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Research Article

An Indian pond snail called *Lymnaea acuminate*'s respiratory metabolism is affected by hexavalent chromium.

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ABSTRACT

Since The amount of oxygen used is highly delicate physiological function, changes in respiratory activity have been utilized to identify stress in animals exposed to toxicants. Between 2004 and 2007, the current research examined the effects of hexavalent chromium on respiratory metabolism using *Lymnaea acuminata* as the snail an experimental model. The Kham River, close to Aurangabad, is where the medium-sized experimental freshwater snails, *Lymnaea acuminata*, were gathered. Weight of snail at N.T.P. represented as ml O2/liter/hour/gm, the oxygen consumption was calculated using the conventional Winkler's approach (Welsh and Smith, 1961).Comparing the current snail, *Lymnaea*, to control snails, the snails treated sublethal with chromium two doses for 96 hours exhibited a respiration initial rise in up to 4 hours, followed by a modest reduction from 8 hours to 24 hours exposure. However, there was a noticeable drop in breathing after 24 hours and continued for 96 hours. After 24 hours of exposure to a 1/10th concentration of LC50, the animals' rate of respiration decreased more significantly.

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1. Introduction

Certain environmental parameters, including as carbon dioxide, pH, dissolved oxygen, salinity, temperature and photoperiod, are known to affect an organism's rate of oxygen consumption (Wright, 1971). Since the physiological process of Changes in respiratory activity and oxygen intake are highly sensitive have been utilized to identify stress in animals exposed to toxicants (Sharp et al., 1979). Numerous studies have examined the connection between animal respiratory activity and pollution in aquatic species (Davis, 1973, Roberts, 1972 and Percy, 1977). Without assessing the biochemical composition and histological structures, freshwater and marine species' respiratory reactions exposed at different pollutant concentrations might be helpful tools for quantitatively assessing sublethal impacts. Studying marine toxicology also involves examining respiratory phenomena in addition to the organisms' reaction. An organism's reaction to pollution action alters its intake of oxygen, which is reflected in modifications to its metabolism and biochemical processes.

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Joshi (1993) examined the The oxygen consumption of the lead, selenium, and lead-selenium combination-exposed snail Bellamya bengalensis. Lead, selenium, and the lead-selenium combo significantly affected oxygen consumption at different exposure times. Research on freshwater snails by Gurusamy and Ramdas (2000), fish by Mathivanan (2004) and Rohankar and Kulkarni (2005), fish by *Bellamya bengalensis*, has shown that pollutants interfere with respiratory metabolism. Many toxicologists have studied the effect of heavy metals on alterations in freshwater snails' oxygen consumption, including Sivaram-akrishna et al., (1991), Muley and Mane (1989), Mule and Lomte (1994), Ishak and Mohamed (1975) and Alam and Lomte (1984). The current study used the snail *Lymnaea acuminata* as the Hexavalent chromium's impact on respiratory metabolism will be investigated using an experimental model.

Material and methods

Lymnaea acuminata, a medium-sized experimental freshwater snail, was obtained from the Kham River in the vicinity of Aurangabad. The snails were transferred to the lab right away, where they were given three days to adjust to the temperature and pH levels (27 + 2 o C, 7-8, 5.2 + 0.5 mg/liter of dissolved oxygen, and 175–180 mg/liter of total hardness). Healthy, normal-sized snails (average shell length: 1.8 + 2.0 cm) for the experimentally chosen. Once they had acclimated. The snails, *L. acuminata*, were subjected to two distinct chromium concentrations. Three groups of the active, acclimated snails were formed. One group of snails received an acute treatment lasting up to 96 hours at a concentration equal to 1/10th of the LC50 value of hexavalent chromium, or 12.690 ppm. The second group of active snails received treatment, while the third and last group of actively acclimated snails were used as the control group an acute treatment of 1/10th concentration of LC50 value of hexavalent chromium, 4.967 ppm, for 96 hours. The quantity of oxygen that was consumed by experimental and control mice was assessed 1, 2, 4, 8, 12, 24, 48, 72, and 96 hours after the animals were exposed to hexavalent chromium. Ten animals were removed after their different exposure times and given an hour to breathe; at the same time, group of animals (control) was kept alive for the duration of the experiment. Following an hour of consumption, the water was syphoned out of the experimental and control jars and the conventional Winkler's procedure was used to determine the oxygen content (Welsh and Smith, 1961). The snails from both jars were taken out at the conclusion of the experiment, deshelled, wiped dry, and weighed. The amount of oxygen used was computed, and the findings are given in milliliters (ml O2/liter/hour) per gram of snail weight at NTP. Every experiment was carried out at least three times. A statistical analysis was performed on the oxygen consumption data to calculate the average value with standard deviation and to assess the significance level.

