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Research Article

Effect of arsenic on lipid metabolism of a fresh water cat fish, *Mystus vittatus*

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ABSTRACT

The present study investigated the effect of sublethal concentrations (10 and 30%) of heavy metal, arsenic on the triglyceride and cholesterol contents in liver and muscles of *Mystus vittatus* after exposure to 30 days. A significantly decreased lipid and increased cholesterol content of liver and muscles tissues of arsenic induced *M. vittatus* suggested that lipid might have undergone lypolysis, and increased in cholesterol could be due to alteration of steroid biosynthesis during the stressful situation in the intoxicated fishes. Thus, the present study concludes that the fat metabolism of fish affected during arsenic exposure and reduces the nutritive value of fish

INTRODUCTION

The environmental pollutants can induce physiological and biochemical changes in fish that lead to growth inhibition (Han *et al.*, 2019). The water pollution, over exploitation and targeted fishing is the biggest problem in aquatic ecosystem (Kumar *et al.*, 2013; Mayank and Dwivedi, 2015; Tiwari *et al.* 2016). Arsenic is one of the heavy metals present in the environment and forms a significant contribution to pesticides and industrial effluents released into water body. It is released into the aquatic environment through both geogenic processes as well as anthropogenic activities such as metal smelting and chemical manufacturing. It is considered to be a toxic trace element, and ecological dangers can arise if large amounts of arsenic are released into the environment as a result of industrial and agricultural activities. Increased concentrations of arsenic in ground water have been reported from several countries, including India (Kumar and Banerjee, 2016).

In the aquatic environment, arsenic exists either as arsenite or arsenate forms, which are inter converted through redox and methylation reactions (Kavitha *et al.*, 2010) and its trivalent salt (sodium arsenite) is more toxic than other forms. Hence, sodium arsenite was preferred as the test toxic component. Further, the wetlands of eastern Uttar Pradesh (U.P) were also contaminated with arsenic (Kumar and Banerjee, 2016). Verma and Prakash (2019) studied the impact of arsenic on carbohydrate metabolism in *M. vittatus*, Lipids play an important role in the architectural dynamics of the cell and transport mechanism across cell membrane. Any stress is found to change the course of events associated with the lipid synthesis. Lipids also contribute to energy production as they are having high caloric values and play a vital role during the biochemical adaptations of animals to stress conditions (Gijare *et al*, 2011). The biochemical function of animal gets disturbed on exposure to heavy metals. So a better understanding of this mechanism can help us to predict the harmful effect of various toxicant on environment. Hence, the present investigation was aimed to study the effect of sublethal concentrations of heavy metal, arsenic on the triglyceride and cholesterol contents in liver and muscles of *M. vittatus*.

MATERIALS AND METHODS

The healthy *M. vittatus* ranging from 7.0-8.0 cm in length and weighting 8.0-9.0 gm were collected from ponds in and around Balrampur and washed with 1% $KMnO_4$ for five minute and transferred to the plastic jar containing 50L dechlorinated tapwater for acclimatization. Fish were acclimated to laboratory conditions for 15 days at room temperature. The LC_{50} for arsenic trioxide for 96 hours was calculated using probit method and found was 3.20 ppm. The LC_{50}values of arsenic for 24, 48, 72 and 96 hours were 4.71, 4.16, 3.68 and 3.25 ppm, respectively. Based on 96 LC_{50}, fish were exposed to sublethal concentrations (10 and 30%) for 10, 20 and 30 days. A control group was maintained in an identical environment. The fish were regularly fed with commercial feed and the medium was changed once daily to remove faeces and food remnants.

The fishes were sacrificed from both experimental and control groups on 10th, 20thand 30th days of exposure periods for sampling. The muscles and liver tissues in each group were dissected out and homogenized. The homogenate was centrifuged at 3500 rpm for 20 minutes. The supernatant was used for the estimation of triglyceride and cholesterol by standard methods. The experimental data were analyzed by student 't' test to determine the significant effect

RESULTS AND DISCUSSION

The triglyceride and cholesterol content in the different tissues of control and arsenic treated fish *M. vittatus* is presented in Table 1 and 2. The triglyceride content was highest in liver (14.25-14.58 mg/g) followed by muscles (8.15-8.25 mg/g) in control group. The maximum decrease of triglyceride content was observed in the tissues of fish exposed to 30% sublethal concentration of arsenic reared for 30 days in both tissues. The cholesterol content was highest in liver (9.18 mg/g) followed by muscles (6.12-6.18 mg/g) in control group. The maximum increase of cholesterol content was observed in the tissues exposed to 30% sublethal concentration of arsenic reared for 30 days was about 22.64% in liver and30.90% in muscles. The decrease in mean triglyceride levels with increase in cholesterol level in the tissues was statistically significant ($p<0.05$) in both sublethal concentrations at all the exposure periods.

