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Effects of Garlic (*Allium sativum*) on Growth and Haematological Parameters in African Catfish (*Clarias gariepinus*) Juveniles

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ABSTRACT

Fishes are most abundant aquatic vertebrates; they are being consumed by humans as protein supplements and as well serve as raw materials in drugs industries and source of foreign exchange. Juveniles *Clarias gariepinus* were sourced from ABU Institute of Agriculture Mando, Zaria Kaduna State and acclimatized for two weeks and fed 4mm Bluecrown feed containing 45% crude protein diet at 3% body weight twice daily at 12hours interval. Feed was formulated with *garlic* extract in to five groups; A (0.0g/kg), B (0.5g/kg), C (1.0g/kg), D (2.0g/kg) and E (5.0g/kg) diet. Fishes were grouped into five (triplicates) and feed different diets. Fish fed with 0.5g/kg garlic mixture supplemented diet increases significantly in growth when compared with the control groups and those other groups fed with 1.0 g/kg, 2.0 g/kg and 5.0 g/kg Garlic supplement. Similarly, among dietary groups, food conversion ratio (FCR) improved significantly ($p < 0.05$) in fish fed with 1.0 g/kg and 0.5 g/kg Garlic supplemented diet when compared with those fed with D (2.0 g/kg), D (5.0 g/kg) and control (0.0 g/kg). Percentage weight gain, mean weight and survival rate decreases as garlic supplements in the diets increases. Differences observed in packed cell volume (PCV) and White blood cell (WBC) were significantly high in 0.5g/kg garlic supplemented groups (PCV 33% and WBC 23.1 $x10^3 \mu L^{-1}$) when compared with the control group (PCV 27% and WBC 19.1 $x10^3 \mu L^{-1}$) and other groups with higher garlic supplements. Overall, fish fed with 0.5 g/kg garlic mixture extracts had improved haematological indices when compared with those fed with higher concentrations and control group. The study concluded that, 0.5g/kg level of garlic could effectively improve the growth performance, healthier and survival rate of *Clarias gariepinus*. This study was conducted to evaluate the dietary effects of garlic on growth and haematological parameters of *Clarias gariepinus*.

Keywords: *Allium sativum*; *Clarias gariepinus*; haematological; packed cell volume; white blood cell

1.0 INTRODUCTION

One of the world's fastest growing sectors in Agricultural business is pisciculture (Villa-Cruz *et al*., 2009). FAO (2020) reported an increase in the consumption of aquatic resources over the years with a slight decrease in total world production of fishes. El-Haroun *et al.* (2006) reported that, the sectors of aquaculture industries that needs to be enhanced, include; culturing of disease resistance fishes; fishes with high rate of feed efficiency and enhanced growth performance. An important aspect of aquaculture management is diet supplementation, especially in semi-intensive and intensive fish culture. The use of medicinal herbs and plants extracts are being encouraged by WHO as substitute for synthetic chemicals through go-back-to-nature global campaign. Shim *et al.* (2009) reported that, development of additives as well as safe dietary supplement for the enhancement of the immune system of farmed fishes life activity and fish health have been intensified by researchers. The use of plant based immune stimulants and probiotics as an alternative to antibiotic to keep fish healthy is now a major focus in fisheries research (Sahu *et al*., 2007).

Scientists have now shifted attention from the use of synthetic chemicals to the use of natural plant extracts for the enhancement of growth in animals; fish inclusive. It has been noted that the use of probiotic in aquaculture, though relatively new but its yielding a positive results. Garlic *(Allium sativum)* among other plants is being investigated and evaluated for its medicinal properties. It is said to have little or no side effect while being

developed into drugs (Cristea *et al.*, 2012). *Allium sativum* is a member of the Liliaceae family and it's highly cultivated throughout Central Asia. It is being used commonly by humans as a spice or a seasoning, which has been reported for its effective cure in the treatment of several ailments in animals; including fish. Heidarieh *et al.* (2013) reported antiprotozoal, antifungal, antibacterial and antiviral effects of garlic, as well as its beneficial effects on the immune and the cardiovascular systems. The inclusion of garlic in fish feed as reported by Metwally (2009) is said to increase fish growth performance.

