DNA electrochemical biosensor for the detection of genotoxic compounds in soil samples

Silvia Raquel Hernandez 1,2, Graziana Bagni 1*, Giovanna Marrazza 1, Marco Mascini 1

1 Department of Chemistry, University of Florence, Via della Lastruccia 3, 50019 Sesto Fiorentino (FI), Italy
2 Department of Chemistry, National University of Littoral, University Campus, 3000 Santa Fe, Argentina

The soil plays a central role within ecosystems and fulfils a multitude of functions (as a habitat, regulatory and production functions). When reaching soils, pollutants can adversely affect these functions; thus they can move to other media and cause damage to other components of the ecosystem.

In this work, an electrochemical DNA-based biosensor is proposed as a screening method for the rapid detection of genotoxic compounds in soil samples. The biosensor was assembled by immobilising double stranded calf thymus DNA on screen-printed electrodes. The interactions between DNA and environmental pollutants can cause variations of the electrochemical proprieties of DNA [1]. Therefore, the changes in oxidation of the guanine peak, obtained by a square wave voltammetric scan, was used as analytical signal. The index of toxicity was expressed by the relative signal G/G0 (where G and G0 are the corrected marker SWV peak currents in experiments with and without the analyte, respectively).

Preliminary studies were performed using the benzene, naphthalene and anthracene derivatives as model compounds. The effect of these compounds on the surface-confined DNA was found to be linearly related to the concentration of these compounds in solution. On the other hand, the objective was to optimise the ultrasonic extraction conditions of these compounds from spiked soil samples. Then, the applicability of such a biosensor was evaluated by analysing soil samples from four sites of an Italian region with ecological risk.

The results were analysed statistically, the analysis of variance (ANOVA) was used to compare between the different sample groups. When the ANOVA indicated that significant differences existed between the groups, Fisher’s “least-significant difference” (LSD) multiple comparison test was then used. A significance level of P<0.05 was applied in all statistical tests. The results demonstrated that the sampling sites presented different pollution levels and that the compounds analysed presented different genotoxic effect.


* CORRESPONDING AUTHOR: E-mail: graziana.bagni@unifi.it, Ph: +39-055-4573311, Fax: +39-055-4573384