

**The 2001 “Research on Drug Evidence” Report**  
**[From the 13th ICPO / INTERPOL Forensic Science Symposium]**

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**ABSTRACT:** A reprint of the 2001 “Research on Drug Evidence” Report (a review) is provided.

**KEYWORDS:** INTERPOL, Illicit Drugs, Controlled Substances, Forensic Chemistry.

**Important Information:**

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For pertinent background, see: Klein RFX. ICPO / INTERPOL Forensic Science Symposia, 1995 - 2016. “Research on Drug Evidence”. Prefacing Remarks (and a Request for Information). *Microgram Journal* 2016;13(1-4):1-3.

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## **I) Routine and Improved Analysis of Drug Substances**

### Issue:

Improved methods of analysis, i.e., faster, more discriminatory, more sensitive, less costly, etc., are needed for all drugs of abuse. Additionally, standard analytical data are required for previously unknown drugs of abuse and/or new homolog or analog (i.e., "designer"-type) drugs.

### Solution:

Illicit drug seizures and clandestine laboratory operations are continuously monitored to provide a comprehensive overview of new developments. Ongoing research in the forensic community, as well as in the general field of analytical chemistry, provide new and/or improved methods of analysis for both routine and specialized analyses of seized drugs. Reports providing standard analytical data for new drugs and/or improved analytical protocols for known drugs are generated for the forensic and enforcement communities.

### Recent Developments:

In the United States, use of methamphetamine continues to increase. Use of amphetamine and other homolog/analog phenethylamines (often sold as methamphetamine) also continue to increase. Use of heroin, cocaine, anabolic steroids, human growth hormones, and LSD have stabilized or decreased. However, use of designer drugs - notably the various methylenedioxyamphetamines (MDA's) - are rapidly increasing. Use of gamma-hydroxybutyric acid (GHB), *gamma*-butyrolactone (GBL) and 1,4-butanediol (BD) are also increasing. Abuse of flunitrazepam (Rohypnol) and other benzodiazepines as so-called "date-rape" drugs has decreased concurrent with the increases in the use of the MDA's, GHB, GBL, and BD. The marketing of commercial products derived from hemp (cannabis) continues to expand. Similarly, the marketing of various "controlled substance mimics" (usually via Internet sales) continues to increase; the majority of these mimics are complex mixtures of non-controlled plants and/or over-the-counter type drugs which are alleged to imitate the physiological effects of marijuana.

In Europe and Russia, use of amphetamines, methylenedioxyamphetamines, and heroin remains widespread, while use of cocaine continue to grow. In the Far East, Australia and New Zealand report general across-the-board increases in drug abuse (especially cocaine and methamphetamine), while methamphetamine use remains ubiquitous in Japan and is rapidly increasing in Cambodia, Thailand, Vietnam, and elsewhere along the Pacific Rim countries, with the spread of so-called “Thai Tabs” (actually primarily produced in Burma/Myanmar) driving the increase. Heroin use in the People’s Republic of China is expanding rapidly, especially in the provinces adjoining the Golden Triangle region. Cocaine use is also increasing throughout South America (especially Brazil) and the Far East. Use of cocaine, heroin, Mandrax (methaqualone), amphetamine, LSD and methylenedioxyamphetamines all continue to increase in South Africa.

#### Summary:

Since 1998, several minor reviews of forensic analysis of drugs of abuse have appeared, and an International Scientific Working Group (SWGDRUG) has begun to formalize standards for forensic laboratories. Routine and/or new/improved methods of analysis have been reported for amphetamines, various substituted amphetamines, barbiturates, benzodiazepines, 4-bromo-2,5-dimethoxyphenethylamine (NEXUS) and related poly-substituted phenethylamines, cocaine, dihydroetorphine and etorphine, etonitazene, fentanyl, flunitrazepam (Rohypnol), heroin, *gamma*-hydroxybutyric acid (GHB), *gamma*-butyrolactone (GBL) and 1,4-butanediol (BD), inhalants, ketamine, LSD, marijuana and related cannabinoids, methamphetamines, methaqualone, methcathinone, methylenedioxyamphetamines and related compounds, morphine, codeine, and related opium alkaloids, opiate alkaloids, opium, 2-phenylethylamine (*beta*-phenethylamine) and related compounds, phenylpropylmethylamine, psilocybin, psilocin, and bufotenine, salvia divinorum, sibutramine, steroids, telazol, and terbinafine.

#### References:

#### Reviews:

1. Brettell TA, Inman K, Rudin N, Saferstein R. Forensic science. Anal Chem

- 2001;73(12):2735.
2. Moffat AC. Drugs of abuse. *Science Justice* 2000;40(2):89.
  3. Brettell TA, Inman K, Rudin N, Saferstein R. Forensic science. *Anal Chem* 1999;71(12):235R.

**Scientific Working Group for Forensic Analysis of Illicit Drugs:**

4. Anonymous. The Scientific Working Group for the Analysis of Seized Drugs (SWGDRUG). *Microgram* 2001;34(6):136 (and previous editions in *Microgram*, not referenced here).
5. Janovsky TJ, Bono JP. The Scientific Working Group for the Analysis of Forensic Drug Samples (SWGDRUG) - Discussion of SWGDRUG recommendations. *Proceedings of the American Academy of Forensic Sciences* 2001;7:26 (and previous editions in the *Proceedings*, not referenced here).

**Amphetamines (see also substituted amphetamines, methamphetamines, methylenedioxyamphetamines):**

6. Di Pietra AM, Gotti R, Del Borrello ED, Pomponio R, Cavrini V. Analysis of amphetamine and congeners in illicit samples by liquid chromatography and capillary electrophoresis. *J Anal Toxicol* 2001;25(2):99.
7. Kotai L, Keszler A, Kazinczy B. The role of self-protonation under direct GC-MS determination of amphetamine hydrochloride. *Chromatographia* 2001;53(7-8):447.
8. Praisler M, Dirinck I, Van Bocxlaer J, De Leenheer A, Massart DL. Identification of novel illicit amphetamines from vapor-phase FTIR spectra - a chemometrical solution. *Talanta* 2000;53:155.
9. Veress T. Determination of amphetamine by HPLC after acetylation. *J Forensic Sci* 2000;45(1):161.
10. Mancinelli R, Gentili S, Guiducci MS, Macchia T. Simple and reliable high-performance liquid chromatography fluorimetric procedure for the determination of amphetamine-

- derived designer drugs. *J Chromatogr B* 1999;735(2):243.
11. McAvoy Y, Cole MD, Gueniat O. Analysis of amphetamines by supercritical fluid chromatography, high-performance liquid chromatography, gas chromatography and capillary zone electrophoresis; a preliminary comparison. *Forensic Sci Int* 1999;102(1):13.
  12. Dimmick I, Meyer E, Van Bocxlaer J, Lambert W, DeLeenheer A. Application of gas chromatography-Fourier transform infrared spectrometry to the analysis of amphetamine analogues. *J Chromatogr A* 1998;819(1-2):155.
  13. Herraiez-Hernandez R, Campins-Falco P, Tortajada-Genaro LA. Chiral determination of amphetamine and related compounds using chloroformates for derivatization and high-performance liquid chromatography. *Analyst* 1998;123(10):2131.
  14. Malone JV. HPLC Quantitation of clandestinely manufactured mixtures of amphetamine and methamphetamine. *J Clan Lab Invest Chem Assoc* 1998;8(4):26.
  15. Malone JV. HPLC Quantitation of clandestinely manufactured mixtures of amphetamine and methamphetamine. *Microgram* 1998;31(11):304.

### **Substituted Amphetamines:**

16. Dal Cason TA. The identification of 4-methoxyamphetamine (PMA) and 4-methoxymethamphetamine (PMMA). *Microgram* 2000;33(8):207.
17. Poortman AJ, Lock E. Analytical profile of 4-methylthioamphetamine (4-MTA), a new street drug. *Forensic Sci Int* 1999;100(3):221.

### **Barbiturates:**

18. Mao Y, Carr PW. Separation of barbiturates and phenylthiohydantoin amino acids using the thermally tuned tandem column concept. *Anal Chem* 2001;73(8):1821.
19. Chang W-T, Lin D-L, Low I-A, Liu RH. <sup>13</sup>C<sub>4</sub>-Secobarbital as the internal standard for the quantitative determination of secobarbital- A critical evaluation. *J Forensic Sci* 2000;45(3):659.

20. Garcia-Borregon PF, Lores M, Cela R. Analysis of barbiturates by micro-high-performance liquid chromatography with post-column photochemical derivatization. *J Chromatogr A* 2000;870(1-2):39.
21. Cuenca-Benito M, Sagrado S, Villanueva-Camanas RM, Medina-Hernandez MJ. Quantitative retention-structure and retention-activity relationships of barbiturates by micellar liquid chromatography. *J Chromatogr A* 1998;814(1-2):121.
22. Rukhadze MD, Bezarashvili GS, Sebiskveradze MV, Meyer VR. Separation of barbiturates with micellar liquid chromatography and optimization by a second order mathematical design. *J Chromatogr A* 1998;805(1-2):45.

**Benzodiazepines (see also Flunitrazepam):**

23. Almirall JR, Garcia AD. Quantitative determination of common benzodiazepines by free zone electrophoresis. *Proceedings of the American Academy of Forensic Sciences* 2000;6:22.
24. Yuan H, Mester Z, Lord H, Pawliszyn J. Automated in-tube solid-phase microextraction coupled with liquid chromatography - electrospray ionization mass spectrometry for the determination of selected benzodiazepines. *J Anal Toxic* 2000;24(8):718.
25. Chen Y, Hu A. Simultaneous determination of trace benzodiazepines from drinks by using direct electrospray probe/mass spectrometry (DEP/MS). *Forensic Sci Int* 1999;103(2):79.
26. Cinta S, Iliescu T, Astilean S, David L, Cozar O, Kiefer W. 1,4-Benzodiazepine drugs adsorption on the Ag colloidal surface. *J Mol Struct* 1999;482-483:685 (Note: diazepam and nitrazepam).
27. He W, Parissis N, Kiratzidis T. Determination of benzodiazepines in forensic samples by HPLC with photo-diode array detection. *J Forensic Sci* 1998;43(5):1061.

**4-Bromo-2,5-dimethoxyphenethylamine (NEXUS) and related polysubstituted phenethylamines:**



28. deBoer D, Gijzels MJ, Bosman IJ, Maes RAA. More data about the new psychoactive drug 2C-B. *J Anal Toxicol* 1999;23(3):227.
29. Stall J. 2,5-Dimethoxy-4-ethylthiophenethylamine (2C-T-2). *J Clin Lab Invest Chem Assoc* 1999;9(1):15.
30. DeRuiter J, Clark CR, Noggle FT. Gas chromatographic–mass spectrometric and high-performance liquid chromatographic analyses of the bromination products of the regioisomeric dimethoxyphenethylamines: differentiation of nexus from five positional isomers. *J Chromatogr Sci* 1998;36(1):23.
31. DeRuiter J, Holston P, Clark CR, Noggle FT. Liquid chromatographic and mass spectral methods of identification for regioisomeric dimethoxyamphetamines and brominated dimethoxyamphetamines. *J Chromatogr Sci* 1998;36(2):73.
32. Giroud C, Augsburger M, Rivier L, Mangin P, Sadeghipour E, Varesio E, Veuthey JL, Kamalaprija PM. 2C-B: A new psychoactive phenylethylamine recently discovered in ecstasy tablets sold on the Swiss black market. *J Anal Toxicol* 1998;22(5):345.

