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AMELIORATING EFFECT OF *CURCUMA LONGA* ON FENVALERATE INDUCED TOXICITY IN BIMODAL OXYGEN UPTAKE OF A FRESHWATER AIR BREATHING FISH *CLARIAS BATRACHUS*

Pratibha Kumari and Dilip Kumar Paul*

Associate Professor, Department of Zoology, Patna University, Patna, Bihar.

Corresponding Author: Dr. Dilip Kumar Paul
Associate Professor, Department of Zoology, Patna University, Patna, Bihar.
Email ID: pratibhakumaricdpo@gmail.com, dkpaul.pat31@gmail.com,

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ABSTRACT

The present paper deals with the ameliorating effect of aqueous extract of a medicinal plant *Curcuma longa* (turmeric) on a pyrethroid pesticide fenvalerate induced toxicity in bimodal oxygen uptake of a freshwater air-breathing fish *Clarias batrachus* (Linn) popularly known as mangur. The fishes after proper acclimatization and giving adequate food, fishes were intoxicated with fenvalerate at the doses of 1/3rd, 1/6th, 1/9th and 1/10th of LC_{50} (i.e. 0.247 ppm) for 96 hours. Control group of fishes showed oxygen consumption level to 68.823± 1.947 ml/kg/hr if surface was allowed while it was more i.e. 71.083±5.144 ml/kg/hr when surface was prevented. Decreasing trend of oxygen uptake in the fishes was found in both the cases after intoxication of the fenvalerate. The trend was due to the stress conditions of fishes correlated with low values of RBC and hemoglobin level as a result of pesticide inhalation. Curcumin, the main constituent of *Curcuma longa* was found to ameliorate the effect of pesticide on oxygen uptake rate of the fishes making almost its normal level of oxygen uptake rate of the control fishes.

KEYWORDS: Oxygen uptake, *Clarias batrachus*, Fenvalerate, *Curcuma longa*, Amelioration.

INTRODUCTION

In recent years the pesticide problem has been the focus of public interest. The reason is that these chemicals have a very important role in agriculture. At the same time, concern for the possible threat of human health has been increasing. Pesticides being used in agricultural tracts are released into the environment and come into the human contact directly or indirectly (Soil, water, air and food) by different routes of exposure such as inhalation, ingestion and dermal contact. Exposure to pesticides results in acute and chronic health problems. Pesticides can enter surface waters via different routes, among which runoff driven by precipitation or irrigation is the most important in terms of peak concentrations. The exposure can cause direct impact on all levels of biological organization, while the toxicant mode of action largely determines which group of organisms (primary producers, microorganisms, invertebrates or fishes) is affected.[31] Pesticides have been found to be highly toxic not only to the fishes but also to the other organisms, which constitute the food chain. The contamination of surface waters by insecticides is known to have ill effects on the growth, survival and reproduction of aquatic animals[29] Fishes are important sources of proteins and lipids for humans and domestic animals, so the health of fishes is very important for human beings.

Fishes are primarily water breathers where gills and skin take part in the metabolic gas exchange. Many species of teleost fishes inhabiting waters of low O_2 and high CO_2 have, however, accessory respiratory organs which enable them to breath atmospheric air. About 140 species of air-breathing fishes exhibit various degrees of bimodal gas exchange.[24] Currently more attention is being devoted to the adaption of teleosts that breath air[10-11] but few studies have been made of the relation to oxygen consumption and growth in air-breathing fishes.[20] Air-breathing fishes, inhabiting tropical freshwater ponds, lakes and rivers, employ two modes of respiration namely aquatic respiration using gills and aerial respiration using highly vascularized air-breathing organs. Estimation of oxygen consumption by the fish is useful for assessment of effects of pollutants and is one of the important indicators which reflect physiological state of animal.[22] The metabolic rate, as expressed in terms of oxygen consumption in fishes, is influenced by a number of factors.[9]

The air-breathing catfish, *Clarias batrachus*, lives in fresh-water pools of East India which have low O_2 and high CO_2 contents. This catfish has special air-breathing organs which allow direct gas exchange with atmospheric air. The accessory respiratory organs comprise (i) suprabranchial chambers situated dorsally to the gill cavities and lined by respiratory membrane; (ii) fans borne on each gill arch and (iii) the respiratory tree or dendritic organs borne by the second and fourth gill arches.[19] The freshwater air-breathing fish *Clarias batrachus* employs two modes of respiration namely aquatic respiration using gills and aerial respiration using highly vascularized air breathing organs which is called bimodal gas exchange for this dual system. Oxygen consumption through bimodal gas exchange affected by exogenous and endogenous factors has been studied in several species.[4,12,14-16,23,25,27-28,30,38]

