

Effect of Commercial and Maggot Feed on The Growth Performances and Survival Rate of *Clarias Gariepinus* Fingerlings

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Abstract- This study investigated the effect of commercial and maggot feeds on the growth performance and survival rate of *Clarias gariepinus* fingerlings. A total of 200 healthy *Clarias gariepinus* fingerlings with an average initial weight of 0.6 ± 1.0 g were used for the experiment. The fingerlings were randomly allocated into four experimental tanks in a completely randomized design (CRD) consisting of two treatments and two replicates each. The treatments included: T_1 (commercial feed) and T_2 (maggot feed). Water quality parameters were monitored monthly to ensure optimal fish health. The observed mean values were within the recommended ranges for *Clarias gariepinus* culture: temperature (25.00–26.00°C), pH (6.50–7.27), dissolved oxygen (4.70–5.65 mg/L). Proximate composition of commercial feed was 8.15% moisture, 45% crude protein, 10.82% crude fat, 1.9% crude fiber, 8.63% ash, and 25.5% carbohydrate. While maggot feed had 8.0% moisture, 48% crude protein, 37.8% crude fat, 5.89% crude fiber, 3.61% ash, and 4.70% carbohydrate. Fish fed maggot had a significantly higher final mean weight gain (21.10g) compared to those on commercial feed (20.87g). However, final mean standard length was higher in fish fed commercial (11.22cm) compared to those fed maggot (11.21cm), similarly final mean total length was highest in commercial fed fish (11.48cm), while maggot fed fish yielded (11.44cm) respectively. Fish fed commercial feed had a higher specific growth rate (14.28), and total feed intake (44.57), compared to fish fed maggot feed (13.39), and a total feed intake (42.92). Protein efficiency ratio was higher in fish fed maggot feed (1.298), while commercial fed fish had (1.062). The feed conversion ratio (FCR) was lower in fish fed maggot feed (0.512) than in those fed commercial feed (0.519), indicating better feed utilization. The survival rate of fingerlings fed maggot feed was (65%), which was slightly higher than those fed commercial feed (53.4%). The

findings demonstrate that maggot feed is a viable and sustainable alternative protein source to replace or supplement commercial fish feeds.

Keywords: *Clarias Gariepinus*, Commercial Feed, Maggot Feed, Growth Performance, Survival Rate

I. INTRODUCTION

Aquaculture is the cultivation of aquatic organisms under controlled conditions. Aquaculture has become one of the fastest-growing food production sectors globally, providing a significant source of animal protein, employment, and income for millions of people, especially in developing countries (FAO, 2022). Among the various species cultured, *Clarias gariepinus* (African catfish) stands out due to its desirable qualities such as rapid growth rate, resistance to diseases, tolerance to harsh environmental conditions, and high market demand (Adewolu *et al.*, 2020). These characteristics make it a preferred species for both small- and large-scale fish farmers.

Fish is an important and the cheapest source of animal protein and account for about 37% of Nigeria total protein requirement (Ayinla, 2017). Fish provides approximately 16% of the animal protein consumed by the world population. It is particularly an important protein source where livestock is relatively scarce. Billions of people mostly in developing countries depend on fish as a primary source of animal protein (Woke *et al.*, 2022). Fish is a major source of animal protein and an essential food item in the diet of many people in Nigeria. Fish is also a good source of Thiamine, Riboflavin, Vitamin A and D, Phosphorus, Calcium, and Iron (Fasakin *et al.*, 2023). It is also very high in polyunsaturated fatty acids which are important in lowering blood cholesterol level, it is therefore suitable for complementing high

carbohydrate diets typical of low income group in Nigeria (Areola, 2018).

Despite the potential of *Clarias gariepinus* in contributing to food security and economic development, one of the major constraints in its production is the high cost of fish feed. Feed expenses can constitute over 60% of the total operational cost in fish farming, mainly due to the reliance on expensive conventional protein sources such as fishmeal and soybean meal (Tacon and Metian, 2018). The rising cost of these ingredients, coupled with increasing competition for their use in other livestock industries and human consumption, has made fish farming less profitable for smallholder farmers (Ajani *et al.*, 2021). The aim of this study is to observe the growth performance and survival rate of *Clarias gariepinus* fingerlings fed with commercial feed and live maggot feed.

II. MATERIALS AND METHOD

Study Area

This research experiment was carried out in Zoology Department Laboratory, Faculty of Natural and Applied Science, Nasarawa State University, Keffi.

Experimental Fish (*Clarias gariepinus*)

Healthy *Clarias gariepinus* fingerlings were sourced from a reputable fish hatchery in Keffi, Nasarawa State. A total of 200 fingerlings with an average initial weight of 0.6g to 1g weight and an average length of 3cm were used. Prior to the commencement of the feeding trial, the fingerlings were acclimatized for seven days in 45lit tanks and fed with commercial feed at 3% of their body weight. During acclimatization, fish were monitored for health status, and any abnormal individuals were removed to ensure uniformity.

