The Bioscan
AN INTERNATIONAL QUARTERLY JOURNAL OF LIFE SCIENCES
20(3): S.I (3), 870-874, 2025 www.thebioscan.com

Effect of Lambda-Cyhalothrin on Nutritive Content of Edible Muscle

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DOI: 10.63001/tbs.2025.v20.i03.S.I(3).pp870-874

KEYWORDS
Pesticides, fishes, nutritive content

Received on:
12-07-2025

Accepted on:
10-08-2025

Published on:
18-09-2025

ABSTRACT

Fish are a significant group of organisms and a significant source of food that is high in protein for human consumption. Many different types of toxicants can affect fish. Fish development and nutritional value are changed by pesticides. Fish and other aquatic invertebrates are extremely poisoned by the synthetic pyrethroid lambda-cyhalothrin. According to its nutritional profile, catfish is a very healthy and wholesome food that is high in protein, low in fat and cholesterol, and a good source of several vitamins and minerals. The purpose of this study is to investigate how lambda-cyhalothrin affects the nutritional value of edible muscle. Through proximate, mineral, and vitamin analysis, the nutritional value of edible muscle was investigated. A notable decrease ($P < 0.05$) was observed in the lipid, protein, and carbohydrate levels exposed to the two different sub-lethal concentrations of the pyrethroid. Different vitamins of the edible muscle of freshwater catfish exposed to lambda showed a decline after 45 days of exposure to the pyrethroid. The composition of various minerals of the edible muscle also showed a decline after 45 days of exposure to the pyrethroid.

INTRODUCTION

Today's environment and water resources are fast becoming polluted due to the overuse of synthetic pyrethroids, putting aquatic life and human life at direct and indirect risk (Hill, 1989). Fish are a significant group of organisms and a significant source of food that is high in protein for human consumption. It is well recognized that pesticides can change fish growth and nutritional value (Tilak et al., 2005). Commercially significant fish species' survival is impacted by the wide range of toxicants that fish are susceptible to in water (Johnson, 1973). According to Chakraborty et al. (2003), contaminants such heavy metals are known to build up in fish's edible parts and can have a long-term negative impact on human health. Biologically active molecules like amino acids, proteins, lipids and coenzymes are impacted by xenobiotic contaminants (Ghosh and Chatterjee, 1985) which may ultimately lead to a decline in the nutritional quality of the fishes.

Lambda-cyhalothrin is highly toxic to fishes and aquatic invertebrates. The degree to which pollutants bioaccumulate in various fish species is determined by the fish's eating habits, fat content, and capacity to metabolize the toxins. The nutrient profile of catfish shows that it is highly nutritious and emdash; high in protein; low in fat and cholesterol and a good source of certain vitamins and minerals.

The nutritional content of most fish has been diminished due to environmental degradation. Fish eat toxic wastes, including industrial waste, sewage, and pesticides and herbicides. In the edible muscle of *Clarias batrachus* exposed to sub-lethal amounts of synthetic pyrethroids, Saravanan et al. (2008) investigated the essential amino acids threonine, methionine, isoleucine, leucine, phenylalanine, and lysine. Research indicates that aquatic contamination is so widespread that almost half of all fish globally are poisoned. These poisons interfere with the organisms' metabolic processes, which ultimately leads to a deterioration in their nutritional status.

Therefore, an effort was made to look into the toxicological effects of the synthetic pyrethroid lambda-cyhalothrin on the freshwater catfish's edible muscle's nutritional value.

MATERIALS AND METHODS:

Acquisition of Lambda Cyhalothrin, Synthetic pyrethroid; collection, grouping, and maintaining the fresh water female catfish, *Clarias batrachus* for analysis was followed by the method (Gulati et al., 2025).

Proximate analysis in Edible Muscle tissue:

Total carbohydrate content was estimated by the method described by Selter et al., (1950). The total carbohydrate content was expressed as mg/g wet tissue weight.

Total protein content of the tissues was estimated by the method of Lowry et al., (1951). The protein content was expressed as mg/g wet tissue.

Total lipids were extracted following the method of Folch et al. (1957) and the total lipids were estimated following the method of Fring et al., (1972). The total lipid content was expressed as mg/g wet tissue.

Mineral analysis in Edible Muscle tissue:

The mineral analysis was performed using the atomic absorption technique and a flame photometer (Model: CL-ZZD, Elicomake). A flame photometer was used to test minerals such potassium, phosphorus, sodium, magnesium, calcium, zinc, iron, and selenium after 1.0 g of muscle tissue had been digested in 0.6N hydrochloric acid. The mineral content of the edible muscle was expressed as μg/g of wet tissue.

Determination of Vitamin content of Edible Muscle tissue:

Vitamin A was extracted and estimated by the method of Bayfield and Cole (1980). The vitamin A content was expressed as μg/g wet tissue.

Vitamin C was extracted and estimated according to the method of Omaye et al. (1979). The ascorbic acid content was expressed as μg/g wet tissue.

