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Toxic Effects of Malathion on Morphology of Freshwater Catfish *Heteropneustes fossilis*

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Abstract: *This study investigates the toxic effects of Malathion on the freshwater, air-breathing stinging catfish, Heteropneustes fossilis, with a focus on behavioral alterations under various pesticide concentrations. Experimental fish were exposed to graded doses of Malathion, and a range of behavioral parameters—including activity levels, opercular movement, air gulping, and schooling behavior—were meticulously analyzed. Results revealed progressive disruptions in swimming activity, resting periods, and respiratory responses, with increased concentration leading to more pronounced lethargy, irregular movements, and physical symptoms such as haemorrhage and skin rashes. No mortality was recorded, but the fish exhibited adaptive stress responses such as rapid opercular movement and increased air gulping. The findings underscore the vulnerability of aquatic fauna to sublethal pesticide exposures, emphasizing the necessity for careful water quality management and toxicant regulation to minimize ecological risk. The study provides critical baseline data for the assessment of chemical safety limits in aquatic environments, supporting sustainable management of freshwater resources and protecting aquatic biodiversity.*

Keywords: *Air gulping, Swimming activity, Stress response, Pesticide impact, Ecotoxicology*

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Introduction

Toxicology is the study of toxic elements and their symptoms, working and its treatments. Extremely high concentrations of pesticides are more toxic to the biological systems. Evaluation of toxicity of a chemical therefore is necessary to know, because it would help us to know its potentiality so that it could be possible to desire more powerful formulations. The toxicity study is essential to find out toxicants limit and safe concentration, so that there will be minimum harm to aquatic fauna in the near future. The toxicity determination of substances to at the lower level of the food chain has been useful and accepted for water quality management. Unconscious and reckless handling of chemicals resulted in several disastrous incidences of pollution and accidental poisoning. Hence man has recognized the need for better control of the present use and future development of chemicals. In recent years it has become a normal practice to test all new chemicals for the toxicity before they could reach consumers. Major purpose of the toxicological investigations to provide a basis for estimating the maximum dose that may be tolerated by animals throughout their life time without manifesting any adverse effect (Gralla, 1981).

Toxicity is the degree to which a substance (a toxin or poison) can harm humans or animals. It is the sum of adverse effects or the degree of danger posed by a substance to living organisms. It is expressed generally as a dose response relationship involving the quantity of substance to which the organism is exposed and the route of exposure is skin (absorption), mouth (ingestion), or respiratory tract (inhalation). Toxicity is classified usually as acute, chronic and subchronic toxicity. A single or short-term exposure of Acute toxicity involves harmful effects in an organism. (Fauci, Anthony, S. *et.al.*, 2008) stated that Chronic toxicity is the ability of a substance or mixture of substances to cause harmful effects over an extended period, usually upon repeated or continuous exposure, sometimes lasting for the entire life of the exposed organism. Subchronic toxicity is the harmful effects produced through repeated or continuous exposure over twelve months or more but less than the normal lifespan of the organism.

Material and Methods:

The present study is intended to investigate the toxicity of Malathion to a freshwater, air-breathing, stinging catfish, *Heteropneustes fossilis* Bloch (Order: Siluriformes; Family: Heteropneustidae). It includes Behaviour aspects of fish to toxicants. Fishes were collected from river Garrha and water reservoirs in and around Shahjahanpur, U.P. (India) with the help of local fisherman, brought to laboratory and acclimatized to laboratory conditions for 15days before the experiments. Stock solution of Malathion was prepared by dissolving weighed amount of salt in double distilled water. Behavioural characteristics were also recorded with respect to activity, movement, mucous secretion, skin colouration and opercular beats. The data obtained for opercular beats were statistically analyzed for student t-test and ANOVA using MINITAB software on PC.

Results:

Behaviour is regarded as a convincing tool in ecotoxicology. In toxic environments, fish showed loss of equilibrium, irregular, erratic and darting swimming movements. Changes in behavioural responses of fishes started 30mins after dosing. Fishes exposed to malathion showed speedy movements as compared to control.This resulted in decrease in resting period. The normal resting period between each swimming action in control was 252.02±2.88 seconds whereas this period decreased with an increase in pesticide concentrations. However, Control fish behaved normally according to the observation (43.51±3.03/min). The increase in opercular movement from 46.14±3.99/min to 54.84±2.23/min, on hypoxic condition was observed with increasing the dose. Malathion exposure caused hypoxia which was reflected in the number of air gulps per 15 mins. Number of air gulps increased from 1.15±0.36 in control group to 5.76±0.52, 3.61±0.50 and 2.52±0.45 in the group exposed to Malathion. The fishes that were exposed to Malathion started exhibiting behavioral changes and clinical symptoms at 25 mg/L after 5 hours, but these changes and symptoms appeared after 2 hours when exposed to 50 mg/L Malathion. The fish showed typical changes in behaviour when exposed to various concentrations of Malathion. They have observed that the fishes experienced progressive lethargicity, loss of equilibrium, difficulty in respiration, exhibited convulsions, dashing against the wall of the experimental aquaria and short unpredictable bumpy body movements, settling to bottom before death.

