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# EFFECTS OF DIFFERENT INCLUSION LEVELS OF OYSTER MUSHROOM (PLEUROTUS OSTREATUS) MEAL ON GROWTH AND SURVIVAL OF CLARIAS GARIEPINUS FINGERLINGS

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**Abstract:** This study evaluated the use of graded levels of oyster mushroom (Pleurotus ostreatus) fruiting body meal on the growth, survival of the African catfish, Clarias gariepinus fingerlings. A diet of approximately 40% crude protein at different levels of inclusion (0%, 1%, 2%, 3%, and 4% otherwise marked as $T_1$, $T_2$, $T_3$, $T_4$ and $T_5$ respectively) was prepared and the fish were fed twice daily at 5% body weight for 84 days. Findings unveil that T5 demonstrated superior growth performance and survival rates, with final mean weight of 29.46±5.38g, final mean length of 19.10±1.24cm, mean weight gain of 25.60±4.86g, length increase of 12.15±0.42cm, weight gain of 985.96±208.74%, specific growth rate of 1.21±0.10 $\%d^{-1}$, and condition factor of 0.50±0.07. Conversely, T1 showed inferior outcome when compared to other treatments. Survival rate was highest in T5 (76.66±14.52%) and lowest in T1 (66.66±12.01%). However, pH and dissolved oxygen attained a decreasing trend with increasing treatment concentrations, with T5 (4%) exhibiting the lowest pH value (6.11±0.06) while T1 with the highest value 6.30±0.06. T4 and T5 respectively had the lowest levels of dissolved oxygen (6.18±0.14 mg/l and 6, 01±0.14 mg/l, but these differences were not significant (P>0.05). From this research, it was observed that incorporation of mushroom meal in the diet of Clarias gariepinus fingerlings had better effects on their growth, survival, and overall health. The mushroom has been indicated to be a potential source to beef up protein content as an additive in the diet of Clarias gariepinus fingerling. Treatment 5, with the highest level of mushroom inclusion, demonstrated the best growth performance and survival rates compared to other treatments.

**Keyword:** Alternative animal feed, dietary supplement, feed formulation, Water Quality.

## Introduction

Aquaculture has become a pivotal sector in global food security, significantly contributing to the protein intake of populations worldwide (FAO, 2024). Among various aquaculture species, Clarias gariepinus, commonly known as African catfish, holds substantial economic and nutritional value due to its rapid growth rate, adaptability, and high nutritional profile (Ali et al., 2016). However, the optimization of its growth performance remains a central focus of aquaculture research, especially in the context of sustainable and cost-effective feed formulations (Tacon and Metian, 2015). Traditional fish feed components, often derived from fishmeal and other expensive protein sources, contribute significantly to the overall cost of fish production (Tacon and Metian, 2015). This has driven the exploration of

alternative protein sources that are both economical and nutritionally adequate. Culinary and medicinal mushrooms are increasingly being tried as alternative source of protein in animal feed formulation, with promising results reported with poultry (Ogbe et al., 2009; Willis et al 2007, 2010, 2011). One such promising mushroom is Pleurotus ostreatus, commonly known as oyster mushroom. Pleurotus ostreatus is known for its high protein content, essential amino acids, vitamins, and minerals, making it a viable supplement in aquafeed (Khan et al., 2018). The integration of Pleurotus ostreatus into the diet of Clarias gariepinus fingerlings could potentially enhance growth performance, reduce feed costs, and promote sustainable aquaculture practices. Previous studies have indicated that mushroom-based diets can improve fish growth and health, but the optimal inclusion level for maximizing growth performance in Clarias gariepinus remains to be systematically evaluated (Ayinla et al., 2019). This research investigated the effects of varying levels of Pleurotus ostreatus in the diet of Clarias gariepinus fingerlings on their growth performance, feed utilization efficiency, and overall health. By examining these parameters, the study sought to provide insights into the potential benefits and limitations of incorporating Pleurotus ostreatus in aquafeeds. The findings could contribute to the development of more sustainable and cost-effective feeding strategies in aquaculture, aligning with the broader goals of enhancing food security and reducing the environmental impact of fish farming as part of aquaculture development.

## MATERIALS AND METHODS Experimental Site

The research was conducted at the Fisheries section of Teaching and Research Farm of the Faculty of Agriculture, Niger Delta University, situated in Wilberforce Island, Bayelsa State, Nigeria.