Literatures dealing with the toxicity of pyrethroid pesticides in Indian fishes are few related to oxygen consumption.[7,21] However, a little works on the effect of fenvalerate pesticide on freshwater Indian fishes have been reported.[26,35] But works of fenvalerate on Indian air-breathing fish *Clarias batrachus* are scanty.[33-34] Now-a-days medicinal plants are being used for anti-toxicant against pesticide[5,8,13,17] but no scientific study is available regrading protective role of turmeric on the oxygen uptake of *Clarias batrachus* fish intoxicated with fenvalerate pesticide.

The present study was undertaken to evaluate the ameliorating effect of aqueous extract of *Curcuma longa* (turmeric) on a pyrethroid pesticide fenvalerate induced toxicity in oxygen uptake of the Indian air-breathing teleost fish *Clarias batrachus*.

MATERIALS AND METHODS

Age group of live specimens of *Clarias batrachus* fishes ranging from 70-88 ±10 gram and sizes between 4.5" ±2" were collected from the local market of Patna, Bihar (India). These fishes were washed with $KMNO_4$ solution for proper disinfection and were acclimatized 15 days in laboratory before experimentation. The laboratory room temperature was maintained to 24 ±2°C. The fishes were kept in big aquaria (50-gallon capacity). The animals were fed with chopped goat liver and earthworms. Care was taken to keep the animals healthy and free from parasites. The experiment was established in the Ecotoxicology Laboratory, Post Graduate Department of Zoology, Patna University, Patna, Bihar, India. The ethical approval was obtained from the Post Graduate Research Council of Patna University, Patna, Bihar.

Fenvalerate 20% (Fenal- Isagro-Asia, Gujarat, India) was administered in water contained in aquarium and LC_{50} was estimated for 96 hours after the dose calculation which was 0.247 ppm.

Turmeric (*Curcuma longa*, family Zingiberaceae) rhizome were collected from the local market of Patna and aqueous extract of turmeric rhizome was obtained as per the method employed by Lalaitha and Selvan.[18] Maximum permissible dose of aqueous extract of *Curcuma longa* rhizome for the experiment was estimated 100 mg/kg body weight per day. The aqueous extract of turmeric was administered orally, daily by gastric intubation method to the fishes.

In the present study, the experiment was designed through dose dependent experiment in case of pesticide whereas days dependent experiment was adopted during turmeric extract treatment.

Initially 5 groups of fishes were selected (a) Control, n=10 (b) Fenvalerate treated, 0.92 ppm i.e.1/3rd of $LC_{50,}$ n=20 (c) Fenvalerate treated, 0.46 ppm i.e.1/6th of $LC_{50,}$ n=10 (d) Fenvalerate treated, 0.31 ppm i.e.1/9th of LC_{50}, n=10 (e) Fenvalerate treated, 0.275 ppm i.e.1/3rd of LC_{50}, n=10 each for 96 hours. After that, 0.92 ppm fenvalerate intoxicated fishes were treated with *Curcuma longa* extract (100 mg/kg b. w.) for 5 days and for 15 days.

The method employed in the determination of rate of uptake of oxygen of the fishes under experimental conditions in which either surfacing prevented (i.e. free access to air not allowed) or allowed (i.e. free access to air allowed) were those of Munshi and Dubey.[20] The concentration of dissolved oxygen in water samples were determined by Azide Modification of Winkler Method.[2,36]

RESULTS AND DISCUSSION

Control group of fishes showed oxygen consumption level to 68.823± 1.947 ml/kg/hr. if surface was allowed while it was 71.083±5.144 ml/kg/hr. if surface was prevented in *Clarias batrachus* fishes **(Figure 1 & 2)**. When the different doses of pesticide fenvalerate were administered to the fishes, they showed decreasing trend of oxygen consumption through surface allowed. Fishes were exposed to fenvalerate for 96 hours to 1/3rd, 1/6th, 7/9th and 1/10th dose of its LC_{50} then their oxygen consumption level through surface allowed were 54.424 ± 0.252, 57.632 ± 3.606, 58.782 ± 4.528 and 58.905 ± 2.324 ml/kg/hr. respectively **(Figure 1)**.

