J Forensic Sci, Jul. 1979, Vol. 24, No. 3

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Spot Tests: A Color Chart Reference for Forensic Chemists

Spot tests, the most common of preliminary screening tests, have been of long-standing use in forensic analysis. With the advent of technological instrumentation, the importance of this utilitarian, albeit basic, test procedure has diminished. In the early development of currently accepted laboratory technique, the spot test (also referred to as the color test) was often employed as a conclusive method for substance identification. Advanced technology has demonstrated that color tests alone indicate nothing but the possible presence or absence of a particular molecular grouping. Consequently, the color test must be considered inconclusive for purposes of positive identification. Thus the main purpose of the spot test is to narrow the list of substances possibly present in any given unknown.

This paper proposes to consolidate the diverse information that has been compiled concerning the color test and to present it in tabular form to foster more effective use of the spot test [*1*]. Table 1 illustrates a series of nine spot tests applied to each of more than 200 compounds. Although not exhaustive, this table may serve to organize pertinent data and facilitate both manual and computer searches. Each compound has been assigned a numerical code keyed to the specific spot test. Properly applied, the spot test can provide a rapid and highly accurate tool for drug screening.

Experimental Procedure

The following procedure represents one of the most simple and most direct methods commonly used to perform spot tests. It is both effective and time-efficient. The tests reported herein were conducted by transferring with a capillary tube a small amount of a primary standard drug, dry, to each of nine wells on a porcelain spot plate. A drop of one of the seven solutions, whose formulations are given in the following section, was then deposited in each of the first seven wells (for example, Marquis reagent was placed in the first well, Mecke reagent in the second, and so forth). Concentrated sulfuric acid and concentrated nitric acid were used as the reagents for Wells 8 and 9, respectively. The colors observed during a 5-min period were then recorded in Table 1.

Definitions and Reagent Formulations

The drug standards used for the tests reported in Table 1 were obtained from the sources listed in the Appendix. The number in parentheses after each compound in Table 1 corresponds to the numbered drug source in the Appendix.

Received for publication 4 Aug. 1978; revised manuscript received 28 Dec. 1978; accepted for publication 29 Dec. 1978.

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TABLE 1—*Drug spot tests.*

Compound (Source)	Marquis	Mecke	Mandelin	Cobalt Thiocyanate	Dille-Koppanyi (DK_1 /DK_2)	Hydrochloric Acid Plus Ehrlich's	Froehde's	Sulfuric Acid	Nitric Acid
Acetaminophen (34)	...	...	olive green	...	...	...	blue	...	yellow/orange
Acetophenazine maleate (40)	yellow/brown → red	red/brown	green	green	...	...	brown	yellow/brown	brown → faint yellow/green
Adiphenine hydrochloride (9)	yellow/orange → orange	yellow	dark olive	blue	...	...	faint yellow	...	...
Akineton hydrochloride (23)	red → brown	dark red/brown	red/brown	...	...	...	red/brown	orange/brown	...
Allobarbital (3)	...	...	...	...	violet	...	...	...	...
Allylisobutylbarbituric acid (butalbital) (4)	...	...	...	...	violet	...	...	...	...
Alphaprodine hydrochloride (41)	red	yellow → olive green	(effervescence) yellow/olive → lime	blue (oil)	...	...	(effervescence) → red/black	...	...
Alphenal (allylphenyl-barbituric acid) (3)	...	...	...	...	violet	...	...	...	...
Aminoglutethimide (9)	...	...	...	...	violet	...	...	...	...
Aminophylline (10)	...	developing blue threads	developing bright yellow	green/brown	DK_1: green/brown; DK_2: violet	...	...	...	...
Amisometradine (44)	...	...	...	...	...	...	...	...	...
Amitriptyline hydrochloride (31)	red → brown	red → brown	olive green → brown	blue	...	...	...	orange-red → brown	...
Amodiaquin hydrochloride (35)	...	olive	olive → brown	green → (precipitate)	DK_1: green	...	olive/green	...	yellow → orange
d.l-Amphetamine sulfate (22)	orange → brown	...	green	...	...	...	...	...	...
Anisotropine methylbromide (15)	...	slight yellow	...	blue (precipitate)	...	...	slight yellow	...	...
Antipyrine (4)	...	developing faint yellow	green → blue/green	blue	...	...	...	developing pale yellow	...
Aprobarbital (33)	...	...	...	...	violet	...	...	...	...
Aspirin	developing red	...	green	...	violet (fades immediately)	...	...	...	...
Atropine sulfate (22)	developing orange/brown	...	...	blue	...	...	...	...	...
Azapetine (41)	developing violet → blue	...	olive brown → brown	developing light blue	faint blue	...	...	...	...
Barbital (16)	...	...	...	...	violet	...	...	...	...

Benactyzine hydrochloride (1)	green → dark blue	orange → brown	yellow/orange → green/brown	blue (precipitate)	...	...	orange → dark brown/red	yellow → orange → pink	...
Benoxinate hydrochloride (11)	(effervescence)	(effervescence)	(effervescence)	blue (oil)	...	...	...	...	yellow → brown
Benzilonium bromide (35)	yellow → green → dark blue	orange/brown → olive	orange → olive green and brown	blue	...	...	orange → brown	yellow/orange	yellow
Benzocaine® (ethyl aminobenzoate) (33)	...	...	brown	...	...	yellow	...	...	...
Benzphetamine hydrochloride (50)	orange → brown	(effervescence) developing yellow	(effervescence) developing green	blue	...	...	...	(effervescence)	...
Benzquinamide (38)	...	yellow → green	olive green	developing blue	...	...	yellow/green	...	yellow → brown
Benztropine mesylate (31)	yellow/orange	yellow/orange	yellow/orange	blue	...	...	yellow/orange	yellow/orange	...
Betamethasone (43)	orange → red/brown → chocolate	developing black	olive → dark brown	...	...	...	red/brown	developing brown	...
Bethanechol chloride (31)	...	(effervescence)	(effervescence) orange/brown	...	...	yellow/green	(effervescence) black	(effervescence)	developing black spots
Bromodiphenhydramine hydrochloride (35)	yellow → orange	yellow → orange	orange	blue (precipitate)	...	...	yellow → orange	yellow → orange	...
Bromural® (bromisovalum) (23)	...	...	...	...	...	..	...	...	...
Bufotenine (2)	light brown	brown → black/purple	green → brown/green	...	...	red → brown → brown/blue	yellow/brown	yellow/brown	dark brown/black
Butabarbital (33)	...	...	...	...	violet	...	...	...	...
Butacaine sulfate (1)	...	...	olive → brown	blue (oil)	...	yellow	...	...	...
Butalbital (42)	...	...	...	...	violet	...	...	...	...
Butethal (3)	...	...	...	...	violet	...	...	...	...
Caffeine (4)	...	...	...	...	...	...	...	...	...
Carbinoxamine maleate (28)	...	...	...	blue (precipitate and oil)	...	...	...	...	...
Carbromal (35)	...	...	...	...	...	...	...	...	...
Carisoprodol (53)	...	...	...	...	...	...	...	...	...
Carphenazine maleate (56)	brown	red	brown → green	(developing) green	...	...	red/brown	yellow/brown	...
Chloral betaine (29)	...	...	...	...	...	...	...	...	...
Chloral hydrate (30)	(effervescence)	(effervescence)	(effervescence)	(effervescence)	violet	...	...	(effervescence)	...
Chlordiazepoxide hydrochloride (20)	(effervescence) light yellow	(effervescence) light yellow	(effervescence) yellow → red/brown	...	...	...	(effervescence) light yellow	(effervescence) light yellow	...
Chloromycetin® (chloramphenicol) (35)	...	...	faint orange	...	...	...	...	...	...

