Technical Note

A Study of Acids Used for the Acidified Cobalt Thiocyanate Test for Cocaine Base

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ABSTRACT: Four acids (hydrochloric, sulfuric, nitric, and acetic) were used as acidifying reagents in the "one well" cobalt thiocyanate test for cocaine base. Concentrated sulfuric, nitric, and acetic acids were found to be equally fast as concentrated hydrochloric acid (the standard acid used in the test). In addition, dilute (down to 0.1 N) hydrochloric acid was found to be as effective as concentrated hydrochloric acid. Only concentrated hydrochloric acid gave a transient blue color upon addition to the cobalt thiocyanate reagent. A number of other controlled substances, adulterants, and diluents were also tested and confirmed to not give false positives with sulfuric, nitric, acetic, or dilute hydrochloric acids.

KEYWORDS: Cocaine, Cobalt Thiocyanate, Acidified Cobalt Thiocyanate, Spot Tests, Color Tests

Introduction

The cobalt thiocyanate color test is widely used in forensic laboratories to determine the presence of cocaine salt, i.e., cocaine hydrochloride (1,2). However, the test requires a water soluble form of cocaine, and is ineffective for testing cocaine base. Therefore, a modified version of the test, the acidified cobalt thiocyanate test, is used to determine for the presence of cocaine base. The addition of an acid to the reagent allows the cocaine base to dissolve, and the color reaction can proceed. A sustained blue colored precipitate is a positive test.

There are two general procedures for running these tests. The first is to have two separate solutions prepared (one "normal" and the second acidified) and use them in two separate spot wells of a standard porcelain spot plate. The other is to run the normal (non-acidified) test first, observe for any color change, and if none then add a small amount of acid to the spot well, and again observe for any color change. This latter technique is referred to as the "one-well" method.

A literature search found that the only documented acid used for this "one well" test is concentrated hydrochloric acid (HCl). However, there is a complication when using this acid in that when it is first introduced to the cobalt thiocyanate solution, the color of the solution temporarily turns from pink to blue even if cocaine base is not present- and blue is also the characteristic color change observed for cocaine. Although this change is only temporary (as well as distinguishable to the trained eye), and there is no blue colored precipitate, it can be confusing to novices, and can potentially give ambiguous results with samples containing only trace amounts of cocaine. The latter problem can be an issue with commercial field test-kits.

In this study, a series of acids commonly utilized in most forensic/analytical laboratories were used to perform the "one well" test for cocaine base. A variety of other controlled and non-controlled substances were also studied using the same acids. In addition, the concentration of HCl used for the "one well" test was also studied to determine if the test would still be effective if a diluted version was used.

Experimental

Chemicals

Chemicals were purchased from the following vendors.

Benzocaine	Mallinckrodt	Lidocaine	K&K Loaboratories
Caffeine	Matheson Coleman and Bell	Mannitol	Mallinckrodt
Cobalt Thiocyanate	Sigma-Aldrich	Methamphetamine	(case sample)
Cocaine HCl and Base	Sigma-Aldrich	Nicotinamide	JT Baker Chemical Co.
Diphenhydramine HCl	Sigma-Aldrich	Nitric Acid	Fisher
Ephedrine	Sigma-Aldrich	Phencyclidine (PCP)	US Pharmacopeia
Glacial Acetic Acid	Fisher	Procaine	JT Baker Chemical Co.
Glucose	Mallinckrodt	Pseudoephedrine	Sigma-Aldrich
Heroin	(case sample)	Quinine HCl	Matheson Coleman and Bell
Hydrochloric Acid	Fisher	Sodium Bicarbonate	Fisher
Inositol	Eastman	Sulfuric Acid	Fisher
Lactose	Mallinckrodt	Tetracaine	K&K Loaboratories

Prepared Reagents

Cobalt thiocyanate reagent: 2 grams of cobalt thiocyanate were dissolved in 100 mL distilled water.

Acidified cobalt thiocyanate reagent: 2 mL of concentrated HCl were added to 98 mL of above cobalt thiocyanate reagent.

Procedure

Several controlled and non-controlled substances were studied, as well as numerous case samples of cocaine base. For each sample, the following procedure was followed:

1. Add a few drops of the cobalt thiocyanate reagent to five (A-E) wells on a spot plate.

2. Add the acidified cobalt thiocyanate reagent to one well (F).

3. Add a few micrograms of solid chemical to each spot well.

4. Observe color changes (if any).

5. Add one drop of each concentrated acid to each designated well (hydrochloric to (B), sulfuric to (C), nitric to (D), and acetic to (E)).

6. Observe any new color changes in wells (B) through (E).

The effect of the concentration of HCl added to the cobalt thiocyanate solution was separately studied. Two to three drops of the cobalt thiocyanate reagent were added to several wells of a spot plate. One drop of HCl (of varying concentrations) was added to each well.