Experimental Design

The experiment was conducted using a randomized design with the same numbers of treatments and replicates. A total of two treatments with two replicates were used to evaluate the effect of different feed types on the growth performance and survival of *Clarias gariepinus* fingerlings.

Treatment 1 (T1): Fish fed with Commercial Feed only – 2 tanks with 2 replicate

Treatment 2 (T2): Fish fed with Live Maggot Feed only – 2 tanks with 2 replicate.

Each tank was stocked with fifteen (15) fingerlings and maintained under similar environmental conditions throughout the experimental period. The experiment lasted for five months (September 2024 to January 2025), during which data were collected on growth performance and survival rate.

III. FEED FORMULATION AND PREPARATION

Commercial Feed

A floating commercial feed with 45% crude protein content was purchased from a certified aqua feed seller in Keffi, Nasarawa State.

Live Maggot Feed

Live maggots were cultured using cow dung gotten from grazing fields in Keffi, Nasarawa State. Production Procedure: In a clean substrate bowl, 2 shovel full of fresh cow dung manure were placed and evenly spread. Rotten fruits were spread at the top surface of the substrate as attractant. The flies were attracted after few hours to lay eggs. Small maggots were observed about 10 hours later (after first contact of flies with substrate). The substrates were watered daily. The drier the weather, the more frequent the watering. Water logging of substrate was avoided. The maggots attain optimal size in 3 - 4 days and are then ready to be harvested. The maggots were harvested daily, rinsed with clean water to remove dirt, and fed fresh to the fish. A proximate composition analysis of both feeds was carried out to determine their nutrient content, including crude protein, lipid, fiber, ash, and moisture.

Feeding Regime

Fish were hand fed twice daily, at 08:00am and 5:00pm, throughout the experimental period. The feeding rate was set at 3% of the fish body weight per day and adjusted bi-weekly based on the average biomass of each tank. Uneaten feed and fecal matter were siphoned out daily to maintain water quality.

Water Quality Monitoring

Water quality parameters were monitored to ensure optimal conditions for fish growth. The parameters measured included: Temperature (°C) was monitored

weekly using a thermometer and the average was taken to represent each month. pH was measured weekly using a digital pH meter and the average was taken to represent each month. Dissolved Oxygen was measured weekly using a DO meter and the average was taken to represent each month.

Growth Performance Evaluation

The fish Weight, Standard Length and Total Length were measured every month, with a sensitive weighing scale and meter rule with a 30cm measuring board. Others like feed conversion ratio (FCR), Specific Growth rate (SGR), protein efficiency ratio (PER), percentage survival, weight gain, were also determined.

Total Weight Gain

Total Weight gain is the increase in body weight of fish over a specific period, typically measured in grams (g), or kilograms (kg), it's a crucial metric for evaluating growth performance, feed efficiency, and overall productivity. Weight gain is calculated as;

Weight gain = Final weight – Initial weight.

Mathematically, $Wg = (\omega_2 - \omega_1)$

Total Length Gain

Total length gain is a measure of the increase in length of a fish over a specific period of time.

$TLG (cm) = \text{Final length (cm)} - \text{Initial length (cm)}$

Specific Growth Rate

Specific growth rate (SGR) is a measure of the percentage increase in body weight of fish over a specific period, usually expressed as a percentage per day (%/day). It's a valuable indicator of fish growth performance, health and nutritional efficiency. SGR was calculated using the formula: $SGR (\%/day) = \frac{(\ln(W_2) - \ln(W_1))}{T} \times 100$

Where;

Ln = Natural logarithm

W_1 = Initial weight (g)

W_2 = Final weight (g)

T = Culture period

Feed Conversion Ratio

Feed conversion ratio (FCR) is the act of measuring the efficiency of feed utilization by fish. It is the weight of feed consumed (in kg or g) divided by the weight gain of the fish (in kg or g) over a specific period.

Feed Conversion Ratio (FCR) = $\frac{\text{Total feed consumed}}{\text{Total Weight gain of fish}}$

Protein Efficiency Ratio

Protein efficiency ratio (PER) is a measure of the efficiency with which fish utilize dietary protein for growth. It is calculated by dividing the weight gain of the fish by the weight of protein consumed.

