**TECHNICAL NOTE**

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# Detection of Cocaine on Various Denominations of United States Currency

**REFERENCE:** Negrusz A, Perry JL, Moore CM. Detection of cocaine on various denominations of United States currency. J Forensic Sci 1998;43(3)626–629.

**ABSTRACT:** The presence of cocaine on U.S. paper currency collected in many cities in the United States has previously been reported. Currency becomes contaminated during the exchange, storage and use of cocaine. Different currency denominations are also rolled by drug users and used to snort cocaine. Illicit cocaine is widely abused and therefore the contaminated paper currency can be easily found in common use. A total of 18 bills were analyzed in our laboratory for cocaine. Ten $20 bills were randomly collected in Rockford, IL and four $1 bills in Chicago. An additional four uncirculated $1 bills were analyzed as a control group. All bills were extracted with 0.1 M hydrochloric acid followed by solid-phase extraction. Cocaine was identified using gas chromatography/mass spectrometry in full scan mode, and drug quantitation was performed in selected ion monitoring mode. A standard curve was prepared and doxepin was used as an internal standard. In addition, for method validation two levels of control solutions were analyzed simultaneously. Precision and accuracy values were within acceptable ranges. Cocaine was present on 92.8% of all bills collected from the general circulation. All $20 bills were contaminated with cocaine and the amount of drug varied from 0.14 to 10.02 μg of cocaine per bill ($\bar{x}$ = 2.86 μg). Only one $1 bill was cocaine free. In one case ($1 bill), only traces (below quantitation limit) of cocaine were found. All four uncirculated $1 bills were cocaine-free.

**KEYWORDS:** forensic science, drugs of abuse, contamination of currency, cocaine, solid-phase extraction, gas chromatography-mass spectrometry

United States paper currency has been reported to be contaminated with illicit cocaine due to the enormous extent of cocaine distribution, sale and consumption. Previously cocaine was found on paper currency collected in 14 different size cities in the United States (1). At present and based on the existing analytical data it is accurate to say that the paper currency contamination of cocaine is widespread. In fact, most Americans handle small amounts of cocaine every day, not as packets sold by drug dealers, but on the dollar bills that line their pockets. Considering all this information, can casual contact with money contaminated with cocaine result in positive urinalysis? In one study (2), the reported concentration of benzoylecgonine in urine following casual contact with cocaine-contaminated currency was below the cutoff value of 150 ng/mL for this particular cocaine metabolite. It has also been suggested that currency becomes contaminated from contact with previously contaminated bills in financial institutions. There are sometimes even hundreds of micrograms (in one case even 1327 μg) of cocaine present on a single bill (1). Widespread currency contamination may cause a problem for people who on a daily basis deal with large numbers of bills: bank tellers, people who operate money counting machines, among others.

The aim of this study was to identify and quantitate cocaine on ten $20 bills collected randomly from the general circulation in Rockford, IL. In addition, four $1 bills were collected randomly in Chicago and analyzed. As a control group, four new and uncirculated $1 denomination bills were analyzed. Gas chromatography/mass spectrometry (GC-MS) was employed for identification and quantitation of drug on paper currency. This study was prompted by the Channel 17 WTVO TV Station in Rockford, which also provided the $20 bills.

## Materials and Methods

### *Drug Standards, Chemicals, and Materials*

Cocaine hydrochloride was obtained from Mallinckrodt, Inc. (St. Louis, MO). Doxepin was purchased from Radian International (Austin, TX). Acetic acid glacial was obtained from Sigma Chemical Company (St. Louis, MO). Methylene chloride, hydrochloric acid, isopropanol, ammonium hydroxide and methanol were purchased from Fisher Scientific (Itasca, IL). All organic solvents were high-performance liquid chromatography (HPLC) or HPLC-GC/MS grade, all other chemicals were American Chemical Society (ACS) grade. The elution solvent, methylene chloride isopropanol:concentrated ammonium hydroxide (78:20:2, v/v/v), was prepared fresh every day. ISOLUTE™ HCX 200 mg, 10 mL extraction columns (International Sorbent Technology) were purchased from Jones Chromatography (Lakewood, CO).

### *Instrumentation*

Analysis was performed using a Hewlett-Packard (Palo Alto, CA) 6890 gas chromatograph with HP 6890 Series injector and

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Received 25 July 1997; and in revised form 23 Sept. 1997; accepted 6 Oct. 1997.

5973 mass selective detector (MSD). Samples (1 μL) were introduced to the system via a split-splitless capillary inlet system in a splitless mode, and an HP-5MS fused-silica capillary column (30 m × 0.25 mm × 0.25 μm) was used. The oven temperature program was: 130°C for 1 min, ramp at 12°C/min to 280°C; 280°C for 1 min. The sample inlet temperature was 270°C. The ion source temperature was kept at 230°C and quadrupole temperature at 150°C. Cocaine was identified by GC-MS operating in the full scan mode (35 to 500 am$\mu$) and quantitation was performed in the selected ion monitoring mode (m/z 82, 182, 303 ions for cocaine and m/z 58 for the internal standard, doxepin) using ion ratios of ±20%. Dwell time for each ion was 50 ms.

