Uttar Pradesh Journal of Zoology

Volume 45, Issue 18, Page 563-569, 2024; Article no.UPJOZ.4090
ISSN: 0256-971X (P)

Lambda Cyhalothrin (LCT)-Induced Long-term Pesticide Effects of Albino Rats

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

Article Information

DOI: https://doi.org/10.56557/upjoz/2024/v45i184473

Open Peer Review History:
This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: https://prh.mbimph.com/review-history/4090

Original Research Article

Received: 07/07/2024
Accepted: 12/09/2024
Published: 17/09/2024

ABSTRACT

Lambda cyhalothrin (LCT), a prominent pyrethroid insecticide, has been linked to a number of negative side effects in non-target animals, including mammals. This study investigated the long-term consequences of lambda- cyhalothrin (LCT) exposure on albino rats, including physiological, biochemical, and behavioural alterations. Adult albino rats were given sub-lethal lambda-cyhalothrin (LCT) doses over an extended period to simulate chronic exposure. Body weight, organ histology, serum biochemical markers, and behavioural reactions were all examined to determine the toxicological impact. The biochemical markers of liver and kidney function showed substantial variation, indicating organ damage. Histopathological evaluation of the liver and kidney tissues revealed structural damage consistent with the biochemical abnormalities discovered. The neurotoxic potential of lambda-cyhalothrin (LCT) was further demonstrated by the exposed rats'

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Cite as: *Rao, Bonu.Narayana, Thotakura.Rahul Sandeep, and G. Simhachalam. 2024. "Lambda Cyhalothrin (LCT)-Induced Long-Term Pesticide Effects of Albino Rats". UTTAR PRADESH JOURNAL OF ZOOLOGY 45 (18):563-69. https://doi.org/10.56557/upjoz/2024/v45i184473.*

notable behavioural changes, which included decreased locomotor activity and increased anxiety-like behaviour. These findings emphasise the potential long-term risks associated with repeated exposure to lambda cyhalothrin (LCT), emphasizing the need for additional research and strong regulations to understand the implications for environmental safety and public health.

Keywords: Lambda-cyhalothrin (LCT); neurotoxic effects; behavioral changes; histopathological evaluations; organ dysfunction.

1. INTRODUCTION

Every day, humans and other animals are subjected to a significant number of toxins in the environment, increasing their risk of developing chronic diseases and eventually dying [1]. Thus, screening and assessing dangerous substances is critical to ensuring that they do not affect non-target species. Pesticides, airborne pollutants, pollution, food additives, and heavy metals are some of the poisons to which humans are often exposed. Every day, more than 50,000 chemicals come into touch with us, and pesticides, in particular, have harmful impacts on people that range from moderate to fatal at certain stages in our lives [2]. Farmers apply pesticides on agricultural land to boost crop quality and productivity. Unfortunately, the negative impacts of pesticides might appear years after they are first introduced into the ecosystem. The pesticide's mobility, degradation, and effect on target and non-target animals must all be continuously monitored, and any novel compounds must be thoroughly evaluated prior to use. Chemicals that reach the human body via bio magnification, such as additives, medications, and pesticides, must be carefully evaluated [3].

Toxicology refers to a chemical's ability to interfere with any of an organism's biological processes. Chemical toxicity in terrestrial organisms is expressed as LD50, whereas it is indicated as LC50 in aquatic creatures [2,3]. The graphic depicts the amount of toxicant in the lethal dosage (LD50) or concentration (LC50) that will cause 50% of the test animal population to die over a specific time period (Finney, 1971). Whereas the toxicity of terrestrial animals is evaluated by administering the toxicant by various channels, including oral, intramuscular, or inhalation approaches, the toxicity of aquatic animals is tested by dissolving the toxicant in water [3]. The LD50 represents toxicity. The time of exposure is critical when determining the toxicity levels of toxicants in aquatic or terrestrial animals; LD50/LC50 values are typically established after 24, 48, 96, or even more hours of exposure [4]. The complex phenomenon of toxicity assessment of hazardous compounds is a source of debate in science. The bio-assessment of pesticide toxicity is an important aspect in toxicity assessments.

The amount of toxicity testing necessary is determined by the chemical formula of the molecule and the biological activity of identified compounds. A complete examination of the toxicity should begin as soon as the industries produce the substances [5]. This provides an accurate picture of the substance's toxicity. The toxicity study's information on health dangers may also assist producers in modifying a chemical's structure to make it less toxic or non-toxic to animals that are not intended for usage [6]. Toxicity screening can provide a complete picture of an effluent's risk to non-target species and the natural world. Therefore, pesticide screening will provide a rough understanding of the toxicant's fatal dose on non-target animals [5,6].

