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Arsenic effects on growth parameters of Indian prawn, *Penaeus indicus*

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Abstract

Chronic toxicity test was conducted for 28 days with post larval stages of *Penaeus indicus* to arsenic for studying the changes associated with growth pattern, specifying the length, weight and condition factor. Arsenic exposures produced significant ($P < 0.05$) effect in terms of length, weight and deteriorated the condition factor of the test animal. Differentiation in relation between the condition factor and geometric increase in the concentration was significant ($P < 0.05$; 0.01). Significant ($P < 0.01$) reduced growth was observed in 40, 80 and 160 µg/l arsenic concentrations.

Introduction

Industrialization and urbanization in and around the coastal region often lead to decrease in coastal resources and increase in the contamination of natural resources (Rajkumar, 2013). Metals in the dissolved form from anthropogenic or natural sources come across brackish water ecosystem; they are readily adsorbed to suspended particulate matter and are detached from water column to sediments, acting as a sink. Long-term accumulation of contaminants can lead to sediment concentrations that can surpass water concentrations (Morillo *et al*., 2008). Sediment associated metals pose a direct risk to detritus and deposit feeding benthic organisms, and may also represent long-term source of contamination to higher trophic levels. The measurement of responses to chemical contaminants in sentinel organisms are used as bio-indicators from aquatic environment allowing early detection of biological effects as well as assessment of the extent of contamination of pollutants (Twining *et al.*, 2008).

Most commonly used stressor end-points are variables related to growth performance. The body size correlates with many ecological as well as life history traits and thus influence the abundance of species as well as population structure and dynamics (Gaston *et al*., 2001). Prawns and bivalves are amongst the most abundant and economically important species supporting major fisheries and have been used extensively in toxicity testing. They are widely distributed, abundant, sensitive to environmental contaminants and relatively easy to hold and culture in the laboratory. Growth rate has been frequently used as a measure of performance of the individual and is believed to be a more appropriate measure of toxicological effects (Schamphelaere and Janssen, 2004). Hence, in the present study the effects of arsenic on the growth pattern of Indian prawn, *Penaeus indicus* in the laboratory was conducted in chronic toxicity bioassay.

Materials and Methods

Post larval stages (PL-12) of *Penaeus indicus* were collected from private farm in Marakkanam (Tamilnadu, India) and transported to the laboratory in air-filled plastic bags. Test organisms were acclimatized in glass aquaria with aerated natural filtered seawater for a period of 7 days with 27 PSU salinity, temperature of 28 ± 2°C, dissolved oxygen of 5.6 mg/l and pH of 8.01. After a day of acclimatization, *P. indicus* was then fed with pellets of mixed feed for *P. indicus.* Stock solutions of arsenic were freshly prepared by dissolving arsenic trioxide (As_2O_3) in Milli-Q water. The experimental method includes static renewal (24-hour renewal) test by following the method of USEPA (2002a). Five concentrations (10, 20, 40, 80 and 160 µg/l) in a geometric series including control were prepared for 30 days for short-term chronic toxicity test (USEPA, 2002b). Toxicant and seawater were replaced on daily basis. Each series of test chambers consisted of triplicate with 10 animals in a 10 L glass trough. Test chambers were loosely covered to prevent loss of test animals with gentle aeration. Test animals were fed regularly three times a day.

Test organisms were subjected to physical

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measurements in terms of length and weight. Condition factor (K) of the experimental animal was calculated by Williams (2000) ($K = 100 W / L^3$). The Total Length (L) of the test organism was measured from the tip of the anterior or part using ruler to the nearest centimeter. Weight was measured after blot drying with a piece of clean hand towel. Weighing was done with a tabletop digital weighing balance (Metller), to the nearest gram. One-way ANOVA (Dunnett's multiple comparison tests) was carried out using Graphpad Prism Software. Arsenic concentrations were measured in the tests chambers using Varian Spectra AA 220FS Atomic Absorption Spectrophotometer (AAS). Suitable internal chemical standards (Merck Chemicals, Germany) were used to calibrate the instrument. All the reagents used were analytical grade of high purity.