### **Cocaine:**

33. Hsu Y-L, Walton J, Lopez C, Rose S, Furton KG. The analysis of drug odor signatures and free fraction drugs from plasma using SPME/GC/MS. *Proceedings of the American Academy of Forensic Sciences* 2001;7:52 (Note: analysis of methylbenzoate from illicit cocaine).
34. Hurst TK, Allison J, Siegel JA. An analysis of the chemistry of the Scott Ruybal test for cocaine. *Proceedings of the American Academy of Forensic Sciences* 2001;7:30.
35. Ishii H, Morishita M, Yamada H, Iwasa S, Yajima T. Simultaneous analysis of coca alkaloids and sugars in illicit cocaine using capillary electrophoresis. *J Forensic Sci* 2001;46(3):490.
36. Reffner JA, Bracken VA, Koulis CV. Comparison of transmission and internal reflection infrared spectra for forensic analysis. *Proceedings of the American Academy of Forensic Sciences* 2001;7:50 (Note: of cocaine base and hydrochloride).
37. Airaksinen AJ, Tuppurainen KA, Lotjonen SE, Niemitz M, Yu MX, Vepsäläinen JJ,

- Laatikainen R, Hiltunen J, Bergstrom KA. Nuclear magnetic resonance and molecular orbital study of some cocaine analogues. *Tetrahedron* 1999;55(34):10537.
38. Brettell TA, Cole DA. The forensic identification of cocaine free base (crack) by Raman microspectroscopy. *Proceedings of the American Academy of Forensic Sciences* 1999;5:45.
39. Brettell TA, Cole DA. The forensic identification of illicit cocaine by Raman microspectroscopy. *Proceedings of the American Academy of Forensic Sciences* 1999;5:28.
40. Wang PP, Bartlett MG. Identification and quantitation of cocaine N-oxide: a thermally labile metabolite of cocaine. *J Anal Toxicol* 1999;23(1):62.
41. Atay O, Oztop F. Quantitative determination for cocaine HCl in synthetic binary mixtures by using spectrophotometric methods. *Anal Letters* 1998;31(15):2663.
42. Krawczeniuk AS, Bravenec VA. Quantitative determination of cocaine in illicit powders by free zone capillary electrophoresis. *J Forensic Sci* 1998;43(4):738.
43. Negrusz A, Perry JL, Moore CM. Detection of cocaine on various denominations of United States currency. *J Forensic Sci* 1998;43(3):626.
44. Wang PP, Bartlett MG. Collision-induced dissociation mass spectra of cocaine, and its metabolites and pyrolysis products. *J Mass Spec* 1998;33(10):961.

#### **Dihydroetorphine and Etorphine:**

45. Hays PA. Dihydroetorphine and etorphine. *Microgram* 1998;31(9):234.

#### **Etonitazene:**

46. Sorokin VI, Ponkratov KV, Drozdov MA. Etonitazene encountered in Moscow. *Microgram* 1999;32(9):239.

#### **Fentanyls:**

47. Micovic IV, Ivanovic MD, Vuckovic SM, Prostan MS, Dosen-Micovic L, Kiricojevic VD. The synthesis and preliminary pharmacological evaluation of 4-methylfentanyl. *Bioorganic and Medicinal Chemistry Letters* 2000;10(17):2011.
48. Ohta H, Suzuki S, Ogasawara K. Studies on fentanyl and related compounds. IV. Chromatographic and spectrometric discrimination of fentanyl and its derivatives. *J Anal Toxicol* 1999;23(4):280.

**Flunitrazepam (Rohypnol) (see also benzodiazepines):**

49. Chociay J, Szarka J, McBride C. Procedure for the identification of flunitrazepam tablets (Rohypnol). *Microgram* 1999;32(2):75.
50. McKibben T. Simple and rapid color screening tests for flunitrazepam (Rohypnol). *J Forensic Sci* 1999;44(2):396.
51. Rucker CL. Chemical screening and identification techniques for flunitrazepam. *Proceedings of the American Academy of Forensic Sciences* 1999;5:40.
52. Rucker C. Chemical screening and identification techniques for flunitrazepam. *Microgram* 1998;31(7):198.

**Heroin:**

53. Macchia M, Manetto G, Mori C, Papi C, DiPietro N, Salotti V, Bortolotti F, Tagliaro F. Use of beta-cyclodextrin in the capillary zone electrophoresis separation of the components of clandestine heroin preparations. *J Chromatogr A* 2001;924(1-2):499.
54. Suryaprakash N, Azoury M, Goren Z, Jelinek R. Identification of heroin in street doses using 1D-TOCSY nuclear magnetic resonance. *J Forensic Sci* 2000;45(5):963.
55. Kushnir MM, Crockett DK, Nelson G, Urry FM. Comparison of four derivatizing reagents for 6-acetylmorphine GC-MS analysis. *J Anal Toxicol* 1999;23(4):262.
56. Besacier F. Isotope fingerprints of illicit heroin samples. Presentation - 5<sup>th</sup> Canadian Continuous-Flow Isotope Ratio Mass Spectrometry Workshop; Ottawa, Canada; 1998.
57. United Nations International Drug Control Programme (Scientific Section). Monograph:

Recommended methods for testing opium, morphine, and heroin. New York, NY:1998.

**gamma-Hydroxybutyric Acid (GHB), gamma-butyrolactone(GBL) and 1,4-butanediol (BD):**

58. Blair S, Song M, Hall B, Brodbelt J. Determination of gamma-hydroxybutyrate in water and human urine by solid phase microextraction – gas chromatography/quadrupole ion trap spectrometry. J Forensic Sci 2001;46(3):688.
59. Catterton AJ. Identification of sodium *gamma*-hydroxybutyrate (NaGHB) by infrared spectroscopy, utilizing a 3 bounce diamond ATR element Microgram 2001;34(1):15.
60. Garcia AD, Lurie IS, Hulett L, Almirall JR. Quantitation of gamma-hydroxybutyric acid and gamma-butyrolactone using capillary electrophoresis and high performance liquid chromatography. Proceedings of the American Academy of Forensic Sciences 2001;7:28.
61. Morris JA. Analogs of GHB. Part 2: Analytical perspective. J Clan Lab Invest Chem Assoc 2001;11(1):16.
62. Naisbitt GH, Murdock DS, McDaniel SR, Hopkins BJ, McNair JM. GHB determination by GC-MS without complication or ambiguity from GBL. Proceedings of the American Academy of Forensic Sciences 2001;7:28.
63. Northrop DM. GHB analysis by capillary electrophoresis. Proceedings of the American Academy of Forensic Sciences 2001;7:27.
64. Andera KM, Evans HK, Wojcik CM. Microchemical identification of *gamma*-hydroxybutyrate (GHB). J Forensic Sci 2000;45(3):665.
65. Beyerle TH. Optimum high performance liquid chromatography parameters for the quantitation of *gamma*-hydroxybutyrate and *gamma*-butyrolactone. Proceedings of the American Academy of Forensic Sciences 2000;6:44.
66. Ciolino LA, Mesmer MZ. Bridging the gap between GHB and GBL: forensic issues of interconversion. Proceedings of the American Academy of Forensic Sciences 2000;6:44.
67. Clandestine Laboratory Investigating Chemists Association. Monograph: GHB. Fresno, CA:2000.

68. Lewis A, Smith E. *gamma*-Hydroxybutyrate: from the 60's to the present. Proceedings of the American Academy of Forensic Sciences 2000;6:43.
69. McCauley HA, Machal AC, Ciolino LA, Mesmer MZ, Satzger RD. GHB, GBL, BD: a recipe for disaster. Proceedings of the American Academy of Forensic Sciences 2000;6:43.
70. Morris JA. Analogs of GHB. Part 1: theoretical perspective. J Clan Lab Invest Chem Assoc 2000;10(2):18.
71. Walker L. Maple syrup and 1,4-butanediol. J Clan Lab Invest Chem Assoc 2000;10(3):13.
72. Chew SL. Identification and quantitation of GHB by nuclear magnetic resonance spectroscopy. Proceedings of the American Academy of Forensic Sciences 1999;5:41.
73. Garcia AD, Shannon M, Almirall JR. Fast analysis of *gamma*-hydroxybutyric acid (GHB) by *in-situ* derivatization on an SPME fiber. Proceedings of the American Academy of Forensic Sciences 1999;5:45.
74. Morris, JA. Extraction of GHB for FTIR analysis and a new color test for *gamma*-butyrolactone (GBL). Microgram 1999;32(8):215.
75. Walker L. Identification of the potassium salt of *gamma*-hydroxybutyric acid (GHB). J Clan Lab Invest Chem Assoc 1999;9(1):17.
76. Mesmer MZ, Satzger RD. Determination of *gamma*-hydroxybutyrate (GHB) and *gamma*-butyrolactone (GBL) by HPLC/UV-VIS spectrophotometry and HPLC/thermospray mass spectrometry. [published erratum appears in J Forensic Sci 1998;43(6):1259] J Forensic Sci 1998;43(3):489.

### **Inhalants:**

77. Dearmore IK. Cyclohexyl nitrite encounter. J Forensic Sci 1999;44(1):197.
78. Ripani L, Nichetti D, Rossi A, Schiavone S. In-depth headspace GC/MS analysis of alkyl nitrites. J Can Soc Forens Sci 1999;32(4):141.

### **Ketamine:**

79. Rees DK, Wasem SE. The identification and quantitation of ketamine hydrochloride. *Microgram* 2000;33(7):163.

**LSD:**

80. Shanks KS. Clandestine extraction of lysergic acid amide (LSA) from morning glory seeds. *J Clan Lab Invest Chem Assoc* 2001;11(2):15.
81. Djordjevic MN, Fitzpatrick F, Houdiere F. Separation of D-lysergic acid diethylamide derivatives using micellar electrokinetic capillary chromatography. *Electrophoresis* 2000;21(4):724.
82. Anderson P, Ehorn CA. Rapid confirmation of hallucinogens after minimal sample preparation by GC/MS and GC/MS/MS. *Proceedings of the American Academy of Forensic Sciences*. 1999;5:43.
83. Clandestine Laboratory Investigating Chemists Association. Monograph: LSD. Fresno, CA:1999.
84. Mestre YF, Band BF, Zamora LL, Calatayud JM. Flow injection analysis - direct chemiluminescence determination of ergonovine maleate enhanced by hexadecylpyridinium chloride. *Analyst* 1999;124(3):413.
85. Paul BD, Smith ML. LSD - An overview on drug action and detection. *Forensic Sci Rev* 1999;11(2):157.
86. Li ZY, McNally AJ, Wang HY, Salamone SJ. Stability study of LSD under various storage conditions. *J Anal Toxicol* 1998;22(6):520.

**Marijuana and related cannabinoids:**

87. Gigliano GS. *Cannabis sativa* L. - botanical problems and molecular approaches in forensic investigations. *Forensic Sci Rev* 2001;13(1):1.
88. Doig MV, Andela R. Analysis of pharmacologically active cannabinoids by GC-MS. *Chromatographia* 2000;52(Suppl S):S101.
89. Ferioli V, Rustichelli C, Pavesi G, Gamberini G. Analytical characterization of hashish

- samples. *Chromatographia* 2000;52(1-2):39.
90. Ross SA, Mehmedic Z, Murphy TP, El Sohly MA. GC-MS analysis of the total *delta*-9-THC content of both drug- and fiber-type cannabis seeds. *J Anal Toxic* 2000;24(8):715.
  91. Zoller O, Rhyn P, Zimmerli B. High-performance liquid chromatographic determination of *delta*-(9)-tetrahydrocannabinol and the corresponding acid in hemp containing foods with special regard to the fluorescence properties of *delta*-(9)-tetrahydrocannabinol. *J Chromatogr A* 2000;872(1-2):101.
  92. Bacigalupo MA, Ius A, Meroni G, Grassi G, Moschella A. Time-resolved fluoroimmunoassay for *delta*-(9)-tetrahydrocannabinol as applied to early discrimination of *cannabis sativa* plants. *J Agric and Food Chem* 1999;47(7):2743.
  93. Gigliano GS. Preliminary data on the usefulness of internal transcribed spacer I (ITS1) sequence in the *Cannabis Sativa* L. identification. *J Forensic Sci* 1999;44(3):475.
  94. Poortman-van der Meer AJ, Huizer H. A contribution to the improvement of accuracy in the quantitation of THC. *Forensic Sci Int* 1999;101(1):1.
  95. Lurie IS, Meyers RP, Conver TS. Capillary electrochromatography of cannabinoids. *Proceedings of the American Academy of Forensic Sciences*. 1999;5:42.
  96. Gigliano GS. Identification of *Cannabis Sativa* L. (Cannabaceae) using restriction profiles of the internal transcribed spacer II (ITS2). *Science Justice* 1998;38:225.
  97. Linacre A, Thorpe J. Detection and identification of *cannabis* by DNA. *Forensic Sci Int* 1998;91:71.
  98. Lurie IS, Meyers RP, Conver TS. Capillary electrochromatography of cannabinoids. *Anal Chem* 1998;70(15):3255.
  99. Ndjoko K, Wolfender JL, Hostettmann K. Analysis of cannabinoids by liquid chromatography-thermospray mass spectrometry and liquid chromatography-tandem mass spectrometry. *Chromatographia* 1998;47(1-2):72.
  100. Rustichelli C, Ferioli V, Baraldi M, Zanolli P, Gamberini G. Analysis of cannabinoids in fiber hemp plant varieties (*cannabis sativa* L.) by high-performance liquid chromatography. *Chromatographia* 1998;48(3-4):215.