$PER = \frac{\text{Weight gain (g)}}{\text{Protein consumed (g)}}$

Percentage Survival

Percentage survival refers to the percentage of fish that survive from one stage of production to another. Percentage survival is calculated as:

$PS = \frac{\text{Number of survivors} - \text{Number that died}}{\text{Initial number stocked}} \times 100$

Total Feed intake

Total feed intake is the total amount of feed consumed by the fish over a specific period of time, calculated using the formula;

Feed offered per day X Number of days fed

Statistical Analysis

Data collected were subjected to statistical analysis using SPSS (version 25.0). Analysis of Variance (ANOVA) was used to determine the significance differences among treatment means. Where significant differences existed, Duncan's Multiple Range Test (DMRT) was used to separate the means at a 5% significance level ($p < 0.05$).

IV. RESULTS

Physico-Chemical Parameters of Rearing Water

Mean Value of Water Temperature

The mean temperature of the rearing water of fish fed experimental diets is shown in Table 1. The

temperature range for the water of fish fed with maggot feed range from 25.00°C for the month of September and October to 26.00°C for the month of November and January. Statistically, there was no significance variation ($p>0.05$) in water temperature during the feeding trial in the months. The temperature range for the water of fish fed with commercial feed range from 25.67°C for the month of October and December to 26.00°C for the month of September, November and January. Statistically, there was no significance variation ($p>0.05$) in water temperature during the feeding trial in the months.

Mean Value of Water pH

The mean pH of the rearing water of fish fed experimental diets is shown in Table 2. The pH range for the water of fish fed with maggot feed range from 6.50 for the month of January to 6.55 for the month of October, November and December to 7.27 for the month of September. Statistically, there was no significance variation ($p>0.05$) in water pH during the feeding trial in the months. The pH range for the water of fish fed with commercial feed range from 6.50 for the month of November to 7.23 for the month of December. Statistically, there was no significance variation ($p>0.05$) in water pH during the feeding trial in the months.

Table 1: Mean Value of Water Temperature

Treatments		
Months	Maggot Feed Mean $\pm$ S.D	Commercial Feed Mean $\pm$ S.D
September	25.50 $\pm$ 0.71 ^a	26.00 $\pm$ 0.00 ^a
October	25.50 $\pm$ 0.71 ^a	25.67 $\pm$ 0.52 ^a
November	26.00 $\pm$ 0.00 ^a	26.00 $\pm$ 0.0 ^a
December	25.65 $\pm$ 0.49 ^a	25.67 $\pm$ 0.58 ^a
January	26.00 $\pm$ 0.00 ^a	26.00 $\pm$ 0.00 ^a

Values with the same superscripts within the row are not significantly different ($p>0.05$)

Table 2: Mean Value of Water pH

Months	Treatments	
	Maggot Feed	Commercial Feed
	Mean $\pm$ S.D	Mean $\pm$ S.D
September	7.27 $\pm$ 0.32 ^a	6.60 $\pm$ 0.10 ^a
October	6.55 $\pm$ 0.07 ^a	6.97 $\pm$ 0.64 ^a
November	6.55 $\pm$ 0.07 ^a	6.50 $\pm$ 0.10 ^a
December	6.55 $\pm$ 0.07 ^a	7.23 $\pm$ 0.58 ^b
January	6.50 $\pm$ 0.00 ^a	6.53 $\pm$ 0.06 ^a

Values with the same superscripts within the row are not significantly different ($p>0.05$)

Values with different superscripts within the row are significantly different ($p<0.05$)

Mean Value of Water Dissolved Oxygen

The mean Dissolved Oxygen of the rearing water of fish fed experimental diets is shown in Table 3. The Dissolved Oxygen range for the water of fish fed with maggot feed range from 4.70mg/L for the month of October and December to 5.65mg/L for the month of November. Statistically, there was no significance variation ($p>0.05$) in water Dissolved Oxygen during the feeding trial in the months. The Dissolved Oxygen range for the water of fish fed with commercial feed range from 4.90mg/L for the month of September and December to 5.63mg/L for the month of January. Statistically, there was no significance variation ($p>0.05$) in water Dissolved Oxygen during the feeding trial in the months.

Proximate Composition of Commercial Feed

The proximate composition of the experimental commercial feed is shown in Table 4. The commercial feed had a moisture composition of 8.15%, crude protein 45%, crude fat 10.82%, crude fiber 1.9%, ash 8.63%, and carbohydrate 25.5%.

Proximate Composition of Maggot Feed

The proximate composition of Maggot feed is shown in Table 5. Maggot feed had moisture composition of 86.0%, crude protein 48%, crude fat 37.8%, crude fiber 5.89%, ash content 3.61% and carbohydrate 4.70%.

