IJPSR (2022), Volume 13, Issue 12 **(Research Article)**

INTERNATIONAL JOURNAL OF PHARMACEUTICAL SCIENCES AND RESEARCH

Received on 23 February 2022; received in revised form, 29 November 2022; accepted 29 November 2022; published 01 December 2022

ARSENIC-INDUCED ALTERATIONS IN GLYCOGEN AND LIPID DURING THE OVARIAN CYCLE OF A FRESHWATER SILUROID, *MYSTUS (M.) VITTATUS* (BL.)

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Keywords:

Mystus (M.) vittatus, Preparatory phase, Spawning phase, Post-spawning phase, Trivalent arsenic, Ovarian cycle, Glycogen, Lipid

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ABSTRACT: Heavy metals get their way into the environment through a wide spectrum of natural and anthropogenic sources. Arsenic (As) has been reported to be present in main too different oxidation states (As^{3+} and As^{5+}). Trivalent arsenic (As^{3+}) has been reported to be more toxic than the pentavalent (As^{5+}) one. *Mystus (M.) vittatus*, a siluroid fish, were exposed to Sublethal concentration (SLC) of As3+ to observe alteration in the glycogen and lipid content during three different phases of the ovarian cycle preparatory, spawning and post-spawning. The increasing order in the glycogen and lipid content was observed during the preparatory and spawning phase. Still, decrease in these biochemical parameters was during post-spawning phase of ovarian cycle in *Mystus (M.) vittatus*, a freshwater siluroid. Less significant alteration in glycogen and lipid was noticed after 15 days of exposure, but a highly significant decrease was observed after 30 days in SLC of trivalent arsenic as $AsCl_3$. The causes for decline in these biochemical parameters have been discussed during the phases of ovarian cycle.

INTRODUCTION: Heavy metal pollution has become a serious environmental and public health hazard. It is because of the concentration of metallic pollutants released into the different sections of the environment from various industrial processes. These are often concentrated because of their bio-accumulative and non-biodegradable features. Heavy metals constitute a core group of aquatic pollutants [1, 2]. Their high toxicity even at low concentrations, may exert cumulative toxic effects in a wide variety of fish fanna and another aquatic biota [3].

QUICK RESPONSE CODE

DOI:
10.13040/IJPSR.0975-8232.13(12).5207-10

This article can be accessed online on
www.ijpsr.com

DOI link: http://dx.doi.org/10.13040/IJPSR.0975-8232.13(12).5207-10

Heavy metals are introduced into the environment through a wide spectrum of natural sources such as volcanic activities, erosion and anthropogenic ones, including industrial waste release and leakage. Certain metallic pollutants such as chromium, arsenic, nickel, cadmium, mercury, *etc*., exert toxic effects on living biota even at low concentrations, whereas zinc, manganese, copper, *etc*., produce toxic effects on living biota only at higher concentrations [4-6].

In the aquatic environment, fishes appear to be remarkable bio indicators of arsenic toxicity[7-8]. Allen and Rana [9] reported that toxicity of arsenical compounds depends upon species, sex, age, dose, duration of exposure, organic or inorganic form, valancy state, *etc*. Arsenic has been reported to be present in two main different oxidation states (+3 and +5). Trivalent arsenic (As^{+3}) has been observed to be more deleterious than pentavalent arsenic [8, 10-

[14]. Even though the toxicity of arsenic (+3) in aquatic biota, particularly fishes and terrestrial animals in general, has been enormously documented [3, 12-13, 15]. However, the deleterious effects of trivalent arsenic on the glycogen and lipid during different phases of fishes' ovarian cycle are scarce; hence, the present study has been undertaken. It is a well-known fact that lipid metabolism dysfunction is a risk factor for cardiovascular diseases and arsenic exposures affect lipid and glycogen metabolism.

MATERIALS AND METHODS: Adult specimens of *Mystus (M.) vittatus* (Bl.) were collected from a local lake having a weight of 92.38±4.48gm during the preparatory phase (January to April); Spawning phase (April to August) and post-spawning phase (September to December). They were acclimatized in laboratory tap water having pH=7.2±0.02; temperature = 22.4±2.2°C; DO= 6.2±40.52 mg/l; hardness as $CaCO_3$ = 126.62±3.6 mg/l. The methods outlined by APHA16 analyzed the physicochemical features of tap water. The sublethal concentration of analytic grade of trivalent arsenic (11.24 mg/l) as $AsCl_3$ was detected for long-term experimentation (15 and 30 days) as outlined by Shukla and Pandey [17]. The control and experimental media were aerated 3-5 h daily using stone diffuser, though *Mystus (M.) vittatus* is hardy air-breathing fish. 20 specimens were placed each in control and experimental media. The total glycogen and lipid in the ovary during preparatory, spawning and post-spawning phases were estimated by adapting the methods outlined by Kemp and Pandey *et al* [18-19]. The data obtained in our study were statistically analyzed for significance by Student's't' test as proposed by Fischer *et al.* [20]. A p-value of 0.05 of less was noticed as significant between the control and experimental groups.

