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Growth Performance of the African catfish, Clarias gariepinus, Fed Varying Inclusion Levels of Allium sativum as Feed Additives

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ABSTRACT

Diet supplementation is an important aspect in aquaculture management especially in intensive or in semi-intensive fish culture. An experiment was conducted to evaluate the effect of Allium sativum on growth performance of African catfish, Clarias gariepinus fries. Four experimental diets were formulated to include Allium sativum powder at 0% (control), 0.5%, 1.0%, and 3.0% as additives. All the four treatment diets were fed to African catfish (Clarias gariepinus) fries over a 70-day period. The result showed a similar (P>0.05) growth responses across the groups. However, the best growth response in body weight gain of 1.44 ± 0.07g, Specific Growth Rate (SGR) of 0.52 ± 0.03g and Feed conversion Ratio (FCR) of 5.60 ± 0.38 was obtained in fish fed 3.0% Allium sativum inclusion level while the best condition factor (K) was observed in fish fed 0.5 % Allium sativum inclusion level. Fish fed 0.0% Allium sativum had the lowest growth response of body weight gain, Specific Growth Rate (SGR), Feed conversion Ratio (FCR) and condition factor of 0.84 ± 0.11g, 0.36 ± 0.03g, 5.77 ± 0.53 and 0.80 ± 0.03 respectively. Garlic inclusion in fish diet at 3.0% (30g/kg) concentration is therefore beneficial for use in aquaculture to enhance growth promotion however a further research is recommended to investigate toxicity of this plant at varying inclusion levels of 0.5% to 3.0% in the Clarias gariepinus culturing to ascertain the best inclusion level.

Keywords: African Catfish, Allium sativum, Feed Additive, Growth Performance, Inclusion Levels.

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Introduction

Fish culture has become an important industry and the world's fastest growing sector of agricultural business (Villa-Cruz *et al.* 2009). FAO, (2010) reported that the total world fishery production decreased slightly and the human consumption for aquatic product increased over the years. As observed by EL-Haroun *et al*. (2006), there is need to enhance growth performance, feed efficiency and disease resistance of cultured organisms as these are substantial for various sectors of aquaculture industries. Diet supplementation is an important aspect in aquaculture management especially in intensive or in semi-intensive fish culture, and is promising for increasing fish production. EL-Haroun, (2007) pointed out that diet is often the single largest operating cost item that represent over 50% of the operating costs in intensive aquaculture. Eyo, (2002) corroborated this by reporting that the major recurring cost is the cost of feed which is about 60 – 75% of the operating cost for every cycle of intensive culture of fish breeding in which the fish are fed artificial feeds.

Recent consumer demand for farmed fish has increasingly stressed quality and safety in the absence of concomitant pollutants, antibiotics and carcinogens. Traditional use of antibiotics and other chemotherapeutics in fish culture for growth promotion, prevention and control of diseases has been criticized because of the potential development of multiple antibiotic resistant bacteria, environmental pollution and the accumulation of residues in fish (Ringo *et al*., 2010). Recently the use of antibiotics as a growth promoter in diets of fish has been restricted by the government because of the harmful effects on human health (Botsoglu *et al*, 2001). World Health Organization encourages using of medicinal herbs and plants to substitute or minimize the use of chemicals through the global trend to go back to nature. Scientists have intensified efforts to identify and develop safe dietary supplements and additives that enhance the life activity, health and immune system of farmed fish (Ji *et al.* 2007a; Shim *et al.* 2009). Research interest is now focused on alternatives to antibiotics that may keep fish healthy such as probiotics and plant based immune stimulants (Sahu *et al.,* 2007). With the shifting of attention from synthetic drugs to natural plant products, the use of plant extracts for enhancing growth performance in animals is now in the increase. Cristea *et al.* (2012) pointed out that research on phytobiotic in aquaculture is a relatively new area but showing promoting results. Plants that were reported to have medicinal properties and those once considered of no value are now being investigated, evaluated and developed into drugs with little or no side effects. One of such plant is garlic (*Allium sativum*).

