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Effect of garlic and onion incorporated feed on the growth and nutritional status on the fresh water fish *Tilapia, Oreochromis mossambicus* (Peters, 1852).

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Abstract

This present study was conducted to show the growth improvement and nutritional status of fresh water fish, *Oreochromis mossambicus* when fed with garlic and onion integrated with coconut oil cake and wheat flour. Fish were fed on diet containing garlic and onion in different concentration (5%, 10%) during different days (15, 30, 45, and 60) of the experiment. The overall influence of these feeds on growth and concentrations of biochemical constituents (protein, carbohydrate and fat) of *Oreochromis mossambicus* were found to be higher in the fishes fed with garlic (10%) followed by the onion supplemented diet and control after 60 days. From the results it can be concluded that garlic containing diet stimulates the growth and also increased the nutritional status of *Oreochromis mossambicus* than with onion incorporated diet and control diet.

Keywords: Garlic (*Allium sativum*), onion (*Allium cepa*), Tilapia (*Oreochromis mossambicus*), morphometry (weight and length), Biochemical Constituents.

1. Introduction

Aquaculture is an important source of human food and like all other agricultural and animal farming activities its productivity also totally depends on the provision and supply of nutrient inputs [1]. However, we need fish farming to meet increasing demands of food and nutrition values need for growing population which seafood best provides. It thus becomes increasingly important source of fish available for human consumption. As a result, it has become an important resource for human worldwide and in addition; it is one of the cheapest sources of animal protein which is easily digestible [24].

Fish food consists of natural food and artificial (supplementary) feeds. When fish have balanced diet to eat, they grow fast and stay healthy. Supplementary feeds that are acceptable to fish are rice bran, cassava leaves, oil seed cakes, coconut oil cake, wheat flour or other agricultural products and by products.

Aqua feeds accounts for about 40 to 60% of the total cost of aquaculture operations. It is therefore necessary to look for non-traditional low cost feed stuffs to decrease the overall cost of fish production. The use of alternate feed resources for the development of aqua feed has therefore gained significance as the traditional ingredients are either becoming costly or less available [13].

To maximize the growth of fish in normal condition, several researches have been carried out. One such study carried out by using garlic (*Allium sativum*) on the *Aeromonas hydrophila* infected Nile Tilapia (*Oreochromis niloticus*) conveyed the anti-bacterial activity of garlic on the infected fishes [19]. Phyto-additives are obtained from medicinal plants or plants extract and are being used on a wide range, by humans as well as by animals, including fish. Recent studies tried to show the effects of phytoadditives usage in all farmed animals. The main advantages of using this phytoadditives are natural substances that do not pose any threat to fish health, human health or to the environment.

The world trends to improve food security and to use natural products which will drive the chemically synthesized antibiotics and growth promoters out of use. The search for new alternative feed the attention was focused on natural solutions like medicinal plants. Garlic (*Allium sativum*) is probably one of the earliest known medicinal plants.

Garlic has been used as both food and medicine and it is found to have antibacterial, antiviral, antifungal activity [23], antioxidant [22], potent cardiovascular benefits [18] and significant hepto

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protective role in detoxification [14]. Garlic also contains sulfur containing compounds: Allicin (responsible for the distinctive odor) diallyl-disulfide, diallyl-trisulfide [5], and also vitamin A, C and F.

Onion (*Allium cepa*) contains many organic di-sulfides [20]. *Allium cepa* also has potential anti-inflammatory, anti-cholesterol, antioxidant and anti-cancer properties. Garlic and onion has several beneficial actions including antihypertensive, antithrombotic, antibiotic and anti-carcinogenic effects [27]. It also contains small quantities of sugar, fats, vitamin, C and B complex, high content of Mg, K and Cu. Simultaneously, it has been considered a digestive material and used to improve the appetite. Growth improvements in aquaculture have led to the use of synthetic antibiotics. The demand for animal protein for human consumption is currently on the rise and is largely supplied from terrestrial farm animals. Today's world population is estimated to be about 6.5 million, but is predicted to reach 9 billion by 2050 (United Nations, 2006). To feed this mass of people, society must develop creative methods to provide a sufficient amount of fish seed, guard against disease outbreak and wastage [16].

In view of the recently increased interest in using garlic and onion as an alternative to supplementary feed, this study was focused on the comparative effectiveness of garlic (*Allium sativum*) and onion (*Allium cepa*) to increase the growth and nutritional status of edible fish *Oreochromis mossambicus*.

