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ACUTE TOXICITY OF AN ORGANOPHOSPHATE, DIMETHOATE TO AN AIR BREATHING FISH, *Colisa fasciatus* (Bl. & Schn.)

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ABSTRACT

Acute toxicity bioassay was carried out in a static renewal system to assess the toxicity of dimethoate to *Colisa fasciatus.* Mortality was recorded at 24, 48, 72 and 96 hr exposure and data was analyzed by US EPA software version 1.5 based on probit methods to calculate LC_{50} values and 95% lower and upper confidence limits. LC_{50} values of dimethoate for 24, 48, 72 and 96 hr were found to be 22.15 mg/L, 21.99 mg/L, 21.74 mg/L and 21.65 mg/L, respectively. Behavioral alterations such as decreased opercular movement, surfacing, abnormal swimming, increased mucus secretion and loss of balance were also observed in the exposed fishes.

KEYWORDS : Acute Toxicity, LC_{50}, Dimethoate, *Colisa fasciatus*

While liberal use of chemical fertilizers and synthetic pesticides helped in ensuring food security to rising population, it inflicted severe injury to the environment especially to the health of soil and aquatic ecosystem. Non target organisms including fish suffer from pesticide pollution directly or/and through food chain in water bodies receiving industrial effluents and runoff water from agricultural fields. Most pesticides used in agriculture and in hygiene programs are non selective, more or less persistent and bioaccumulate in the food chain and pose great danger to the health of non target organism in fresh water (Ramaneswari and Rao, 2008; Amanchi and Hussain, 2010).

Although mostly pesticides occur at low concentrations in ponds and other water bodies, they create serious problems for non-target aquatic biota, especially the fishes, due to their extensive range of biological activity, affinity and stability. Fishes are one of the most susceptible animals to pesticide pollution because of their anatomy and physiology. Fishes live in intimate contact with surrounding water through their gills and branchial surface comprises over half the surface area of the body. Only a few microns thick delicate gill epithelium separates the internal environment of fish from external aquatic environment which makes the fish very susceptible to aquatic pollutants. Therefore, contamination of water bodies by pesticides causes acute and chronic poisoning of fish and results in severe damage to vital organs (Singh et al., 2009; Singh, 2012, 2013).

Dimethoate is a broad spectrum systemic organophosphate insecticide active against acaridae, aphididae, aleyrodidae, coccodidea, coleoptera, collembola, diptera, lepidoptera, pseudococcidae and thyanoptera in cotton, cereals, fruits, vegetables, tea, coffee, tobacco and pastures (Aysal et al., 2004). Like other organophosphates, dimethoate is an inhibitor of acetyl cholinesterase and causes accumulation of acetylcholine in nerve tissue and effecter organs with the principal site of action being the peripheral nervous system (Cope, 2004). The accumulation of acetylcholine results in a prolonged stimulation of the cholinergic receptors downstream leading to intense activation of autonomic nervous system, which depending upon the severity of acetyl cholinesterase inhibition results in tremors, convulsion, respiratory arrest and death (Breckenridge and Stevens, 2008). Though the organophosphate pesticide may disappear rapidly from the body either by hydrolysis or elimination, long term and repeated exposure to these pesticides have cumulative effect on fish.

MATERIALS AND METHODS

Fish were collected from local ponds with the help of fishermen and carefully packaged into aerated polythene bags filled with tube well water. In the laboratory fishes were disinfected by treatment of 0.05% potassium permanganate and transferred into plastic pools of 500 liter capacity for one week acclimatization to laboratory conditions. During acclimatization water of the tank was

