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Research Article

The Effects of Cypermethrin (A Synthetic Pyrethroid) on Some Biochemical Parameters (Ca, P, Na and TP) of Rainbow Trout (*Oncorhynchus mykiss*)

Muhammed ATAMANALP
Atatürk University, Faculty of Agriculture, Fisheries Department, 25240, Erzurum - TURKEY

M. Sait KELEŞ
Atatürk University, Medical Faculty, Department of Biochemistry, 25240, Erzurum - TURKEY

H. İbrahim HALİLOĞLU, M. Sıtkı ARAS
Atatürk University, Faculty of Agriculture, Fisheries Department, 25240, Erzurum - TURKEY

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Abstract: Fish were exposed to three different sublethal doses in order to determine the effects of Cypermethrin on some biochemical parameters (Ca-Calcium, P-Phosphorus, Na-Sodium and TP-Total Protein) of rainbow trout (*Oncorhynchus mykiss*). After 15 days exposure, Ca and P decreased, while TP and Na took various values depending on the doses of synthetic pyrethroid.

Key Words: Rainbow trout, *Oncorhynchus mykiss*, synthetic pyrethroid, calcium, phosphorus, sodium, total protein.

Cypermethrin'in Gökkuşağı Alabalığının Bazı Biyokimyasal Parametreleri (Ca, P, Na ve TP) Üzerine Etkileri (*Oncorhynchus mykiss*)

Özet: Cypermethrin' in Gökkuşağı alabalığı (*Oncorhynchus mykiss*)'nın bazı biyokimyasal parametreleri (Ca-Kalsiyum, P-Fosfor, Na-Sodyum ve TP-Total Protein) üzerine etkilerinin belirlenmesi amacıyla balıklar pestisitin 3 farklı subletal dozuna maruz bırakıldı. 15 günlük uygulamadan sonra kalsiyum ve fosfor değerlerinde azalma, total protein ve sodyumda ise sentetik piretroitin dozlarına bağlı olarak değişimler gözlendi.

Anahtar Sözcükler: Gökkuşağı alabalığı, *Oncorhynchus mykiss*, sentetik piretroit, kalsiyum, fosfor, sodyum, total protein

Introduction

The use of pesticides has increased with the growing awareness about their utility in agriculture production, animal husbandry, post-harvest technology, and in the public health and welfare of mankind. Pesticides carried away by rains and floods to larger water bodies like ponds and rivers alter the physico-chemical properties of water (1).

Synthetic pyrethroid insecticides are extensively used in place of organochlorine, organophosphorus insecticides and carbamates to control various types of pests and increase agricultural production. These chemicals are potentially more toxic to fish and other aquatic organisms, and are least toxic to mammals (2).

Owing to the excessive use of synthetic pyrethroids, the environment and water resources are being polluted, thus endangering aquatic life directly and human life indirectly (3). The lipophilicity of pyrethroids indicates that these chemicals will be absorbed by fish even from very low concentrations in water (4).

Heavy contamination of pesticides in water in turn leads to oxygen depletion and cases of poisoning, and the mass mortality of fishes is not uncommon. The recently introduced synthetic pyrethroids, with multiple beneficiary qualities, have attracted farmers to use these compounds in pest control. But these compounds have been found to be highly toxic to fish (5).

Haematological values are widely used to determine systematic relationships and physiological adaptations including the assessment of the general health condition of animals and are more quickly reflected in the poor condition of fish than in other commonly measured variables. Most studies on the effects of pyrethroids are confined to reporting biochemical and physiological changes, and very little attention has been paid to the haematological modulations induced by these pesticides (2).

The off-target movement of chemicals used in industry and agriculture is usually unavoidable. These chemicals getting into natural water may cause significant tissue damage in fish. The degree of increase in the activity of cellular enzymes in sera depends primarily on the magnitude and severity of cell damage. Furthermore pollutants may get into water in combination with each other, causing additive harmful effects on the fish (6).