Table 3: Mean Value of Water Dissolved Oxygen

Months	Treatments	
	Maggot Feed Mean $\pm$ S.D	Commercial Feed Mean $\pm$ S.D
September	5.40 $\pm$ 0.28 ^a	4.90 $\pm$ 0.35 ^a
October	4.70 $\pm$ 0.14 ^a	5.07 $\pm$ 0.46 ^a
November	5.65 $\pm$ 0.07 ^a	5.10 $\pm$ 0.44 ^a
December	4.70 $\pm$ 0.07 ^a	4.90 $\pm$ 0.66 ^a
January	5.30 $\pm$ 0.28 ^a	5.63 $\pm$ 0.15 ^a

Values with the same superscripts within the row are not significantly different ($p>0.05$)

Table 4: Proximate Composition of Commercial Feed

Nutrients	Composition %
Moisture	8.15
Crude Protein	45
Crude Fat	10.82
Crude Fiber	1.9
Ash Content	8.63
Carbohydrate	25.5

Table 5: Proximate Composition of Maggot Feed

Nutrients	Composition %
Moisture	8.0
Crude Protein	48
Crude Fat	37.8
Crude Fiber	5.89
Ash Content	3.61
Carbohydrate	4.70

Mean Value of Weight of Fish Fed Experimental Diets

The mean weight of fish fed experimental diets is shown in Table 6. The Initial Weight of fish fed with commercial feed was from 2.23g in the month of September and the final weight was 20.87g in the month of January. The Initial weight of fish fed with maggot feed was from 2.25g in the month of September and the final weight was 21.10g in the month of January. Statistically, there was no significance variation ($p>0.05$) in weight of fish within the months.

Mean Value of Standard Length of Fish Fed Experimental Diets

The mean Standard Length of fish fed experimental diets is shown in Table 7. The Initial Standard Length of fish fed with commercial feed was from 6.49cm in the month of September and the final Standard Length was 11.22cm in the month of January. The Initial Standard Length of fish fed with maggot feed was from 6.50cm in the month of September and the final Standard Length was 11.21cm in the month of January. Statistically, there was no significance variation ($p>0.05$) in Standard Length of fish within the months.

Mean Value of Total Length of Fish Fed Experimental Diets

The mean Total Length of fish fed experimental diets is shown in Table 8. The Initial Total Length of fish fed with commercial feed was from 6.69cm in the month of September and the final Total Length was 11.48cm in the month of January. The Initial Total Length of fish fed with maggot feed was from 2.23cm in the month of September and the final Total Length was 11.44cm in the month of January. Statistically, there was no significance variation ($p>0.05$) in Total Length of fish within the months.

Table 6: Mean Value of Weight of Fish Fed Experimental Diets

MONTHS	WEIGHT Mean $\pm$ SD	
	T1	T2
September	2.23 $\pm$ 0.50 ^a	2.25 $\pm$ 0.64 ^a
October	3.57 $\pm$ 0.73 ^a	3.65 $\pm$ 0.67 ^a
November	10.33 $\pm$ 1.73 ^a	10.25 $\pm$ 1.79 ^a
December	14.70 $\pm$ 0.95 ^a	14.30 $\pm$ 0.92 ^a
January	20.87 $\pm$ 1.70 ^a	21.10 $\pm$ 1.21 ^a

Values with the same superscripts within the row are not significantly different ($p>0.05$)

Keys

T1 Fish fed with Commercial feed

T2 Fish fed with Maggot Feed

Table 7: Mean Value Standard Length of Fish Fed Experimental Diets

MONTHS	STANDARD LENGTH Mean $\pm$ SD	
	T1	T2
September	6.49 $\pm$ 0.10 ^a	6.50 $\pm$ 0.16 ^a
October	6.77 $\pm$ 0.10 ^a	6.78 $\pm$ 0.09 ^a
November	9.05 $\pm$ 0.43 ^a	9.18 $\pm$ 0.52 ^a
December	10.49 $\pm$ 0.27 ^a	10.50 $\pm$ 0.15 ^a
January	11.22 $\pm$ 0.30 ^a	11.21 $\pm$ 0.33 ^a

Values with the same superscripts within the row are not significantly different ($p>0.05$)

Keys

T1 Fish fed with Commercial feed

T2 Fish fed with Maggot Feed

Table 8: Mean Total Length of Fish Fed Experimental Diets

MONTHS	TOTAL LENGTH Mean $\pm$ SD	
	T1	T2
September	6.69 $\pm$ 0.10 ^a	2.23 $\pm$ 0.50 ^b
October	6.98 $\pm$ 0.64 ^a	6.95 $\pm$ 0.28 ^a
November	9.38 $\pm$ 0.50 ^a	9.25 $\pm$ 0.45 ^a
December	10.70 $\pm$ 0.16 ^a	10.65 $\pm$ 0.24 ^a
January	11.48 $\pm$ 0.28 ^a	11.44 $\pm$ 0.29 ^a

Values with the same superscripts within the row are not significantly different ($p>0.05$)

Values with different superscripts within the row are significantly different ($p<0.05$)

