



Effect of deltamethrin on the physiological response of Mudskipper (*Apocryptes bato*)

Md. Abu Saem

Roll No: 0123/06

Registration No: 1278

Session: 2023-2024

**A thesis submitted in the partial fulfillment of the requirements for the degree of
Master of Science in Fish Biology and Biotechnology**

Department of Fish Biology and Biotechnology

Faculty of Fisheries

Chattogram Veterinary and Animal Sciences University

Khulshi, Chattogram-4225, Bangladesh

DECEMBER 2024

AUTHORIZATION

I hereby declare that this thesis is entirely my original work. I grant Chattogram Veterinary and Animal Sciences University (CVASU) the right to share this thesis with individuals or organizations for academic research purposes. Additionally, I authorize CVASU to reproduce this thesis, in full or in part, through photocopying or other means as requested by any individual or organization for academic use. Furthermore, I certify that the electronic version of this thesis provided to the CVASU library is a true and accurate replica of the printed thesis submitted, within the limits of current technological capabilities.

Md. Abu Saem

December 2024

**Effect of deltamethrin on the physiological response of
Mudskipper (*Apocryptes bato*)**

Md. Abu Saem

Roll No: 0123/06

Registration No: 1278

Session: 2023-2024

This is to certify that we have examined the above Master's thesis and have found that is complete and satisfactory in all respects and that all revisions required by the thesis examination committee have been made

.....
Dr. Md. Mahiuddin Zahangir
Supervisor

.....
Dr. Md Asaduzzaman
Co-supervisor

.....
Dr. Md. Mahiuddin Zahangir

Chairman of the Examination Committee

Department of Fish Biology and Biotechnology

Faculty of Fisheries

Chattogram Veterinary and Animal Sciences University

Khulshi, Chattogram-4225, Bangladesh

DECEMBER 2024

ACKNOWLEDGEMENT

I am deeply grateful to the Almighty for granting me the strength, perseverance, and patience to successfully pursue and complete my postgraduate studies and thesis for the Master of Science (MS) degree in Fish Biology and Biotechnology.

My sincere appreciation goes to **Dr. Md. Mahiuddin Zahangir**, Associate Professor in the Department of Fish Biology and Biotechnology, CVASU, for his steadfast support, expert guidance, constructive feedback, and constant encouragement, all of which were instrumental in the completion of my work.

I am deeply grateful to **Dr. Md Asaduzzaman**, Associate Professor and Head, Department of Marine Bioresource Science, Faculty of Fisheries, CVASU, for his invaluable support and guidance.

I am also profoundly thankful to **Azmaien Naziat and Shifat-Ara Noor**, Lecturer in the Department of Fish Biology and Biotechnology, CVASU, for their unwavering support, which significantly contributed to my growth as a confident and capable researcher.

Finally, I would like to express my cordial thanks to Joya Chakrabarty (MS Student), Tushar Mahmud (MS Student) and laboratory attendants of Department of Fish Biology and Biotechnology for their sincere and laborious working support during the experimental period.

Lastly, I am deeply thankful to my parents and friends for their unconditional support, blessings, and sacrifices, which have been my source of strength and motivation throughout this journey.

Md. Abu Saem
December 2024

TABLE OF CONTENTS

CHAPTER	TITLE	PAGE NO.
	AUTHORIZATION	ii
	SIGNATURE PAGE	iii
	ACKNOWLEDGMENTS	iv
	TABLE OF CONTENTS	v- vii
	LIST OF PLATES	viii
	LIST OF FIGURES	ix
	LIST OF TABLES	x
	ABSTRACT	xi
1	INTRODUCTION	1-5
	Background	1-5
	Objectives	5
2	REVIEW OF LITERATURE	6-15
	2.1. Pesticides	6
	2.1.2. Impacts of pesticides on ecosystem and human health	7
	2.1.3. LC ₅₀ of different pesticides in different fish species	8-9
	2.3. Deltamethrin	9
	2.3.1. Impacts on environment	9-10
	2.3.2. Impacts on human health	10-11
	2.3.3. Deltamethrin toxicity in different fish	11-13
	2.3.4. Impacts on other aquatic organisms	13-14
	2.4. Mudskippers	14-15

3	MATERIALS AND METHODS	16-22
	3.1. Pesticides used in experiment	16
	3.2. Experimental site	16
	3.3. Experimental fish	17
	3.4. LC ₅₀ determination	17-18
	3.5. Exposure to sublethal concentration	18
	3.6. Growth parameters	18-19
	3.7. Collection of internal organs and determination of gastrointestinal indices	19
	3.7.1. Determination of hepatosomatic index (HSI)	20
	3.7.2. Determination of viscerasomatic index (VSI)	20
	3.8. Collection of blood	20
	3.9. Hemato-biochemical parameters measurement	21
	3.10. Biochemical and enzymatic parameters measurement	21
	3.11. Red and white blood cell counts	21
	3.12. Observation of red blood cell alterations in fish treated with pesticides	21-22
	3.13. Statistical analysis	22

