POTASSIUM FERROCYANIDE AS A REAGENT IN THE MICROSCOPIC QUALITATIVE CHEMICAL ANALYSIS OF THE COMMON ALKALOIDS

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TWO PLATES

The division of organic chemistry of the Bureau of Science is often called upon to determine the presence or absence of habit-forming drugs in minute amounts of material, such as a drop of liquid clinging to a syringe or a grain or two of powder in an otherwise empty container. Obviously, color tests are not feasible in such cases and recourse is had to microchemical reactions by which many tests can be made upon an exceedingly small amount of sample.

Descriptions of these tests are scattered throughout the literature. Wormeley's [1] classic on the microchemistry of poisons contains many tests and beautiful etchings. The various types of crystals formed by the reaction of such standard reagents as platinum or gold chloride are well known, but not so much attention has been paid to some of the less-common reagents. Among these potassium ferrocyanide should hold a prominent place. Behrens,[2] Grutterink,[3] Stephenson,[4] and others mention the use of potassium ferrocyanide as a reagent, but none of them gives a complete list of the alkaloids yielding characteristic crystalline precipitates with this reagent. I have tested forty of the common alkaloids [5] with potassium ferrocyanide. By

[1] Wormeley, T. G., Micro-chemistry of Poisons ed. 2 (1885).
[2] Behrens, H., Anl. zur mikrochemishe Analyse 3 (1896).
[3] Grutterink, A., Zeitschr. Anal. Chem. 51 (1912) 175.
[4] Stephenson, C. H., Some Microchemical Tests for Alkaloids (1921).
[5] The alkaloids tested were: Aconitine, apomorphine, arecoline, atropine, berberine, β-eucaine, brucine, caffeine, cinchonidine, cinchonine, cocaine, codeine, coniine, curare, emetine, ergotinine, heroine, homatropine, hydrastine, hyoscyamine, morphine, narceine, narcotine, nicotine, novocaine, papaverine, physostigmine, pilocarpine, piperazine, piperidine, piperine, quinine, quinoline, scopalamine, sparteine, stovaine, strychnine, theobromine, theophylline, veratrine.

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the methods mentioned below, thirteen of these (β-eucaine, brucine, cinchonidine, cinchonine, cocaine, coniine, heroine, hydrastine, quinoline, sparteine, strychnine, stovaine, and veratrine) give characteristic crystalline precipitates. Bolland [6] states that apoatropine and hydrocotarnine give crystalline plates with potassium ferrocyanide. Grutterink [7] includes tropococaine and cotarnine. Unfortunately these four alkaloids were unobtainable by me. The crystalline compounds obtained are of the addition type, and probably have the general formula [8] $B_2.H_4Fe(CN)_6.X\ H_2O$.

The sensitivity and the best method of applying the tests have also been determined.

TECHNIC

The alkaloid or alkaloidal salt to be tested is dissolved in distilled water acidified with dilute hydrochloric acid. A drop of this solution is placed upon a miscroscope slide. The drop should not be more than 2 to 3 millimeters in diameter. Close to this drop is placed a smaller drop of a 5 per cent aqueous solution of potassium ferrocyanide. By means of a platinum wire or drawn-out glass rod, a tiny channel is made to flow from the reagent into the test drop. Usually an amorphous precipitate results which gradually becomes crystalline. If no precipitate appears, or if the precipitate remains amorphous after a minute or two, the preparation is vigorously scratched with a platinum or glass rod. In fact, I have found that, generally speaking, much more characteristic and perfect crystals result upon scratching and upon the use of comparatively dilute alkaloidal solutions. The drop is examined under a low power. The color, shape, crystal angles, polarization, extinction angles, and habit aid in the identification of the crystals under examination.

The sensitivity was obtained by testing solutions of the alkaloid in decreasing concentration until one was reached that failed to give crystals with the reagent within five minutes. The most-dilute solution, one drop of which yields crystals within five minutes, gives the sensitivity. The dilution of the drop by the reagent solution must of course be taken into consideration.

[6] Bolland, A., Monatsh. 32 (1910) 120, 129.
[7] Grutterink, A., Zeitschr. Anal. Chem. 51 (1912) 175.
[8] Cuming, W. M., Journ. Chem. Soc. 121 (1922) 1287.

β-EUCAINE

Sensitivity, 1 : 200.

β-eucaine forms with potassium ferrocyanide in hydrochloric acid solution colorless, thin, elongated, hexagonal or rhombic plates. They tend to grow to a very large size but they remain very thin. Under crossed nicols they are weakly polarized, exhibiting parallel and symmetrical extinction. Scratching of the preparation to induce crystallization is necessary. Plate 1, fig. 1.