*Currency Collection*

Ten paper bills ($20 denominations) were collected randomly from wallets of ten people in Rockford, and four $1 bills were collected at the University of Illinois at Chicago from general circulation (employees and graduate students). Four uncirculated $1 bills were obtained from the Federal Reserve and shipped for analysis in a plastic bag. Single bills were placed in plastic ziplock bags and delivered to the Department of Pharmaceutics and Pharmacodynamics, University of Illinois at Chicago for analysis.

*Extraction Procedure*

Single bills were placed in 50-mL plastic tubes and 0.1 M hydrochloric acid (5 mL) was added. All tubes were capped, placed on a rotator, and the bills were extracted for 15 min at 30 rpm. A standard curve was prepared for the following concentrations of cocaine: 50, 100, 200, and 500 ng. Control samples were prepared in duplicate at 75 and 300 ng and the specimens were run in two batches. After extraction, aliquots (0.5 mL) were transferred to glass test tubes and internal standard (300 ng, doxepin) was added to each sample, standard and control solutions. Acetic acid (1.93 M, 1 mL) and deionized water (8 mL) were added to each solution and all samples were further extracted using solid-phase extraction. Extraction columns were placed on the vacuum manifold and conditioned with methanol (3 mL), deionized water (3 mL), and acetic acid (1.93 M, 1 mL). All samples were added to the columns and were slowly drawn through. The columns were dried (2 min) and were washed with deionized water (3 mL), hydrochloric acid (0.1 M, 1 mL), and methanol (3 mL). After the last wash, the columns were dried for 5 min and collection tubes were placed in the manifold rack. Drugs were eluted with a mixture of methylene chloride: isopropanol:concentrated ammonium hydroxide (78:20:2, v/v/v) (3 mL). All samples were then evaporated to dryness under a stream of air, reconstituted in methanol (100 μL), transferred to the autosampler vials and placed on the autosampler.

## Results

In this study cocaine was identified on 92.8% of all bills analyzed by GC-MS (Table 1). All the extracts from $20 bills were positive for cocaine and the amount of the drug was between 0.14 and 10.02 μg per bill ($\bar{x}$ = 2.86 μg). Four $1 bills were analyzed. One bill was negative for cocaine and traces of cocaine (below quantitation limit) were present on another one ($\bar{x}$ = 0.83 μg). All uncirculated $1 bills were negative for cocaine. Table 1 gives the results of analysis of all bills for the presence of cocaine. Cocaine retention time was 11.32 min and the drug was identified by comparison of the mass spectrum (full scan mode) with cocaine standards. Quantitation of cocaine with doxepin as an internal standard was performed using GC-MS working in the selected ion monitoring mode. Doxepin retention time was 11.50 min. The standard curve was linear over the range of cocaine concentrations (50 to 500 ng) and had correlation coefficient, slope and intercept of 0.999, $-8.6 \times 10^{-3}$, and 8.75, respectively. The wash from the specimens was diluted to produce concentrations of cocaine within the linear range. The limit of quantitation (LOQ) was arbitrarily established to be 50 ng, the lowest cocaine concentration on the standard curve, and the limit of detection (LOD) 1 ng of cocaine per bill using the lowest concentration at which ion ratio criteria were met and signal-to-noise was greater than 5. Two sets of control solutions (75 and 300 ng of cocaine per bill) were analyzed. For the 75 ng controls ($N$ = 8), the precision and accuracy values were 3.61% and −4.13%, respectively, for the 300 ng control solutions ($N$ = 8), the precision and accuracy were 3.24% and 4.86%, respectively. Figures 1*a* and 1*b* represent typical total ion chromatogram and mass spectrum, respectively, of the extract from $20 bill #4.

TABLE 1—*Amounts of cocaine on $20 and $1 denominations collected randomly from general circulation in two Illinois Cities: Rockford and Chicago.*

| Denomination | Bill No. | Amount of Cocaine (μg/bill) |
|---|---|---|
| $20 | 1 | 4.54 |
| $20 | 2 | 2.17 |
| $20 | 3 | 3.43 |
| $20 | 4 | 5.98 |
| $20 | 5 | 1.04 |
| $20 | 6 | 10.02 |
| $20 | 7 | 0.47 |
| $20 | 8 | 0.65 |
| $20 | 9 | 0.16 |
| $20 | 10 | 0.14 |
| $1 | 11 | 2.99 |
| $1 | 12 | 0.31 |
| $1 | 13 | N.D.* |
| $1 | 14 | <0.05 |

*Not detected.

## Discussion

This study demonstrates that paper currency ($20 and $1 denominations) randomly collected from the general circulation in the Illinois area is contaminated with cocaine. In the most recent study Oyler et al. analyzed $1 bills collected from the general circulation in several cities in the United States for the presence of cocaine (1). Cocaine was extracted from bills using methanol followed by solid-phase extraction. The drug was identified using GC-MS in full scan mode and quantitation was achieved in selected ion monitoring mode with deuterated internal standards. In addition, all bills were analyzed for benzoylecgonine, ecgonine methyl ester, cocaethylene, norcocaine, anhydroecgonine methyl ester, and norcocaethylene. Benzoylecgonine, a hydrolysis product of cocaine, was present on 17% of the currency analyzed and its amounts did not exceed one tenth of the measured cocaine concentration. All the currency analyzed was negative for other cocaine constituents. In the Oyler et al. study cocaine was present in 79% of the currency samples analyzed in amounts above 0.1 μg and in 54% of the samples above 1.0 μg. Cocaine contamination was found on currency from all the cities examined.

