MDMA or MDA: Combined colorimetric and electrochemical screening method for selective detection of amphetamine-type stimulants in forensic samples using 3D-printed electrodes

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ABSTRACT

Aiming to combine the advantages of colorimetric and electrochemical methods, this work presents the selective determination of MDMA and MDA in forensic samples using a two-step procedure: Simon's test and electrochemical detection by differential pulse voltammetry (DPV) with 3D printed lab-made sensors.

Keywords: Simon's test, 3D Printing, Voltammetry, MDMA, MDA.

Introduction

The increasing number of seizures containing MDA and MDMA in association with other amphetamines demonstrates the importance of selective preliminary drug identification methods in the forensic scenario. Colorimetric tests, like Simon's and Marquis, are commonly used for fast screening of seizures. However, they are prone to produce false-positive and false-negative results due to similarities between molecules and/or the presence of other substances in different samples. Furthermore, high dye concentrations in colored tablets can affect the perception of color change, making colorimetric tests unreliable. Electrochemical methods have emerged as an option for forensic applications due to their selectivity, speed, simplicity, low cost, and potential for on-site data acquisition. In this scenario, disposable electrodes, produced at low cost by 3D printing, are an appealing alternative due to their portability, ability for large-scale production, and reduced risk of cross-contamination.

Objectives

Selective detection of MDMA and MDA in forensic samples by both Simon's and electrochemical tests.

Methods

Simon's reagent was prepared with 1g of sodium nitroprusside, 100 mL of water, 2 mL of acetaldehyde and 2% w/v sodium carbonate. Britton-Robinson (BR) 0.1 M buffer solution pH 10.0 was used as supporting electrolyte. MDMA and MDA electrochemical detection was performed by DPV in a double cell with 3D printed working, counter, and pseudo-reference electrodes (partly covered with silver ink).

Results and Discussion

The presence of MDMA in the sample was suggested by the color change in the Simon's test (Fig. 1A) and by the appearance of two MDMA characteristics oxidations (O_1 at +0.9 V, O_2 at +1.1 V; Fig. 1B), as well as by the decrease in the Simon's reagent oxidation peak (P_{Simon} at +0.38 V).

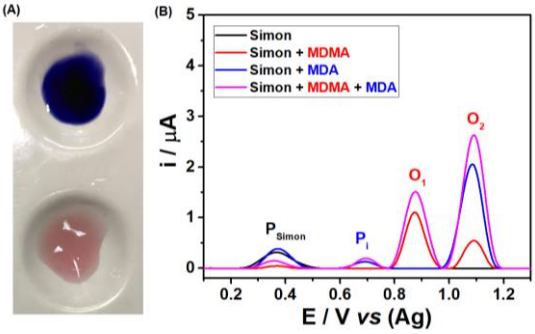

Fig.1. (A) Simon's test for MDMA. (B) DPVs of Simon's reagent in the absence and presence of both drugs in 0.1 M BR pH10.

MDA can be identified by its first oxidation (P_i at +0.6 V), since its second oxidation is at the same potential as the one from MDMA. Furthermore, the presence of MDA does not cause a decrease in P_{Simon} peak. The proposed method showed a wide linear range (1 to 175 µM) and a limit of detection (LOD) of 0.1 µM for both analytes. These parameters are suitable for application to seized samples containing MDMA and MDA. In addition, good response stability was obtained using the same electrode (N = 10; RSD < 5%).

Conclusion

The combination of two techniques (Simon's test and DPV) is a rapid and portable strategy for the selective and sensitive screening of MDMA and MDA in seized forensic samples.

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