Results and Discussion

It was found that all four acids (hydrochloric, sulfuric, nitric, and acetic) produced the same test results for cocaine base (see Table 1, next page). All four concentrated acids were equally fast. In addition, no false

positives were observed with any of the other controlled substances, adulterants, and diluents tested when sulfuric, nitric, or acetic acids were substituted for concentrated HCl. Notably, *only* concentrated HCl gave the transient blue-colored solution when added to the "normal" (non-acidified) cobalt thiocyanate reagent that did not contain cocaine.

1. Results of Cobalt Thiocyanate + Acid

	Cobalt Thiocyanate	Add HCl	Add H2SO4	Add HNO3	Add HOAc	Acidified Cobalt Thiocyanate (w/ HCl)
Standard Samples						
Cocaine HCl	Blue	Blue	Blue	Blue	Blue	Blue
Cocaine Free Base	NR	Blue	Blue	Blue	Blue	Blue
Lactose	NR	NR	NR	NR	NR	NR
Glucose	NR	NR	NR	NR	NR	NR
Mannitol	NR	NR	NR	NR	NR	NR
Inositol	NR	NR	NR	NR	NR	NR
Tetracaine	Blue	Some disappears	Most disappears	Most disappears/yellow	Blue	Blue
Benzocaine	NR	Slight Blue	Slight Blue	NR	NR	NR
Procaine	Blue	Disappears	Disappears	Disappears	Some disappears	Slight Blue
Lidocaine	NR	Blue	Blue	Blue	Blue	Blue
Caffeine	NR	NR	NR	NR	NR	NR
Diphenhydramine HCl	Deep Blue	Deep Blue	Deep Blue/Yellow	Disappears	Disappears	Deep Blue
Heroin	Blue/Green	Blue/Green	Blue/Green	Blue/Green	Blue/Green	Blue/Green
Methamphetamine	Dirty Blue	Fades	Fades	Fades	Fades	Dirty Blue
Nicotinamide	NR	NR	NR	NR	NR	NR
Sodium Bicarbonate	NR	Fizz	Fizz	Fizz	Fizz	NR
Phencyclidine (PCP)	Blue	Blue	Blue	Blue	Blue	Blue
Ephedrine HCl	Slight Blue (disappears)	Slight Blue	NR	NR	NR	NR
Pseudoephedrine	Slight Blue (disappears)	NR	NR	NR	NR	NR
Quinine Sulfate	NR	Blue	Blue	Blue (Disappears)	Blue	Blue at edges (insol.)
Case Samples						
Cocaine Base Samples						
Test Sample 1	NR	Blue	Blue	Blue	Blue	Blue
Test Sample 2	NR	Blue	Blue	Blue	Blue	Blue
Test Sample 3	NR	Blue	Blue	Blue	Blue	Blue
Test Sample 4	NR	Blue	Blue	Blue	Blue	Blue
Test Sample 5	NR	Blue	Blue	Blue	Blue	Blue
Test Sample 6	NR	Blue	Blue	Blue	Blue	Blue
Test Sample 7	NR	Blue	Blue	Blue	Blue	Blue
Test Sample 8	NR	Blue	Blue	Blue	Blue	Blue
Test Sample 9	NR	Blue	Blue	Blue	Blue	Blue
Test Sample 10	NR	Blue	Blue	Blue	Blue	Blue
Test Sample 11	NR	Blue	Blue	Blue	Blue	Blue
Test Sample 12	NR	Blue	Blue	Blue	Blue	Blue
Test Sample 13	NR	Blue	Blue	Blue	Blue	Blue
Test Sample 14	NR	Blue	Blue	Blue	Blue	Blue
Test Sample 15	NR	Blue	Blue	Blue	Blue	Blue
Test Sample 16	NR	Blue	Blue	Blue	Blue	Blue
Cocaine Salt Samples						
Test Sample 17	Blue	Blue	Blue	Blue	Blue	Blue
Test Sample 18	Blue	Blue	Blue	Blue	Blue	Blue
Test Sample 19	Blue	Blue	Blue	Blue	Blue	Blue

(NR = No Reaction)

Dilute HCl (from 1:1 down to 0.1 N) produced the same results as concentrated HCl, but also did not give the transient blue-colored solution when added to the "normal" (non-acidified) cobalt thiocyanate reagent that did not contain cocaine (see Table 2). When cocaine base was present, it was noted that the weaker the HCl solution, the slower the color reaction, but it never took more than a few seconds for the blue precipitate to form, and the overlaying solution did not turn blue even when cocaine was present. Thus, dilute HCl is as effective as concentrated HCl for the test. The collective results suggest that substituting an alternative acid or a diluted form of HCl for concentrated HCl for the acidified cobalt thiocyanate test would be advantageous.

Table 2. Effects of Hydrochloric Acid Dilution

Concentration of HCl (v/v)		Turns solution blue?	Proper reaction with Coc Base?
Concentrated	(12 N)	Yes	Yes
50%	(6 N)	No	Yes
40%	(4.8 N)	No	Yes
30%	(3.6 N)	No	Yes
20%	(2.4 N)	No	Yes
10%	(1.2 N)	No	Yes
0.80%	(0.1 N)	No	Yes

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