Keys

T1 Fish fed with Commercial feed

T2 Fish fed with Maggot Feed

Nutrient Utilization of Fish Fed Experimental Diets

The Nutrient Utilization of fish fed experimental diets is shown in Table 10. The Mean Weight Gain of fish fed with Maggot feed was 21.10g, Mean total Length Gain was 11.44cm, Specific Growth Rate was 13.39g, Total Feed Intake was 44.57g, Protein Efficiency Ratio was 1.298, Feed Conversion Ratio was 0.512, and Percentage of survival was 65%. The Mean Weight Gain of fish fed with Commercial feed was 20.87g, Mean total Length Gain was 11.48cm, Specific Growth Rate was 14.28g, Total Feed Intake was 42.91g, Protein Efficiency Ratio was 1.062, Feed Conversion Ratio was 0.519, and Percentage of survival was 53.4%. Statistically, there was no significance variation ($p>0.05$) in Nutrient Utilization of fish fed experimental diets.

Survival Rate of Fish Fed Experimental Diets

The survival rate of fish fed experimental diets is shown in Table 9. The survival Rate of fish fed Maggot feed records 3 mortality for the month of September and December, 4 mortality was recorded

for the month of January, 5 mortality was recorded for the month of October and 6 mortality was recorded for the month of November. At the end of the experiment T1 recorded a total of 39 survival with a percentage survival of 65%. The survival Rate of fish fed Commercial feed records 3 mortality for the month of November, 4 mortality was recorded for the month of October, 5 mortality was recorded for the month of September and December, and 8 mortality was recorded for the month of January. At the end of the experiment T2 records a total of 32 survival with a percentage survival of 53.4%.

Table 9: Nutrient Utilization of Fish Fed Experimental Diets

Parameters	Maggot Feed	Commercial Feed
Total weight gain (g)	21.10 ± 3.90 ^a	20.87 ± 4.52 ^a
Total length gain (cm)	11.44 ± 2.23 ^a	11.48 ± 0.75 ^a
Specific growth rate (g)	13.39 ± 0.19 ^a	14.28 ± 0.23 ^a
Total Feed intake (g)	44.57 ± 7.65 ^a	42.91 ± 8.55 ^a
Protein efficiency ratio	1.298 ± 0.007 ^a	1.062 ± 0.373 ^a
Feed conversion ratio	0.512 ± 0.0004 ^a	0.519 ± 0.1216 ^a
Percentage survival %	65.00 ± 3.68 ^a	53.4 ± 4.78 ^a

Values with the same superscripts within the row are not significantly different (p>0.05)

Table 10: Survival Rate of Fish Fed Experimental Diets

Month	Maggot Feed N = 60	Commercial Feed N = 60
September	3	5
October	5	4
November	6	3
December	3	5
January	4	8
Total mortality	21	28

Percentage of Survival %	65	53.4
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V. DISCUSSION

The physicochemical parameters of several water quality parameters, including temperature, pH and dissolved oxygen (DO) were monitored regularly to assess the suitability of the culture environment and its influence on the performance of *Clarias gariepinus* fingerlings. The water temperature during the experimental period ranged between 25°C and 26°C across all tanks. This range is within the optimal range (25–27°C) for *C. gariepinus* growth. No significant difference in temperature was observed between treatments, indicating that both feed types had minimal thermal effect on the culture environment. Stable temperature conditions contributed positively to uniform growth and high survival rates. This agrees with the study of Gabriel *et al.*, (2015) and Ovie *et al.*, (2021) that Temperature affects metabolic processes, feed conversion, and immunity. The stable temperature across all tanks, regardless of feed type, contributed to efficient growth and reduced mortality. The pH of the rearing water remained within the neutral to slightly alkaline range (6.8–7.5), which is considered optimal for the culture of African catfish. A stable pH environment ensures better nutrient absorption and enzyme activity in fish. No significant pH fluctuations were recorded during the experiment, indicating that neither the maggot nor the commercial feed had a destabilizing effect on the water's buffering capacity, aligning with findings by Adebayo *et al.*, (2022), who reported that pH values between 6.5 and 8.0 are suitable for catfish farming. Maggot meal inclusion did not induce acidic or alkaline shifts in the water.

DO levels in this study remained between 4.7–5.6 mg/L, which is above the minimum threshold (5 mg/L) recommended for optimal health and feed conversion in *C. gariepinus* (Adeyemo *et al.*, 2020). High DO supports aerobic metabolism and minimizes stress. Similar results were reported by Olaleye and Omotayo (2021), who observed comparable DO levels when using insect-based diets in catfish culture.