### Experimental Design/Setup

A Complete Randomized Design (CRD) was employed for this study. Fifteen black round plastic tanks, each with a capacity of forty-five (45) litres of water, filled up to 2\3 were utilized. Each tank was stocked with ten Clarias gariepinus fingerlings and was assigned one of five different treatment diets. Feeding was carried out in triplicates over a 12-week period. The tanks were covered with nets to prevent fish from jumping out.

### Experimental Fish

The total length and weight of the experimental fish were measured at the start i.e., before stocking in order to calculate the feeding rate, then weekly until the end of the experiment. The mortality in each treatment were recorded daily

### Preparation of Basel Ingredients

The composition of the diet used for the study is presented in Table 1. Corn and soybean were sourced from Amassoma market Wilberforce Island, while wheat bran was purchased from Dio Agro Limited (Feed House) Akenpai branch, Yenagoa, Bayelsa State. Methionine and lysine were included to meet amino acid requirements. Ingredients were processed using a locally made hammer mill and grinding machine. The milled feed ingredients underwent sieving through a 0.2mm sieve to ensure uniformity and remove debris. Five diets were formulated, incorporating Oyster mushroom fruiting bodies meal as an additive at levels of 0% as control (T1), 1% (T2), 2% (T3), 3% (T4), and 4% (T5) respectively,

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aiming for a crude protein content of approximately 40%, following the recommendation by Madu (2006).

**Table 1: The Gross Composition of Experimental Diets**

| Ingredients | $T_1$ (0%) | $T_2$ (1%) | $T_3$ (2%) | $T_4$ (3%) | $T_5$ (4%) |
|---|---|---|---|---|---|
| Fish Meal (Oreochromis niloticus) (71.26% CP) | 32 | 32 | 32 | 32 | 34.2 |
| Soybean Meal (45.25% CP) | 32.9 | 32.9 | 32.9 | 32.9 | 30.3 |
| Corn Meal (10.85% CP) | 21.3 | 21.3 | 21.3 | 21.3 | 17.7 |
| Pleurotus ostreatus | 0 | 1 | 2 | 3 | 4 |
| Vitamin/mineral premix | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 |
| Methionine | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 |
| Lysine | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 |
| Palm oil | 7.0 | 7.0 | 7.0 | 7.0 | 7.0 |
| Bone meal | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 |
| Salt | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 |
| Starch | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 |
| Dietary Crude protein (%) | 40.00 | 40.00 | 40.00 | 40.00 | 40.00 |

**Feeding Procedure for Experimental Fish**

The fish underwent a 12-hour starvation period before the experiment to ensure empty stomachs and stimulate appetite for the new diet. They were then fed the prepared diet at a rate of 5% biomass (Bello and Nzeh, 2013), with feeding taking place twice daily: in the morning at 0800h and 0900h, and in the evening at 1700h and 1900h. Feed quantities were adjusted weekly to match the fish's new biomass. Tank waste and any leftover food were removed daily, with freshwater replenished from a storage tank every day.

**Water Quality Parameters**

Temperature was measured using a mercury-in-glass thermometer. pH levels were determined with a Jenway pH meter (Model E 5122), while dissolved oxygen levels were assessed
Winkler's method following the APHA (1976) guidelines. Growth performance and feed utilization of Clarias gariepinus were evaluated under different dietary levels.

**Measurement of Growth Parameters**

The experimental fish underwent weekly measurements of total length and body weight using a 30 cm meter rule and an Emerald Jewelry scale (Model Ohaus JE120), respectively, throughout the experiment. These parameters were used to assess the growth performance of the experimental fish.

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**Mean Body Weight Gain (g)**

Mean body weight gain was computed as the difference between the initial (Wi) and final weight (Wf) values of the fish:

$W_f - W_i$ (Adewolu and Benfey, 2009).

**Percentage Weight Gain (%)**

$Weight\ gain\ (\%) = \frac{W^f - W^i}{W_i} \times 100$ (Adewolu and Benfey, 2009),

**Where**

$W_f$ = final mean body weight and

$W_i$ = initial mean body weight of experimental fish.

**Mean Increase in Fish Length (cm).**

Mean increase in fish length was calculated as the difference between the initial and final length values of the fish.

$L_f - L_i$ (Adewolu and Benfey, 2009).

