

Effects of dietary garlic (*Allium sativum*) supplementation on growth performance and survival of *Clariobrachius* fingerlings

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ABSTRACT: *Clariobrachius* fish is a fast-growing species reported to reach market size within a short time. This study investigated the growth performance and survivability of *Clariobrachius* fingerlings in the North-Central part of Nigeria fed Garlic-supplemented diets. Two hundred and forty (240) fingerlings of the hybrid *Clariobrachius* ($\text{♂Clarias gariepinus} \times \text{♀Heterobrachius longifilis}$) were stocked in twelve concrete 2 X 2 X 1 m² tanks. Each tank housed twenty (20) fingerlings distributed into four treatments with garlic inclusion levels (%), thus: G0, G0.5, G1.0, G1.5, with three replicates per treatment. *Clariobrachius* fingerlings were fed twice a day to satiation for thirty (30) days. There was no significant difference ($p>0.05$) in their initial weights of 2.00 ± 0.00 g, but there were significant differences ($p<0.05$) in final weights within the experimental groups, ranging from 8.50 ± 0.11 g to 12.3 ± 0.41 g. *Clariobrachius* fingerlings fed the 1.5% garlic-supplemented diets improved significantly in length, weight gain and survival rates. The highest survival rate (%) was recorded as 99.0 ± 0.01 in fish fed the 1.5% diet. Meanwhile, the 0% group had the lowest survival rate of 75.0 ± 0.00 . The results for serum catalase (CAT) and serum superoxide dismutase (SOD) activities revealed significant differences ($p<0.05$) in the 1.5% garlic-supplemented formulation diet at 4.3 ± 0.29 and 1.3 ± 1.20 U/L, respectively. Comparisons between catalase and serum superoxide dismutase for the different inclusion levels depict a statistical difference ($p<0.05$). The increase in CAT and SOD was attributed to the presence of allicin, a bioactive defence component in the garlic bulb, which promoted digestion, giving the immune system energy for growth and survival. The overall results from this study inferred that the garlic-supplemented formulation enhanced fish growth while increasing survivability.

Keywords: Antioxidant, *Clariobrachius*, feed additives, garlic, growth, immunity.

INTRODUCTION

Garlic is a functional food for treating various fish diseases (Salgado-Moreno, 2025). Supplemented feed in the diets of fish species enhances fish growth, resulting in maximum weight gain within a short time frame (Brum *et al.*, 2025; Ragasa *et al.*, 2022; Bhosale *et al.*, 2010). Eco-friendly herbs and herbal products are now encouraged by the World Health Organisation (WHO) in the right amounts as alternatives to the use of chemicals in fish diets (Dada, 2015). They are known to have antibacterial, antiviral, and antioxidant properties (Yaniv, 2025; Delgado *et al.*, 2023;

Sahidur *et al.*, 2023; Citarasu, 2010), which foster an increase in fish growth, stimulate appetite, boost immunity by preventing infections and reduce stress in fish. These result in the production of healthy fish (Delgado *et al.*, 2023; Pandey *et al.*, 2012). The flavour imparted by herbs and herbal products increases feed consumption and stimulates digestion by increasing the secretion of saliva and various digestive enzymes in fish (Haetami *et al.*, 2023; Shakya, 2017; Lee and Gao, 2012). The use of antibiotics in fish culture tanks can be replaced by the

optimal dose of garlic to promote growth performance and enhance the meat quality of fish (Muahiddah and Diamahesa, 2023; Shakya and Labh, 2014).

Therefore, plant products have reportedly aided activities such as growth promotion, appetite stimulation, anti-stress and immune stimulation in aquaculture management (Nwakpa and Ikwor, 2024). However, the response of fish to garlic in their diets has been reported to result in high mortalities at higher concentrations (Gabriel *et al.*, 2024), so care must be taken never to exceed the recommended dose. Excessive use of antibiotics, hormones and synthetic drugs in fish over time has resulted in the emergence of drug-resistant bacteria, toxic substances harmful to fish and overall suppression of fish immunity (Okeke *et al.*, 2022; Esiobu *et al.*, 2002). This has been an increasingly challenging issue in aquaculture. This study aimed to investigate the effects of garlic-supplemented diets on the growth and survival of *Clariobrachius*, addressing the challenge of using toxic chemicals in aquaculture. This study will further encourage the use of herbs and herbal products to balance fish health, promote sustainable fish growth and enhance survivability (Delgado *et al.*, 2023; John *et al.*, 2007).