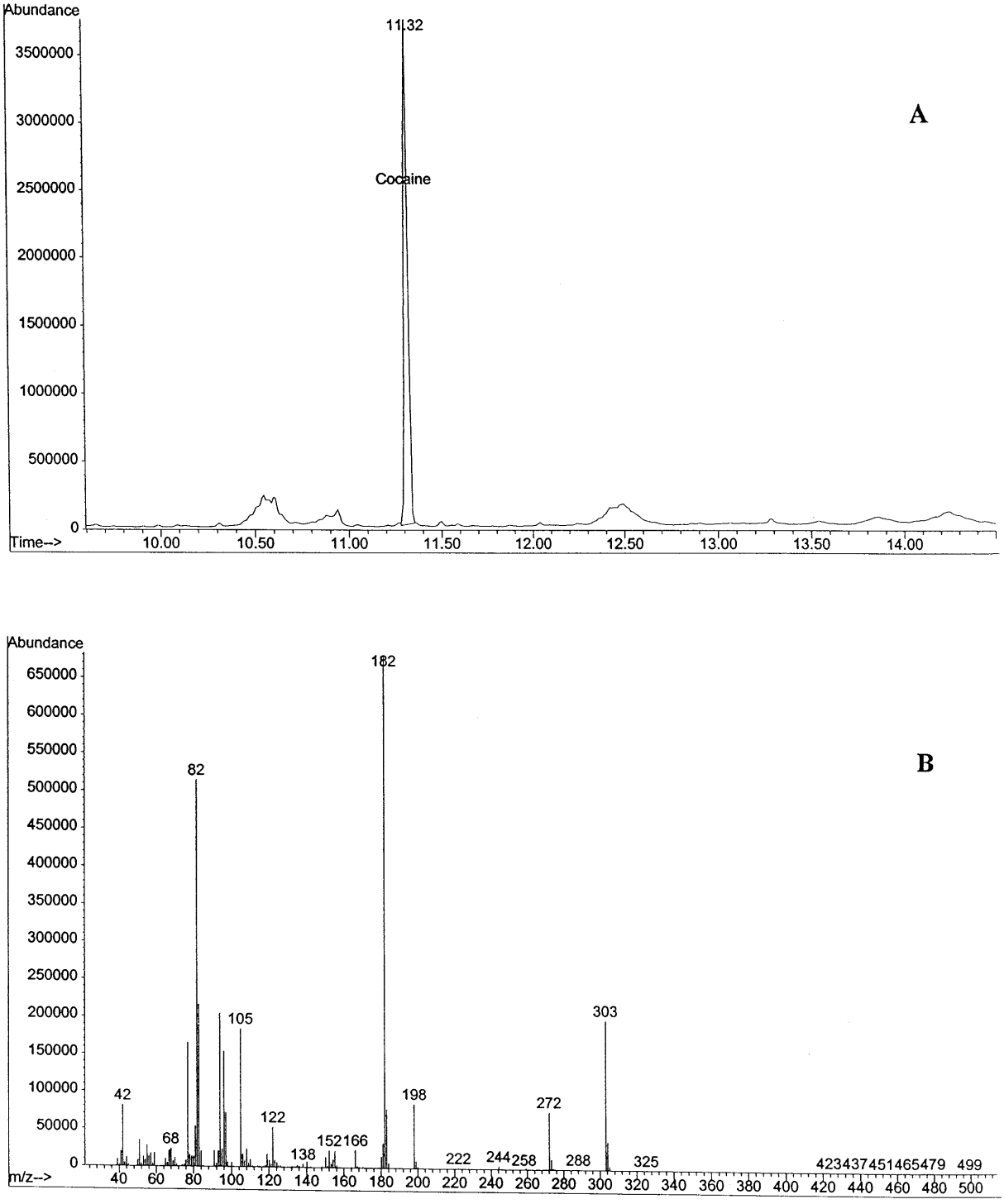


FIG. 1—*Typical total ion chromatogram (A) and mass spectrum (B) of the extract from the twenty-dollar bill #4 (cocaine amount 5.98 μg).*

In this study, the analysis of $20 bills (10) was carried out for the first time, together with the analysis of four $1 bills. Cocaine was present on 13 of all bills analyzed (92 8%) and on 12 (85.7%) in amounts above 0.1 μg and on 7 (50%) above 1.0 μg. Ten $20 bills collected in Rockford, IL were analyzed and they were all positive for cocaine. The results from this study clearly show that $20 and $1 denominations circulated in the Illinois area are contaminated with cocaine. In conclusion, based on this study and other data (1) it is accurate to say that the entire population of various denominations of United States currency is contaminated to a significant degree with illicit cocaine.

**References**

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