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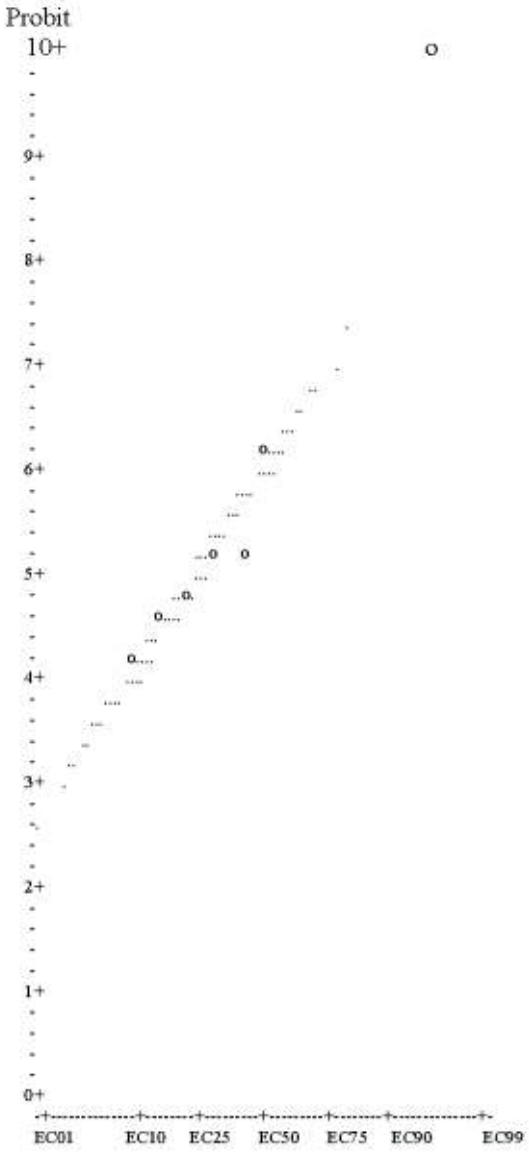

Figure 1 : Plot of Adjusted Probits and Predicted Regression Line

changed daily and fish were fed dried shrimp twice a day.

The experiment was conducted under natural photoperiod and temperature in the month of January. The temperature of the experimental water was 17±2 ºC, pH was 7.4 ± 0.2, Dissolved oxygen was 7.8 ± 0.4 mgl^{-1}, free carbon dioxide was 6.2 ± 0.4 mgl^{-1} and total hardness as calcium carbonate was 115 ± 2.8 mgl^{-1}.

Colisa fasciatus individuals of size, 5.8±1.4 cm, and weight, 7.5±3 gm were sorted and starved for 24 hr before starting the experiment. Stock solution of dimethoate (EC 30%, Rallis India Ltd) was prepared in absolute alcohol. Two replicates of each test concentration along with a control were used in the experiment. After determining the range of acute toxicity, eight test concentrations viz. 20.5, 21.0, 21.5, 22.0, 22.5, 23.0, 23.5, 24.0 mg/L and a control was run in each set. Stock solutions were thoroughly mixed in trough water before releasing the fishes. Five individuals were released in each test concentration and control, and mortalities were recorded at 24, 48, 72 and 96 hr. Mortality data was analyzed by USEPA software version 1.5, based on probit analysis to determine LC_{50} values and 95% lower and upper confidence limits.

Behavioral parameters were recorded during first six hours and then at 24, 48, 72 and 96 hr.

LC_{50} values, 95% lower and upper confidence limits for different periods of exposure are given in table 1 and plot of adjusted probits and predicted regression line as obtained after analysis of 96 h mortality data by USEPA software version 1.5 is given in figure 1.

RESULTS AND DISCUSSION

No mortality was observed at and below 20.0 mg/l, but 100% mortality occurred at 24.0 mg/l within 96 hr of exposure. LC_{50} values, 95% lower and upper confidence limits exhibit decrease with increasing duration of exposure. Behavioral alterations like uncoordinated movements, erratic swimming, convulsions, excess mucus secretion, decreased opercular movements, loss of balance, drowning and change in body pigmentation became more apparent with increase in duration of exposure at all test concentration.

The results of the water quality of the tap water used in the bioassay are in the normal range and suggest that parameters of the test water were not the cause of fish mortality. However, temperature, hardness, pH, alkalinity and biological factors such as sex, age, health, weight and physiological status are reported to have profound effects on the acute toxicity of pesticides (Table).

Toxicity of dimethoate to *Colisa fasciatus* is relatively lower when compared to other air breathing fishes. The 96 hr LC_{50} value of dimethoate (21.42 mg/l) found in the present work is higher than 17.9 mg/l of *Channa punctatus* (Srivastava and Singh, 2001) and 2.98 mg/l of *Heteropneustes fossilis* (Pandey et al., 2009). However, dimethoate is reported to be far less toxic to *Clarias batrachus* (Begum and Vijayaraghavan, 1995) with 65 mg/l as 96 hr LC_{50} value. In contrast, very low LC_{50} values have been reported for dimethoate in carp fishes. 0.007ppm is reported as 96 hr LC_{50} value for dimethoate in *Catla catla* (Kumar and Singh, 2000) and 1.60 mg/l in *Cyprinus carpio* (Singh et al., 2009). Wide differences in LC_{50} values of air breathing and carp fishes reflect greater resistance of air breathing fishes to dimethoate which probably occurs due to their ability to adaptively shift towards aerial breathing in contaminated water. Different LC_{50} values of dimethoate in different fish species occur probably due to differences in susceptibility and tolerance related to differences in rates of accumulation, biotransformation and excretion of toxicant.

