

DETERMINATION OF COCAINE IN BRAZILIAN PAPER CURRENCY BY CAPILLARY GAS CHROMATOGRAPHY/MASS SPECTROMETRY**Enrico Di Donato, Carmen Cinira Santos Martin and Bruno Spinosa De Martinis***

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The presence of illicit drugs such as cocaine and marijuana in US paper currency is very well demonstrated. However, there is no published study describing the presence of cocaine and/or other illicit drugs in Brazilian paper currency. In this study, Brazilian banknotes were collected from nine cities, extracted and analyzed by capillary gas chromatography/mass spectrometry, in order to investigate the presence of cocaine. Bills were extracted with deionized water followed by ethyl acetate. Results showed that 93% of the bills presented cocaine in a concentration range of 2.38-275.10 µg/bill.

Keywords: Brazilian paper currency; cocaine; capillary gas chromatography/mass spectrometry.

INTRODUCTION

Cocaine is one of the most widely extended illicit drugs and its use remains a significant worldwide public health problems¹. The most common administration way of cocaine is by inhalation or snorting commonly using banknotes that will retain drug powder residues. Thus, the investigation of this illicit drug on banknotes is of interest for evidentiary purposes in legal cases involving the drug trade².

U.S. banknotes are the most evaluated currency regarding cocaine and other illicit drugs contamination, with a positivity ranging from 79 to 92.8% of banknotes investigated, in average concentration of 0.06 to 922 µg/bill³. However, other studies have reported the identification of cocaine and other illicit drugs on banknotes from different countries³⁻⁵. Despite its directly use to snort cocaine, other mechanisms have been reported to explain the presence of the drugs in this kind of matrix, including contamination due to handling during drug deals and the transference from one contaminated bill to others during counting in financial institutions³.

To date, there is no similar study to investigate the presence of cocaine or other illicit drug in the Brazilian paper currency.

The goal of this work was to investigate the presence of cocaine in Brazilian paper currency in general circulation using capillary gas chromatography/mass spectrometry.

EXPERIMENTAL**Chemicals**

Ethyl acetate and methanol were HPLC grade from Merck (Darmstadt, Germany). Cocaine hydrochloride standard was obtained from Cerilliant (Austin, TX, USA).

Paper currency collection

Paper currency in R\$ 1.00 (One Real) (N = 46) were collected randomly from nine cities in Brazil. Cities were selected based on different demographic populations, ranging from very small towns

to metropolitan areas as demonstrated on Table 1.

All notes were in general circulation at time of collection and were placed individually in plastic bags and storage at room temperature (26 – 30 °C) until analysis.

Uncirculated banknotes were kindly provided by banks and were used to prepare the calibration curve and as blank samples.

Cocaine extraction

Each banknote was rolled and placed separately in a 10 mL glass tubes. Deionized water (8 mL) was added to each tube, capped and then agitated in mechanic shaker for 30 min. After extraction, the banknotes were removed from the tubes. Ethyl acetate (2 mL) was added to the aqueous phase and shaken for 15 min. The tubes were centrifuged for 4000 rpm for 15 min for phase separation. The organic layer was removed, evaporated to dryness at 45 °C, under N₂ flow and the residue reconstituted in 1.0 mL of methanol. The extracted banknotes were placed in an oven at 70 °C during 24 h to dry and returned to circulation.

Capillary gas chromatography/mass spectrometry analysis

Extracts were analyzed by gas chromatography/mass spectrometry for the presence of cocaine. Analyses were carried out on a Varian CP3800 gas chromatograph (Varian, California, USA) coupled to a Saturn 2000 mass selective detector (Varian, California, USA) and a Combi Pal autosampler (CTC Analytics, Basel, Switzerland).

Compounds were analyzed on a CP Sil 5 - fused silica capillary column (30 m x 0.25 mm I.D., film thickness 0.25 µm) (Chrompack). The injection mode was splitless for 0.30 min. The column temperature was set for 140 °C (4 min) to 220 °C (2 min) at 15 °C/min. The temperature of injector was set for 220 °C and helium was used as carrier gas with linear velocity of 33 cm/s.

The mass spectrometer was operated in the electron impact ionization. The ions *m/z* 82 and 182 were selected for cocaine identification/quantitation. A four-point calibration curve was prepared spiking uncirculated banknotes with cocaine standard solution in a concentration range of 2-400 µg/bill.

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RESULTS AND DISCUSSION

Several studies have been published reporting the presence of cocaine in paper currency.

Carter *et al.*⁶ used bundles of paper to simulate sterling banknotes, with the purpose of study the distribution of illicit drugs on banknotes via counting machines, determined the presence of crystalline material, similar to cocaine hydrochloride on the surface of the paper after counted.

