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MONITORING OF TOXICITY OF PESTICIDE IN FISH

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By:

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ABSTRACT

The rapid rise in population is exhausting earth's available resources. Therefore, to sustain the food demand for exponentially growing population through limited cultivation of lands at disposal, several agrochemicals are being used including pesticides. The surface water contamination is mainly owe due to industrial effluents and the agricultural runoff that are directly discharged. Fish & other marine organisms are being impacted strictly due to these highly toxic compounds released. Pesticides toxicity is a function of temperature and as the temperature changes there are significant rise or drop in the toxicity. Considering toxic pesticide Lambda cyhalothrin, the toxicity is increased as the temperature is reduced. The fundamental aim of the study is to evaluate the change in LD_{50} of Lambda cyhalothrin with temperature variation. Grass carp was selected as the test organism for this study. The mortality rate of fish at two different temperatures was evaluated after application of different dosage. The acclimatization period was kept at two weeks. For the experimental setup, 6-glass tanks were used and each constitute 8-fish in the water of 50L capacity and in according to the guidelines of OECD, the fish were not fed during 96 hr experiment. The range of applied dosage ranged between 0.001 µg/L to 4 µg/L. Under these conditions, the LD_{50} was determined and the mortality rate was also monitored. The results concluded that, LD_{50} at 27°C and 13°C was 1.17 µg/L and 1.5 µg/L respectively. Various biomarkers are utilized to assess the impact of pesticides on the fish. The study investigates the different effects of LD_{50} of Lambda cyhalothrin on blood and tissues of fish were studied for sub-acute toxicity test. Between 24 hours to 72 hours, it was observed that there was an increase in blood protein and glucose levels with increasing dose, and decreased at 96 hours. The significant difference (P<0.05) was reported in values of control group and experiment. There was some fluctuation in triglycerides as well with increasing dose concentration and time of study. The significant difference (P<0.05) between experimental and control group was observed. Drastic change in the behavior and swimming patterns were also observed in exposed fish.

Key words: Pesticide toxicity, fish blood, biochemical, sub-acute toxicity, LD-50

Introduction

Pesticides play a vital role in increasing the agricultural yield by acting as protective shield for crops against vector-borne diseases and pest attack but at the same time also cause environmental pollution especially in aquatic ecosystems as it is increasing day by

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day due to widespread pesticide usage in agriculture (Wang et al., 2017). Generally, pesticides come into contact with soil and travel to surface water through runoff and ground water through leaching. These pesticides find their way into water reservoirs, river, stream etc. and alter the chemical composition of theses water bodies which results in adverse impacts on the fresh water fauna particularly fish. Fish is an important food item for human consumption therefore it is significantly important to evaluate adverse effects of pesticides on fish as it plays a major part in food chain (Xing et al., 2012). The pesticides impact on water quality and aquatic biota is associated with the different factors, which includes active ingredient, adjutants and contaminants that exist as impurities in the active ingredient deteriorating water quality (Sharbidre et al., 2011). Due to physiological and structural similarities between pest & non-pest species, Large number of pesticides are also toxic to non-target organisms such as fish alongside with target species. In the past the ecotoxicology studies investigated the fish have considered only one pesticide at a given time, the pesticides investigated includes organophosphate, organochlorine or carbamate pesticides. (Clasen et al., 2018). Fish which is polluted with pesticides is a potential source of direct introduction of insecticides in the fish bodies in aquaculture farms (Nardelli et al., 2004). In this vicious cycle, fish becomes a major source of contamination not only for top marine predators but also for human consumers (Wang et al., 2005 ; Campos et al., 2005). For environmental stressors and pollutants fish have been broadly used as bio-indicator. In the current study grass carp (*Ctenopharyngodon idella*) was chosen as a model organism to monitor the impacts of a pyrethroid pesticide, Lambda cyhalothrin.

Materials and methods:

The fish were acclimatized for the period of two weeks to the laboratory conditions using de-chlorinated tap water whose physicochemical characteristics (pH, dissolved oxygen, temperature, total hardness as CaCO3) were determined according to standard methods mentioned in APHA (2012) regularly. Acute toxicity test was performed in semi-static tanks to determine lethal dose of Lambda cyhalothrin for grass carp following OECD guidelines 203 (OECD, 1992). A set of 10-fish in each tank was exposed to Lambda cyhalothrin for 96h at following sub lethal concentration: 0.25,0.5,0.75,1,1.25 µg/L which corresponds to 96h LD-50 (1.175 µg/L) of Lambda cyhalothrin for grass carp. For biochemical analysis of fish, blood samples were collected from each tank after 24h,48h,72h and 96h in gel activator tubes. Blood serum was separated by centrifugation of blood samples at 1000rpm for 25 minutes. Blood serum was used further by adding different reagents to check parameters by chemistry analyzer.

