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Original Research Paper

Effect of Acute Toxicity of Imidacloprid on Glycogen Metabolism in Estuarine Clam, *Katelysia opima* (Gmelin)

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ABSTRACT

The rapid industrialization and successful green revolution have introduced a large variety of chemicals into the environment. Such chemicals include pesticides, which can affect aquatic ecosystems. Imidacloprid is a systemic, chloronicotinyl insecticide mainly used to control sucking insects such as rice hoppers, aphids, thrips, termites and some species of beetles. Further, the pesticide is known to cause apathy, myatonia, tremor and myospasms in humans. Toxic effects of Imidocloprid were estimated by selecting *Katelysia opima* as a test animal. Effect of Imidacloprid on total glycogen content of gill, mantel, hepatopancreas, foot, male gonad and female gonad of estuarine clam, *Katelysia opima* was studied. The clams were exposed to 86.6 ppm (LC_{50}) Imidacloprid for acute treatment. It was found that there was decrease in glycogen content in various tissues as compared to control. In LC_0 group, glycogen was decreased in gill, mantle, foot, male gonad and female gonad except in hepatopancreas, while in LC_{50} group glycogen was decreased in all target organs. This decrease was more in foot, male gonad and female gonad in LC_{50} group as compared to LC_0 group. Decrease in glycogen content indicates greater utilization of glycogen for metabolic purposes and to combat with Imidacloprid stress. The significant increase in glycogen content in hepatopancreas may be due to increased energy demand.

INTRODUCTION

Food is an important source of energy for all living organisms. Food energy is used for building up body tissue, which further signifies that a balanced diet is necessary for proper functioning of the body. The study of proximate composition helps to find out the nutritional quality of food (George & Mathew 1996). Recent understanding of different biochemical processes has proved useful in determining the mechanism of toxicity of different toxicants, and also in unfolding the adaptive protective mechanism of the body to combat the toxic effect of pollutants. Besides, it is also observed that some biochemical alterations occurring in the body give first indication of stress in the organism and hence the efforts, on the part of pollution biologist, to explore the possibility of making use of this phenomenon to locate certain type of pollutants in nature.

Imidacloprid ($C_9H_{10}ClN_5O_2$) is a systemic, chloronicotinyl insecticide used to control the sucking insects like rice hoppers, aphids, thrips, white flies, termites, turf insects, soil insects and some beetles. It is most commonly used on rice, cereals, maize, potatoes, vegetables, sugar beets, fruits, cotton, hopes and turf and is especially systemic when used as a seed or soil treatment. It acts on the nervous system of insect which causes a blockage in the neural pathway. This blockage leads to the accumulation of acetyl choline, an important neurotransmitter, resulting in the insect's paralysis and

eventually death. It is effective on contact and via stomach action (Kidd & James 1994). It is found in the variety of commercial insecticides (Meister 1995). In market, it is available in the form of the products like Admire, Confidor, Premier, Provado, etc., with Imidacloprid as an active ingredient. In Ratnagiri, it is mainly used against mango hoppers, mango mealy bugs, aphids and other insect pests of mango. Due to this, Imidacloprid is getting concentrated in the aquatic bodies and might get biomagnified in the food chains in the coming future.

Clams are known to accumulate pesticides without getting killed easily and have relatively long life span. They also can be easily collected during the low tide and their reasonable size supports adequate tissues for various analysis. Therefore, for the present study *Katelysia opima* was selected as an experimental animal.

MATERIALS AND METHODS

The experimental clams (*Katelysia opima*) used for the study were collected from Bhatye estuarine region, Ratnagiri. Clams of medium size (4.0-4.4cm) were selected and brought to the laboratory and stocked in the plastic containers containing filtered, aerated estuarine water for 48 hrs. Well acclimatized clams to the laboratory condition were grouped in ten and kept into plastic containers containing five litres filtered estuarine water. Static bioassay tests were conducted for 96 hr by using Imidacloprid (17.8% SL). For each experiment, a control group of clams was also run simultaneously.

The toxicity tests were repeated for three times and LC_0 and LC_{50} values were determined. After acute exposure to Imidacloprid the various tissues (gill, mantle, hepatopancreas, foot, male and female gonad) of live clams were pooled, weighed and dried in an oven at 70°C until a constant weight was obtained. Oven dried tissues were used for biochemical analysis. Various tissues of live clams were analysed for total glycogen (De Zwaan & Zandee 1972).

RESULTS AND DISCUSSION

Imidacloprid induced alterations in the total glycogen content in different organs of estuarine clam, *Katelysia opima* are shown in Table 1. Clams of control group showed glycogen content in different body parts in ascending order, gill < hepatopancreas < male gonad < mantle < foot < female gonad containing 9.970 ± 0.18658, 12.00 ± 0.16105, 19.065 ± 0.15165, 22.040 ± 0.16163, 24.090 ± 0.10839, 26.940 ± 0.16733 mg/100mg of dry wet tissue respectively.

