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Research Article

Study of dietary garlic induced effects on behaviour responses, growth performance and feed utilization in *Clarias batrachus* (Linnaeus, 1758)

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Abstract

The aim of this study was to assess the effect of garlic (*Allium sativum*) on behaviour, growth performance and feed utilization in *Clarias batrachus* for period of 21 days. The frequency of feeding, aggression was observed to increase in experimental group when compared with control. The duration of feeding, swimming, aggression, rest, and surface visit was noticed to be increased experimental group when compared with control. The results showed significant increase in Total Weight gain, Total Length gain, Body Weight Index, Specific Growth Rate, Relative Growth Rate, Average Health Condition, Average Feed Intake, Feed Efficiency Ratio and Average Survival Rate than control fishes. The performance of fish was increase with increase in duration. The obtained results cleared that garlic (*Allium sativum*) is a growth promoter that enhance the growth, increase feed utilization and supports the survival of *Clarias batrachus* so it should be added to the diets of fish.

INTRODUCTION

Feed and feeding are among the most important factors influencing growth, feed utilization and tissue composition of the fish in intensive culture (Okumus and Mazlum, 2002). Garlic is an important vegetable extensively cultivated in many countries. It is used as food for humans as well as some animals and as remedy for several diseases, as reported in folk medicine (Shalaby *et al.,* 2006). It is probably one of the earliest known medicinal plants. In recent years, the concern about bacterial resistance to antibiotics in livestock industry has led to legislation minimizing the use of such compounds. Garlic contains sulfur containing compounds. Alliin is converted to the antimicrobial active allicin, when the bulb is cut or bruised. The fresh bulb contains Alliin, Allicin and volatile oils. Allicin gives garlic its characteristic pungent smell. Also, it contains vitamins and minerals and trace elements like selenium and germanium. Allicin is the most abundant compound representing about 70% of all thiosulfinates present or formed in crushed garlic (Skidmore-Roth, 2003). Using of garlic in fish farming has become popular for as a growth promoter (Diab *et al.,* 2002) also it increased body gain, feed intake and feed efficiency ratio (Metwally, 2009).

The present work was carried out to study the effect of dietary garlic on behaviour responses, growth performance and feed utilization in *Clarias batrachus.*

MATERIALS AND METHODS

The present study is the evaluation of behavior responses, growth performance and feed utilization of *Clarias batrachus* fed on garlic based diet. For the presented experiment, the following protocol suggested by Joshi (2017) was adopted

Experimental fish: The fishes measuring about 20±0.5 cm length and weighing ranges from 50±05g in weight were selected for the experimental study. Fishes were transferred to the place of experiment and acclimated for a week. During the acclimation, fish were fed the experimental diet to satiation twice a day at 09:00 and 15:00 hours. After acclimation, fish were fasted for one day; batch weighted and randomly distributed among density of 10 fish per tank. During experiment, the water quality, aeration and light: dark cycle of 12:12 h was maintained (Joshi *et al.*, 2015).

Experimental diet and feeding regime: The basal experimental diets were formulated with the commonly available ingredients. The formula and analyzed proximate composition of the basal diet are shown in Table 1. The ingredients were dried, grinded, milled, weighed, mixed and pelleted. After pelleting, the feeds were air dried and put in an air-tight container. During the experiment, fish were fed the experimental diet to satiation third a day at 08:00, 12:00 and 16:00 hours.

Behavioural Responses: The behavioral changes were observed in control and exposed fish. The behavior of fishes were recorded in the period between 09:00 till 15:00 h for initial 21 days by using focal sample technique for 15 sec. with intervals during one hour daily. The observations were recorded according to Altmann (1974). It was made visually by using a note book for recording behavior and a digital stop watch. the frequency and duration of feeding, swimming, aggression, rest, arousal and surface visit were recorded according to Stephan (2008).

Growth Performance and Feed Utilization: The evaluation of growth performances of control and experimental fishes was carried out by the intervals of 7, 14 and 21 days. Records were analyzed by using the formulae suggested by Altorre-Jacome *et al.*, (2012) with some modification.

Table 1: Formulation of experimental fish diets with different concentration of garlic powder (g/100g diet).

