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ORIGINAL ARTICLE

Toxic Effect of Synthetic Pyrithroid Pesticide (Cypermethrin) and an Organo Phospate Pesticide (Chlorpyrifos) on Certain Parameters of fresh water Carp Fish *Labeo rohita*

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ABSTRACT

Aquatic ecosystems are vulnerable to the detrimental effects of various agrochemicals, including synthetic pyrethroids and organophosphates. In this study, we investigated the toxicity of cypermethrin and chlorpyrifos on a commonly found freshwater fish species Labeo rohita,. The fish Labeo rohita were treated for acute toxicity with cypermethrin and chlorpyrifos, separately and in combination for 7 days with 1/10th of the LC_{50} dosage for individual treatment (0.015ppm and 0.042ppm respectively) and 1/20th of the LC_{50} of cypermethrin and chlorpyrifos for combined treatment (i.e., 0.0075ppm and 0.021ppm respectively). Individual and combined treatment resulted in a significant ($p<0.05$) change in glucogen, proteins and lipid contents in muscle, liver and kidney tissues were recorded. Muscle shows the greatest loss of protein followed by liver and kidney. Liver shows significant reduction of lipid and glycogen in comparison with other selected tissues of the experimental fish species. The changes were greater in combination than individual treatment, possibly because of a synergistic effect of cypermethrin and chlorpyrifos.

Key Words: *Cypermethrin, Chlorpyrifos, Labeo rohita, glycogen, protein, lipid, Liver, Muscle, Kidney*

INTRODUCTION

Pesticides can have significant toxic effects on aquatic ecosystems, including fish. These chemicals are designed to kill or control various pests in agriculture, but they can also harm non-target organisms when they enter aquatic environments. Pesticides can alter the water quality in aquatic ecosystems by contaminating the water with chemical residues. This can impact the physicochemical properties of the water and, in turn, affect fish and other aquatic organisms [1]. The toxic effects of pesticides on fish and aquatic ecosystems can be attributed to several factors, including their chemical properties, persistence, and toxicity.

Pesticides can disrupt the balance of aquatic food webs by affecting the abundance and diversity of primary producers (algae, plants) and invertebrates. This can have cascading effects on fish populations, as their prey may be impacted[2].

Some pesticides are persistent in the environment and can accumulate in sediments and aquatic organisms over time. This long-term exposure can lead to chronic toxicity and ecosystem disruption [3]. Pesticides, especially insecticides and herbicides, can directly harm fish by interfering with their biological processes. Some pesticides can affect fish through various routes, such as gills, skin, or ingestion. Organophosphate and carbamate insecticides are well-known for their acute toxicity to fish [4]. The impacts of pesticides can vary depending on the type of pesticide, its concentration, the duration of exposure, and the characteristics of the aquatic ecosystem. They can impact fish behavior, such as feeding and reproductive behaviors, which can have significant consequences for their survival and population dynamics [5].

Cypermethrin is a synthetic pyrethroid insecticide that is widely used in agriculture to control a variety of pests. It is known to be toxic to aquatic organisms, including fish. Acute exposure to cypermethrin can lead to various adverse effects, such as gill damage, behavioral changes, and mortality in fish species like *Labeo rohita.* Chlorpyrifos is an organophosphate pesticide used in agriculture to control insect pests. It is also toxic to aquatic organisms, and exposure to chlorpyrifos can result in neurotoxic effects and behavioral changes in fish.

Pesticides like cypermethrin and chlorpyrifos are commonly used in agriculture to control pests. When these pesticides are applied to crops, they can enter nearby water bodies through runoff and drift. When these two pesticides are present together in aquatic environments, they can interact and potentially have more significant adverse effects on fish and other aquatic organisms. In aquatic environments, fish are exposed to a mixture of these pesticides. Both cypermethrin and chlorpyrifos can have toxic effects on fish individually, but their combined presence can lead to synergistic or additive effects, which may result in increased toxicity. The interaction between these pesticides in aquatic ecosystems is of concern for the health and survival of fish populations. Synergistic toxic effects of multiple pesticides, including chlorpyrifos, which can provide insights into how combinations of pesticides may affect aquatic organisms [6].

