FoodSmartphone—On-site Biosensor for Pesticides Detection in the Area of Food Safety

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Pesticides are primarily used in the agricultural sector but also in forestry, horticulture, amenity areas and in-home gardens. The widespread and intensive use of pesticides induces negative cascading effects on ecosystems. Herein we report on the fabrication and characterization of an electrochemical sensor for detection of different pesticides in food samples on a smartphone.

Herbicides are the most common type of pesticide found in streams and ground water within agricultural areas. The most common herbicides in agricultural streams were atrazine which was found in about two-thirds of all samples from agricultural streams. Consumer concerns on food safety and society awareness of chemical contaminants, in the environment have increased in the past few years. As a consequence, more restrictions in the use of chemical products have been imposed at national and international levels.

Electrochemistry (EC) could potentially be a good addition to the standard method for quality control. Potentiostats nowadays are small portable devices furthermore relatively cheap. Moreover, if carbon screen printed electrodes (SPE) are used as transducer the cost per analyses can be drastically reduced making them the perfect candidates for on-site analysis.

CSEM in collaboration with CSIC [1] has characterized and developed a carbon black (CB) based biosensor for the detection of atrazine in the area of food safety. The nanomaterial CB is highly attractive for this application since it has been reported to have comparable or even better performance than graphene-oxide and carbon nanotubes, in terms of electron transfer constant, redox reversibility and background currents [2]. CB is also quite inexpensive (~1 €/kg for CB versus ~100-1000 €/kg for graphene [3] depending on the quality and ~1000 €/g for CNT [4]).

SPE modification with CB has been done both by drop-casting directly onto the working electrode (WE) and by mixing CB into the printing ink. All the electrochemical characterization tests have been done by using cyclic voltammetry (CV) and electrochemical impedance spectroscopy (EIS). The first technique (CV) was used to evaluate the sensors in terms of electron transfer and current signal; the second one (EIS) in order to evaluate the charge transfer resistance at the WE surface.

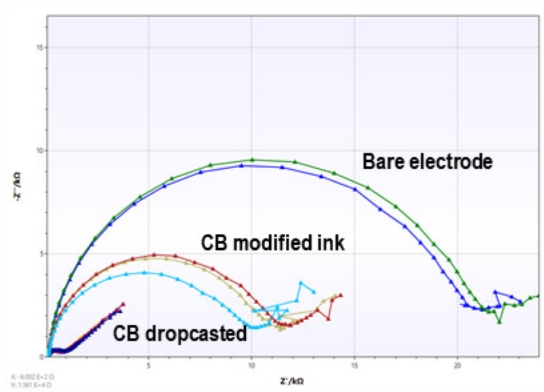

Figure 1: Nyquist plots of the EIS analysis of the different SPEs using 1 mM [Fe(CN)6]3-/4- in 0.1 M KCl solution as redox probe.

After the electrochemical characterization, the drop-casted electrode, which showed the best electrochemical characteristics was selected and used as the transducer for an atrazine assay using magnetic beads as a platform for the immunoassay (ELIME format, see for example [5]). The electrochemical response curve towards atrazine seen in Figure 2 was recorded using chronoamperometry as detection technique.

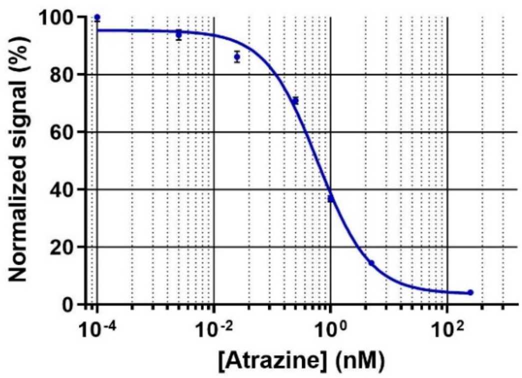

Figure 2: Calibration curve for atrazine.

Figure 2 shows that the achieved IC50 (0.83 nM) fulfils the requirements of the EU regulations (maximum residue level (MRL) for Atrazine in cereals is 0.05 mg/kg), which is important from the view of the real sample analysis.

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