Table

Duration Of exposure (hr)	LC_{50} (mg/l)	95% lower Confidence limits	95% upper Confidence limits
24h	22.15	21.93	22.36
48	21.99	21.74	22.24
72	21.74	21.51	21.95
96	21.42	21.42	21.86

At lethal concentrations, dimethoate toxicity like other organophosphate is rapidly reflected in behavioral alterations of exposed fishes. Decrease in opercular rate appears to be an effort of exposed fish to reduce contact of gill epithelium with the poison. To compensate for the loss of oxygen uptake from water fish frequently swims to the surface to gulp air. Increased mucous secretion probably helps in countering irritating effect of dimethoate in skin and mucous membrane. Excitement, hyperactivity and abnormal jerky swimming observed in exposed fishes may be caused by accumulation of neurotransmitter in neuro-muscular junctions. Loss of balance and drowning reflect the progression towards death as fish succumbs to the continued high exposure of dimethoate. Similar alterations in behavior of dimethoate exposed fish have been reported earlier in *Heteropneustes fossilis* (Pandey et al., 2009) and *Cyprinus carpio* (Singh et al., 2009).

It is concluded that dimethoate is highly toxic to fish which is swiftly reflected in behavioral alterations culminating in death. Further studies on toxicity of dimethoate and its combinations with other pesticides in laboratory and field may help in deciding judicious use of the pesticide.

REFERENCES

Amanchi N.R. and Hussain M.M., 2010. Cytotoxicity of assessment of monocrotophos in *Paramecium caudatum* and *Oxytricha fallax*. J. Environ. Biol., **31**: 603-607.

Aysal P., Tiryaki, O. and Tuncbilek, A.S., 2004. Dimethoate residues in tomato and tomato products. Bull. Environ. Contam. Toxicol., **73**: 351-357.

Begum G. and Vijayaraghavan S., 1995. In vivo toxicity of dimethoate on proteins and transaminases in the liver tissue of freshwater fish *Clarias batrachus* (Linn.). Bull. Environ. Contam. Toxicol., **54**: 370-375.

Breckenridge C.B. and Stevens, J.T., 2008. Crop Protection Chemicals: Mechanism of Action and Hazard Profiles. In: Principles and Methods of Toxicology (Ed. A.W. Hayes). CRC Press, Taylor and Francis Group, Boca Raton : 727-774.

Cope W.G., 2004. Exposure Classes, Toxicants in Air, Water Soil, Domestic and Occupational Settings. In: A T. B. of Modern Toxicology (Ed. E. Hodgson). John Wiley and Sons Inc., New Jersey, USA : 33-48.

Kumar S. and Singh, M., 2000. Toxicity of dimethoate to a fresh water teleost *Catla catla*. J. Exp. Zool. India, **3**: 83-88.

Pandey R.K., Singh R.N., Singh, S. Singh, N.N. and Das, V.K., 2009: Acute toxicity bioassay of dimethoate on freshwater air breathing catfish *Heteropneustes fossilis* (Bloch). J. Environ. Biol., **30**: 437-440.

Ramaneswari K. and Rao L.M., 2008. Influence of endosulfan and monocrotophos exposure on the activity of NADH cytochrome c reductase (NCCR) of *Labeo rohita* (Ham). J. Environ. Biol., **29**: 183-185.

Singh R.N., Pandey R.K., Singh N.N. and Das V.K., 2009. Acute toxicity and behavioral responses of common carp *Cyprinus carpio* (Linn.) to an organophosphate (Dimethoate). WJZ, **4**: 70-75.

Singh R. N., 2012. Histopathological alterations in the kidney of *Cyprinus carpio* after exposure to dimethoate (30%). Indian J. Sci. Res., **3**: 127-131.

Singh R. N., 2013. Effects of dimethoate (30%), an organophosphate pesticide on liver of common carp, *Cyprinus carpio*. J. Environ. Biol., **34**: 657-661.

Srivastava V.K. and Singh A., 2001. Studies on seasonal variation in toxicity of frequently used commercial organophosphates, carbamates and synthetic pyrethroid pesticides against freshwater fish *Channa punctatus* and behavioral responses to treated fish. Malay. Appl. Biol., **30**: 17-23.