Sr.	Ingredients (g dry wt.)	Control	Experimental
1	Wheat flour	45	40
2	Soybean flour	25	25
3	Corn flour	10	10
4	Meat powder	15	15
5	Soybean oil	05	05
6	Garlic Powder	-	05

a) Total Weight Increase = Final weight – Initial weight

b) Total Length Increase (TLI) = Final length – Initial length

c) Specific growth rate (SGR) = $\frac{\text{ln Final weight} - \text{ln Initial weight}}{\text{Time}} \times 100$

d) Relative Growth Rate (RGR)= $\frac{\text{Weight gain (g)}}{\text{Time (Days)}}$

e) Body Weight Index (BWI)= $\frac{\text{Weight (g)}}{\text{Length (cm)}}$

f) Average Health Condition (AHC)= BWI ×100

g) Feed Intake (FI)=$\frac{\text{Total feed intake per fish (g)}}{\text{Number of days}}$

h) Feed Conversion Ratio (FCR)=$\frac{\text{Total dry feed given (g)}}{\text{Total weight gained (g)}}$

i) Feed Efficiency Ratio (FER)= $\frac{\text{Total weight gained (g)}}{\text{Total dry feed given (g)}} \times 100$

j) Average Survival Rate (ASR)= $\frac{\text{No.of experimental fish survive at end}}{\text{No.of experimental fish at the start}} \times 100$

Statistical Analysis: Data were collected, organized and analyzed using one-way analysis of variance (ANOVA) through the general linear models (GLM) procedure of the Statistical Package for Social Sciences version 21.0 (SPSS for Windows 21.0, Inc., Chicago, IL, USA). The comparison of means was carried out with Duncan's multiple range tests (DMRT). Results were recorded as mean ± standard deviation (SD) of triplicate. The value of $P<0.05$ was used to indicate statistical significance.

RESULTS AND DISCUSSION

The effect of dietary garlic on behaviour responses, growth performance and feed utilization and proximate body composition of fresh water fish *Clarias batrachus* were studied.

The observed results related to the effects of dietary garlic on behavioral responses of *Clarias batrachus* for seven days are summarized below (Table 2). In the presented study, frequency and duration of feeding, aggression was observed to increase in experimental group when compared with control. The frequency and duration of Feeding, swimming, aggression and surface visit was noticed to be increase in fish fed on garlic based diet. The frequency and duration of arousal, rest decrease in experimental group when compared with controlled group

Table 2: The effects of dietary garlic on behavioural responses of *Clarias batrachus;* Means within the same row for frequency and duration independently carrying different superscripts are significant different at *P<0.05* based on Duncan's Multiple Range Test (DMRT).

Sr. No.	Behavioural Pattern	Frequency		Duration (S.)	
		Control	Experimental	Control	Experimental
1	Feeding	3.05+0.14[a]	4.76+0.23[b]	76.01+3.07[a]	82.30+2.84[b]
2	Swimming	1.38+0.15[b]	2.86+0.40[a]	27.28+1.86[a]	28.34+3.33[a]
3	Aggression	0.84+0.10[a]	3.04+0.26[b]	04.23+0.94[a]	05.08+1.99[b]
4	Surface Visit	1.70+0.13[b]	2.83+0.10[a]	98.06+4.19[a]	102.5+3.87[b]
5	Rest	0.46+0.19[b]	0.25+0.05[a]	14.87+3.19[a]	11.37+3.53[b]
6	Arousal	1.00+0.00[a]	0.97+0.01[a]	108.8+3.17[b]	105.6+3.52[a]

The noted results related to the effects of dietary garlic on growth performance of *Clarias batrachus* for 7, 14 and 21 days are summarized below (Table 3). In the present study, the experimental fish group had highest total weight increase, total length increase, body weight index, specific growth rate, relative growth rate, average health condition, average feed intake, feed efficiency ratio and average survival rate than control fishes. The performance of fish was increase with increase in duration. The feed conversion ratio showed the contradictory pattern.

The effect of dietary garlic on behaviour responses, growth performance, feed utilization and proximate body composition of fresh water fish *Clarias batrachus* were studied in the present experiment.

The behavioral patterns of species were observed to be influenced by dietary garlic. As in case of feeding frequency and duration in which there was a significant increase in group in which fish fed high garlic in diet. It may be attributed to that increase the nutrient rich diet increase the feed intake fish and growth rate which correlated with increase oxidative metabolism and protein synthesis. This result could be supported by Borge *et al.* (2006) who reported that high numbers of factors including feeding affect fish welfare for maintaining homeostasis and normal development and protected against physical damages.

Table 3: The effects of dietary garlic on growth performance and feed utilization in *Clarias batrachus* at different intervals of time*;* Means within the same row for independent intervals of time carrying different superscripts are significant different at *P<0.05* based on Duncan's Multiple Range Test (DMRT).