Vitamin E was extracted and estimated by the method of Desai (1984). The Vitamin E content was expressed as μg/g wet tissue. Thiamine and riboflavin was extracted and estimated following the procedure of Ghasemi et al. (2004). The thiamine and riboflavin content was expressed as μg/g wet tissue.
Niacin was extracted and estimated following the procedure of Rosenblum and Jolliffe (1940). The niacin content was expressed as μg/g wet tissue.

RESULTS:

The proximate nutrient composition of the edible muscle of fishes exposed to the sub-lethal concentrations of the pyrethroid is represented in table 1a & 1b. A significant decline ($P < 0.05$) was witnessed in the carbohydrate, protein and lipid content of fishes exposed to the two different sub-lethal concentrations of the pyrethroid. The total carbohydrate content of the muscle tissue of the pyrethroid-exposed fishes showed an overall decline of 64.01% and 52.87% after 45 days of exposure. The total protein content of the muscle tissue showed a decline of 36.53% and 30.52% in the fishes exposed to the higher and lower sub-lethal concentration of the pesticide respectively, while the muscle total lipid content showed a decline of 26.11% and 16.93% in the two groups of pyrethroid-exposed fishes.
The variation in the composition of vitamins in the edible muscle of fishes exposed to the sub-lethal concentrations of the pyrethroid is represented in table 2a & 2b. The different vitamins of the edible muscle showed a decline after 45 days of exposure to the pyrethroid.
The variation in the composition of minerals in the edible muscle of fishes exposed to the sub-lethal concentrations of the pyrethroid is represented in table 3a & 3b. The composition of various minerals of the edible muscle also showed a decline after 45 days of exposure to the pyrethroid.

DISCUSSION

A good source of all essential amino acids, including lysine, methionine, and threonine, fish muscle proteins, which make up roughly 17–20% of the protein, are well adapted to human nutritional needs (Mukundan and James, 1978; Nettleton et al., 1990; Corser et al., 2000). According to their nutrient profile, freshwater catfish are rich in polyunsaturated fatty acids (PUFA), low in cholesterol, high in protein, and a good source of several vitamins and minerals (Tidwell et al., 1992). The proximate analysis of the edible muscle significantly decreased when the fish were exposed to sub-lethal amounts of lambda-cyhalothrin. The muscle tissue's levels of carbohydrates, proteins, lipids, and vitamins (A, C, E, thiamine, riboflavin, Pyridoxine and niacin) and minerals (potassium, phosphorous, sodium, magnesium, calcium, zinc, iron and selenium) drastically decreased at the end of the experimental studies.
The present study showed that the vitamin concentrations of the muscle tissue were similar to that reported by Nettleton et al. (1990) and the mineral concentrations were close to the values reported by Nettleton et al. (1990) and Clement and Lovell (1994). The present findings gain support of the earlier findings of Shukla V et al. (2002) where a significant decline was witnessed in the total protein, ash, and mineral contents such as iron, calcium, phosphorous, sodium and potassium content of the muscle tissue of *Channa punctatus* in response to exposure to cadmium.
Cirrhinus mrigala's protein intake and efficiency declined in response to industrial pollutants (Sheela and Muniandy, 1992), and *Cyprinus carpio* (2006) reported a significant decrease in carbohydrate, protein, and ash. Additionally, *Cyprinus carpio* was exposed to textile dye effluent (Sakthivel and Sampath, 1989). The breakdown of stored compounds like glycogen, proteins, and lipids for the animal's use under stressful conditions for a constant supply of energy may be the cause of the decline in the nutritional content of the muscle tissue observed in this study. Similarly, oxidative stress following toxic exposure has been shown to cause muscle deterioration (Passi et al., 2004).
The decline in the nutritional content of the muscle tissue may also be due to the effect of the toxicant on the feed consumption and the efficiency of feed utilization of the fishes. Earlier studies have also showed reduced food consumption accompanying toxicant exposure (Beyers and Sikoski, 1994; Heath, 1995). Thus, low doses of pyrethroids can cause direct (to fish) and indirect (on food supply species) toxicity which may ultimately affect the nutritive content of edible muscles of the freshwater catfishes.

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TABLES:

Table 1a: Proximate nutrient composition of crude edible muscle of *Clarias batrachus* exposed to lambda cyhalothrin at higher sub-lethal concentration (5.768 ppm)

Biochemical component	**Control**	**45 days**	**Recovery**
Total Carbohydrate	8.81 ± 0.08	3.17 ± 0.25 (-64.01)	7.79 ± 0.24
Total Protein	20.69 ± 0.33	13.13 ± 0.38 (-36.53)	19.30 ± 0.33
Total lipid	10.57 ± 0.23	7.81 ± 0.22 (-26.11)	9.49 ± 0.18

Table 1b: Proximate nutrient composition of crude edible muscle of *Clarias batrachus* exposed to lambda cyhalothrin at lower sub-lethal concentration (2.884 ppm)

Biochemical component	**Control**	**45 days**	**Recovery**
Total Carbohydrate	8.70 ± 0.14	4.10 ± 0.22 (-52.87)	7.76 ± 0.17
Total Protein	21.26 ± 0.34	14.77 ± 0.27 (-30.52)	19.64 ± 0.28
Total lipid	10.28 ± 0.29	8.54 ± 0.26 (-16.93)	9.72 ± 0.21

Values are mean ± SD (n=6); expressed as mg/g tissue. Values in parentheses in experimental groups are % reduction (-) over control.

