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Lethality of Quinalphos on *Oreochromis mossambicus*

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A B S T R A C T

Pesticide production and usage are inseparable from modern agricultural practices posing detrimental ecological consequences. Fishes are sensitive bioindicators of aquatic environment and the intensity of susceptibility of fish to xenobiotic depends on fish species, the concentration of the toxicant and the duration of exposure. Studies on quinalphos toxicity and oxidative stress in fish are not well elucidated though quinalphos is extensively used due to its biodegradability and its hazardous effects against nontarget organisms are recorded, the present work evaluates acute toxicity of quinalphos to *Oreochromis mossambicus.* Acute toxicity was carried out doing static renewal method and LC50of quinalphos for *Oreochromis mossambicus* was calculated.Lethal concentration was 0.024mg/L calculated according to Probit analysis. The upper 95% confidence limit was 0.027mg/L and lower 95% confidence limit was 0.021mg/L.

Keywords: Pesticide, Quinalphos, L_c 50, *Oreochromis mossambicus*

INTRODUCTION

Quinalphos is an organophosphate considered less persistent and widely used in aquaculture for killing ectoparasites and controlling weeds. The non-judicious use of the pesticides leads to contamination. Quinalphos is an organophosphate classified as yellow labelled (highly toxic) pesticides in the Indian subcontinent but as a moderately hazardous pesticide by World Health Organization (WHO) and banned in few countries due to its toxicity (Hemalatha *et al*., 2015). Quinalphos is a non-systemic pesticide used for control of wide variety of pest of crops like coffee, tea, sugarcane, wheat, corn, cotton, paddy, potato, soya bean, coconut, and fruits and vegetables. The indiscriminate use of pesticides results in environmental contamination and impose toxic hazards to non-target organisms. Pesticides reach aquatic environment through industrial effluents, drifts and surface runoff from area of application, washing of spray equipment's after spray operations and handling during production, transport and storage. Aquatic environment forms the ultimate receptacle of all pesticides applied in agriculture intentionally or unintentionally. Uncontrolled use of pesticides in agriculture and public health has created an ecological imbalance and the non-target organisms being the victim of pesticide toxicity. The pesticides reach streams, rivers, lakes, ponds resulting in toxic hazards to aquatic organisms. Fishes are an important ecological link between the lower organisms that it consumed as food and the higher organisms that consumes it as food and hence the most affected of pesticide toxicity. Skin, gills and ingested food materials are the sources through which pesticides enter the body of fish. The toxicity of pesticides in fish reaches birds, mammal especially human that consume fish.

The effects of quinalphos may be acute causing death of fish population or sometimes chronic when the pesticide is applied a greater number of times at sub lethal level. The persistence of quinalphos in the natural environment depends on its interaction with the biotic and abiotic factors of the aquatic medium which in turn influences the fish population. The Food Safety and Standards Authority of India (FSSAI, 2011) has recommended a tolerance limit of 0.01 ppm of quinalphos for fish, paddy and cardamom. Quinalphos yields metabolites through hydrolysis, oxidation, dealkylation and isomerization process that may be more toxic and persistent than the parent compound (Gupta *et al.*, 2011). The metabolites of quinalphos are quinalphosaxon, O-ethyl-O-quinoxalin-2yl phosphoric acid,2-hydroxyquinoxaline-quinoxaline-2-thiol.

QUINALPHOS AND TOXICITY

Most of the ecotoxicological studies have focused attention on aquatic environment as it is the ultimate sink for toxic compounds. Fish is a sensitive indicator of health of an environment hence used for toxicological studies. The economic importance of fish makes it a valuable model of study. Aquatic toxicology is the study of natural and synthetic chemicals on aquatic organism in its environment from subcellular activities to

organisms, population and ecosystem both under natural conditions and laboratory conditions. Toxicity of aquatic organisms reflect the environmental hazards caused by a chemical and its impact on an organism as well as population. The toxicity of a pesticide solely depends on the concentration of the pesticides in the aquatic system and organism. The toxicity on non-target organisms are species specific. The deleterious effects the pesticides imposed on target organism is a concerned and the presence of quinalphos in aquatic environment has been reported.

Toxicity is assessed using acute toxicity and chronic toxicity studies. Acute toxicity measures the toxic effects leading to lethality at high concentration of the chemical exposed for a short duration of time. Chronic toxicity studies depict the toxic effects that appear on sub lethal exposure for a longer period of time as assessed in cellular, molecular, physiological, hematological, histopathological, biochemical and behavioral studies. Aquatic ecosystems are exposed to quinalphos that reaches from agricultural land and it is difficult to assess the impact of quinalphos in water column due to low solubility and rapid degradation. The monitoring of toxicity of quinalphos is of importance as they are highly toxic to aquatic organisms. Studies on quinalphos toxicity and oxidative stress in fish are not well elucidated though quinalphos is extensively used due to its biodegradability and its hazardous effects against nontarget organisms are recorded, the present work evaluates acute toxicity of quinalphos to *Oreochromis mossambicus.*

MATERIAL AND METHODS

Technical grade quinalphos 25% EC was procured from Anjiparambil Traders, Ernakulam. It was stored under refrigerated conditions. For the experimental purpose a stock solution of 100mg/litre was prepared.

