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Research Article

Bioremedial effect of turmeric (*Curcuma longa*) on haematological and biochemical parameters against fenvalerate induced toxicity in air-breathing fish *Clarias batrachus*

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Abstract

Indiscriminate use of insecticides has increased many folds in the recent times. Farmers for the better yield of crops, are widely utilising the pesticides. These pesticides through agricultural run offs have reached the surface water like ponds and has contaminated the flora and fauna of it. Fish is the animal which are extensively cultivated in these ponds. Humans are consuming these fishes as food as they have high nutritious value. These contaminated fish if consumed by the human has caused various health hazards to humans. The present research work is therefore focused to know the bioremedial effect of turmeric on fenvalerate induced toxicity in fish *Clarias batrachus*.

Fenvalerate EC 20% (pyrethroid) was administered directly in water contained in aquarium at the dose of 0.92 ppm and observed for 96 hours after the dose calculation through LC₅₀. Thereafter, aqueous rhizome extract of Turmeric was administered orally, daily by gastric intubation method at the dose of 100 mg/Kg body weight per day for 15 days. The study reveals that after the exposure of fenvalerate, there was significant damage at the haematological and biochemical levels in fish *Clarias batrachus*. But, after the administration of rhizome extract of turmeric, there was significant normalisation in the haematological and biochemical levels in fish. This denotes that turmeric not only possesses ameliorating and rejuvenating property but also maintains the normal functioning of the body of the fish. Thus, it proves to be one of the best antidote against fenvalerate induced toxicity.

Introduction

The wide use of agrochemicals under conventional agriculture has caused severe health hazards for human beings. It also has caused numerous other side effects on the environment including destruction of the biodiversity. The pesticide enters aquatic ecosystems through various routes and poses a risk to many non-target aquatic organisms, particularly those inhabiting water bodies adjacent to agricultural fields. Although synthetic pyrethroids have been claimed as safe and environmentally friendly because of their selective toxicity

to insects, low persistence and low toxicity to mammals and birds, they are highly toxic to a number of other non-target organisms including fish, lobster, shrimp, mayfly nymphs and many species of zooplankton. Fenvalerate is compatible with many other pesticides, plant growth regulators and micronutrients [1-3]. It causes very least impact on the mammals but possesses very high insecticidal activity. It is known to be very potent neurotoxicant and disrupts the function of sodium channels in insects [4,5]. Furthermore, it also damages the gamma aminobutyric acid receptors [6] and ATPase pathways [7,8]. Indiscriminate use of fenvalerate



pesticides in agricultural practices has resulted in accumulation in vital tissues of fish [9,10]. The toxicological evaluation of fenvalerate has been carried out by various researchers [11–13].

In the recent years, the Indian System of Health Practice *Ayurveda* has attracted use of medicinal plants as antidote for various types of drug and chemical toxicity [14].

Most of the studies demonstrate the promising potential of medicinal plants used in various traditional, complementary and alternate systems of treatment of human diseases. *Curcuma longa* (turmeric), belongs to Zingiberaceae family and is found in tropical South Asia. Turmeric is widely used in food, cosmetics and pharmaceutical industries. There are about 100 active compounds found in this herb but curcumin is the major active ingredient [15]. It has different biological activities such as antioxidant [16], anti-carcinogenic [17,18] and anti-inflammatory activity [19,20].

The objective of the present investigation is to ascertain the toxic impact of Fenvalerate a most commonly used insecticide on haematological and biochemical parameters of an air breathing fish *Clarias batrachus* and bioremedial property of a medicinal plant, Turmeric (*Curcuma longa* L.) in order to generate data for medicinal use of Turmeric as detoxifying and antioxidant agent.

Materials and methods

Animals

Live specimens of air breathing fish *Clarias batrachus* were procured from the local market of Patna, Bihar (India) and were acclimatized in laboratory before experimentation. The laboratory room temperature was maintained to 24±2 degree centigrade. 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 Department of Zoology, Patna University, Patna, Bihar, India. The ethical approval was obtained from the Post Graduate Research Council of Patna University, Patna, Bihar.