**Methamphetamines (see also amphetamines and methylenedioxyamphetamines):**

101. Lurie IS, Bethea MJ, McKibben TD, Pelligrini P, Sahai R, Weinberger R. Routine analysis of methamphetamine, amphetamine, and related compounds using capillary electrophoresis. *Proceedings of the American Academy of Forensic Sciences* 2000;6:41.
102. Rager K, Williams G, Traugber M, Melgoza L. "Ice" recrystallized from street methamphetamine samples. *J Clan Lab Invest Chem Assoc* 2000;10(2):13.
103. Hensley D, Cody JT. Simultaneous determination of amphetamine, methamphetamine, methylenedioxyamphetamine (MDA), methylenedioxymethamphetamine (MDMA), and methylenedioxyethylamphetamine (MDEA) enantiomers by GC-MS. *J Anal Toxicol* 1999;23(6):518.
104. Kozma D, Madarasz Z, Kassai C, Fogassy E. Optical resolution of N-methylamphetamine via diastereomeric salt formation with 2R,3R-O,O'-di-p-toluoyltartaric acid. *Chirality* 1999;11(5-6):373.
105. Reese ES, Harrington P. The analysis of methamphetamine hydrochloride by thermal desorption ion mobility spectrometry and SIMPLISMA. *J Forensic Sci* 1999;44(1):68.
106. Clandestine Laboratory Investigating Chemists Association. Monograph: A Review of the Birch Reduction Method. Fresno, CA:1998.
107. Jirovsky D, Lemr K, Sevcik J, Smysl B, Stransky Z. Methamphetamine - properties and analytical methods of enantiomer determination. *Forensic Sci Int* 1998;96(1):61.
108. Kuroda N, Nomura R, Al Dirbashi O, Akiyama S, Nakashima K. Determination of methamphetamine and related compounds by capillary electrophoresis with UV and laser induced fluorescence detection. *J Chromatogr A* 1998;798(1-2):325.
109. Lurie IS, Odeneal II NG, McKibben TD, Casale JF. Effects of various anionic chiral selectors on the capillary electrophoresis separation of chiral phenethylamines and achiral neutral impurities present in illicit methamphetamine. *Electrophoresis* 1998;19:2918.

**Methaqualone:**

110. Clandestine Laboratory Investigating Chemists Association. Monograph: Methaqualone. Fresno, CA:2000.



### **Methcathinone:**

111. Clandestine Laboratory Investigating Chemists Association. Monograph: A Review of the Syntheses and Analyses of Methcathinone and its Analogues. Fresno, CA:1998.

### **Methylenedioxyamphetamines and related compounds:**

112. Franzosa ES. MDMA, MDEA & MBDB tablets seen in the US. *Microgram* 2001;34(4):80.
113. Soltis BH, Panusky DD, Pedrini D. Crystal MDMA. *Microgram* 2001;34(3):59.
114. Wesley JF. Cops and crime lab unite to improve street MDMA identification. *Proceedings of the American Academy of Forensic Sciences* 2001;7:29.
115. Aalberg L, DeRuiter J, Noggle FT, Sippola E, Clark CR. Chromatographic and mass spectral methods of identification for the side-chain and ring regioisomers of methylenedioxymethamphetamine. *J Chromatogr Sci* 2000;38(8):329.
116. Bell SEJ, Burns DT, Dennis AC, Matchett LJ, Speers JS. Composition profiling of seized ecstasy tablets by Raman spectroscopy. *Analyst* 2000;125:1811.
117. Bell SEJ, Burns DT, Dennis AC, Speers JS. Rapid analysis of ecstasy and related phenethylamines in seized tablets by Raman spectroscopy. *Analyst* 2000;125:541.
118. Borth S, Hansel W, Rosner P, Junge T. Synthesis of 2,3- and 3,4-methylenedioxyphenylalkylamines and their regioisomeric differentiation by mass spectral analysis using GC-MS-MS. *Forensic Sci Int* 2000;114(3):139.
119. Borth S, Hansel W, Rosner P, Junge T. Regioisomeric differentiation of 2,3- and 3,4-methylenedioxy ring-substituted phenylalkylamines by gas chromatography/tandem mass spectrometry. *J Mass Spectrom* 2000;35(6):705.
120. Chappell J. Hydration polymorphism of 3,4-methylenedioxymethamphetamine hydrochloride and other amine drug salts. *Proceedings of the American Academy of Forensic Sciences* 2000;6:41.
121. Franzosa ES. MDMA, MDEA, and MBDB tablets seen in the US. *Microgram* 2000;33(6):121.

122. Garcia AD, Lurie IS. Quantitation of 3,4-methylenedioxyamphetamine and related compounds using capillary electrophoresis. *Proceedings of the American Academy of Forensic Sciences* 2000;6:40.
123. Lewis RJ, Reed D, Service AG, Langford AM. The identification of 2-chloro-4,5-methylene-dioxyamphetamine in an illicit drug seizure. *J Forensic Sci* 2000;45(5):1119.
124. Chappell JS. Identification of the phosphate salt of 3,4-methylenedioxyamphetamine. *Microgram* 1999;32(4):143.
125. Chappell J, Lee M. Hydration polymorphism of 3,4-methylenedioxyamphetamine hydrochloride. *Microgram* 1999;32(5):159.
126. Franzosa ES. MDMA, MDEA, and MBDB tablets seen in the US. *Microgram* 1999;32(6):190.
127. Lee GSH, Craig DC, Kannagara GSK, Dawson M, Conn C, Robertson J, Wilson MA. Analysis of 3,4-methylenedioxy-N-methylamphetamine (MDMA) in "ecstasy" tablets by <sup>13</sup>C solid state nuclear magnetic resonance (NMR) spectroscopy. *J Forensic Sci* 1999;44(4):761.
128. Mizrachi N, Burla R, Sonenfeld D, Goren Z. The separation and identification of 3,4-methylenedioxyamphetamine derivatives (MDA, MDMA, MDEA and MBDB) in tablets. *Microgram* 1999;32(1):16.
129. Sherlock K, Wolff K, Hay AWM, Conner M. Analysis of illicit ecstasy tablets: Implications for clinical management in the accident and emergency department. *J Accident Emergency Med* 1999;16(3):194.
130. Sondermann N, Kovar K-A. Identification of ecstasy in complex matrices using near-infrared spectroscopy. *Forensic Sci Int* 1999;102(2-3):133.
131. Sondermann N, Kovar K-A. Screening experiments of ecstasy street samples using near infrared spectroscopy. *Forensic Sci Int* 1999;106(3):147.
132. Varesio E, Gauvrit JY, Longerey R, Lanteri P, Veuthey JL. Optimization of fast CE analyses of ecstasy derivatives by use of experimental designs. *Chromatographia* 1999;50(3/4):195.
133. Clark CR, Noggle FT, Holston PL, DeRuiter J. Methods of differentiation for

- regioisomeric 2,3- and 3,4-methylenedioxyphenalkylamines by liquid chromatography and mass spectrometry. *Microgram* 1998;31(9):244.
134. Europol Drugs Unit. *Manual of the Production of Synthetic Drugs*. 1998 (The Hague).
135. Fox J. The analysis of ecstasy (MDMA analogs and homologs) using an FT/IR spectrophotometer with microscope attachment. *Microgram* 1998;31(12):344.
136. Garofano L, Santaro M, Patri P, Guidugli F, Bollani T, Favretto D, Traldi P. Ion trap mass spectrometry for the characterization of N-methyl-1-(3,4-methylenedioxyphenyl)-2-butanamine and N-ethyl-3,4-methylenedioxyamphetamine, two widely distributed street drugs. *Rapid Commun Mass Spectrom* 1998;12(12):779.
137. Morimoto BH, Lovell S, Kahr B. Ecstasy: 3,4-Methylenedioxymethamphetamine (MDMA). *Acta Crystallogr C* 1998;54:229.
138. Parker MA, Marona Lewicka D, Kurrasch D, Shulgin AT, Nichols DE. Synthesis and pharmacological evaluation of ring-methylated derivatives of 3,4-(methylenedioxy)-amphetamine (MDA). *J Med Chem* 1998;41(6):1001.
139. Sadeghipour F, Veuthey JL. Enantiomeric separation of four methylenedioxyated amphetamines on *beta*-cyclodextrin chiral stationary phases. *Chromatographia* 1998;47(5-6):285.

### **Morphine, Codeine and Related Opium Alkaloids:**

140. Altun ML, Ceyhan T, Kartal M, Atay T, Ozdemir N, Cevheroglu S. LC method for the analysis of acetylsalicylic acid, caffeine, and codeine phosphate in pharmaceutical preparations. *J Pharm Biomed Anal* 2001;25(1):93.
141. Nassr S, Brunet M, Lavoie P, Brazier JL. HPLC-DAD method for studying the stability of solutions containing morphine, dexamethasone, haloperidol, midazolam, famotidine, metoclopramide, and dimenhydrinate. *J Liq Chromatogr Related Technol* 2001;24(2):265.
142. Smet E, VanderWeken G, Baeyens WRG, Remon JP. A validated HPLC method for assay of morphine hydrochloride and hydromorphone hydrochloride in pharmaceutical preparations. *Chromatographia* 2001;53(1-2):35.

143. Liu SY, Woo SO, Holmes MJ, Koh HL. LC and LC-MS-MS analyses of undeclared codeine in antiasthmatic Chinese proprietary medicine. *J Pharm Biomed Anal* 2000;22(3):481.
144. Ragonese R, Mulholland M, Kalman J. Full and fractionated experimental designs for robustness testing in the high-performance liquid chromatographic analysis of codeine phosphate, pseudoephedrine hydrochloride and chlorpheniramine maleate in a pharmaceutical preparation. *J Chromatogr A* 2000;870(1-2):45.
145. Visky D, Kraszni M, Hosztafi S, Noszal B. HPCE analysis of hydrolysing morphine derivatives. Quantitation of decomposition rate and mobility. *Chromatographia* 2000;51(5/6):294.
146. Barnett NW, Hindson BJ, Lewis SW. Determination of morphine, oripavine and pseudomorphine using capillary electrophoresis with acidic potassium permanganate chemiluminescence detection. *Analyst* 1999;125(1):91.
147. Haque A, Stewart JT. Simultaneous determination of codeine, butalbital, and aspirin by free solution capillary electrophoresis. *J Liq Chromatogr and Rel Tech* 1999;22(8):1193.
148. Proksa B. Separation of morphine and its oxidation products by capillary zone electrophoresis. *J Pharm Biomed Anal* 1999;20(1-2):179.
149. Fitsev IM, Garifzyanov AR. Spectrophotometric determination of morphine by flow-injection analysis. *Anal Chem* 1998;53(2):195.
150. Popa DS, Oprean R, Curea E, Preda N. TLC-UV densitometric and GC-MSD methods for simultaneous quantification of morphine and codeine in poppy capsules. *J Pharm Biomed Anal* 1998;18(4-5):645.
151. Stubberud KP, Astrom O. Separation of ibuprofen, codeine phosphate, their degradation products and impurities by capillary electrophoresis. II. Validation. *J Chromatogr A* 1998;826(1):95.

