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Acute toxicity test of pesticide abamectin on common carp (*Cyprinus carpio*)

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PEER REVIEW

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Comments

Generally, this is a potential research work in which authors have demonstrated that availability as a suitable model of eco-toxicological studies in common carp (*C. carpio*) experimental doses exposed to abamectin.

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ABSTRACT

Objective: To determine acute toxicity of abamectin (abamectin used for agricultural fields and also is a common acaridae used in farms) to common carp (*Cyprinus carpio*).

Methods: In this research, common carps were exposed to abamectin for 96 h. LC₅₀ values of 24 h, 48 h, 72 h and 96 h were attained by probit analysis software SPSS Version 16. Fish were exposed to different concentrations (1, 2, 3, 6, 12 and 15 mg/L) of abamectin for 96 h and physicochemical properties of water used for these experiments were stable and every mortality was recorded daily.

Results: The 96 h LC₅₀ of abamectin for *Cyprinus carpio* was 1.243 mg/L.

Conclusions: Eventually toxicity values indicated that abamectin has same toxicity in studied other specie and we can state lower value of LC₅₀ for studied specie in compare with most species.

KEYWORDS

LC₅₀, Toxicity, Abamectin, *Cyprinus carpio*

1. Introduction

Pharmaceutically active compounds are produced and used in very large volumes and their use and diversity is increasing every year^[1]. Pharmaceuticals as such are continuously dispersed into the environment as a result of veterinary use, posing environmental concerns. Abamectin (*i.e.* ivermectin, abamectin, doramectin) is a group of fermentation products from a strain of *Streptomyces avermitilis* possessing potent anthelmintic and insecticidal activities. The relative popularity of the abamectin amongst farmers and veterinarians can be attributed to their spectrum of activity, convenience and wide margin of safety

to the targeted animals. Presently, abamectin are the active components of some insecticides and nematocidal products used in agriculture and the most used agents in veterinary medicine for several years in prevention of parasitic diseases^[2]. Abamectin is highly insoluble in water due to their lipophilicity distribution in soil is limited. Some of these pesticides with the involvement in the environment in life cycle cause pollution even bodies organisms, especially in vertebrates and fish^[3]. Fish aquatic organisms are one of the most polluted species because of economic value and high sensitivity to pollutants. Different fish species sensitivity to toxic substances varies. The toxicology tests are carried out on various fishes which were used

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extensively in the bioassay[4].

Common carp [*Cyprinus carpio* Linnaeus (*C. carpio*), 1758] has been one of the oldest domesticated species of fish for food. According to the FAO statistics of 2004, production of farmed common carp was 13% (3387918 tonnes) of the total global freshwater aquaculture production. Asia is the main producing region of the species (China claimed about 70% of the 2005 world production) with the majority of production consumed domestically. According to official statistics, the Ministry of Jihad–E–Agriculture Islamic Republic of Iran in 2012, number of aquaculture of warm water increased from 10527 in 2011 to 11968 in 2012; also, fish production in 2012 has grown to 10.9% compared to previous year[2,5]. While this year's growth rate was 8.6% because of preparation of agricultural pesticides. Pesticides through irrigation and rainfall flowed into the soil and eventually led to pollution of surface and underground water resources. This led to the spread contaminants in the food chain to humans and other consumers[6].

The purpose of this research was to determine the toxicity of pesticide abamectin on *C. carpio*.

2. Materials and methods

Lethal experiments were conducted using 147 common carps. They were acclimatized for 2 weeks. Before the test, fish were fed triplet daily with biomar feed at 3% of body weight. Physicochemical properties of water used for these experiments were stable as follows: (18±1) °C, 7 to 9 mg/L dissolved oxygen, 7.5 to 8 pH and 210 mg/L total hardness. Each aquarium was equipped with aeration system and water physicochemical conditions were similar in all aquariums[1,7].

Experiments were performed according to the Organization for Economic Co–operation and Development standard method to determine the 96 h LC₅₀ of common carp[8]. Six concentrations of abamectin (1, 2, 3, 6, 12 and 15 mg/L) with three replacements were considered for common carp.