MATERIALS AND METHODS

Experimental site and study area

The experimental site was the Fish Breeding and Culture Program (Hatchery Unit) of the National Institute for Freshwater Fisheries Research (NIFFR), New Bussa. New Bussa is located at 9°53'N 4°31'E coordinates (<https://latitude.to/articles-by-country/ng/nigeria/237463/new-bussa>).

Experimental set-up and design

Clariobrachius fry, numbering six thousand, were obtained from the Fish Breeding and Culture Program (Hatchery Unit) of the National Institute for Freshwater Fisheries Research (NIFFR), New Bussa, Niger State of Nigeria. Two hundred and forty (240) fingerlings of hybrid *Clariobrachius* (♂ *Clarias gariepinus* X *Heterobrachius longifilis* ♀) were stocked in twelve concrete 2 X 2 X 1m² tanks. Each tank had twenty (20) *Clariobrachius* fingerlings distributed into the four treatment groups with garlic inclusion levels: G0, G0.5, G1.0, G1.5 in triplicate using a randomised design. Treatments were in triplicate. *Clariobrachius* fingerlings were fed twice daily to satiation for thirty (30) days. Fish were fed experimental feed of 2mm diameter pellets until the end of the experiment. However, a weekly manual exchange of water was carried out on each sampling day; total water exchange was up to ¾ (75%) full. Data on weight differences were measured using a CAMRY Electronic pocket scale, model: EHA251.

Data on length differences were measured using a long metre rule placed on a smooth table surface.

Preparation, phytochemical constituents of garlic and feed formulation

Raw garlic (*Allium sativum*) was purchased from a local market in New Bussa, Niger State, Nigeria. The garlic purchased was sliced, crushed, air-dried to avoid direct sunlight, then pulverised into powder. Garlic was then extracted by soaking 100g of the pulverised garlic powder in 600ml of distilled water for 24 hours. The garlic residue and filtrate were then filtered using a fine mesh filtering cloth. The residue was dried on cardboard paper. This yielded 380 mL of filtrate, which was then analysed for phytochemical constituents according to Ayanwale *et al.* (2021).

Growth parameters

At the end of the feeding trial, data on the final body weight were measured using a CAMRY Electronic pocket scale MODEL: EHA251 and final body length was measured using a ruler placed on a smooth surface. Growth parameters such as percentage weight gain (%WG) and survival rate (%) were calculated according to Sarker *et al.* (2016).

Enzyme assay

The activities of catalase (CAT) and superoxide dismutase (SOD) in the serum and blood, respectively, were determined by the use of a spectrophotometer (Owais *et al.*, 2026; Sinha, 1972; Misra, 1972).

Physico-chemical parameters

The following water quality parameters were measured: pH using a pH meter, Dissolved Oxygen (DO) using a DO meter and measured in mg/l, water temperature using a mercury-in-glass thermometer and measured in °C, and conductivity using a conductivity meter with its measurement in µS/cm (Adeyeni *et al.*, 2022). Measurements were carried out weekly, on each sampling day.

Data analysis

The data from all treatments were analysed using One-way Analysis of Variance (ANOVA) and Duncan's multiple range test with the SPSS 20 statistical package (Duncan, 1955). Each treatment was assessed and compared.

Table 1. Composition of the feed ingredients for *Clariobrachius* fingerlings in the study.

Ingredients	Diet 0(Kg)	Diet 0.5(Kg)	Diet 1.0(Kg)	Diet 1.5(Kg)
Fish meal	15.00	15.00	15.00	15.00
Soyabean meal	20.00	20.00	20.00	20.00
Groundnut cake	27.00	27.00	27.00	27.00
Wheat offal	11.00	11.00	11.00	11.00
Maize	20.00	19.50	19.00	18.50
Oil	2.00	2.00	2.00	2.00
Bone meal	1.00	1.00	1.00	1.00
Starch	2.00	2.00	2.00	2.00
Premix	2.00	2.00	2.00	2.00
Garlic (<i>Allium sativum</i>) Kg	0	0.5	1.0	1.5

¹G0=Garlic inclusion level 0; ²G0.5=Garlic inclusion level 0.5; ³G1.0=Garlic inclusion level 1.0; ⁴G1.5=Garlic inclusion level 1.5.

Table 2. Proximate analysis of formulated feed fed to *Clariobrachius* fingerlings in concrete tanks.

Nutrients (%)	Percentage (%) composition
Moisture content	5.20±0.20
Ash	5.30±0.70
Crude protein	38.20±2.50
Crude fat	6.50±0.01
Crude Fibre	9.90±4.00
Carbohydrate	20.10±0.50

Table 3. Proximate analysis of garlic-formulated feed fed to *Clariobrachius* fingerlings in concrete tanks.