**Opiate Alkaoids:**

152. Anonymous. Oxycodone (trade names: Tylox, Percodan, Oxycontin). Microgram

- 2001;34(3):48.
153. Matz LM, Hill HH. Evaluation of opiate separation by high-resolution electrospray ionization – ion mobility spectrometry/mass spectrometry. *Anal Chem* 2001;73(8):1664.
  154. Lim JT, Zare RN, Bailey CG, Rakestraw DJ, Yan C. Separation of related opiate compounds using capillary electrochromatography. *Electrophoresis* 2000;21(4):737.
  155. Singh J, Burke RE, Mertens LE. Elimination of the interferences by keto-opiates in the GC-MS analysis of 6-monoacetylmorphine. *J Anal Toxicol* 2000;24(1):27.
  156. Cremese M, Wu AHB, Cassella G, O'Connor E, Rymut K, Hill DW. Improved GC/MS analysis of opiates with use of oxime-TMS derivatives. *J Forensic Sci* 1998;43(6):1220.

### **Opium:**

157. Krenn L, Boros B, Ohmacht R, Jelinek L. HPLC Separation of opium alkaloids on porous and non-porous stationary phases. *Chromatographia* 2000;51(Part 2, Suppl S):S175.
158. Lazar IM, Naisbitt G, Lee ML. Capillary electrophoresis time-of-flight mass spectrometry of an opium powder. *Chromatographia* 1999;50(3-4):188.
159. Krenn L, Glantschnig S, Sorgner U. Determination of the five major opium alkaloids by reversed-phase high-performance liquid chromatography on a base-deactivated stationary phase. *Chromatographia* 1998;47(1-2):21.
160. Saha U, Sanyal M, Roy L, Sarkar B, Majumdar K. A simple method for extraction and spectrophotometric quantitation of morphine in raw opium. *Microgram* 1998;31(11):310.
161. Shoyama Y, Kawachi F, Tanaka H, Nakai R, Shibata T, Nishi K. Genetic and alkaloid analysis of *Papaver* species and their F1 hybrid by RAPD, HPLC, and ELISA. *Forensic Sci Int* 1998;91:207.

### **2-Phenylethylamine (beta-Phenethylamine) and related compounds:**

162. Massetti J.  $\beta$ -Phenethylamine: 4th quarter - 1998. *J Clan Lab Invest Chem Assoc*

1999;9(1):11.

163. Massetti J.  $\beta$ -Phenethylamine. J Clin Lab Invest Chem Assoc 1998;8(3):10.

### **Phenylpropylmethylamine:**

164. Hays PA, McKibben T, Koles JE, Bethea MJ. Phenylpropylmethylamine. Microgram 1998;31(10):269.

### **Psilocybin, Psilocin, and Bufotenine:**

165. Gross ST. Detecting psychoactive drugs in the developmental stages of mushrooms. J Forensic Sci 2000;45(3):527.

166. Lee JCI, Cole M, Linacre A. Identification of members of the genera *Panaeolus* and *Psilocybe* by a DNA test; A preliminary test for hallucinogenic fungi. Forensic Sci Int 2000;112:123.

167. Lee JCI, Cole M, Linacre A. Identification of hallucinogenic fungi from the genera *Psilocybe* and *Panaeolus* by amplified fragment polymorphism. Electrophoresis 2000;21(8):1484.

168. Montgomery MA, LeBeau MA. Differentiation of bufotenine and psilocin by GC/MS(CI). Proceedings of the American Academy of Forensic Sciences 2000;6:22.

169. Musshoff F, Madea B, Beike J. Hallucinogenic mushrooms on the German market - simple instructions for examination and identification. Forensic Sci Int 2000;113(1-3):389.

170. Gross ST, Almirall JR. The analysis of the *Psilocybe Cyanescens* (Wakefield) mushroom. Proceedings of the American Academy of Forensic Sciences. 1999;5:42.

171. Keller T, Schneider A, Regenscheit P, Dirnhofer R, R ker T, Jaspers J, Kisser W. Analysis of psilocybin and psilocin in *Psilocybe subcubensis* GUZM N by ion mobility spectrometry and gas chromatography-mass spectrometry. Forensic Sci Int 1999;99(2):93.

172. Phelan CP. Identification of psilocin and bufotenine via GC/IRD. Microgram

1999;32(2):83.

### **Salvia Divinorum**

173. Giroud C, Felber G, Augsburg M, Horisberger B, Rivier L, Mangin P. *Salvia Divinorum*: A hallucinogenic mint which might become a new recreational drug in Switzerland. *Forensic Sci Int* 2000;112(2-3):143.

### **Sibutramine:**

174. Blackledge RD, Sorenson PD. The identification of sibutramine. *Microgram* 2000;33(1):18.

### **Steroids:**

175. Lin WC, Sue CC, Kuei CH. Separation of anabolic steroids by micellar electrokinetic capillary chromatography. *Chromatographia* 1999;49(7/8):454.
176. Maume D, LeBizec B, Marchand P, Montrade MP, Andre F. N-methyl-N-alkylsilyl-trifluoroacetamide-I-2 as new derivatization reagent for anabolic steroid control. *Analyst* 1998;123(12):2645.

### **Telazol:**

177. Gagliano A, Smith PR, Hays PA, Cooper DA, Moore JM. The analysis of telazol: A tiletamine/zolazepam mixture. *Microgram* 1999;32(1):26.
178. Gagliano A, Smith PR, Hays PA, Cooper DA, Moore JM. The analysis of telazol: A tiletamine/zolazepam mixture. *Proceedings of the American Academy of Forensic Sciences* 1999;5:41.

### **Terbinafine:**

179. Hays PA. Terbinafine hydrochloride. *Microgram* 1999;32(1):11.

**Miscellaneous:**

180. Narcotics Division, Pharmaceutical and Medical Safety Bureau, Ministry of Health and Welfare, Japan. Monograph: Manual for Identification of Abused Drugs. Tokyo, Japan:1998.



## II) Novel Syntheses of Illicit Drugs, Precursors and Essential Chemicals

### Issue:

Forensic chemists must maintain familiarity with existing and new clandestine syntheses of illicit drugs in order to assist enforcement activities, to ensure safety and effectiveness during enforcement operations, and to provide expert testimony in legal proceedings.

### Solution:

Illicit drug seizures and clandestine laboratory operations are continuously monitored to maintain a comprehensive overview of the field. In cases where new drugs are synthesized, or new methodologies are utilized, case reports are generated for the forensic and enforcement communities.

### Recent Developments:

Continuing use of the Internet has spread a wide variety of both new and old synthetic procedures for all drugs throughout the world. In the United States, the most prevalent synthetic drug is methamphetamine, produced on both large and small (“cottage industry”) scales. Large scale operations are centered in Mexico and California (Mexican run), and are based on ephedrine reduction with hydriodic acid. Similarly, most small scale operations have concentrated on reduction of ephedrine or pseudoephedrine to methamphetamine, using a variety of synthetic routes. Use of commercial pseudoephedrine and phenylpropanolamine tablets as precursor sources continue to increase. Use of active metal reductions (i.e., with lithium or sodium metals in ammonia), and iodine-based reductions with hypophosphorous acid, both continue to increase. Use of unusual solvents for salting out procedures, including new refrigerants (Freons), camping stove fuels, and industrial solvents, has dramatically increased. Reductive aminations of phenylacetone continue, but only at a low level.

New designer drugs have also appeared, but are mostly isolated incidents arising from single operations. The only significant exception are the methylenedioxyamphetamines (MDA’s), which are now a worldwide abuse problem. Virtually all MDA’s are produced via reductive aminations of the corresponding ketone; large (industrial-scale) operations are

primarily based in Europe, but similar large scale production laboratories have been identified in South Africa and in Asia. One new analog drug which may become a significant problem is 2,5-dimethoxy-4-*n*-propylthiophenethylamine (2C-T-7), which is one of the hundreds of analog drugs developed by Alexander Shulgin (author of PIHKAL and TIHKAL). In Europe, amphetamines are also commonly produced on industrial scales. In Southeast Asia, illicit production of methamphetamine has exploded, with manufacture of so-called “Thai Tabs” (methamphetamine tablets, commonly also containing caffeine) becoming a major industry in Burma/Myanmar and the People’s Republic of China.

The abuse of *gamma*-hydroxybutyric acid (GHB) and its corresponding cyclic lactone *gamma*-butyrolactone (GBL) have also dramatically increased over the past 5 years, primarily in Europe and the United States. Originally utilized as a steroid substitute and “health food supplement” in body-building circles, GHB became popular as a fast-acting hypnotic/sedative, and rapidly spread via the “rave” party scene. It is clandestinely produced from *gamma*-butyrolactone (GBL), and clandestine chemists soon realized that GBL is in chemical equilibrium with GHB, and could therefore be utilized interchangeably with GHB. This is a significant complication in enforcement efforts against GHB, since GBL is a fairly widely used industrial chemical. In an additional complication, it has been discovered that 1,4-butanediol (BD) and (to a lesser extent) tetrahydrofuran (THF) both convert to GHB in the body, and both of these industrial chemicals are now also being abused as GHB. Several methyl and dimethyl analogs of GHB and GBL have also been reportedly abused.

In southwestern Asia, especially Afghanistan, opium, morphine and heroin production has exploded. In South America, coca cultivation in Bolivia and Peru has dramatically decreased, but cultivation in Colombia has hugely increased. Brazil, Ecuador, and Venezuela are becoming increasingly involved in cocaine production and trafficking. A large variety of commercially available farming and industrial products have been used as effective substitutes for “classic” reagents in cocaine production, especially in Colombia. Industrial production of essential chemicals in Bolivia, Peru and especially Colombia has increased as importation of these same materials has become increasingly restricted. Production of heroin continues to increase in Colombia, and Ecuador and especially Peru are increasingly involved in opium cultivation in support of Colombian heroin production.

### Summary:

Since 1998, a variety of alternate precursors, unusual substitutes for essential chemicals, and new or modified synthetic methods have been reported.

### References:

#### Clandestine Laboratory Case Reports:

181. Farnsworth R. Former Idaho chemistry professor suspected of synthesizing pseudoephedrine and ephedrine via benzaldehyde and nitroethane. *J Clan Lab Invest Chem Assoc* 2000;10(1):8.
182. Hugel J, Pearson M. Marijuana extraction using a modified iso-2 apparatus. *J Clan Lab Invest Chem Assoc* 2000;10(1):27.
183. Poortman-van der Meer AJ. P-2-P and MDP-2-P converted to cyclic ketals: a new meaning to protective chemistry. *J Clan Lab Invest Chem Assoc* 2000;10(1):17.
184. Cooper DA. From the opium poppy field to heroin. *Proceedings of the American Academy of Forensic Sciences* 1999;5:3.
185. Maloney BJ. Case study: clandestine laboratory; Kansas City, Missouri. *J Clan Lab Invest Chem Assoc* 1999;9(1):13.

#### Clandestine Laboratory Production of New or Unusual Drugs and/or Precursors:

186. Ohta H, Suzuki Y, Sugita R, Suzuki S, Ogasawara K. A confiscation case involving a novel barbiturate designer drug. *J Can Soc Forens Sci* 2000;33(3):103. [Author's Note: The drug was identified as 1-benzyl-1-*n*-butylbarbituric acid.]
187. Sorokin VI, Drozdov MA. Synthesis of aminopropiophenon in Russia. *J Clan Lab Invest Chem Assoc* 2000;10(1):16.
188. Willers-Russo LJ. Possible new pseudoephedrine source discovered. *J Clan Lab Invest Chem Assoc* 2000;10(2):14.
189. Mitchell WJ, Pearson JR, White MJ. Clandestine manufacture of tetrahydrocannabinol

- precursors. *J Clan Lab Invest Chem Assoc* 1999;9(2-3):29.
190. Poortman-van der Meer AJ. The synthesis of 2,5-dimethoxy-4-ethylthiophenethylamine (2C-T-2). A case report. *J Clan Lab Invest Chem Assoc* 1999;9(4):17.
191. Sorokin VI. Illegal synthesis of etonitazene. *J Clan Lab Invest Chem Assoc* 1999;9(2-3):20.