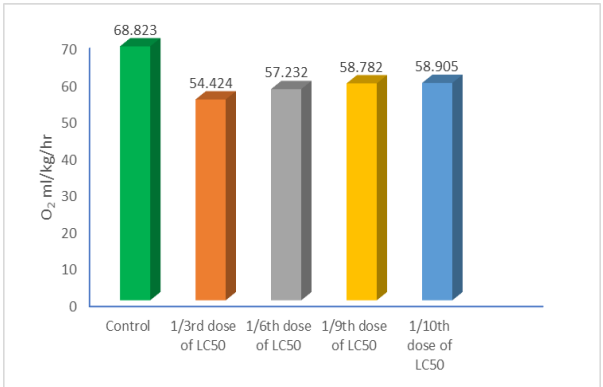

Figure 1: Oxygen Consumption of *Clarias batrachus* (Surface allowed ml/kg/hr.)

Fenvalerate administered fishes also showed decreasing trend of oxygen consumption in fishes through surface prevented. Fishes exposed to fenvalerate for 96 hours to 1/3rd, 1/6th, 7/9th and 1/10th dose of its LC_{50} then their oxygen consumption level through surface prevented gradually increased i.e.56.293 ± 0.216, 58.971 ±7.328, 60.337 ± 1.629 and 62.491 ± 0.869 ml/kg/hr. (**Figure 2**).

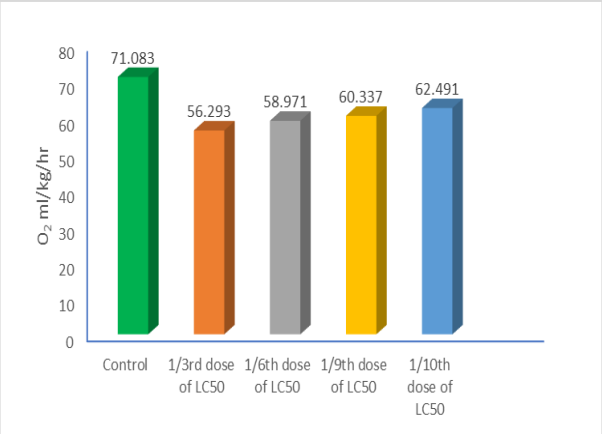

Figure 2: Oxygen Consumption of *Clarias batrachus* (Surface prevented ml/kg/hr.).

Turmeric showed ameliorating effect on oxygen consumption in pesticide exposed fishes. Longer duration of turmeric administration gave better restorative effect. After 5 days of turmeric administration oxygen consumption became 60.302 ± 0.316 ml/kg/hr. if surface allowed but it restored to greater extent after 15 days of turmeric administration and became 66.792 ± 0.163 ml/kg/hr. almost like normal one (**Figure 3)**.

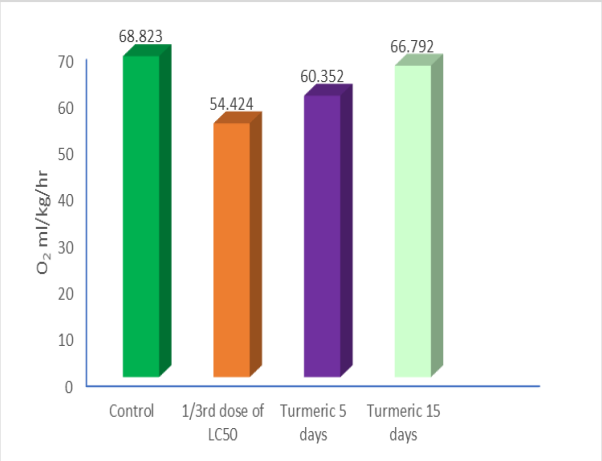

Figure 3: Oxygen Consumption of *Clarias batrachus* (Surface allowed ml/kg/hr) after treatment with *Curcuma longa.*

Turmeric extract also had bio remedial impact on oxygen consumption if surface was prevented. It also showed similar trend i.e.: longer duration gave better result. After 5 days of turmeric administration it became 64.782 ± 0.326 ml/kg/hr while after 15 days of turmeric administration it was 67.823 ± 0.657 ml/kg/hr almost like normal group of fishes **(Figure 4)**.

