Effect of Monocrotophos on Histopathological Changes in Gills of an Air Breathing Fish *Channa gachua* (Ham.)

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Abstract

Gills are the most vital organs in all aquatic animals including fishes which carry out respiration and osmoregulation. The gills are the first target site organ which is affected severely on exposure to various aquatic pollutants as they are continuously bathed in the surrounding water. Since gills have a key role in the transport of oxygen for the metabolic activities, hence they serve as an ideal material for studies on the effect of toxic pollutant on respiration. Thus, the study of gill pathology is important in understanding the biological response of aquatic animals to a variety of aquatic pollutants. *Channa gachua* is a fresh water fish, but occurs also in muddy water. In aquatic resources, fishes are sensitive to the toxic substances mixed into water and deleterious effect of metals or heavy metals on fishes. The toxic substances caused damage to the organism and degree of the cell damage reflects the various concentrations of the pollutants. In the present study an attempt has been made to study the effects of monocrotophos, an industrial as well agricultural effluent on *Channa gachua*. 50% mortality was exposure to monocrotophos on 0.4 ppm at 96 hours respectively. The impact of monocrotophos on the gill of *Channa gachua* showed gill filaments were twisted and primary axis was in filtered. The gill exhibited a film of coagulated mucous over the gill surface.

Keywords: Monocrotophos, histopathology, toxicity, *Channa gachua*.

Introduction

Oxygen, the most primary necessity for all living organisms for survival and it provides energy for vital activities of organisms. The toxic substance alter the chemical properties of aquatic body, thereby brings about behavioural, physiological and biochemical changes in fishes. The organophosphate insecticides are liquids of liphophilic character, and some volatile and a few are solids. The organ phosphorous inhibits the variety of esterases but associated with cholinesterase inhibition. Increasing industrialization leads to continuous addition of harmful pollutants in the environment especially in water. Monocrotophos, one of the organophosphate is becoming the serious pollution threats to public health. The insecticides were affected the aquatic ecosystem, especially fishes. This biochemical changes inhibited the slow blood flow as compared to the cardiac output as well as association of hepatocytes in mammal (Hinton and Lauren, 1990).The domestic sewage, agricultural pesticides, industrial waste are harmful to the threatened status of fishes or aquatic life. The fish population was hampered because of the daily used agricultural pesticides. The world wide uses of chemicals are very hazardous to high risk of toxicity and environmental pollution of the other organism (Rao *et.al*., 2005). The polluted water is not suitable for drinking by physico chemical properties and microbial activities which shows microbial content infection. The deeper depth of water should carry out at the tar sand in which presence of potential elements (Parihar *et.al*., 2012; Odunaike *et.al.*, 2013). Pollution has been occurred by most of the human interference and daily used products which are hazardous to the environment (Abbai and Sunkad, 2013). Uncontrolled discharged of pollutants into any water body degrades the water quality to such an extent that it produced lethal effects on the fish fauna. The extent and degree of their harmful effect on fish can be gauged to a greater extent by experimental studies in a laboratory

(Sonaraj *et. al.*, 2005). In the environment, metals are anthropogenic sources and natural spectrum (Sajid and Muhammad 2006). The submerged and industry less zone surrounding supply of water was tolerant to fish cultivation (Hossain *et.al.*, 2013) the water conductivity total dissolve oxygen (TDS) and carbon oxygen demand (COD) was significant (Kushwah *et. al.*, 2012). Fishes come in contact to the various metals which are very hazardous to the aquatic environment. The aquatic life, fishes, are highly sensitive to a toxic substances present in water and deleterious effects of the metals on fishes can be easily established (Ayyappan, 2000; Revathi *et.al.*, 2003; Baird and Girard 1853; Wooten *et.al.*, 1988; Fuller *et.al.*, 1999). The *Channa gachua* is introduced as a bio-control for various countries and is commonly present in ponds and lakes and are easy to maintain in the aquarium. Gills perform various functions like respiration, osmoregulation and excretion of nitrogenous wastes. Hence gills are an important biomarker of water pollution and good indicator of water quality. The histopathological studies of gills in *Channa gachua* on exposure to malathion shows primary makers gills are aquatic pollution (Cengiz and Unlu, 2001; 2003).

