Sensitive Detection of Cathinones and Their Adulterants in Street Samples Using Electrochemical Fingerprinting

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Introduction

The abuse of illicit drugs has become a global concern considering the widespread use of these substances and the consequences it has on societies. The current methods used to quickly detect drugs on-site, such as color-tests, are presumptive tests and they lack selectivity, giving a high number of false negative and false positive results, due to the presence of adulterants and cutting agents. Their characterization is important from a forensic point of view, in order to link different seizures to one original batch, as well as from a toxicological point of view, for the health implications some of them might have.

The purpose of the study was the development of a sensitive method for the detection of cathinones and their adulterants/cutting agents in street samples. The electrochemical fingerprinting was performed by means of square wave voltammetry (SWV) using screen-printed electrodes (SPE) functionalized with different types of nanomaterials:

- graphene (GPH);
- multiwalled carbon nanotubes (MWCNTs);
- platinum nanoparticles (PtNPs);
- gold nanoparticles (AuNPs).

Depending on the obtained signal for the oxidation of drugs, graphene and multiwalled carbon-nanotubes based platforms were chosen to further test the cathinones. Two cathinones (methilmethcathinone (MMC) and alfa-pirolidinopentiofenona (PVP)) were tested, as well as several adulterants/cutting agents such as procaine, benzocaine, quinine and starch, lactose, respectively.

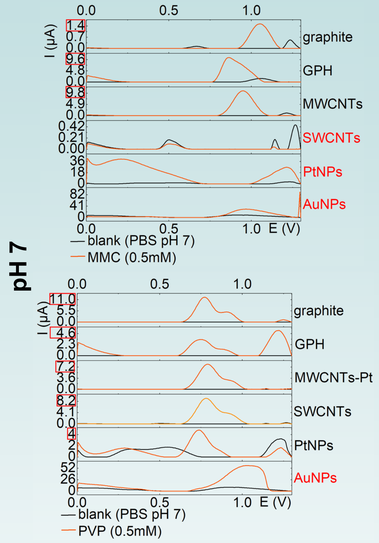
The effectiveness of the developed method was tested for the detection of drugs in simulated drugs samples.

Methodology

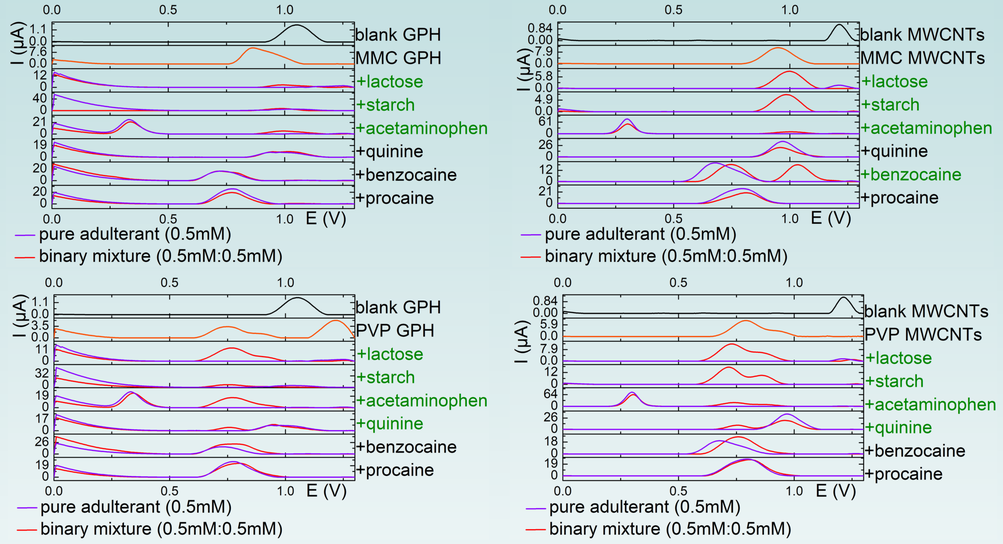
SWV was performed in the potential window of 0-1.3V with a step potential of 5mV, an amplitude of 25 mV and a frequency of 10Hz in the following solutions:
(i) 0.5 mM adulterant in PBS pH 7 and pH 12;
(ii) 0.5 mM drug in PBS pH 7 and pH 12;
(iii) binary mixtures of drug:adulterant 0.5 mM:0.5 mM in PBS pH 7 and pH 12.

Results

Cathinones screening



Cathinones mixtures with adulterants on GPH and MWCNTs



Discussions

MMC at pH 7 in mixtures with adulterants

- **GPH** SPE: the PVP peak can be observed in mixture with **lactose, starch and acetaminophen.**
- **MWCNTs** SPE: the PVP peak can be observed in mixture with **lactose, starch, acetaminophen and benzocaine.**

PVP at pH 7 in mixtures with adulterants

- **GPH** SPE: the PVP peak can be observed in mixture with **lactose, starch, acetaminophen and quinine** and it is overlapped with the benzocaine and procaine peaks;
- **MWCNTs** SPE: the PVP peak can be observed in mixture with **lactose, starch, acetaminophen and quinine** and it is overlapped with the benzocaine and procaine peaks.

MMC at pH 12 in mixtures with adulterants

- **GPH** SPE: there is a peak in the blank in the same area of potential as the MMC peak;
- **MWCNTs** SPE: the MMC peak can be observed in mixture with **lactose, starch, acetaminophen, benzocaine and procaine** and it is overlapped with quinine peak.

PVP at pH 12 in mixture with adulterants

- **GPH** SPE: the PVP peak can be observed in mixture with **lactose, starch, acetaminophen and quinine** and it is overlapped with the benzocaine's and procaine's peaks;
- **MWCNTs**: the peak can be observed in mixture with **lactose, starch, acetaminophen and quinine** and it is overlapped with the benzocaine and procaine peaks.

Conclusions

Screening at pH 12 showed better performance in terms of selectivity and sensitivity than screening at pH 7.

Electrochemical methods proved to be excellent techniques for the fast detection of drugs with high sensitivity and specificity, suitable for the development of miniaturized portable devices to be used in-field.

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