MATERIAL AND METHOD:

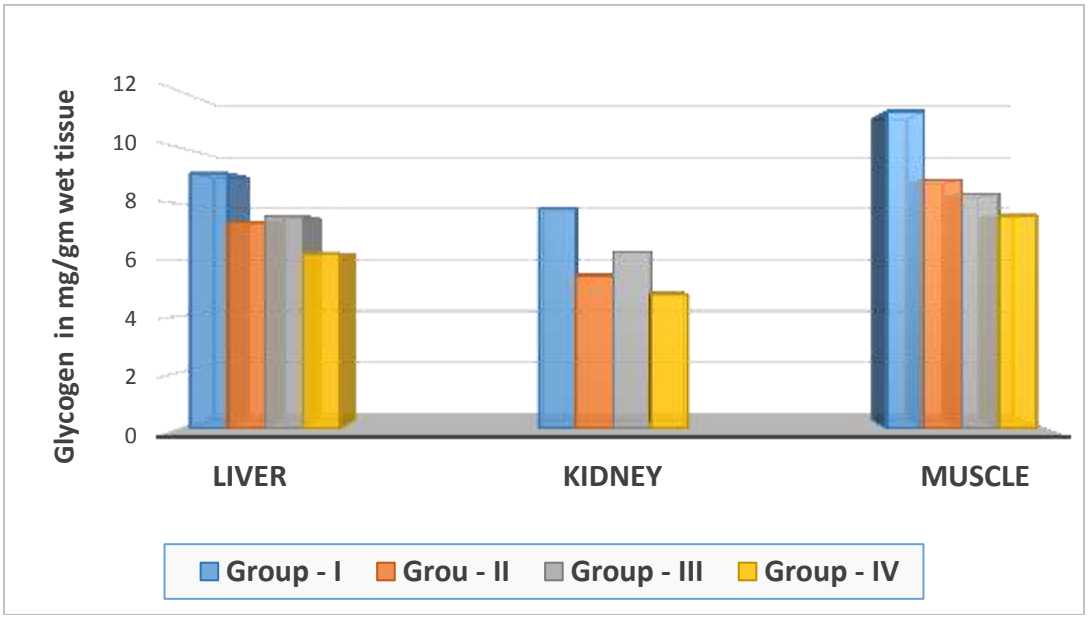
The fresh water fishes *Labeo rohita* measuring about 8 to 12 cm and 60-80g weight were collected from fish seed rearing center. The collected fish were acclimatized under laboratory condition at 28-30°C, pH 8.1 slight alkalinity, Dissolved oxygen 8 – 10 ppm for 10 days. During the period of acclimatization, the water was changed daily and the fish were fed rice bran and groundnut oil cake. The test chemicals Cypermethrin technical grade (92% purity; cis:trans isomers ratio 40:60) was obtained from Tagros Chemicals India Limited, Chennai and Chlorpyrifos technical grade insecticide with 97.5% purity was obtained from Nagarjuna, Agri Chem Limited, Ravulapalem, East Godavari (Dt), AP, India. Acute toxicity experiment was conducted for 48hrs by Finney [7] probit analysis and the LC_{50} value for Cypermethrin (0.15ppm) and for Chlorpyrifos (0.42ppm) were determined. $1/10^{th}$ of the LC_{50} value of cypermethrin (0.015ppm) and chlorpyrifos (0.042ppm) were taken as sublethal concentrations for this study. The fish were divided into different groups having a batch of 10 in each. Group I was maintained in tap water and treated as controls, Group II exposed to cypermethrin $1/10^{th}$ of LC_{50}, Group III exposed to chlorpyrifos $1/10^{th}$ of LC_{50} and Group IV exposed to cypermethrin ($1/20^{th}$ of LC_{50}) and chlorpyrifos ($1/20^{th}$ of LC_{50}) combinedly. All are maintained in separate 10 liters plastic containers. After exposure the fishes for 7 days were sacrificed and the tissues liver, kidney and muscle are collected for the estimation of selected biochemical parameters, viz., glycogen, total proteins and lipids which are estimated by the method of Carroll *et al.,* [8], Lowry *et al.,* [9], Folch *et al.,* [10] respectively.

RESULTS

The alteration in glycogen, protein and lipid were determined in the control as well as experimented fishes after exposure to cypermethrin and chlorpyrifos individually and in combination for seven days. The significant changes were observed in the experimental fish. The glycogen content in different tissues of *Labeo rohita* was in the order of muscle > live > kidney (Graph 1). The protein content from all the tissues

