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Comparative Acute Toxicity of Certain Pesticides Against *Daphnia Longispina*

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Abstract

Some of commercial pesticides used in Egypt were examined in laboratory against first generation of *Daphnia longispina*. The tested animals were collected from Kafr El-zayat district, Egypt and acclimatized in laboratory until used. The examined compounds were imidaclopride, indoxcarb and pyriproxyfen. It is evident from LC_{50} (96 hrs) values of the compounds that, indoxcarb is highly toxic, while pyriproxyfen is the lowest one. On the other hand, imidacloprid induced LC_{50} (3.4 ppm; 24 hrs) and decreased to 104 ppm after 96 hrs. The obtained data declared that, Daphnia is a very useful tool for screening pesticides pollution and evaluate their acute toxicity.

Keywords: Pesticides, *Daphnia longispina*, Acute toxicity, Kafr El-Zayat district.

Contents

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1. Introduction

Water pollution by hazardous chemicals such as pesticides is considered a main problem for providing safe water to human aquatic ecosystems [1]. Pesticides monitoring by using certain methods is very expensive as soon as time consuming, not detect all chemical and their metabolites and need different confirmation aspects. Thus, simple screening methods were expected to be developed. Moreover, aquatic organisms such as fish, mollusca and crustacea were employed for detecting water pollution with chemicals depending on their toxicity.

As example, Daphnia is used for monitoring of water quality because it has high sensitivity to toxicants, short reproductive cycle and easy to be cultured and handled [2]. Moreover, there are a lot of studies that have been done on the effect either acute or chronic toxicity testes of pesticides with dominate zooplankton Daphnids [3-9].

In Egypt, the effect of chemical pollution of Nile river water and their toxicity on the dominate zooplankton cladocera (Daphniidae) had received little attentions by several toxicologists [10-18].

The present study aimed to evaluate the acute toxicity to certain pesticides which commercially used in Egypt and produced locally in Kafr El-zayat district against *Daphnia longispina*.

2. Material and Methods

2.1. Pesticides

They were supplied from produced companies. These pesticides were imidaclopride (Admire® 20% SC); 1-(6-chloro-3-pyridiyl) methyl]-N-nitro-2-imidazolidinimine which is used to control sucking insects including rich pipers, aphids, thrips and white flies; indoxcarb (Avaunt®); N-(7chloro-1,3,4,5 tetrahydro 4a-(metaxycarboyl) indeono (1,2-e) (1m,3,4)oxadiazin—ylcabonyl)4-trifluoromethoxy) carbonilate is used against broad spectrum of Lepidoptera in cotton, vegetables and fruits. Finally, pyriproxylm (Admiral® 10% EC), 2-(1-Methyl-2-[4-Phenoxy phenoxy) ethoxy] pyridine. It is used to control public health insects e.g. flies, beetles, midges and mosquito.

2.2. Experimental Animals

Three water streams around Kafr El-zayat district, Egypt were monitored as follows: Nile river zone, Bnoufer drain and Ganak drain. The samples were collected by special zooplankton net with mesh (size 100µm) in two litter glass bottle and transferred to the laboratory for assay.

The animals were observed in chosen sites to obtain healthy status and screen the population densities of animals. Nile river zone was selected to produce first generation for acute toxicity assay. Daphnia organisms were transferred to dechlorinated water (27 ºC) and they fed daily with yeast and algae; *Chlorella vulgaris* as a best food [10]. When the mature *D. longispina* or the first newborn less then (≤ 24 hrs old) observed, they were carefully removed with pipette (8 mm glass tube with rubber bulb), and transferred to an extra jar of culture medium to be examined for appropriate pesticide concentrations.

2.3. Acute Toxicity Assay

A series of six concentrations of each pesticide were prepared in dechlorinated tap water (27 ºC) in glass containers. For each compound, total number of 126 individuals of normal healthy Daphnia were used. The animals were divided into six groups of 21 samples for each concentration. The exposed animals were observed after 24, 48, 72 and 96 hrs of treatment, respectively. The used concentrations were as follows: 5, 15, 20, 25, 30, 40; 1.5, 2.0, 2.5, 3.0, 3.5, 4.0; and 1.0, 3.0, 4.0, 5.0, 7.0, 9.0 ppm for indoxcarb, imidacloprid and pyriproxyfen, respectively. A control group was used without any treated and all aquaria were provided with air pumps. The exposure was carried out for 96 hrs and no food was supplied during the experiment. The mortalities and their percentage were recorded at each time interval. The obtained data were analyzed for estimating LC_{50} according to Finney [19].

3. Results and Discussion

Acute toxicity of examined pesticides on freshwater *D. longispina* was assayed as described before. The rates of

Table-1. Mean percentage of mortality of *Daphnia longispina* exposed to different concentrations of indoxacarb after different periods.

Insecticide	Concentrations (ppm)	Mortality %			
		24 hrs.	48 hrs.	72 hrs.	96 hrs.
Indoxacarb (Avaunt®)	5	0	10.5	15.8	21.1
	15	15.8	21.1	21.1	26.3
	20	21.1	21.1	31.6	47.4
	25	47.4	63.2	68.4	73.7
	30	52.6	68.4	68.4	68.4
	40	73.9	89.5	89.5	89.5

Table-2. Mean percentage of mortality of *Daphnia longispina* exposed to different concentrations of imidacloprid after different periods.

