Highly selective electrochemical profiling of heroin in street samples

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INTRODUCTION

Trafficking and consumption of drugs of abuse are a global concern that threatens social structures and jeopardizes the security of nations **[1]**. Particularly, heroin use still accounts for the largest share of drug-related harms **[2]**. Thus, effective, rapid, low-cost and selective analytical methods are vital to hinder drug trafficking and prevent its availability in the drug market **[3]**. This way, chemical color tests and sophisticated spectroscopic instrumentation are often the first choice. However, significant drawbacks should be considered e.g. the inaccuracy of the color tests or the high cost and low portability of the spectroscopic devices. Interestingly, electrochemical sensors proved to be the solution for the on-site detection of illicit drugs due to their balance between affordability and analytical performance **[4,5]**. The present study reports an improved method for the on-site profiling of heroin. The principle is based on two-peak recognition i.e. from heroin and its main metabolite 6-monoacetylmorphine (6-MAM) at basic pH. Unfortunately, paracetamol, which is the most used cutting agent in heroin seizures, overlaps completely 6-MAM peak at unmodified electrodes, hindering its potential use to selective detect heroin. As a result, a rapid and smart electrochemical pretreatment is presented to overcome this masking phenomena. Overall, the proposed strategy paves the way to a rapid, user-friendly and low-cost on-site detection of heroin in real scenarios by law enforcement officers: (i) analysis of suspicious powders in the street; and (ii) rapid screening of cargos in border settings.

RESULTS

1. EC BEHAVIOR OF HEROIN AT SPE

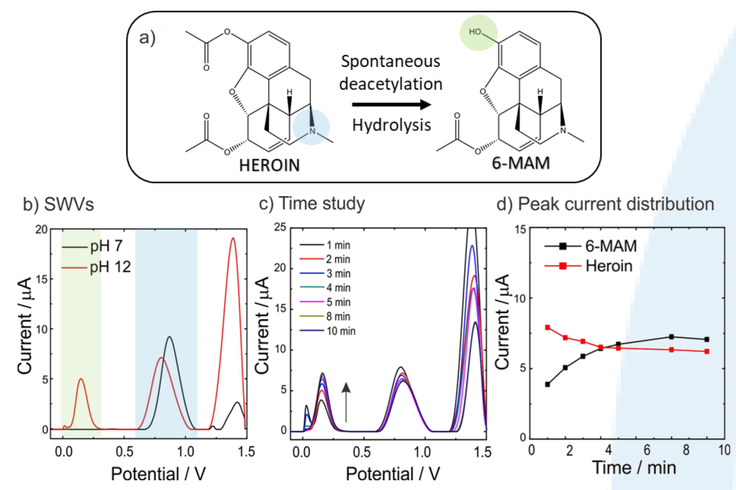

Figure 1. Fig. 1. a) Hydrolysis of heroin and consecutively conversion to 6-MAM. Degradation study of 0.5 mM heroin at SPE by SWV: b) SWVs at PBS pH 7 and pH 12, c) time study (1 min-10 min), and d) peak current Vs. time.

2. TO PARACETAMOL AND HEROIN DETECTION

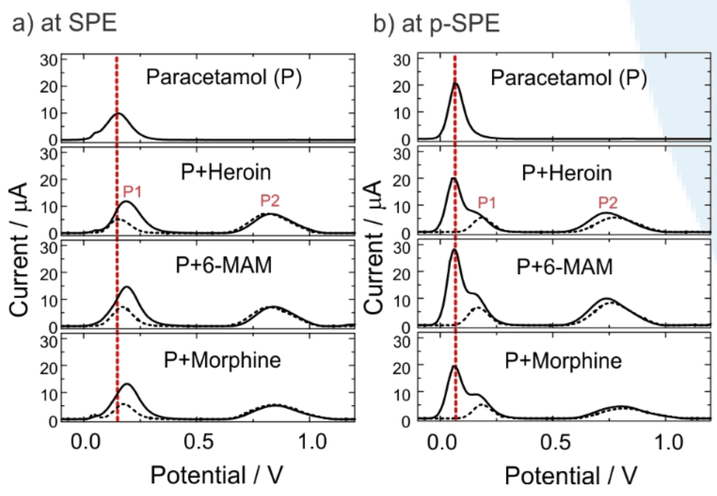

Figure 2. SWVs of 0.5 mM paracetamol and corresponding 1:1 binary mixtures with heroin, 6-MAM and morphine in PBS pH 12 at: a) untreated SPE and b) p-SPE (previous treatment: 60s at 1.5V). The dotted red line indicates where the signal of paracetamol is located. The dashed SWVs indicates the EF of the pure compounds, others than paracetamol.