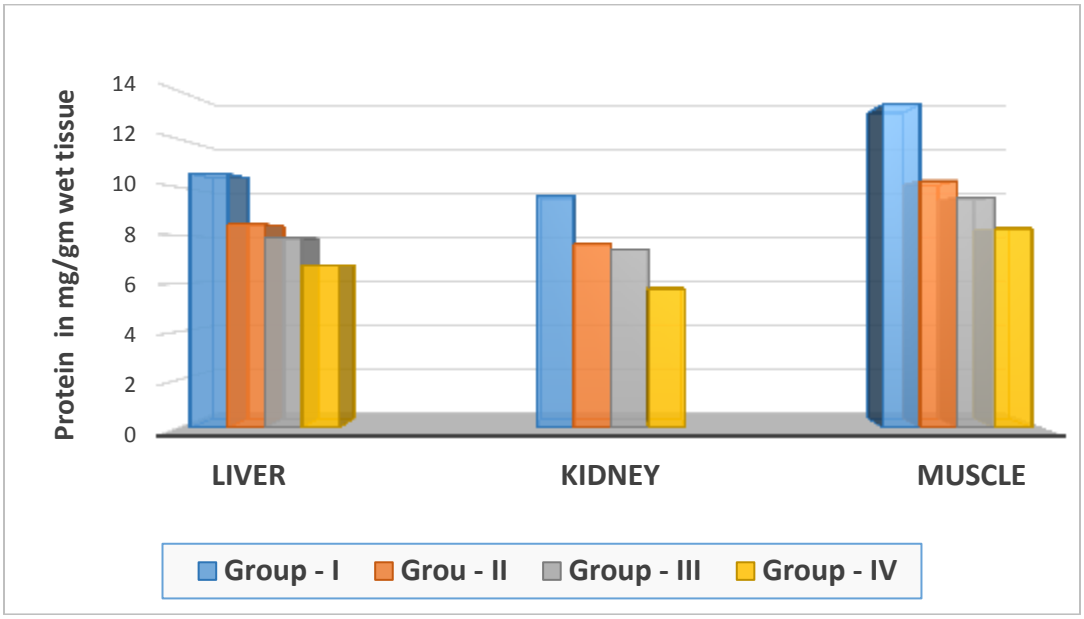
decreased significantly, Muscle showed the greatest loss of protein as compared to all other tissues (Graph 2). Liver shows significant reduction of lipid and glycogen in comparison with other selected tissues of the experimental fish species. The changes were greater in combination than individual treatment, possibly because of a synergistic effect of cypermethrin and chlorpyrifos.

Graph- 1: Changes in Glycogen content in different tissues of *Labeo rohita* after acute exposure to cypermethrin and chlorpyrifos



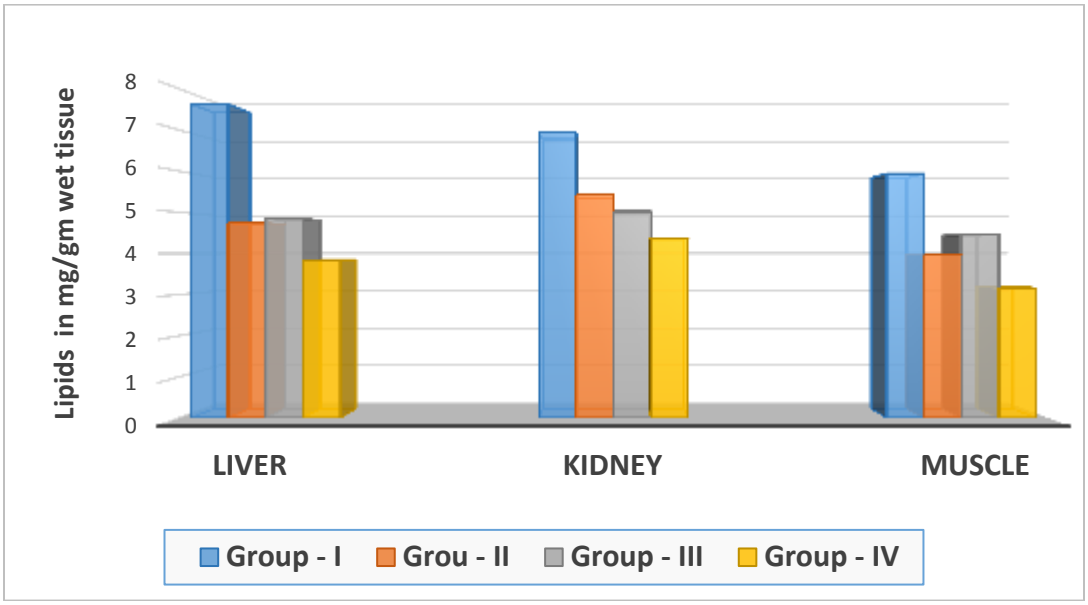
Results are the mean values of five observations and the standard deviation, significant at p.0.05 level; "T" test

