceptable method of production than a fish meal, and will therefore be much welcome intervention to curtail this problem. The black soldier fly is the preferred insect because it is easy to handle and it does not spread diseases.

Materials and Method

Experimental Site

The experiment was conducted in the student experimental unit of the Department of Agricultural Technology, The Federal Polytechnic, Ilaro, Ogun State, Nigeria.

Acquisition of experiment animal

Three hundred (300) catfish fingerlings used in this experiment were procured from De Heritage Fish Farm in Ilaro, Ogun State. Twenty (20) fingerlings per aquaria were acclimatized to experimental conditions for one week before the experiment started. Before the acclimation period, 20 fingerlings were randomly weighed using a sensitive scale to establish the initial weight at the start of the experiment and these were recorded.

Collection of target organism

Accurate 2 kg of dried black soldier fly larvae were obtained from Tucur Farm at Ibadan. The dried black soldier fly larvae were packed inside a zip lock bag for transportation to the experimental site.

Experimental Setup

The feeding experiment was conducted at The Federal Polytechnic, Ilaro School Farm from November to December 2021. A total of 15 aquaria were used in this study. Twenty catfish fingerlings were put into each aquarium. 15 aquaria in total were used for the five treatments, each replicated three times. Clean water was supplied from a reservoir tank into each aquarium through inlet pipes and the effluent water was drained.

Feed diets formulation

Five different diets were produced using Pearson square method of fish feed formulation. All other ingredients were milled using hammer mill, then the Black soldier fly larvae meal was incorporated to each diet at different percentage level to replace Fishmeal at (a) 0% replacement in the control (T0), (b) 25% in the first diet (T1), (c) 50% replacement in the second diet (T2), (d) 75% replacement in the third diet (T3) and (e) 100% replacement in the fourth diet (T4).

Table 1: Ingredient composition of experimental feed diet

	Control	1	2	3	4
Fishmeal	150	112.5	75	37.5	-
Soybean meal	300	300	300	300	300
Poultry meal	100	100	100	100	100
GNC	200	200	200	200	200
BSF	-	65	130	195	260
Corn	160	132.5	105	77.5	50
Premix	15	15	15	15	15
Meth	5	5	5	5	5
Lysine	5	5	5	5	5
DCP/Limestone	5	5	5	5	5
Salt	5	5	5	5	5
Oil	50	50	50	50	50
Vit. E	5	5	5	5	5

Feeding Protocol

The five experimental diets were randomly assigned to each aquarium tanks in triplicate. The fingerlings were fed daily to satiation at 10% body weight two times a day at 10.00 am and 4.00 pm for three weeks. Aquaria were cleaned daily prior to feeding by siphoning out the water with fecal matter and left over feed at the bottom of the tank using siphoning pipes.

Determination of Survival Rate of Catfish Fingerlings

Dead catfish fingerlings, if any, were removed daily and the mortality used to determine the number of live fingerlings left in each aquarium. Survival rate was determined at the end of the experiment by counting the number of live catfish fingerlings remaining in each aquarium and expressed as a percentage of the stocked fish as follows;

$$SR(\%) = \frac{N_1}{N_0} X\ 100$$

Where N_1 = Total number of fingerlings at the end of the experiment
N_0 = Total number of fingerlings at the beginning of the experiment.

Determination of Specific Growth Rate of Catfish Fingerlings

The growth performance of catfish fingerlings was assessed in terms of weight gain and specific growth rate for each treatment. A sample of twenty fingerlings were scooped out using a hand scoop net from each aquarium. To achieve accurate fingerlings weight, the excess water on the hand scoop net was carefully wiped using a kitchen towel. The fingerlings were then introduced into a zeroed half-filled water bowl on a weighing balance and the weight recorded. After weighing, the fingerlings were returned to their respective aquarium immediately. Growth of the fingerlings was expressed as specific growth rate (SGR) using the formula:

$$SGR\% = \frac{\ln FBW - \ln IBW}{t}\ x\ 100$$

Where FBW = final body weight In = natural logarithmic;
IBW = initial body weight t = time.

Statistical Analysis of Experimental Data

The data describing the survival rate and specific growth rate were analyzed statistically using one way analysis of variance. SPSS (2020) was used to test for difference among means ($p>0.05$) in order to see if these parameters were significant or not.

Results and Discussions

Results

Growth performance of catfish fingerlings fed on experimental diets

The catfish fingerlings were sampled once per week during the experimental period to determine the growth performance. The initial weight of the catfish fingerlings ranged between 0.10 and 0.44 g. The body weight of fish increased progressively during the three weeks' experimental period and was significantly higher at the end of the experiment as compared to the start of the experiment. At the end of the experiment, fish fed on black soldier fly larvae had a significant higher weight gain.