TABLE 1—*Continued.*

Compound (Source)	Marquis	Mecke	Mandelin	Cobalt Thiocyanate	Dille-Koppanyi (DK_1/DK_2)	Hydrochloric Acid Plus Ehrlich's	Froehde's	Sulfuric Acid	Nitric Acid
Chloroprocaine hydrochloride (37)	...	...	orange/brown	blue	...	light yellow	...	...	...
Chlorothiazide (31)	...	...	...	...	violet	...	...	...	...
Chlorpheniramine maleate (46)	...	...	...	blue	...	...	...	...	...
Chlorphentermine hydrochloride (54)	...	...	faint green	...	...	...	...	...	...
Chlorpromazine hydrochloride (46)	pink	red → green	red/orange → brown	blue	...	...	red	pink	red → yellow
Chlorpropamide (38)	...	...	...	...	...	...	...	...	...
Chlorprothixene (41)	red → orange	red → orange	red → orange	...	...	red → orange	orange	orange	red
Chlorzoxazone (28)	...	...	olive	...	violet	...	...	...	...
Cinchocaine® hydrochloride (dibucaine hydrochloride) (9)	...	...	...	blue (precipitate)	...	...	...	...	...
Clidinium bromide (45)	orange → deep green → blue	orange → brown → green	orange → deep green → blue	...	...	...	orange → brown	orange → light pink	faint yellow
Clorazepate dipotassium (1)	yellow	yellow	...	blue (precipitate)	...	yellow	yellow	yellow	yellow
Clortermine (52)	orange	...	...	...	...	...	...	...	...
Cocaine (30)	...	...	...	blue	...	...	...	...	...
Cocaine hydrochloride (30)	...	...	...	blue (precipitate)	...	...	...	...	...
Codeine phosphate (36)	brown → purple	bright green → blue green	olive	blue	...	...	green → blue	...	orange
Codeine sulfate (36)	purple	bright green → blue green	olive	blue	...	...	green → blue	...	yellow/orange
Cyclomethycaine sulfate (26)	slight orange	slight orange/ brown	olive green	...	...	...	...	...	...
Cyclopentamine hydrochloride (26)	...	...	...	...	...	...	...	...	...
Cycrimine hydrochloride (26)	orange → red	yellow → brown	red/brown	...	...	...	orange/brown	...	...
Cyproheptadine hydrochloride (31)	purple → dark brown	purple → dark brown	purple → dark brown	...	...	...	purple → dark brown	dark purple → dark brown	light yellow
Debrisoquine sulfate (41)	orange → brown	...	...	blue	...	...	...	...	...

Deserpidine (1)	purple	dark green	dark green	...	...	...	purple/blue	yellow/green	green → orange/ yellow
Desipramine (24)	...	light blue	...	blue (precipitate and oil)	slight violet	...	...	...	dark blue
Dexamethasone (31)	...	...	...	...	...	...	...	...	...
Dexbrompheniramine maleate (43)	...	...	...	blue (oil)	...	...	...	...	...
Diazepam (4)	...	...	...	...	...	...	...	...	...
Didrate® (dihydrocodeine) (4)	purple	green/blue	slight green	blue (precipitate)	...	...	yellow	...	yellow
Diethylpropion hydrochloride (amfepramone) (32)	...	...	...	blue (oil)	...	...	...	...	...
N,N-Diethyltryptamine oxalate (DET) (22)	yellow → yellow green	yellow → green/ black → brown/green	brown	blue	...	rose	very pale yellow	very pale yellow	light yellow
Dimethoxyamphetamine (DMA) (12)	yellow/green	yellow → green → red/brown	yellow → green → brown	...	...	...	...	...	...
N,N-Dimethyltryptamine (DMT) (40)	yellow → green → brown	green/yellow → green → brown	green → brown	green/blue	...	rose → brown/ violet	very pale yellow	very pale yellow	deep brown/ yellow
Diphenhydramine hydrochloride (4)	yellow/orange → brown	yellow	brown	blue (oil)	...	...	yellow/orange	yellow/orange	...
Diphenidol hydrochloride (46)	orange/brown	red/brown	olive	...	...	...	yellow → green	yellow	...
Diphenylhydantoin (phenytoin) (4)	...	...	...	...	slight violet	...	...	...	pale yellow
Droperidol (28)	pink	...	olive → brown	...	...	...	...	...	...
Ephedrine sulfate (33)	...	...	...	faint blue	...	...	...	...	...
Ergotamine tartrate (2)	tan → brown → black	green/black	dark green	...	...	purple	orange	yellow	red/brown
Ethinamate (21)	red	red → brown	red → brown	...	...	...	red	red	...
Ethionamide (4)	...	...	light blue/green	...	...	...	...	...	orange
Ethylmorphine hydrochloride (4)	purple	blue/green	green	...	...	...	slight green/ yellow	...	...
Ethylnoradrenaline hydrochloride (ethylnorepinephrine) (48)	orange → brown	red/brown	olive	...	black	...	olive/black	yellow	yellow/orange
Fenfluramine hydrochloride (39)	...	slow orange	...	blue	...	...	...	...	...
Fentanyl citrate (28)	orange → brown	...	green	...	...	...	...	...	...

