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Effect of nickel induced respiratory alterations in fresh water bivalve, lammellidens marginalis

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Abstract
The rate of oxygen consumption was measured in nickel chloride treated bivalve for 15 and 30 days and compared to the levels of controlled bivalves. The study shows that the average oxygen consumption rate was decreased in treated as compared to controlled bivalves.

Keywords: Nickel, oxygen consumption, bivalve

INTRODUCTION

Respiration is the most important and vital process of life for the derivation of energy in the form of ATP to perform different biological and physiological functions likes locomotion, feeding, reproduction, muscular contraction etc. Metabolic processes are the most sensitive parameters of stress as all enzymatic reactions on the substances and physiological responses are incorporated in a unique manner [1]. A Metabolic response of an organism to a changing or stressful environment is an overall indicator of its adaptive ability. Different species of mussels vary in their ability to reduce metabolism. Therefore any change in the respiratory activities has been rightfully used as an indicator of stress in general and toxicant and chemical induced change in exposed animals in particular [2,3,4 and 5] . By evaluating an index of stress on metabolic rate respiratory study is a great device [6]. Heavy metals are most hazardous pollutants because of their non degradable nature and property to affect all kinds of ecological systems. The salts of metal, released from commercial, industrial sources passes certain biological properties. The heavy metals enter into body of animal including man through the vegetarian & non vegetarian diet. These heavy metals have high biological activity and have tendency to accumulate in organism, making adverse effect at very levels of exposure. Nickel is one of the heavy metal which shows above properties, so it has been taken in consideration of experimentation for investigation of its impact. Oxygen consumption of animal is a very sensitive physiological process and changes in respiratory activity have been used the indicator of stress in pollutant exposed animals. However it is well known that respiration is a vital phenomenon of life & rate of oxygen consumption in turn control the metabolic activities. Oxygen consumption is generally taken as measure of the intensity of metabolism. The rate of oxygen consumption is influenced by size, activity, stage in the life cycle of the animal and different environmental factors such as, oxygen, pH, Oxygen content of water etc. The factors have well pronounced effect on oxygen consumption of freshwater poikilotherms, since they have to live under the influence of natural fluctuations of these parameters.

The responses of different animal to the environmental factor are different and even within the same species, the rate of oxygen consumption may be different. Considerable amount of literature is available showing relationship between respiratory activity and pollution stress in aquatic animals [7]. The metals are toxic when present in excess amount causing disturbance in normal metabolism in aquatic and terrestrial life. Many disturbance in metabolism collectively results into death of organism.

In present investigation, rate of oxygen consumption is considered as tool to evaluate the toxic effect of heavy metal as salt of nickel chloride. The alteration caused in the toxicant is toxicity dependent and dose dependent.

MATERIALS AND METHODS

The selected model animals, the freshwater bivalves, *Lamellidens marginalis* were collected from the Dhondwadi dam at Borana River Tal. Parli Vijanath Dist. Beed (M.S.). After collection, the bivalves were acclimatized in the laboratory condition at room temperature for 2-3 days. The active acclimatized bivalves of approximately same size were selected for experiment.

Before starting the experiment, these bivalves were divided into two groups one group of bivalves was maintained as control while the second group was exposed to the chronic dose of nickel chloride (0.227 ppm, equivalent to the $LC_{50}/10$) for 30 days. After 15 and 30 days of exposure, the bivalves were maintained in one liter airtight water container. The oxygen contents of water before and after one hour were estimated by the method of Winkler. The weight of the animals from each water container was measured to calculate the oxygen consumed per gram of body weight.

The rate of oxygen contents was estimated as ml/gm of body weight/ hour / liter and is presented in table 1. The standard deviation and test of significance was applied and presented in the table.

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OBSERVATIONS AND RESULTS

In control and nickel exposed bivalves the rate of oxygen consumption after 15 days and 30 days of exposure was 0.0589 $\pm$ 0.01 and 0.0552 $\pm$ 0.012 ml/gm/hr/l while in nickel exposed bivalves the rate was reduced to 0.0459 $\pm$ 0.009 and 0.0403 $\pm$ 0.011 ml/gm/hr/l. The percent decrease in the rate of oxygen contents was 22.0713 after 15 days and 26.3359 after 30 days. The significant change in the rate of oxygen consumption was observed after exposure to nickel.

Table 1- Rate of oxygen consumption of *Lamellidens marginalis* after chronic exposure to nickel chloride

Treatments	Average oxygen consumed ml/gm/hr/l ± S.D.	
	15 Days	30 days
Control	0.0589 $\pm$ 0.01	0.0552 $\pm$ 0.012
Nickel Chloride 0.227 ppm	0.0459 $\pm$ 0.009 (-22.0713)	0.0403 $\pm$ 0.011 (-26.3359)

The values in () Brackets indicate present change over with respective days control.

DISCUSSION

Under stressful conditions, bivalves show the change, not only in metabolic activities but also in the behavior. The bivalves react against this stressful condition by various ways in variable organisms. Hence the interpretation of the reduction in oxygen uptake due to effect of drug is difficult. Impact of antibiotics on invertebrates and specifically on mollusks has not been studied and hence references regarding effect of undesirable substances in the water are quoted.

The prominent mucus secretion on the gills and body surface was also observed during experimentation. These activities are helpful to minimize the toxic effect of toxicant on the body. As bivalves are filter-feeders, the close contact of gill tissues with polluted water alters the respiratory surface and in turn decreases the diffusion of gases through gills [8 and 9] and severely affects the lamellar structure of gills in fresh and marine water shrimps [10 and 11].

Toxicants alter the metabolic processes of the organism. The change in metabolic rate alters the biochemical pathways to resist the pollution stress [12].

Toxicant exposure causes respiratory disturbances and reduces oxygen consumption in crabs [13] and also in molluscs [12, 14, 15,16 and 17].

The rate of oxygen consumption was decreased due to the role of toxicants as inhibitors acting between i) NAD^+ and coenzymes ii) the chain of cytochrome b and c iii) and inhibitors of cytochrome C-oxidase. These inhibitors block energy derivation and affects oxygen uptake [18].

Nagaratnamma and Ramamurthi (1982) [19] suggested the compensatory mode of anaerobiosis due to reduction in succinate dehydrogenase activity and increased lactate dehydrogenase activity caused due to methyl parathion exposure. The anaerobic metabolism fulfils the energetic need and shows physiological adaptation under stressful conditions.

One of the reasons for decrease in oxygen consumption is the copious secretion of mucus on gills and body surface to overcome the effect of stress. According to Wong *et al*., (1977) [20] formation of mucoid cords on gill lamellae hindered the diffusion of gases and ultimately resulted in less respiratory rate. In the present investigation tremendous amount of mucus secretion was observed suggesting it as one of the causes of reduction in the rate of oxygen consumption.

The bivalves, oysters and shrimps are also severely affected by the different pathogens leading to dramatic diseases and mortality in farms. These diseases are caused by viruses, bacteria, rickettsia-like organisms etc. [21]. *Tridacna gigas*, suffered by *Vibrio* in Australia [22 and 23] while the manila clam, *Ruditapes philippinarum*, by bacteria *Vibrios tapetis* in France [24, 25 and 26].

Present study shows that rate of oxygen consumptions in animals were affected by nickel chloride.

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