One of the most important cultivated fish in Nigeria is Catfish (*Clarias gariepinus*). It has proven to be a fish species of considerable potential and most suitable for intensive aquaculture. Despite this remarkable potentials, its size under culture is still far less when compared with *Heterobranchus* spp, its hybrids (Dada *et al*., 2009). This calls for the needs of growth enhancement research using probiotics for the culture of this valuable fish species for the sustainability of aquacultural industries. This also will help to meet the ever increasing population of the country's demand for fish / protein supplements.

Food insecurity is a serious economic challenges and is rising in the developing countries especially Nigeria. The use of medicinal plants such as; black seeds, fenugreek seeds, funnel seeds, garlic bulbs, ginger cloves and peppermint leaves as natural growth enhancers of fish has proven to have a significant improvement in feed conversion rate, survival and weight gain by more than 50% (El-Dakarv *et al*., 2004). Synthetic antibiotic that are used as growth enhancers in *Clarias gariepinus* production are expensive, which calls for the use of natural products.

Garlic has been reported in different climes of the world by several authors for cure of several ailments, effective treatment and also having beneficial effect on growth enhancement, immune and cardiovascular systems. Few trials have been reported in Nigeria's aquaculture industries with the use of garlic for growth promotion. This study is therefore aim to determine the effect of garlic on growth and haematological parameters of African catfish (*Clarias gariepinus*).

2.0 Materials and Methods

2.1 Experimental Design

Juveniles of *Clarias gariepinus* were sourced from Ahmadu Bello University, Institute of Agriculture Mando, Zaria Kaduna State and transported in plastic containers to the Department of Biological Sciences Laboratory, Federal University Gusau. The juveniles were allowed to acclimatize to the new environment for 14 days. The total of three hundred (300) juveniles were grouped into five (5); A, B, C, D and E with each containing 20 juveniles in three (3) replicates each. Fifteen (15) fibre aquaria, each holding 20 fishes measuring 120×50×40cm were set up. Fishes in all the treatment were fed at 3% body weight twice daily at 12hours interval (Jabbi *et al.*, 2012).

2.2 Preparation of Plant Materials

Allium sativum bulbs was purchased from Central Market Gusau in plastic bags and transported to the herbarium section of the Department of Biological Sciences for identification (FUG/BIO/HAB/21/0033). The clove of *Allium sativum* were cut into small bits with knife and dried at room temperature. The fresh dried sample was pulverized with mortar and pestle into powder to pass through 0.5mm mesh size to standardize the particles. The powder was then stored in glass bottle in lab at room temperature.

2.3 Experimental Feeds Preparation

Feeds were produced from the feed mill with the standard procedures as experimental fed. A basal diet 40% crude protein was formulated with the following ingredients; maize, fish meal, soya bean meal, groundnut cake, starch (binder), minerals/vitamins premix, methionine. Prepared plant extract was added to the feed in the following categories; A = 0.0g/kg of *Allium sativum*, B = 0.5g/kg of *Allium sativum*, C = 1g/kg of *Allium sativum*, D = 2g/kg of *Allium sativum* and E = 5g/kg of *Allium sativum***.**

2.4 Water Quality Parameters

Water quality parameters were taking weekly, these include; Temperature, Dissolved oxygen, pH, TDS, and electric conductivity using HANNA Combo pH/EC/Temp metre model/HI 98129. The water in the aquaria was replaced every week.

2.5. Determination of Growth Indices and Nutrient Utilization

The specific growth rates were computed as describe by Rodger *et al.* (2017), while Relative growth rate was determined using the formula as described by Esenowo *et al.* (2010). *Clarias gariepinus* were weighed at the beginning of the study and weekly, using digital weighing balance. Data on performance, which include; specific growth rate, feed conversion ratio, body weight change, relative weight gain and condition factors was taken for the study and calculated as follows:

Weight gain (g) = $\text{Final weight of fish} - \text{Initial weight of fish}$.

Relative weight gain (RWG, %) = $\text{weight gain/initial weight} \, x \, 100$.

Specific growth rate SGR (% per day) = $\frac{(\text{net Log final weight} - \text{net Log initial weight})}{60 \text{ (days of the experiment)}} \, x \, 100$.

Feed conversion ratio (FCR) = $\frac{\text{Total feed consumed by the fish (g)}}{\text{Weight gain by the fish}}$.

Survival Rate (SR%) = $\frac{(\text{No of fish at the start of the expt.} - \text{No of fish at the end of the expt.})}{\text{Number of fish at the start of the experiment}} \, x \, 100$

.