According to the method used (Static–renewal test condition), all water tanks were exchanged with daily water replacement containing the same concentration of abamectin, to avoid the effects of metabolites and waste organic matter of fish. Dead fish were removed from the water and mortality rates were recorded at time 0, 24, 48, 72 and 96 h. Acute toxicity tests were carried out according to Hotos and Vlahos, the nominal concentration of abamectin estimated to result in 50% mortality of fish within 24 h (24 h LC₅₀), 48 h, 72 h and 96 h was attained by probit analysis in confidence limit of 95% by software SPSS version 16 and degree of toxicity was determined.

3. Results

No fish died during the acclimation period before exposure and also no control fish died during acute toxicity tests. Poisoning, stimulation, excitement and feeding caused by acute toxicity tests decreases were observed in samples. The mortality of common carp was checked during the exposure times at 24, 48, 72 and 96 h with the rates were 1, 2, 3, 6, 12 and 15 mg/L (Table 1).

Table 1

The mortality rate of common carp exposed to acute toxicity of abamectin.

Concentration (mg/L)	Number	No. of mortality			
		24 h	48 h	72 h	96 h
1	21	0	0	8	12
2	21	2	9	15	16
3	21	7	11	17	20
6	21	9	13	15	21
12	21	15	17	21	21
15	21	17	18	21	21
Control	21	0	0	0	0

The result of this study indicated 96 h LC₅₀ of pesticide abamectin was 1.243 mg/L for *C. carpio* (Table 2). The results indicated pesticide abamectin was high toxicity for common carp.

Table 2

Lethal concentration of abamectin.

Point	Concentration (mg/L)			
	24 h	48 h	72 h	96 h
LC ₁₀	1.303	–	–	0.086
LC ₂₀	3.825	0.795	0.123	0.483
LC ₃₀	5.645	2.780	0.768	0.769
LC ₄₀	7.199	4.476	1.319	1.014
LC ₅₀	8.652	6.061	1.834	1.243
LC ₆₀	10.105	7.061	2.349	1.472
LC ₇₀	11.659	9.343	45.450	1.716
LC ₈₀	13.478	11.328	3.545	2.003
LC ₉₀	16.001	14.081	4.440	2.400
LC ₉₅	18.084	16.354	5.179	2.728

Common carps were exposed to 1, 2, 3, 6, 12 and 15 mg/L of abamectin in non renewal test for 96 h. After 24 h, in all the treatments, some fish were lying at the bottom of the tanks, still alive, but unable to swim. After 48 h, some individuals recovered and were able to moving slowly, while the others died.

The same effect of inability to move as in non renewal test was observed and therefore swimming was also taken as a poisoning endpoint. The 96 h LC₅₀ was 1.243 mg/L.

4. Discussion

Abamectin in the organism's body inhibits the function

of gamma amino acid butyric acid in the nervous system to cause death. Abamectin is extracted from a bacterium (*Streptomyces avermitilis*). The value in use is lower than other toxins, but it is dangerous for bees, birds, fish and other marine animals. Toxicity in the field can be affected by many factors including temperature, pH and water hardness, which may have different effects across species.

Literature data in open sources showed that the toxicity of abamectin to fish strongly depends on the fish species. The most sensitive species in literature was rainbow trout with a 96 h LC₅₀ of 3.2 mg/L. Jencic *et al.* based on the measured concentrations of abamectin in the water samples for the rainbow trout, established a 58 h LC₅₀ of 1.5 mg/L. In our experiments, the least sensitive fish species was carp, which was similar to that of other agricultural poisons^[9].

The results of our test showed that the doses tested were very toxic at low concentrations. For this test species, the average nominal concentration that caused mortality in 50% of the fish was 1.24 mg/L. The toxicity results of abamectin is in the literature report low values for fishes.

The species sensitivity levels to abamectin reported in the open sources was varying depending on the individual tested. Nevertheless, all scientific papers show toxic effects at very low concentrations, on the order of mg/L. The LC₅₀ 96 h values for different fish species (rainbow trout, bluegill sunfish, channel catfish and carp) are 3.2, 9.6, 24 and 40 mg/L, respectively^[10]. Likewise, in another report with abamectin, it was found that sensitivity values are very near to those of abamectin, *i.e.*, 3.0 mg/L for rainbow trout and 4.8 mg/L for bluegill sunfish^[11].