Test chemical

Fenvalerate 20% (Isagro-Asia, Gujarat, India) was administered directly in water contained in aquarium at the dose of 0.92ppm and observed after 96hrs after the dose calculation through LC₅₀ (2.75ppm).

Preparation of turmeric rhizome dose

In the present study, Turmeric rhizome were collected from the local market of Patna and aqueous extract of Turmeric rhizome was made to the dose of 100 mg/Kg body weight per day after the LD₅₀ estimation (700 mg/Kg body weight). The aqueous extract of Turmeric was administered orally, daily by gastric intubation method to the fish.

Study groups & sampling

The control group of fish received no treatment. The 'treatment' groups received fenvalerate at the dose of 0.92ppm

and observed for 96hrs in the aquariums and were sacrificed thereafter. The third aquarium fishes were first treated with fenvalerate insecticide at the dose of 0.92ppm and observed for 96hrs then after were administered with Turmeric aqueous extract at the dose of 100 mg/Kg body weight per day orally, daily by gastric intubation method to the fish for 15 days.

Haematological evaluation

The haematological parameters Red Blood Cell Count (RBC's), Total Leukocyte Count, Packed Cell Volume (PCV), Haemoglobin percentage (HGB), and Differential counts (DLC) – Eosinophil, Lymphocytes and Monocytes were done manually.

Biochemical evaluation

For biochemical study, serum from the fish blood was extracted and tests were carried out. In this study, the total glucose levels, total protein levels and total cholesterol levels were evaluated.

Statistical analysis

Results are presented as mean ± SD and total variation present in a set of data was analysed through one-way analysis of variance (ANOVA). Difference among mean values has been analysed by applying Dunnett's test. Calculations were performed with the Graph Pad Prism Program (Graph Pad software, Inc., San Diego, U.S.A.). The criterion for statistical significance was set at $P < 0.05$.

Results

Haematological Evaluation: In the haematological study, there was significant decrease in the RBC counts, TLC counts, differential counts, PCV percentage, haemoglobin percentage, PCV, neutrophils, eosinophils and monocyte levels after Fenvalerate exposure while after Turmeric treatment there was significant restoration in their levels. But, in Lymphocytes percentage there was significant increase after the fenvalerate treatment but there was gradual decrease in the percentage after the turmeric treated for 15 days (Table 1).

Biochemical evaluation

In the present study, there was significant increase in the levels of serum glucose and serum cholesterol levels while significant decrease in the levels of serum total protein levels in Fenvalerate treated group in comparison to control. But, after the treatment of turmeric for 15 days, there was significant decrease in the serum glucose and cholesterol levels while significant increase in the serum plasma levels in comparison to the control group (Table 2 and Figures 1–3).

Discussion

Environmental problems in the recent times has increased many folds. The technological development has improved the quality of life while on the other hand it has created serious health hazards to the humans. The indiscriminate use of pesticides in agricultural practices has increased the pollution



level at much extent. The impact of pesticides on aquatic system is due to the migration of pesticides from various diffuse or point sources. This has led to cause threat to the aquatic life especially the fishes. The biomagnification of these pesticides in the aquatic life has posed serious threats to them. Humans are consuming the fish as one of the major sources of protein in their diet. But, if there is threat of poisoning of the fish through the pesticides, then it will cause severe entry of toxicants in the human system [21,22].

The fish act as bio-indicator of water quality and the impact of the pesticide can be well understood by analyzing either blood or serum of the fish, because blood is a pathophysiological reflector of whole body [23,24].

Table 1: Mean haematological parameters of *Clarias batrachus* exposed to sub lethal concentration of Fenvalerate (0.92ppm) for 96 hrs and amelioration by turmeric.

