The acute toxicity of endosulfan on the survival of shrimp *Caridina babaulti basrensis* (Al-Adhub and Hamzah,1987) from Garmmat Ali River

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Abstract

This study investigated the acute toxicity of Endosulfan, a polycyclic organochlorine pesticide, to the tropical shrimp *Caridina babaulti basrensis*. *C. babaulti basrensis* specimens were collected from Garmmat Ali-River at 30°34'16" N 47°44'59"E during April, 2006. The 24h, 48h, 72h and 96-h LC_{50s} values for shrimp were estimated as (0.010, 0.006, 0.003 and0.002) mg/l., respectively. Safe concentration level for endosulfan was 0.02 $\mu g\ L^{-1}$.

Key words: Endosulfan; Acute toxicity; *Caridina babaulti basrensis*; LC_{50}

Introduction

Pesticides are widely used to minimize the damage by insect in agriculture. However, they also may have significant adverse effect on the natural environment. , For example, through surface runoff and sub-surface drainage from the treated area they may reach surface water and have obvious effect on non-target aquatic organisms, including those commercially cultured important fish and crustaceans [1, 2].

Endosulfan ,6,7,8,9,10,10-Hexachloro-1,5,5a,6,9,9a-hexahydro- 6,9-methano-2,4,3-benzo(e)-dioxathiepin-3-oxide; Endosulfan technical; 5-Norbornene- 2,3-dimethanol-1,4,5,6,7,7-hexachlorocyclic sulfite, is an organochlorine and a member of the cyclodiene class of insecticides. It is made up of a mixture of two isomers, α and β, both of which have similar insecticidal properties [3]. Endosulfan and its both isomers work by inhibiting the Na+ - K+ ATPase (enzyme responsible for regulating the Na+ -K+ channels along nervous system pathways) and the mitochondrial Mg2+ ATPase (enzyme responsible for regulating the ATP production in the mitochondria [3, 4]. Pesticides are widely used by fishermen illegally to capture fish or in agriculture especially in the Southern Iraqi Marshes and that cause a great destruction of the marshes environment [5, 6, 7,8].

Freshwater shrimps play an increasingly important role in the fields of freshwater ecology and aquaculture: their role as large crustacean detritivores and herbivores within the food webs connected to epibenthos in mostly subtropical and tropical ecosystems is well acknowledged [9], while increasing world demand for animal proteins has boosted freshwater shrimp aquaculture, especially in Asia [10]. The fact that freshwater shrimps can successfully be used in bioassays and biomonitoring has been demonstrated by [11, 12, 13 and 14]. As [13] pointed out, the absence of cannibalism, resulting in very high control survivals, combined with their easy culture, handling, and sensitivity to pollutants make them excellent candidates for biomonitoring programs.

Caridina babaulti basrensis is a dominant freshwater macroinvertebrate that is widespread in Iraq. It is an important member of the aquatic community, as it serves to be a primary food source for higher organisms. Because there is a lack of toxicity data on pesticides for tropical species, *C. babaulti basrensis* was selected in the present toxicity study.

Materials and Methods

For the toxicity tests described in this paper *C. babaulti basrensis* specimens were collected from Garmmat Ali-River at 30°34'16'' N 47°44'59''E during April, 2006. The shrimp were brought to the laboratory and acclimatized to laboratory conditions for 7 days, under 12:12 hour light : dark regime with continuous aeration. Before starting the test, all experimental beakers (1 L) were cleaned and filled with dechlorinated tap water. The experimental water was kept in the tank for 48 h before endosulfan was added. Some of the Parameters of the water used in the expriments were measured as follows: pH, DO, salinity, nitriate, nitrite, and total hardness as CaCO3, 7.3, 7.2 mg/l, 0.8 PSU, 1.5mg/l, 0.005 mg/l and 139 mg/l, respectively . No moulting occurred during the experiments, and ovigerous females were not used in the tests.

Commercial grade endosulfan, Thiodan® 35 EC (Made in Iran) (soluble in water), was used in this study. Six different concentrations of endosulfan (0.001, .003, 0.006, 0.01, 0.03 and 0.05) mg/l and a control with three replicates were used. Exceeding aeration was applied to the beakers for 2 h in order to obtain a homogeneous concentration of the toxic compound, and then 10 shrimps (mean weight 15 ±0.07 mg, length 14± 0.05 mm) were transferred into each beaker. The bioassay was carried out as a static test with no solution replacements during the 96 hours of exposure. Mortalities were recorded every day and dead organisms were removed regularly from the test solutions. For the animals were considered dead when they exhibited a total lack of movement, and did not respond to gentle touching with a glass rod and when the body color turned red.