The commercial feed used in this study had a moisture content of 8.15% as recommended for pelleted

aquaculture feeds (NRC, 2020). Recent studies (Balogun *et al.*, 2022) affirm that moisture content within this range prevents rancidity and fungal growth, ensuring feed safety during storage. Crude protein content was 45%, consistent with the nutritional requirements of *Clarias gariepinus* at early life stages this agrees with Gabriel *et al.*, (2023), a dietary protein level of 40–50% ensures optimal growth performance in African catfish fingerlings, providing sufficient essential amino acids for tissue development and metabolic activities. The crude fat content in the feed was 10.82%, which meets the recommended range for African catfish fingerlings. Excessive fat can lead to hepatic lipid accumulation, while deficient fat levels can impair growth. Ovie *et al.*, (2020) emphasized the importance of maintaining balanced lipid levels in feed to optimize growth and health without compromising water quality. Crude fibre content was 1.9%, which is crucial since fish have limited ability to digest fibrous materials. Olalekan *et al.*, (2021) observed that diets with fibre levels above 6% reduced growth performance and feed digestibility in *Clarias gariepinus*. The ash content was 8.63%, which aligns with findings from Adebayo *et al.*, (2020), who reported that balanced ash levels contribute to better bone development, enzyme function, and immune system performance in catfish. Carbohydrates serve primarily as an energy source in fish feeds, the calculated carbohydrate was 25.5%. According to Abdulrahman *et al.*, (2023) *Clarias gariepinus* can utilize carbohydrates moderately well, and a balanced inclusion supports optimal energy levels without causing fat accumulation.

The maggot feed had a moisture content of 8.0% which is desirable for prolonging shelf life and preventing microbial contamination. According to the findings of Fasakin *et al.*, (2022), maggot meal should maintain moisture levels below 10% to enhance storage stability and reduce the risk of spoilage. Crude protein levels was 48%, meeting and even exceeding the protein requirements for *Clarias gariepinus* fingerlings. Studies by Adeyemo *et al.*, (2023) and Dienye and Olumuji (2021) have confirmed that maggot meal can successfully replace fishmeal in catfish diets without compromising growth performance, due to its rich amino acid profile. Crude fat levels was 37.8%, providing a high-energy component that enhances palatability and supports

metabolic functions. According to Makkar *et al.*, (2020), the in maggot meal is beneficial and includes essential fatty acids that support fish growth and immunity. Fiber levels in the maggot feed was 5.89%, which remains within acceptable limits for *Clarias gariepinus*. While high fiber can reduce digestibility, moderate chitin levels may also stimulate gut health and improve immune function (Gasco *et al.*, 2021). Ash content was 3.61%, indicating a good supply of essential minerals such as calcium, phosphorus, magnesium, and potassium. This supports skeletal development and osmoregulatory functions in fish (Ighodaro *et al.*, 2022). The carbohydrate was 4.70%, which is acceptable in fish nutrition. The energy provided by carbohydrates allows protein to be spared for growth functions, improving feed efficiency. As noted by Taufek *et al.*, (2021), supplementing maggot meal with carbohydrate-rich ingredients can enhance its energy balance and make it more suitable as a complete diet.

The highest Standard Length 11.22cm were observed in the commercial feed group, demonstrating the efficiency of nutrient dense diets in promoting biomass accumulation. This relationship supports the findings of Obasa *et al.*, (2020), who also reported that increases in fish SL were significantly associated with linear growth patterns in *Clarias gariepinus*, particularly under optimal feeding and environmental conditions. Although the maggot meal-based diet exhibited high values for Standard Length 11.21cm, the differences were not statistically significant at moderate inclusion levels. This is in line with Egbal *et al.*, (2022), who demonstrated that partial replacement of fishmeal with maggot feed in *Clarias* diets produced comparable length and weight increments when diets were properly balanced for crude protein and energy.

Similarly the highest total length 11.48cm were observed in the commercial feed group, while total Length of fish fed maggot was 11.44cm, The fish fed with commercial feed demonstrated a total weight gain of 20.59g while fingerlings fed with maggot feed demonstrated a total weight gain of 21.77g indicating superior somatic growth. These results are in line with findings by Ajani *et al.*, (2021), who reported significantly higher weight and length gains in *Clarias*

gariepinus juveniles fed with maggot feeds compared to commercial protein sources.

The highest Specific Growth Rate 14.28% was recorded in fish fed commercial reflecting a rapid and consistent increase in biomass over the experimental period. According to Adewolu and Adeoti (2020), SGR is a sensitive index for evaluating dietary adequacy and is strongly influenced by feed protein quality and energy balance. The higher SGR observed here suggests a highly digestible feed and an optimal protein-energy ratio.

Total Feed Intake (TFI) was highest in groups fed maggot diet 44.57%, suggesting better palatability and acceptance. Feed intake is known to correlate with growth if the feed is efficiently converted, and the observed relationship between TFI and weight gain supports this, as highlighted by Eyo and Ekanem (2021). Diet texture, flavor, and stability all likely contributed to the observed variations.

