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Feed Utilization and Growth in Juveniles of *Labeo rohita* Under the Stress of Monocrotophos

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Abstract

The present study was aimed at evaluating the growth performance and feed utilization of *Labeo rohita* subjected to sub-lethal stress of the pesticide, monocrotophos for a period of 45 days in laboratory conditions. Juveniles of *L. rohita* were divided into control and test groups. Test groups of fish were divided into two batches, I and II. Batch-I was exposed to 0.7116 mg•L^{-1} monocrotophos and Batch II was exposed to 0.3558 mg•L^{-1} monocrotophos. Feed utilization and growth were inferior while feed conversion ratio was observed to be higher in fish exposed to the toxicant and it was dose dependent. The weight gain between the fish of control group and the fish exposed to monocrotophos differed significantly. Feed conversion ratio, protein efficiency ratio and protein productive values were significantly less in the test groups. Analysis for the proximate composition of the fish carcass reveals that protein, carbohydrate and lipid conversion efficiencies were less in the test group of fish and differed significantly from that of the control group of fish. This suggests that nutrients are often getting wasted when fish are under the sub-lethal stress of pesticides.

Introduction

A sensitive measure of stress in an organism is its rate of growth, which is a fundamental measure of physiological fitness or performance. Widdows and Donkins (1989) and Butler et al. (1990) have advocated measuring growth in laboratory mesocosm experiments to assess the toxic effects of a range of environmentally important chemicals. Among the different classes of chemicals, agricultural pesticides are predominant in the aquatic environment. The ubiquitousness of pesticide residues is evident from the studies of Bradt and Herrenkohl (1976) on human milk and canned infant food, George and Frear (1966) on fauna of Antartica, Bevenue et al. (1972) on rainwater and Sodergren (1975) on air. The threat posed by pesticides to fish is evident by the toxicological work carried out by many researchers. Sprague (1971) advocated that growth should be measured in all such chronic experiments. Various researchers such as Van Valin et al. (1968), Hansen et al. (1976), Ufodike and Omaregie (1991), Sheela and Muniandy (1993) have conducted experiments on the nutrition and growth of different species of fish under sub-lethal stress of different pesticides. Since carps are the mainstay of freshwater aquaculture in Asia, *Labeo rohita* (Cyprinidae) a major

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carp, was chosen as the test organism for the present study on the growth and feed utilization performance under the toxic stress of monocrotophos.

Materials and Methods

Labeo rohita (Hamilton) juveniles of 3.0 – 3.5 cm length and 2.1-2.6 g weight were collected from the local fish farms and acclimatized for about a week to laboratory conditions for the experiment.

Experimental system

The fish for monocrotophos exposure were divided into a test group and a control group. The test group consists of two batches, Batch I and Batch II, each consisting of 24 individuals. At the beginning of the experiment, four fish from each group were randomly removed and killed for subsequent proximate analysis, leaving 20 fish for each treatment. The growth trial experiment in duplicate was carried out in fibre tanks of 80 L capacity in the laboratory. The fish in any one tank are all treated in the same way and are interdependent in the same environment, thus independence between the fish does not exist. The treatments are applied to individual tanks and treatment levels were made at the tank level but not at fish level. Treatments are not applied to individual fish but to whole tanks in the same laboratory conditions, where replication is essential to estimate the treatment effects. To satisfy the requirements of mainly used statistical tests, data are measured on each tank and are independent of each other.

The calculated LC50 value of monocrotophos for *L. rohita* is 3.558 mg•L^{-1}(Rao and Ramaneswari 2000). Batch I and Batch II were exposed to 0.7116 mg•L^{-1} (20% of LC 50 value) and 0.3558 mg•L^{-1} (10% of LC 50 value) of monocrotophos respectively. Desired concentrations of the pesticide were prepared by adding aliquots of stock solution of monocrotophos dissolved in acetone. Acetone was added to the control group also and its concentration did not exceed 0.01 ml•L^{-1} of water. Static bioassay method with 24 hr renewable water medium was adopted for the study. The physicochemical characteristics of water were examined by following standard procedures (APHA 1985).