Results and Discussion

Reduced growth was observed in 40, 80 and 160 µg/l concentrations of arsenic. The test organisms showed frequent moulting, piercing with the glass trough and cannibalistic behavior. The dead organisms showing red colouration were regularly removed. Significant ($P < 0.001$) mean weight difference represented by negative values and differences in mean length were observed in 80 and 160 µg/l concentrations of arsenic (Figures 1 and 2). The condition factor of the *P. indicus* exposed to 80 and 160 were significant at $P < 0.05$, that brought the changes during arsenic exposure (Figure 3). The sensitivity of a species to growth effects caused by arsenic exposure may be influenced by the relative growth rate of the species. In the present study, a significant decrease of growth rate as well as the decrease of the locomotion after exposure to even lower concentrations (10 and 20 µg/l) was observed. Hansen *et al.* (2002) reported an negative effect on the growth is a effect of heavy metal action in marine organisms. The inhibitory actions towards growth receiving the highest heavy metal concentration to the test organisms were observed in the present study could be due to the influence of food intake and assimilation. Arsenic exposure decreased the tendency of food intake and assimilation leading to decreased growth rate in crustaceans. James *et al*. (1992) reported reduced feed conversion rate in marine organisms at sub-lethal levels of heavy metals might be due the tissue burden of more heavy metals, which in turn could cause increase in metabolic cost. Rajkumar (2012) studied the effects of cadmium, copper, lead and zinc on the growth parameters of *P. monodon* and concluded that, heavy metal exposures degraded the health quality of marine organisms, correlating with the results of the present study.

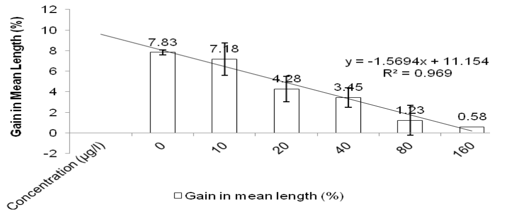

Figure 1. *P. indicus* differences in mean length in percentage exposed to long term effects of arsenic

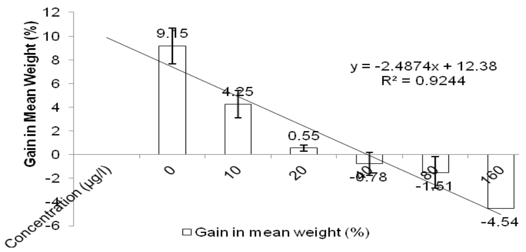

Figure 2. Effects of mean weight of *P. indicus* exposed to long term effects of arsenic

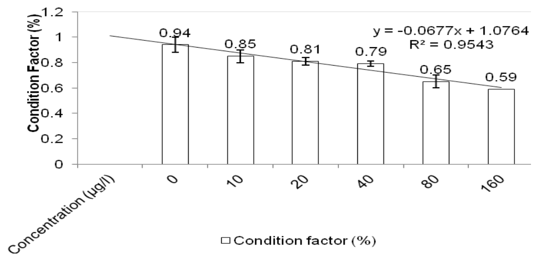

Figure 3. Health status of *P. indicus* exposed to long term effects of arsenic

Arsenic is prevalent in the environment originating from both anthropogenic and natural processes. It is omnipresent but is potentially a toxic trace element. Inorganic as well as organic forms of arsenic are present in the environment and inorganic arsenic is more toxic and slightly more accumulated in organisms. Trivalent As may show an adverse effect on aquatic biota and is considered more toxic than the inorganic pentavalent form. General health conditions in marine organisms were investigated through condition factor (K), which has often been used as an indication of general fitness of the organism (Bolger and Connolly, 1989) as well as to investigate the effects of contaminants (Pyle *et al*., 2005). Hogstrand *et al.* (1995) showed increased metabolic demands could divert resources from normal growth processes. Lawrence and Poulter (1998) reported decreased swimming stamina due to metal exposure indicating a reduction of available energy to detoxification process for survival. Movement of aquatic organisms is a highly ecologically relevant behavioural marker as well, since locomotion is required to find food, escape predation and obtain mates. Heavy metal interferences with the growth activity could reduce the health status of aquatic organisms and may involve ecological death (Scott and Sloman, 2004). It is well known that the defense and repair mechanisms depend on energy requiring processes such as active transport and synthetic activity. Therefore, confronting stress is likely to be energetically costly for the stressed organisms (Smolders *et al.*, 2005). Pollutants are inevitably permanently immobilized in sediments constituting a potential danger and are capable of exerting considerable biological effects even at low levels because of their pervasiveness and persistence nature. Accumulation of heavy metals in marine organisms for a longer period of time can ultimately lead to death thereby endangering the biodiversity of aquatic biota. Estuarine ecosystems are the breeding grounds and nurseries for young ones; hence, ecological risk assessment will identify several environmental problems, using growth parameters as behavioural markers. The process can identify existing risks or forecast the risks of stressors not yet present in the environment for the protection of habitats and endangered species.