BRUCINE

Sensitivity, 1 : 2,500.

Brucine forms with potassium ferrocyanide in hydrochloric acid solution highly refractive, stocky prisms with chisel-shaped ends. Usually the prisms occur in rosettes. Under crossed nicols the crystals are strongly polarized, exhibiting parallel extinction. There is a tendency toward supersaturation, and scratching of the preparation is necessary. Plate 1, fig. 2.

CINCHONIDINE

Sensitivity, 1 : 300.

Cinchonidine in hydrochloric acid solution yields with potassium ferrocyanide rosettes of yellow, curving, hairlike needles (Plate 1, fig. 3) when the concentration of the alkaloid is over 0.5 per cent. At 1 : 300 long thin rectangular yellow plates, exhibiting parallel extinction under crossed nicols, form near the edge of the drop. Scratching or seeding aid in the crystal formation.

CINCHONINE

Sensitivity, 1 : 1,000.

Cinchonine forms with potassium ferrocyanide in hydrochloric acid solution yellow, irregular, trapesium-shaped crystals, often grouping in the form of rosettes. They polarize strongly. Cinchonine is readily distinguished from cinchonidine and quinine by this test. Quinine does not yield a crystalline precipitate, and cinchonidine yields either hairlike crystals or thin rectangular plates. Plate 1, fig. 4.

COCAINE

Sensitivity, 1 : 500.

Cocaine forms with potassium ferrocyanide in hydrochloric acid solution colorless, six-sided plates and prisms of irregular shape. They polarize strongly under crossed nicols. On edge

they exhibit parallel extinction. Scratching of the preparation is usually necessary to induce crystallization.

The crystals tend to grow much thicker, polarize more strongly, and are more irregular in shape than those from β-eucaine. They form much more readily than those from heroine and do not form the spheroidal type of crystal characteristic of the latter. Stovaine is also readily distinguished from cocaine by this test. Plate 1, fig. 5.

CONIINE

Sensitivity, 1 : 50.

Coniine yields with potassium ferrocyanide in hydrochloric acid solution rosettes of colorless needles and long, thin, square-ended prisms. Scratching aids in the formation of the crystals. Under crossed nicols the crystals polarize weakly, exhibiting oblique extinction. The extinction angle is rather large, about 30°. Plate 1, fig. 6.

HEROINE

Sensitivity, 1 : 50.

Heroine forms spheroidal crystals with potassium ferrocyanide in hydrochloric acid solution only when the concentration of the alkaloid is very high. These crystals often do not appear for five minutes. With vigorous scratching there are sometimes obtained hexagonal plates belonging to the hexagonal system. Plate 2, fig. 1.

HYDRASTINE

Sensitivity, 1 : 700.

Hydrastine forms with potassium ferrocyanide in hydrochloric acid solution white, spheroidal crystals. Isolated crystals are not present. The spheroids are polarized under crossed nicols. Plate 2, fig. 8.

QUINOLINE

Sensitivity, 1 : 800.

Quinoline yields with potassium ferrocyanide in hydrochloric acid solution lemon yellow rhombohedrons exhibiting parallel and oblique extinction. Scratching is unnecessary. The crystals are very characteristic. Plate 2, fig. 9.

SPARTEINE

Sensitivity, 1 : 2,000.

Sparteine yields with potassium ferrocyanide in hydrochloric acid solution characteristic, colorless rhombs exhibiting symmetrical extinction under crossed nicols. Scratching aids in the crystal formation. Plate 2, fig. 10.

Sensitivity, 1 : 300.

STOVAINE

Stovaine yields with potassium ferrocyanide in hydrochloric acid solution rosettes of needles usually radiating from a solid mass at the center. The individual crystals exhibit parallel extinction under crossed nicols. The crystals tend to form first at the edge of the drop. Plate 2, fig. 11.

Sensitivity, 1 : 20,000.

STRYCHNINE

Potassium ferrocyanide affords a very sensitive test for strychnine. In hydrochloric acid solution this reagent yields with strychnine long, slender needles, or spear-shaped crystals with serrated edges (Plate 2, fig. 12). Hemimorphic triangular plates are sometimes formed. Under crossed nicols the long crystals exhibit oblique extinction. When the concentration of the strychnine is high but very little reagent is added, the true form of the compound sometimes comes out on scratching. These are small rhombic plates exhibiting symmetrical extinction under crossed nicols.

Sensitivity, 1 : 100.

VERATRINE

The white amorphous precipitate obtained when potassium ferrocyanide is added to a hydrochloric acid solution of veratrine yields crystals only with great difficulty. The crystals formed are imperfect and might not be recognized if polarized light were not used. Under crossed nicols they polarize strongly. The test, however, is not a satisfactory one.