Results and discussion

After being exposed for 24 and 96 hours to a chromium concentration that was one-tenth of the fatal (LC50) concentration, *Lymnaea acuminata*, a freshwater snail, demonstrated a reduction in oxygen consumption. Tables 3.1 and 3.2 provide an overview of how much oxygen was utilized by the experimental and control snails after their exposure to two distinct hexavalent chromium concentrations. The findings for the snail's oxygen consumption at N.T.P. are reported as ml O2/liter/hour/gm. wt.

Table 3.1: The rate of oxygen consumption of the snail, *Lymnaea acuminata* after exposure to 12.690 ppm of hexavalent chromium($1/10^{th}$ cons. of LC_{50} value of 24 hours)

Treatment	**Average O_2 consumed ml/g/hr/l, $\pm$ S.D.**								
	1 hr.	**2 hrs.**	**4 hrs.**	**8 hrs.**	**12 hrs.**	**24 hrs.**	**48 hrs.**	**72 hrs.**	**96 hrs.**
a Control	0.1030 $\pm$ 0.0041	0.1022 $\pm$ 0.0037	0.1040 $\pm$ 0.0048	0.1042 $\pm$ 0.0052	0.1087 $\pm$ 0.0064	0.1024 $\pm$ 0.0039	0.1048 $\pm$ 0.0055	0.1052 $\pm$ 0.0058	0.1038 $\pm$ 0.0045

b Hexavalent Chromium ($K_2Cr_20_7$)	0.1174** ± 0.0039	0.1186** ± 0.0043	0.1191** ± 0.0047	0.0962 ± 0.0054	0.0913 ± 0.0043	0.0763** ± 0.0090	0.0674*** ± 0.0040	0.0594*** ± 0.0051	0.0512*** ± 0.0048

Values are the average of three observations.

Statistically significant differences in the experimental and control values at $P < 0.05$, $P < 0.01^{**}$, $P < 0.001^{***}$.

(A) Impact of hexavalent chromium on L. acuminata's rate of oxygen consumption following exposure to 1/10th concentration of LC_{50} value of 24 hour exposure (12.690 ppm): When compared to control snails, The rate of oxygen consumption following exposure to 12.690 ppm chromium was seen to increase initially up to a 4-hour exposure period, ranging from 0.1034 to 0.1038 ml O2/liter/hour/gm weight at N.T.P. (0.1174 + 0.0039 to 0.1191 + 0.0054, respectively, after exposure for 1 and 4 hours). Following then, there was a steady decline in the rate of oxygen intake. Nevertheless, the rate of oxygen absorption was significantly reduced after additional exposure for 24, 48, 72, and 96 hours (See Table 3.1). The exposed snails' lower oxygen consumption is not statistically significant, though, after 8 and 12 hours of exposure. Examining further, Table 3.1 demonstrates that the rate of oxygen consumption increases after exposure for 1, 2, and 4 hours. After 8, 12, 24, 48, 72, and 96 hours of exposure, on the other hand, the pond snail Lymnaea starts to absorb less oxygen.

Table 3.2 shows the snail Lymnaea acuminata's oxygen consumption rate following exposure to 4.967 ppm of hexavalent chromium (1/10th conc. of LC50 value of 96 hours).

Treatment	**Average O_2 consumed ml/g/hr/l, ± S.D.**								
	1 hr.	**2 hrs.**	**4 hrs.**	**8 hrs.**	**12 hrs.**	**24 hrs.**	**48 hrs.**	**72 hrs.**	**96 hrs.**
[A] Control	0.1034 ± 0.0041	0.1022 ± 0.0037	0.1040 ± 0.0048	0.1042 ± 0.0052	0.1087 ± 0.0064	0.1024 ± 0.0039	0.1048 ± 0.0055	0.1052 ± 0.0058	0.1038 ± 0.0045
[B] Hexavalent Chromium ($K_2Cr_20_7$)	0.1157 ± 0.0029	0.1178** ± 0.0033	0.1184** ± 0.0036	0.0984 ± 0.0048	0.0953 ± 0.0056	0.0792** ± 0.0091	0.715*** ± 0.0074	0.0619*** ± 0.0042	0.0563*** ± 0.0049

Values are the average of three observations.

The experimental and control values diverge at a statistically significant level at $P < 0.05$, $P < 0.01^{**}$, $P < 0.001^{***}$.

