IMIDALOPRID INSECTICIDE RESIDUES IN LIVER SAMPLES OF FRESH WATER
TELEOST CHANNA PUNCTATUS

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ABSTRACT

The present study was aimed to detect the levels of chloro-nictinyl insecticide residues in liver samples of fresh water teleost Channa punctatus as a case study. After 96 hrs of exposure, the fish liver samples were homogenized, dried and ground to obtain powdered samples. The powdered fish samples were analyzed for pesticide residues using standard laboratory procedure GC method. The results showed that significant increase in the levels of insecticide residues in exposed fish liver samples which were directly proportional to the concentration of Imidacloprid insecticide and duration of exposure. In control group the levels pesticide residues were not detected. It was observed that the results of present investigation reported less than the Indian maximum Residual Limit (MRL) of fresh water fish.

KEYWORDS: Chloro-nicotinyl, pesticide residue, Channa punctatus.

INTRODUCTION

In recent years, various environmental issues have aroused a concern on the pollution of pesticides in rivers and in their various intercompartments. Farmers are using chemical pesticides indiscriminately to control the pests without knowing the danger. Pesticides are indispensable in modern agriculture, but their use or misuse may lead to serious groundwater contamination. The pesticides may impart toxicity to the groundwater and cause various health hazards. The unused pesticides and their degradation product and metabolites in the various intercompartments are known as pesticide residues. They may concentrate in the adipose tissues and in the blood serum of animals leading to environmental persistence, bioconcentration and biomagnification through the food chain.

Pesticides can broadly be classified as insecticides, fungicides and herbicides are mainly organochlorines, organophosphorus, carbamates and pyrethroids. Organochlorine insecticides had been most used pesticide but they have now been replaced with organophosphorous insecticide because of their environmental persistency.

Imidacloprid is a systemic chloro-nicotinyl insecticide. It is a patented chemical manufactured by Bayer Cropscience (part of Bayer AG) and sold under the trade names of Kohinoor, Admire, Advantage, Merit, Confidor and Premise. Imidacloprid belongs to the nicotinoid chemical family, a family of chemicals similar to the tobacco chemical, nicotine. It works by interfering with the transmission of stimuli in the insect nervous system causing irreversible blockage of acetylcholine receptors, which are found in a type of neural pathway that is more abundant in insects than in warm-blooded animals. Imidacloprid has a short half life in surface water and is rapidly broken down in water by sunlight. However, it is more persistent in groundwater.

Even with a potential to persist in soil, the potential for imidacloprid to bioaccumulate in the environment is low due to the high photodegradation tendency and high water solubility. Imidacloprid induces toxic
effects at very low levels in a number of aquatic organisms. Only a few studies were identified the toxicity of common transformation products of Imidacloprid to invertebrates. Furthermore, remarkably little is known about imidacloprid’s long-term chronic effects or the effects of short pulse exposures on nontarget aquatic biota. 7,8.

Fishes are valuable source of high grade protein and they occupy an important position in the socio-economic condition of the South Asian countries by providing the population not only the nutritious food but also income and employment opportunities. India ranks second in the world in fish production. 9. The monitoring and surveillance of pesticide residues in fish, although important and inadequate. Based on the available information, so many researchers conducted pesticide residues in organophosphate and organochlorine pesticides, paucity in the information, an attempt has been made to elucidate the findings of chloro nicotinyl pesticide residues in six samples (six concentrations in triplicate) of liver tissue of fresh water teleost Channa punctatus analyzed using gas chromatographic technique to determine the levels of chloro nicotinyl insecticide contamination in the test fish.

MATERIALS AND METHODS

The adult Channa punctatus weighing 20-25 cm has been chosen for the experimental fish to evaluate the toxicity of Imidacloprid a systemic insecticide widely used for agricultural applications in various sectors. The fishes were procured from River Sarada, Anakapalli, Visakhapatnam Dist., Andhra Pradesh, India. They were brought to the laboratory and acclimatized under laboratory conditions for a period of 2 weeks. The fishes were fed daily with commercial pellets and rice bran. The tubs were disinfected with 0.01% KMnO4 solution and washed thoroughly prior to introduction of fish to prevent dermal infection and fishes were maintained in circular plastic tubs with dechlorinated tap water which was continuously aerated. Water was renewed daily and feeding was withheld 24 hrs before the commencement of the experiment. Preliminary toxicity tests were carried out to find out the acute toxicity tolerance limit of test fish to Imidacloprid insecticide for 96 hrs. Five groups of 10 acclimatized fishes were taken in each circular plastic tub of 10 litres of water capacity and different concentrations of Imidacloprid (0.002ppm, 0.00ppm, 0.006ppm, 0.008ppm and 0.010ppm) were added. Respected controls were maintained simultaneously. All experiments were carried out in triplicates.