TABLE 1—*Continued.*

Compound (Source)	Marquis	Mecke	Mandelin	Cobalt Thiocyanate	Dille-Koppanyi (DK_1/DK_2)	Hydrochloric Acid Plus Ehrlich's	Froehde's	Sulfuric Acid	Nitric Acid
Flurazepam dihydrochloride (41)	developing pink	...	slight brown	blue (precipitate)	...	...	...	...	...
Furazolidone (14)	...	...	...	...	...	...	...	...	...
Glutethimide (4)	orange	orange	orange	blue	violet	...	orange	orange	yellow
Haloperidol (28)	orange	red/brown	green	...	...	...	...	...	...
Harmaline (22)	red/brown	olive/brown	olive/brown	...	...	bright yellow with chloric acid	orange/brown → olive	orange/brown	orange/brown
Heroin hydrochloride (12)	red → purple	green/blue	olive	...	...	...	purple	yellow/brown	...
Hexobarbital (3)	...	...	...	...	violet	...	...	...	...
Hexocyclium methylsulfate (1)	dark red	yellow → green	green → blue	blue	...	...	orange	...	...
Hexylcaine hydrochloride (33)	...	...	...	blue	...	...	...	...	...
Homatropine hydrobromide (27)	...	yellow	slight brown	slight blue (precipitate)	...	...	...	...	...
Hydrochlorothiazide (46)	...	...	green	...	blue violet	...	...	...	...
Hydrocodone bitartrate (4)	red → purple	dark blue	...	...	...	...	...	...	...
Hydrollazine hydrochloride (9)	...	...	orange	black (precipitate)	black with DK_1	...	...	...	...
Hydroxyamphetamine hydrobromide (46)	(effervescence) brown	(effervescence) orange/brown	(effervescence) olive	...	...	...	blue → green	(effervescence)	yellow
Hydroxyzine hydrochloride (38)	...	...	brown/orange	blue (oil)	...	...	...	...	...
Hydroxyzine dihydrochloride (38)	...	...	orange	blue (oil)	...	...	...	...	...
Hyoscyamine sulfate (46)	...	...	slight brown	blue	...	...	...	...	...
Ibogaine (12)	deep purple → dark olive → yellow	yellow → green → purple	brown → black	pale blue	...	light green	yellow	pale yellow	deep yellow
Indole (13)	orange/brown	green	red/brown	...	...	orange	green	light yellow → brown	red/brown
Iprindole (56)	...	...	brown/yellow	blue	...	...	...	brown	yellow
Isocarboxazid (41)	...	...	green	...	brown	...	...	...	...
Isoniazid (47)	...	brown	green	rose (precipitate)	brown	yellow	...	...	...
Isopropamide iodide (46)	purple	brown	green	...	...	...	purple	purple/black	red/brown
Levorphanol tartrate (41)	gray/black	slight gray/black	olive	blue (precipitate)	...	...	blue	...	yellow

Lysergic acid (4)	dark purple/ black	dark blue/black	olive	...	...	purple	olive	olive	brown/orange
Lysergic acid diethylamide (LSD) (42)	...	...	...	...	...	purple	...	...	...
Mazindol (42)	orange	orange	orange	...	...	...	orange	orange	...
Mebutamate (53)	...	...	...	...	...	...	...	...	...
Meclizine hydrochloride (38)	slight yellow	slight yellow	green	...	...	...	slight yellow	slight yellow	...
Mefenamic acid (36)	yellow	dark blue	olive	...	...	...	...	...	dark green
Mepenzolate bromide (24)	orange → brown → green → blue	orange → brown → green	orange → brown → green	...	...	...	orange/brown	orange	light yellow
Meperidine hydrochloride (4)	yellow → orange → brown	...	...	blue	...	...	...	...	...
Mephentermine sulfate (56)	orange → red/brown	...	green	...	...	...	...	...	...
Meprobamate (4)	...	...	...	...	...	yellow	...	...	...
Mescaline hydrochloride (2)	orange	yellow	green → brown	...	...	...	slight yellow	brown	red
Methadone (7)	red	green/brown	blue	...	...	...	...	...	...
Methamphetamine hydrochloride (2)	orange → brown	...	light green	blue	...	...	...	...	...
Methaqualone hydrochloride (4)	...	...	slight orange (precipitate)	...	...	...	...	...	...
Metharbital (33)	...	...	...	violet	...	...	...	...	...
Methenamine mandelate (54)	yellow/orange	...	brown	...	...	...	...	...	...
Methimazole (26)	...	yellow	light blue/green	...	DK_1: green; DK_2: blue	...	...	...	...
Methixene hydrochloride (11)	brown	orange/brown	orange	...	...	...	orange/brown	orange	orange
Methohexital sodium (33)	yellow/brown	yellow/brown	green	...	violet	...	...	...	...
Methscopolamine bromide (49)	...	...	...	blue	...	...	yellow	light yellow	light yellow
Methyclothiazide (1)	yellow	brown	yellow	...	violet	...	yellow	yellow	...
Methylenedimethoxy-methamphetamine (MDMA) (12)	blue → purple → black	green → dark blue	blue → dark purple → black	...	...	...	yellow/green → dark blue	red/purple	light yellow
3,4-Methylenedioxy-amphetamine (MDA) (12)	purple	green → blue	red → purple	...	...	...	green → olive → blue	purple	light yellow
Methylergonovine maleate (42)	black	blue green → black	olive → black	...	...	violet	yellow/green	yellow/brown	brown
Methylphenidate (9)	...	...	...	blue (oil)	...	...	...	...	...

