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Application of *Allium cepa* (Onion) bioassay for assessing toxicity of copper, cadmium and chromium at the concentrations established as national tolerance limits for the discharge of industrial effluents into inland surface waters

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Allium cepa bioassay is an efficient test system which can be routinely used to evaluate the cytotoxic and genotoxic potential of chemical mixtures in the aquatic environment. In the present study, *Allium cepa* bioassay was used to evaluate the cytotoxic and genotoxic effects of selected heavy metals at the concentrations established as national tolerance limits (Cu 3 mg L⁻¹, Cd 0.1 mg L⁻¹ and Cr(VI) 0.1 mg L⁻¹) for the discharge of industrial effluents into inland surface waters. *Allium cepa* bulbs were exposed to aged tap water (controls) and Cu²⁺ (3 mg L⁻¹), Cd²⁺ (0.1 mg L⁻¹) and Cr⁶⁺ (0.1 mg L⁻¹) in aged tap water singly and in a combination of mixtures following standard procedures. Cytotoxic and genotoxic evaluations were based on the inhibition of root growth (RG), mitotic indices (MI), induction of nuclear abnormalities (NA) and chromosomal aberrations (CA) in the root tip cells of onion bulbs exposed to the metal ions at fixed time periods in comparison to the controls. The onion bulbs exposed to the tolerance limit level of Cu, singly or in mixtures with the other metals exhibited the highest RG inhibition (up to 97%), depression of MI (up to 92%) and increased occurrence of different NA in the root tip cells compared to the controls signifying higher cytotoxic potentials of copper at the concentration tested (P < 0.05). In addition, root tip cells exposed to Cr(VI) alone or the mixture of Cr(VI) and cadmium displayed significantly higher (P < 0.05) degree (3.2 folds and 3.4 folds respectively) of total CA including C-metaphase, lagging and vagrant chromosomes, multipolar and polar slip in the anaphase and sticky chromosomes in telophase in comparison to the controls indicating their genotoxic effects. This study provides scientific evidence that the national tolerance limits in relation to these heavy metals in the industrial effluents need to be reviewed considering their potential cytotoxicity and genotoxicity on biological systems.

Keywords: *Allium cepa* bioassay, cytotoxicity, genotoxicity, heavy metals, tolerance limits

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