Cypermethrin is highly toxic to fish and aquatic invertebrates. The LC_{50} (96 h) value of this pesticide for rainbow trout is 0.0082 mg/l. The metabolism and excretion of cypermethrin in fish is slower than in birds and mammals (7).

Synthetic pyrethroids are neither fully metabolized nor quickly detoxicated and therefore create serious problems of residue accumulation (8).

The objective of the present study was to determine if sublethal concentrations of cypermethrin induced changes in the blood biochemical parameters of rainbow trout (Oncorhyncus mykiss).

Materials and Methods

Fish source, maintenance and water

Rainbow trout were obtained from Atatürk University, Faculty of Agriculture, Trout Breeding and Research Centre. Fish (both sexes weighing 150 ± 30 g) were acclimatized to laboratory conditions for four weeks. They were maintained in fibreglass tanks (600 l volume) which have 0.5 l/min/kg fish, fresh water flow and waste water discharge. Water temperature was 12.5 ± 0.5 °C during the experiment. There were four groups (3 tanks with toxicant doses and a control tank) and each group was made up of 9 fish. During acclimatization and the experiment, fish were fed with trade trout pellets.

Toxicant

A synthetic pyrethroid insecticide Cypermethrin ($C_{22}H_{19}Cl_2NO_3$, Figure) was obtained from Koruma Tarım Ltd. It is known as Siperkor in trade formulation. The lethal concentration of Cypermethrin for rainbow trout is 8.2×10^{-3} mg/l. In this experiment fish were exposed to 1/2 the lethal dose (1st group, 4.1×10^{-3} mg/l), 1/4 the lethal dose (2nd group, 2.05×10^{-3} mg/l) and 1/8 the lethal dose (3rd group, 1.025×10^{-3} mg/l) of Cypermethrin. After calculating the water volumes of each tank and the desired pesticide concentrations, the toxicant was put into the tanks once a day.

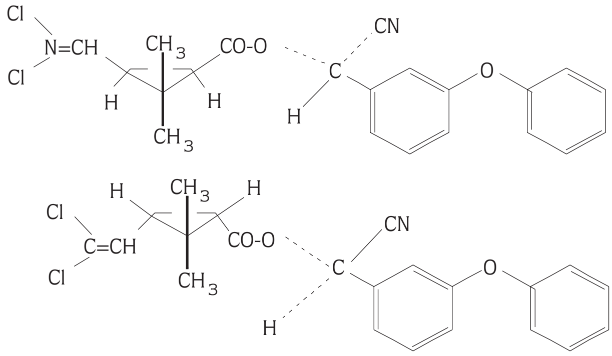

Figure. Cypermethrin (a synthetic pyrethroid) (9)

Blood collection and biochemical analyses

Blood was collected from the caudal vein and put in vacutainer biochemical tubes (10,11,12). Blood samples were centrifuged at 4,000 rpm for 10 minutes (13), and then analysed in an autoanalyser (Merck-Mega/Toshiba).

Statistical analyses

Differences among the groups were statistically tested with variance analyses and the averages of the groups were analysed using Duncan's test.

Results

The general results of this experiment are given in the Table.

Sublethal doses of Cypermethrin decreased Ca. Ca value in the control group was found to be 16.333 ± 2.88 mg/dl, while in the third group it was 16.262 ± 1.769 mg/dl, in the second group 11.544 ± 1.66 mg/dl and in the first group 10.962 ± 1.76 mg/dl (Table).

We observed the same phenomenon with phosphorus values as with Ca. Depending on the doses, phosphorus took decreasing values. The values were 10.687 ± 0.98 mg/dl, 13.444 ± 0.93 mg/dl, 14.012 ± 0.98 mg/dl and 15.133 ± 1.61 mg/dl in the first, second, third and control group, respectively.

Table. General results of experiment.