TABLE 1—*Continued.*

Compound (Source)	Marquis	Mecke	Mandelin	Cobalt Thiocyanate	Dille-Koppanyi (DK_1/DK_2)	Hydrochloric Acid Plus Ehrlich's	Froehde's	Sulfuric Acid	Nitric Acid
α-Methyltryptamine (2)	green	blue	light brown	light brown	...	red/violet	slight yellow	slight yellow	dark brown
Methyprylon (20)	...	...	blue/green	...	...	...	...	...	...
Methysergide maleate (42)	dark blue	green	red/brown	...	...	purple	...	...	yellow
Morphine base (36)	purple	blue/green	olive	...	...	...	purple	...	orange/brown
Morphine hydrochloride (30)	red — purple	green	olive	...	...	...	purple	...	orange/brown
Nalorphine (4)	purple	green	olive	blue (precipitate)	slight violet	...	purple	...	red/orange
Nalorphine hydrochloride (30)	purple	green	olive	blue	slight violet	...	purple	...	red/orange
Naloxone (53)	red	gray/blue	slight brown	...	slight violet	...	purple	...	yellow
Naphazoline hydrochloride (9)	dark green → blue	brown	olive	blue	blue	...	brown	...	...
Nitrazepam (41)	...	...	...	...	yellow	...	...	...	...
Nortriptyline hydrochloride (26)	red/brown	red/brown	red/brown	blue	...	...	red/brown	red/orange	...
Octin® mucate (isometheptene) (23)	light yellow	light yellow	light green	...	...	...	...	...	...
Opium (30)	brown → purple	green	...	...	...	...	...	...	...
Oxazepam (56)	yellow	yellow	olive	...	...	yellow	yellow	yellow	yellow
Oxycodone hydrochloride (15)	yellow → purple	yellow → olive green	yellow — green	...	...	...	yellow/brown	...	yellow
Oxymetazoline hydrochloride (43)	brown	brown	olive	blue	...	...	green → dark blue	dark blue	brown → yellow
Oxymorphone hydrochloride (15)	red/brown — purple	yellow → brown	black	...	violet	...	royal blue — purple	yellow	orange
Oxyphencyclimine hydrochloride (38)	orange → brown	orange	olive — bright green	...	...	...	...	orange	...
Oxyphenonium bromide (9)	...	yellow — brown	olive	blue	...	...	light yellow	...	yellow
Papaverine hydrochloride (4)	red	dark green	olive	...	...	...	green	...	yellow
Paramethoxyamphetamine (PMA) (12)	(effervescence)	lime/green	(effervescence) green → red/brown	...	...	...	...	...	...
Peganone® (ethotoin) (1)	...	...	brown	...	...	yellow	...	...	...

Pentazocine (33)	red → purple	purple	olive	...	...	...	blue	...	yellow
Pentobarbital sodium (22)	...	...	...	blue	violet	...	...	...	...
Percodan® (oxycodone) (15)	dark pink	pale yellow	pea/green	...	...	...	...	...	...
Phenacemide (1)	brown/yellow	...	blue green	...	...	...	...	...	...
Phenacetin (acetophenetidin) (4)	...	...	olive	...	...	...	...	...	yellow/orange
Phenazocine hydrobromide (4)	gray → dark brown	olive	olive	...	...	...	...	...	yellow
Phencyclidine hydrochloride (PCP) (4)	...	light yellow	...	blue	...	...	...	...	...
Phendimetrazine tartrate (6)	...	...	...	blue	...	...	...	...	...
Phenelzine sulfate (56)	orange	...	olive	...	...	...	slight purple	...	...
Phenindamine tartrate (41)	purple → black	light green	green	blue	...	...	yellow/green	yellow/orange	light yellow
Pheniramine maleate (22)	...	...	...	blue (oil)	...	...	...	...	...
Phenmetrazine (17)	...	...	...	...	...	...	...	...	...
Phenobarbital (27)	...	...	...	...	violet	...	...	...	...
Phenoxybenzamine hydrochloride (46)	red	light green	dark green → brown	blue	...	...	green	...	...
Phentermine base (37)	orange	faint orange	olive	blue	...	...	brown	brown	...
Phentermine resin (37)	orange	...	...	...	...	...	...	...	...
Phenylephrine hydrochloride (46)	orange	orange/brown	green	...	...	...	bright blue	...	yellow
Phenylpropanolamine hydrochloride (46)	slight yellow	slight yellow	brown	...	...	...	...	...	...
Pipenzolate bromide (24)	orange → yellow → blue	orange → olive	orange → brown → green	blue	...	...	orange → brown	orange	yellow
Piperiodolate (24)	orange	pale yellow	green	...	...	...	...	...	...
Piperocaine hydrochloride (26)	...	...	orange → brown (precipitate)	blue	...	...	...	...	...
Prilocaine hydrochloride (5)	pink	yellow	red → orange	light blue	light blue	...	...	...	...
Primidone (primaclone) (4)	...	...	...	...	...	...	...	...	...
Probenecid (4)	...	...	...	...	...	...	...	...	...
Procainamide (47)	...	...	orange	blue	...	yellow	...	...	...
Procaine hydrochloride (3)	...	...	orange	blue	...	yellow	...	...	...
Prochlorperazine dimaleate (46)	red	red	red	blue	...	orange	pink	pink	red → brown → yellow
Promazine hydrochloride (56)	red → orange	green	orange → olive	blue	...	...	green → red brown	light orange	yellow → brown
Promethazine hydrochloride (56)	pink	red → dark green	red/brown → green	blue	...	...	red	red	red → yellow