RESULTS & DISCUSSION: Reproductive cycle includes the gonadal cycle, which is a dynamic process always in the state of gametogenesis. SLC of trivalent arsenic produced less significant dimension in the glycogen and lipid content during preparatory, spawning, and post-spawning phases under 15 days exposure than control. But a clear significant decrease in glycogen and lipid content was noticed after 30 days of exposure during all the phases. From **Table 1**, it becomes clear that the level of glycogen and lipid in the ovary during its control spawning phase of the ovarian cycle was maximum in comparison to a preparatory and post-spawning phase which indicates the possible supply of carbohydrate and lipid content in the form of glucose and lipid derivatives for active maturation of ova. The increasing order of decrease in glycogen content during preparatory and spawning phases of ovarian cycle *of Mystus (M.) vittatus*, a siluroid fish may be due to its enhance utilization as an immediate source to meet energy demands for maturation of ova under trivalent arsenic stress. It could also account for the prevalence of hypoxic or anoxic condition of the trivalent arsenic stress which generally enhances glycogen utilization in one way or another [21-25].

TABLE 1 TOTAL GLYCOGEN AND LIPID CONTENT IN MG/GM DRY WEIGHT OF OVARY DURING ITS DIFFERENT PHASES UNDER SLC OF TRIVALENT ARSENIC IN *MYSTUS (M.) VITTATUS*. EACH VALUE REPRESENTS MEAN +SE OF 5 OBSERVATIONS

Content	Parameters	Control	15 days exposure	% Change	30 days exposure	% Change
Preparatory	Glycogen	24.12±1.02	$22.04\pm0.84^{**}$	8.62	$18.82\pm1.04^{***}$	21.97
	Lipid	76.22±1.02	$70.82\pm1.38^{*}$	7.08	$66.26\pm1.24^{**}$	13.06
Spawning	Glycogen	30.34±1.04	$28.34\pm0.84^{**}$	6.59	$22.22\pm1.04^{****}$	26.76
	Lipid	94.72±1.84	$86.28\pm1.44^{**}$	8.91	$80.52\pm1.34^{***}$	14.99
Post-spawning	Glycogen	14.12±0.60	$12.46\pm0.52^{**}$	11.75	$11.04\pm0.60^{***}$	21.81
	Lipid	40.08±1.06	$37.68\pm1.36^{*}$	5.98	$34.88\pm1.02^{**}$	12.97

* = p>0.05 (insignificant) ** = p<0.05 *** = p<0.01 **** = p <0.001

Arsenic interferes with phosphate binding sites in adenosine triphosphate (ATP) resulting in the formation of ADP-arsenate which inhibits metabolic pathways and requires ATP. Glucose 6-phaspharte is an essential mediator for glycolysis, glycogenesis, gluconeogenesis, glycogenesis and the pentose phosphate pathways (PPP), also called an HMP shunt. Acute arsenic toxicity may be associated with hepatic necrosis and elevated levels of liver enzymes. The dimension in the lipid content during different phases of the ovarian cycle of *Mystus (M.) vittatus* (Bl.), a freshwater siluroid might be partly due to its utilization in cell repair and tissue organization with the formation of lipoprotein, which is a salient constituent of the cell membrane and cytoplasmic organelles [26-29].

Our findings may well be correlated with the observation made by Vutukuru [1-2], Shukla, *et al.* [25,] and confirms that long-term exposure to trivalent arsenic interferes with the fishes' ovarian physiology.

CONCLUSIONS: Least significant alteration ($P>0.05$) was observed in the biochemical parameters (Glycogen and lipid) after 15 days of exposure to SLC of trivalent arsenic during different phases (preparatory; spawning and post-spawning) of ovarian cycle of *Mystus (M.) vittatus* (Bl.). However, more or less significant alteration ($P<0.05$-0.001) in glycogen and lipid content has been observed during selected different phases of ovarian cycle when exposed to SLC of trivalent arsenic after 30 days. Our finding reveals that trivalent arsenic may interfere in Oogenesis by interfering with the lipid, glycogen, and lipid metabolism.

ACKNOWLEDGEMENTS: The author thanks CST (UP) for financial assistance vide letter no. CST/D-265 dt. 14.5.2015.

CONFLICTS OF INTETREST: Nil

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How to cite this article:

Shukla A, Payasi YK and Shukla JP: Arsenic induced alterations in glycogen and lipid during ovarian cycle of a freshwater siluroid, Mystus (*M.) vittatus* (BL.). Int J Pharm Sci & Res 2022; 13(12): 5207-10. doi: 10.13040/IJPSR.0975-8232.13(12).5207-10.