Insecticide	Concentrations (ppm)	Mortality %			
		24 hrs.	48 hrs.	72 hrs.	96 hrs.
Imidacloprid (Admire®)	1.5	4.8	42.9	47.6	47.6
	2.0	14.3	61.9	71.4	76.2
	2.5	23.8	52.4	76.2	81.0
	3.0	42.9	66.7	76.2	85.7
	3.5	57.1	66.7	81.0	85.7
	4.0	61.9	71.4	85.7	95.2

Table-3. Mean percentage of mortality of *Daphnia longispina* exposed to different concentrations of Pyriproxyfen after different periods.

Insecticide	Concentrations (ppm)	Mortality %			
		24 hrs.	48 hrs.	72 hrs.	96 hrs.
Pyriproxyfen (Admiral®)	1.0	9.1	9.1	13.6	18.2
	3.0	19.0	28.6	38.1	42.9
	4.0	19.0	30.0	45.0	50.0
	5.0	23.8	38.1	47.6	52.4
	6.0	33.3	42.9	47.0	47.6
	9.0	61.9	66.7	71.4	85.7

Table-4. Regression equation of three insecticides for *Daphnia longispina.*

Insecticide	Time (hr)	Regression equation	f.sig.	R^2
Indoxacarb	24	Y = 4.0963 + 6.2873 X	0.001*	0.969
	48	Y = 1.5227 + 2.6070 X	0.039*	0.739
	72	Y = 1.9563 + 2.3622 X	0.028*	0.725
	96	Y = 2.3684 + 2.1590 X	0.02*	0.746
Imidaclorid	24	Y = 2.456 + 4.8618 X	0.00*	0.990
	48	Y = 4.6230 + 1.5500 X	0.022*	0.763
	72	Y = 4.4585 + 3.4307 X	0.004*	0.903
	96	Y = 4.6903 + 2.2805 X	0.004*	0.886
Pyriproxyfen	24	Y = 3.4628 + 1.4695 X	0.021*	0.817
	48	Y = 3.5902 + 1.6624 X	0.002*	0.962
	72	Y = 3.8916 + 1.5462 X	0.002*	0.960
	96	Y = 3.9793 + 1.6953 X	0.023*	0.833

Where (X) is dependent variable [log conc.] and (Y) is independent variable [propit mortality].* is significant at 0.05

mortality against *Daphnia longispina* associated with various concentrations of chosen compounds were appared in Tables 1, 2 and 3. The LC_{50} values and the relative susceptibility for *D. longispina* were given in Table 4.

It was indicated that, LC_{50} values decreased with increase in exposure period, where the LC_{50} value of indoxcarb was decreased from 27.98 ppm (24 hrs) to 16.6 ppm (96 hrs). However, it was decreased from 3.4 ppm (24 hrs) to 1.4 ppm for imidaclprid. On the other hand, LC_{50} value of pyriproxyfen was decreased from 11.1 ppm (24 hrs) to 4.0 ppm (96 hrs). It is evident from LC_{50} (96 hrs) values of the investigated pesticides that, indoxicarb is highly toxic, while pyriproxyfen is the lowest one. Thus, the order of pesticides toxicity had the sequence of indoxcarb > imidacloprid > pyriproxfen.

Determination of LC_{50} values is starting point in toxicological studies. Since it provides fundamental data for design of more complex animal study. Previously studies of pesticides were done on *D. magna* as reported by [6, 7, 20-23]. However, in Egypt, previous studies were presented by Mansour [13]; Ahmed [14]; Saeed [15] and El-Shabrawy, et al. [16]. On the other hand, the comparison between acute toxicity on *D. longispina* and other cladocera species may be depend on different factors such as temperature around media and species susceptibility[21]. Also, the differences in susceptibility to different chemical structure may depend on pesticides metabolism. Thus, it is evident that, the toxicity differs from species to another [24] and in some cases from place to place, which may be due to differences in bioassay techniques and purity of insecticides as reported by Lovern and Klaper [23].

Therefore, juvenile hormone analogs (JHA_s) that possess both of these properties without compromising their efficacy are among the preferred insecticides. The JHA_s do not kill the insect but interact with some insectal endocrine systems resulting in preventing larval maturation, metamorphosis and ultimately lead to the death of larvae. Fenoxycarb, methoprene, kinoprene and pyriproxifen are the commonly used as JHA_s with varying levels of efficacy. Pyriproxyfen is of special interest to application in Egypt and non-target effects on daphnia. Moreover, it have short stability or persistent in aquatic environment. This phenomena may lead to minimizing in its toxicity to different biota [25].

On the other hand, neonicotinoid insecticide (imidacloprid) is a neurotoxic substance acting specifically on the insect nervous system. Additionally, imidacloprid has the potential to indirect cause lethality in aquatic invertebrate population at low, sublethal concentrations by impairing movements and thus feeding [26].

Among species response or sensitivity to pesticides and environmental contaminants, *D. magna* showed the mostly response to their toxicity as desrbied before in review. Recently, the Clodocera; *D. magna* is considered usefulness in evaluating freshwater/sediment toxicity [27]. Moreover, indoxcarb observed as the highest toxic to Daphnia compared with other examined insecticides. This fact may be revealed to its affinity and bioavailability on action site and receptors In addition, it may be related to high persistent in the water more than others.

In worldwide, aquatic toxicity data are routinely used to evaluate risks associated with discharge of effluents into water bodies and sediments. Chemicals which present in environmental water and sediment as a complex mixture induce highly ecotoxicological effects among their interaction with biota [28]. Aquatic organisms of all trophic levels have been used in ecotoxicological evaluation of pollution in ecosystems and sediments [29].

4. Conclusion

It is documented as reviewd previously or from the present study that, Daphnia is a very useful tool for screening pesticides pollution and evaluate their acute toxicity. This test is very simple, low cost and fast. The bioassay from toxicological stand point is suitable for finding and assessing target and non target chemical pollution and their interaction effect.

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