TABLE 1—*Continued.*

Compound (Source)	Marquis	Mecke	Mandelin	Cobalt Thiocyanate	Dille-Koppanyi (DK_1/DK_2)	Hydrochloric Acid Plus Ehrlich's	Froehde's	Sulfuric Acid	Nitric Acid
Propantheline bromide (43)	green → blue	yellow → orange/brown	orange/brown	blue	...	yellow/brown	yellow/brown	yellow/brown	brown/yellow
d-Propoxyphene hydrochloride (26)	purple	red/brown	brown/purple	blue	...	...	purple/brown	light pink	...
Protriptyline hydrochloride (31)	green and black	red/brown	olive/brown	blue	...	light/yellow	purple/brown	olive/brown	orange
Pseudoephedrine hydrochloride (33)	light brown	...	brown	...	light green	...	...	...	...
Psilocybin (12)	brown	green	green	...	blue	purple	green	...	...
Psilocyn (psilocin) (12)	light green → olive	green	dark green/brown black	blue	...	green → purple	...	...	...
Quinacrine (4)	yellow → orange → yellow	orange/green → green/brown	dark green → green/brown → rust	green	yellow	yellow	olive green	yellow → orange	yellow
Quinidine gluconate (10)	...	...	light green	...	...	...	...	...	...
Quinine sulfate (16)	light yellow	light yellow	light green	blue	...	...	light yellow	light yellow	...
Rauwolfia serpentina (46)	brown	dark black	olive	...	...	...	black	dark brown	orange/brown
Ravocaine® hydrochloride (propoxycaine hydrochloride) (48)	light yellow	...	brown	blue	...	yellow	...	...	light yellow
Reserpine (46)	green → brown	blue → green	olive green	...	...	light brown	blue green	yellow	green → red brown
Salicylamide (55)	...	...	olive/brown	...	...	...	...	...	...
Scopolamine hydrobromide (18)	...	yellow	...	blue	...	...	yellow	...	...
Secobarbital (22)	...	...	...	...	violet	...	...	...	...
Sparteine sulfate (6)	...	...	...	blue	...	...	...	...	...
STP (4-methyl-2,5-dimethoxy-amphetamine, JB 238) (12)	pale yellow → red brown	yellow → green → yellow/green	yellow/green	...	...	...	yellow/green	yellow/green	green particles
Strychnine sulfate (45)	...	...	purple → red/violet → orange	...	...	...	...	...	...
Sulfadiazine (46)	...	...	brown (precipitate)	...	...	yellow	...	...	...
Sulfaethylthiadiazole (46)	...	...	...	...	violet	yellow	...	...	...
Sulfamethoxazole (41)	...	...	brown (precipitate)	...	violet	yellow	...	...	...

Sulfamethoxydiazine (39)	...	...	brown spots	...	...	yellow	...	...	...
Sulfapyridine (4)	...	...	...	...	...	yellow	...	...	...
Tandearil® (oxyphenbutazone) (9)		...	orange/brown	...	...	...	light green	...	yellow
Tegretol® (carbamazepine) (9)	...	light brown	olive	...	...	...	light yellow	...	yellow
Tetracycline hydrochloride (45)	red → yellow	black → green/black	red	light blue	...	yellow	...	...	...
Tetrahydrozoline hydrochloride (38)	orange	green/brown	green	blue	blue	...	...	...	...
Thebaine (4)	red/brown	brown	red/brown	blue	...	...	brown	orange/brown	yellow
Theophylline (22)	...	...	...	...	violet	...	...	...	...
Thiabendazole (31)	...	...	...	...	...	...	...	...	...
Thiophene analog of PCP (TCP) (12)	light yellow → gray	yellow → dark green → blue green	...	...	...	...	...	...	...
Thiopropazate hydrochloride (44)	pink	green	red/green	blue	...	pink	red	pink	yellow
Thioridazine hydrochloride (31)	green/blue (effervescence)	purple (effervescence)	dark brown/green	blue	...	light green	dark purple	green/blue	red/purple
Thiothixene (38)	orange	orange	orange	...	...	light orange	orange	orange	red
Tofranil® (imipramine) (9)	...	...	brown	blue	...	...	...	...	...
Tranylcypromine sulfate (46)	red/brown	light green/blue	...	...	...	...	...	...	...
Trifluoperazine dihydrochloride (46)	light orange	orange → green	orange → green	blue	...	...	brown	orange	brown/yellow
Trimeprazine tartrate (46)	pink	red → olive green	orange → olive	blue	...	...	orange	pink	brown/yellow
Trimethadione (1)	...	...	...	...	...	...	...	...	...
Trimethaphan camsylate (41)	green/blue	...	...	blue	...	...	...	...	...
Trimethoxyamphetamine (TMA) (12)	orange	lime green → brown green	olive/green	...	...	...	...	...	...
Trimipramine maleate (21)	...	light blue	brown/green	...	...	light brown	...	...	...
Tripelennamine hydrochloride (25)	brown → red/brown	brown	brown	blue (oil)	...	pale blue	olive green	pale yellow	...
Tryptamine hydrochloride (13)	yellow	red/brown	light green	...	...	violet	light green	light yellow	yellow
Tuaminoheptane sulfate (26)	...	...	light brown	...	...	...	...	...	...
Tybamate (53)	...	...	...	...	...	...	...	...	...

For the Marquis reagent [*2–8*], add eight to ten drops of 40% formaldehyde solution to 10 ml of concentrated sulfuric acid.

For the Mecke reagent [*2,5–8*], dissolve 0.25 g of selenious acid in 25 ml of concentrated sulfuric acid.

For the Mandelin reagent [*2,4,6–8*], dissolve 1 g of ammonium vanadate in 100 ml of concentrated sulfuric acid.

For the cobalt thiocyanate reagent [*2–4,7*], dissolve 2 g of cobalt thiocyanate in 100 ml of methanol.

The Dille-Koppanyi reagent [*2–4,7*] consists of two solutions. For the first, dissolve 0.1 g of cobaltous acetate in 100 ml of methanol, and for the second, add 5 ml of isopropylamine to 95 ml of methanol.

For the Ehrlich's reagent [*5*], add 5 g of *p*-dimethylaminobenzaldehyde to 100 ml concentrated hydrochloric acid.

For the Froehde's reagent [*2,6–8*], dissolve 50 mg of sodium molybdate in 10 ml of hot concentrated sulfuric acid.

These seven reagents were chosen for the following reasons:

1. They are effective in detecting drugs in the major groups of interest to the forensic chemist (such as narcotics, stimulants, barbiturates, and hallucinogens).
2. The reagents, though selective, are not so specific that they will react with only a very few given compounds.
3. If the class of compounds with which a given reagent would react was very large (such as narcotics), several different reagents were chosen for that class, with the expectation that each reagent would produce a different color in reaction with a given drug. The object was to collect as many different data points as possible for each drug.
4. The Marquis, Mecke, Mandelin, and Froehde's reagents each contain sulfuric acid as the solvent. Since a multitude of reactions (such as esterification, oxidation, dehydration, and hydrolysis) are fostered by sulfuric acid, this solvent was chosen as one of the nine reagents [*5*]. By using sulfuric acid as a control, the behavior of a given substance in the acid was determinable. One drop of concentrated hydrochloric acid preceded the addition of the Ehrlich's reagent to each sample for the same reason, that is, as a control. Nitric acid, which is not used as a solvent in any of the given reagents, was chosen as a third acid control.