Materials and Methods

Live specimens of *Channa gachua* were procured from local fish dealers at Hazaribag (Latitude 25º 59'N and Longitude 85º 22'E) and maintained in large glass aquaria size (90x60x60cm) with continuous flow of water. The specimens were fed on chopped goat liver daily during a minimum acclimation period of 15 days in the laboratory. Thus the fish could exchange gases with water by way of its gills as well as with the air using the supra branchial chamber. The fish were acclimatized to the respirometers for at least 12 hours before the readings were taken. The experiments were conducted at 29.0 ± 1.5°C. However, sexually mature fishes of almost same weight group (40-50g) were used. The water was stored for 15 days so as to be free from chlorine. The aged water was used for acclimatization and for making test solution. After acclimatization, fishes were collected, weighed on weighing balance and divided into six groups having ten fishes, out of six groups, one group was considered for control and remaining five groups were exposed to 0.2, 0.4, 0.6, 0.8 and 1.0 ppm concentration to chronic duration of 24, 48, 72 and 96 hours (Pandey *et al*., 2011). The tests were carried out again for about 10 times and the results were calculated. After stipulated time, the fishes were sacrificed, tissue was fixed in 10% formalin and processed for histological studies (Godkar and Godkar , 2003).

Results and Discussion

The impact of monocrotophos on the mortality of *Channa gachua* shows that 0.4 ppm at 96 hours exposure, the gills exhibited a film of coagulated mucous over the gill surface (figure-4). The gills of *Channa gachua* showed lamellar epithelial cells changed, twisted tips of gill filaments and primary axis infiltration of cells respectively (figure-2 and 3). The epithelial cells of secondary gill filaments also degenerated by changed effect of monocrotophos (figure- 1 and 2). Also, fusion and shortening of secondary lamellae was observed (figure-3). Edematous separation of gill epithelial and desquamated secondary lamellae was observed (Figure-2). Degenerated secondary lamellae and pycnotic nuclei were also observed. All the changes were pronounced in 0.4 ppm at 96 hours monocrotophos exposed in *Channa gachua* depend on the quantity of the pollutants reaching the gill ventilation volume as well as concentration of the pollutants in the water (Llyod, 1960). Since gills are continuously bathed by polluted water that brings more pollutants in contact with gill epithelium due to heavy metal salts, detergents, and phenol toxicity (Hughes and Morgan , 1973) respectively.

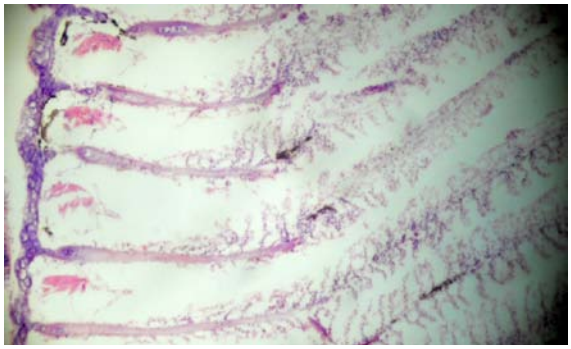

Fig. 1. Control gills showing, secondary gill filament (SGF), respiratory gill filament (RGF), primary axis (P) and respiratory filament (RF) in *Channa gachua*.

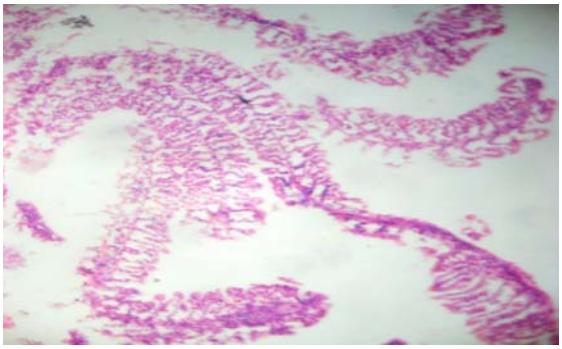

Fig. 2. Experimental gills showing secondary gill filament (SGF) and respiratory filament (RF) in *Channa gachua*.

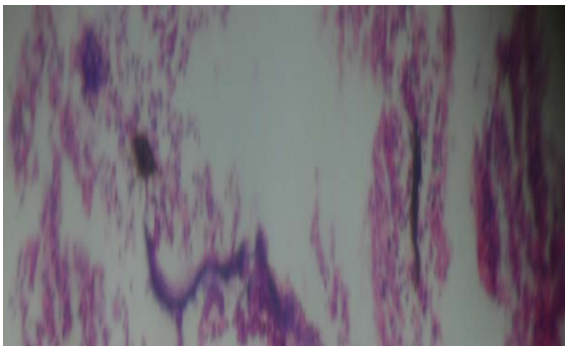

Fig. 3. Gill showing, hemorrhages in secondary gill filaments (HGSGF) and necrosis in secondary gill filaments (NGSGF) in *Channa gachua*.

