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Influence of Pesticide–Fertilizer Combination on Food Intake, Growth, and Conversion Efficiencies of *Oreochromis mossambicus*

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Man has attempted to increase the world's food production. He achieved this by increased use of fertilizer to nourish the plants and by increased use of pesticides to protect them from pests. Now, a large quantity of pesticides and fertilizers are used to nourish the plants. These chemicals have entered into the aquatic system and produce unwanted and unwarranted residues, which pose a great threat to aquatic organisms. There are several reports regarding the effects of pesticides (Arunachalam et al. 1985) and fertilizers (Rani et al. 1998) on the physiology of fish. However, studies on the effect of fertilizers in combination on aquatic organisms are meagre except the work of Rani et al. (1999). Most of the freshwater fishes are inhabitants of paddy fields and shallow water bodies surrounding these fields where fishes face the problem posed by chemicals from agriculture. Therefore, it is of interest to investigate the effect of a pesticide (cartap hydrochloride) and a fertilizer (urea) in combination on the survival, food intake, growth and conversion efficiencies of the freshwater fish *Oreochromis mossambicus*.

MATERIALS AND METHODS

Juveniles of *Oreochromis mossambicus* weighing 2.9 to 3.2 g were collected from the local pond and acclimated to the laboratory conditions for one week. They were fed chopped goat liver pieces.The water in the aquaria was renewed daily. Prior to the experiment (1 day) and throughout the test the fish were starved. To determine the 96 h LC_{50} a static renewable bioassay method as described by Sprague (1973) was adopted for the chosen pesticide (cartap hydrochloride) and fertlizer (urea) individually and also in various combinations. The latter comprised of different concentrations of cartap hydrochloride with a single concentration of urea and different concentrations of urea with single concentrations of cartap hydrochloride.

For feeding energetic studies, well acclimated *O.mossambicus* were divided into four groups of ten specimens each. The fishes of group I were reared in chemical- free water and treated as the control. Fish belonging to group II were exposed to the 1.0 mg/L concentration of cartap hydrochloride. Group III were exposed to 22,000 mg/L of urea and group IV were exposed to urea (8,000 mg/L) with cartap hydrochloride (0.20 mg/L) for 28 days. For each group, individuals were reared separately

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in a plastic trough containing five liters of the test medium. The fish were fed chopped goat liver pieces once a day for about one hour (10-11 AM) and the test media was changed daily. The food remains were carefully collected using a pipette without disturbing the fish and dried to constant weight. At the time of changing the culture medium, the entire trough was filtered for the collection of faeces. Food intake was determined by subtracting dry weight of remaining food from the dry weight of food given and expressed as mg dry food absorbed/g live fish/d. The absorption efficiency was calculated as the percentage of food absorbed in relation to food consumed. In the present work, the sacrifice method described by Maynard and Loosly (1969) for domestic animals was performed. Gross conversion efficiency (K_1) was calculated as the percentage of food converted into body tissues in relation to feeding rate and was expressed in terms of mg dry substance gained/g live fish/d:

K_1 = Growth rate / Feeding rate X 100.

The net conversion efficiency (K_2) was expressed in terms of the percentage of food converted into fish tissues in relation to absorption rate:

K_2 = (mg growth per day) / (mg food absorbed per day) X 100 .

The IBP formula (Petrusewicz and Mac Fadyen 1970) was used to express the scheme of energy balance, C = P+R+F+U where ‘C’ is the food energy consumed, ‘P’ is the growth, ‘R’ is the energy lost as heat due to metabolism, ‘F’ is the faecal rate and ‘U’ is the nitrogenous excretory product. Due to lack of facilities, the values of ‘R’ and ‘U’ were not estimated. Hence, the remainder of the food energy factor other than faeces and growth were considered. The energy utilized for the metabolic process included excretion, i.e., C = P+F+M (Rani 1998) where ‘M’ is the metabolism i.e energy lost as heat during metabolism and excretion. The data was subjected to students ‘t’ distribution according to the method of Bailey (1959).

RESULTS AND DISCUSSION

The 96 hour LC_{50} values for cartap hydrochloride and urea on *O. mossambicus* were 1.75 mg/L and 28,000 mg/L, respectively. The median lethal concentrations for cartap hydrochloride and urea in mixtures were lower than those for cartap hydrochloride and urea when tested alone (Table 1). Thus, the mixtures of cartap hydrochloride and urea in water produced increased toxicity on *O. mossambicus*. Similar results have been reported in *O. mossambicus* when exposed to the combination of monocrotophos (pesticide) and ammonium chloride (fertilizer) (Rani et al. 1997).

Toxicity studies on mixtures are refered to as interaction studies (Rand and Petrocelli 1985). Generally, the interactions are between the chemicals and physiological systems within the body of the organism. Thus, the interactions of chemicals may influence the absorption, distribution, biotransformation or excretion of one chemical by another. The increased toxicity of cartap hydrochloride and urea together on *O.mossambicus* may be due to the increase in the rate of uptake of chemicals, formation of the metabolites of the chemicals, reduction in the rate of excretion or in biotransformation mechanisms as suggested by Rand and Petrocelli (1985).

Table 1. Lethal (LC_{100}), median lethal (LC_{50}) and sublethal levels in *Oreochromis mossambicus* exposed to cartap hydrochloride, urea and cartap hydrochloride- urea combinations at 96 h exposure.