Table 1. Cocaine concentration in the Brazilian currency notes (R\$ 1.00) collected in nine cities (N = 46)

Bill #	Cities	Population	Cocaine ($\mu\text{g}/\text{bill}$)
1	São Paulo (SP)	10.838.581	19.15
2	São Paulo (SP)		14.08
3	São Paulo (SP)		8.85
4	São Paulo (SP)		8.72
5	São Paulo (SP)		16.92
6	São Paulo (SP)		21.70
7	São Paulo (SP)		54.41
8	São Paulo (SP)		31.73
9	Santos (SP)	418.255	39.35
10	Santos (SP)		38.59
11	Santos (SP)		5.80
12	Santos (SP)		28.07
13	Santos (SP)		20.16
14	Ribeirão Preto (SP)	542.912	132.80
15	Ribeirão Preto (SP)		114.90
16	Ribeirão Preto (SP)		4.50
17	Ribeirão Preto (SP)		134.80
18	Ribeirão Preto (SP)		151.70
19	Ribeirão Preto (SP)		200.60
20	Ribeirão Preto (SP)		142.10
21	Ribeirão Preto (SP)		20.48
22	Ribeirão Preto (SP)		49.22
23	Ribeirão Preto (SP)		259.40
24	Ribeirão Preto (SP)		14.60
25	Ribeirão Preto (SP)		6.41
26	Guaíra (SP)	36.426	275.10
27	Guaíra (SP)		11.93
28	Guaíra (SP)		9.01
29	Guaíra (SP)		16.52
30	Rio de Janeiro (RJ)	6.051.399	113.60
31	Rio de Janeiro (RJ)		44.61
32	Rio de Janeiro (RJ)		21.38
33	Brasília (DF)	2.282.049	167.60
34	Brasília (DF)		7.74
35	Brasília (DF)		6.83
36	Brasília (DF)		5.30
37	Brasília (DF)		66.05
38	Goiânia (GO)	1.181.438	7.17
39	Goiânia (GO)		18.06
40	Goiânia (GO)		ND
41	Juiz de Fora (MG)	493.121	76.83
42	Juiz de Fora (MG)		5.11
43	Juiz de Fora (MG)		2.38
44	Londrina (PR)	480.822	ND
45	Londrina (PR)		ND
46	Londrina (PR)		9.26

ND: Not detected.

SP - São Paulo State; MG - Minas Gerais State; DF - Federal District; GO - Goiás State; PR - Paraná State; RJ - Rio de Janeiro State

Esteve-Turrillas *et al.*⁴ determined the presence of cocaine in euro banknotes analyzing 16 samples in a concentration ranging from 1.25 to 889 $\mu\text{g}/\text{bill}$.

Study performed by Oyler *et al.*⁷ using ten single dollar bills from several cities in the United States for cocaine investigation, determined that 79% of the bills were contaminated in a concentration higher than 0.1 mg/bill and in 54% of them higher than 1.0 $\mu\text{g}/\text{bill}$ with the highest concentration of cocaine of 1327 $\mu\text{g}/\text{bill}$.

Jenkins³ analyzed 10 randomly collected US\$ 1 bills from five cities, for cocaine and other drugs. She found that 92% of the bills were positive for cocaine in a concentration range of 0.01-922.72 $\mu\text{g}/\text{bill}$.

In the present study, Brazilian paper currency (R\$ 1.0 bill - 1 Real) was collected in different Brazilian cities and the presence of cocaine investigated. The results of cocaine (concentration/bill) for each city are showed on Table 1.

It was collected 46 R\$ 1.0 bills and cocaine was detected in 93% (43 banknotes) with concentrations ranging from 2.38 to 275.10 $\mu\text{g}/\text{bill}$ and mean concentration 51.15 $\mu\text{g}/\text{bill}$. The highest cocaine concentration was detected in Guaira, SP (275 $\mu\text{g}/\text{bill}$), and the lowest concentration was observed in Juiz de Fora, MG (2.38 $\mu\text{g}/\text{bill}$). Interesting to point out that Guaira is a small town in São Paulo State, where the presence of drugs is not supposed to be a serious social or health problem when compared with large metropolitan areas such as São Paulo or Rio de Janeiro. In 3 banknotes either cocaine was not detected or it was below the limit of quantification. All uncirculated bills had cocaine negative.

CONCLUSIONS

This study presented the extraction and detection of cocaine in Brazilian banknotes collected randomly from nine cities around the country. To date, this is the first study for investigation of illicit drug in Brazilian currency and it is important to corroborate with other studies that used other currencies for cocaine investigation in banknotes. According to the results obtained, it is accurate to infer that the contamination of Brazilian paper currency with cocaine is widespread inclusive in small towns. However, it is important to point out that more experiments, using more bills and collected from other Brazilian cities must be performed to obtain detailed information about the presence and distribution of cocaine in this matrix.

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