### III)

### Clandestine Laboratory Appraisals and Safety

#### Issue:

Forensic chemists must maintain familiarity with clandestine laboratory procedures, setups, and techniques in order to assist enforcement activities, to ensure safety and effectiveness during enforcement operations, and in order to provide expert testimony in Court proceedings.

#### Solution:

Clandestine laboratory operations are continuously reviewed to provide a comprehensive overview of the field. In cases where new methodologies are noted, or unusual safety concerns are salient, reports are generated for the forensic and enforcement communities.

#### Recent Developments:

Expanding use of the Internet has spread a wide variety of clandestine laboratory methodologies throughout the world, including basic set-up procedures, adaptations of standard consumer products as substitutes for laboratory glassware, equipment, and essential chemicals, concealment techniques, covert surveillance and countersurveillance techniques, and booby trapping. Numerous websites and “chat-lines” are dedicated to illicit drug production and/or use.

#### Summary:

Since 1998, a number of clandestine laboratory reports have been published.

#### References:

#### Clandestine Laboratory Appraisals and Safety:

192. Culshaw PN. Arsenic oxide: A potential reagent in methylamphetamine synthesis? J Clan Lab Invest Chem Assoc 2001;11(2):13.
193. Schieferecke J. GC/MS identification of iodine - Part two. Microgram 2001;34(5):112.
194. Worley D, Schieferecke J, Baer J. GC/MS identification of iodine - Part one. Microgram 2001;34(5):110.

195. Lazarus B. Clandestine laboratory contaminated properties: assessment and remediation strategies. *J Clan Lab Invest Chem Assoc* 2000;10(2):21.
196. Lazarus B. OSHA training requirements for clandestine laboratory enforcement teams. *J Clan Lab Invest Chem Assoc* 2000;10(1):19.
197. White MJ. Clandestine drug laboratories: impact and outcomes of state and national training initiatives. *J Clan Lab Invest Chem Assoc* 2000;10(4):11.
198. Angelos SA, Bono JP. Production capabilities of clandestine methamphetamine laboratories. *Proceedings of the American Academy of Forensic Sciences*. 1999;5:43.
199. Lazarus B. The new revised OSHA respiratory protection standard. *J Clan Lab Invest Chem Assoc* 1998;8(4):13.

### **Confined Space Laboratories:**

200. Lazarus B. OSHA amendments to the permit-required confined space standard. *J Clan Lab Invest Chem Assoc* 1999;9(2-3):14.

### **Safety Issues - Case Reports:**

201. Burgess JL. Phosphine exposure from a methamphetamine laboratory investigation. *Clin Toxicol* 2001;39(2):165.
202. Cameron M. A review of real-time monitoring instrumentation for the detection of phosphine gas. *J Clan Lab Invest Chem Assoc* 2001;11(3):18.
203. Willers-Russo LJ. Three fatalities involving phosphine gas, produced as a result of methamphetamine manufacturing. *J Forensic Sci* 1999;44(3):647.

### **Miscellaneous:**

204. Moreno E, Roca I, Peso A, del Menendez M. Clandestine plantation of cannabis sativa in Spain. *Microgram* 2001;34(4):67.
205. Hammer C. 22-Liter heating mantle manufacturer noticed. *J Clan Lab Invest Chem*

----- Note: Section IV moved up to avoid a one-line page. -----

#### IV) Reference Drug Standards and Total Syntheses

##### Issue:

Many reference drug standards or structurally related internal standards are either commercially unavailable, or if available are extremely expensive.

##### Solution:

Controlled substances and their structural or isotopically labelled analogs are synthesized as needed. Internal standards are also prepared as needed. Case reports are published for new or unusual standards or improved synthetic approaches.

##### Recent Developments:

Increasing use of single ion-monitoring techniques for identification and quantitation of controlled substances and/or precursor compounds and essential chemicals has necessitated the development and use of isotopically labelled analogs, enantiomers, or closely related structural isomers.

##### Summary:

Since 1998, several reports detailing “total syntheses” of various controlled substances have been reported.

##### References:

206. Somei M, Yamada F, Kurauchi T, Nagahama Y, Hasegawa M, Yamada K, Teranishi S, Sato H, Kaneko C. The chemistry of indoles. CIII. Simple syntheses of serotonin, N-methylserotonin, bufotenine, 5-methoxy-N-methyltryptamine, bufobutanoic acid, N-

- (indol-3-yl)-methyl-5-methoxy-N-methyltryptamine, and lespedamine based on 1-hydroxyindole chemistry. *Chem Pharm Bull* 2001;49(1):87.
207. Harrington PE, Stergiades IA, Erickson J, Makriyannis A, Tius MA. Synthesis of functionalized cannabinoids. *J Org Chem* 2000;65(20):6576.
208. Lee JC, Lee K, Cha JK. Enantioselective synthesis of unnatural (S)-(+)-cocaine. *J Organic Chem* 2000;65(15):4773.
209. Reddy GV, Rao GV, Sreevani V, Iyengar DS. An enantioselective synthesis of (1S,2S)-pseudoephedrine. *Tetrahedron Letters* 2000;41(6):953.
210. Everhart ET, Jacob P, Mendelson J, Jones RT. The synthesis of deuterium-labelled cocaine, cocaethylene and metabolites. *J Labelled Compounds and Radiopharmaceuticals* 1999;42(13):1265.
211. Mulzer J, Trauner D. Practical synthesis of (-)-morphine. *Chirality* 1999;11(5-6):475.
212. Nichols DE, Frescas S. Improvements to the synthesis of psilocybin and a facile method for preparing the O-acetyl prodrug of psilocin. *Synthesis - Stuttgart* 1999;(6):935.
213. Zhao LY, Kozikowski AP. Synthesis of the 2 *beta*,3 *beta*-, 2 *alpha*,3 *beta*-, 2 *beta*,3 *alpha*-, and 2 *alpha*,3 *alpha*- isomers of 6 *beta*-hydroxy-3-(P-tolyl)tropane-2-carboxylic acid methyl ester. *Tetrahedron Letters* 1999;40(27):4961.
214. Cozzi NV, Ruoho AE. Radiosynthesis of [H-3]methcathinone, an inhibitor of nonamine reuptake transporters. *J Labelled Compounds and Radiopharmaceuticals* 1998;41(10):927.
215. Lin RH, Castells J, Rapoport H. Enantiospecific synthesis of natural (-)-cocaine and unnatural (+)-cocaine from D- and L-glutamic acid. *J Org Chem* 1998;63(12):4069.



V)

## Comparative Analyses

### Issue:

Comparative analysis (i.e., the systematic application of impurity profiling for determination of commonality of origin) is complicated due to both the high complexity of the data and the large numbers of exhibits. Improved analytical and data handling techniques are needed.

### Solution:

In-depth analysis via improved instrumental methodologies help identify discriminatory components in impurity profiles. Computer databases, sorting programs, and pattern recognition/neural networks provide enhanced data handling and analysis. Case reports of new methodologies are generated for the forensic and enforcement communities.

### Recent Developments:

In conjunction with impurity profiling, a number of comparative analysis protocols were reported.

### Summary:

Since 1998, comparative analyses have been conducted on heroin, and tablet and capsule logos.

### References:

#### Pattern Recognition:

216. Praisler M, Dirinck I, Van Bocxlaer J, De Leenheer A, Massart DL. Pattern recognition techniques screening for drugs of abuse with gas chromatography - Fourier transform infrared spectroscopy. *Talanta* 2000;53:177.

**Heroin:**

217. Klemenc S. In common batch searching of illicit heroin samples - evaluation of data by chemometrics methods. *Forensic Sci Int* 2001;115(1-2):43.
218. Janhunen K, Cole MD. Development of a predictive model for batch membership of street samples of heroin. *Forensic Sci Int* 1999;102:1.

**Source Determination (Ballistics/Toolmarks):**

219. Franzosa ES, Harper CW (US Drug Enforcement Administration Special Testing and Research Laboratory McLean VA USA). *The logo index for tablets and capsules*, 5th Edition, 2000; US. Department of Justice Drug Enforcement Administration (Arlington, Virginia).

## **VI) Source Determination of Drugs (Impurity Profiling)**

### **Issue:**

Impurity profiling of drugs is important for comparative analysis protocols, geo-sourcing, and synthetic route determinations. However, although certain drugs have been well characterized with respect to their impurity profiles, most have not been properly investigated.

### **Solution:**

High sensitivity analytical techniques (primarily chromatographic) provide detailed profiles of trace-level impurities, ions, trace metals, and stable isotopes. Identification of individual impurities enhance origin identification and comparative analyses and also aid in development of internal standards for improved accuracy and precision of analysis. Case reports are generated for the forensic and enforcement communities.

### **Recent Developments:**

Since 1998, the ongoing and systematic effort to identify impurities and establish signature profiles via in-house syntheses has continued and expanded. Heroin impurity profiling continues in the United States, Australia, and Germany. Cocaine impurity profiling continues in the United States and Europe, and has expanded in South America. Amphetamine profiling continues in Northern Europe, and methamphetamine profiling is expanding in the United States, Japan, and Australia. Analysis of occluded solvents in finished products (notably cocaine, heroin, and methamphetamine) continues, and stable isotope analyses (notably Isotopic Ratio Mass Spectrometry and Inductively Coupled Plasma/Mass Spectrometry) have expanded.

### **Summary:**

Since 1998, impurity profiling has been conducted on amphetamine, cocaine, heroin, marijuana, methamphetamine, 4-methoxyamphetamine, methylenedioxy-amphetamines, opium, and occluded solvents.

### **References:**

### **General Review:**

220. United Nations International Drug Control Programme (Scientific Section). Monograph: Drug characterization/impurity profiling; background and concepts. United Nations (New York, NY):2000.

### **Amphetamine:**

221. Kirkbride KP, Ward AD, Jenkins NF, Klass G, Coumbaros JC. Synthesis of 4-methyl-5-arylpurimidines: route specific markers for the Leuckardt preparation of amphetamine, 4-methoxyamphetamine, and 4-methylthioamphetamine. *Forensic Sci Int* 2001;115(1-2):53.
222. Jonson CSL, Artizzu N. Factors influencing the extraction of impurities from Leuckart amphetamine. *Forensic Sci Int* 1998;93(2-2):99.

### **Cocaine:**

223. Ehleringer J, Lott M, Casale J, Ford V. Tracing the geographic origin of cocaine. *Nature* 2000;408:311.
224. Bermejo-Barrera P, Moreda-Pineiro A, Moreda-Pineiro J, Bermejo-Barrera A, Bermejo-Barrera AM. A study of illicit cocaine seizure classification by pattern recognition techniques applied to metal data. *J Forensic Sci* 1999;44(2):270.

### **Heroin:**

225. Lurie IS, Anex DS, Fintschenko Y, Choi W-L. Profiling of impurities in heroin by capillary electrochromatography and laser induced fluorescence detection. *J Chromatogr A* 2001;924(1-2):421.
226. Myors RB, Crisp PT, Skopec SV, Wells RJ. Investigation of heroin profiling using trace organic impurities. *Analyst* 2001;126(5):679.

227. Hays PA, Remaud GS, Jamin E, Martin Y-L. Geographic origin determination of heroin and cocaine using site-specific isotopic ratio deuterium NMR. *J Forensic Sci* 2000;45(3):552.
228. Stromberg L, Lundberg L, Neumann H, Bobon B, Huizer H, van der Stelt NW. Heroin impurity profiling. A harmonization study for retrospective comparisons. *Forensic Sci Int* 2000;114(2):67.
229. Besacier F, Chaudron-Thozet H. Chemical profiling of illicit heroin samples. *Forensic Sci Rev* 1999;11(2):105.
230. Ehleringer JR, Cooper DA, Lott MJ, Cook CS. Geo-location of heroin and cocaine by stable isotope ratios. *Forensic Sci Int* 1999;106:27.
231. Infante F, Dominguez E, Trujillo D, Luna A. Metal contamination in illicit samples of heroin. *J Forensic Sci* 1999;44(1):110.
232. Johnston A, King LA. Heroin profiling: predicting the country of origin of seized heroin. *Forensic Sci Int* 1998;95(1):47.
233. Myors R, Wells RJ, Skopec SV, Iavetz R, Skopec Z, Crisp P, Ekanagaki A, Robertson J. Preliminary investigation of heroin fingerprinting using trace element concentrations. *Anal Commun* 1998;35(12):403.