Condition factor (K) = $\frac{\text{Weight of fish (g)}}{(\text{Standard length of fish})^3 (\text{cm})} \, x \, 100$.

2.6 Haematological Parameters

Blood samples were taken from *C. gariepinus* (after 60 days) by the ventral side needle space through the anal pore for haematological analysis. The samples were analysed according to the methods of Haghighi *et al.* (2014). The following haematological parameters were determined as described by Dacie and Lewis (2001); Neutrophils (%), Lymphocytes (%), Packed cell volume (PCV), White blood cell (WBC), Eosinophil (%), Monophils (%) and Basophils.

2.7 Statistical Analysis

Values obtained were recorded as mean plus/minus standard deviation. One-way ANOVA was used to present the statistical significance of difference in the mean deviation ($p < 0.05$). IBM SPSS Version 21 was used to compare each of the test group and control while differences among the individual means was compared using Duncan's multiple range test**.**

3.0 RESULTS

3.1 Water Quality Parameters

The results of the following water quality parameters; Dissolved Oxygen (DO), Total Dissolve Solids (TDS), Temperature, pH and Electrical Conductivity (EC) measured were presented in Table 1. Temperature was not significantly different across the experimental aquariums and the control throughout the study period, likewise the pH. Electrical conductivity, total dissolved solids and dissolved oxygen of treatment A (0.5g/kg) and control were significant different from the rest of treatments groups (Table 1).

Table 1: Water Quality Parameters Across the Experimental Aquaria

Parameter	Control	A (0.5g/kg)	B (1.0g/kg)	C (2.0g/kg)	D (5.0g/kg)
TEMP	24.35±1.9^a	24.25±1.6^a	24.3±1.3^a	24.133±1.2^a	24.3±0.6^a
EC	915.7±31.6^b	922.3±77.2^b	942.7±68.4^a	937.7±60.1^a	939.7±47.3^a
pH	6.92±0.43^a	6.98±0.72^a	6.76±1.12^a	6.69±1.31^a	6.84±1.52^a
DO	7.82±1.8^b	7.91±2.1^b	7.26±2.0^a	7.18±1.4^a	7.12±2.01^a
TDS	432.7±22.9^a	457±40.5^a	493.5± 29.3^{ab}	527.3±29.3^b	570.3±22.5^b

Keys words; TEMP; Temperature (ºC), EC; Electric conductivity (µS/cm), DO; Dissolved Oxygen (mg/l) and TDS; Total dissolve solid (ppm).

3.2 Utilization of Nutrients and Growth Parameters of *C. gariepinus*

Table 2 shows the results of growth parameters and nutrient utilization of *Clarias gariepinus* fed with garlic bulb (*A. sativum*) at different inclusion levels. The weight of the fishes at the start of the experiment (initial weight) were not different significantly ($P > 0.05$) from one another.

Meanwhile the final weight after 60 days of the experiment in aquaria B, C, D and control were not significantly different from one another but they were different significantly (P > 0.05) from the aquarium A fish at the end of the experiment.

The highest average weight gains of fish (21.1 ±3.8) and the percentage weight (824.22 ±18.7) were recorded in aquarium A (fish that were fed with 0.5g/kg inclusion of *A. sativum)* while 12.36 ±2.5g were recorded as the least weight gain in aquarium D (fish that were fed with 5g/kg *A. sativum*). The result of specific growth rate (SGR) treads a similar pattern as weight gains of the fish in the course of the research. The highest SGR (1.6±1.2) was recorded in aquarium A (fish that were fed with 0.5g/kg inclusion of *A. sativum*), while 1.23±0.1 was recorded as the least SGR from aquarium D (fish fed with 5.0g/kg *A. sativum*). All the experimental aquariums (A, B, C, D and Control) show no significant difference (P < 0.05) in specific growth rate at the end of the experiment. The highest food conversion ratio (FCR) of 7.36±3.67 was recorded by fish fed with 5.0g/kg *A. sativum* included in the diet while the lowest and best FCR of 4.30± 1.8 was recorded by fish fed with 0.5g/kg of *A. sativum* in diet. The FCR of the fish were significantly higher (P > 0.05) in aquaria B and D than what was observed in aquaria A, C and Control. Condition factor (K) was highest (1.23± 0.5) in aquarium A and lowest (0.62± 0.9) in control aquarium, which was also significantly different from the rest of the treatment aquaria.

