How much cocaine is in your wallet?

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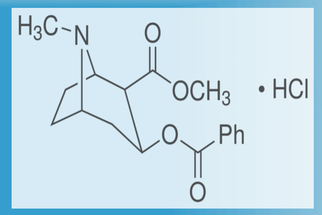


Introduction

- CNN suggests that cocaine is found on 90% of dollar bills[3]
- Cocaine is allegedly snorted from dollar bills, which can then transfer it onto other dollar bills in money sorters in banks
- This study assesses the extent to which cocaine is found on dollar bills
- Experimental considerations include a non-destructive method to extract and identify cocaine in its ionic form from a complex matrix

Figure 1. Cocaine is a widely used substance. Often it is snorted from the dollar bill.

Methods

Sampling Procedure
- Circulated US $1 bills were collected from different areas in Philadelphia
- Uncirculated US $1 bills were obtained from a local bank
- All bills were stored at room temperature in independent plastic bags to avoid cross contamination

Standards Procedure
- Solutions were prepared from a 1mg/mL cocaine stock (Sigma Aldrich) to deliver 1 μg, 5 μg, 10 μg, 25 μg, and 100 μg of cocaine onto uncirculated dollar bills
- Spiked bills were allowed to dry for 10 minutes

Extraction Procedure
- Each dollar bill, circulated and spiked, was shaken by vortex in 13mL of methanol for 5 minutes
- Each dollar bill was shaken by vortex in another 10mL of methanol for 1 minute
- The two extraction volumes were mixed and allowed to dry in a 100˚C oven with the door open for 48 hours
- The dried extract was reconstituted in 1.0mL of methanol

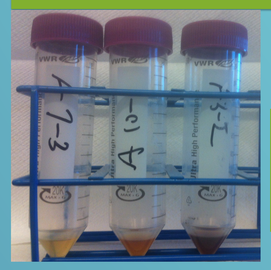


Figure 2. Reconstituted extract in 1.0 mL of methanol from three different bills. The matrices for each appear complex and varied.

Methods

Analytical Procedure
- Samples were injected in triplicate into a Varian 431 Gas Chromatograph – Varian 220 Ion Trap Mass Spectrometer

Conditions for GC-MS analysis:
Injection:
1. Injector temperature: 250 ˚C

Separation:
1. Mobile phase: He
2. Mobile phase flow rate: 1.0 mL/min (constant flow)
3. Stationary Phase: Varian FactorFour VF-5ms column (30 m long, 0.25 mm internal diameter, 0.25 micrometer thickness of stationary phase)
4. Split ratio:

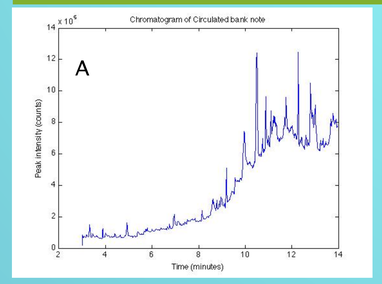
Initial	10
0.17 minute	100
00.50 minutes	10

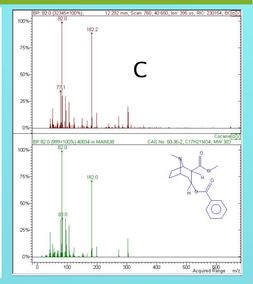
4. Temperature programming:
a. Initial temperature: 60 ˚C
b. Hold at 60 ˚C for 2 minutes
c. Ramp at 20 ˚C/min up to 250˚C
d. Hold at 250 ˚C for 3 minutes

Detection:
1. Mass range: 42-650 amu
2. Solvent delay: 3 minutes

Results

Cocaine was found





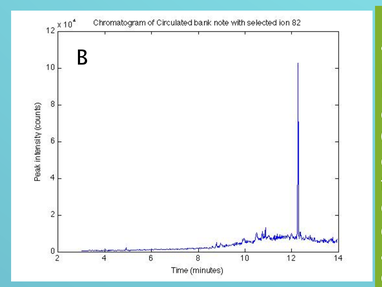


Figure 3. Chromatogram and Mass Spectrum recorded for a circulated bill. A shows the chromatogram from the GC. B shows the ion 82 chromatogram. Peaks from the chromatogram of ion 82 were used for quantification. C shows a mass spectrum for the cocaine peak.