LC50 values were calculated using a computerized probit analysis according to [20]. Safe concentration level was estimated by the quotient of LC_{50} (96hr)/100, according to the same methodology used by [21].

Results and Discussion

Caridina babaulti basrensis [15] (Decapoda, Atydae) inhabits waters of the Shatt Al-Arab, all the Southern marshes, Tigris and Euphrates Turkey, Syria and Iran). *Caridina babaulti basrensis* , is a small species of atyid shrimp with a maximum adult body length of approximately 39mm. Adult *C. babaulti basrensis* lives in dense stands of hornwort (*Ceratophyllum sp.*) with another atyid shrimp, *Atyaephyra desmaresti mesopotamica* and the hymenosomatid crab, *Elamenopsis kempi* [16, 17]. This species' life cycle covers an annual cycle with five larval stages after hatching, followed by a megalopal stage, all six stages remain in the plankton from one to two weeks [18].

Caridina babaulti basrensis is an ideal test organism because it grows very quickly to an adult size of approximately 39mm. At Shatt Al-Arab, *Caridina babaulti basrensis* breeds throughout the year. The smallest mature female found was 14mm of total length. Fecundity was directly proportional to the size of the female, with brood size varying from 71 eggs in the smallest female to 464 eggs in the largest. The shrimp produces more than one broad per year [19].

No mortality was found in control. No significant differences between males and females mortalities. The 24h, 48h, 72h and 96-h LC_{50}s values for shrimp were estimated as (0.010, 0.006, 0.003 and0.002) mg/l., respectively (Tables 1-4). Safe concentration level for endosulfan was 0.02 $\mu g\ L^{-1}$.

Table 1. 24h acute toxicity of endosulfan on the shrimp *C. babaulti basrensis.*

Point	Concentration (mg/l)	95% confidence limits	Slope± SE	Intercept± SE
LC/EC 1.00	0.001	0.000- 0.002	1.9292±0.425	8.81968±0.87
LC/EC 5.00	0.001	0.000- 0.003		
LC/EC 10.00	0.002	0.001- 0.004		
LC/EC 15.00	0.003	0.001- 0.005		
LC/EC 50.00	**0.010**	**0.006- 0.018**		
LC/EC 85.00	0.036	0.021- 0.115		
LC/EC 90.00	0.048	0.026- 0.188		
LC/EC 95.00	0.075	0.036- 0.393		
LC/EC 99.00	0.168	0.066- 1.594		

Note: Control group (theoretical spontaneous response rate)= 0.0000.

Table 2. 48h acute toxicity of endosulfan on the shrimp *C. babaulti basrensis.*

Point	Concentration (mg/l)	95% confidence limits	Slope± SE	Intercept± SE
LC/EC 1.00	0.000	0.000- 0.001	1.6796±0.385	8.6967±0.845
LC/EC 5.00	0.001	0.000- 0.002		
LC/EC 10.00	0.001	0.000- 0.002		
LC/EC 15.00	0.002	0.000- 0.003		
LC/EC 50.00	**0.006**	**0.003- 0.011**		
LC/EC 85.00	0.026	0.014- 0.090		
LC/EC 90.00	0.036	0.019- 0.161		
LC/EC 95.00	0.060	0.027- 0.384		
LC/EC 99.00	0.153	0.054- 2.017		

Note: Control group (theoretical spontaneous response rate)= 0.0000.

Table 3. 72h acute toxicity of endosulfan on the shrimp *C. babaulti basrensis.*

Point	Concentration (mg/l)	95% confidence limits	Slope± SE	Intercept± SE
LC/EC 1.00	0.000	0.000- 0.001	1.9079±0.471	9.8721±1.134
LC/EC 5.00	0.000	0.000- 0.001		
LC/EC 10.00	0.001	0.000- 0.001		
LC/EC 15.00	0.001	0.000- 0.002		
LC/EC 50.00	**0.003**	**0.001- 0.005**		
LC/EC 85.00	0.010	0.006- 0.027		
LC/EC 90.00	0.013	0.007- 0.045		
LC/EC 95.00	0.020	0.011- 0.101		
LC/EC 99.00	0.046	0.019- 0.476		

Note: Control group (theoretical spontaneous response rate)= 0.0000.

