Development of an electrochemical immunosensor based on specific antibodies labelled with CdS nanoparticles devoted to the paraquat residues detection in spiked potato samples

Enrique Valera[a,b], Raül García-Febrero[a,b], Isabel Pividori[c], Francisco Sánchez-Baeza[a,b], M.-P. Marco[a,b]

[a] Applied Molecular Receptors Group (AMRg), IQAC-CSIC, Jordi Girona 18-26, 08034 Barcelona, Spain.
[b] CIBER de Bioingeniería, Biomateriales y Nanomedicina (CIBER-BBN), Barcelona, Spain.
[c] Unitat de Química Analítica, Grup de Sensors i Biosensors. Edifici C - Campus de la UAB – 08193 Bellaterra (Cerdanyola del Vallès), Barcelona, Spain.
enrique.valera@iqac.csic.es

The analysis of the presence of potentially hazardous chemicals (e.g. pesticides, antibiotics) in food remains a major concern in the European Community. However, to ensure quality and traceability, there is a great need to increase the continuous control and monitoring of foodstuff at critical steps in the food chain, such as for example after the recollection of the raw materials, after the food processing (monitoring of storage and logistics), as well as of final products.

Fast, reliable and cost-effective analytical methods are necessary to ensure the safety of the food products. Following the flexibility, sensitivity, specificity and efficiency of analysis demonstrated by the numerous immunochemical and biological tests today available, research is now intending to go forward by developing devices capable of working out of laboratory, i.e. in the different steps of the food chain. With this idea the concept arises of biosensor as a miniaturized analytical devices, consisting of an immobilized biological component (antibody, enzyme, receptor, DNA, etc.) in intimate contact with a transducer (optic, electrochemical, piezoelectric, etc.) that may convert the biorecognition process into a quantifiable electrical signal.

With regards to the use of biosensors as a method to verify compliance of legislation, most of the devices reported until now, rely on the use of labels to reach the necessary detection limits required. Likewise, the use of inorganic nanocrystals tracers as labels for electrochemical immunoassays have recently received great attention because the possibility of obtain simultaneous detection/measurements of DNA targets and proteins [1,2].

In this work, the potential of a new electrochemical immunosensor to detect residual amounts of paraquat (PQ) in a complex matrix, such as potatoes, is evaluated. The immunosensor presented is based on graphite composite electrodes (GECs), immunoreagents specifically developed to detect paraquat, magnetic μ-particles, and CdS nanoparticles labelled to the specific antibodies. The assay relies on the immunochemical competitive reaction between the pesticide residues and a fixed amount of the immobilized antigen on the magnetic beads for a small amount of the specific antibody. At the end of the reaction the amount of antibody captured by the free antigen is evacuated (Figure 1). By means of the well-known anodic stripping techniques, CdS nanoparticles are read, and the amounts of its metal ions are expressed as a signal of current or charge. Due to the amplification of the amperometric/coulombimetric signal, produced by the presence of the CdS nanoparticles, PQ can be detected in spiked potato samples. The results obtained showed that after the extraction and dilution of the matrix, PQ can be determined in potato samples with limits of detection of 0.64 μg L^{-1} and 0.39 μg L^{-1}, depending of the chosen parameter for the detection (current or charge), and taking into account the dilution used. Hence, the LODs obtained are far below the Maximum Residue Level (0.02 mg Kg^{-1}) established by EU for most crops.

References

[1] Wang, J.; Liu, G.; Merkoçi, A., Journal of the American Chemical Society, 125 (2003) 3214-3215.

[2] Liu, G.; Wang, J.; Kim, J.; Jan, M.-R., Analytical Chemistry 76 (2004) 7126-7130.

Figures

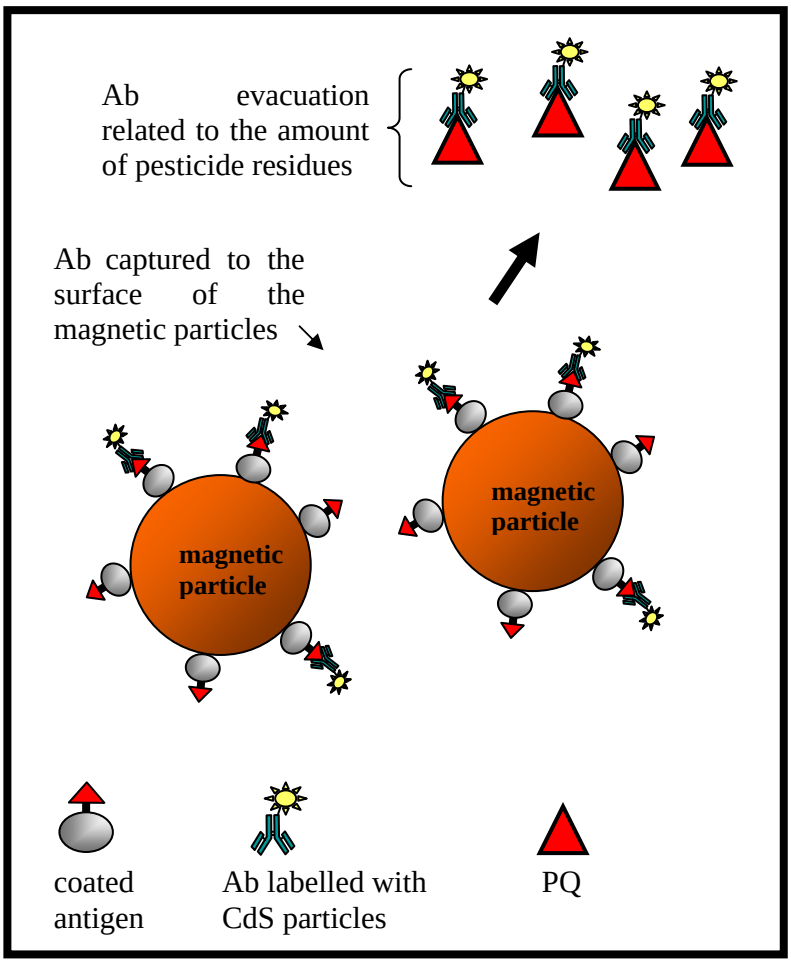

Fig. 1. Electrochemical immunosensor reaction. An amount of the specific antibody is captured by the coated antigen. Likewise, the amount of Ab bound to the pesticide was evacuated. The amount of CdS particles is indirectly related to the PQ residues concentration.