Groups	Ca (mg/dl)	P (mg/dl)	TP (mg/dl)	Na (mg/dl)
Group[1]	10.962 ± 7.769 [a]	10.687 ± 0.986 [a]	5.162 ± 0.510 [a]	190.250 ± 3.280 [a]
Group[2]	11.544 ± 1.667 [a]	13.444 ± 0.930 [a b]	4.766 ± 0.481 [a]	163.555 ± 3. 092 [b]
Group[3]	16.262 ± 1.769 [a]	14.012 ± 0.986 [a b]	5.912 ± 0.510 [a]	154.250 ± 2.280 [b]
Control	16.333 ± 2.889 [a]	15.133 ± 1.610 [b]	5.000 ± 0.831 [a]	157.333 ± 5.356 [b]

First group, 1/2 lethal dose (4.1 x 10^{-3} mg/l)
Second group, 1/4 lethal dose (2.05 x 10^{-3} mg/l)
Third group, 1/8 lethal dose (1.025 x 10^{-3} mg/l)
[a b]: The results of statistical analyses.

Total protein (TP) was 5.00 ± 0.83 mg/dl in the control group. The third group, which was exposed to a 1/8 lethal dose of Cypermethrine, and the first group (1/2 lethal dose), increased TP (18.2 %) to 5.91 ± 0.83 mg/dl, and (3.2 %) to 5.16 ± 0.51 mg/dl, respectively. But the second group, which was exposed to a 1/4 lethal dose of Cypermethrine, decreased TP (4.8 %) to 4.76 ± 0.48 mg/dl.

Sodium was 190.250 ± 3.28 mg/dl, 163.555 ± 3.09 mg/dl, 154.250 ± 3.28 mg/dl and 157.333 ± 5.35 mg/dl in the first, second, third and control groups, respectively (Table). At the low dose there was a small decrease (1.95 %), but at medium (3.95 %) and high doses (20.9 %) blood Na levels increased.

Discussion

The synthetic pyrethroid decreased Ca levels. This result was parallel to that of Jeney and Jeney (14), who observed that different stressors decrease Ca values in Cyprinids, and also was in line with Jeney et al. (15), who noted that chronic exposure to pulp and paper mill effluent decreases Ca in the roach (*Rutilus rutilus*).

Differences among the groups and the control have no statistical significance (Table).

Decreasing P value with chemical exposure is similar to Jeney et al. (15).

In statistical analyses, the difference between the first group's P value and the control's was significant, but not the others (Table).

Malla Reddy and Philip (16) observed that malathion decreased TP to 104.27 ± 1.94 mg/g wet weight after 7 days exposure and 76.31 ± 1.98 mg/g wet weight after 15 days exposure, while the control was 135.85 ± 2.76 mg/g wet weight in *Cyprinus carpio*.

Mercury chloride decreased TP values in Chinese grass carp (*Ctenopharyngodon idella*) from 201.14 ± 16.65 mg/g to 97.64 ± 3.69 mg/g after 24 h exposure and to 97.45 ± 3.60 mg/g after 48 h (17). Also, fenvalarate caused a decrease in TP from 211.32 ± 22.31 mg/g after 48 h exposed in the same fish (18). Shakoori et al. (19) observed that inorganic mercury first increased then decreased the TP of *C. idella*.

Sublethal doses of fenvalarate decreased TP from (control group) 217 ± 16 mg to 184 ± 13 mg in the first week, 164 ± 7 mg in the second week, 159 ± 9 mg in the third week and 138 ± 28 mg in the fourth week (20). Ahmad et al. (21) observed that Danitol decreased the TP of the same fish at a rate of 45%.

Jeney et al. (15), noted that subchronic pulp and paper mill effluent caused an increase in TP for the roach (*Rutilus rutilus*).

Our experiment gave similar results to some of the aforementioned research but not with others. It may be thought that these disagreements could stem from the difference between fish species, from the chemicals or from the exposure time.

In the statistical analyses, no statistical significance was found among the groups and the control.

Depending on the doses, Na value first decreased a little then increased. We found no study in our archive about the effects of chemicals on Na value, and so we were unable to discuss this parameter.

In statistical analyses, the difference between the first group and the other groups had statistical significance, but not the others.

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