Abamectin is an agricultural poison rapidly degraded by oxidation and photo-oxidation mechanisms in the ecosystems. In the soil, the half-life is 21 h, while at the water surface, it is different from 4 to 6 h and in the water column it is less than 4 d^[10].

The abundant of abamectin in the ecosystems, as well as its mortality effects depends on the degradation processes and the amount of residues released into the ecosystems^[12]. However, in addition to these parameters, commercial brand may be more toxic than the active compound. These formulations are known to contain other formulations besides the active ingredient, such as surfactants added to the parent formulation to elevate the products physical and chemical effectiveness. However, such formulations can significantly elevate the toxicity to non-target species^[13–15]. So we could confirm that the toxicity at low concentrations to non-target species may be even greater, because of application of the commercial compound in aquaculture purposes.

Results of this study clearly indicate toxicity effects because of the toxic nature of the insecticide abamectin on the oxygen consumption and the biochemical constituents

of the common carp. The changes in proteins, carbohydrates and lipid in the abamectin poison of infected fishes will naturally affect the nutritive value of common carp and all the metabolites studied are found to be sensitive variations in the normal parameters, which reflect changes in the normal activities of various functional systems. So it is necessary to focus on changes in biochemical composition of aquatic species, which are under agricultural poisons.

In the present study, LC₅₀ values indicated that abamectin is toxic to common carp. Compared with corresponding values that have been published in the literature for other species of fish, LC₅₀ obtained in the present study show that the toxicity of LC₅₀ of abamectin varies in different species and even different time, but lower value of LC₅₀ for studied fish was important and confirm sensitively of aquaculture species to low abamectin doses.

In conclusion, comparing the sensitivity of this agricultural poison to common reference pollutants, we could suggest using common carp for toxicity determinations as a suitable model of eco-toxicological studies. Therefore it is need to conduct further studies with specific agricultural poisons on this species to assess its suitability for detecting toxicity, in order to detect water environment monitoring program.

Conflict of interest statement

We declare that we have no conflict of interest.

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Comments

Background

The important sources of water pollution are industrial effluent, domestic, sewage, drainage and pesticides. Nutritional value of fish depends on their biochemical composition, which is affected by the water pollution. Abamectin, a mixture of avermectin B1a and B1b homologs, is widely used as an anthelmintic and antiparasitic agent for animals and can run off from the sites of application and becomes an aquatic pollutant. The aim of this study

was to determine acute toxicity of abamectin on *C. carpio*. This study has a potential significant about using *C. carpio* for toxicity determinations as a suitable model of eco-toxicological studies.

Research frontiers

The manuscript described LC₅₀ of 24 h, 48 h, 72 h and 96 h by using in different concentrations (1, 2, 3, 6, 12 and 15 mg/L) of abamectin. According to the statistical analyses determined by probit analysis, the obtained results indicated that abamectin had same toxicity in studied other species and lower value of LC₅₀.

Related reports

Pesticides are not highly selective but are generally toxic to many macrophytes, non-target organisms such as fish. Abamectin, a pesticide for the assessment of toxicant stress on the aquatic organisms, was reported by earlier workers. The abundant of abamectin in the ecosystems, as well as its mortality effects, depends on the degradation processes and the amount of residues released into the ecosystems. The literature data shows that the toxicity of abamectin has low values for fishes.

Innovations and breakthroughs

This scientific study support and suggest availability as a suitable model of eco-toxicological studies for fish of abamectin used as anthelmintic and antiparasitic agent for animals.

Applications

This study has a potential significant about using *C. carpio* for toxicity determinations as a suitable model of eco-toxicological studies.

Peer review

Generally, this is a potential research work in which authors have demonstrated that availability as a suitable model of eco-toxicological studies in common carp (*C. carpio*) experimental doses exposed to abamectin. Toxicological effect (96 h LC₅₀) was observed in low dose (1.243 mg/L) in fish exposed abamectin.

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