**Marijuana:**

234. Coyle HM, Divakaran K, Jachimowicz E, Ladd C, Lee HC. Individualization of marijuana (*cannabis sativa*) samples for forensic applications and narcotics enforcement. *Proceedings of the American Academy of Forensic Sciences* 2001;7:30 (by AFLP).
235. Tanaka H, Shoyama Y. Monoclonal antibody against tetrahydrocannabinolic acid distinguishes *Cannabis Sativa* samples from different plant species. *Forensic Sci Int* 1999;106:135.
236. Ross SA, El Sohly MA. CBN and *delta*-9-THC concentration ratio as an indicator for the age of stored marijuana samples. *Bull Narc* 1997/1998;(49(1,2)/50(1,2)):139.
237. Gigliano GS, Di Finizio A. The *Cannabis Sativa* L. fingerprint as a tool in forensic investigation. *Bull Narc* 1997/1998;(49(1,2)/50(1,2)):129.

### **Methamphetamine:**

238. Lekskulchai V, Carter K, Poklis A, Soine W. GC-MS analysis of methamphetamine impurities: Reactivity of (+)- or (-)-chloroephedrine and *cis*- or *trans*-1,2-dimethyl-3-phenylaziridine. *J Anal Toxicol* 2000;24:602.
239. Lurie IS, Bailey CG, Anex DS, Bethea MJ, McKibben TD, Casale JF. Profiling of impurities in illicit methamphetamine by high-performance liquid chromatography and capillary electrochromatography. *J Chromatogr A* 2000;870:53.
240. United Nations International Drug Control Programme (Scientific Section). Monograph: A Practical Guide to Methamphetamine Characterization/Impurity Profiling: Method Procedures, Mass Spectral Data of Selected Impurities, and Literature References - 2000. New York, NY:2000.
241. Melgoza L. Impurities in methamphetamine manufactured from over-the-counter pseudoephedrine tablet preparations. *J Clan Lab Invest Chem Assoc* 1999;9(2-3):21.
242. Muratsu S, Fukui S, Maeda T, Matsushita T, Hasegawa H, Sakurai Y, Shimoda O, Kaizaki S, Ninomiya T. Trace elemental analysis of illicit methamphetamines using total reflection X-ray fluorescence spectroscopy. *J Health Sci* 1999;45:166.
243. Oulton SR, Skinner HF. Reaction byproducts of common cold tablet ingredients via hydriodic acid/red phosphorus. *Microgram* 1999;32(10):257.
244. Oulton SR, Skinner HF. Reaction byproducts of common cold tablet ingredients via hydriodic acid/red phosphorus. *J Clan Lab Invest Chem Assoc* 1999;9(4):21.
245. Remberg B, Stead AH. Drug characterization/impurity profiling, with special focus on methamphetamine: recent work of the United Nations International Drug Control Programme. *Bull Narc* 1999;51(1,2):97.

### **4-Methoxyamphetamine:**

246. Coumbaros JC, Kirkbride KP, Klass G. Application of solid-phase microextraction to the profiling of an illicit drug: manufacturing impurities in illicit 4-methoxyamphetamine. *J*

Forensic Sci 1999;44(6):1237.

### **Methylenedioxyamphetamines:**

247. Rashed AM, Anderson RA, King LA. Solid-phase extraction for profiling of ecstasy tablets. J Forensic Sci 2000;45(2):413.
248. Kongshaug KE, Pedersen-Bjergaard S, Rasmussen KE, Krogh M. Solid-phase microextraction/capillary gas chromatography for the profiling of confiscated ecstasy and amphetamine. Chromatographia 1999;50(3-4):247.
249. Rashed AM, Anderson RA, King LA. Solid-phase extraction for profiling of ecstasy tablets. Proceedings of the American Academy of Forensic Sciences 1999;5:26.

### **Opium:**

250. Decker G, Wanner G, Zenk MH, Lottspeich F. Characterization of proteins in latex of the opium poppy (*Papaver Somniferum*) using two-dimensional gel electrophoresis and microsequencing. Electrophoresis 2000;21(16):3500.

### **Occluded Solvent Analyses:**

251. Morello DR, Casale JF, Stevenson ML, Klein RFX. The effects of microwave irradiation on occluded solvents in illicitly produced cocaine hydrochloride. J Forensic Sci 2000;45(5):1126.
252. Cole MD. Occluded solvent analysis as a basis for heroin and cocaine sample differentiation. Forensic Sci Rev 1998;10(2):113.

### **Miscellaneous:**

253. Roux C, Bull S, Goulding J, Lennard C. Tracing the source of illicit drugs through plastic packaging - a database. J Forensic Sci 2000;45(1):99.

## VII)

### Analysis of Adulterants and Diluents

#### Issue:

Most "street-level" drugs are "cut" with various adulterants and diluents. Separation and identification of these extraneous materials can be tedious, especially in exhibits which contain many components. In addition, new or unusual adulterants and/or diluents are occasionally identified in drug exhibits, and standard analytical data are required for these substances. Finally, improved methods of analysis, i.e., faster, more discriminatory, less costly, etc., are needed for all cutting agents.

#### Solution:

Illicit drug seizures are continuously monitored to provide a comprehensive overview of adulterants and diluents. Case reports providing standard analytical data for new and/or unusual cutting agents are generated for the forensic and enforcement communities. Ongoing research in forensic community provides new and/or improved methods of analysis for routine identification of all adulterants and diluents.

#### Recent Developments:

In the United States, the extensive use of over-the-counter ephedrine or pseudoephedrine containing products for methamphetamine production has resulted in numerous reports on these two precursors. It is increasingly common to identify cocaine in South American heroin, and South American heroin in cocaine. "Thai Tabs" are usually cut with caffeine, and some may contain ketamine as well. "Ecstasy" tablets may contain a mixture of methylenedioxyamphetamines and/or homolog/analog drugs. Use of infrared, Raman, or nuclear magnetic resonance spectroscopy for the simultaneous identification of moderate quantities (i.e., 5 - 20 %) of certain cutting agents in cocaine or heroin is increasing.

#### Summary:

Since 1998, several reports detailing common cutting agents were published.



## References:

### Ephedrine and/or Pseudoephedrine:

254. Bhushan R, Martens J, Arora M. Direct resolution of (+/-)-ephedrine and atropine into their enantiomers by impregnated TLC. *Biomed Chromatogr* 2001;15(3):151.
255. Hellriegel C, Handel H, Wedig M, Steinhauer S, Sorgel F, Albert K, Holzgrabe U. Study on the chiral recognition of the enantiomers of ephedrine derivatives with neutral and sulfated heptakis(2,3-O-diacetyl)-beta-cyclodextrins using capillary electrophoresis, UV, nuclear magnetic resonance spectroscopy and mass spectrometry. *J Chromatogr A* 2001;914(1-2):315.
256. Makhija SN, Vavia PR. Stability indicating HPTLC method for the simultaneous determination of pseudoephedrine and cetirizine in pharmaceutical formulations. *J Pharm Biomed Anal* 2001;25(3-4):663.
257. Erk N. Assay of ephedrine hydrochloride and theophylline in pharmaceutical formulations by differential-derivative spectroscopy. *J Pharm Biomed Anal* 2000;23(2-3):255.
258. Choi YH, Kim J, Kim YC, Yoo KP. Selective extraction of ephedrine from *Ephedra Sinica* using mixtures of CO<sub>2</sub>, diethylamine, and methanol. *Chromatographia* 1999;50(11-12):673.
259. Iwanicki RM, Maier K, Zlotnick JA, Liu RH, Kuo T-L, Tagliaro F. Separation of enantiomeric ephedrine and pseudoephedrine - high pressure liquid chromatography and capillary electrophoresis. *J Forensic Sci* 1999;44(3):470.
260. Okamura N, Miki H, Harada T, Yamashita S, Masaoka Y, Nakamoto Y, Tsuguma M, Yoshitomi H, Yagi A. Simultaneous determination of ephedrine, pseudoephedrine, norephedrine and methylephedrine in Kampo medicines by high-performance liquid chromatography. *J Pharm Biomed Anal* 1999;20(1-2):363.
261. Moses AJ. Determination of pseudoephedrine from a mixture of pseudoephedrine and chlorpheniramine. *J Clin Lab Invest Chem Assoc* 1998;8(4):11.

**Other Adulterants/Diluents (may include ephedrine and/or pseudoephedrine):**

262. Chew S, Chappell J. Analytical update on creatine. *Microgram* 2001;34(2):33.
263. Blackledge RD. "DXM" Or dextromethorphan. *Microgram* 2000;33(1):10.
264. Churchill KT. Creatine; an analytical profile. *Microgram* 2000;33:223.
265. Hays PA, Cooper DA. Determination of the weight percent of acetic acid in acetic anhydride by <sup>1</sup>H-nuclear magnetic resonance (NMR) spectroscopy. *Microgram* 2000;33(8):160
266. Klemenc S. Noscapine as an adulterant in illicit heroin samples. *Forensic Sci Int* 2000;108(1):45.
267. Wilcox ML, Stewart JT. HPLC Determination of guaifenesin with selected medications on underivatized silica with an aqueous-organic phase. *J Pharm Biomed Anal* 2000;23(5):909.
268. Xu XH, Stewart JT. MEKC determination of guaifensin, pseudoephedrine, and dextromethorphan in a capsule dosage form. *J Liq Chromatogr and Rel Tech* 2000;23(1):1.
269. Boberic-Borojevic D, Radulovic D, Ivanovic D, Ristic P. Simultaneous assay of ephedrine hydrochloride, theophylline, papaverine hydrochloride and hydroxyzine hydrochloride in tablets using RP-LC. *J Pharm Biomed Anal* 1999;21(1):15.
270. DeFrancesco JV. Analysis of methamphetamine hydrochloride exhibits containing a hydrocarbon wax. *Microgram* 1999;32(12):357.
271. Haque A, Xu XH, Stewart JT. Determination of ephedrine, theophylline and phenobarbital in a tablet dosage form by capillary electrophoresis. *J Pharm Biomed Anal* 1999;21(5):1063.
272. Morales R. The use of heat to eliminate dimethyl sulfone from amphetamine and methamphetamine hydrochloride samples. *Microgram* 1999;32(1):10.
273. Fucci N, De Giovanni N. Adulterants encountered in the illicit cocaine market. *Forensic Sci Int* 1998;95(3):247.
274. McCrossen SD, Bryant DK, Cook BR, Richards JJ. Comparison of LC detection methods in the investigation of non-UV detectable organic impurities in a drug substance.

- J Pharm Biomed Anal 1998;17:455.
275. Oulton SR, Skinner HF. Identification of common inorganic acids encountered at clandestine laboratories. Microgram 1998;31(10):277.
276. Oulton SR, Skinner HF. Identification of common inorganic acids encountered at clandestine laboratories. J Clan Lab Invest Chem Assoc 1998;8(4):17.
277. Sorgen GJ. Sublimation of dimethyl sulfone. Microgram 1998;31(11):308.

**Simultaneous Analyses of Drugs and Adulterants/Diluents:**

278. Carter JC, Brewer WE, Angel SM. Raman spectroscopy for the *in situ* identification of cocaine and selected adulterants. Appl Spectrosc 2000;54:1876.
279. Morales R. The use of specific infrared absorption bands to distinguish cocaine base and cocaine HCl when mixed with known adulterants or diluents. Microgram 2000;33(9):247.

## VIII)

### New and/or Improved Instrumental Techniques

#### Issue:

Forensic Chemists must maintain familiarity with updates in current instrumental techniques and become versant in new, improved methods of analysis.