A chemical's toxicity analysis usually starts with its dose, where "dose" given topically, intraperitoneally, or orally. Usually, the dosage is given as mg/kg of body weight. The aspects of diet, light, and stressful environments all have a major role in setting the dosage of the chemical. The dosage of the drug is also infected by a number of other variables, such as age, sex, health, and hormonal state [7]. Measurements of the levels of food and environment at various time intervals are used to estimate the dose before it is administered. In addition, dietary intake, inhalation rate, and the appropriate deposition and retention characteristics are assessed during this process. It is important to use dose-response studies for evaluating toxicity. The behavior that happens when laboratory animals are given toxicant dosages is considered to as "response" [8]. Doses-mortality is a measure of how fatal a chemical is to an animal species or to any other poisonous substance over a specific amount of time, usually 48 hours. The dose response relationship can help you identify, evaluate, and interpret the majority of pharmacological and toxicological reactions to

medications. As a result, information gained from animal dose-response trials is utilized to determine human exposure limits as well as the maximum amount of chemical residue permitted in the environment. According to Alewu and Nosiri (2011), dose-response relationships reduce the risk to people and the environment make it possible to accurately estimate the health hazards connected to chemical exposure. Rats and mice are frequently utilised for oral toxicity testing because of their similar metabolic responses to humans, their digestive systems' propensity for a diet similar to humans', and the obvious reason that human subjects are not suited for use in toxicological research [8,9]. The most ideal and useful model is one that closely mimics humans and won't endanger the lab personnel. Because albino rats are easier to handle and raise in a laboratory, they were chosen in the current investigation. Since these animals are mammals with short gestation periods, they can serve as role models for people [10]. The toxicity evaluation of a pesticide can be used to determine the safe threshold, or the degree of environmental contamination that can be tolerated, more easily. This will support the establishment of biotic element tolerance limits and constraints [11].

To evaluate toxicity, a number of concentrations are estimated, including the safe, medium, and lethal levels [9]. There are several methods for determining the concentration at which half of the animals would perish.

The graphical method, regression analysis, and confidence limit determination are the most often used techniques for calculating LD50, as explained by Finney (1971).

1.1 Toxicity Evaluation of Type II Synthetic Pyrethroid

Since their discovery more than a century ago, organophosphates and synthetic pyrethroids have been the most widely used class of insecticides globally. These substances are dangerous to people and other animals and constitute a significant domestic source of toxicity. Synthetic pyrethroids are a class of reversible acetyl cholinesterase inhibitors that produce a deadly cholinergic crisis, much to organophosphate poisoning [12]. The medical therapy of poisoning from synthetic pyrethroids requires atropine treatment. The timing of the clinical effects of synthetic pyrethroids is determined by several factors, including the type of synthetic pyrethroid used, the exposure route, the usage of protective garments, and the animal's metabolic health. When synthetic pyrethroid are ingested or inhaled, their clinical effects become apparent sooner than with cutaneous exposure [11]. Pyrethrins, natural compounds derived from Chrysanthemum plants, are the source of synthetic pyrethroid pesticides. These compounds include tetramethrin, resmethrin, fenvalerate, permethrin, cypermethrin, ë-cyalothrin, lambda-cyhalothrine, and deltamethrin [13,14]. These are all commonly used in agriculture. They are normally non-toxic to animals, possess significant insecticidal effects, and are photostable, with low volatility and persistence [15].

Lamba-Cyhalothrine, a synthetic pyrethroid, was used in this experiment. LCT is an insecticide used to treat or protect agricultural seeds. It causes cancer and disrupts the cholinergic system. Inhaling this material has an effect on the eyes [7]. This medication lowers hemoglobin levels and cholinesterase activity in blood and nerve cells. Neurotoxic flexivations are observed and rats' body weight is reduced [8].

2. MATERIALS AND METHODS

The current study evaluated the neurotoxicity of Lambda Cyhalothrin (LCT) in a rat model. The current study looked on the neurotoxic effects on albino rats' brain tissue. The neurotoxic effects of Lambda cyhalothrin (LCT) were investigated using trials on Toxicological, studies, Contraryto the recommendations provided by the Organization Animal Ethical Committee (Resolution No. 1821/PO/Re/S/15/CPCSEA dt. 18.06.2018),

2.1 Selection of Experimental Model

This investigation was conducted on a male albino rat (**Rattus norvegicus)** weighing 160 ±20 g. The following are the reasons that rats were chosen as the experimental model for this investigation.