Table 2: Growth Performances of *Clarias Gariepinus* Fed with Various Concentration of *Allium Sativum* Supplemented Diets

Parameter	Treatments				
	Control (0.0g/kg)	A (0.5g/kg)	B (1.0g/kg)	C (2.0g/kg)	D (5.0g/kg)
IW (g)	50.11±1.8^{a}	50.56±1.9^{a}	50.68±1.9^{a}	49.87±1.6^{a}	49.74±1.3^{a}
FW (g)	453.87±1.6^{a}	509.66±1.9^{b}	432.14±1.9^{a}	441.2±1.6^{a}	422.1±1.8^{a}
WG (g)	403.76± 2.4^{b}	459.1± 3.8^{c}	382.46± 2.4^{a}	392.33± 3.3^{a}	373.36± 2.5^{a}
RWG (%)	805.75.53± 24.8^{ab}	908.03±18.7^{b}	754.66±18.9^{a}	786.71±1.7^{a}	750.62.09±19.3^{a}
FCR	5.85± 3.8^{a}	4.30± 1.8^{a}	4.85± 3.3^{b}	4.54± 2.77^{a}	7.36± 3.67^{b}
SGR (%)	1.52± 0.01^{a}	1.6± 1.2^{a}	1.3± 0.5^{a}	1.25± 0.2^{a}	1.23± 0.1^{a}
SR (%)	92.5± 0.4^{a}	97.3± 1.4^{a}	92.2± 3.1^{a}	90.2± 1.4^{a}	88.5± 1.7^{a}
CF (K)	0.62± 0.9^{a}	1.23± 0.5^{b}	0.98± 1.1^{b}	0.92± 0.7^{b}	0.88± 1.5^{b}

Data were presented as mean ± standard deviation. Data in the same row with the same superscript letter are not different significantly (P > 0.05). Keywords; IW - Initial weight (g), FW - Final weight (g), WG - Weight gain (WG), RWG% - Percentage weight gain, FCR - Food conversion ratio, SGR - Specific growth rate, SR - Survival rate, CF/K - Condition factor.

3.3 Effect of *A. sativum* on Haematological Parameters

The haematological results of fish in experimental aquaria revealed that for WBC (white blood cells), no significant difference (p> 0.05) was observed among the fish in aquaria C (2.0g/kg), D (5.0g/kg) and Control (0.0g/kg) but were different significantly from fishes in aquaria A (0.5g/kg) and B (1.0g/kg) inclusion of *A. sativum*. RBC (Red blood cells), revealed no significant difference (p> 0.05) among the fish in all the experimental aquaria A - D (0.5g/kg, 1.0g/kg, 2.0g/kg, 5.0g/kg) inclusion of *A. sativum*, but were different significantly (p< 0.05) from the fish in control (0.0g/kg) aquarium. Haemoglobin concentration (HB) revealed no significant difference (p> 0.05) among the fish in aquariums A (0.5g/kg), B (1.0g/kg) and C (2.0g/kg), but they were different significantly (p< 0.05) from fish in aquaria D (5.0g/kg) and Control (0.0g/kg). PCV (packed cell volume) revealed no significant difference (p> 0.05) among the fishes in aquaria B, C, D and control (1.0g/kg, 2.0g/kg, 5.0g/kg, 0.0g/kg). The result showed that PVC value in aquarium A (0.5g/g) was significant higher than the rest of the aquaria (Table 3).

The MCHC (mean cell haemoglobin concentration) revealed that the fish in all the experimental aquariums were not different significantly (p>0.05) from one another, except from the fish in aquaria A (0.5g/kg) which was significant higher than the rest of the aquariums. The highest lymphocytes (77.11±0.21%) was recorded in aquarium A (0.5g/kg) while the lowest

(68.3±2.3%) was recorded in the Control (0.0g/kg) aquarium. A similar trend was also recorded in Neutrophils concentration. Only aquarium A (0.5g/kg) was significantly higher than the rest of the experimental aquaria, including the Control aquarium (Table 3).