After 15 and 30 days of exposure fish showed more surfacing, air gulping, restlessness, escaping movement, erratic swimming and loose schooling. Sudden irregular swimming, increased mucus secretion and high rate of opercular beat rate was also noticed, fish became lethargic, less active, irresponsive which resided at the bottom of aquaria. Schooling was found completely disturbed and fish were scattered. Fish showed very less response for food and became very weak. Haemorrhage, colour fading, peeling of skin and rashes were also observed (**Table 1**). Responsiveness to stimuli and food consumption became less the control fish. Ulcerative tubercles, haemorrhages and skin rashes were also start to appear on caudal and abdominal region.

After 60 days of exposure increased surfacing, fast swimming, jerky movement, restlessness, loss of balance, loose schooling and erratic swimming was observed in exposed fishes (**Table 1**). Fish became less active and less responsiveness to external stimuli and food. The skin was found peeling off more with increased haemorrhages and skin rashes on body surface particular in opercular and caudal region along skin colour fading in exposed animals

PARAMETERS	**CONTROL**	**25 mg/L**	**50mg/L**	**75 mg/L**
Resting period (second)	251.02±2.88	224.93±2.48	198.15±4.04	184.84±2.15
Opercular movement (1min)	43.51±3.03	46.14±3.99	51.9±2.17	54.84±2.23
Air gulp (15 mins)	1.14±0.36	2.50±0.45	3.59±0.50	5.73±0.52
S-jerk (15 mins)	20.53±1.37	23.05±1.O9	31.56±1.77	35.07±2.04

Table 1: Effect of Malathion doses on different behavioural parameters of *Heteropneustes fossilis*

The fishes of control and the lowest concentration of Malathion i.e 25mg/L were calm and quiet and preferred to confine themselves to the bottom of the aquarium whereas 50mg/L and 75mg/L

Malathion treated fishes were found active and mostly swimming near the upper surface of water and also found hanging vertically most of the time in water.

However, no mortality has been recorded in any of the treatments during investigation period. During acute toxicity test, fish exhibited peculiar reactions from the beginning time of exposure. At first, the fish looked surfacing movement tendency for 1 to 20 minutes, then slowly became lethargic and settled at the bottom of the container. The fish exhibited asphyxiation and occasionally jumped up to gulp air. As the fish has a sensitivity to external stimulus, the fish is sometimes observed to exhibit rapid jig-jug movements with sudden jerks.

Discussion:

The behavioural changes are the manifestation of motivational, biochemical, physiological and environmentally influenced state of the organism. Warner *et al*. (1966) commented that "The behavioral activity of an organism represents the final integrated results of a diversified biochemical and physiological processes". Thus, a single behavioral parameter is generally more comprehensive than a physiological or biochemical parameter. So, behavior is a selective response that constantly adapts through direct interaction with physical, chemicals, social and physiological aspects of environment. Fishes exposed to sublethal concentrations of pesticides showed increase in swimming activity as compared to control. This resulted in decrease in resting period. This increase in swimming activity may be due to disruption of schooling behavior which occurs because of the stress of the toxicant (Venkata *et al*., 2008). Similar alteration was also observed by Yaji *et al.* (2011) in *Orechromis niloticus* treated with cypermethrin and also by Ramesh and Saravanan (2008) in *Cyprinus carpio* exposed to chlorpyrifos.

Increased in swimming activity entails increased expenditure of energy (Venkatarathnamma *et al*., 2008). Opercular movement per minute showed increasing trend with the increase in concentration of pesticides. Under toxic condition the supply of oxygen becomes deficient and so the fish breathe rapidly (Susan *et al*., 2010). Increase in opercular movement has also reported by Omitoyin *et al.* (2006), Koprucu *et al.*(2006) and Srivastava *et al*. (2010) in *Clarias gariepinus*, *Silurus glanis* and *Heteropneustes fossilis* exposed to lindane, diazinon and dimethoate respectively. Rapid opercular movement was also noticed by Wasu *et al.* (2009) in *Clarias batrachus* treated with carbaryl and malathion. Shivakumar (2006) also observed increased opercular movement in *Cyprinus carpio* exposed to three different pesticides- endosulfan, cypermethrin and fenvalerate. The increase in opercular movement clearly indicates that fish adaptively shifts towards aerial respiration (by obtaining atmospheric oxygen) (Santhakumar *et al.,* 2000; Prashanth and

Patil, 2006). The rapid opercular movement could also be due to clearance of the accumulated mucus debris in the gill region for proper breathing.

Variation in the respiratory rate of animal is an indicator of stress, which is frequently used to evaluate the altered metabolism under environmental deterioration (Chinni *et al.,* 2000). Exposure to the three pesticides caused hypoxia which was reflected in the number of air gulps per 15 minutes. Gulping of air may help to avoid contact with toxic medium as suggested by Schmidt *et al.* (2005). Similar observation has reported by Patil and David (2008) in malathion treated fish *Labeo rohita* and by Parithabhanu (2013) in cypermethrin treated *Orechromis mossambicus*.

In the present study movements like S-jerking, threat and burst swimming were increased in the experimental fishes when exposed to pesticides. Similar observations were reported by Nimila and Nandan (2010) in *Etroplus maculatus* when it was treated with lindane and by AL-Akel and Shamsi(2000) in carbaryl treated fishes. S jerk and burst swimming were also observed by Marigoudar *et al.* (2009) in *Labeo rohita* exposed to cypermethrin.

The fishes of the control were calm and preferred to confine themselves to the bottom of the aquarium whereas pesticide treated fishes were found active and mostly swimming near the upper surface of water and also found hanging vertically most of the time in water. These findings can be correlated with the findings of Narwaria and Saksena (2012).

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