Parameters	G0	G0.5	G1.0	G1.5
Moisture content (%)	7.5±1.50 ^b	7.5±1.20 ^b	7.0±1.20 ^a	7.8±1.30 ^c
Ash (%)	11.28±0.03 ^c	10.20±0.01 ^b	9.0±0.03 ^a	9.0±0.00 ^a
Crude protein (%)	38.10±2.40 ^a	39.0±1.00 ^b	39.0±1.20 ^b	39.0±1.11 ^b
Crude fat (%)	9.60±0.02 ^c	9.40±0.01 ^a	9.50±0.05 ^b	9.50±0.10 ^b
Crude fibre (%)	5.0±0.60 ^a	5.0±0.40 ^a	5.0±0.20 ^a	5.0±0.35 ^a
Carbohydrate (%)	26.0±0.70 ^a	26.5±0.50 ^b	26.5±0.30 ^b	26.5±0.20 ^b

Means in the same column (for each section) with different superscripts are statistically different ($p < 0.05$). ¹G0=Garlic inclusion level 0; ²G0.5=Garlic inclusion level 0.5; ³G1.0=Garlic inclusion level 1.0; ⁴G1.5=Garlic inclusion level 1.5

RESULTS

Composition of feed ingredients, proximate analysis of garlic-formulated feed

The experimental diets were locally formulated using the Pearson Square method of feed formulation for 100kg of fish feed, with increasing inclusion levels of garlic from G0 (0%), G0.5 (0.5%), G1.0 (1.0%) and G1.5 (1.5%) to produce four experimental feeds with crude protein content of 38.20% (almost 40%) and lipid (Table 1). The diets were then oven-dried at 35°C. Proximate composition of the formulated feed without garlic inclusion (Table 2) was determined, as well as the proximate

composition of the garlic-supplemented feed (Table 3) at the various inclusion levels.

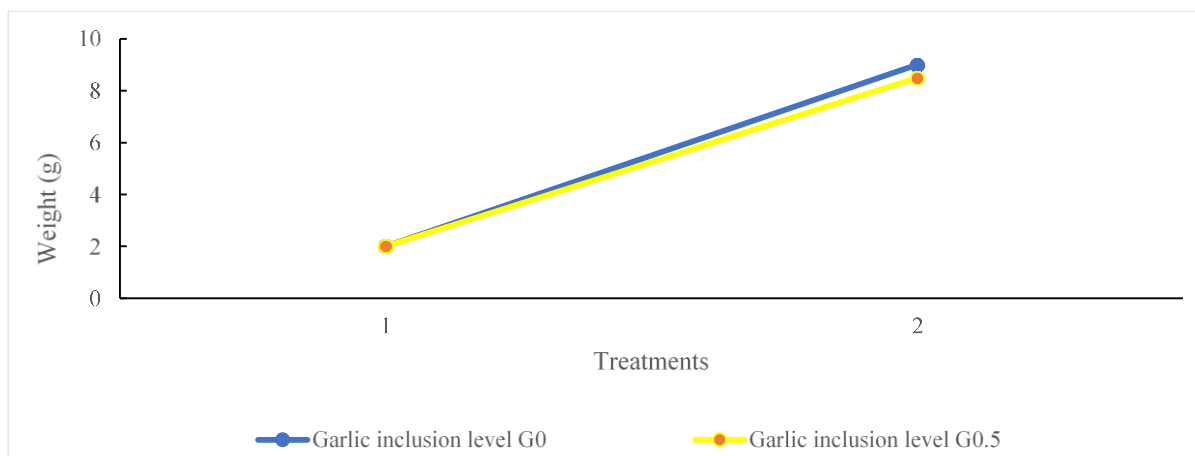
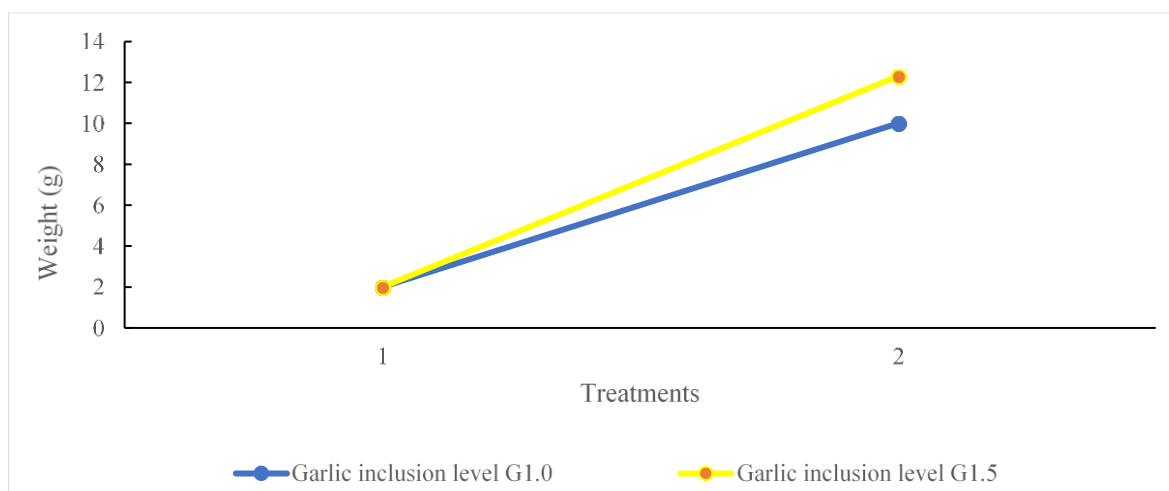
Growth and survival of *Clariobrachius* fingerlings fed garlic-formulated feed