#### Solution:

Improved/existing and new technologies are reviewed and applied to both routine and specialized analyses of drugs. In cases where improved performance is observed, case reports are generated for the forensic community.

#### Recent Developments:

Capillary electrophoresis and related techniques have moved to the forefront of liquid chromatographic analyses of controlled substances. Advanced applications have included direct chiral discrimination of optical isomers without derivatization or specialized columns. Specialized injection techniques have enhanced detection limits for a variety of liquid chromatographic and gas chromatographic techniques. Raman spectroscopy has been investigated for identification of controlled substances (and shows great promise for portable instrumentation). Laser-induced fluorescence has been utilized for ultra-trace level detection of both controlled substances and their associated impurities.

#### Summary:

Since 1998, a variety of new and/or improved/existing instrumental methods have been utilized for drug analysis; most have been based on capillary electrophoretic and Fourier transform infrared and/or Raman techniques.

#### References:

#### Capillary Electrophoresis (and related CE techniques):

280. Kuroda N, Sata D, Ohyama K, Wada M, Nakahara Y, Nakashima K. Separation of sympathomimetic amines of abuse and related compounds by micellar electrokinetic chromatography. *Chem Pharm Bull* 2001;49(7):905.
281. Backofen U, Matysik FM, Hoffman W, Lunte CE. Analysis of illicit drugs by nonaqueous capillary electrophoresis and electrochemical detection. *Fresenius J Anal Chem* 2000;367:359.
282. Cherkaoui S, Geiser L, Veuthey JL. Rapid separation of basic drugs by nonaqueous capillary electrophoresis. *Chromatographia* 2000;52(7-8):403.
283. Chinaka S, Tanaka S, Takayama N, Komai K, Ohshima T, Ueda K. Simultaneous chiral analysis of methamphetamine and related compounds by capillary electrophoresis. *J Chromatogr B* 2000;749(1):111.
284. Garcia AD, Almirall JR, Lurie IS. A comprehensive review of the analysis of controlled substances by capillary electrophoresis, using free zone, MECC, and cyclodextrin systems. *Proceedings of the American Academy of Forensic Sciences* 2000;6:23.
285. Gil-Agusti M, Torres-Lapasio JR, Garcia-Alvarez-Coque MC, Esteve-Romero J. Comparison of the performance of butanol and pentanol as modifiers in the micellar chromatographic determination of some phenethylamines. *J Chromatogr A* 2000;866(1):35.
286. Gotti R, Pomponio R, Cavrini V. Linear, neutral polysaccharides as chiral selectors in enantioresolution of basic drug racemates by capillary electrophoresis. *Chromatographia* 2000;52(5/6):273.
287. Lurie I, Bethea M, McKibben T, Hays P, Garcia A, Pellegrini P, Sahai R, Weinberger R. Use of dynamically coated capillaries for the routine analysis of methamphetamine, amphetamine, MDA, MDMA, MDEA and cocaine using capillary electrophoresis. *J Forensic Sci* (**in press**).
288. McCord BR, Lurie IS, Buel E, Hudson JC, Northrop DM, Robertson JM, Seto Y, Sinha SK, Schoeniger JS, Tagliaro F, Trenarry VC, Xu X. Forensic applications of capillary electrophoresis. *Proceedings of the American Academy of Forensic Sciences* 2000;6:9.
289. Wallenborg S, Arnold D, Lurie I, Bailey C. On-chip separation of amphetamine and related compounds labeled with 4-fluoro-7-nitrobenzofurazane. *Electrophoresis*

- 2000;21(15):3257.
290. Bjornsdottir I, Hansen SH. Fast separation of 16 seizure drug substances using non-aqueous capillary electrophoresis. *J Biochem Biophys Methods* 1999;38:155.
  291. Cherkaoui S, Mateus L, Christen P, Veuthey JL. Nonaqueous capillary electrophoresis for the analysis of selected tropane alkaloids in a plant extract. *Chromatographia* 1999;49:54.
  292. Gong ZL, Zhang Y, Zhang H, Cheng JK. Capillary electrophoresis separation and permanganate chemiluminescence on-line detection of some alkaloids with *beta*-cyclodextrin as an additive. *J Chromatogr A* 1999;855(1):329.
  293. Ku YR, Chang YS, Wen KC, Ho LK. Analysis and confirmation of synthetic anorexics in adulterated traditional Chinese medicines by high-performance capillary electrophoresis. *J Chromatogr A* 1999;848(1-2):537.
  294. Lurie IS. Capillary electrophoresis for drug analysis. *Proc SPIE - Int Soc Opt Eng* 1999;3576:125.
  295. Mateus L, Cherkaoui S, Christen P, Veuthey JL. Capillary electrophoresis - diode array detection - electrospray mass spectrometry; tropane alkaloids; hyoscyamine; scopolamine; plant extracts. *Electrophoresis* 1999;20(17):3402.
  296. Porras SP, Valko IE, Jyske P, Riekkola ML. Effect of electrolyte and solvent composition on capillary electrophoretic separation of some pharmaceuticals in non-aqueous media. *J Biochem Biophys Methods* 1999;38:89.
  297. Salvador A, Varesio E, Dreux M, Veuthey JL. Binding constant dependency of amphetamines with various commercial methylated *beta*-cyclodextrins. *Electrophoresis* 1999;20:2670.
  298. Thormann W, Wey AB, Lurie IS, Gerber H, Byland C, Malik N, Hochmeister M, Gehrig C. Capillary electrophoresis in clinical and forensic analysis: recent advances and breakthrough to routine applications. *Electrophoresis* 1999;20(15-16):3203.
  299. Cherkaoui S, Varesio E, Christen P, Veuthey JL. Selectivity manipulation using nonaqueous capillary electrophoresis. Application to tropane alkaloids and amphetamine derivatives. *Electrophoresis* 1998;19(16-17):2900.
  300. Deyl Z, Mikšik I, Tagliaro F. Advances in capillary electrophoresis. *Forensic Sci Int*

- 1998;92(2-3):89.
301. Dong YY, Sun Y, Sun Z. Influence of the buffer organic cation on the chiral separation of some basic drugs by capillary zone electrophoresis. *J High Resol Chromatogr* 1998;21(8):445.
  302. Fanali S, Aturki Z, Desiderio C. New strategies for chiral analysis of drugs by capillary electrophoresis. *Forensic Sci Int* 1998;92(2-3):137
  303. Lazar IM, Naisbitt G, Lee ML. Capillary electrophoresis-time-of-flight mass spectrometry of drugs of abuse. *Analyst* 1998;123(7):1449.
  304. Lurie IS. Capillary electrophoresis of illicit drug seizures. *Forensic Sci Int* 1998;92:125.
  305. Lurie IS, Conner TS, Ford VL. Simultaneous separation of acidic, basic, and neutral organic compounds, including strong and moderate acids and bases, by capillary electrochromatography. *Anal Chem* 1998;70:4563.
  306. Tagliaro F, Manetto G, Crivellente F, Smith FP. A brief introduction to capillary electrophoresis. *Forensic Sci Int* 1998;92:75.
  307. Thormann W, Caslavská J. Capillary electrophoresis in drug analysis. *Electrophoresis* 1998;19(16-17):2691.

### **Gas Chromatography (and GC/MS):**

308. Whiting TC, Liu RH. Isotopic analogues as internal standards for quantitative analyses of drugs and metabolites by GC-MS - Non-linear calibration approaches. *J Anal Toxicol* 2001;25(3):179.
309. Steeves JB, Gagne HM, Buel E. Normalization of residual ions after removal of the base peak in electron impact mass spectrometry. *J Forensic Sci* 2000;45(4):882.
310. Stimpfl T, Vycudilik W. Identification of the general unknown. Application of mass selective detectors in forensic toxicology. *J Anal Toxicol* 2000;24(1):32.
311. Wu C, Siems WF, Hill HH. Secondary electrospray ionization ion mobility spectroscopy/mass spectrometry of illicit drugs. *Anal Chem* 2000;72(2):396.
312. Aebi B, Bernhard W. Gas chromatography with dual mass spectrometric and nitrogen-phosphorus specific detection: a new powerful tool for forensic analysis. *Forensic Sci*

- Int 1999;102:91.
313. Besacier F, Chaudron-Thozet H, Lascaux F, Rousseau-Tsangaris M. Application du couplage chromatographie gazeuse-spectrométrie de masse isotopique de l'azote à l'analyse d'échantillons de drogues. *Analysis* 1999;27:17.
  314. Bogusz MJ, Maier RD, Kruger KD, Webb KS, Romeril J, Miller ML. Poor reproducibility of in-source collisional atmospheric pressure ionization mass spectra of toxicologically relevant drugs. *J Chromatogr A* 1999;844(1-2):409.
  315. Dallabetta-Keller T. Trace analysis by GC/MS using pulsed splitless injections. *Microgram* 1999;32(5):168.
  316. O'Connell D, Heffron JJA. Rapid analysis of illicit drugs by mass spectrometry: results from seizures in Ireland. *Analyst* 1999;125(1):119.
  317. Williams TA, Riddle M, Morgan SL, Brewer WE. Rapid gas chromatographic analysis of drugs of forensic interest. *J Chromatogr Sci* 1999;37(6):210.
  318. Molins-Legua C, Campins-Falco P, Sevillano-Cabeza A. Automated pre-column derivatization of amines in biological samples with dansyl chloride and with or without post-column chemiluminescence formation by using TCPO-H<sub>2</sub>O<sub>2</sub>. *Analyst* 1998;123(12):2871.
  319. Selby DS, Guilhaus M, Murby J, Wells RJ. Direct quantification of alkaloid mixtures by electrospray ionization mass spectrometry. *J Mass Spec* 1998;33(12):1232.

**High-Performance Liquid Chromatography (and tandem HPLC techniques):**

320. Jandera P, Fischer J, Jebava J, Effenberger H. Characterisation of retention in micellar high-performance liquid chromatography, in micellar electrokinetic chromatography and in micellar electrokinetic chromatography with reduced flow. *J Chromatogr A* 2001;914(1-2):233.
321. Szasz G, Budvari-Barany Z, Gyimesi-Forrás K. Optimized and validated HPLC methods for compedial quality assessment. IV. Non-chiral and chiral purity tests for *solanaceous* (Tropane) alkaloids. *J Liq Chromatogr and Rel Tech* 1999;22(5):747.



### **HPLC Retention Indices:**

322. Elliot SP, Hale KA. Applications of an HPLC-DAD drug-screening system based on retention indices and UV spectra. *J Anal Toxicol* 1998;22:279.

### **Infrared and Raman Spectroscopy:**

323. Praisler M, Dirinck I, Van Bocxlaer JF, DeLenheer AP, Massart DL. Computer-aided screening for hallucinogenic and stimulant amphetamines with gas chromatography-Fourier transform infrared spectroscopy (GC-FTIR). *J Anal Toxicol* 2001;25(1):45.
324. Koulis CV, Hymes KJ, Rawlins JL. A new infrared spectral library of controlled and noncontrolled drug standards using internal reflection spectroscopy. *J Forensic Sci* 2000;45(4):876.
325. Ryder AG, O'Connor GM, Glynn TJ. Quantitative analysis of cocaine in solid mixtures using Raman spectroscopy and chemometric methods. *J Raman Spectrosc* 2000;31(3):221.
326. Sun S, Zhou Q, Xuan Z, Wang Z, Yu J. Undamaged determination of raw plant medicinal drugs with Fourier transform Raman spectroscopy. *Fenxi Huaxue* 2000;28(2):211.
327. White PC. Surface enhanced resonance raman scattering (SERRS) spectroscopy - a new technique for forensic science? *Science Justice* 2000;40(2):113.
328. Angel SM, Carter JC, Stratis DN, Marquardt BJ, Brewer WE. Some new uses for filtered fiber-optic Raman probes: *In-situ* drug identification and *in situ* and remote Raman imaging. *J Raman Spectrosc* 1999;30(9):795.
329. Ryder AG, O'Connor GM, Glynn TJ. Identifications and quantitative measurements of narcotics in solid mixtures using near-IR raman spectroscopy and multivariate analysis. *J Forensic Sci* 1999;44(5):1013.
330. Sulk RA, Corcoran RC, Carron KT. Surface enhanced Raman scattering detection of amphetamine and methamphetamine by modification with 2-mercaptocotinic acid. *Appl Spectrosc* 1999;53(8):954.