Where $L_f$ = final mean length increase; $L_i$ = initial mean length of experimental fish.

**Specific Growth Rate (SGR)** $SGR\ (\%d^{-1}) = \frac{W_f - W_i}{T} \times 100$ (Adewolu and Bentfey, 2009)

Where T represents trial duration (day)

**Condition Factor (CF)**

Fulton's condition factor (K) was calculated according to Htun-Han (1978) equation: $K = \frac{W}{L^3} x\ 100$ Htun-Han (1978) equation:

Where W = Weight of fish (g); L = Length of fish (cm)

**Survival of Fish (%)**

Percent survival was calculated as

$S\ (\%) = \frac{N_t}{N_o} x100$ (Effiong et al. 2009).

Where:

S= Percent survival; $N_t$= Number of fingerlings at the start of the experiment; $N_o$= Number of fingerlings at the end of the experiment.

**3.18 Statistical Examination**

All collected data underwent analysis of variance (ANOVA). The Duncan Multiple Range Test was utilized to identify significant differences among the mean values of the diets at a significance level of 0.05. Statistical computations were performed using the Statistical Package for Social Science (SPSS) version 21.

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## RESULTS

The growth and survival of Clarias gariepinus fingerlings fed different dietary levels of mushroom meal is shown in Table 2. The initial weight and length of the fingerlings used for the experiments were not significantly different for all the treatments ($P > 0.05$). Among the treatments/diets, Treatment T5 (4% Mushroom meal) had the highest final mean weight (29.46g), while Treatment 1 (0% inclusion of mushroom) recorded the least mean value (17.70g), though, not significantly different ($P > 0.05$). Treatment T5 also exhibited the highest final mean length (19.10cm), whereas the lowest value of 15.83cm was obtained from $T_1$ (0% inclusion), which was also not significantly different ($P > 0.05$). Weight gain increased in all the treatments, though at different rates (Figure 1). Treatment T5 showed the highest mean weight gain (25.60g), while the lowest (14.26g) was recorded in Treatment 1. Significant differences were observed between Treatment 1 and Treatments 3, 4, and 5 ($P < 0.05$), but not between Treatment 2 and 1 ($P > 0.05$). There was an increase in percentage weight gain with each increase in mushroom inclusion level, with Treatment T5 showcasing the highest percentage weight gain (985.96%), and Treatment 1 recording the lowest (582.13%), but were all not significantly different ($P > 0.05$).

Treatment T5 recorded the highest Specific Growth Rate of 1.21 $\%d^{-1}$, while Treatment 1 obtained the lowest value of 0.43, but was not significantly different among all the diets ($P >$ 0.05). The condition factor increased with an increase in mushroom inclusion. Treatment T3 (2% Mushroom meal inclusion levels) had the highest condition factor of 0.54, while Treatment 1 recorded the lowest condition factor of 0.43, which were however not statistically different. All treatments exhibited relatively high percentages of survival (Figure 2), ranging from 66.66% to 76.66%, with no significant differences observed among treatments ($P > 0.05$). Treatment 5 had the highest survival rate (76.66%), while Treatments 1 and 4 recorded the lowest (66.66%).

The mean values of water quality parameters monitored during the culture of Clarias gariepinus fingerlings with varying levels of mushroom (Pleurotus ostreatus) inclusion is presented in Table 3. The average water temperature remained relatively stable across all inclusion levels, ranging from 27.0°C to 27.5°C ($P > 0.05$). However, the mean pH tends to decrease slightly as the mushroom inclusion level increases, with the lowest pH observed at T4 and T5 compared to T1, but were also not significantly different among the treatments ($P > 0.05$).

Regarding dissolved oxygen (mg/l), the mean levels exhibited a declining trend as the mushroom inclusion level increases. The highest mean value was noted at T1 (control), with a gradual decrease in mean values as the mushroom inclusion levels increased, reaching the lowest mean value at T4 and T5. These observed differences in dissolved oxygen saturation is also not significantly different ($P > 0.05$).