This study reported that there was no significant difference ($p > 0.05$) in the initial weights, but there were significant differences ($p < 0.05$) in final weights in all the experimental diets. Survival rates (%) indicated the highest survival values for the 1.5 garlic-supplemented diet at 99.0±0.01^c. This was closely followed by the 1.0 garlic-supplemented diet at 97.0±0.40^b. The 0.5 garlic supplemented diet and

Table 4. Growth and survival of *Clariobrachius* fingerlings fed garlic-supplemented formulation in concrete tanks.

Parameters	G0	G0.5	G1.0	G1.5
Initial weight (g)	2.00±0.00 ^a	2.00±0.00 ^a	2.00±0.00 ^a	2.00±0.00 ^a
Final weight (g)	9.00±0.04 ^b	8.50±0.11 ^a	10.00±0.21 ^c	12.3±0.41 ^d
Mean weight gain (g)	7.00±0.33 ^b	6.30±0.20 ^a	8.00±0.20 ^c	10.0±0.37 ^d
Specific growth rate (%)	2.81±0.01 ^a	2.61±0.08 ^b	3.21±0.03 ^c	4.12±0.05 ^d
Survival rate (%)	75.0±0.00 ^a	95.0±0.03 ^a	97.0±0.40 ^b	99.0±0.01 ^c

Means in the same column (for each section) with different superscripts are statistically different ($p < 0.05$). ¹G0=Garlic inclusion level 0; ²G0.5=Garlic inclusion level 0.5; ³G1.0=Garlic inclusion level 1.0; ⁴G1.5=Garlic inclusion level 1.5.

**Figure 1.** Growth response of *Clariobrachius* fingerlings fed a garlic-supplemented formulation in concrete tanks.**Figure 2.** Growth response of *Clariobrachius* fingerlings fed a garlic-supplemented formulation in concrete tanks.

the 0% garlic supplemented diet, which was the control, indicated survival rate values of 95.0 ± 0.03^a and 75.0 ± 0.00^a , respectively. There were significant differences ($p < 0.05$) in survival rate values among the diets (Table 4). *Clariobrachius* fingerlings fed the 1.5% garlic-supplemented formulation in their diets improved tremendously in length and weight (Figures 1 and 2).

Quantitative phytochemical screening of aqueous extract of garlic bulb

Findings in this study also showed the presence of phytochemicals such as alkaloids, saponins and tannins in the Garlic bulb, with the highest number being (2.40%) (Table 5).

Table 5. Quantitative phytochemical screening of aqueous extract of Garlic bulb under study.

Phytochemicals (g/100g)	Status	Percentage composition (%)
Tannins	+	2.40±0.20 ^a
Saponins	+	0.21±0.10 ^c
Cardiac glycoside	+	1.90±0.31 ^b
Alkaloid	+	0.10±0.05 ^c

Means in the same column (for each section) with different superscripts are statistically different (p<0.05).

Table 6. Influences of catalase and serum superoxide dismutase on *Clariobrachus* fingerlings cultured in concrete tanks

Influences	Catalase (CAT) (U/L)	Serum superoxide dismutase (SOD) (U/L)
G0	2.0±0.15 ^b	0.8±1.02 ^a
G0.5	2.3±0.16 ^b	0.7±1.07 ^a
G1.0	2.1±0.20 ^b	1.1±1.10 ^a
G1.5	4.3±0.29 ^b	1.3±1.20 ^a

Means in the same column (for each section) with the same superscripts are not statistically different (p>0.05). Comparisons between catalase and serum superoxide dismutase for the different inclusion levels depict a statistical difference (p<0.05).