SUMMARY

1. Thirteen of forty of the common alkaloids yield crystalline precipitates with potassium ferrocyanide in hydrochloric acid solution. These precipitates are sufficiently characteristic to be used as corroborative identification tests.

2. The tests can be applied to very minute amounts of material.

3. Potassium ferrocyanide is a satisfactory microchemical reagent for the distinction of cinchonidine, cinchonine, and quinine.

4. Brucine and strychnine are readily distinguished by this reagent.

5. Cocaine can be distinguished from β-eucaine, stovaine, and heroine by the potassium ferrocyanide test.

6. The sensitivity of the potassium ferrocyanide test for the various alkaloids has been determined.

ILLUSTRATIONS

Crystals of alkaloids obtained with potassium ferrocyanide and hydrochloric acid. The figures 1 : 50, etc., signify the dilutions at which the respective crystals were produced. Magnification of microphotographs, × 50.

PLATE 1

FIG. 1. β-eucaine, 1 : 50.
2. Brucine, 1 : 400.
3. Cinchonidine, 1 : 200.
4. Cinchonine, 1 : 300.
5. Cocaine, 1 : 300.
6. Coniine, 1 : 25.

PLATE 2

FIG. 7. Heroine, 1 : 25.
8. Hydrastine, 1 : 400.
9. Quinoline, 1 : 400.
10. Sparteine, 1 : 500.
11. Stovaine, 1 : 200.
12. Strychnine, 1 : 5,000.