2. Materials and methods

2.1. Experimental Animal

Freshwater fish, *Oreochromis mossambicus* were collected from the Palakkad district [10.7700°N 76.6500°E], Kerala, India. The fishes were kept in large aquarium tanks and acclimatized to laboratory conditions for two weeks prior to the beginning of the experiment. During this period they were fed with control feed (wheat flour and coconut oil cake). The tanks were cleaned periodically and water was infused at regular intervals to ensure sufficient oxygen supply to fish.

2.2. Experimental feed and feed formulation

Fish feeds were prepared by adding proportions of wheat flour, coconut oil cake, vitamin and mineral mixture. The ingredients of each diet were mixed thoroughly and ground into fine powder. These substances were mixed with hot water and made into dough and boiled for 30 minutes. Then the boiled feed was taken outside and cooled. Finally multivitamin mineral tablet were added and made into noodles. The moist noodles were dried for 2-3 days in the sun and were broken into pieces of 0.5 cm in length. Four different diets and with control were prepared for the present investigation.

1. Control - Wheat Flour and coconut oil cake 100% (control)
2. T1 - Wheat flour (47.5%), coconut oil cake (47.5%) and Garlic Powder (5%).
3. T2 - Wheat flour (45%), coconut oil cake (45%) and Garlic Powder (10%).
4. T3 - Wheat flour (47.5%), coconut oil cake (47.5%) and Onion Powder (5%).
5. T4 - Wheat flour (45%), coconut oil cake (45%) and Onion Powder (10%).

2.3. Experimental Design

The experiment was carried out in four treatments in three replicates and a control. In each trough six individuals was

introduced. Prior to stocking, the initial weights of all the fishes were noted and biochemical compositions were also analyzed in the fish *Oreochromis mossambicus*. The water level in each trough was maintained throughout the experimental period.

During this time, experimentally prepared garlic and onion added feed was given to the fishes. Before feeding biochemical composition such as protein, carbohydrate and fat were calculated in prepared fish feeds (Table 1).

Every fifteen days, growth performance were analyzed in terms of length and weight (%) and Biochemical composition such as Moisture, Protein, Carbohydrate and Fat were calculated in the muscle tissues of the fishes grown in control and four different treatments before and after the experiments. The medium was changed daily in order to remove the faecal and unconsumed wastes.

2.4. Morphometric Measurements

Growth performance of fish was determined in terms of initial and final individual fish weight (g) and length (cm).

Growth rate were calculated by adopting these formulae.

$$\text{Percentage weight gain} = \frac{\text{Final weight} - \text{Initial weight}}{\text{Initial weight}} \times 100$$

$$\text{Percentage length gain} = \frac{\text{Final length} - \text{Initial length}}{\text{Initial length}} \times 100$$

2.5. Biochemical Analysis

For biochemical analysis, muscle tissues were taken, moisture, Protein, Carbohydrate and Fat were analyzed.

After initial growth measurement, the protein was estimated by adopting the method of Lowery *et al.*, 1957, carbohydrate by Hedge and Hofreiter, 1962 and fat using Folch *et al.*, 1957 in the muscle tissue of sample in four different treatments.

Results were subjected to two way ANOVA ($P < 0.05$) of variance to evaluate the mean differences among individual diet treatments and fish *Tilapia* (*Oreochromis mossambicus*) composition at 0.05 level of significance.

3. Results and Discussion

3.1. Morphometric Measurements (Growth performances)

Growth performances of fish during different days of the experiment in the control and four different treatments were presented in Table 2. Fish groups (T2) fed with garlic at 10% concentration had higher body weight and length gain (8.02 to 35.68) and (7.93 to 42.22) was observed, followed by T3 (4.90 to 32.04) and (7.27 to 16.63), (4.43 to 30.88) and T4 (4.73 to 17.66), T1 (3.80 to 31.87). The final weight and length was found to be increased in all treated groups respectively. The minimum weight and length gain was recorded in control as 1.67 to 31.40 and 2.53 to 15.25.

During the experimental period (15, 30, 45, 60 days), two different treatments and the control showed the maximum weight and length gain in T2 fishes fed with wheat flour and coconut oil cake (90%) and garlic powder (10%). The growth indices showed significant differences from those produced by the diet.

The results of the present investigation suggests that the increasing growth may be due to garlic having a variety of organosulfur compounds such as allicin, ajoene, S-allylcysteine, diallyldisulfide, and S-methylcysteine sulfoxide. These results were in close congruence with the earlier studies [8].

The garlic contains allicin, which promotes the performance

of the intestinal flora, thereby improving digestion and enhancing the utilization of energy, leading to improved growth^[17].

The present investigation showed the highest growth performance in fish fed on garlic containing diets. The highest growth performance in *Oreochromis niloticus* with 2.5% garlic/Kg diet was also reported^[9] which support the present study in *Oreochromis mossambicus*.