Color-Coded Directories

For wider application and easy reference, the color test chart (Table 1) is numerically coded. Each color is assigned a digit according to the following key:

Digit	Color
1	red
2	orange
3	yellow
4	green
5	blue
6	violet
7	purple
8	brown
9	black
0	no reaction

The digit assigned is based on the final color obtained after 5 min regardless of the color transitions that the reaction may have undergone. The order of the nine digits in the color code for a drug corresponds to the order in which the tests were performed and listed in Table 1. As an example, the coding of *d,l*-amphetamine sulfate is shown below:

Marquis	orange-brown	8
Mecke	...	0
Mandelin	green	4
cobalt thiocyanate	...	0
Dille-Koppanyi	...	0
Ehrlich's	...	0
Froehde's	...	0
sulfuric acid	...	0
nitric acid	...	0

There is always a certain amount of subjectivity that must be taken into account when a color is reported. It is not uncommon for two analysts to describe the same color differently. Aside from the differences in reporting colors that can be attributed to the analysts, colors can also be influenced by the concentration of the solvent or solute or by the presence of contaminants. Also, the length of time during which the colors are observed may influence the color reported because color transitions and instabilities are not unusual. Allowances should therefore be made for these differences, especially with street samples, where neither the concentration of the drug nor the presence or composition of any contaminant is known [*8*].

Two coded directories have been included in this paper. Table 2 presents the drugs arranged alphabetically, whereas Table 3 lists them according to numerical code. Table 3 is useful in obtaining information about what compounds give similar color reactions. Since the coded colors do not reflect color transitions, it is possible for two identically coded drugs to be distinguished by reference to the spot test results in Table 1. Being that subjectivity is inherent in the color reported, subjectivity also exists in the numerical codes. When any of the tables are used, alternatives should be considered.

TABLE 2—*Alphabetically arranged drugs with color codes.*

Drug	Code	Drug	Code
Acetaminophen	004000502	Azapetine	508550000
Acetophenazine	184400884	Barbital	000060000
Adiphenine	239500300	Benactyzine	588500810
Akineton	888000880	Benoxinate	000500008
Allobarbital	000060000	Benzilonium	548500823
Allylisobutylbarbituric acid	000060000	Benzocaine®	008003000
Alphaprodine	144500900	Benzphetamine	834500000
Alphenal	000060000	Benzquinamide	044500408
Aminoglutethimide	000060000	Benztropine	222500220
Aminophylline	000860000	Betamethasone	898000880
Amisometradine	000000000	Bethanechol	008004909
Amitriptyline	888500080	Bromodiphenhydramine	222500220
Amodiaquin	048440402	Bromural®	000000000
d,l-Amphetamine	804000000	Bufotenine	874005889
Anisotropine	030500300	Butabarbital	000060000
Antipyrine	034500030	Butacaine	008503000
Aprobarbital	000060000	Butalbital	000060000
Aspirin	104060000	Butethal	000060000
Atropine	000500000	Caffeine	000000000

TABLE 2—*Continued.*

Drug	Code	Drug	Code
Carbinoxamine	000500000	Hexobarbital	000060000
Carbromal	000000000	Hexocyclium	145500200
Carisoprodol	000000000	Hexylcaine	000500000
Carphenazine	814400880	Homatropine	038500003
Chloral betaine	000000000	Hydrochlorothiazide	004060000
Chloral hydrate	000060000	Hydrocodone	750000000
Chlordiazepoxide	338000330	Hydrollazine	002990000
Chloromycetin®	002000000	Hydroxyamphetamine	884000403
Chloroprocaine	002503000	Hydroxyzine	003500000
Chlorothiazide	000060000	Hyoscyamine	008500000
Chlorpheniramine	000500000	Ibogaine	479504333
Chlorphentermine	004000000	Indole	848002488
Chlorpromazine	148500113	Iprindole	003500083
Chlorpropamide	000000000	Isocarboxazid	004080000
Chlorprothixene	222002221	Isoniazid	084183000
Chlorzoxazone	004060000	Isopropamide	784000798
Cinchocaine®	000500000	Levorphanol	994500503
Clidinium	545000813	Lysergic acid	994007442
Clorazepate	330503333	Lysergic acid diethylamide	
Clortermine	200000000	(LSD)	000007000
Cocaine	000500000	Mazindol	222000220
Codeine phosphate	744500502	Mebutamate	000000000
Codeine sulfate	744500502	Meclizine	334000330
Cyclomethycaine	284000000	Mefenamic acid	354000004
Cyclopentamine	000000000	Mepenzolate	548000823
Cycrimine	188000800	Meperdine	800500000
Cyproheptadine	888000883	Mephentermine	804000000
Debrisoquine	800500000	Meprobamate	000003000
Deserpidine	744000543	Mescaline	288000331
Desipramine	050560005	Methadone	105500000
Dexamethasone	000000000	Methamphetamine	804500000
Dexbrompheniramine	000500000	Methaqualone	002000000
Diazepam	000000000	Metharbital	000060000
Didrate®	754500303	Methenamine	208000000
Diethylpropion	000500000	Methimazole	034050000
N,N-Diethyltrypramine		Methixene	882000822
(DET)	448501333	Methohexital	884060000
Dimethoxyamphetamine		Methscopolamine	000500333
(DMA)	488000000	Methyclothiazide	383060330
N,N-Dimethyltryptamine		Methylenedimethoxy-	
(DMT)	888507333	methamphetine (MDMA)	959000573
Diphenhydramine	838500220	Methylenedioxyamphetamine	
Diphenidol	884000430	(MDA)	757000573
Diphenylhydantoin	000060003	Methylergonovine	999006488
Droperidol	108000000	Methylphenidate	000500000
Ephedrine	000500000	α-Methyltryptamine	458806338
Ergotamine	994007238	Methyprylon	004000000
Ethinamate	188000110	Methysergide	548007003
Ethionamide	004080002	Morphine	744000708
Ethylmorphine	744000300	Nalorphine	744560702
Ethylnoradrenaline	884090932	Nalorphine hydrochloride	744560702
Fenfluramine	020500000	Naloxone	158060703
Fentanyl	804000000	Naphazoline	584550800
Flurazepam	108500000	Nitrazepam	000030000
Furazolidone	000000000	Nortriptyline	888500820
Glutethimide	222560223	Octin®	334000000
Haloperidol	284000000	Opium	840000733
Harmaline	888003488	Oxazepam	334003333
Heroin	754000780	Oxycodone	744000803