Oreochromis mossambicus was procured KUFOS campus Vypeen, Ernakulam, India and transported to laboratory under aerated conditions. Fish were kept in aerated tanks for two-week acclimatization to laboratory conditions and provided with commercial dry feed pellets ad libitum having 40% protein content.

EXPERIMENTAL DESIGN

The experiment was carried out in tanks of 50 litre capacity (60x30x30cm). Before introducing the fish, the tanks were filled with 15 ppm potassium permanganate and kept overnight. The tanks were properly cleaned with water and washed three times and chlorine free water was added up to the 40-litre mark. The temperature in the tanks during the experiment was maintained at 26 to 27°C, pH at 7 to 7.5, Dissolved oxygen 6 to 6.8 mg/L and salinity at 0 ppt. The water in the aquarium was changed every day and proper photoperiod of 13hours light and 11hours dark was maintained. Feeding of fish were done one hour before changing the water. Fish weighing 25$\pm$1.8 g of length 12.4$\pm$1.2 cm irrespective of sex were used for study. Fish were introduced at a stocking density of 10 fish/ aquarium and feeding was stopped 24 hours prior to start of experiment. Aeration was maintained with an air stone and a plastic regulator. The tanks were covered by meshed lids.

RANGE FINDING TEST

Prior to acute toxicity test a range finding test was conducted to select the upper and lower limits of acute toxicity value of quinalphos for *Oreochromis mossambicus*. Static non-renewal acute toxicity was conducted minimizing animal killing. The range of concentration used was based on previous studies of quinalphos (0.01, 0.05, 0.1, 0.5, 1, 5 ml/L). The percent mortality for quinalphos was recorded for 24, 48, 72 and 96 hours. The mortality percentage 0-100 for quinalphos was between 0.01- 0.05ml/L in range finding test.

MEDIAN LETHAL CONCENTRATION ($LC50_0$) STUDIES)

Median lethal concentration (LC50) was studied for quinalphos to the fish, *O. mossambicus.* The fish were exposed for 96 hours to different concentrations of quinalphos (0.01, 0.02, 0.03, 0.04 and 0.05 ml/L) and a control was maintained. The experiment was carried out for six concentrations including control with each concentration having three replicates. Static non-renewal acute toxicity was employed and mortality was recorded at 24, 48, 72 and 96 hours. Dead fishes were removed immediately. The mortality in relation to test concentration was maintained and used to determine the median lethal concentration (LC50) for 96 hours using Probit analysis (Finney, 1971)

The temperature in the tanks during the experiment was maintained at 26 to 27°C, pH at 7 to 7.5, Dissolved oxygen 6 to 6.8 mg/L and salinity at 0 ppt. The water in the aquarium was renewed every alternate day and proper photoperiod of 13h light/11h dark was maintained. Fish weighing 25$\pm$1.8 g of length 12.4$\pm$1.2 cm irrespective of sex were used for study.

STATISTICAL ANALYSIS

The LC50 values were calculated using Probit analysis using the statistical software SPSS version 20 (IBM SPSS Statistics, IBM Chicago USA).

RESULT AND DISCUSSION

MEDIAN LETHAL CONCENTRATION, LC_{50} at 96 hours

Acute toxicity was carried out you doing static renewal method and LC50of quinalphos for *Oreochromis mossambicus* was calculated (Table 1). The median Lethal concentration was 0.024mg/L calculated according to Probit analysis (Fig 1). The upper 95% confidence limit was 0.027mg/L and lower 95% confidence limit was 0.021mg/L (Table 2).

Table 1: Table showing percent mortality of *Oreochromis mossambicus* exposed to different concentration of quinalphos for 96 hours.

Sl.No.	Concentration in mg/L	Log 10 of Concentration	No. of Fishes Exposed (n)	No. of Fishes died	Percentage Mortality (%)	Probit Mortality
1.	0.01	-2	10	1	10.00	3.72
2.	0.02	-1.7	10	3	30.00	4.48
3	0.03	-1.52	10	6	60.00	5.25
4	0.04	-1.4	10	8	80.00	5.84
5	0.05	-1.3	10	9.8	98.00	7.05