Graph 2: Changes in total protein content in different tissues of *Labeo rohita* after acute exposure to cypermethrin and chlorpyrifos



Results are the mean values of five observations and the standard deviation, significant at p.0.05 level; "T" test

Graph 3: Changes in total Lipid content in different tissues of *Labeo rohita* after acute exposure to cypermethrin and chlorpyrifos



Results are the mean values of five observations and the standard deviation, significant at p.0.05 level; "T" test

DISCUSSION

Aquatic ecosystems are constantly challenged by the presence of multiple pesticides, raising concerns about their synergistic or additive impacts on fish health. This study systematically investigated the toxic effects of cypermethrin and chlorpyrifos, with a focus on both individual and combined exposures in fresh water edible fish species *Labeo rohita* showed a synergistic effect. The effects of agricultural runoff, including pesticides like chlorpyrifos, on fish assemblages, highlighting the potential risks of pesticide exposure in aquatic ecosystems [11]. Cholinesterase activity was disturbed in aquatic organisms exposed to chlorpyrifos [12].

Kajare *et al.,* [13] & Padmini and Rajaram [14] reported that chlorpyrifos induced biochemical alterations in protein, glycogen and lipid contents in liver and kidney of fish *Channa gachuva.* Chlorpyrifos significantly decreased total protein, catalase, glutathione S transferase and induced lipid peroxidation in *Chanos chanos* [15, 16]. Investigations have been shown that changes include depletion of proteins, glycogen and pyruvate stores from fish tissues such as liver and muscle with pesticide toxicity [17]. Organophosphorus insecticide chlorpyrifos induced histological alterations in liver and kidney tissue of *Catla catla* freshwater fish were observed, it leads to changes in the liver and kidney metabolism [18].

The alteration of biochemical parameters total protein, free amino acid and glucose of liver and kidney tissue of *Cirrhinus mrigala* exposed to cypermethrin was studied by Vasanthraja *et al*., [19]. Decrease in protein content of *Clarias batrachus* exposed to fenvalerate was reported by Tripathi *et al*., [20]. A reduction in protein content was also observed in *C. carpio* and *Labeo rohita* exposed to cypermethrin [21]. The decreased level of total proteins in gill, liver and muscles of the freshwater fish, *Channa striatus* were estimated, it indicated the toxic nature of the pesticide chlorpyrifos [22].

Combined toxic effect of an organophosphate pesticide chlorpyrifos and cypermethrin altered the metabolism observed in zebrafish [23]. Combination of cypermethrin and chlorpyrifos are susceptible to high degree of damage in ambient water, though the low concentration of toxicants in the water may be

considered within safe limits, still the vital organs are adversely affected which may interfere with physiological functioning of *Labeo rohita* [24].

CONCLUSION:

Cypermethrin and chlorpyrifos are commonly used pesticides and can have toxic effects on aquatic organisms, including fish. When these pesticides are combined, there is a possibility of a synergistic effect, where the combined toxicity is greater than the sum of their individual toxicities. The synergistic effects of cypermethrin and chlorpyrifos interferes with various metabolic activities and biochemical changes are observed in the level of Carbohydrate, protein and lipid content in experimental fish *Labeo rohita*. It also showed that these chemicals had synergistic effects on all parameters since the combined effects were more severe than those from independent exposure.