Table 7. Water quality parameters for cultured *Clariobrachus* fingerlings during the study

Parameters	G0	G0.5	G1.0	G1.5
Water temperature (°C)	27.5±0.40 ^a	27.5±0.60 ^a	28.0±0.80 ^a	28.0±0.20 ^a
Dissolved oxygen (DO)(mg/l)	4.0±0.20 ^a	4.1±0.10 ^a	4.15±0.00 ^a	4.2±0.20 ^a
pH	7.5±0.50 ^a	7.5±0.25 ^a	7.35±0.30 ^a	7.5±0.55 ^a
Conductivity (µS/cm)	50.0±0.02 ^a	52.2±0.01 ^a	55.0±0.00 ^a	55.0±0.03 ^a

Means in the same column (for each section) with different superscripts are statistically different (p<0.05). ¹G0=Garlic inclusion level 0; ²G0.5=Garlic inclusion level 0.5; ³G1.0=Garlic inclusion level 1.0 ⁴G1.5=Garlic inclusion level 1.5.

Influences of catalase and serum superoxide dismutase on *Clariobrachus* fingerlings

The results for serum catalase and serum superoxide dismutase influences revealed significant differences (p<0.05) in the 1.5% garlic-supplemented formulation diet as: 4.3±0.29^b and 1.3±1.20^a U/L (Table 6).

Water quality parameters for cultured *Clariobrachus* fingerlings

The water quality parameters in the study revealed no significant differences (p>0.05) in the diets of the fishes. (Table 7).

DISCUSSION

Composition of feed ingredients, proximate analysis of garlic-formulated feed

During the course of this study, the 100 kg feed formulated

was oven-dried according to a previous work by Antia *et al.* (2022). Proximate composition of the formulated feed was carried out before the proximate composition of the garlic infused into the fish diets at different inclusion levels was carried out. The moisture content, crude protein, crude fat, ash and carbohydrates all showed no significant differences (p>0.05) in the experimental diets. Only the crude fibre content showed significant differences (p<0.05) in the experimental diets. This result was also in agreement with Godwin *et al.* (2021).

Growth and survival of *Clariobrachus* fingerlings fed garlic-formulated feed

While this study reported higher growth in *Clariobrachus* fingerlings fed with the Garlic-supplemented diet at the level of 1.5%, the report of Abdel-Hakim *et al.* (2010) disagrees with the findings of this study, instead reporting higher growth and feed utilisation values for low inclusion levels of Garlic at 0.5% in their study on Tilapia. Higher growth rates are a result of excellent feed utilisation

abilities and enhanced immune responses (Nwakpa and Ikwor, 2024). The growth and survival values reported in this study were in agreement with Godwin *et al.* (2021). Agbebi *et al.* (2013) from an earlier study on the African catfish *Clarias gariepinus* and Kalyankar *et al.* (2013) from an earlier study on the Swordtail fish, *Xiphophorus helleri*, also support the findings of this study.

Quantitative phytochemical screening of aqueous extract of garlic bulb

Phytochemical screening of the garlic bulb used in this study reported the presence of many alkaloids, tannins, and saponins. All of these (alkaloids, tannins, and saponins) may contribute to antimicrobial and antioxidant effects in many fish (Usman *et al.*, 2009) (Table 5).

Influences of catalase and serum superoxide dismutase on *Clariobranchus* fingerlings

The increase in CAT and SOD could be attributed to the presence of allicin, a bioactive antioxidant defence component of the garlic bulb present in their diet, which promotes digestion, giving energy for growth (Khalil *et al.*, 2001). This result agrees with Ayanwale *et al.* (2021), whose earlier investigations revealed values of catalase and serum superoxide dismutase as 4.67 ± 0.34 and 1.23 ± 0.03 U/L for garlic-supplemented diet treatment 1.5%.

Water quality parameters for cultured *Clariobranchus* fingerlings

The physico-chemical properties of the water used in the study showed no significant differences ($p > 0.05$), thus aligning with the findings of Godwin *et al.* (2021), whose study documented normal ranges for water quality measurements.

Conclusion

The presence of garlic in the diets of fish produces a resultant effect of higher body weight gain, final body length and high survival rates because of the presence of tannins, which provide a higher antioxidant defence against diseases. A garlic inclusion level of 1.5% produced the highest response under the conditions of this study, promoting disease resistance in fish and healthy fish growth. This study further suggests that aquaculture stakeholders minimise the use of chemicals and antibiotics in feed, reverting to natural materials which are widely accepted as enhancing feed utilisation in fish.

CONFLICT OF INTEREST

The authors declare that they have no conflict of interest.

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