Toxicants	Lethal	Sub Lethal	Median Lethal	Toxicant concentration tested (mg/L)
Cartap hydrochloride	2.0	1.00	1.75	1.00 - 2.75
Urea	32,000	22,000	28,000	22,000 - 38,000
Urea + Cartap hydrochloride	1.25	0.25	0.75	20,000 + 0.25 - 1.75
Cartap hydrochloride + Urea	28,000	20,000	24,000	0.25 + 20,000 - 32,000

The effect of cartap hydrochloride (cartap), urea and their combination on food utilization parameters (Table 2) show that fish reared in chemical - free water had a feeding rate of 34.3 mg/g/ d. Feeding rates were reduced significantly ($p < 0.001$) for cartap-exposed (1 mg/L - 10.3 mg/g/d), urea-exposed (22,000 mg/L - 13.9 mg/g/d), and cartap plus urea-exposed (0.20 mg/L + 8,000 mg/L - 8.5 mg/g/d) fish. Such a negative relationship between food consumption and increasing sublethal concentrations of chemicals has been observed by Arunachalam and Palanichamy (1982) in *Macropodus cuppanous* when reared in carbaryl.

Decreased feeding rate at higher chemical concentrations may have a variety of causes. There is evidence that when the level of toxicants in water is increased,the excretion of ammonia by freshwater fishes decreases while its level in blood and tissues increases (Mangum et al. 1976). This will slow or stop feeding, causing reduction in growth (Olson and Fromm 1971). Alternatively, decreased food intake may be due to damage caused to taste receptors (Hidaka 1970). In this context Heath (1987) suggests that fishes subjected to long-term pollutant exposure exhibited reduction in appetite.The mechanism for this has not been determined, but it may be caused by hormonal changes, which could cause a direct inhibition of feeding or indirectly alter blood glucose levels. Reduction in feeding rate may also be due to the inhibition of intestinal absorption, as Filis (1968) observed that external and internal tissues were extensively damaged by sublethal concentrations of ammonia.

Diminished feeding rate was reflected in absorption and growth rates. The trend for absorption efficiency was similar to that of feeding rates. For *O. mossambicus* reared in chemical-free medium, absorption efficiency was 96.4%, but decreased to 89.4%, 89.2% and 80.0% respectively at the given concentrations of cartap,urea and cartap with urea. The reduction in absorption rate and efficiency may be due to inhibition of

Table : 2. Effects of cartap hydrochloride, urea and mixtures of cartap hydrochloride with urea on food intake, growth, metabolism and conversion efficiency in *Oreochromis mossambicus*. Each value represents the average (X ± SD). Performance of five individuals observed for a period of 28 days while the feeding rate, absorption rate, growth rate and metabolic rate are expressed as mg/g/d and efficiencies as percentage.

Conc mg/ L	Feeding rate	Absorption rate	Growth rate	Metabolic rate	Absorption efficiency	Conversion efficieny (%)	
						K_1	K_2
Control Chemical free Medium (o)	34.3 ± 7.1	33.2 ± 7.3	3.4 ± 0.7	29.8 ± 6.8	96.4 ± 10.2	9.9 ± 1.9	10.2 ± 2.2
Cartap hydrochloride (1.00)	10.0 ± 1.7 ***	9.0 ± 0.1**	0.5 ± 0.1***	8.4 ± 2.1 ***	89.4 ± 13.9	5.4 ± 1.1	6.1 ± 1.1
Urea (22,000)	13.9 ± 2.3 ***	12.4 ± 0.2 ***	0.8 ± 0.2***	11.6 ± 1.8 ***	89.2 ± 13.5 ***	6.0 ± 1.2 **	6.7 ± 1.3 *
Urea + Cartap (8,000 + 0.20)	8.5 ± 1.7 ***	6.8 ± 1.1***	0.4 ± 0.1 ***	6.4 ± 0.1 ***	80.0 ± 12.3 *	4.4 ± 0.8*	5.5 ± 1.1 ***

Asterisks indicate values which are significantly different from control * $P<0.05$ ** $P< 0.01$ *** $P<0.001$.

intestinal absorption by pollutants (Farmanfarmain et al.1980). Gastric evacuation is an important factor in regulation of appetite and food intake in fishes. Inhibition of intestinal absorption results in food retention in the alimentary canal (Baskaran et al. 1989), so food intake can decrease as a result of pollutant exposure.

In the present investigation, conversion efficiency decreased when the fish were reared in cartap or urea individually or together. Growth rate of the control fish was 3.40 mg dry substance per gram of fish/day. This rate was significantly reduced ($p < 0.001$) in the 1 mg/L cartap (0.54 mg/g/d), 22,000 mg/L urea (0.83 mg/g/d), and 0.2 mg/L cartap plus 8,000 mg/L urea (0.37 mg/g/d) exposed fish. Similar observations were made (Palanivelu and Balasubramanian 1997) on fishes exposed to maximum sublethal concentrations of pesticides and fertilizers. Variation in growth is considered to be an indicator of differences in sublethal stress and is influenced by abiotic and biotic factors (Rani et al.1998).

Decreased growth and conversion efficiency may be due to the expenditure of more energy for maintenance metabolism as a result of stress caused by pesticide / fertilizer exposure (Arunachalam and Palanichamy 1982). Reduction in conversion efficiency similar to that of growth rate suggests that factors other than food consumption can contribute to lower growth rate. It is conceivable that decreased efficiency of energy utilization, together with increased maintenance costs may be limiting growth (Waiwood and Beamish 1978). Stonner and Livingston (1978) suggested that reduction in conversion efficiencies may be due to the results of three different mechanisms: 1) lowered assimilation efficiency - which reduces the amount of food available for maintenance and growth, 2) higher energetic costs to pollutant-exposed fishes versus controls - as the former have increased metabolic rate, spontaneous activity, ventilatory volume or tissue repair, and 3) protein synthesis inhibition due to organic pollutant exposure. Therefore, conversion of food in body tissues is minimized because more energy is needed to maintain life when an organism is under chemical stress.

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