**Table 2: Growth and Survival, Clarias gariepinus Fingerlings Fed Different Dietary Levels of Mushroom Meal**

| Parameters | T1 (0%) | T2 (1%) | T3 (2%) | T4 (3%) | T5 (4%) |
|---|---|---|---|---|---|
| Initial Number of Fish | 10 | 10 | 10 | 10 | 10 |

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| | | | | | |
|---|---|---|---|---|---|
| Initial Mean Weight(g) | 2.63±0.48a | 2.90±0.80a | 3.30±1.15a | 2.80±0.72a | 3.86±1.47a |
| Initial Mean Length(cm) | 6.45±0.50a | 6.62±0.65a | 6.76±0.84a | 6.54±0.61a | 6.95±0.96a |
| Final Mean Weight(g) | 17.70±0.56a | 26.06±2.26a | 27.16±4.98a | 27.40±1.20a | 29.46±5.38a |
| Final Mean Length(cm) | 15.83±0.92a | 17.48±0.25a | 17.76±0.89a | 18.33±1.12a | 19.10±1.24a |
| Mean Weight Gain(g) | 14.26±1.22b | 23.16±1.86ab | 23.86±3.86a | 24.60±0.80a | 25.60±4.86a |
| Length Increase(cm) | 9.37±0.58b | 10.94±0.42a | 11.00±0.10a | 11.73±1.28ab | 12.15±0.42a |
| Percentage Weight Gain (%) | 582.13±122.19 a | 810.53±128.13 a | 833.96±320.07 a | 896.63±196.05 a | 985.96±208. 74a |
| Specific Growth Rate (%$d^{-1}$) | 0.97±0.09a | 1.09±0.16a | 1.12±0.07a | 1.16±0.10a | 1.21±0.10a |
| Condition Factor(K) | 0.43±0.06a | 0.44±0.05a | 0.54±0.02a | 0.51±0.02a | 0.50±0.07a |
| Percentage Survival (%) | 66.66±12.01a | 70.00±5.77a | 73.33±14.52a | 66.66±8.81a | 76.66±14.52 a |

Note: Across the rows, means with the same superscript are not significantly different at (p>0.05).

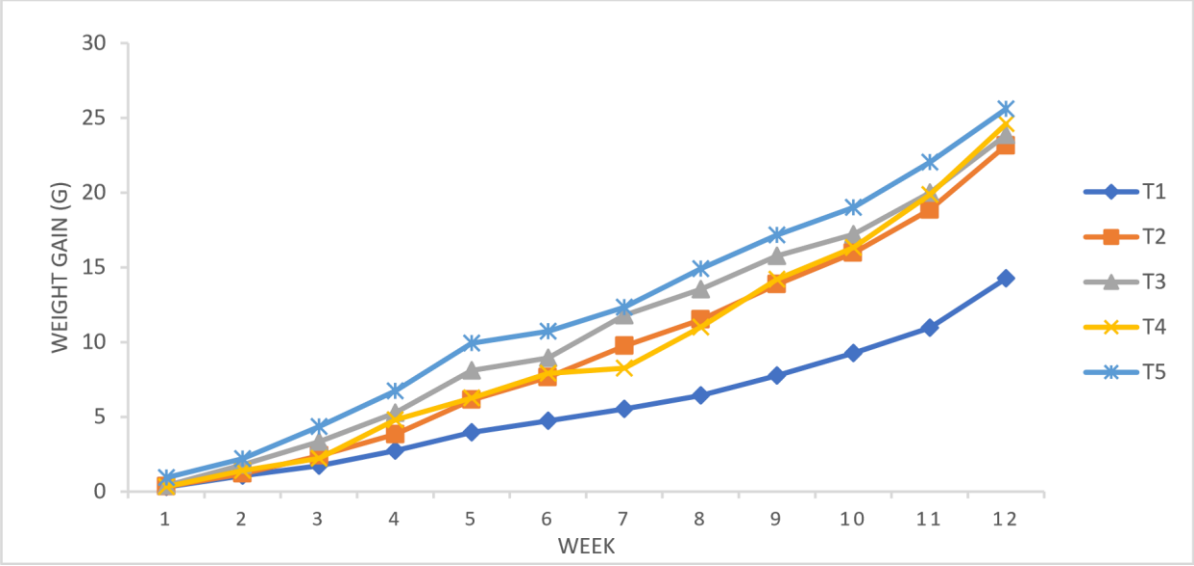

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**Fig 1 Weight Gain of Clarias gariepinus Fed Varying Inclusion Level of Oyster Meal for 12 Weeks**