At the end of 96 h acute exposure period, the fishes were dissected and separated liver in each concentration with care. The liver samples of the fish samples were dried in hot air oven. The dried samples were ground using mortar and pestle and stored in pre-cleaned glass bottles for analysis. About 2g of dried fish liver samples were weighed and wrapped in butter paper. The wrapped fish liver samples labeled with concentration code ID. The amount of Imidacloprid was calculated against known standard values by employing the following formula.

\[
\text{Concentration} = \frac{\text{Area of sample} \times \text{Amount of standard}}{\text{Area of standard}}
\]

The total six liver sample residue analysis done by VIMTA LABS, Hyderabad. The pesticide residues detected in LC-MS/MS (AB Sciex-API4000) and detection limit was 0.010mg/kg.

RESULTS AND DISCUSSION

The results of liver tissue analysis of Channa punctatus (Bloch) exposed to Imidacloprid insecticide were reported in the Table 1. In control group the levels of pesticide residues were not detected. The mean values of pesticide residues were significantly \( p<0.0001 \) increased as concentration of pesticide was increased. The highest mean value of pesticide residue level was showed in concentration 0.010ppm and lower level of pesticide residue found in 0.002ppm.

<table>
<thead>
<tr>
<th>Sr.No</th>
<th>Concentration ppm</th>
<th>Mean and SE Values mg/g</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>Control</td>
<td>nd</td>
</tr>
<tr>
<td>II</td>
<td>0.002</td>
<td>0.062±0.0068*</td>
</tr>
<tr>
<td>III</td>
<td>0.004</td>
<td>0.066±0.00045*</td>
</tr>
<tr>
<td>IV</td>
<td>0.006</td>
<td>0.076±0.00089*</td>
</tr>
<tr>
<td>V</td>
<td>0.008</td>
<td>0.079±0.00013*</td>
</tr>
<tr>
<td>VI</td>
<td>0.010</td>
<td>0.087±0.00051*</td>
</tr>
</tbody>
</table>

\( \text{nd}=\text{not detected} \), * Significant \( p<0.0001, n=5 \)

The occurrence of higher level of Imidacloprid might be due to the oxidative process suffered by Imidacloprid in the aquatic environment. The variation in concentration of Imidacloprid insecticide detected in fish species could be attributed to differences in feeding habit and metabolic characteristics of the fish species. However, the levels of pesticide residues detected in this study fell...
below the Australian Maximum Residual Limits of 0.05 mg to 1mg for fresh water fish \(^{10}\). The Maximum Residue Level (MRL) is the maximum amount of pesticide residue which if found in food substances will not cause any health effect or hazard \(^{11}\).

Kumari et al.\(^{12}\) studied the organochlorine contamination in the fish of the River Ganges, India and reported that organochlorine contaminants may affect the human population who consumes the contaminated fish from the river may be at risk from those contaminants. Kiziewicz and Czeczuga (2003)\(^{13}\) studied the DDT and its metabolites in the muscle, liver and brain tissues of certain fishes. They reported that the higher concentration of DDT was detected in the brain and liver tissues than muscle tissue. Gurunadha Rao et al. (2004)\(^{14}\) analyzed pesticide residues in ground water samples. He reported that generally, the organ chlorine pesticide residues presented in the groundwater were about six to eight times higher than other pesticides, which may be attributed to growth of cotton crop. Wasim Aktar (2009)\(^{15}\) conducted investigation to determine the residual concentration of five pesticides in Ganga river fishes. They found that total \(\delta\)-HCH concentrations were above the MRL values in comparison to other four pesticides. The pesticide pollution may be due to untreated sewage sludge of the river.

S. Afful et al.\(^{3}\) conducted pesticide residue analysis on seven banned pesticides. Among the seven banned organochlorine pesticides (aldrin, chlordane, DDT, dieldrin, endrin, lindane (\(\delta\)-HCH), heptachlor) in Ghana detected, \(\delta\)-HCH recorded the highest residue concentration of 35.2: g/kg in Channa obscura (CON). The global contamination due to OC pesticides probably occurs as these chemicals volatilize into the atmosphere and deposit with rains\(^{16}\).

The above-mentioned studies revealed that out of the all the different types of pesticides, organochlorine pesticides are most commonly found as they break down slowly and remain in the environment long after its application. Pollution by these pesticides leading to food chain accumulation cannot be ignored. Therefore, there is a need to monitor the concentration of pesticides in every intercompartment from time to time and also to generate awareness among people so as to fight this serious problem.

The detectable level of such residues were varied in quantities dependent on the way of nutrition and the fat content of particular species of fish, type of tissue examined and exposure of examined fish to insecticide before catching and processed as well as the degree of accumulation of these compounds in examined samples. The results of present investigation indicated that chloro-nicotinyl pesticide residues in fish liver samples were below the stipulated Australian Maximum Residual Limits of 0.05 mg to 1mg for fresh water fish so the results revealed that prolonged exposure may lead to increase in the accumulation and affect the aquatic biota. The residues were accumulated in different tissues, causing toxicity to the fish which ultimately result in biomagnifications through the food chain.

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