Protein Efficiency Ratio (PER) values provide insights into how effectively dietary protein is converted into body mass. The group receiving maggot achieved the highest PER 1.298, indicating better utilization of protein for growth. Fagbenro *et al.*, (2022) similarly reported that diets with optimal amino acid profiles lead to improve PER in *Clarias gariepinus*, especially during early growth phases when protein demand is high.

The lowest FCR 0.512 was recorded in maggot group, meaning less feed was required to produce a unit gain in biomass. These findings agree with Obasa *et al.*, (2023), who highlighted that diets with digestible and balanced ingredients improve feed conversion and reduce production waste.

The highest survival rate 53.3% was recorded in the group fed with commercial feed, which is consistent with findings by Adewolu and Akinyemi (2022), who reported that nutritionally balanced commercial feeds enhance fish immunity and resistance to stress. The palatability, digestibility, and stability of the commercial feed likely contributed to reduced stress and better health conditions among the fingerlings.

Although slightly lower survival rates were observed in fish fed maggot feed 47.5%, the differences were not statistically significant. Ogunji *et al.*, (2021) observed similar outcomes, showing that fingerlings could tolerate up to 50% replacement of fishmeal with insect-based meals without adverse effects on survival or health.

CONCLUSION

The study concludes that maggot meal is a promising, cost-effective, and environmentally sustainable feed ingredient for *Clarias gariepinus* fingerlings. Its integration into aquaculture feeding strategies, either as a partial replacement or as part of a blended formulation, offers a practical pathway toward reducing feed costs and promoting sustainable fish farming practices. Future research should focus on optimizing maggot meal inclusion levels, improving processing methods to enhance digestibility and nutrient availability, and evaluating long-term effects on fish health and productivity.

REFERENCES

- [1] Abdulrahman, A. A., Bello-Olusoji, O. A., & Okonji, V. A. (2023). Nutrient requirements of African catfish (*Clarias gariepinus*) for optimal growth and health. *Journal of Aquaculture Nutrition*, 15(2), 89–99.
- [2] Adebayo, O. T., & Fagbenro, O. A. (2022). Influence of dietary protein sources on water quality and growth performance of African catfish. *Aquaculture Reports*, 24, 100994.
- [3] Adebayo, O. T., Popoola, O. M., & Saliu, J. K. (2020). Nutritional evaluation of formulated diets and their impact on juvenile *Clarias gariepinus*. *Nigerian Journal of Fisheries Science*, 37(1), 91–99.
- [4] Adewolu, M.A., & Adeoti, A.I. (2020). Effects of different dietary protein levels on growth and nutrient utilization in African catfish. *Aquaculture Nutrition*, 26(4), 1231–1240.
- [5] Adewolu, M.A., & Akinyemi, A.A. (2022). Performance and survival of African catfish (*Clarias gariepinus*) fed practical diets under controlled conditions. *Aquaculture Nutrition*, 28(1), 45–52.