Table 2a: Composition of vitamins in edible muscle of *Clarias batrachus* exposed to lambda cyhalothrin at higher sub-lethal concentration (5.768 ppm)

Vitamin	**Control**	**45 days**	**Recovery**
Vitamin A	27.91 ± 0.50	11.50 ± 0.50 (-58.80)	24.70 ± 0.52
Vitamin E	9.05 ± 0.40	4.17 ± 0.41 (-53.92)	6.21 ± 0.44
Vitamin C	4.54 ± 0.43	2.20 ± 0.40 (-51.54)	3.24 ± 0.49
Riboflavin	1.62 ± 0.37	0.34 ± 0.13 (-79.01)	1.30 ± 0.34

Thiamine	2.48 ± 0.40	0.41 ± 0.21 (-83.47)	1.97 ± 0.43
Niacin	16.10 ± 0.46	4.15 ± 0.39 (-74.22)	10.15 ± 0.42

Table 2b: Composition of vitamins in edible muscle of *Clarias batrachus* exposed to lambda cyhalothrin at lower sub-lethal concentration (2.884 ppm)

Vitamin	Control	45 days	Recovery
Vitamin A	28.19 ± 0.43	14.95 ± 0.44 (-46.97)	25.84 ± 0.49
Vitamin E	9.29 ± 0.45	6.07 ± 0.46 (-34.66)	7.81 ± 0.43
Vitamin C	4.73 ± 0.46	2.62 ± 0.40 (-44.61)	3.85 ± 0.34
Riboflavin	1.79 ± 0.38	0.55 ± 0.26 (-69.27)	1.23 ± 0.34
Thiamine	2.42 ± 0.39	0.74 ± 0.22 (-69.42)	2.16 ± 0.39
Niacin	15.90 ± 0.52	7.19 ± 0.36 (-54.78)	11.85 ± 0.42

Values are mean ± SD (n=6); expressed as µg/g tissue. Values in parentheses in experimental groups are % reduction (-) over control.

Table 3a: Mineral composition in edible muscle of Clarias batrachus on exposure to higher sub-lethal concentration (5.768 ppm) of lambda cyhalothrin

Minerals	Control	45 days	Recovery
Potassium (K)	3834.66 ± 58.43	1278.33 ± 43.79 (-66.65)	2974.33 ± 43.25
Phosphorous (P)	920.00 ± 35.20	534.00 ± 33.43 (-41.96)	877.00 ± 35.77
Sodium (Na)	352.67 ± 41.96	149.33 ± 33.11 (-57.66)	328.50 ± 45.13
Magnesium (Mg)	210.83 ± 40.49	112.83 ± 26.36 (-46.48)	173.50 ± 30.32
Calcium (Ca)	77.83 ± 15.50	27.50 ± 11.47 (-64.66)	69.67 ± 18.37
Zinc (Zn)	7.60 ± 0.39	1.43 ± 0.25 (-81.18)	6.39 ± 0.41
Iron (pb)	5.93 ± 0.35	2.49 ± 0.32 (-58.01)	4.43 ± 0.35
Selenium (Se)	0.20 ± 0.06	0.08 ± 0.04 (-60.00)	0.18 ± 0.05

Table 3b: Mineral composition in edible muscle of Clarias batrachus on exposure to lower sub-lethal concentration (2.884 ppm) of lambda cyhalothrin

Minerals	Control	45 days	Recovery
Potassium (K)	3815.17 ± 43.65	2353.00 ± 41.04 (-38.32)	3702.50 ± 42.90

Phosphorous (P)	923.83 ± 38.37	727.83 ± 45.21 (-21.22)	862.50 ± 33.60
Sodium (Na)	336.67 ± 52.66	181.33 ± 36.68 (-46.14)	305.83 ± 40.47
Magnesium (Mg)	216.17 ± 35.48	138.33 ± 32.25 (-36.00)	197.33 ± 19.13
Calcium (Ca)	80.17 ± 13.89	43.33 ± 15.93 (-45.95)	69.50 ± 20.20
Zinc (Zn)	7.23 ± 0.40	3.13 ± 0.40 (-56.71)	6.23 ± 0.45
Iron (pb)	6.13 ± 0.40	(-46.17) 3.30 ± 0.43	5.39 ± 0.28
Selenium (Se)	0.26 ± 0.12	0.19 ± 0.12 (-26.92)	0.28 ± 0.21

Values are mean ± SD (n=6); expressed as μg/g wet tissue. Values in parentheses in experimental groups are % reduction (-) over control.