2.2 Pesticide Selected: Lambda-cyhalothrin (LCT)

2.2.1 LD50 Determination

The LD50 was defined to using the log-dose/probit regression line method (Finney, 1971). 10 sets of 10 albino rats each were obtained, and ten serially diluted dosages were

given orally with the aid of a gavage tube. Lambda-cyhalothrin (LCT) was administered at different weight-based doses of 10, 14, 18, 22, 26, 30, 34, 38, 42, and 46 mg. To facilitate additional calculations, the rat's mortality was reported following a 48-hour observation period.

2.2.2 Toxicity Assessment

The study's goal is to examine the toxicity of a drug in rats over a 45-day period. The rats will be separated into four groups; the second will get a sub lethal dose for 15 days, the third for 30 days, and the fourth for up to 45 days. The rats will be sacrificed by cervical dislocation on the 16th, 31st, and 46th days. The Morris water maze, a popular model for studying spatial memory, has received substantial attention for its neurological, neurochemical, and neurophysiological implications. The investigation will focus on the rats' memory index.

IUPAC designation for lambda chlorothrin (LCT) (98% surety) is C23H19ClF3NO3.3-(2-chloro-3,3,3-trifluoro-1-propenyl)-2,2-dimethyl-cyano(3-phenoxypheny l) methyl cyclopropane carboxylate

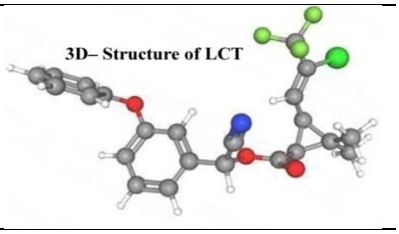

Fig. 1. 3D-Structure of LCT

Fig. 2. Induction of LCT to Albino Rat model

Table 1. The mortality rate of albino rats subjected to different lambda cyhalothrin dosages after 48 hours.(Mortality was expressed both in percent and probit kill)

S.No	Concentration mg/kg body weight	Log concentration	Number of animals		Percent mortality	Probit mortality
			Exposed	Dead		
1	10	1.000	10	0	0	-
2	14	1.146	10	1	10	3.71
3	18	1.255	10	2	20	4.16
4	22	1.342	10	3	30	4.47
5	26	1.415	10	5	50	5.00
6	30	1.477	10	7	70	5.52
7	34	1.531	10	8	80	5.84
8	38	1.579	10	9	90	6.28
9	42	1.623	10	10	100	8.09
10	46	1.681	10	10	100	8.09

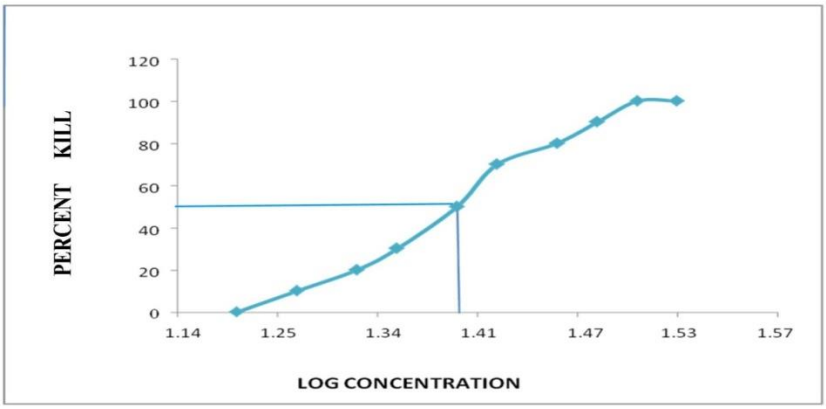

Fig. 3. A sigmoid curve is shown in the graph of Albino rat mortality against log LCT concentration

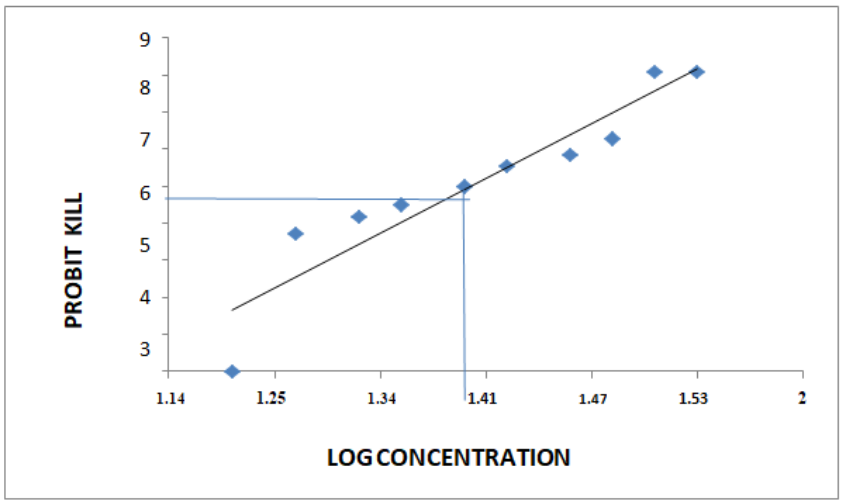

Fig. 4. Graphical representation of probit regression line showing mortality of albino rats against log concentration of LCT