TABLE 2—*Continued.*

Drug	Code	Drug	Code
Oxymetazoline	884500553	Quinacrine	388433423
Oxymorphone	789060732	Quinidine	004000000
Oxyphencyclimine	824000020	Quinine	334500330
Oxyphenonium	084500303	Rauwolfia serpentina	894000933
Papaverine	144000403	Ravocaine®	308503003
Paramethoxyamphetamine		Reserpine	844008438
(PMA)	048000000	Salicylamide	008000000
Peganone®	008003000	Scopolamine	030500300
Pentazocine	774000503	Secobarbital	000060000
Pentobarbital	000560000	Sparteine	000500000
Percodan®	134000000	STP (4-methyl-2,5-dimethoxy-	
Phenacemide	204000000	amphetamine)	844000444
Phenacetin	004000002	Strychnine	002000000
Phenazocine	844000003	Sulfadiazine	008003000
Phencyclidine (PCP)	020500000	Sulfaethylthiadiazole	000063000
Phendimetrazine	000500000	Sulfamethoxazole	008063000
Phenelzine	204000700	Sulfamethoxydiazine	008003000
Phenindamine	944500423	Sulfapyridine	000003000
Pheniramine	000500000	Tandearil®	808000403
Phenmetrazine	000000000	Tegretol®	084000303
Phenobarbital	000060000	Tetracycline	391503000
Phenoxybenzamine	148500400	Tetrahydrozoline	284550000
Phentermine base	224500880	Thebaine	888500883
Phentermine resin	200000000	Theophylline	000060000
Phenylephrine	284000503	Thiabendazole	000000000
Phenylpropanolamine	338000000	Thiophene analog of PCP	
Pipenzolate	554500823	(TCP)	440000000
Piperidolate	834000000	Thiopropazate	144501113
Piperocaine	008500000	Thioridazine	574504757
Prilocaine	132550000	Thiothixene	222002221
Primidone	000000000	Tofranil®	008500005
Probenecid	000000000	Tranylcypromine	805000000
Procainamide	002503000	Trifluoperazine	244500823
Procaine	002503000	Trimeprazine	144500213
Prochlorperazine	111502113	Trimethadione	000000000
Promazine	244500828	Trimethaphan	500500000
Promethazine	144500113	Trimethoxyamphetamine	
Propantheline	588508883	(TMA)	244000000
d-Propoxyphene	787500810	Trimipramine	054008005
Protriptyline	988503882	Tripelennamine	888505430
Pseudoephedrine	808400000	Tryptamine	384006433
Psilocybin	844057400	Tuaminoheptane	008000000
Psilocyn	494507000	Tybamate	000000000

TABLE 3—*Numerically arranged color code directory.*

Code	Drug	Code	Drug
000000000	Amisometradine	000000000	Dexamethasone
000000000	Bromural®	000000000	Diazepam
000000000	Caffeine	000000000	Furazolidone
000000000	Carbromal	000000000	Mebutamate
000000000	Carisoprodol	000000000	Phenmetrazine
000000000	Chloral betaine	000000000	Primidone
000000000	Chlorpropamide	000000000	Probenecid
000000000	Cyclopentamine	000000000	Thiabendazole

TABLE 3—*Continued.*

Code	Drug	Code	Drug
000000000	Trimethadione	004080002	Ethionamide
000000000	Tybamate	008000000	Salicylamide
000003000	Meprobamate	008000000	Tuaminoheptane
000003000	Sulfapyridine	008003000	Benzocaine®
000007000	Lysergic acid diethylamide (LSD)	008003000	Peganone®
		008003000	Sulfadiazine
000030000	Nitrazepam	008003000	Sulfamethoxydiazine
000060000	Allobarbital	008004909	Bethanechol
000060000	Alphenal	008063000	Sulfamethoxazole
000060000	Allylisobutylbarbituric acid	008500000	Hyoscyamine
000060000	Aminoglutethimide	008500000	Piperocaine
000060000	Aprobarbital	008500005	Tofranil®
000060000	Barbital	008503000	Butacaine
000060000	Butabarbital	020500000	Fenfluramine
000060000	Butalbital	030500000	Phencyclidine (PCP)
000060000	Butethal	030500300	Anisotropine
000060000	Chloral hydrate	030500300	Scopolamine
000060000	Chlorothiazide	034050000	Methimazole
000060000	Hexobarbital	034500030	Antipyrine
000060000	Metharbital	038500003	Homatropine
000060000	Phenobarbital	044500408	Benzquinamide
000060000	Secobarbital	048000000	Paramethoxyamphetamine (PMA)
000060000	Theophylline		
000060003	Diphenylhydantoin	048440402	Amodiaquin
000063000	Sulfaethylthiadiazole	050560005	Desipramine
000500000	Atropine	054008005	Trimipramine
000500000	Carbinoxamine	084000303	Tegretol®
000500000	Chlorpheniramine	084183000	Isoniazid
000500000	Cinchocaine®	084500303	Oxyphenonium
000500000	Cocaine	104060000	Aspirin
000500000	Dexbrompheniramine	105500000	Methadone
000500000	Diethylpropion	108000000	Droperidol
000500000	Ephedrine	108500000	Flurazepam
000500000	Hexylcaine	111502113	Prochlorperazine
000500000	Methylphenidate	132550000	Prilocaine
000500000	Phendimetrazine	134000000	Percodan®
000500000	Pheniramine	144000403	Papaverine
000500000	Sparteine	144500113	Promethazine
000500008	Benoxinate	144500213	Trimeprazine
000500333	Methscopolamine	144500900	Alphaprodine
000560000	Pentobarbital	144501113	Thiopropazate
000860000	Aminophylline	145500200	Hexocyclium
002000000	Chloromycetin®	148500113	Chlorpromazine
002000000	Methaqualone	148500400	Phenoxybenzamine
002000000	Strychnine	158060703	Naloxone
002500000	Hydroxyzine	184400884	Acetophenazine
002503000	Chloroprocaine hydrochloride	188000110	Ethinamate
002503000	Procaine	188000800	Cycrimine
002503000	Procainamide	200000000	Clortermine
002990000	Hydrollazine	200000000	Phentermine resin
003500083	Iprindole	204000000	Phenacemide
004000000	Chlorphentermine	204000700	Phenelzine
004000000	Methyprylon	208000000	Methenamine
004000000	Quinidine	222000220	Mazindol
004000002	Phenacetin	222002221	Chlorprothixene
004000502	Acetaminophen	222002221	Thiothixene
004060000	Chlorzoxazone	222500220	Benztropine
004060000	Hydrochlorothiazide	222500220	Bromodiphenhydramine
004080000	Isocarboxazid	222560223	Glutethimide