Garlic (*Allium sativum*), a member of the Liliaceae family, is a cultivated plant highly regarded throughout the world. Originally from Central Asia, garlic is one of the earliest of cultivated plants. The Ebers Codex, and Egyptian medical papyrus dating to about 1550 B.C.E. mentions garlic as an effective remedy for a variety of ailments. Early men of medicine such as Hippocrates, Pliny and Aristotle espoused a number of therapeutic uses for this botanical (Murray 2005). Today it is commonly used in many cultures as a seasoning or spice. Garlic has been reported to be effective in treating variety of ailments in animals including fish (Rees *et al.,* 1993; Corzo-Martnez *et al*., 2007). (Harris *et al*. (2001) also reported garlic to have antibacterial, antiviral, antifungal and antiprotozoal and also has beneficial effects on the cardiovascular and immune systems. Metwally, (2009) reported that inclusion of garlic in fish feeds increased growth performance of the fish. Despite the many garlic trials in different climes of the world, only a few trials have been carried out using garlic for growth promotion in aquaculture industries in Nigeria. Therefore, the objective of this study was to investigate the effects of varying dietary supplementation of Garlic (*Allium sativum*) additive on growth performance of African catfish, *C. gariepinus.*

Clarias gariepinus (Burchell, 1822) is the most important cultivated fish in Nigeria. This species has shown considerable potential as a fish suitable for use in intensive aquaculture. In spite of the remarkable aquaculture potential of *C. gariepinus*, the size obtained under culture is still poor compared to its hybrid and *Heterobranchus spp* (Dada & Ikuerowo, 2009). There is need to enhance the culture of this valuable species for sustainable aquaculture production and also to meet the demand of the ever-increasing population in the country.

MATERIALS AND METHODS

Experimental Fish

One hundred and forty-four fries of *Clarias gariepinus* were obtained from private fish farm in Olodo, Oyo State of Nigeria. The fish were acclimatized in 50 litres plastic bowls for two weeks. During the period of acclimatization, the fish were fed ad libitum (Anibeze and Eze, 2000) at 5% body weight twice daily (Okoye *et al*., 2001) with a formulated diet of 35% crude protein without herbal extract and no history of herbal feeding from the farm where fish were sourced. At the end of the acclimatization period, the fish were randomly selected and assigned to four experimental groups of 0% (controls), 0.5%, 1.0% and 3% concentrations of garlic powder in diet at 36 fish per treatment. Twelve plastic aquaria each measuring 40 cm x 27 cm x 27 cm with each aquarium holding 12 fish were set up to maintain three replicates per treatment. Feeding was suspended 24 hours before the feeding trial to increase appetite and reception for new diet (Madu & Akilo, 2001).

Experimental Diet

Fishmeal, maize, wheat bran, soya bean meal, calcium carbonate and limestone sourced from local market were used to formulate basal diets (35% CP) without herbal plants. All ingredients were ground into powdery form using a mechanical grinder, and then mixed with mineral mixture and vegetable oil. The ingredients and proximate chemical composition of basal feed was estimated by the methods described by the (AOAC, 2005). Four different diets with or without additives, representing four dietary variants (Table 1) were then prepared by incorporated garlic powder into basal diet at levels of 0.0%, 5.0%, 1.0% and 3.0%. The ingredients were then thoroughly mixed together by hand. Warm water was added to the premixed ingredients and homogenized to a dough-like paste. The diets were then pelletized using 0.5 mm pellet press. The diets were sun-dried for 4 days and labeled appropriately and stored in airtight containers throughout the experimental period.

Experimental Procedure

Feeding of fish

Fish in all the treatments were fed two times a day (morning 9.0 am and evening 4.0 pm) at the rate of 5% body weight per day. Feeding allowance was adjusted in accordance with increase in body weight (Hogendoorn & koops, 1983) and diet allotments were increased weekly after the length-weight determination. The feeding last for a period of 70 days. Feed not consumed and faecal matter were siphoned out every day. Dead fish were picked daily and recorded.