The result obtained for Neutrophils (%) decreases as the level of *Allium sativum* extract increases in the diet. The diet containing 0% *Allium sativum* extract recorded the lowest value of 51% and was different from the value of 54% obtained in fish fed diet containing *Allium sativum extract.* The diet containing 5.0g/kg *Allium sativum* extract recorded the lowest value of 23% and was significantly different from the value of 29% obtained in fish fed diet containing 0.5g/kg *Allium sativum extract.* The high value of lymphocyte counts of 77% was observed in fish fed diet containing 0.5g/kg *Allium sativum* extract and 68% observed in the control group as shown in Table 3.

Table 3: Haematological Parameters of *Clarias Gariepinus* fed with *a. Sativum* Extract Supplemented Diets

Parameters	Treatments				
	Control	**A (0.5g/kg)**	**B (1.0g/kg)**	**C (2.0g/kg)**	**D (5.0g/kg)**
PCV (%)	27.0±1.5^{a}	33.2±0.8^{b}	29.1±0.2^{a}	28.6±1.1^{a}	28.7±1.8^{a}
WBC (10^3µL^{-1})	19.1±1.8 ^{a}	23.1±0.5^{b}	21.1±0.7^{b}	19.4±.9^{a}	18.2±1.4^{a}
Neutrophils (%)	25.2±2.1^{a}	29.4±1.3^{b}	25.8±2.1^{a}	24.7±.0.3^{a}	23.11±0.1^{a}
Lymphocytes (%)	68.3±2.3^{a}	77.11±0.21^{b}	73.3±0.36^{ab}	72.23 ^{ab}	69.5±1.4^{a}
MCHC (gdµL^{-1})	26.6±0.3^{a}	35.7±0.5^{b}	29.8±0.4^{a}	27.3±0.4^{a}	29.2±0.4^{a}
RBC(10^6µL^{-1})	2.7±0.2^{a}	5.4±0.1^{b}	3.7±0.6^{b}	3.4±0.2^{b}	3.3±0.1^{b}
HB(gdµL^{-1})	68.2±0.5^{a}	77.3±0.2^{b}	72.4±0.2^{ab}	73.2±0.2^{ab}	70.8±0.6^{a}

Data were presented as mean ± standard deviation. Mean values with the same superscript letter along the same row are not significantly different (p > 0.05).

Note: PVC (Packed Cell Volume), WBC (White Blood Cell), MCHC (Mean Cell Haemoglobin Concentration), HB (Haemoglobin Concentration), RBC (Red Blood Cells).

4.0 DISCUSSION

The growth performance of *Clarias gariepinus* fed with various *Allium sativum* concentrations revealed a general increase in weight gain in the course of the experiment. Highest performance in terms of growth was observed in fish fed with 0.5g/kg level of *Allium sativum* extract. Bello *et al,* (2012) recorded a similar increase in weight gain of *Clarias gariepinus* which were fed with diets supplemented with onions bulbs and walnut leaf residues. The recorded increase in fish weight across the experimental aquaria in the first week of this research could be ascribed to the fish acclimatization which makes them more active metabolically. Obasa and Faturoti, (2001) recorded a similar observation, which also involved increase in fish growth while subjecting them to delay in feed distribution during their research on *Heterotis niloticus* juveniles. An increase in the total length of fish observed across the treatment groups was slightly higher than the control. The reports of Dias *et al.* (2002) and Metwally (2009) corroborated with this submission as they recorded higher growth performance of Tilapia fish fed with *Allium sativum* supplemented diets. Heidarieh *et al.* (2013) reported a similar positive result while demonstrating a higher growth performance in rainbow trout fed with 2% *Aloe vera* feed supplement.

However, the observed increase in feed intake as the concentrations of *A. sativum* increases could be attributed to changes in the taste of the feed and stimulated appetite of the fish. This is in agreement with Darabighane *et al*. (2012) who opined that increased feed supplemented with 2% *Aleo vera,* increases the fish feed intake. A higher feed conversion ratio (FCR) in fish fed with *A. sativum* supplemented diets than the control, observed in this study is similar to the report of Bello *et al.* (2012) who supplemented fish feed with 1.5% walnut leaf. Abd-El-Rhman (2009) corroborated this result in his research on crude and ethanolic extract of propolis feed supplement on *Oreochromis niloticus* which recorded higher FCR than the control groups. Meanwhile,

Zomrawi *et al.* (2011) result showed no significant differences in FCR among all treatment groups in ginger supplemented feed.