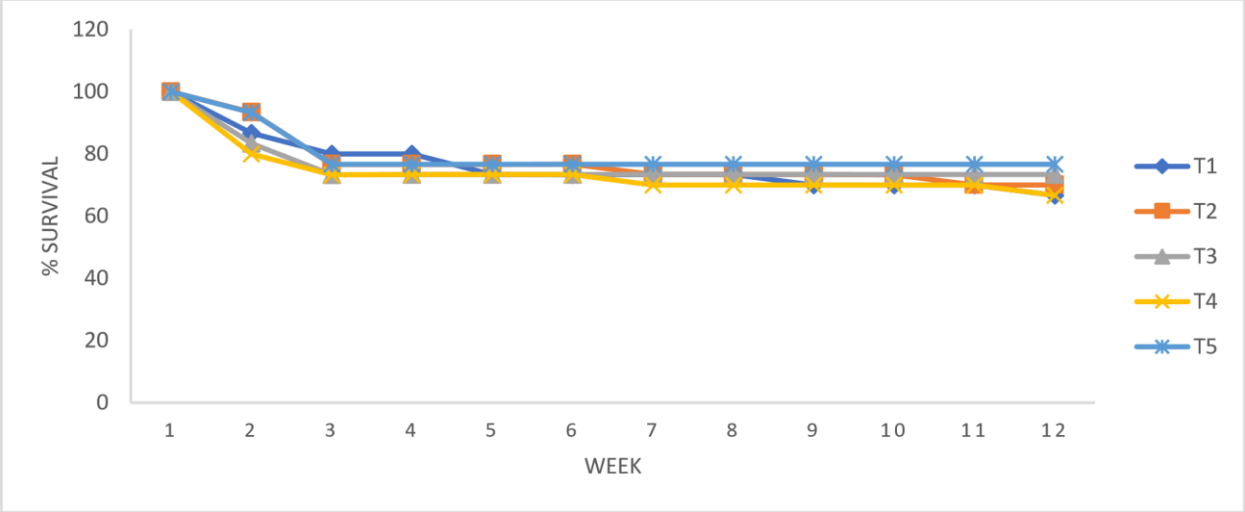


**Fig 2 Percentage Survival of Clarias gariepinus Fingerlings fed varying inclusion**

**Table 3: Water Quality Parameters During the Culture Clarias gariepinus Fingerlings Fed Varying Inclusion Levels of Mushroom (Pleurotus ostreatus)**

| Parameter | $T_1$ (0%) | $T_2$(1%) | $T_3$(2%) | $T_4$(3%) | $T_5$(4%) |
|---|---|---|---|---|---|
| Temperature $^{o}C$ | 27.5±0.19$^{a}$ | 27.0±0.19$^{a}$ | 27.25±0.19$^{a}$ | 27.0±0.19$^{a}$ | 27.0±0.19$^{a}$ |
| pH | 6.30±0.06$^{a}$ | 6.22±0.06$^{a}$ | 6.19±0.06$^{a}$ | 6.12±0.06$^{a}$ | 6.11±0.06$^{a}$ |
| Dissolved oxygen (mg/l) | 6.36±0.14$^{a}$ | 6.37±0.14$^{a}$ | 6.20±0.14$^{a}$ | 6.18±0.14$^{a}$ | 6.01±0.14$^{a}$ |

Note: Means with the same alphabets for a given parameter in the same l row are not significantly different (P>0.05).

## Discussion

The growth and survival of Clarias gariepinus fingerlings fed varying levels of mushroom meal were assessed. Notably, Treatment $T_5$ exhibited the highest final mean weight of 29.46g. This finding is consistent with Olude et al. (2019), whom reported increased final mean weight in Clarias gariepinus fingerlings fed with alternative dietary supplements like soybean meal. Similarly, Smith et al. (2020) observed comparable final mean weight values with alternative dietary interventions such as fishmeal supplementation, indicating the potential effectiveness of diverse dietary strategies in enhancing fish growth. However, contrary findings were reported by Yusuf et al. (2022), where Clarias gariepinus fed