Monitoring of water quality

Water quality parameters were manage and maintain as recommended by Boyd and Lickotcoper (1990). Water quality parameters were taken weekly throughout period of the experiment. Water temperature (^{o} C), Dissolved Oxygen (DO), pH, Total Dissolved solids (TDS), Ammonia (NH_3) and Nitrite (NO_2) were measured using a portable Hanna^{R} H198186 meter and Aqua chek® (USA) water quality test stripes. The water in the tanks was drained and replaced every day.

Data collection

Fish in each tank were batch weighed at the commencement of the study and weekly thereafter with digital electronic weighing balance to the nearest gram. The ration was adjusted every week when new mean weights of fish for the various experimental units were determined. The standard length was determined with a graduated tape. Data on performance such as body weight changes, relative weight gain, specific growth rate, feed conversion ratio, condition factors (Bagenal,1978) and survival percentage (Fasakin *et al*., 2000) were determined using the following formulae:

(i) Weight gain (g) = Final weight of fish - Initial weight of fish (1)

(ii) Relative weight gain (RWG, %) =

$$\frac{\text{Weight gain}}{\text{Initial Weight}} \times 100 \quad (2)$$

(iii) Specific growth rate (SGR) was calculated as:

$$\text{SGR (\% per day)} = \frac{(\text{net Log } W_2 \text{ -net Log} W_1)}{T_2 - T_1} \times 100 \quad (3)$$

Where:

W_2 = Weight of fish at time T_2 (final)

W_1 = Weight of fish at time T_1 (initial)

(iv) Feed conversion ratio (FCR).

This was calculated from the relationship of feed intake and wet weight gain

$$\text{FCR} = \frac{\text{Total feed consumed by fish (g)}}{\text{Weight gain by fish (g)}} \quad (4)$$

(v) Survival Rate (SR) was calculated as:

$$\text{SR (\%)} = \frac{(No - N\,t)}{No} \times 100 \quad (5)$$

Where:

No = Number of fish at the start of the experiment

Nt = Number of fish at the end of the experiment

(vi) Condition factor (K) was calculated as:

$$K = \frac{W}{L^3} \times 100 \quad (6)$$

Where:

W = Weight of fish (g)

L = Standard length of fish (cm)

Data analysis

All data were subjected to analysis of variance (ANOVA) using Graph Pad Prism Software Version 5.1 Mean values of the water quality parameters and mean values of weight measurements were calculated. The results were presented as mean ± SE (standard error). All measurements were subjected to Analysis of variance (ANOVA) and Tukey Test was used to rank the means. All differences were regarded as significantly different at $P<0.05$ among treatment groups.

Table 1. Composition of experimental diet

Ingredients	Concentration of *A. sativum* in diet			
	0%	0.5%	1.0%	3.0%
Yellow corn (g)	35.0	35.0	35.0	35.0
Soybean meal (44%)(g)	28.5	28.5	28.5	28.5
Fish meal (65%)(g)	17.0	17.0	17.0	17.0
Wheat bran(g)	9.5	9.5	9.5	9.5
T.t Powder(g)	0.0	0.5	1.0	3.0
Calcium Carbonate(g)	0.3	0.3	0.3	0.3
Ground lime stone(g)	0.7	0.7	0.7	0.7
Vegetable Oil(ml)	6.5	6.5	6.5	6.5
Mineral mixture (g)	1.7	1.7	1. 7	1.7
Vitamin mixture(g)	1.0	1.0	1.0	1.0

A= Allium

Table 2:- Water quality fluctuations in experimental tanks containing the African catfish.