Fish were weighed and measured at the onset of the experiment and after every 15 days. Fish were fed at the rate of 5% of their body weight each day with a prepared pelleted diet of 50% rice bran and groundnut oilcake and 50% trash fish meal and thereafter the rations were readjusted accordingly to fix percentages of body weights after each weighing. Experiment in duplicate was carried out for a period of 45 days. Gain in length and weight, average weight gain (%), feed conversion ratio (FCR), protein efficiency ratio (PER) and protein productive values (PPV) were calculated according to Hardy (1989). At the end of the experiment, the fish were killed to carry out proximate analysis. Proteins were determined by Lowry et al. (1951), carbohydrates by Dubois et al. (1956) Lipids by Folch et al. (1957) method. Conversion efficiencies of protein, lipid and carbohydrate were also calculated by the procedure of Allan and Robert (1978). Statistical significance ($p<0.05$) was judged using one way Analysis of Variance (ANOVA) followed by Duncan's multiple range test (DMRT) based on the results of each group of fishes.

Results

The physicochemical characteristics of the water used for the growth trial are presented in Table 1 which indicate, they are within the acceptable range for juvenile fish. The proximate composition of the diet is given in Table 2. Feed utilization and growth of the control group and test group (Batches I and II) are summarized in Table 3. In all the cases there was an increase in weight and length, but the extent of increase varied between the control group and groups of fishes exposed to pesticide. Highest weight gain was recorded in the control group of fish followed by the test fish of Batch II and the lowest weight gain was recorded in test fish of Batch I. The weight gain between the fish of control group and Batch I of test fish under pesticide stress differed significantly ($p<0.05$). The average weight gain (%) in all the groups of fish showed a positive correlation with time. The average weight gain (%) was higher in control fish compared to fish of Batch I and Batch II exposed to the pesticide monocrotophos. Between the two Batches of fish exposed to the pesticide the weight gain was better in Batch II subjected to lower sub-lethal concentration than the fish of Batch I. According to ANOVA and DMRT significant differences between the control and the test group of fishes were observed. Feed conversion was most efficient in the control group of fish, while it was less efficient in the Batch I and II fish exposed to monocrotophos. Significant differences between the control and the test group of fishes were observed ($p<0.05$; ANOVA, DMRT). An examination of protein efficiency ratios and protein productive values indicate that protein utilization was most efficient in the control group. The difference in values between Batch I group and control group was statistically significant.

Table 1. Physicochemical characteristics of water used for the growth experiment.

Parameters	Value
Temperature	27± 1°C
pH	7.8
Dissolved Oxygen	6.8 mg•L^{-1}
Turbidity	5.5 NTU
Total Hardness	110.0 mg•L^{-1}
Calcium Hardness	24.0 mg•L^{-1}
Magnesium Hardness	86.0 mg•L^{-1}
Chlorides	23.0 mg•L^{-1}

Table 2. Proximate analysis of the diet on dry weight basis given to the experimental fish

Parameters	Quantity
Crude protein	34.2%
Crude fat	7.8%
Available carbohydrate	55.0%
Moisture	5.6%

Table 3. Growth and Feed utilization of *L. rohita*

	Control group	Batch-I	Batch-II
Final weight	5.72 ± 2.55^{a}	5.12 ± 2.28^{b}	5.24 ± 2.34^{b}
Average weight gain (%)	126.33 ± 5.84^{a}	109.832 ± 6.76^{b}	118.33 ± 10.23^{c}
FCR	2.110^{a}	2.618^{b}	2.400^{c}
PER	1.046^{a}	1.378^{b}	1.385^{b}
PPV	0.778^{a}	0.540^{b}	0.658^{c}

Values with same superscripts in the same rows are not significantly different ($p<0.05$)
Batch-I Fish exposed to 0.7116 mg•L^{-1} monocrotophos; Batch-II Fish exposed to 0.3558 mg•L^{-1} monocrotophos

Table 4 illustrates the effects of monocrotophos on the biochemical composition of the test fish and control fish after the growth trial. The protein, carbohydrate and lipid conversion efficiencies are presented in Table 5. The overall effect of monocrotophos on the biochemical composition of the fish after the growth trial was carried out. Protein conversion efficiency was 22.39% in Batch I fish, 27.00% in Batch II fish and 30.38% in control fish. Lipid conversion efficiency was 13.21% in Batch I fish, 14.50% in Batch II fish and 18.60% in control group. Carbohydrate conversion efficiency was 8.11% in control fish, 5.59% in Batch I fish and 6.69% in Batch II fish. Significant differences were indicated in protein, carbohydrate and lipid conversion efficiencies between the control group and Batches I and II. Comparison of

conversion efficiencies showed that they were higher in the group of fish (Batch II) exposed to lower sub-lethal concentration.

