

RESEARCH ARTICLE

Toxicity assessment of industrial wastewaters reaching Dandugan Oya, Sri Lanka using a plant based bioassay

D.N.M. Kannangara and A. Pathiratne*

Department of Zoology and Environmental Management, Faculty of Science, University of Kelaniya, Kelaniya.

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Abstract: Industrial waste may contain complex chemical mixtures with potential cytotoxic and genotoxic effects. The Dandugan Oya, a water canal located in the Western Province of Sri Lanka receives industrial waste from multiple sources. In the present study potential toxicity of selected industrial wastewaters reaching the Dandugan Oya, and the downstream water was assessed using a plant based bioassay with onion (*Allium cepa* L. var. *ascalonicum*) as the test organism. Of the physico-chemical characteristics tested, temperature, pH, biochemical oxygen demand, chemical oxygen demand, cadmium and chromium levels of the wastewaters collected during three sampling occasions in the year 2012 were within the national tolerance limits specified for the discharge of industrial effluents into inland surface waters. The exposure of *A. cepa* bulbs to wastewater and downstream water from the Dandugan Oya resulted in the reduction of root growth (24 – 62 %) and mitosis (31 – 55 %), induction of micronuclei (up to 0.6 %), nuclear abnormalities (3 - 14 folds) and chromosomal aberrations (3 - 21 folds) in the root tip meristematic cells compared to those exposed to the control and the upstream water, indicating cytotoxic and genotoxic effects. No significant difference between the control and the upstream water was found in relation to the measured biological effects ($p > 0.05$). The present study revealed that the tested wastewaters contained cyto-genotoxic contaminants and, the inherent dilution/detoxification capacity of Dandugan Oya during the study period was not adequate to eliminate the toxic effects in the downstream water. In addition to the conventional physico-chemical analyses, inclusion of suitable bioassays as additional assessments in water quality monitoring programmes could alert cyto-genotoxic impacts in wastewater receiving inland surface waters.

Keywords: Bioassay, cytotoxicity, Dandugan Oya, genotoxicity, wastewater.

INTRODUCTION

Industrial wastewaters may contain complex chemical mixtures including metallic and organic compounds with potential cytotoxic and genotoxic effects. The evaluation of hazardous wastes and effluents by genotoxicity assays may provide data useful for hazard identification and comparative risk assessment (Claxton *et al.*, 1998). In a review of mutagens in surface waters, Ohe *et al.* (2004) emphasized the importance of conducting mutagenicity/genotoxicity assays in addition to the analysis of conventional water quality parameters to efficiently assess the presence of mutagens in water.

Higher plants are recognized as excellent genetic models to detect environmental mutagens and may serve as a warning to other biological systems, since the target of the mutagens is DNA, which is common to all organisms. Among the plant species, *Allium cepa* ($2n = 16$) bioassay is frequently used for *in situ* environmental monitoring studies of waste, surface water and groundwater quality assessments (Grant, 1982; Smaka-Kincl *et al.*, 1996; Leme & Marin-Morales, 2009). The *A. cepa* bioassay is a low cost and easily handled toxicity test, which has advantages over other short-term tests that require previous preparations of tested samples. The *A. cepa* bioassay facilitates testing different toxicity endpoints *viz.* root growth inhibition, mitotic index alterations (Fiskesjo, 1985), chromosome aberrations, nuclear alterations and micronucleus analysis (Grant, 1982; Rank & Nielsen, 1993; Ma *et al.*, 1995). A combination of these toxicity

* Corresponding author (asoka@kln.ac.lk)