(B) Impact of hexavalent chromium on *L. acuminata's* rate of oxygen consumption following exposure to 1/10th concentration of LC_{50} value of 96 hours exposure period (4.967 ppm):

An overview of the snail L. acuminata's oxygen consumption statistics following exposure to 4.967 ppm can be found in Table 3.2. The pond snail L. acuminata shows an increase in oxygen consumption rate of up to 4 hours (0.1184 + 0.0036 ml O2/liter/hour/gm. wt. of snail at NTP) when exposed to 1/10th concentration of LC50 value of 96 hours (i.e. 4.967 ppm) in comparison to control snails (0.1040 + 0.0048 ml O2/liter/hour/gm. Wt. of snail at NTP). The extra oxygen that snails take in is not a significant gain. The oxygen consumption of simultaneous control animals at NTP was 0.1034 + 0.0041 to 0.1038 + 0.0045 ml O2/liter/hr/gm/wt of snail. The rate of respiration is inhibited by hexavalent chromium therapy, which can persist up to 96 hours after 8 hours of exposure in snail *Lymnaea*, resulting in a continual decline in the snails' ability to absorb oxygen throughout the duration of the treatment (See Table 3.2). The rate at which the animals used oxygen dropped dramatically after the third and fourth days of exposure compared to the control group. Treatment with

hexavalent chromium caused differences in the respiratory response of the freshwater pulmonate snail Lymnaeaacuminata. Examining the data shown in observation Tables 3.1 and 3.2, it is clear that, at least in the early stages of the experiment, the chromium has caused an increase in oxygen consumption. The presence of heavy metal pollution might potentially put freshwater creatures under physiological stress. The analysis of modifications in respiratory metabolism caused by pollutants very challenging, nevertheless, since these changes differ depending on the pollutant, species, and environmental circumstance. According to Thurnberg et al. (1973), the interpretation of pulmonary physiology alterations brought on by metals is confounded by the fact that changes vary not only across species and between different metals, but also between different experimental conditions. Stress has long been identified by changes in the metabolic processes that occur after exposure to heavy metals. "Knowing the physiological action of a toxicant is the key to predict important sub-lethal effects," according to Sprague (1971). One of the most significant signs of acute heavy metal poisoning is respiratory distress, which is known to cause physiological imbalance. It is common knowledge that an organism's rate of oxygen consumption indicates its overall metabolism and, therefore, its metabolic state. After being exposed to sub-lethal concentrations of metal chromium, the snail *L. acuminata* first increased its oxygen consumption, which might be a new steady state of metabolism meant to physiologically offset the stress generated by the toxic metal pollution. Kumta et al. (1998), Singh (1994) and Ghosh (1987) state that for exposed animals to sustain improved physiological activities in metabolizing and excreting the pollutants, a portion of an increased oxygen consumption is necessary. It is inevitable for the heavy metals discharged into aquatic environments to settle into the surrounding ecosystem and build up in the tissues of aquatic life. *L. accuminata*, a freshwater snail, is not an exception when it comes to the chromium metal bioaccumulation in its bodily tissues. Also, it is widely recognized that aquatic invertebrates can concentrate trace metals that are important for nutrition (Cu, Zn, Mn, and Co) and that are harmful (Cd, Ag, Hg, Pb, and Cr). Depending on the metals' nutritional worth or potential for toxicity, metabolic strategies may be needed to either use or sequester them. The snail's increased respiration for up to four hours of exposure may be caused by this. However, throughout the subsequent exposure period, this elevated respiratory status did not persist. The freshwater snail *Bellamya bengalensis* showed similar kinds of alterations in oxygen consumption after acute exposure to phosphamidans (Rohankar and Kulkarni, 2005). Their findings indicate noticeable increase consumption of oxygen from the first hour to the twelve-hour exposure and a steady decrease from the twenty-four hours to the conclusion of the trial. The rate of respiration of the freshwater *basomma tophoran* snail, *L. acuminata*, gradually decreased exposure to chromium's two doses, or 1/10th of the LC50 value for exposures lasting 24 and 96 hours. Both experimental groups consistently exhibit reduced respiratory rates. In their investigation into the effects of copper, mercury as well as heavy metals on the freshwater snail *Thiara tuberculata's* oxygen consumption, Muley and Lomte (1994) found that both acute and long-term treatment reduced the rate of oxygen consumption, suggesting that mercury was more hazardous than copper. Respiratory inhibitory factors may potentially contribute to reduced oxygen intake at greater concentrations of heavy metals. Extensive mucous discharge and external mantle fold bulging were seen in the current investigation. *L. acuminata*'s decreased metabolic rate with exposure to chromium may result from mucus obstructing the lung cavity. The decrease in metabolic rate can also be compared to the reduction in the surface area of the mantle cavity brought on by damage induced by chromium, such as Necrosis, separation of epithelial cells from inner muscle layers, atrophy, bulging of the mantle epithelium, hypertrophy and hyperplasia of the mantle layer.

Conclusion

When exposed to two sub-lethal doses of chromium for up to 96 hours, the current snail, Lymnaea, exhibited a modest reduction to respiration from 8 to 24 hours after the first rise in respiration that lasted up to 4 hours. However, respiration significantly decreased up to 96 hours of exposure after 24 hours. The animals' reduced breathing rate was more pronounced after being exposed for 24 hours to a 1/10th concentration of the LC50.

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