The growth performance in the fishes fed with garlic incorporated feed showed little growth than the *Oreochromis mossambicus* fed with onion incorporated diet, may be due to onion containing growth stimulants or constituents (flavonoids and thiosulfates) as reported^[19] whose studies also showed highest growth performance with the combination of onion with 30g garlic/ Kg. These properties could contribute to improving the digestion and nutrient absorption with a subsequent increase in the fish- weight. The presence of vitamin such as vitamin 'C' in onion bulb was hypothetical possibility of the growth factor or antioxidant property that enhance growth performance.

At the end of the experimental period a significant increase had been observed in growth performances fed with garlic and onion incorporated feed and also a significant decrease of the mortality rates may be due to its antioxidant properties. This observation was supported^[22] who studied the effect of garlic on some antioxidant activities in Nile Tilapia.

3.2. Biochemical constituents

Table 3 represents the biochemical constituents in the selected fish with formulated feeds. Also the moisture content in the muscle tissue of *Oreochromis mossambicus* in the four different treatments were estimated. The maximum value of (74.07%) was observed in T2 during experimental period followed by T1 (72.27%) and T3 (71.60%) and minimum value was observed in the control treatment (64.00%)

Moisture content increased the body weight. The increased moisture content was due to the presence of 10% concentration protein content in the body of fish was significantly increased in T2 (19.57%) groups fed on diet containing garlic at 10% concentration during different days of the experiment followed by T1 (18.77 %), T4(18.20 %) and T3(17.80). The minimum protein content (17.30%) was recorded in the control group.

Generally carbohydrates was found to be higher ($P < 0.05$) in T2 (13.20%) fishes fed with garlic at 10% concentration followed by T1 (12.40%), T4 (11.20%) and T3 (10.87%). The minimum value (10.10%) was observed in the control fishes.

The fat content was also maximum (2.50%) in T2 fed fishes followed by T1 (2.10%), T3 (1.70%) and T4 (1.60%). The minimum value (1.70%) was recorded in control fed fishes

Fish and animals need a constant source of amino acids for tissue protein synthesis and for synthesis of other compounds associated with metabolism and also maintenance of normal body function and growth. Therefore, protein constitutes the important ingredients in feeds. In this study, the results showed that the increased protein content may be due to the

presence of organosulfur compounds.

The higher body protein deposition and increased weight gain is an indicative of the adequacy of the protein content and higher protein intake. The sulfur containing compounds in garlic are considered as active antimicrobial agents and therefore stimulate growth and improve nutrient utilization^[10].

In the case of *Oreochromis niloticus* 50% fish meal and 50% soyabean meal using garlic and onion as feed additives improves their growth better than other groups (different concentration) due to its protein. Lysine is a limiting amino acid for growth and its role as necessary building blocks for all protein in the body and also plays a major role in calcium absorption and building muscle protein^[28].

In the present study, the formulated feeds contained (30-38%) protein (Table.1) and fishes efficiently utilized total protein available in formulated feeds. The onion and garlic dietary administration for *Clarias lazera* caused a rise in liver free amino acids, meanwhile, the garlic fed fish presented a rise in muscle free amino acid levels and according enhance muscle uptake of free amino acids may enhance protein synthesis^[26].

Carbohydrates are utilized by the cells mainly in the form of glucose. A major part of dietary glucose is converted in to glycogen for storage. These results suggest that garlic enhanced the process of glycogenesis in white muscle of fish. Such finding may be due to the rise in white muscle uptake of glucose in *Clarias lazera* fed onion or garlic juice. These digest probably increased insulin release. This concept is in agreement with the elevation in insulin level in garlic fed rate as reported by^[7]. Therefore, in this study, it is suggested that the carbohydrate enhanced the uptake of protein in formulated feeds towards growth.

Lipids provide a source of indispensable nutrients as they are important in maintaining structural and physiological integrity of cellular membranes. It also serve as an alternative source of energy and act as carriers of certain fat nutrients notably that fat soluble vitamins like A, D, E and K^[7]. The higher lipid content was observed in the muscles of fish fed with garlic incorporated feed (10%). The fish fed on garlic diet showed significantly ($P < 0.05$) higher lipid contents in their muscle as compared to fish fed with all other diets (Table.1).

The garlic increased the level of total lipids in the liver, 5 hours and 5 days (Repeated doses) after treatment, inspite of unchanged levels of triglycerides and cholesterol or in the liver total lipids and triglycerides in the serum. Such results may be due to an increased accumulation of free fatty acids in liver in *Clarias lazera* treated with garlic daily for 5 days^[25].