4	RESULT	23-30
	4.1. LC ₅₀ of deltamethrin pesticide for <i>Apocryptes bato</i>	23
	4.2. Hematological parameters of <i>Apocryptes bato</i> exposed to sublethal concentration of deltamethrin	23-24
	4.3. Changes in serum biochemistry of <i>Apocryptes bato</i> exposed to sublethal concentration of deltamethrin	24-25
	4.4. Changes of serum ion concentration (Na ⁺ and Cl ⁻) of <i>Apocryptes bato</i> exposed to sublethal concentration of deltamethrin	25
	4.5. Erythrocytic abnormalities of <i>Apocryptes bato</i> exposed to sublethal concentration of deltamethrin	26-28
	4.6. Changes in gastrointestinal indices of <i>Apocryptes bato</i> exposed to sublethal concentration of deltamethrin	28-29
	4.7. Growth performance of <i>Apocryptes bato</i> exposed to sublethal concentration of deltamethrin	29-30
5	DISCUSSION	31-38
	5.1. LC ₅₀ of deltamethin for <i>Apocryptes bato</i>	31-32
	5.2. Hematological and biochemical parameters	32-34
	5.3. Serum biochemistry	34-35
	5.4. Serum ions	35-36
	5.4. Erythrocytic alterations	36-37
	5.6. Gastrointestinal indices	37
	5.7. Growth performance of <i>Apocryptes bato</i>	37-38
6	CONCLUSION	39
7	RECOMMENDATION	40
8	REFERENCES	41-58
9	BIOGRAPHY OF AUTHOR	59

LIST OF PLATES

Plate no.	Title	Page no.
1	Mudskipper (<i>Apocryptes bato</i>)	16
2	Experimental site	17
3	Tank preparation for experimental fish	18
4	Measuring weight and length	19
5	Blood collection of fish	20
6	Observation of red blood cell alterations	26

LIST OF FIGURES

Figure no.	Title	Page no.
1	Determination of LC ₅₀ value of Deltamethrin for <i>Apocryptes bato</i>	23
2	Variations in Na ⁺ and Cl ⁻ ion concentration in Mudskippers fish (n=8). Different letters of alphabets represent significant differences between treatment groups ($p < 0.05$). Values are presented as mean \pm standard deviation (SD)	26
3	Cellular abnormalities in Giemsa-stained blood smears of <i>Apocryptes bato</i> under pesticide doses treatment- 1 and treatment-2; a) Regular cells; b) Twin; c) Tear-drop shaped cell; d) Elongated; e) Fusion; f) Echinocytic; g) Spindle	27
4	Nuclear abnormalities in Giemsa-stained blood smears of <i>Apocryptes bato</i> under pesticide doses treatment- 1 and treatment-2; a) Regular cells; b) Nuclear degeneration; c) Notched nuclei; d) Micro nuclei; e) Dead cells; f) Karyopyknosis	28
5	Variations in hepatosomatic index (HSI) (A) and viscerasomatic index (VSI) (B) of <i>Apocrypto bato</i> (n = 8) at different sublethal concentration (10% and 20%) of deltamethrin. Different letters of alphabets represent significant differences between treatment groups ($p < 0.05$). Values are presented as mean \pm standard deviation (SD).	29

LIST OF TABLES

Table no.	Title	Page no.
1	Variation in hematological parameters of <i>A. bato</i> after sublethal exposure to deltamethrin. Values are expressed as mean \pm SD (n = 8). Different superscripts of alphabets indicate statistically significant ($p < 0.05$) differences between the control and the different treatment groups by one-way analysis of variance (Tukey-HSD)	24
2	Changes in serum biochemistry of <i>Apocryptes bato</i> . Values are expressed as mean \pm SD (n=8). Different superscripts of alphabets indicate statistically significant ($p < 0.05$) differences between the control and the different treatment groups by one-way analysis of variance (Tukey-HSD)	25
3	Cellular abnormalities in erythrocytes of <i>Apocryptes bato</i>	26
4	Nuclear abnormalities in erythrocytes of <i>Apocryptes bato</i>	28
5	Growth performance of <i>Apocryptes bato</i> . Values are expressed as mean \pm SD. Different superscripts of alphabets indicate statistically significant ($p < 0.05$) differences between the control and the different treatment groups by one-way analysis of variance (Tukey-HSD)	30

ABSTRACT

The extensive use of agrochemicals and industrial effluents that contain toxic substances pollutes water bodies and damages aquatic ecosystems. This study focused to investigate the sublethal toxicity of deltamethrin (DM) on a Mudskipper species (*Apocryptes bato*) highlighting its physiological, hematological, and biochemical consequences. After 48 hours, the lethal concentration (LC₅₀) of DM was found to be 42.2 ppm. Significant disruptions in growth performance, including decreased weight gain, specific growth rate, and feed conversion efficiency, as well as an increased feed conversion ratio, were caused by sublethal exposure at concentrations of 4.25 ppm (10% of LC₅₀) and 8.50 ppm (20% of LC₅₀). Under pesticide stress, hematological parameters determines including hemoglobin, cholesterol, and red blood cell count showed notable decreases, whereas glucose levels increased rapidly. Decreases in serum albumin, globulin, total protein, and ion (Na⁺ and Cl⁻) concentrations were found due to deltamethrin exposure. Additionally, fish exposed to DM had higher erythrocytic morphological alterations, including both cellular (twin, tear-drop shaped cell, elongated, fusion, echinocytic) and nuclear abnormalities (nuclear degeneration, karyopyknosis, notched nuclei and micronuclei). These results demonstrate how susceptible mudskippers are to exposure to deltamethrin, even at sublethal levels, and how the pesticide can interfere with essential physiological and metabolic functions. The study's assessed characteristics are reliable signals for assessing pesticide toxicity in aquatic environments, indicating the necessity of appropriate pesticide application regulations to protect aquatic ecosystems. This study demonstrates that, even at sublethal doses, deltamethrin poses serious ecological risks to aquatic ecosystems by significantly altering hematological, physiological, and ion concentration parameters.

Keywords: Deltamethrin, *Apocryptes bato*, Growth, Hematological parameters, Serum biochemistry, Gastrointestinal indices