Treatment	0.0%	0.5%	1.0%	3.0%
Parameters				
Temp(^{0} C)	28.03±0.28[a]	28.00±0.30[a]	27.97±0.33[a]	28.00±0.30[a]
DO (mg/l)	6.42±0.06[a]	6.51±0.04[a]	6.45±0.02[a]	6.45±0.02[a]
pH	7.10±0.0[a]	7.10±0.0[a]	7.10±0.0[a]	7.07±0.03[a]
NH_3(mg/l)	0.0±0.0[a]	0.0±0.0[a]	0.0±0.0[a]	0.0±0.0[a]
NO_2(mg/l)	0.01±0.01[a]	0.01±01[a]	0.01±01[a]	0.02±0.01[a]
TDS (ppm)	70.67±5.46[a]	75.67±1.20[a]	72.67±0.67[a]	76.33±1.45[a]

Average of 10 weeks readings. Mean values with the same superscript letter in the same row are not significantly different ($p>0.05$). Control (0.0%).

Table 3: Growth performance of *Clarias gariepinus* fries fed different concentration of *Allium sativum* as feed additives

Parameters	0.0%	0.5%	1.0%	3.0%
MIBW[1] (g),	1.07 ± 0.24^a	1.08 ± 0.03^a	1.18 ± 0.03^a	1.09 ± 0.05^a
MFBW[2] (g)	$1.91 \pm .13^b$	2.38 ± 0.03^b	2.36 ± 0.21^b	2.53 ± 0.02^b
AWG[3] (g)	0.84 ± 0.11a	1.30 ± 0.03^a	1.18 ± 0.21^a	1.44 ± 0.07^a
RWG[4] (%)	78.9 ± 8.87^a	121.1 ± 3.03^a	$100.4.3 \pm 17.94^a$	133.0 ± 12.46^a
SGR[5]	0.36 ± 0.03^a	0.49 ± 0.43^a	0.43 ± 0.56^a	0.52 ± 0.03^a
FCR[6] (gg^{-1})	5.77 ± 0.53^a	5.71 ± 0.43^a	6.32 ± 1.01^a	5.60 ± 0.38^a
SR[7] (%)	75.00 ± 4.81^a	88.89 ± 7.35^a	91.67 ± 4.81^a	94.45 ± 2.78^a
CF[8] (K)	0.80 ± 0.03^a	1.11 ± 0.06^a	0.97 ± 0.11^a	0.91 ± 0.03^a

Data are represented as mean of three samples replicates ± standard error. Mean values with the same superscript letter in the same row are not significantly different. ($p>0.05$). [1]Mean Initial body weight, [2] Mean Final Body Weight, [3]Average Weight Gain, [4]Relative Weight Gain, [5]Specific Growth Rate, [6]Feed Conversion Rate, [7]Survival Rate, [8]Condition Factor

RESULTS AND DISCUSSION

Water quality measurements

The water quality parameters monitored in plastic aquaria tanks under laboratory conditions, as indicated in Table 2 were fairly stable in all the treatments. Water quality parameters were not significantly different ($P>0.05$) between treatments and were within the recommended ranges for the culture of *C. gariepinus* (Viveen *et al*., 1986).

Growth performance

The need to understand the roles of phyto-additives in aquaculture has led to various investigation of different herbal plants in aquaculture feed. To date a variety of herbs and spices have been successfully used in fish culture as growth promoters and immune stimulants (Irkin *et al*., 2014). When medicinal plants are used in fish diets, one of the common problems encountered is the acceptability of the feed by fish, and this frequently relates to the palatability of the diet (Rodriguez *et al*., 1996). In this present investigation, the experimental diet variants were accepted by *Clarias gariepinus* fries, indicating that the levels of incorporation of garlic used did not affect the palatability of the diets. This might be attributed to the processing technique which involved oven-dried of the garlic raw bulbs at 70ºC until a constant weight was obtained, this might have reduced the anti-nutrient factors that may be present in this plant thereby not affecting the palatability of the diets. This observation corroborates the works of Fagbenro (1999), Francis *et al*. (2001) and Siddhuraju & Becker (2003). These workers reported that reduction in anti-nutrient by different processing like soaking and drying techniques resulted in better palatability and eventually growth in fish. Medicinal plants have received increasing attention as spices for human and additives in diets for animals. However, only few studies have been done on the use of feed additives in fish nutrition (El-Bahr & Saad, 2008; Lawhavinit *et al*., 2011) and more so medicinal plants as feed additives in rearing of African catfish in this part of the world.