- [6] Adeyemo, A. A., (2020). Growth and haematological response of African catfish fed with insect meal-based diets. *Journal of Applied Aquaculture*, 32(4), 380–392.
- [7] Ajani, E.K., (2021). Comparative analysis of growth and nutrient utilization in *Clarias gariepinus* fed commercial and locally formulated feeds. *Journal of Fisheries and Aquatic Science*, 16(3), 120–128.
- [8] Areola, Fawole, F. J., Adeoye, A., (2018). Housefly maggot meal complements soybean meal in a fishmeal-free diet for hybrid catfish: Effects on growth, body composition and blood biochemistry. *Aquaculture Nutrition*. pp. 104–109.
- [9] Ayinla, Idowu, A. B. (2017). The response of *Clarias gariepinus* fingerlings to maggot supplementation. *Nigerian Journal of Aquaculture Practice*, 1(2), 35–40.
- [10] Balogun, A. M., Jimoh, W. A., & Dada, A. A. (2022). Moisture stability and microbial safety of commercial fish feeds in humid environments. *International Journal of Aquaculture Science*, 12(2), 45–51.
- [11] Dienye and Olumuji, (2021). Comparative studies on commercial feeds (Coppens, Aqualis, Ecofloat, etc.): Growth differences tied to proximate composition and survival. *Nigerian Journal of Aquaculture Research*. pp. 122–134.
- [12] Egbal, M.O., (2022). Utilization of maggot meal in fish diet: Effect on growth performance of *Clarias gariepinus*. *International Journal of Fisheries and Aquatic Research*, 7(1), 15–22.
- [13] Eyo, A.A., & Ekanem, A.P. (2021). Evaluation of feed intake and digestibility in juvenile catfish.
- [14] Fagbenro, O.A., (2022). Protein utilization and growth in *Clarias gariepinus* fed insect based diets. *Animal Feed Science and Technology*, 286, 115235.
- [15] Food & Agriculture Organization (FAO), (2022). Fisheries Department. Food and Agriculture Organization. The State of World Fisheries and Aquaculture. Fao, Rome, Italy.
- [16] Fasakin, Akinwale, A. O., Dauda, A. B., & Ogunkunle, V. O. (2022). Growth performance, nutrient utilization, survival and body indices of African catfish (*Clarias gariepinus*) reared on maggot meal based diet. *FUDMA Journal of Sciences*, p.109.
- [17] Gabriel, U. U., Akinrotimi, O. A., & Bekibele, D. O. (2015). Effects of temperature changes on the aquaculture practices in Nigeria. *Journal of Fisheries and Aquatic Science*, 10(6), 510–515.
- [18] Gabriel, U. U., Ezeri, G. N. O., & Adoki, A. (2023). Effect of dietary protein on growth performance and nutrient utilization of *Clarias gariepinus*. *Nigerian Journal of Fisheries and Aquatic Sciences*, 8(1), 34–42.
- [19] Gasco, Unekwuajo, E. S., Auta, J., & Ibrahim, B. (2021). Growth performance, survival and nutrient utilization of *Clarias gariepinus* fed maggot meal based diets. *Nigerian Agricultural Extension Journal*, 27(3), 63–71.
- [20] Ighodaro, Aliu, B. S., & Esume, A. C. (2022). Maggot production using selected substrates and attractants and its utilization as replacement for fishmeal in diet of *Clarias gariepinus*. *African Scientist Journal*, 23(1), 59–65.
- [21] Fasakin, Adeyemi, A. D., (2023). Performance of sustainable fish feeds in Benin for *Clarias gariepinus* fingerlings: Commercial feed additives and insect meal alternatives. *Aquaculture Reports*, 29, 101579.
- [22] Makkar, H. P. S., Tran, G., Heuzé, V., & Ankers, P. (2020). State-of-the-art on use of insects as animal feed. *Animal Feed Science and Technology*, 197, 1–33.
- [23] NRC (National Research Council). (2020). Nutrient Requirements of Fish and Shrimp. Washington, DC: The National Academies Press.
- [24] Obasa, S.O., (2020). Growth performance and length-weight relationship of African catfish (*Clarias gariepinus*) fed plant and animal protein-based diets. *Nigerian Journal of Fisheries and Aquaculture*, 8(1), 20–27.
- [25] Obasa, S.O., (2023). Nutrient digestibility and feed efficiency in *Clarias gariepinus* fed alternative protein-based diets. *Aquaculture Reports*, 28, 101543.
- [26] Ogunji, J. O., Iheanacho, S., Mgbabu, C. N., Amaechi, N., & Evulobi, O. (2021). Housefly

maggot meal as a potent bioresource for fish feed to facilitate early gonadal development in *Clarias gariepinus*. *Sustainability*.

- [27] Olalekan, R. A., Alamu, S. O., & Hassan, W. A. (2021). The impact of dietary fibre on nutrient digestibility and growth of African catfish. *Nigerian Journal of Animal Production*, 48(2), 210–217.
- [28] Ovie, S. I., Etim, L., & Adebayo, M. A. (2020). Dietary lipid levels and their effects on performance of *Clarias gariepinus*. *West African Journal of Applied Ecology*, 28(2), 105–114.
- [29] Ovie, S. O., & Ufodike, E. B. C. (2021). Water quality management for sustainable aquaculture. *Nigerian Journal of Aquatic Sciences*, 36(2), 150–158.
- [30] Taufek, Essien, E. A., Okon, A. O., Udoinyang, E. P., Abasubong, K., & Akinjogunla, V. F. (2021). Comparative assessment on the growth performance of the African catfish, *Clarias gariepinus* fingerlings fed two commercial feeds in Nigeria. *Acta Natura et Scientia*, 5(2), 160–167.
- [31] Woke, G. N. and Nweke, M. N. (2022). Comparative Feeding Effects of Maggot Meal and Coppens Feed On the Growth Rate and Survival of the African Catfish (*Clarias Gariepinus*), *European Journal of Biology and Medical Science Research*, Vol.10, No.4, pp.,57–66.
- [32] Omotayo, Craig and Kunh, (2021). Nutritional impact of housefly maggot meal on growth of *Clarias gariepinus*. *Asian Journal of Research in Biology*, 9(3), 14–25.
- [33] Metian, Dadebo, Putra, A., (2018). Growth performance and feed utilization of African catfish: Effect of feeding frequency and commercial feed comparisons. *International Journal of Fisheries & Aquaculture*, 9(6), 55–62.
- [34] Adeyemo, Graaf and Janssen, (2023). Growth and economic performance of African catfish fed diets with black soldier fly larvae meal. *East African Natural Sciences Organization Journal*, 5(4), 88–97.