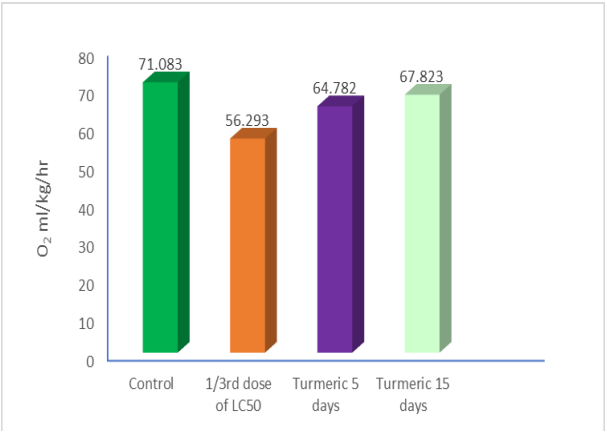

Figure 4: Oxygen Consumption of *Clarias batrachus* (Surface prevented ml/kg/hr) after treatment with *Curcuma longa.*

The degradation of aquatic system is a worldwide phenomenon originated from the intense population and from the corresponding increase in agriculture practices as well as industrial and domestic activities. Pesticides are major cause of concern for aquatic environment because of their toxicity, persistency and tendency to accumulate in the organisms. The impact of pesticides on aquatic organisms is due to movement of pesticides from various diffuse or point sources.[31]

The pesticides and related chemicals originating from human activity or agricultural farming are discharged directly or indirectly into the receiving waters. Fish species are sensitive to enzymatic and hormonal disruptors. Chronic exposure to the levels of pesticides may have a more significant effect on fish populations than acute poisoning.[14] Biochemical changes induced by pesticidal stress lead to metabolic disturbances, inhibition of important enzymes, retardation of growth and reduction in the fecundity and longevity of the organisms. Liver, kidney, brain and gills are the most vulnerable organs of a fish exposed to the medium containing any type of toxicant.[11]

The oxygen uptake of an organisms is considered to be an index for demonstrating the intensity of metabolism. Generally, with an increase in metabolic activity the rate of oxygen uptake also increases. Oxygen uptake in a fish depends on various intrinsic and extrinsic factors. Mean oxygen consumption was observed more when the fishes were kept without access to air in comparison to the condition of the fishes with access to air.[6] Oxygen consumption of *Clarias batrachus* in the present investigation were decreased after administration of 1/3rd of LC_{50} dose of pesticide indicating that the metabolic activities of pesticide exposed fishes decreased which might be due to decrease in hemoglobin affecting the physiological activities are affected. Decrease in the level of hemoglobin has been reported in *Clarias batrachus* intoxicated with fenvalerate.[17] Alterations in oxygen consumption may be due to respiratory distress as a consequence of impaired oxidative metabolism.[22]

In air breathing fishes such as *Clarias batrachus*.[32] a reduction in oxygen consumption had, always been observed when they were kept immersed in well irritated water without access to air. The effect of fenvalerate on *Clarias batrachus* might have been through failure or suppression of normal mechanisms promoting erythropoiesis or deficiency of some factors required for the maturation of the red cell. The causes of leucopenia observed in the present study are supposed to be according to the degeneration, depression, depletion and destruction of the blood forming materials by these compounds.[17]

Turmeric (*Curcuma longa*), a medicinal plant, has been used for thousands of years in Indian ayurvedic medicine. Components of turmeric are collectively termed as curcuminoids, which mainly include curcumin (diferuloyl methane), demethoxycurcumin and bisdemethoxy-curcumin.[1] But the major biologically active component of turmeric is curcumin, which is a yellow phytochemical, hydrophobic and polyphenolic compound. Immunostimulatory effect of curcumin was also observed in *Labeo rohita*.[3] The antioxidant property and the protective effect of curcumin found in *Curcuma longa* extract has played the important role to restore the physiology conditions[37,39] which further caused to ameliorate rate of oxygen consumption of the fish intoxicated with fenvalerate.[38]

CONCLUSION

Thus, it is concluded that fenvalerate causes alteration of oxygen consumption rate of the fish due to least energy requirements in the fishes which were not able to tolerate the stressed condition. The turmeric was able to combat the pesticidal toxicity in *Clarias batrachus.*

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