Results and discussion:

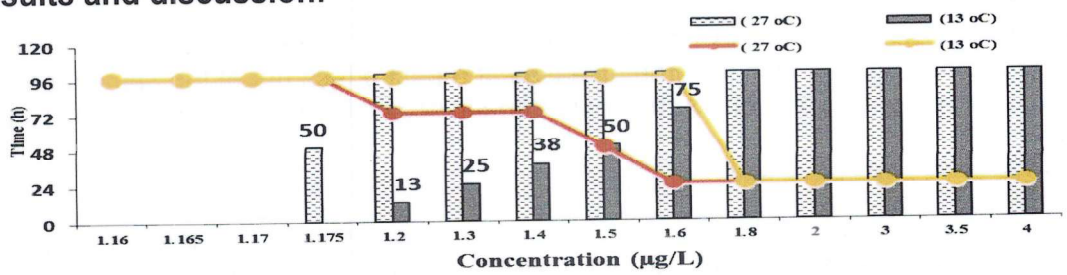


Figure-1: LD-50 of Lambda cyhalothrin

Acute toxicity assessment:

Due to seasonal variation LD-50 determined at 27ºC and 13ºC was 1.17µg/L and 1.5µg/L respectively. Since toxicity of a pesticide varies with the temperature change therefore LD-50 was determined at two different temperatures as reported in the literature, The malathion (a pyrethroid) concentration that resulted in 50% mortality (LC-50; 274.1 µg/L) of the Chinook salmon at 19° C was significantly less than the LC-50 at 11° C (364.2 µg/L) (Dietrich et al., 2014). The concentrations of toxic contaminants which are not active at low and moderate temperature proved lethal with increase in water temperature (Mehta, 2017).

Biochemical analysis of fish blood:

In this study, blood glucose level in exposed fish was increased with the concentration and time period till 72 hours. Then, decline in blood glucose level was observed at 96 hours. The general response of the fish to acute pollutant effects which includes organophosphates and pyrethroids, is that it increases its blood glucose level (Lusková et al., 2002). There was a significant increase ($P<0.05$) in blood glucose level (mg/dl) in 0.25 µg/L compared to 0 µg/L concentration of cypermethrin at both treatments as shown in Figure-2.

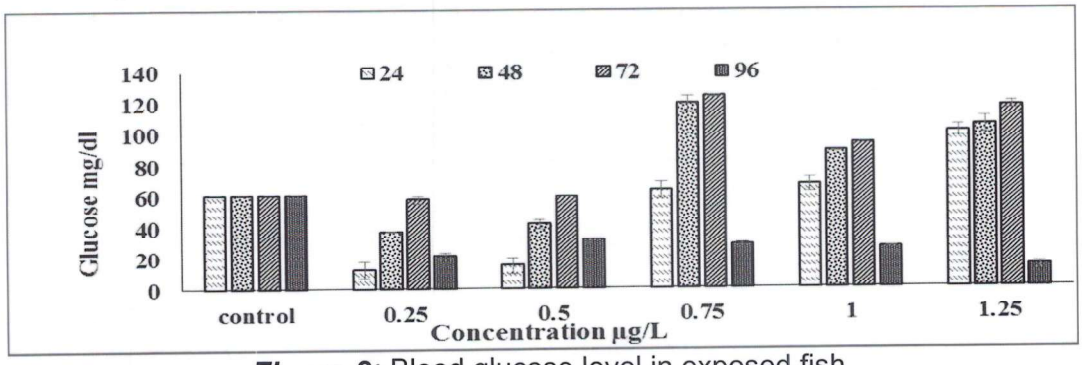


Figure-2: Blood glucose level in exposed fish

The rate of protein synthesis limits the quantity of protein being produced or degraded. Due to the impairment in incorporation of amino acids in the peptide chains, the quantity of protein is strictly affected (Singh et al., 1996) as indicated in Figure-3.