Reduction in survival rate recorded at higher concentration of *A. sativum* might be as a result of the increased concentration of phytochemical inherent in these feeds. This observation agrees with the findings of Farah *et al*. (2012) who used *Mellisa officinalis* and *Aloe vera* as feed supplement. However, an improved SR (survival rate), weight gain, K (condition factor) and FCR (feed conversion ratio) was observed in treatment groups A (0.5g/kg) and B (1.0g/kg) compared with C (2.0g/kg), D (5g/kg) and control groups. The increase in weight of fish across the experimental aquaria is an indication of the positives growth resulting from diet supplementation. However, aquarium A (0.5g/kg) of *A. sativum* supplemented feed was adjudged the best in terms of weight gain and specific growth rate.

Rainza-paiva *et al*. (2000) opined that haematological parameters are routinely used for the evaluation of husbandry stressors and physiological environment of fishes. A lot of studies have been conducted especially in capture fisheries, examining the changes in the blood characteristics of *Clarias gariepinus* resulting from the stress due to pathogens, diseases or environmental pollutants (Gabriel *et al*, 2001). The haematological parameters of *C. gariepinus* fed with different levels of *A. sativum* extract shows a higher PVC on the experimental treatment aquaria than the control group. Fish fed 0.5g/kg level of *Allium sativum* extract was significantly different from the fish that were fed with the control diet and other treatment groups. Oyawoye and Ogunkunle (2009) reported haematological components as a valuable tool in feeds toxicity monitoring, particularly components of blood which could affect blood formation in culture fisheries. The observed 33% of PCV recorded in this study still falls within the acceptable 20 – 50% range as reported by Pietse *et al*. (1981). Packed cell volume and White blood cell (WBC) of *C. gariepinus* were significantly higher in 0.5g/kg *A. sativum* feed extract than other treatment groups and the control. The result agrees with the submission of Haghigi *et al*. (2014) on rainbow trout feed with ginger powder. A similar submission was also reported by Farah *et al*. (2012) who reported that the inclusion of *Aloe vera* and *M. officinalis* as supplement feed of Rain trout has significant enhancement on WBC and PCV. De Pedro *et al*. (2005) opined that differential and total leukocyte counts are indices that are important for fish non-specific defence activities.

This study's increase in lymphocytes and WBC in *A. sativum* feed supplement of *C. gariepinus* may be attributed to leucocytes production in the liver haematopoietic tissue. Schaperclaus *et al*. (2019) reported a similar lymphocytes and WBC increase in *Claria carpio* fed with *Aloe vera.* Circulatory system and microbial infection as reported by Oyawoye and Ogunkunle (2009) are usually associated with high WBC counts. Also Douglas and Jane (2010) describe lymphocytes and WBC as the body defence cells and its level in the blood has implication in immune responses and the animal's ability to combat infection. WBC counts increased significantly across all treatment groups. Ndong and Fall (2011) similarly reported a significant WBC increase in Tilapia hydrid juvenile fed with diet supplemented with 0.5% and 1% *Allium sativun*. Total WBC astronomical increase, particularly on 0.5g/kg *Allium sativum* treatment group suggested that the supplement at that concentration improves and stimulates the blood's immunological functions. This concentration invariably might help reduce the environmental stressors and increase the resistance of fish.

The result of RBC in this study is in agreement with the findings of Sotolu and Faturoti (2009) who worked on haematology and growth performance of *C. gariepinus* using *Leucaena laucocephala* as feed supplement. RBCs was observed to reduce as the level of *Allium sativum* in the feed increases, which could be as a result of higher tannin concentration as anti-metabolite. The significant increase in RBC counts across the treatment groups is similar to the findings of Lee *et* al. (1999). It also implies that haemoglobin levels in the blood increases significantly when compared to the control. Seeley *et al*. (1992) and Dias *et al*. (2002) reported a significant RBC increase in diets supplement feeds of fish and opined its enhances activity of non-specific defence system of fish.

5.0 CONCLUSIONS

It can be concluded that fish fed with 0.5g/kg *Allium sativum* supplement elicit a tremendous increase in fish weight gain, survival rate, percentage weight gain and haematological indices than those fed with 1.0g/kg, 2.0g/kg, 5.0g/kg and control. Therefore, *Allium sativum* inclusion as feed supplement in fish diet at the concentration of 0.5g/kg enhances the growth of *C. gariepinus* and it is thus beneficial for use in aquaculture.

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CONFLICTS OF INTEREST

The authors declare no conflict of interest.

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