Table1. Effects of sublethal concentrations of arsenic on triglyceride (mg/g) content of liver and muscles in *M. vittatus* at different exposure periods (N=6).

Tissues	Group	Exposure duration(days)		
		10	20	30
Liver	Control	14.25± 0.31	14.58±0.36	14.52±0.24 NS
	10%	11.56±0.21	9.23±0.32*	7.65±1.23**
	30%	7.18±1.25	6.34±1.47*	5.39±1.18**
Muscles	Control	8.25± 0.31	8.15±0.36	8.20±0..24 NS
	10%	7.76±0.21	6.12±0.25*	5.78±0.21**
	30%	6.75±0.32	5.62±1.03*	4.23±0.31**

*NS= Non Significant; *P<0.05; **P<0.001*

Table 2. Effects of sublethal concentrations of arsenic on cholesterol (mg/g) content of liver and muscles in *M. vittatus* at different exposure periods (N=6).

Tissues	Group	Exposure duration(days)		
		10	20	30
Liver	Control	9.25±1.23	9.54±1.11	9.18±0.87 NS
	10%	9.89±1.06	10.35±1.06	11.25±1.11*
	30%	11.76±1.32	12.86±1.12*	13.52±0.05**
Muscles	Control	6.15±0.34	6.12±0.32	6.18±0.12 NS
	10%	6.75±0.32	6.98±0.22	7.55±0.41*
	30%	7.11±0.17	7.16±0.28*	8.09±0.26**

*NS= Non Significant; *P<0.05; **P<0.001*

High concentration of arsenic in the environment causes severe oxidative stress in living organisms thereby the cellular metabolic impairment and tissue damage was observed in fishes (Haque *et al*., 2016). In the current study, after 30 days of exposure to sublethal concentrations of arsenic, the triglyceride content in liver and muscles were decreased and cholesterol increased in all groups of arsenic exposed fishes (Table 1). Similar results have been observed in the *Channa punctatus* exposed to toxicant by Maruti and Rao (2001), Amudha *et al.*, (2002), Gijare *et al*., (2011) and Prakash and Verma (2018). In the present study, decline in triglyceride content in liver and muscles of arsenic exposed fishes could be due to inhibition of lipid synthesis as well as increased utilization of stored lipid as a source of energy to conduct regular metabolic activity during stress condition. Since lipids forms rich energy reserves whose caloric value was reported to be twice than that of an equivalent weight of either carbohydrates or proteins. Another possible reason for decreased triglyceride content of arsenic exposed fish was that, arsenic could interfere with fatty acid oxidation and also inhibits the enzyme acetyl-co-enzyme synthetize involved in fatty acid oxidation. Cholesterol is a sterol compound synthesized in liver and is used to synthesize hormones and cell membranes. In the present study increased in cholesterol content in liver and muscles of arsenic exposed fishes was due to alteration of steroid biosynthesis. Similar results were also observed in fluoride exposed fish by Srivastava *et al*., (2011). The increased synthesis of cholesterol also may induce liver weight and fatty liver cause lipogenesis (Kumar and Banerjee, 2012).

Prakash and Singh (2011) reported that during stress condition circulatory cholesterol level was decreased resulting the increase in cholesterol level in tissues like liver and muscles of fish, which is helpful to counteract toxic effect produced by distillery effluent. The increased cholesterol level in liver and muscles of arsenic induced fishes might be due to the higher oxidative effects as these stimuli have been believed to be involved in augmentation of causing of oxidative stress (Haque *et al*., 2016). The result of the present study indicates that the toxic nature of arsenic that affects the triglyceride and cholesterol contents of liver and muscles of *M. vittatus*. Alterations in the triglyceride and cholesterol content may be due to lypolysis of lipid and disturbance in steroid biosynthesis or the mitochondrial injury, which impaired the function of Tricarboxylic Acid (TCA) cycle and the fatty acid oxidation mechanism. Thus it can be concluded that sodium arsenate interfered in the metabolic regulation of triglyceride and cholesterol in liver and muscles of *M. vittatus,* however the clear mechanism is not clear yet.

CONCLUSION

The present study indicated that even the low concentrations of arsenic is toxic to fishes and alters the biochemical components of fish tissues. Since fishes are one of the important food sources, the manmade pollutants will return through the food consumption. Hence, the use of arsenic should be reduced to an extent that our future generations should be protected from its deleterious effects. Therefore, the information obtained in the current study may be useful for management and monitoring of heavy metals contamination in aquatic environment.

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