TABLE 3—*Continued.*

Code	Drug	Code	Drug
224500880	Phentermine base	757000573	Methylenedioxyamphetamine (MDA)
239500300	Adiphenine		
244000000	Trimethoxyamphetamine (TMA)	774000503	Pentazocine
		784000798	Isopropamide
244500823	Trifluoperazine	787500810	*d*-Propoxyphene
244500828	Promazine	789060732	Oxymorphone
284000000	Cyclomethycaine	800500000	Debrisoquine
284000000	Haloperidol	800500000	Meperidine
284000503	Phenylephrine	804000000	*d,l*-Amphetamine
284550000	Tetrahydrozoline	804000000	Fentanyl
288000331	Mescaline	804000000	Mephentermine
308503003	Ravocaine®	804500000	Methamphetamine
330503333	Clorazepate	805000000	Tranylcypromine
334000000	Octin®	808000403	Tandearil®
334000330	Meclizine	808040000	Pseudoephedrine
334003333	Oxazepam	814400880	Carphenazine
334500330	Quinine sulfate	824000020	Oxyphencyclimine
338000000	Phenylpropanolamine	834000000	Piperidolate
338000330	Chlordiazepoxide	834500000	Benzphetamine
354000004	Mefenamic acid	838500220	Diphenhydramine
383060330	Methyclothiazide	840000733	Opium
384006433	Tryptamine	844000003	Phenazocine
388433423	Quinacrine	844000444	STP (4-methyl-2,5-dimethoxy-amphetamine)
391503000	Tetracycline		
448501333	*N,N*-Diethyltryptamine (DET)	844008438	Reserpine
458806338	α-Methyltryptamine	844057400	Psilocybin
479504333	Ibogaine	848002488	Indole
488000000	Dimethoxyamphetamine (DMA)	874005889	Bufotenine
		882000822	Methixene
494507000	Psilocyn	884000403	Hydroxyamphetamine
500500000	Trimethaphan camsylate	884000430	Diphenidol
508550000	Azapetine	884060000	Methohexital
544500823	Pipenzolate	884090932	Ethylnoradrenaline
545000813	Clidinium	884500553	Oxymetazoline
548500823	Benzilonium	888000880	Akineton
548000823	Mepenzolate	888000883	Cyproheptadine
548007003	Methysergide	888003488	Harmaline
574504757	Thioridazine	888500080	Amitriptyline
584550800	Naphazoline	888500820	Nortriptyline
588500810	Benactyzine	888500883	Thebaine
588508883	Propantheline	888505430	Tripelennamine
744000300	Ethylmorphine	888507333	Dimethyltryptamine (DMT)
744000543	Deserpidine	894000933	Rauwolfia serpentina
744000708	Morphine	898000880	Betamethasone
744000803	Oxycodone	944500423	Phenindamine
744500502	Codeine phosphate	959000573	Methylenedimethoxymeth-amphetamine (MDMA)
744560702	Nalorphine hydrochloride		
750000000	Hydrocodone	988503882	Protriptyline
754000780	Heroin	994007238	Ergotamine
754500303	Didrate®	994007442	Lysergic acid
		994500503	Levorphanol
		999006488	Methylergonovine

Summary

The results of nine different color tests were recorded for each of more than 200 drugs. The drugs included in the study consisted of those most commonly encountered in forensic chemistry. The formulations for the different test reagents used are given along with their references. The data from the spot tests are organized in tables by assigning a numerical digit for each color test result.

APPENDIX

Drug Sources

(1) Abbott Laboratories
(2) Aldrich Chemical Co.
(3) Analabs, Inc.
(4) Applied Science Laboratories, Inc.
(5) Astra Pharmaceutical Products, Inc.
(6) Ayerst Laboratories
(7) Brinkmann Instruments, Inc.
(8) California Toxicology Service, Inc.
(9) CIBA Pharmaceutical Co.
(10) Cooper Laboratories, Inc.
(11) Dorsey Laboratories
(12) Drug Enforcement Administration
(13) Eastman Organic Chemicals
(14) Eaton Laboratories
(15) Endo Laboratories, Inc.
(16) Fisher Scientific Co.
(17) Geigy Pharmaceuticals
(18) Gilman Laboratories
(19) Hoechst Pharmaceutical Co.
(20) Hoffman-LaRoche, Inc.
(21) Ives Laboratories, Inc.
(22) K & K Laboratories, Inc.
(23) Knoll Pharmaceutical Co.
(24) Lakeside Laboratories, Inc.
(25) Lederle Laboratories
(26) Eli Lilly and Co.
(27) Mallickrodt, Inc.
(28) McNeil Laboratories
(29) Mead Johnson Laboratories
(30) Merck & Co., Inc.
(31) Merck Sharp & Dohme
(32) Merrell-National Laboratories, Inc.
(33) National Formulary
(34) Norwich Pharmaceutical Co.
(35) Parke-Davis & Co.
(36) S. D. Penick & Co.
(37) Pennwalt Pharmaceutical Div.
(38) Pfizer Laboratories
(39) A. H. Robins Co.
(40) Regis
(41) Roche Laboratories
(42) Sandoz Laboratories
(43) Schering Corp.
(44) G. D. Searle & Co.
(45) Sigma
(46) Smith Kline & French Laboratories
(47) E. R. Squibb & Sons
(48) Sterling-Winthrop
(49) Supelco
(50) The Upjohn Company
(51) U. S. Pharmacopeia
(52) USV Pharmaceutical Corp.
(53) Wallace Laboratories
(54) Warner-Lambert
(55) Warren-Teed Pharmaceuticals, Inc.
(56) Wyeth Laboratories

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