The result of the feed utilization and survival rate are presented in **Table 2.** Fishes fed with T1 gained 33.20 g body weight while fishes fed with T2 gained 26.67 g, fishes fed with T3gained 25.37 g, fishes fed with T_0 gained 25.07 g while 22.07 g weightgain was recorded in fishes fed with T4. Means of all treatment ($T_0$to T4) were significantly different. There was no significant difference ($p>0.05$) in the feed conversion ratio (FCR) in fishes fed with T2 and T4. The highest value of 0.47 for protein efficiency (PER) was observed in fishes fed with T1 and the lowest value of 0.35 was recorded in fishes fed with T4.

Table 2: Nutrient utilization and survival rate of *C. gariepinus* fingerlings fed with black soldier fly larvae meal based diet.

Parameter	T0	T1	T2	T3	T4
MW	10.30±0.32	10.37±0.10	9.87±0.32	10.47±0.32	10.1±0.44
FMW	35.37±2.58bc	43.57±1.19a	36.53±3.11b	35.83±2.31bc	32.17 ±1.53c
MWG	25.07±2.68bc	33.20±1.31a	26.67±1.82b	25.37±2.00bc	22.07 ±1.33c
MFI	16.32±0.65b	17.80±0.15a	16.10±0.74b	16.67±0.49bc	15.74±0.62b
FCR	1.54±0.19ab	1.87±0.07a	1.66±0.04b	1.52±0.08ab	1.40±0.11b
SGR	5.84±0.46bc	6.98±0.28a	6.27±0.18b	5.83±0.20bc	5.43±0.23c
PI	6.53±0.26b	7.12±0.06a	6.44±0.29b	6.67±0.20b	6.30±0.25b
PER	0.38±0.05bc	0.47±0.02a	0.41±0.01b	0.38±0.02bc	0.35 ±0.03c

Survival and Mortality

The fishes were observed every morning and evening for any abnormality and mortality from each tank.
The survival rates at the end of three weeks' study period were100% in all the treatment groups except treatments T0 and T1 with 95% and 99.3% survival rates respectively. Survival was constant throughout the course of the study except for three catfish fingerlings from treatment diet T0 and one fromT1 whose skulls were found in the experimental tanks.This signifies a sign of predation among the fishes.

Table 3: The survival and mortality of the African catfish during the three weeks' study period as per treatment diet.

Treatment	Initial stock	Final stock	Total mortality	% Survival
T0	60	57	3	95
T1	60	59	1	99.3
T2	60	60	0	100
T3	60	60	0	100
T4	60	60	0	100

Discussion

The final mean weight showed a significant difference ($p<0.05$) between the treatments, as high weight gain in animals is attributed to increased feed intake. In this study, there was an increase in final mean and body weight gain with an increased level of black soldier fly larvae meal. The weight gain value showed a significant difference ($p<0.05$) between the treatment.
There is a significant difference ($p<0.05$) in the protein efficiency ratio (PER) of all treatments T_0 to T4. It shows that there is an increase in the PER as the inclusion of BSFL increases up to75% in the diet. The presence of BSFL in diets increases, and results in higher feed intake, Feed intake is important in the sense that it is the determinant of its performance.

The feed conversion ratio (FCR) was better in fishes fed diets T1 and T2 among all experimental diets., high fat content of black soldier fly in the formulated diet may inhibit the intake of nutrient required for growth (Ali&Jauncey,2004) and it could reduce the feed digestibility (watanable ,1982), that could result to the low values recorded for treatment T4.

The low survival rate in T_0 diet may be due to environmental factors and handling of the fish throughout the experimental period
Growth performance from the present study was comparable to those from other previous experiments (Wen et al., 2013; Cummins et al., 2017; Zarantoniello et al., 2018) with very little differences. Differences in composition and formulation of treatment diets and rearing conditions of the fish may also have contributed to the varied results (Wen et al., 2013; Yu et al., 2013). Several researcher have demonstrated that black soldier fly larvae meals have an ideal amino acid profile that is comparable to conventional protein sources such as fishmeal (Newton et al., 2005b). A review by Rumpold & Schluter,(2013) indicated that insect have a great potential to be incorporated in fish feed as insect fall within the nutrient range of fish in their natural habitat.

Conclusion and **Recommendations**

The study established that Black soldier fly larvae meal could be substituted with fish meal up to 75% in *C. gariepinus* diet without any negative effect on growth and feed efficiency and there are nutritional benefits from using cheaply available dried insect such as BSF larvae to substitute fish meal in diets of catfish fingerlings. Fish feed can therefore be produced at a relatively cheaper cost and as thus profit of the fish farmer can be increased. The substitution of BSFL in the treatment diets didn't negatively affect the survival rates of the African catfish as the survival rates were above 95%.

It is recommended that there is need to evaluate the effectiveness, acceptability and utilization of insects in fish farms with different farmed fish species and that the insect to be used as target material for feed should have a positive response towards fish growth. Therefore, they can be potential protein source for fish feeds at a lower cost. Ways should be established on how to rear the insects for mass production for fish feeds to be used by Nigerian fish farmers. Use of BSFL meal is also recommended for better quality fish in terms of the quality of protein.

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