References

Bolger, T. and Connolly, P.L. 1989. The selection of suitable indexes for the measurement and analysis of fish condition. Journal of Fish Biology 34: 171-182.

Gaston, K.J., Chown, S.L. and Mercer, R.D. 2001. The animal species-body size distribution of Marion Island. PNAS. 98: 14493-14496.

Hansen, J.A., Welsh, P.G. Lipton, J. and Suedkamp, M.J. 2002. The effects of long-term cadmium exposure on the growth and survival of bull trout (*Salvelinus confluentus*). Aquatic Toxicology 58: 165-174.

Hogstrand, C. and Wood, C.M. 1995. Mechanisms for zinc acclimation in freshwater rainbow trout. Marine Environmental Research 39: 131-135.

James, R., Sampath, K. Pattu, V.J. and Devakiamma, G. 1992. Utilization of *Eichhorina crassipes* for the reduction mercury toxicity on food transformation in *Heteropneustes fossilis*. Journal of Aquaculture in the Tropics 7: 189-196.

Lawrence, A.J. and Poulter, C. 1998. Development of a sub-lethal pollution bioassay using the estuarine amphipod *Gammarus duebeni.* Water Research 32: 569-578.

Morillo, J., Usero, J. and Rojas, R. 2008. Fractionation of metals and As in sediments from a biosphere reserve (Odiel salt marshes) affected by acidic mine drainage. Environmental Monitoring Assessment 139: 329-337.

Pyle, G.G., Rajotte, J.W. and Couture, P. 2005. Effects of industrial metals on wild fish populations along a metal contamination gradient. Ecotoxicology and Environmental Safety 61: 287-312.

Rajkumar, J.S.I. 2012. Effects of heavy metals in growth of tiger prawn, Penaeus monodon (fabr.1798)-an effective assessment tool. Journal of Applied Sciences in Environmental Sanitation 7 (2): 87-92.

Rajkumar, J.S.I. 2013. Arsenic induced biochemical changes in Perna viridis as potential biomarkers in metal pollution. Asian Journal of Biochemical and Pharmaceutical Research 1 (3): 179-186.

Schamphelaere, K.A.C. and Janssen, C.R. 2004. Bioavailability and chronic toxicity of zinc to juvenile rainbow trout: Comparisons with other fish species and development of a biotic ligand model. Environmental Science and Technology 38: 6201-6209.

Scott, G.R. and Sloman, K.A. 2004. The effects of environmental pollutants on complex fish behaviour: Integrating behavioural and physiological indicators of toxicity. A review. Aquatic Toxicology 68: 369-392.

Smolders, R., Baillieul, M. and Blust, R. 2005. Relationship between the energy status of *Daphnia magna* and its sensitivity to environmental stress. Aquatic Toxicology 73: 155-170.

Twining, J., Creighton, N. Hollins, S. and Szymczak, R. 2008. Probabilistic risk assessment and risk mapping of sediment metals in Sydney Harbour embayments. Human and Ecology Risk Assessment 14: 1202-1225.

USEPA. 2000a. Revised Baseline Ecological Risk Assessment Hudson River PCBs Reassessment. Phase 2 Reports. Prepared by TAMS Consultants, Menzie-Cura and Associates for USEPA Region 2. Washington, DC, USA. Retrieved from: *http://www.epa.gov/hudson/revisedbera-text.pdf.*

USEPA. 2000b. United States Environmental Protection Agency. Understanding and Accounting for Method Variability in Whole Effluent Toxicity Applications under the National Pollutant Discharge Elimination System. EPA 833- R-00-003. Retrieved from: *http://www.toxicity.com/pdf/epa2000june.pdf.*

Williams. J.E. 2000. The Coefficient of Condition of Fish. In: Schneider, James C. (ed.). Manual of fisheries survey methods II: With periodic updates. Michigan Department of Natural Resources, Fisheries Special Report 25. Ann Arbor. P 1-2, retrieved from: *http://www.michigandnr.com/PUBLICATIONS/PDFS/ifr/Manual/SMII%20Chapter13.pdf.*