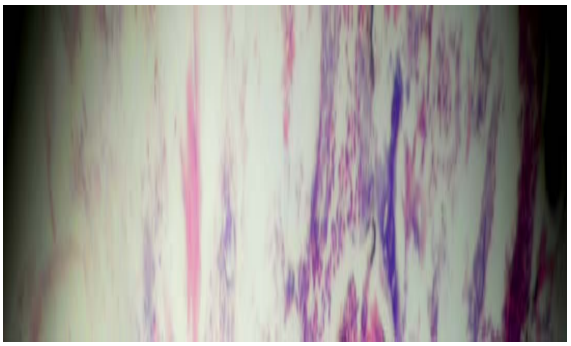

Fig. 4. Gill showing, clubbing of secondary gill filaments (CSGF), severe necrosis in inter lamellate space (SNILS) and separation of epithelial layer in SGF and infiltration of respiratory lamellae in *Channa gachua*.

In the present investigation the monocrotophos induced architectural changes in gill of *Channa gachua*. It includes bulging of lamellae and structural disorganization of primary gill lamellae. There is fusion and destruction of secondary gill lamellae, which is main seat of gaseous exchange. In respiratory epithelium hyperplasia is observed. Excess of mucus secretion and disorganization of gill lamellae took place. The fish exposed to monocrotophos indicates that disturbance in proper gaseous exchange and also affect osmoregulation. Swelling in the gill epithelia, unusual enhancement in the rate of mitosis which stimulate epithelial cells to give effect to bulged out or swollen condition. Vacuoles and damaged gill lamellae and damage to respiratory epithelium hematomas. The epithelial lesions observed on the respiratory surface, due to collapse of pillar cells, increasing number of mucous openings and mucus secretions are due to the hyperplastic condition. In gills clubbing, hyperemia, and edema were observed. The toxic substances or pesticides normally attacked the respiratory organ (Ferguson, 1967). If oxygen decreases, the gills probably consume more pesticide through the polluted water (Ferguson and Bingham, 1966). The intimate contact of the gills with the polluted water may lead to alterations in normal respiratory mechanism, lower the diffusion mechanism through the gill and thereby oxygen consumption is reduced, which creates a

physiological imbalance to the organism (Finney and Berman,1976). After some time they showed vigorous fin movement with fast swimming than normal. The fish remained at the corner of the bottom part of container with continuous gill or operculum movements. They loss balance and went deep by keeping head down in position and touching the bottom of container. If fishes were disturbed, they showed sudden body pulses. When they died they appeared slimier than control due to the secretion of large amount of mucus on their body. There are also little changes in body weight and water content of body due to susceptibility of fish to monocrotophos pesticide. Supportive cartilage was also observed in secondary gill lamellae, in primary gill filament of cartilage or fusion of supportive cartilage. Destruction of epithelial lining of gill lamella and supporting cartilage directly affect on the respiration of fish. Due to accumulation of monocrotophos in the nucleus of cells, it is densely staining and this can affect nuclear function. Due to the secretion of mucus which filled the space between gill filament and gill lamellae, ultimately affecting the gaseous exchange leading to stasis of blood and death of the fish. In support of this, done in laboratory conditions, proved that heavy metal mixtures cause the histopathological changes (Vinodhini and Narayanan, 2009) respectively. The present result concluded that the histopathological changes found in gills of the examined freshwater fish are typical for the clinical finding in aquatic habitats polluted with heavy metals. Influence of water pollution is not only devastating to human being, animals, insects but also aquatic organisms. The more polluted industrial water destroys the aquatic ecosystem and reduces its biodiversity. The decrease in the rate of oxygen consumption after exposure to monocrotophos is due to the sluggishness of the fish, as a result of the pesticide stress and also the secretion of excessive mucous, which formed a thin film over the gill thereby preventing absorption of oxygen during the process of gaseous exchange. The present study also suggests that, the monocrotophos pesticide is very harmful to the aquatic life especially to the fishes, and there is urgent need to control this water pollution.

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References

Abbai, S.S. and Sunkad, B. N. 2013. Effect of anthropogenic activities on zooplankton population of sogal pond, Belgaum District, Karnataka, India. *Res. J. Recent Sci.* **2(7):** 81-83.

Ayyappan,. K. 2000. *Studies on the impact of coal carbonization and fertilizer plant combined effluent in relation to abiotic and biotic components of a riverine ecosystem.* Ph. D. thesis, Annamalai University, Tamil Nadu.

Baird, S.F. and Girard, C. 1853. Descriptions of new species of fishes collected by Captains R. B. Marcy, and Geo. B. MasClellan, in Arkansas. *Proc. Acad. Nat. Sci. Phil.* **6:** 390- 392.