3. RESULTS

The present research used oral administration of lambda-cyhalothrin (LCT) to determine rat fatality rates. Lambda-cyhalothrin (LCT) was tested at dosages and concentrations ranging from 54 to 90 mg/kg body weight to assess its mortality. The mortality rate was presented as a percentage at different doses following the administration of lambda-cyhalothrin (LCT) to the Wister albino rat, a mammalian model.

Rats were chosen at random for an LCT toxicity test. After being exposed to varied amounts of LCT, the animals' mortality rates were as follows: 0% at 10 mg/kg body weight, 10% at 14 mg/kg bw, 20% at 18 mg/kg bw, 30% at 22 mg/kg bw, 50% at 26 mg/kg bw, 70% at 30 mg/kg bw, 80% at 34 mg/kg bw, 90% at 38 mg/kg bw, and 100% at 4 (Table 1). The LD50 value was 26 mg/kg body weight, and the percent fatality rate was plotted against the log concentration of LCT, yielding the sigmoid curve (Fig. 2). The probit method (Finney, 1971) was used to plot percent mortality following transformation to probit mortality against the log concentration of LCT. A straight line was obtained, and the graph's LD50 value was 26 mg/kg body weight (Fig2).

The albino rat's probit mortality was computed using its percent mortality. Plotting the Probit Morality versus the pesticide's log concentrations produced a straight line, as seen in Figs. 3&4. This sigma curved-line graph yielded an LD50 value of 70 mg/kg bw.

4. DISCUSSION

Probit Analysis (Finney, 1971) is supported by the graph gives an explanation of mortality

percent versus log concentration and probit mortality versus long doses of lambda-cyhalothrin, they, respectively, showed a typical sigmoid curve (Fig.3) and a straight line (Figs. 3&4). The LD50 value in the present experiment is 70 mg/kg bw. Lambda-cyhalothrin's lethal dose is contingent upon several factors, including as its isomers, ambient conditions, light, and water content [16]. Depending on the chemical's purity and the species' ability to tolerate the pesticide, the LD50 values for animals of the same basic strain acquired from various sources can also vary significantly [15]. The LD50 values for water-deprived and non-deprived people were different [16]. As a consequence, one (or more) of the aforementioned factors could be to blame for the differences in LD50 values found in the present research from those reported by other researchers [13].

The LD50s for insecticides in various vertebrate species exhibit a wide range of toxicity. The toxicity (LD50) of lambda-cyhalothrin in rabbits differed from rats and mice. Lambda-cyhalothrin's oral LD50 was 325-392 mg/kg for rats and 70-100 mg/kg for rats. Each of these doses exceeded the rabbits' respective ocular and oral LD50s (9.8 mg/kg). Lambda-cyhalothrin's LD50 in rats was 59 mg/kg, hence killing rabbits required an intravenous (i.v.) injection of 5 mg/kg of the medication [17]. Lambda-cyhalothrin's acute toxicity is clearly species dependent, with rabbits being more susceptible than rats and mice. Due to the Draize test, Lambda-cyhalothrin causes sudden mortality in rabbits, making it difficult to administer a single dose of 100 mg of Lambda-cyhalothrin to elicit ocular pain without killing the animals [18]. To minimize accidental intoxication, pesticides like Lambda-cyhalothrin, which is highly toxic to rabbits when tested for eye irritation, may need to be branded as severe eye irritants and classed as limited use pesticides [19].

5. CONCLUSION

The results of this study indicated a dose-dependent toxicity. Lambda-cyhalothrin is extremely toxic (even at the lowest dose used in this experiment) and can cause cell damage, organ failure, anaemic conditions, and a reduction in immunity with prolonged exposure, impacting the overall health and well-being of the LCT-treated animals.

DECLARATION

All animals were handled in compliance with the laboratory animal care and use guidelines, as well as any applicable national regulations.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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Peer-review history:
The peer review history for this paper can be accessed here:
https://prh.mbimph.com/review-history/4090