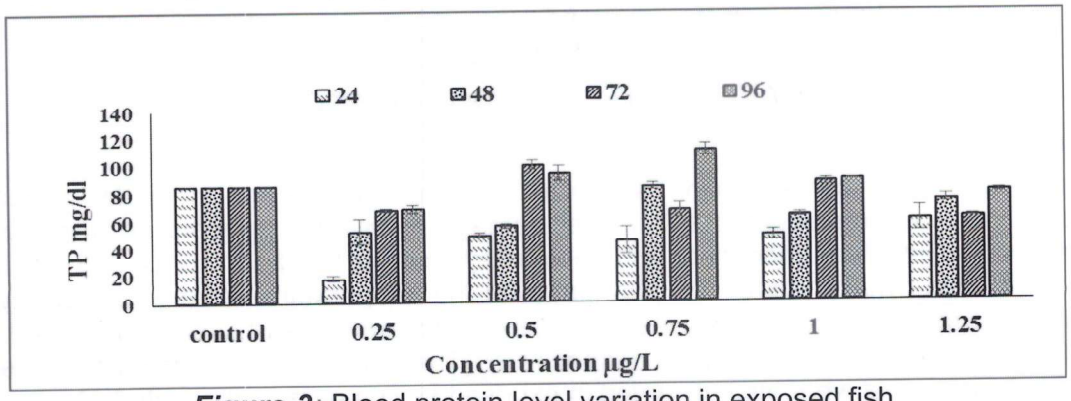


Figure-3: Blood protein level variation in exposed fish

There was dose dependent elevations glucose and triglyceride levels in the serum as the results of sub-lethal exposure to Lambda cyhalothrin were evaluated. In comparison to exposed fish, the control values of protein and cholesterol were lower. In this study the blood sugar gradually increasing with increase in exposure period. It was observed that there were elevations in values of glucose, protein and ALP of the serum and significant inhibition in triglyceride, cholesterol, GOT & GPT seral enzymes with time (Auta, 2007). Triglycerides showed varied trends due to impairment in hepatic functions as shown in fig below.

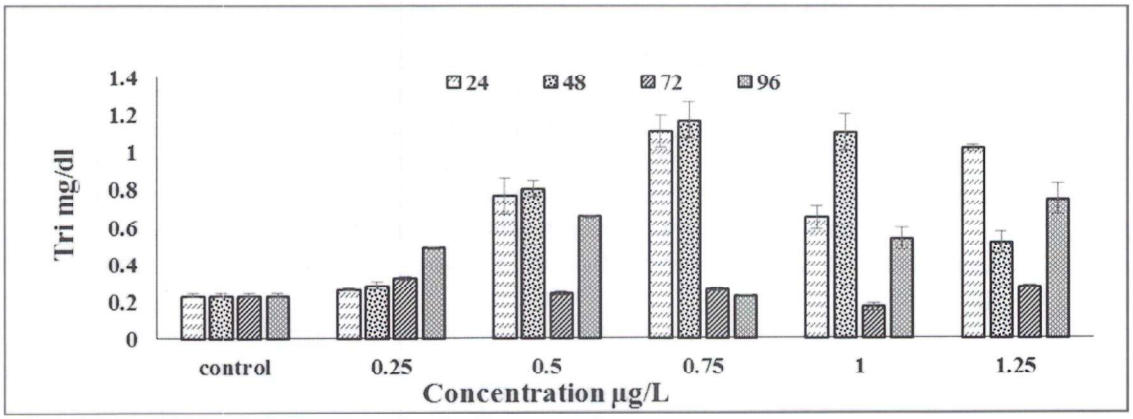


Figure-4: Triglycerides level in fish blood of exposure group

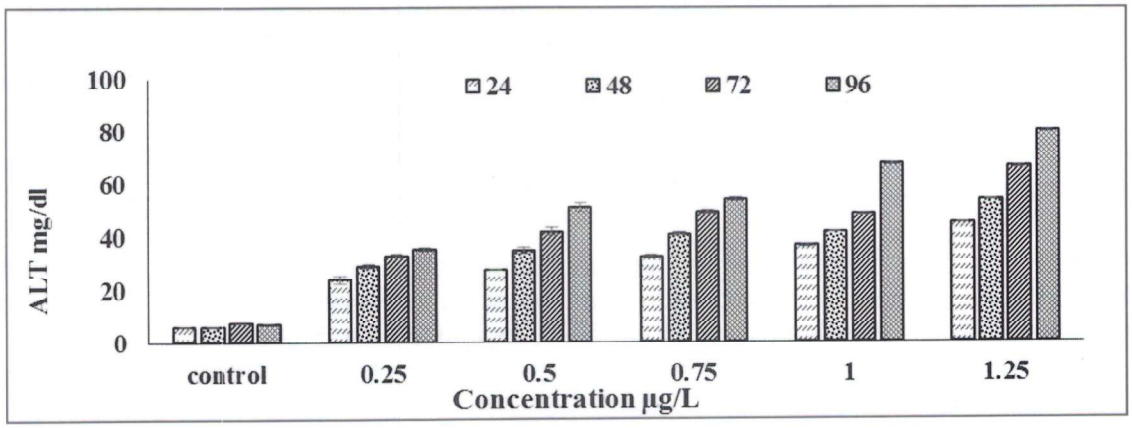


Figure-5: ALT levels in fish exposed to Lambda cyhalothrin

Conclusion:

The surface water contamination is due to agricultural runoff and industrial effluents. These chemicals represent a substantial damage to living organisms as damage to reproductive, immune, endocrine, and nervous systems. It has been concluded that LD-50 of Lambda cyhalothrin for fish changes with the temperature variation as toxicity of pesticide applied increased with the increase in temperature as LD-50 observed at 27 and 13°C was 1.175 and 1.5µg/L respectively. There were significant fluctuations in blood glucose level were also observed in exposed as compared with control. Pesticides cause hematological changes in fish i.e. protein level, ALT and triglycerides levels.

Altered behavioral patterns were exhibited by fish in the experimental tanks due to pesticide exposure.

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