Sr. No.	Growth Parameter	7 days		14 days		21 days	
		Con.	Exp.	Con.	Exp.	Con.	Exp.
1	Total Weight Increase (TWI)	2.513[a] ±0.131	5.697[c] ±0.345	5.847[a] ±0.056	12.61[c] ±0.465	8.721[a] ±0.450	18.70[c] ±0.533
2	Total Length Increase (TLI)	1.515[a] ±0.031	2.254[b] ±0.064	2.964[a] ±0.065	4.775[c] ±0.042	4.184[a] ±0.056	5.965[b] ±0.015
3	Body Weight Index (BWI)	1.667[a] ±0.070	2.591[c] ±0.086	2.034[a] ±0.021	2.681[b] ±0.054	2.122[a] ±0.063	3.169[b] ±0.012
4	Specific Growth Rate (SGR)	0.298[a] ±0.005	0.629[c] ±0.004	0.327[a] ±0.006	0.692[c] ±0.008	0.342[a] ±0.002	0.771[c] ±0.002
5	Relative Growth Rate (RGR)	0.357[a] ±0.002	0.657[c] ±0.005	0.421[a] ±0.004	0.798[c] ±0.003	0.434[a] ±0.001	0.838[c] ±0.007
6	Average Health Condition (AHC)	166.7[a] ±1.456	259.1[b] ±1.764	203.4[a] ±2.348	268.1[b] ±1.890	212.2[a] ±1.947	316.9[b] 2.931
7	Average Feed Intake (AFI)	1.976[a] ±0.053	2.285[b] ±0.035	2.143[a] ±0.054	2.503[b] ±0.042	2.286[a] ±0.041	2.714[b] ±0.014
8	Feed Conversion Ratio (FCR)	5.601[b] ±0.231	3.048[a] ±0.153	5.085[c] ±0.217	2.803[a] ±0.147	5.017[b] ±0.193	2.778[a] ±0.127
9	Feed Efficiency Ratio (FER)	0.357[a] ±0.001	0.814[c] ±0.004	0.407[a] ±0.003	0.890[c] ±0.002	0.414[b] ±0.001	0.913[c] ±0.007
10	Average Survival Rate (ASR)	100.0	100.0	90.00	100.0	80.00	100.0

The swimming frequency and duration showed significant increase in experimental group. This result was in harmony with that mentioned by Brannas *et al.* (2003) who illustrated that, food deprivation and deficiency in the diet leads to changes in metabolic activity and changes in territorial behavior strategies and activity pattern especially swimming. The aggressive frequency and duration showed significant increase in moderate group. It may be due to decrease dietary protein levels which enhance the aggressive behavior. This result was in agreement with that of Höglund *et al.* (2005) who illustrated that increase nutrient levels has been shown to suppress aggressive activity.

The rest and arousal behavior and duration have a significant increase in control group. These results agreed with Khalil *et al* (2016) who suggested that the availability of nutrient rich food increase the activity, arousal and decrease the rest duration of fish. The fish coming to the surface of aquaria behavior showed a significant increase in moderate group. This may be due to that the nutrients deficiency in diet acts as a stress factor in which fish become aggressive and try to visit the surface to get more food in order to be more growth rate and development as suggested by Bhalerao (2017).

The behavioral changes are physiological responses shown by the animal, which are often used as the sensitive measure of stress syndrome in the organism experiencing it. The observation clears the suitability of dietary garlic for selected fish. These findings are in well agreement with the observations and Hassan and Soltan (2016).

In the present study indicated that the fish group fed on dietary garlic had highest total weight increase, total length increase, body weight index, specific growth rate, relative growth rate, average health condition, average feed intake, feed efficiency ratio and average survival rate than control fishes. The performance of fish was increase with increase in duration. The feed conversion ratio showed the contradictory pattern. The garlic is one of the main vegetable with high pharmacological potential and successfully utilized as a growth promoter in Nile tilapia (Diab *et al.*, 2008; Nya and Austin, 2009; Amin *et al.*, 2010; Ajiboye *et al.*, 2016).

The growth rates for these previous studies were significantly higher in fish fed diets supplemented with garlic than control groups. Garlic contains allicin, which promotes biogenic performance due to its positive effect on the intestinal flora, thereby improving digestion and enhancing nutrients utilization which influences the growth of fish (Khalil *et al.,* 2001). Steam distillation of mashed garlic produces garlic oil containing methyl and allyl-sulphides of allicin and having the practical advantage of being more stable than allicin itself (Fazllolahzadeh *et al.,* 2011). Abdel-Tawwab *et al.,* (2010) suggested that the herbal medicinal plants has much higher contents of active substance that help the fish to grow faster by increased feed utilization. The present view also support the findings of Khattab *et al* (2004), Shalaby *et al* (2006), Aly *et al.* (2008), Abdel-Hakim *et al.* (2010); Joshi *et al.,* (2015); Joshi and Gulhane (2015); Labrador *et al.* (2016); Joshi (2017); Joshi and Gulhane (2017) and name a few.

The obtained results cleared that garlic (*Allium sativum*) is a growth promoter that enhance the growth, increase feed utilization and supports the survival of *Clarias batrachus* so garlic should be added to the diets of fish.

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