In LC_0 (38.5ppm) group, clams showed glycogen content in ascending order as gill < hepatopancreas < male gonad < mantle < female gonad < foot containing 7.575 ± 0.22569, 13.655 ± 0.26362, 15.825 ± 0.19235, 19.415 ± 0.20340, 21.067 ± 0.21902, 23.630 ± 0.20263 mg/100mg of dry wet tissue respectively. As compared to control there was 14.12% increase in glycogen content in hepatopancreas, and 24.02%, 21.80%, 16.83%, 11.91% and 1.90% mg/100mg of dry wt decrease in glycogen content in gill, female gonad, male gonad, mantle and foot respectively.

In LC_{50} (86.6ppm) group glycogen content was present in increasing order as gill < hepatopancreas < male gonad < mantle < female gonad < foot containing 6.735 ± 0.181439, 11.775 ± 0.18758, 13.660 ± 0.15968, 17.550 ± 0.18758, 19.845 ± 0.20721, 19.985 ± 0.23184 mg/100mg of dry wt. As compared to control there was 31.74%, 28.35%, 26.33%, 20.37%, 17.39% and 1.58% decrease in glycogen content in respective organs as gill, male gonad, female gonad, mantle, foot and hepatopancreas.

In estuarine clams glycogen is prime source of energy for carrying out various activities, but due

Table 1: Imidacloprid induced alterations in the total glycogen content of *K. opima* after acute exposure.

Tissue	Control	LC_0 Group	LC_{50} Group
Gill	9.970 ± 0.186581	7.575 ± 0.225693 (-24.02)	6.735±0.181439 (-32.44)
Mantle	22.040 ± 0.161632	19.415 ± 0.203408 (-11.91)	17.550±0.187586 (20.37)
Hepatopanceas	12.00 ± 0.161051	13.655 ± 0.263629 (13.89)	11.775±0.167332 (-1.875)
Foot	24.090 ± 0.108397	23.630 ± 0.202639 (-1.90)	19.985±0.23184 (-17.04)
Male gonad	19.065 ± 0.151658	15.825 ± 0.192354 (-16.99)	13.660±0.159687 (-28.35)
Female gonad	26.940 ± 0.167332	21.067 ± 0.219024 (-21.80)	19.845±0.207214 (-26.33)

Values in parentheses are percentage difference from control, ± S.D. of five readings

to contaminants stress such prime source of energy is affected severely and retarding various processes in the clam's body (Kumbhar & Muley 2003). In Lamellibranch, glycogen is stored in considerable amount in certain tissues while in others it is insignificant (Giese 1969). Glycogen in stressed marine bivalves was studied by Hummel et al. (1989) who observed that the glycogen content decreased coinciding with high mortality. Muley (1991) observed significant decrease in glycogen in freshwater clam, *Indonaia caeruleus* under endosulfan stress.

The studies on biochemical changes enable us to define the dose response relationship, threshold limit value and reversible and irreversible nature of pollutant effect. In addition, the biochemical indices of toxicity derived after a relatively short exposure time may be useful in predicting the appropriate threshold concentration of chronic effects (Christensen & Hunt 1977). Glycogen, protein and lipid are biochemical constituents. Due to the pesticide stress, such prime energy source is decreased in gill, mantle, foot, male gonad and female gonad except in hepatopancreas in LC_0 group, while in LC_{50} group glycogen was decreased in all the target organs. Decline in glycogen in various tissues may be due to stress resulting in breakdown of tissue glycogen to meet the energy demand under toxic stress of pesticide (Mc Leay & Brown 1979). Decrease in glycogen content indicates greater utilization of glycogen for metabolic purposes and to combat with Imidacloprid stress. The significant increase in glycogen content in hepatopancreas may be due to increased energy demand. While studying cadmium impact on estuarine clams like *Katelysia opima*, *Meretrix meretrix* and *Paphia laterisulca*, Kumbhar (2001) noted similar type of results.

Metabolic activity of the clams showed utilization of the biochemical energy to counteract the toxic stress. After acute exposure of Imidacloprid, clams showed remarkable changes in the biochemical composition, i.e., total glycogen, protein and lipid content of the various tissue like gill, foot, mantle, and hepatopancreas, male and female gonads. In general, there was decrease in glycogen level in LC_0 and LC_{50} concentrations of the pesticide in the organs except hepatopancreas of the clam of LC_0 group. The clams from LC_{50} group showed significant decrease of glycogen in the organs than those of LC_0 group when compared to control group. However, the glycogen was more in LC_{50} group as compared to LC_0 group in the present study. The elevation of the glycogen content in hepatopancreas might be accounted for increased lipolysis to cope up with the increased glycogen demand.

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