Parameters	Control	Fenvalerate Treated for 96 hours	Turmeric Treated for 15 days
RBC ($\times 10^6 \text{mm}^{-3}$)	2.76 \pm 0.032	2.14 \pm 0.023	2.62 \pm 0.012
Total Leukocyte Count ($\times 10^3 \text{m}^{-3}$)	18.10 \pm 0.015	16.30 \pm 0.074	17.95 \pm 0.030
Differential Count ($\times 10^9 \text{mm}^{-3}$)	12 \pm 0.230	09 \pm 0.083	12 \pm 0.364
Packed Cell Volume (%)	24 \pm 0.189	16 \pm 0.041	23 \pm 0.174
Haemoglobin (g/100ml)	6.89 \pm 0.031	4.23 \pm 0.073	6.37 \pm 0.309
Neutrophils (%)	21.70 \pm 0.085	42.60 \pm 0.253	26.12 \pm 0.782
Eosinophils (%)	78 \pm 0.027	64 \pm 0.061	76 \pm 0.0201
Lymphocytes (%)	10 \pm 0.152	16 \pm 0.091	10 \pm 0.152
Monocytes (%)	01 \pm 0.039	0	0.7 \pm 0.499

Data are presented as SEM with $P < 0.05$

Table 2: Mean biochemical parameters of *Clarias batrachus* exposed to sub lethal concentration of Fenvalerate (0.92ppm) for 96 hrs and amelioration by turmeric.

Parameters	Control	Fenvalerate Treated for 96 hours	Turmeric Treated for 15 days
Serum Glucose Levels (mg/dl)	50.31 \pm 5.811	103.8 \pm 4.336	51.51 \pm 4.519
Serum Cholesterol Levels (mg/dl)	169.4 \pm 11.84	248.6 \pm 17.58	167.6 \pm 6.844
Serum Total Protein Levels (mg/dl)	3.150 \pm 0.112	2.577 \pm 0.167	3.103 \pm 0.092

Data are presented as SEM with $P < 0.05$

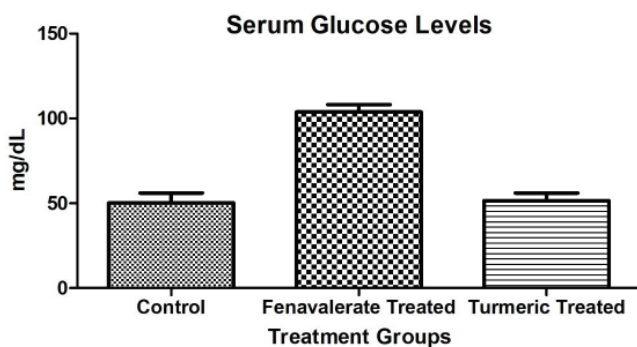


Figure 1: Effect of Turmeric on Fenvalerate induced toxicity showing Serum Glucose levels (n=6, values are mean \pm S.D).

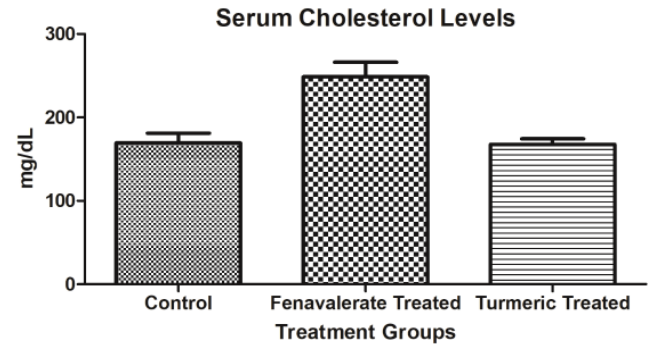


Figure 2: Effect of Turmeric on Fenvalerate induced toxicity showing Serum Cholesterol levels (n=6, values are mean \pm S.D).