Table 1: Biochemical Constituents (%) in the Feeds

Feed	Protein (%)	Carbohydrate (%)	Fat (%)
Control	30	4	8
T1	37	10	15
T2	38	12	17
T3	34	8	14
T4	32	6	13

Table 2: Morphometry of *Oreochromis mossambicus* during treatment

Treatments	No of Days During Experiment							
	15		30		45		60	
	W(gm)	L(cm)	W(gm)	L(cm)	W(gm)	L(cm)	W(gm)	L(cm)
Control	1.67±0.25	2.53±0.21	9.07±1.10	9.00±0.95	20.0±1.47	11.47±1.20	31.40±0.96	15.25±1.36
T1	3.80±1.12	10.11±2.67	13.83±1.88	17.10±2.50	23.70±3.23	29.14±2.16	31.87±2.89	37.13±0.02
T2	8.02±0.59	7.93±0.76	16.28±0.39	17.58±0.75	25.73±2.57	25.68±1.97	35.68±0.93	42.22±1.36
T3	4.90±1.30	7.27±1.32	15.87±2.06	13.73±1.25	16.30±2.52	14.40±3.45	32.04±2.12	16.63±1.42
T4	4.43±2.04	4.73±0.86	15.35±1.09	14.39±0.98	23.13±1.54	15.25±1.02	30.88±1.43	17.66±1.84

Values are mean ± SD of three samples in each group

Table 3: Biochemical Constituents in the Muscle Tissue of *Oreochromis mossambicus*

Treatments	No of Days During Experiment				
		15	30	45	60
Control	Moisture (%)	60.00±2.00	61.20±2.00	62.30±2.00	64.00±2.00
	Protein(mg/g)	16.27±2.00	16.90±0.20	17.20±1.65	17.30±1.80
	Carbohydrate(mg/g)	9.00±0.50	9.30±0.30	9.80±0.10	10.10±0.20
	Fat(mg/g)	1.10±0.65	1.28±0.82	1.50±0.59	1.70±0.64
T1	Moisture(%)	70.20±0.20	71.70±0.20	71.50±1.22	72.27±0.02
	Protein(mg/g)	17.87±0.25	18.30±0.20	18.57±0.15	18.77±0.15
	Carbohydrate(mg/g)	11.20±0.20	11.40±0.20	12.07±0.21	12.40±0.20
	Fat(mg/g)	1.23±0.15	1.50±0.20	1.90±0.20	2.10±0.20
T2	Moisture(%)	70.17±0.35	71.80±0.20	73.07±0.95	74.07±1.01
	Protein(mg/g)	18.10±0.10	18.40±0.20	18.87±0.15	19.57±0.25
	Carbohydrate(mg/g)	12.03±0.15	12.47±0.25	12.84±0.21	13.20±0.30
	Fat(mg/g)	1.30±0.20	1.87±0.31	2.10±0.20	2.50±0.20
T3	Moisture(%)	70.13±0.15	71.27±0.25	71.50±0.20	71.60±0.20
	Protein(mg/g)	17.10±2.10	17.35±1.46	17.50±0.20	17.80±0.20
	Carbohydrate(mg/g)	10.17±0.25	10.37±0.25	10.67±0.25	10.87±0.15
	Fat(mg/g)	1.10±0.20	1.27±0.25	1.50±0.20	1.70±0.20
T4	Moisture(%)	66.10±0.20	66.27±0.25	66.50±0.30	66.80±0.20
	Protein(mg/g)	17.50±0.20	17.70±0.20	18.00±0.10	18.20±0.20
	Carbohydrate(mg/g)	10.60±0.20	10.83±0.25	11.00±0.30	11.20±0.20
	Fat(mg/g)	1.03±0.25	1.23±0.25	1.50±0.20	1.60±0.20

Values are mean ± SD of three samples in each group

4. Conclusion

In this study, it was observed that supplementation of garlic had significantly improved the growth rate in terms of length and weight gain followed by onion and control fed fishes. In coherence to the above obtained results, supplemented nutrients from garlic (*Allium sativum*) and onion (*Allium cepa*) provided sustainable growth for the fish *Oreochromis mossambicus*. Furthermore, dietary garlic and onion might enhance the levels of both carbohydrate and lipid. The use of garlic and onion led to an increase in protein content in fishes. Moreover, the study provided a new dimension for use of medicinal plants as supplementation to fish food to improve the growth as well as nutrients utilization.

Finally it was proved that the garlic and onion as feed additives represent alternative solutions in aquaculture feed as growth promoters. More clearly, it showed the significant increase in growth performance, feed utilization and biochemical composition.

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