Table 4. 96h acute toxicity of endosulfan on the shrimp *C. babaulti basrensis.*

Point	Concentration (mg/l)	95% confidence limits	Slope± SE	Intercept± SE
LC/EC 1.00	0.000	0.000 - 0.000	2.1684±0.63	11.104±1.628
LC/EC 5.00	0.000	0.000 - 0.001		
LC/EC 10.00	0.000	0.000 - 0.001		
LC/EC 15.00	0.001	0.000 - 0.001		
LC/EC 50.00	**0.002**	**0.001 - 0.003**		
LC/EC 85.00	0.005	0.003 - 0.012		
LC/EC 90.00	0.006	0.004 - 0.021		
LC/EC 95.00	0.009	0.005 - 0.048		
LC/EC 99.00	0.018	0.008 - 0.241		

Note: Control group (theoretical spontaneous response rate)= 0.0000.

Although the toxicity of pesticides was studied for numerous species of fish and crustacean, it is difficult to make a direct comparison amongst the available results, since the methods and test conditions and organism size and age were different. Reddy et al. (1995) estimated 96h LC_{50} for the freshwater crab *Barytelphus guerini* exposed to endosulfan and it was 0.018 µg L^{-1} [22]. Mcleese and Metcalfe recorded 96h LC_{50} for the seawater shrimp *Crangon septemspinosa* exposed to endosulfan and it was 0.20 µg L^{-1} [23], while the 96h LC_{50} for the shrimp *Macrobrachium rosenbergii* exposed to endosulfan was 0.31 µg L^{-1} and 5.40 µg L^{-1}, respectively, [24 ; 25]. Omkar and Murti estimated 96h LC_{50} for freshwater prawn, *Macrobrachium dayanum* exposed to endosulfan and the 96h LC_{50} was 4.10µg L^{-1}[26] . Reddy et al. (1992) estimated 96h LC_{50} for the freshwater crab *Oziotelphusa senex senex* exposed to endosulfan and it was 0.019µg L^{-1}[27]. Sucahyo et al. (2008) estimated 24h LC_{50} and 96h LC_{50} of endosulfan to the freshwater shrimp *Caridina laevis* and they were (2.38 and 1.02) µg L^{-1}, respectively[28].

Endosulfan toxicity on shrimp increased with exposure time. Comparing the LC_{50}s of the present study with LC_{50}s results of [28] reveal that *C. babaulti basrensis* is less sensitive to endosulfan toxicity of the tropical shrimp *Caridina laevis*. The differences in LC_{50}s in crustacean organisms generally or in the shrimp in particular are due to many reasons , the size of the organism, species, and the water quality of the test experiments .

This study showed *Caridina babaulti basrensis* to be suitable for toxicity testing as *Caridina laevis* which investigated by Sucahyo et al. [28]. Large numbers of *C babaulti basrensis* were relatively easy to collect from among vegetation along the Shatt Al- Arab and Southern Iraqi Marshes using a hand net. Related species of the genus *Caridina* are found widespread in tropical regions, with records from South California, Cuba, Africa, Madagascar, India, Sri Lanka, China, Taiwan, Korea, Vietnam, Eastern Australia, Malaysia, Indonesia, Philippines, and Japan [29 and 30]. Several species are important for economic reasons, mainly fisheries [29].

Conclusion

Endosulfan is highly toxic to *Caridina babaulti basrensis*. The present study assures the importance of the use of this species in the next toxicological studies as is being widely distributed in the Shatt Al- Arab with high fecundity, small size, easily adapted to laboratory conditions.

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السمية الحادة لمبيد الاندوسولفان تجاة الربيان *Caridina babaulti basrensis* من نهر كرمة علي (Al-Adhub and Hamzah, 1987)

مرتضى دبيج ناصر

قسم الاحياء البحرية/مركز علوم البحار/ جامعة البصرة/البصرة/ العراق

الخلاصة

في الدراسة الحالية اختبرت السمية الحادة للمبيد العضوي الكلوريني الاندوسولفان تجاة الربيان *Caridina babaulti* basrensis . جمعت عينات من الربيان *C. babaulti basrensis* من نهر كرمة علي "16'34°30شمالا و "59'44°47 شرقا خلال شهر نيسان 2006. قيم التراكيز المميته النصف القاتلة للاوقات 24 و 48 و 72و 96 ساعة للربيان كانت (0.010, 0.006, 0.003 and0.002) mg/l. على التوالي. وقد كان التركيز الامن للمبيد L^{-1} µg 0.02.