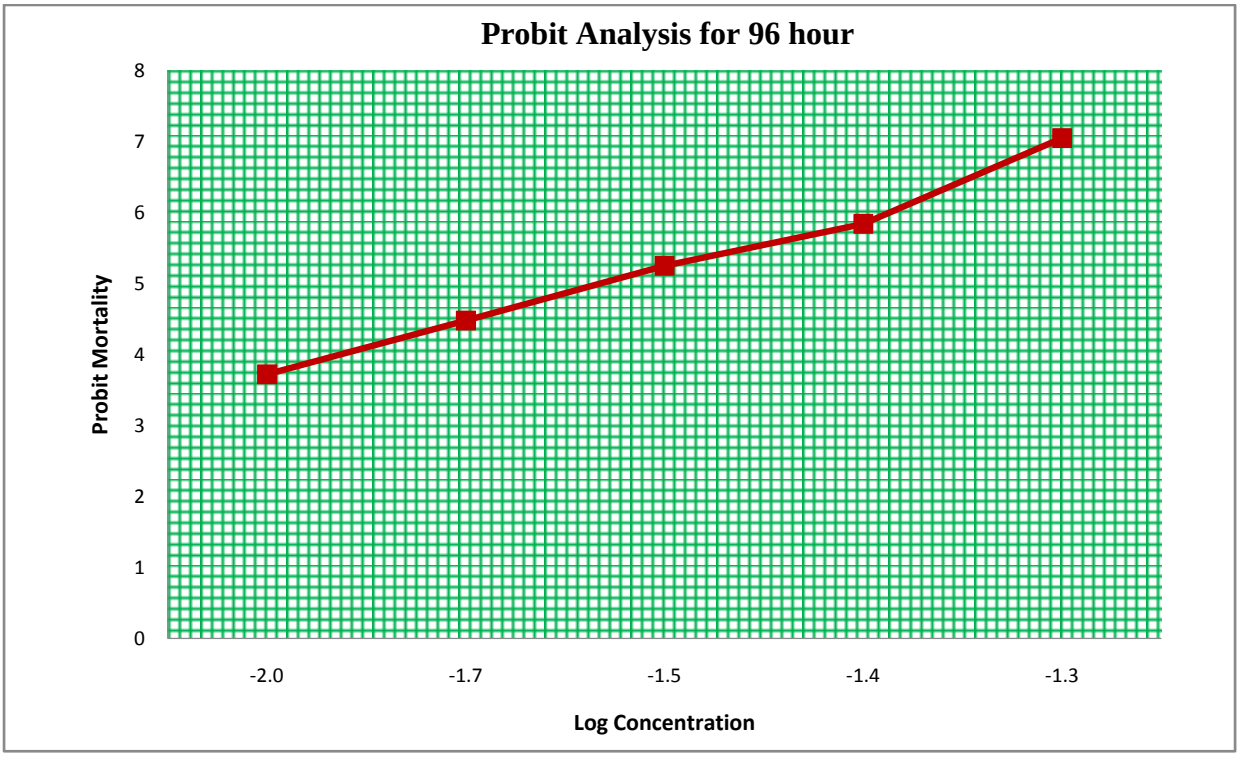

Fig 1: The linear transformation and relationship of Probit of concentrations of quinalphos for *Oreochromis mossambicus* exposed to different concentrations used for determining LC50 values after 96 hours of exposure.

Table 2: Estimation of Probit line LC50

Component	Values
Mean X	**0.027**
Mean Y	**0.230**
Intercept	**6.777**
Beta	**4.188**
LC50	**0.0024**
Lower 95% confidence Limit	**0.021**
Upper 95% confidence Limit	**0.027**
Log(LC50)	**-1.618**
Log Lower 95% confidence limit	**-1.669**
Log Upper 95% confidence limit	**-1.567**

The pesticide residues reach aquatic environment the ultimate Reservoir for anthropogenic activities. Quinalphos, an organophosphate finds its way to aquatic environment as it is widely used in agricultural practices due to its biodegradability. The indiscriminate use of quinalphos has led to its presence in deleterious amount to the aquatic organisms. The penetration of these toxic compounds through skin, gills and food injection induces stress and intoxication in the non-target organism fish. Acute toxicity studies of quinalphos showed LC50 of 0.0024 mg/L for *Oreochromis mossambicus.*LC50 of quinalphos for *Cyprinus carpio* was 7.5 µ/L (Chebbi and David, 2010). The 96-hour LC_{50} of quinalphos for *Cyprinus carpio* fingerlings was 2.75 ppm (Padmanabha *et al.*, 2015). *Oreochromis niloticus* exposed to quinalphos showed 96 hours lc50 of 6.53 µ/L (Greeshma et al., 2019).

The lethality of an organism to a pesticide depends on the entry of the toxicant into the species, its metabolic activity and rate of elimination from its body, the size of an organism and the physical chemical parameters of its environment. Dose and duration of exposure, biotransformation and bioaccumulation are factors concerned with the magnitude of lethality informing that lethality of a toxic compound is species specific (Pickford *et al.,* 2003).

The analysis evidenced that silica nanoparticle is toxic and had a profound impact on*Oreochromis mossambicus*. In the present investigation it isconcluded proper measures to limit the use of such Pesticides, otherwise it will remain inthe ecosystem and through food chain it is accumulated in to the humans.

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