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An Automated Magnetic Dispersive Solid-Phase Extraction Method for Detection of Cocaine in Human Urine

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Abstract : Cocaine is the most frequently used illegal drug globally, with the global annual prevalence of cocaine used ranging from 0.3% to 0.4 % of the adult population aged 15–64 years. Growing consumption trend of abused cocaine and drug crimes are a great concern, therefore urine sample testing has become an important noninvasive sampling whereas cocaine and its metabolites (COCs) are usually present in high concentrations and relatively long detection windows. However, direct analysis of urine samples is not feasible because urine complex medium often causes low sensitivity and selectivity of the determination. On the other hand, presence of low doses of analytes in urine makes an extraction and pretreatment step important before determination. Especially, in gathered taking drug cases, the pretreatment step becomes more tedious and time-consuming. So developing a sensitive, rapid and high-throughput method for detection of COCs in human body is indispensable for law enforcement officers, treatment specialists and health officials. In this work, a new automated magnetic dispersive solid-phase extraction (MDSPE) sampling method followed by high performance liquid chromatography-mass spectrometry (HPLC-MS) was developed for quantitative enrichment of COCs from human urine, using prepared magnetic nanoparticles as absorbants. The nanoparticles were prepared by silanizing magnetic Fe3O4 nanoparticles and modifying them with divinyl benzene and vinyl pyrrolidone, which possesses the ability for specific adsorption of COCs. And this kind of magnetic particle facilitated the pretreatment steps by electromagnetically controlled extraction to achieve full automation. The proposed device significantly improved the sampling preparation efficiency with 32 samples in one batch within 40mins. Optimization of the preparation procedure for the magnetic nanoparticles was explored and the performances of magnetic nanoparticles were characterized by scanning electron microscopy, vibrating sample magnetometer and infrared spectra measurements. Several analytical experimental parameters were studied, including amount of particles, adsorption time, elution solvent, extraction and desorption kinetics, and the verification of the proposed method was accomplished. The limits of detection for the cocaine and cocaine metabolites were 0.09-1.1 ng·mL-1 with recoveries ranging from 75.1 to 105.7%. Compared to traditional sampling method, this method is time-saving and environmentally friendly. It was confirmed that the proposed automated method was a kind of highly effective way for the trace cocaine and cocaine metabolites analyses in human urine.

Keywords : automatic magnetic dispersive solid-phase extraction, cocaine detection, magnetic nanoparticles, urine sample testing
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