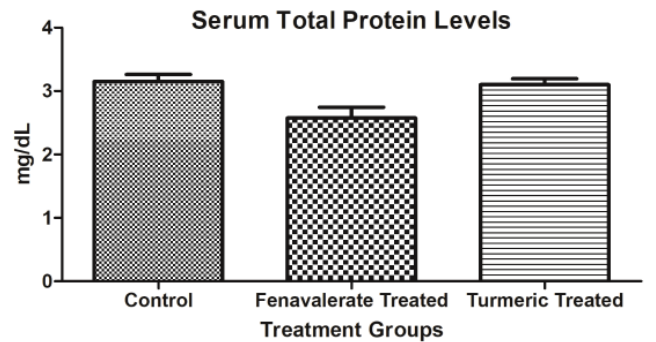


Figure 3: Effect of Turmeric on Fenvalerate induced toxicity showing Serum total Protein levels (n=6, values are mean \pm S.D).

Haematological study is an important parameter in the evaluation of toxicity in the aquatic animals. A thin epithelial membrane separates fish blood from the water and any significant change in the water body are reflected in the blood parameters [25]. In the present study, in the haematological study there was significant decrease in the RBC counts, TLC counts, Differential counts, haemoglobin percentage, PCV percentage, neutrophils, Eosinophils and monocytes percentage after Fenvalerate exposure while after Turmeric treatment there was significant decrease in their levels. There was significant increase in the Lymphocyte percentage after Fenvalerate exposure but in Turmeric treated group there was significant decrease in their levels.

This 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. The observed depletion in the haemoglobin percentage in the fish could also be attributed to the lysis of erythrocytes. Thus, the significant reduction in these parameters is an indication of severe anaemia [26-28].

The white blood cells in fish respond to various stressors including infections and chemical irritants. Thus, increasing or decreasing numbers of white blood cells are a normal reaction on the exposure of toxicants. In the present investigation,



there was gradual decrease in the WBC counts as leucocytosis may have resulted due to the breach in the defence mechanism which resulted in the increased levels. A sharp increase was observed in the lymphocytes percentage denotes that the magnitude of toxicity was very high [29].

In the present study, there was significant increase in the biochemical parameters in serum glucose levels and serum cholesterol levels while decrease in the serum total protein levels. This denotes that pesticides are severely accumulated in the fat tissue of the fish disrupting the glucose biomarkers of the fish. On the other hand, the fish are the major source of rich proteins but due to the pesticide toxicity there is significant loss protein content as it is clearly reflected the serum total protein levels [30,31].

In the present study, the Turmeric was used as antidote against the Fenvalerate induced toxicity in *Clarias batrachus*. There was significant increase in the haematological parameters RBC counts, Total leucocyte counts, Differential counts, Packed cell volume percentage, haemoglobin percentage, neutrophil percentage, Eosinophil percentage and Monocyte percentage while decrease in the Lymphocyte percentage against Fenvalerate induced toxicity. This denotes that the haematopoietic stem cells are significantly revived due antioxidant activity of Curcumin. Moreover, the defence mechanism in the fish has enhanced many folds due to the defence activity of curcumin [32,33]. Curcumin possesses dual antioxidant activity and acts through the scavenging reactive oxygen species (ROS) including superoxide and hydroxyl radicals due to its phenolic structure, and induces the upregulation of several endogenous cytoprotective and antioxidant proteins. It is also an effective lipid peroxidation inhibitor [34,35].

In the present study, there was significant normalisation in the biochemical parameters - serum glucose levels, serum cholesterol levels and total protein levels after turmeric treatment. The antioxidant activity and the protective effect of curcumin has played the major role to control the Fenvalerate induced toxicity [32,36-41].

The study denotes that Turmeric possesses antidote and antitoxic effect against Fenvalerate induced toxicity in *Clarias batrachus*.

Conclusions

Fenvalerate causes severe damage to the fish at haematological and biochemical level. But, turmeric plays the vital role in combating the deleterious effects of Fenvalerate induced toxicity thus possesses the antidote and bioremedial activity.

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