3. CHARACTERIZATION OF p-SPE SURFACE

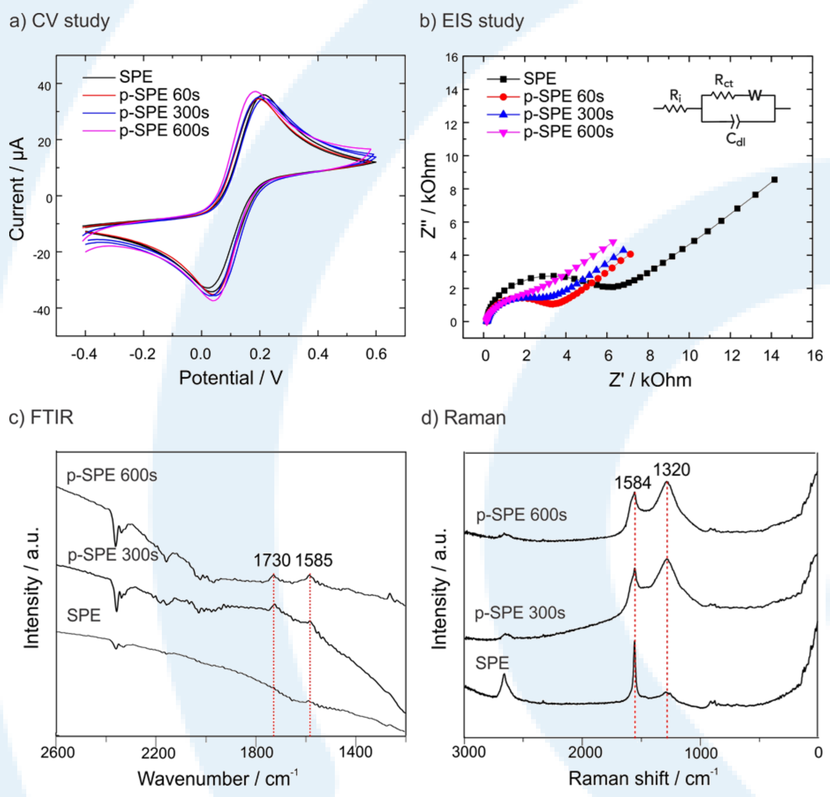

Figure 3. Electrochemical characterization of the anodic pretreatment: a) CV measurements of SPE, p-SPE at 60, 300 and 600 s. CV was performed at 0.1 V s-1. b) EIS measurements of SPE, p-SPE at 60, 300 and 600 s. EIS was performed under the following parameters: Edc=0.2 V, Eac=5 mV, frequencies= 0.1 Hz-100 KHz. All electrochemical measurements were performed in PBS with 2 mM K3[Fe(CN)6] pH 7.4. Chemical characterization of the anodic pretreatment: c) FTIR spectra of p-SPE compared to SPE d) Raman spectra of p-SPE compared to SPE.

4. BINARY MIXTURES AT p-SPE

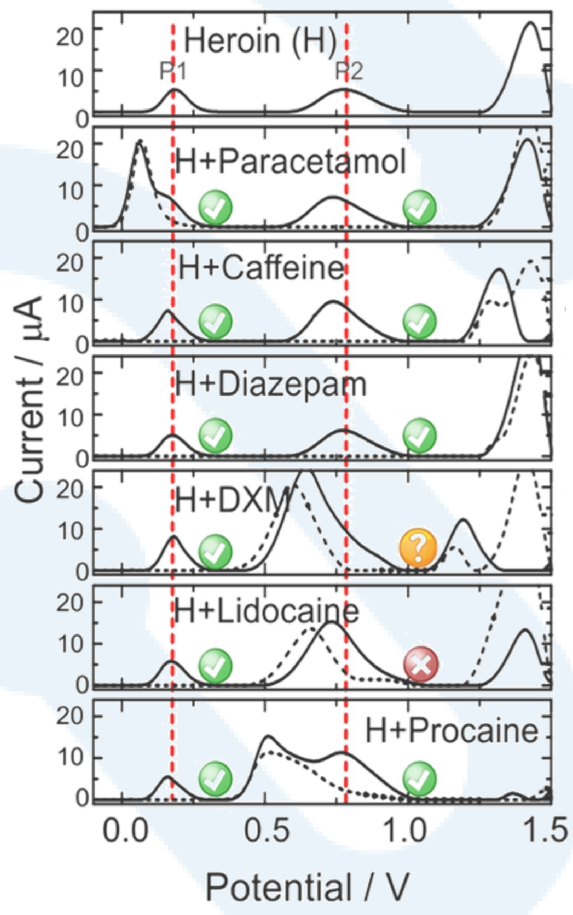

Figure 4. SWVs of heroin on different binary mixtures at 0.5 mM in PBS pH 12 at p-SPE with 0,5 mM cutting agents. The dotted red (vertical) line indicates the signal of 6-MAM and heroin, respectively. The dashed SWVs indicates the EF of the pure adulterants or illicit drugs.

CONCLUSIONS

- ✓ The signal of 6-MAM in alkaline medium is exploited to detect heroin
- ✓ The pretreatment allows to distinct 6-MAM in mixtures paracetamol
- ✓ The characterization of p-SPE surface suggested an enhancement of the electron transfer rate with an increment in the electrical conductivity
- ✓ A deep study of heroin mixtures with cutting agents has successfully demonstrated outstanding sensor performance to discriminate heroin by using 6-MAM signal

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REFERENCES

[1] European Monitoring Centre for Drugs and Drug Addiction, EU Drug Markets Report 2020, 2020.
[2] European Monitoring Centre for Drugs and Drug Addiction, EU Drug Markets Report 2019, 2019.
[3] W.R. de Araujo, T.M.G. Cardoso, R.G. da Rocha, M.H.P. Santana, R.A.A. Muñoz, E.M. Richter, T.R.L.C. Paixão, W.K.T. Coltro, Anal. Chim. Acta. 2018, 1034, 1.
[4] H. Teymourian, M. Parrilla, J.R. Sempionatto, N. Felipe Montiel, A. Barfidokht, R. Van Echelpoel, K. De Wael, J. Wang, ACS Sensors. 2020, 5, 2679.
[5] F. Truta, A. Florea, A. Cernat, M. Tertis, O. Hosu, K. de Wael, C. Cristea, Front. Chem. 2020, 8.

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