REFERENCES

1. Anderson, J.C., and Dindal, D.L. (1993). Effects of pesticide runoff on aquatic ecosystems. Environmental Toxicology and Chemistry, 12(12), 2269-2285.
2. Sánchez-Bayo, F and Goka, K. (2006). Ecological effects of the insecticides imidacloprid and dieldrin on the abundance of surface and soil-dwelling non-target fauna in a vineyard. Environmental Pollution, 140(3), 521-529.
3. Weston, D.P., and Lydy, M.J. (2010). Stormwater input of pyrethroid insecticides to an urban river. Environmental Toxicology and Chemistry, 29(5), 1151-1159.
4. Solomon, K.R., Giesy, J.P., LaPoint, T.W., Giddings, J.M., Richards, R.P., and eds. Kendall, R.J. (2013). Ecological Risk Assessment for Chlorpyrifos in Terrestrial and Aquatic Systems in the United States. Reviews of Environmental Contamination and Toxicology, Volume 221.
5. Brodin, T., Fick, J., and Jonsson, M. (2014). Klamath-Rogue River basin odonate larvae show high levels of pesticide exposure and altered behavior in the presence of the insecticide malathion. Environmental Toxicology and Chemistry, 33(1), 172-178.
6. Li, X., Zhu, Y., Liu, J., Liu, L., Zhao, X., Ding, J., ... & Xie, L. (2016). Synergistic toxicity of bifenthrin, carbendazim, and chlorpyrifos to the earthworm Eisenia fetida. Environmental Pollution, 209, 24-31.
7. Finney, D.J. (1971): Probit analysis 3rd ed. Cambridge University Press, London, 303 pp.
8. Carroll, N.V. Longley, R.W. and J.H. Row. (1956). Glycogen determination in liver and muscle by using Anthrone reagent. *J. Biol. Chem.,* 220: 583-593.
9. Lowry, O.H., Rosebrough, N.J; Farr, A.B. and Randall, R.J. (1951). Protein measurement with folinphenol reagent. J. Bio.Chem. 193: 265-275.
10. Floch J, Lees M, Sloane- Stalely GH. (1957). A sample method for isolation and purification of total lipid fron animal tissue. J Bio Chem.226:497-507.
11. Aliko, V., Peñas, M., Carrassón, M., & Barata, C. (2006). Effects of agricultural runoff in fish assemblages in an irrigation channel of the Llobregat River (NE Spain). Ecotoxicology and Environmental Safety, 65(2), 187-202.
12. Almeida, J. R., Marques, M., Gravato, C., Guilhermino, L., & Carvalho, F. (2008). Cholinesterases as environmental biomarkers in aquatic ecosystems. Environmental Research, 106(1), 8-21.
13. Kajare A, Singh S, Shrivastava K, (2000). Malathion induced biochemical changes in kidney of freshwater fish Clarias batrachus, Ecotoxicology and Environmental Monitoring.10:11-14.
14. Padmini K, Rajaram P, (2016). Effect of chlorpyrifos on some biochemical constituents in liver and kidney of freshwater fish, *Channa gachua* (F. Hamilton), International Journal of Science and Research (IJSR);5(4):1975-1979.
15. Palanikumar L, Kumaraguru AK, Ramakritinan CM, Anand M. (2014). Toxicity, biochemical and clastogenic response of chlorpyrifos and carbendazim in milkfish Chanos chanos, International Journal of Environment, Science and Technology;11:765-774.
16. Sharma N. (2014). Assessment of the changes in some diagnostic enzymes in fish Gambusia affinis treated with pesticide chlorpyrifos, International Journal of Research in Pharmcology and Pharmacotherapeutics;3(4):205-210.
17. Laul, R.T., Pradhan, P.V. and Bhagwat, A.M. (1974). Effect of muscular exercise on glycogen content in Tilapia mossambica (in captivity). Journal of Biological Chemistry 17:72-77.
18. Usha Rani, K. (2023). Histopathological effect of chlorpyrifos pesticide on liver and kidney of fresh water fish catla catla. Journal of Advanced Scientific Research; 14 (08):66-70.
19. Vasantharaja C., Pugazhendy K., Venkatesan S., Meenambal M., Prabakara S and Jayachandran K. (2012). Acute Toxicity of Cypermethrin and its Impact on Biochemical Alteration in the Fresh Water Fish Cirrhinus mrigala (Hamilton) and Protective Effect of Cardiospermum helicacabum (Linn). International Journal of Pharmaceutical & Biological Archives; 3(1):146-152.

20. Tripathi, G., Harsh, S., Verma, P., (2002). Fenvalerate-induced macromolecular changes of biochemical alteration in a freshwater cat fish, Clarias batrachus. Indian J. Comp. Anim. Physiol. 6: 5–12.
21. David, M., S.B. Mushigeri, R., Shivakumar, and Philip, G.H., (2004). Response of Cyprinus carpio (Linn) to sub-lethal concentration of cypermethrin: alterations in protein metabolism profiles. Chemosphere 56: 347-52.
22. Revathi.T and Krishnamurthy.R (2018). Impact of pesticide chlorphyrifos on protein alterations in a freshwater fish, Channa striatus. International Journal of Pharmacy and Biological Sciences. 8(3): 926-931.
23. Zhang, Y., Wang, J., Zhang, H., Du, G., & Liu, W. (2009). Acute toxicity of organophosphorus pesticides and its interaction with cypermethrin to zebrafish (Danio rerio). Chemosphere, 77(11), 1458-1464.
24. Saravanan R, Sivachandran R, Muthulakshmi R and Revathi K. (2013). Synergistic effect of organophosphate chlorpyrifos and synthetic pyrethroid cypermethrin in fresh water commercially cultivable fish Labeo rohita. Environment conservation Journal 14(1&2) 35-39.