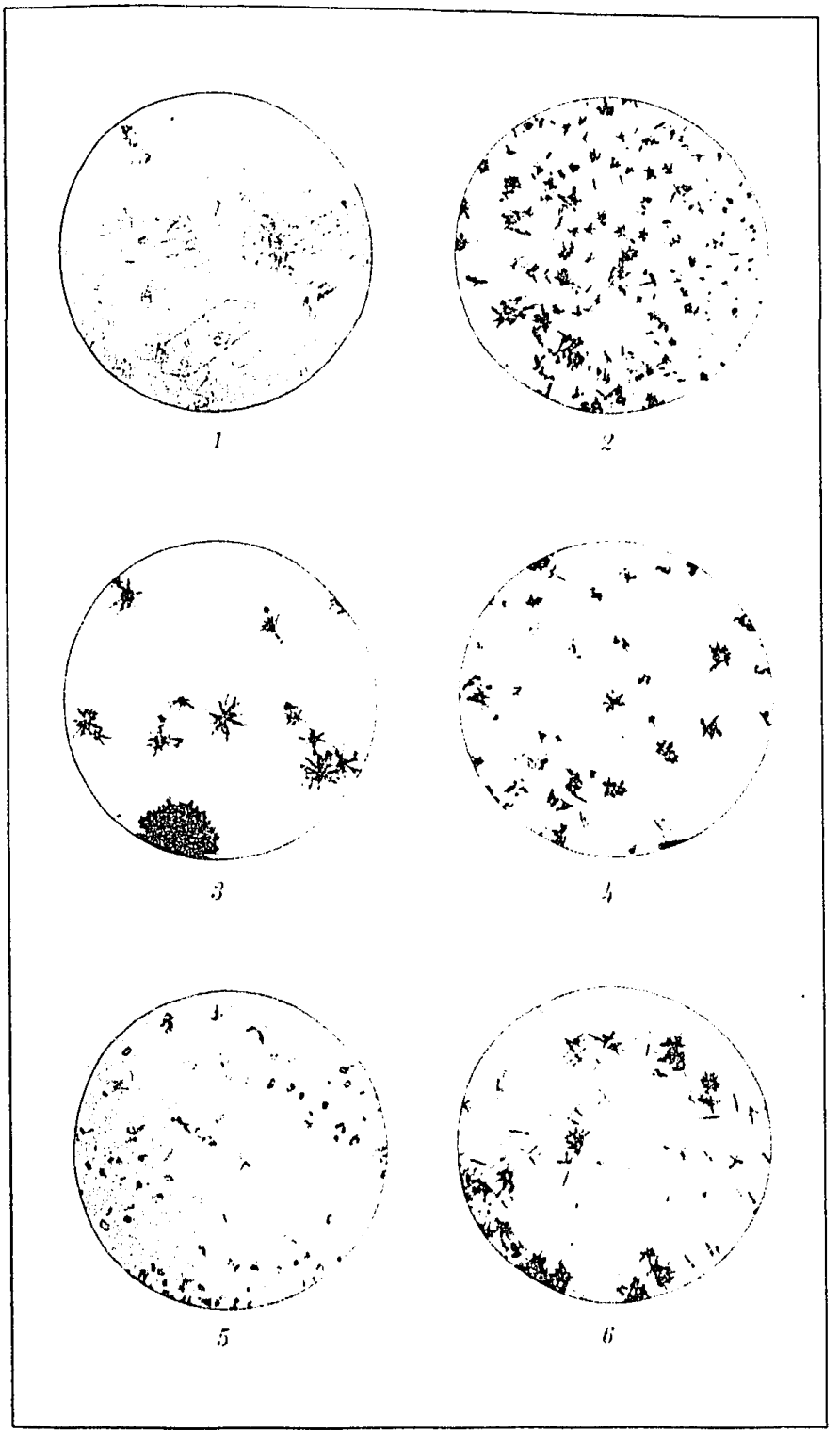

PLATE 1.

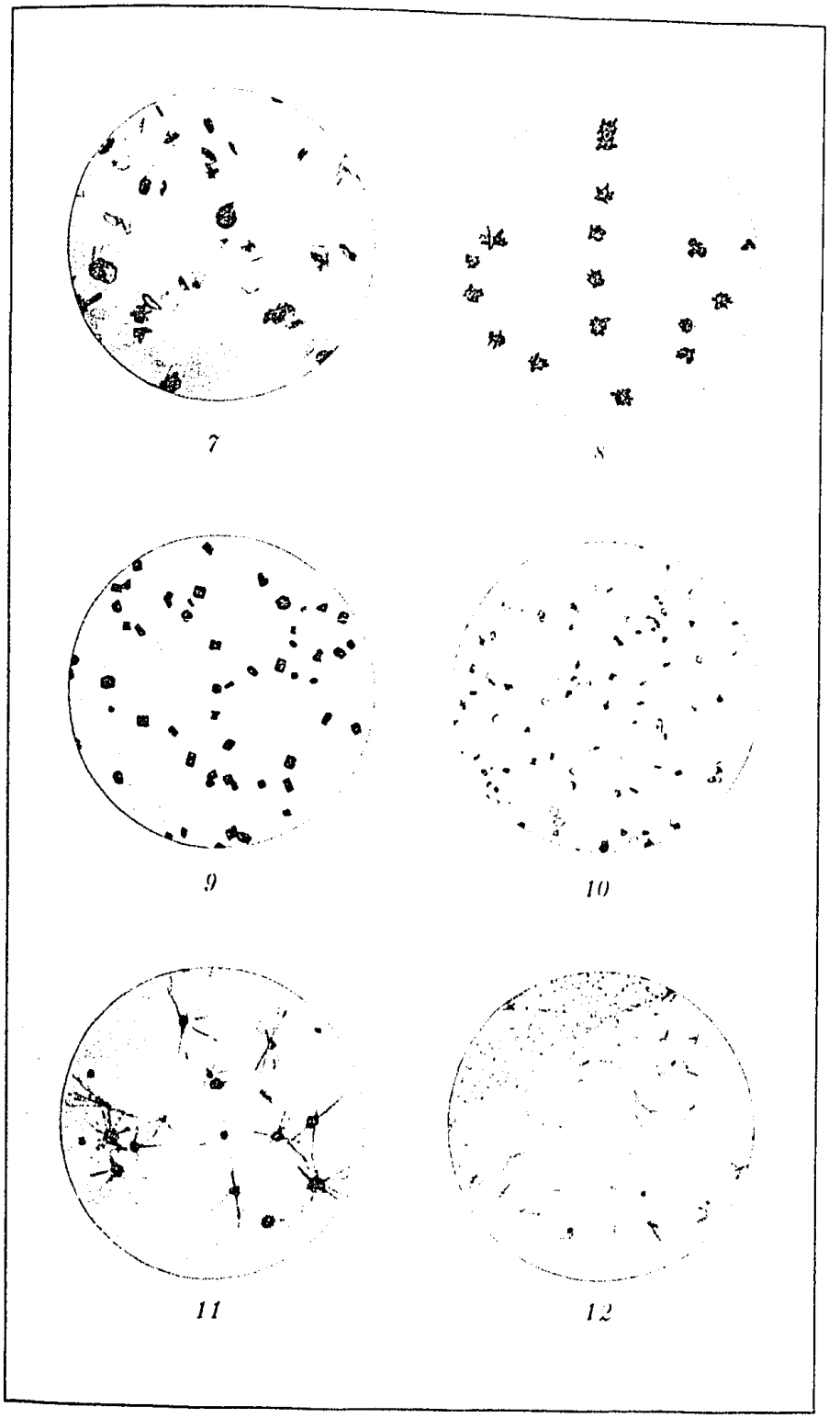

PLATE 2.