APTADRU

Finger-tip biosensor for the on-site selective detection of cocaine

DURATION
15/12/2014 - 31/01/2018

BUDGET
150 000 €

PROJECT DESCRIPTION

Context
Cocaine is one of the most abundant drugs of abuse entering Belgium, both for local consumption and for distribution all around Europe. Being important points of entry, the Belgian customs service in the harbour of Antwerp and police and customs in Brussels National Airport are very keen to monitor passing cargo, luggage and people for the presence of drugs. An on-site screening by means of color tests based on cobalt thiocyanate is commonly used, but these tests are difficult to interpret and unreliable, with false positive results leading to economic damage for companies moving legal cargo and the unauthorized arrest of innocent people, and false negative results leading to the passing of illegal goods. A more reliable and user-friendly approach is required to perform these screening tests and to replace the outdated color tests.

Objectives
The final objective of this project is to develop a portable, reliable sensor device for cocaine, which is designed for effective and efficient use by customs and police services in the field. A fingertip sensor was firstly proposed as the main design. The selectivity of the sensor needs to be significantly better compared to the color tests by using a combination of electrochemical techniques and aptamers as bio recognition elements.

Conclusions
Square wave voltammetry was successfully used as an electrochemical alternative for the on-site detection of cocaine. By using a small, portable potentiostat and disposable graphite screen printed electrodes, on-site detection of cocaine street samples could be easily obtained. To build in selectivity into the sensor, a cocaine specific aptamer 38-GC was successfully selected by performing potentiometric titration measurements and built into the sensor by immobilizing the aptamers to the electrode surface in polysilane films. The enrichment of cocaine near the electrode surface for increased selectivity was obtained in this way, but other ways for increasing the selectivity were also explored and in the end more successful. Therefore, the initial proposal of a glove sensor was abandoned since the direct detection of powders in a gel matrix had a slight drawback on the kinetics of the voltammetric measurements. A new approach was developed for the detection of solutions instead, with extra attention going to minimalizing the sample preparation procedure. Varying measurement conditions like the pH of the measurement solution, using single or double scan voltammetry and preconditioning of the electrodes prior to measurements led to a defined three-step method capable of determining the presence of cocaine in a large dataset of powder samples (357) with an accuracy of 96.9 %. In comparison to the color tests, the accuracy was drastically improved and the newly developed electrochemical method also has the benefits that the cutting agents could be detected as well, while the weaknesses of the color test were eliminated in the new method.

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In addition, an Android application was developed which enables the end users to automatically detect cocaine without extensive data analysis procedures, generating a simple 'positive' or 'negative' output after a measurement, for quick determination of the presence of cocaine. The developed method was presented to and discussed with potential end users on multiple occasions, with the most important ones the customs at the Port of Antwerp and Brussels Airport. The most important findings from this project were also shared on multiple (inter)national conferences and symposia, as well as in three A1 scientific journals, among which Analytical Chemistry (IF: 6.320) and Chemical Science (IF: 8.668). The promising results obtained in APTADRU resulted to the application of multiple follow-up projects, that were also approved, showing the potential of the obtained detection strategy. A small market study at the end of this project shows the promising prospects for developing a commercial device which is able to replace the color tests.

CONTACT INFORMATION

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