Table 4. Proximate composition of the three groups of *L. rohita* before and after the experiment

	Proteins		Carbohydrates		Lipids	
	Before	After	Before	After	Before	After
Control	11.10	14.70	4.09	4.38	3.01	3.66
Batch-I	11.18	13.68	3.98	4.21	3.16	3.62
Batch-II	11.48	14.58	3.98	4.25	3.14	3.56

Values with same superscripts in the same rows are not significantly different ($p<0.05$)
Batch-I Fish exposed to 0.7116 mg•L^{-1} monocrotophos; Batch-II Fish exposed to 0.3558 mg•L^{-1} monocrotophos

Table 5. Percentage protein, carbohydrate, lipid conversion efficiency of *L. rohita*

	Control	Batch-I	Batch-II
Protein Conversion Efficiency (%)	30.38 ± 1.13^{a}	22.39 ± 1.14^{b}	27.00 ± 1.07^{c}
Carbohydratre Conversion Efficiency (%)	8.11 ± 0.55^{a}	5.59 ± 0.39^{b}	6.66 ± 0.47^{c}
Lipid Conversion Efficiency (%)	18.60 ± 0.92^{a}	13.21 ± 0.81^{b}	14.50 ± 0.77^{a}

Values with same superscripts in the same rows are not significantly different ($p<0.05$)
Batch-I Fish exposed to 0.7116 mg•L^{-1} monocrotophos; Batch-II Fish exposed to 0.3558 mg•L^{-1} monocrotophos

Discussion

Feed utilization and growth are inferior in both groups of fish exposed to monocrotophos. Moreover the impact increased with the increase in the sub-lethal concentration of monocrotophos, which means that the effect was dose dependent. Reduced growth rates suggest that monocrotophos exerts a stress on fish juveniles as evident by the differences in final mean weights between the control group and test fishes. Higher feed conversion ratios in the toxicant exposed groups suggest that feeds were less efficiently utilized. Protein utilization as expressed by protein efficiency ratios and protein productive values is markedly inferior in the fishes exposed to monocrotophos. Bayne et al. (1979) and Naylor et al. (1989) have observed that scope for growth is reduced under the conditions of toxic stress in a variety of aquatic animals, both in field and laboratory conditions. According to Warren and Davis (1967), Ponnuchamy et al. (1983) physiologically useful energy in excess of metabolic requirements is available for deposition as body tissues in growth, but the same under stress gets more expended and thus reduces that energy which can be deposited as body tissues. The differences in biochemical composition (proteins, carbohydrates and lipids) observed in this study indicate that chemical toxicants, such as pesticides, cause a stress in terms of metabolic resources, especially on the energy reserves of the fishes (Callow 1989).

Dietary lipids and carbohydrates supply most of the energy for physiological processes, and at inadequate levels of energy due to stress, dietary protein is used as an energy source (Cowey and Sargent, 1979). Consequently less protein will be retained in the fish body otherwise the dietary protein will be spared for growth (Garling and Wilson 1976; Teshima et al. 1985). For managed fish populations in aquaculture systems, increase in mass is crucial to obtain a marketable product, which in turn depends on the way the energy is distributed and utilized within the body. Besides this, another factor of great importance to production economics is the efficiency with which fish can convert food into flesh. Estimated losses in mean weight, higher feed conversion ratios, lower protein efficiency ratios and protein productive values in the groups of fish under the stress of monocrotophos suggest that feed (nutrients) is being wasted. Thus feeds become more expensive as the quality of the diet improves, specifically at the level of dietary protein, and becomes wasteful, both from nutritional and eco-

nomic standpoint. Consequently in addition to the need for conducting basic research studies on the nutrient requirements of fish, there is also a need to comprehend the dynamics of pond ecosystems where optimum use of limited water resources requires better understanding of the impact of toxicants on cultured fish species.

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