Results

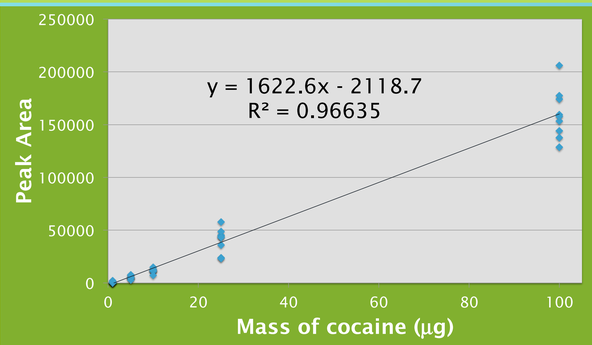


Figure 4. Calibration curve using spiked bank notes at 1 μg, 5 μg, 10 μg, 25 μg, and 100 μg. Horizontal axis shows the mass of cocaine added to each uncirculated bill. Vertical axis shows the area under peaks for ion 82 as seen in Figure 3.

89% of bills had between 1µg and 50 μg of cocaine

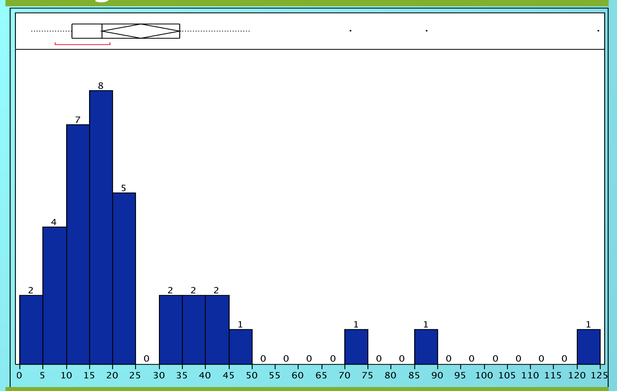


Figure 5. Histogram of cocaine found on dollar bills. Horizontal axis shows the mass (µg) of cocaine calculated from the calibration curve. Box plot at the top shows three outliers. Replicate measurements were averaged.

Error analysis:

$$\text{Uncertainty in } x\ (=s_x) = \frac{s_y}{|m|}\sqrt{\frac{1}{k}+\frac{1}{n}+\frac{(y-\bar{y})^2}{m^2\sum(x_i-\bar{x})^2}}$$

Equation 1 was used to calculate error from standard curve, additionally, standard deviation was calculated for each replicate measurement

Table 1. Sample of error found for a measurement. Errors are around 10% due to measurement variation.

Sample	Calculated mass of cocaine (μg)	Error due to Calibration Curve	Measurement standard deviation	Total Error
Taken from Old City Pizzeria	42	9.88×10^{-7}	4.86	4.86

Discussion

Results obtained show that only 1 out of the 36 bills falls below the detection limit of our experiment. At the same time, 3 bills seem to be outliers, as they have higher amounts of cocaine, with the highest one being 125 μg. Finally, about 89% of the analyzed bills have between 1 μg and 50 μg of cocaine.

The calibration curve in Figure 4 was created based on recovery studies, but there was also an attempt to make a standard curve from the different cocaine solutions. Such a curve would provide a direct relationship between mass of cocaine and peak area, and allow for the calculation of the detection limit. Unfortunately, problems with the automated injections, sample volume in the vials, and evaporation made such an attempt unfeasible. However, one study shows recoveries of >99% using a very similar method, so the presented calibration curve should provide amounts that are very close to the actual mass.[2]

The GC/MS analysis also allowed for the identification of different matrix components, including various food oils, oils used in the production of soaps and cosmetics, acetaminophen and Bisphenol A.

Conclusions

The results from this analysis show that 97% of one-dollar bills have detectable amounts of cocaine. Even though the data for different locations did not yield significant information, such an experiment can be developed if the proper sampling technique is utilized. Other future work could detect and quantify other illegal drugs such as heroin and harmful substances, such as bisphenol A, in order to determine whether certain bank notes could contain harmful levels of them.

Literature Cited

1. Armenta, S.; de la Guardia, M., Analytical methods to determine cocaine contamination of banknotes from around the world. *Trends in Analytical Chemistry* **2008**, *27* (4), 344-351.

2. Esteve-Turrillas, F. A.; Armenta, S.; Moros, J.; Garrigues, S.; Pastor, A.; de la Guardia, M., Validated, non-destructive and environmentally friendly determination of cocaine in euro bank notes. *Journal of Chromatography A* **2005**, *1065* (2), 321-325.

3. Park, M., 90 percent of U.S. Bills carry traces of cocaine. *CNN* 2009

Acknowledgements

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