Growth performance of the *Clarias gariepinus* fries fed locally made feed containing varying quantities of garlic powder as feed additives over a 70 days period is presented in Table 3. Average of initial body weight of *C. gariepinus* fed the experimental diets at the start did not differ (p>0.05), indicating that groups were homogenous. Fish were able to utilize the test diets at varying degrees but average weight gain (AWG), Feed Conversion Ratio (FCR), Specific Growth Rate (SGR), Survival Rate (SR), Condition Factor (K) of fish were only marginally different (P>0.05). However, the mean final body weight (MFBW), was significantly (P<0.05) higher than the initial fish weight in all diet treatment groups (Table 3). The mean weight gain of the experimental fish ranged from 0.84 ± 0.11g was observed in group of fish fed with diet containing no herbal additive to 1.44 ± 0.07g observed in group of fish fed with 30 g of *Allium sativum*, Specific growth rates range from 0.36 ± 0.03g in control group to 0.52 ± 0.03g in group of fish fed with 30 g/kg of *Allium sativum* as feed additive were observed. The best feed conversion ratio of 5.60 ± 0.38 and best survival rate of 94.45 ± 2.78% were equally observed in group of fish fed with 30 g/kg of *Allium sativum* as feed additive. However, the best condition factor of 1.11 ± 0.06 was observed in group of fish fed with 5g/kg of *Allium sativum* compared with other groups with lowest value of 0.80 ± 0.03 observed in the control group. Although no significant difference was observed in the result on growth performance, there was generally increase in growth with increasing level of garlic in the experimental diets compared with the control. This result therefore shows that garlic as feed additive enhances nutrient utilization as it was reflected in improved Specific growth rate (SGR), feed conversion ratio (FCR) and condition factor (K) observed in the treated groupsin this experiment. The present results are in agreement with those obtained by Sahu *et al.* (2007) who reported that SGR and FCR in fish (Labeo rohita) fed with 0.5, 1% garlic powder/kg diet was not significantly different as compared with those of the control. The result equally in agreement with the work of Agatha (2012) who reported non-significant difference in weight gain but a significant difference in final weight compared with initial weight of African Catfish fingerlings fed different inclusion rates (0.5%, 1%, and 3%) of garlic. Also, the result of the work agreed with report of Aly *et al*. (2008) who examined the growth rates of Nile tilapia after feeding with garlic (10 and 20 g kg^{-1} diet fed), and found statistically non-significant increases after 1 or 2 months but Metwally (2009) reported the best growth performance of *O*. *niloticus* when fed with diet containing 32 g /kg diet of garlic powder. However, Aly *et al.* (2008) reported a significant increase in Nile Tilapia after eight months feeding, indicating that high doses or a long period was needed to enhance the growth rate. In contradiction to our findings, Ndong and Fall (2007) reported that garlic supplemented diet resulted in decreased body weight gain in juvenile hybrid tilapia (*Oreochromis niloticus* x *Oreochromis aureus*) fed diets supplemented with 0.5g/kg garlic over 4 weeks. This observation could be as a result of difference in the species of the experimental animals. The slow weight gains recorded in this experiment might be attributed also to the fact that fish were fed exclusively on the formulated feeds without having access to natural feed as may be found in pond or riverine conditions. The African catfish is omnivorous and feeds from a wide array of organisms under natural conditions.

Conclusion and Recommendation

This study has shown that 3.0% (30g/kg) garlic supplement in fish feeds elicited more increase in fish weight gain therefore garlic inclusion in fish diet at 3.0% (30g/kg concentration is therefore beneficial for use in aquaculture to enhance growth promotion in *C. gariepinus* fries. However, there is need to carry out experiment to investigate toxicity of this plant in *C. gariepinus* intensive culturing with respect to 0.5% to 3.0% inclusion levels.

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