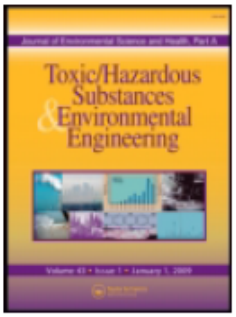

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Assessment of the genotoxicity of heavy metals in *Phaseolus vulgaris L.* as a model plant system by Random Amplified Polymorphic DNA (RAPD) analysis

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Impact assessments of environmental pollutants are important in eco-genotoxicology. A random amplified polymorphic DNA (RAPD) technique was used to detect genotoxicity-induced DNA damage in *Phaseolus vulgaris L.* from heavy metals at two different concentrations. The results from six 10-base pair (bp) random RAPD primers with 60–70% GC content used, showed a total of 295 RAPD fragments of 700–4000 bp in molecular size in the seedlings of untreated and treated samples, of which only 163 fragments were polymorphic. Polymorphisms became evident as the disappearance and/or appearance of DNA fragments in treated samples compared to the control. A dendrogram constructed using the Numerical Taxonomy and Multivariate Analysis System (NTSYSps), showed that the control group merged with groups treated with $CuSO_4 \cdot 5H_2O$ (150 mg L^{-1}) and $MnSO_4 \cdot H_2O$ (150 mg L^{-1}) in a separate cluster. These groups were linked with all of the other samples treated with metals at concentrations of 150 mg L^{-1} and $CuSO_4 \cdot 5H_2O$ and $Cd(NO_3)_2$ at concentrations of 350 mg L^{-1}. Finally, the samples treated with metals at concentrations of 350 mg L^{-1} together with $NiSO_4$ at the concentration of 150 mg L^{-1}, clustered separately. The DNA polymorphism detected by RAPD analysis offered a useful biomarker assay for the detection of toxic chemicals genotoxicity in plant model systems.

Keywords: RAPD, genotoxic effects, *Phaseolus vulgaris*, heavy metals.

Introduction

Toxic chemicals adversely affect individual health when they interfere with the normal physiological processes of an organism. This interference may occur on a direct, toxicant to organism basis (i.e., primary toxic chemicals), or it may occur after the toxic compound is transformed via physicochemical interactions with its environment (secondary toxic chemicals).[1] During the past decades, the scientific community and regulatory agencies have focused on measuring contaminant levels in tissues and environmental samples and on understanding the mechanisms of toxicity of the most pervasive contaminants.[2] With the rapid pace of economic development and industrialization, a vast range of genotoxic chemicals was produced, and distributed throughout the environment. These chemicals adversely affect living organisms, and often lead to serious diseases in humans.

Due to the highly conserved structure of genetic material, it is possible to use a broad variety of species including bacteria, yeasts, animals and plants in genotoxicity tests.[3] Heavy metals induce several cellular stress responses and damage to different cellular components, such as membranes, proteins and DNA. Although essential metals carry out important biological functions because they act as cofactors for a wide variety of metalloproteins and enzymes, they are cytotoxic when they accumulate in excess of cellular needs.[4, 5] In particular, heavy metals cause acute toxic effects and cancer in mammals due to DNA damage.[6,7]

Higher plants provide a useful genetic system for screening and monitoring environmental pollutants. The major advantages of using plants as monitoring tools are the following: they are eukaryotes; they are easy to grow and resistant to environmental stress; they do not contaminate easily; they, along with plant cells in culture, can allow assays on a range of environmental conditions; they can be used for outdoor monitoring; they show a positive correlation with mammalian cytogenetic assays for mutagenesis;

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