with varying substitution levels of fish meal with cattle hoof meal showed a significantly higher final weight gain of 204.20g. Nonetheless, Aghoghovwia et al. (2022) reported an improved mean final weight gain of 3.87% with a 20% replacement of plantain peel to maize meal, a report which align with the findings of the present study. While this study underscores the positive impact of mushroom meal supplementation on final mean weight in Clarias gariepinus fingerlings, it is crucial to recognize the versatility of alternative dietary interventions in achieving similar growth outcomes. Research from Nigeria and abroad (Liu et al., 2019; Smith et al., 2020; Yusuf et al., 2022; Aghoghovwia et al., 2022) has demonstrated comparable final mean weight values with various protein sources such as soybean meal, fishmeal, maggot meal, and insect meal. The effectiveness of diverse dietary strategies in enhancing final mean weight emphasizes the importance of considering multiple options when formulating fish diets, particularly in terms of availability, cost-effectiveness, and environmental sustainability of alternative protein sources.

The observed percentage survival rates in this study are consistent with prevailing trends in aquaculture research, where survival rates typically exceed 60% across various dietary interventions and experimental conditions (Johnson et al., 2021; Akande et al., 2020). However, the survival rate of the experimental fish in this study was relatively lower compared to the findings of Aghoghovwia et al. (2022), who reported survival rates ranging from 87.5% to 95% for fish fed with plantain peel meal, all of which surpassed the rates observed in this study with mushroom-based diets. Conversely, the results of this study showed higher survival rates compared to those reported by Aghoghovwia and Obomunu (2022), where Clarias gariepinus fed with water lily as a soybean replacement exhibited survival rates ranging from 52.0% to 90.0%. The variation in percentage survival rate could be attributed to differences in diet formulations for the fish.

Treatment T5 demonstrated the highest length increase of 12.15 cm in this study, indicating enhanced growth potential associated with mushroom meal supplementation. However, further research could delve into exploring the relationship between length increase and specific dietary interventions targeting growth factors in Clarias gariepinus fingerlings.

Moreover, Treatment 5 exhibited the highest weight gain of 985.96% in the present study, suggesting significant growth enhancement due to mushroom meal supplementation. This finding is consistent with studies by Olude and Adebayo (2019), further validating the effectiveness of mushroom meal as a dietary supplement for improving weight gain in Clarias gariepinus fingerlings. Furthermore, Treatment 5 also showed the highest specific growth rate of 1.21 $\%d^{-1}$ in the present study, indicating rapid growth in Clarias gariepinus fingerlings fed with mushroom meal-supplemented diets. This aligns with findings by Akande et al. (2020), emphasizing the potential of mushroom meal as a growth-promoting dietary supplement in aquaculture practices. Lastly, Treatment 3, with a 2% mushroom meal inclusion level, exhibited the highest condition factor of 0.54 in the present study, suggesting better overall health and physiological condition in Clarias gariepinus fingerlings fed with 2% mushroom meal-supplemented diets. However, Aghoghovwia and Obomunu (2022) reported a condition factor superior to that of the present study.

Across all experimental conditions (T1-T5), the temperature remained relatively steady, fluctuating between 27.0 to 27.5°C, aligning with the optimal temperature parameters for fish cultivation documented in prior research (Aghoghovwia et al., 2022). Regarding pH, the observed values in this investigation (ranging from 6.11 to 6.30) fall within the acceptable range for aquaculture systems, typically set between 6.5 and 8.5, as noted in prior studies (Aghoghovwia and Obomunu, 2022). Dissolved oxygen levels across treatments ranged from 6.01 to 6.37 mg/l, indicating sufficient oxygenation for fish, in line with findings from previous studies examining water quality parameters in aquaculture systems (Ahmed and Ahmed, 2018). This study delved into the growth and survival of Clarias gariepinus fingerlings under varying dietary levels of Mushroom meal. Notably, the inclusion of mushroom positively impacted growth performance, showing enhancement in growth parameters with each increment of mushroom inclusion.

## Conclusion

This study evaluated graded levels of oyster mushroom meal as alternative protein source in the diet of African catfish fingerlings. Fish fed diets incorporating 3% and 4% mushroom meal additives exhibited the highest growth rates and survival. This was evidenced by significant improvements in mean weight gain, length increase, percentage weight gain and specific growth rate, Moreover, these diets demonstrated higher survival rates compared to lower dietary levels of mushroom meal. Based on the findings, it is advisable to consider integrating mushroom meal into the diet of Clarias gariepinus fingerlings, particularly at levels of 3% and 4%, to enhance growth performance, nutrient utilization and positive feed conversion ratio.

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