Cengiz, E. I. and Unlu, E. 2001. Histopathological changes in the gills of mosquito fish, *Gambusis affinis* exposed to endosulfan. *J. Environ. Conta. Toxicol.* **68:** 290-296.

Cengiz, E. I. and Unlu, E. 2003. Histopathology of gills in mosquito fish, *Gambusia affinis* after long term exposure to sub lethal concentration of malathion. *J. Environ. Sci. Health. Bd*. **38:** 581-589.

Ferguson, D.E. 1967. The ecological consequences of pesticide resistance in fishes. *Bull. Environ. Contam. Toxicol.* **1:** 97-103.

Ferguson, D.E. and Bingham, C.R. 1966. The effect of combination of pesticides on susceptible and resistant mosquito fish. *Bull. Environ. Contam. Toxicol.* **1:** 97-102.

Finney, L. and Berman, E.R.1976. *Invest. Opthamol*. **15:** 789-792.

Fuller, P. L., Nico, L.G. and Williams, J. D. 1999. Non indigenous fishes introduced into inland water of the United States. *J. Am. Fish. Soc. Pub.* **27:** 613-619.

Godkar, P. B. and Godkar, D.P. 2003. ***Text Book of Medical Laboratory Technology***, Bhalani Publishing House, Mumbai, India. 570 pp.

Hinton, and Lauren. 1990. Liver structural alterations accompanying chronic toxicity in fishes potential biomarkers of exposure. p. 17-51. *In*: *Biomarkers of Environmental Contamination* (J. F. McCarthy,. and L. R. Shugart, eds.). Lewis Publishers, Boca Raton.

Hossain, M. A., Sujaul, I. M. and Nasly, M.A. 2013. Water quality index an indicator of surface water pollution in eastern part of Peninsular Malaysia. *Res. J. Recent Sci.* **2(10):** 10- 17.

Hughes, G. M. and Morgan, M.1973. The structure of gills in relation to their respiratory function. *Biol. Rev*. **48:** 419-475.

Kushwah, R. M., Malik, S. and Singh, A. 2012.Water quality assessment of raw sewage and final treated water with special reference to waste water treatment plant. Bhopal, (MP.) India. *Res. J. Recent Sci*. **1:** 185-190.

Llyod, R. 1960. The toxicity of zinc sulphate to rainbow trout. *Ann. App. Biol.* **48:** 89-94.

Odunaike, R.K., Fasunwon, O.O., Akinyemi, L.P. and Odusote, O.O. 2013. Physical chemical characterization of oil sands at Lmeri in Ogun state of South West, Nigeria. *Res. J. Recent Sci*. **2(8):** 1-7.

Pandey, K., Shukla, J. P. and Trivedi, S. P. 2011. ***Fundamentals of Toxicology.*** New Central Book Agency, Kolkata, India. 380 pp.

Parihar, S.S., Kumar, A., Gupta, R. N., Pathak M., Shrivastav, A. and Pandey, A.C. 2012. Physico chemical and microbiological analysis of under ground water in and around Gwalior City, MP, India. *Res. J. Recent Sci.* **1(6):** 62-65.

Rao, J.V., Begum, G., Shridhar, V. and Reddy, N. C. 2005. Effect of monocrotophos on locomotor behaviors and gill architecture of the mosquito fish, *Gambusia affinis*. *J.Environ. Sci. Helth. Bull.* **40:** 813-825.

Revathi, K., Sharmili, R. and Usha, S. 2003. Biochemical studies on the effect of organophosphorous compound on *Sarotherodon mossambicus. J. Exp. Zool. India.* **6:** 365-368.

Sajid, A. and Muhammad, J. 2006. Studies on acute toxicity of metals to the fish *Catla catla. Pak. J. Biol. Sci*. **9:** 1807-1811.

Sonaraj, I. R., Ranjitsingh, A. J., Pushparaj, A. and Ramathilagam, G. 2005. Pesticidal stress influenced respiratory alterations in the fresh water fish, *Mystus vittatus. Indian J. Environ. Ecoplan.* **10:** 803-806.

Vinodhini, R. and Narayanan, M. 2009. Heavy metal induced histopathological alterations in selected organs of the *Cyprinus carpio*. *Int. J. Environ. Res.* **3:** 95-100.

Wooten, M. C., Scribner, K. T. and Smith, M. H. 1988. Genetic variability and systematic of *Gambusia affinis* in the South Eastern United States. *Copeia.* **2:** 283-289.