331. Sun S, Yu J, Hu X. New research in the non-destructive identification of Chinese traditional drugs with molecular spectroscopy. *Guangpuxue Yu Guangpu Fenxi* 1999;19(6):841.
332. Zhao J, Zhang P, Chen D, Zhang Y, Lu F, Xie H, Li H. Studies of narcotics by micro-Raman spectroscopy. *Guangpuxue Yu Guangpu Fenxi* 1999;19(6):837.
333. Zhao J, Chen D, Zhang P, Lu F, Xie H, Li H. Vibrational studies of amphetamine and methamphetamine by micro-Raman scattering. *Guangpuxue Yu Guangpu Fenxi* 1999;19(5):687.
334. Kishi T, Ohtsuru O. Applications of IR and Raman spectroscopy in drug analysis. *Nippon Sekigaisen Gakkaishi* 1998;8(2):70.
335. Perez R, Ruperez A, Laserna JJ. Evaluation of silver substrates for surface-enhanced Raman detection of drugs banned in sport practices. *Anal Chim Acta* 1998;376(2):255.
336. Ryder AG, O'Connor GM, Glynn TJ. Near-IR Raman spectroscopy as a tool for the identification of illegal drugs in solid mixtures. *Proceedings of the European Union Symposium - Fighting Crime Through Technology*, London, UK:1998.
337. Sands HS, Hayward IP, Kirkbride TE, Bennett R, Lacey RJ, Batchelder DN. UV-Excited resonance raman spectroscopy of narcotics and explosives. *J Forensic Sci* 1998;43(3):509.
338. Whitley A, Barnett S. Advances and useful applications of Raman spectroscopy, imaging, and remote sensing. *Proc SPIE-Int Soc Opt Eng* 1998;3261:250.

#### **Nuclear Magnetic Resonance Spectroscopy:**

339. Phelan CP. Quantitation of illicit drugs in routine forensic analysis via NMR. *Microgram* 1999;32(11):312.
340. Thunhorst M, Holzgrabe U. Utilizing NMR spectroscopy for assessing drug enantiomeric composition. *Mag Res Chem* 1998;36(3):211.

#### **Supercritical Fluid Chromatography:**

341. Ashraf-Khorassani M, Taylor LT. Feasibility of on-line supercritical fluid extraction of steroids from aqueous-based matrices with analysis via gas chromatography-mass spectrometry. *J Chromatogr Sci* 2000;38(11):477.
342. Brachet A, Christen P, Gauvrit JY, Longerey R, Lanteri P, Veuthey JL. Experimental design in supercritical fluid extraction of cocaine from coca leaf. *J Biochem Biophys Methods* 2000;43:353.
343. Brachet A, Mateus L, Cherkaoui S, Christen P, Gauvrit J-Y, Lanteri P, Veuthey J-L. Application of central composite designs in the supercritical fluid extraction of tropane alkaloids in plant extracts. *Analisis* 1999;27:772.
344. Cole MD, Janhunan KA. An evaluation of supercritical fluid chromatography as an analytical technique for forensic science. *Proceedings of the American Academy of Forensic Sciences* 1999;5:55.
345. McAvoy Y, Bäckström B, Janhunen K, Stewart A, Cole MD. Supercritical fluid chromatography in forensic science: a critical appraisal. *Forensic Sci Int* 1999;99(2):107.

**Miscellaneous:**

346. Amick GD. Archive of mass spectral data files on recordable CD-ROM's and creation and maintenance of a searchable computerized database. *J Anal Toxic* 1999;23(1):46.
347. Furton KG, Wang J, Hsu Y-L, Walton J, Almirall JR. The use of solid-phase microextraction - gas chromatography in forensic analysis. *J Chromatogr Sci* 2000;38(7):297.

**IX)****Portable Detection and Analytical Instrumentation****Issue:**

New trade agreements and the easing of formally restrictive national and international borders have resulted in dramatic increases in cargo transshipments and personal travel, thereby complicating drug inspection and interdiction efforts at POE's. Discovery and confirmational analysis of suspected drugs in cargo or on individuals is severely hampered by the lack of on-site detection and/or analytical equipment.

**Solution:**

Development of portable and highly sensitive detectors for drug detection and analyses allows law enforcement personnel and/or forensic chemists to perform screening type analyses on-site. In those cases where new methodologies have proven effective, case reports are generated for the forensic and enforcement communities.

**Recent Developments:**

Use of ion mobility spectrometers has become routine in the United States, and has resulted in numerous seizures of controlled substances (primarily cocaine) at POE's, highway monitoring stations, on board marine vessels (both in port and on the high seas), and at individual buildings (both residential and commercial). Other ongoing efforts involve further miniaturization of various GC, GC/MS, and ion mobility-type instruments, and development of new technologies based on surface-acoustic-wave (SAW), pulsed neutron or biosensor technologies. This field continues to expand very rapidly; however, most reports are proprietary and are rarely reported in forensic chemistry journals.

**Summary:**

Since 1998, a variety of new, portable vapor and/or particle detectors have been reported for drug analyses. Several instruments based on fast neutron analyses have also been reported.

**References:**

348. Dindal AB, Buchanan MV, Jenkins RA, Bayne CK. Determination of cocaine and heroin vapor pressures using commercial and illicit samples. *Analyst* 2000;125(8):1393.
349. Furton KG, Hsu YL, Luo TY, Norelus A, Rose S. Field and laboratory comparison of the sensitivity and reliability of cocaine detection on currency using chemical sensors, humans, K-9's, and SPME/GC/MS/MS analysis. *Proc SPIE - Int Soc Opt Eng* 1999;3576:41.
350. Komorsky-Lovri E, Gali I, Penovski R. Voltametric determination of cocaine microparticles. *Electroanalysis* 1999;11(2):120.
351. Sleeman R, Burton IFA, Carter JF, Roberts DJ. Rapid screening of banknotes for the presence of controlled substances by thermal desorption atmospheric pressure chemical ionization mass spectrometry. *Analyst* 1999;124:103.
352. Bendahan J, Gozani T. Mobile TNA system to detect explosives and drugs concealed in cars and trucks. *Proc SPIE - Int Soc Opt Eng* 1998;3575:363.

X)

Miscellaneous

References:

Analytical Artifacts:

353. ElSohly MA, Feng S, Murphy TP. Improved procedure for overcoming nitrite interferences in GC-MS procedures for cannabinoids - The authors' reply. *J Anal Toxicol* 1998;22(3):256.
354. Frederick DL. Improved procedure for overcoming nitrite interferences in GC-MS procedures for cannabinoids. *J Anal Toxicol* 1998;22(3):255.

Qualitative Tests:

355. Smiley JC, Hickmon T, Karr C. Analysis of anhydrous ammonia via precipitation of ammonium salt. *J Clan Lab Invest Chem Assoc* 2001;11(1):31.
356. Anderson OC. Lithium spot test. *J Clan Lab Invest Chem Assoc* 2000;10(3):11.
357. Hourigan J, Ascano MP. Microcrystal test and quality control procedures employed at the LAPD Narcotics Analysis Unit. *Proceedings of the American Academy of Forensic Sciences* 2000;6:53.
358. McCrone WC. Chemical problem solving without FTIR, EDX, NMR, XRD, etc., or Why I still use the polarized light microscope, PLM. *Microscope* 2000;48(3):155.
359. O'Neal CL, Crouch DJ, Fatah AA. Validation of twelve chemical spot tests for the detection of drugs of abuse. *Forensic Sci Int* 2000;109:189.
360. Schieferecke J. Red phosphorus analysis using a gas chromatograph/mass spectrometer. *J Clan Lab Invest Chem Assoc* 2000;10(3):12.
361. Schieferecke J. Red phosphorus analysis using a gas chromatograph/mass spectrometer. *Microgram* 2000;33(12):339.

Sampling Plans:

362. Aitken CGG. Sampling - how big a sample? *J Forensic Sci* 1999;44(4):750.
363. Azoury M, Grader-Sageev D, Avraham S. Evaluation of a sampling procedure for heroin street doses. *J Forensic Sci* 1998;43(6):1203.
364. Curran JM, Triggs CM, Buckleton J. Sampling in forensic comparison problems. *Science Justice* 1998;38:101.

### **General Surveys:**

365. ElSohly MA, Ross SA, Mehmedic Z, Arafat R, Yi B, Banahan BF. Potency trends of  $\Delta^9$ -THC and other cannabinoids in confiscated marijuana from 1980-1997. *J Forensic Sci* 2000;45(1):24.
366. Poulsen HA, Sutherland GJ. The potency of cannabis in New Zealand from 1976 to 1996. *Science Justice* 2000;40(3):171.
367. Richer K. Statistical data on drug strengths for heroin, cocaine, and cannabis from British Columbia. *Proceedings of the American Academy of Forensic Sciences* 2000;6:51.
368. Senac S, Dominguez A, Pujol EP. MDMA, MDA, MDEA, NEXUS, and MBDB tablets seen in southwestern Spain. *Microgram* 2000;33(12):340.
369. Stefanidou M, Athanaselis S, Alevisopoulos G, Papoutsis J, Koutselinis A. *Delta*-(9)-tetra-hydrocannabinol content in cannabis plants of Greek origin. *Chem Pharm Bull* 2000;48(5):743.
370. United Nations International Drug Control Programme (Analysis and Statistics Section). Monograph: Global Illicit Drug Trends - 2000. New York, NY:2000.
371. United Nations International Drug Control Programme. Monograph: World Drug Report - 2000. Northamptonshire, United Kingdom:2000.
372. Morselli O, Bovolenta A, Ripani L, Santoro M, Coletta C, Ciotola G, Bosio L, Garofano L. Designed [sic] drugs in Italy. *Microgram* 1999;32(2):51.
373. United Nations International Drug Control Programme (International Narcotics Control Board). Monograph: Report of the International Narcotics Control Board - 1999. New York, NY:1999.
374. United Nations International Drug Control Programme (International Narcotics Control

- Board). Monograph: International Narcotics Control Board: Narcotic Drugs Estimated World Requirements - 1999. New York, NY:1999.
375. United Nations International Drug Control Programme (International Narcotics Control Board). Monograph: International Narcotics Control Board: Psychotropic Substances - Statistics - 1999. New York, NY:1999.
376. United Nations International Drug Control Programme (International Narcotics Control Board). Monograph: International Narcotics Control Board: Precursors and Chemicals Frequently Used in the Illicit Manufacture of Narcotic Drugs and Psychotropic Substances - 1999. New York, NY:1999.
377. United Nations International Drug Control Programme (Treaty and Legal Affairs). Monograph: Manufacture of Narcotic Drugs, Psychotropic Substances, and their Precursors - 1999. New York, NY:1999.
378. United Nations International Drug Control Programme (International Narcotics Control Board). Monograph: List of Narcotic Drugs under International Control (INCB “Yellow List”) - 1999. New York, NY:1999.
379. United Nations International Drug Control Programme (International Narcotics Control Board). Monograph: List of Narcotic Drugs under International Control (INCB “Green List”) - 1999. New York, NY:1999.
380. United Nations International Drug Control Programme (International Narcotics Control Board). Monograph: List of Precursors and Chemicals Frequently Used in the Illicit Manufacture of Narcotic Drugs and Psychotropic Substances under International Control (INCB “Red List”) - 1999. New York, NY:1999.
381. United Nations International Drug Control Programme (Analysis and Statistics Section). Monograph: Global Illicit Drug Trends - 1999. New York, NY:1999.
382. United Nations International Drug Control Programme. Monograph: Terminology and Information on Drugs - 1999. New York, NY:1999.
383. Buchanan BE, O’Connell D. Survey on cannabis resin and cannabis in unsmoked handrolled cigarettes seized in the Republic of Ireland. *Science Justice* 1998;38(4):221.
384. Cole, MD. Drugs of Abuse, in: *Crime Scene to Court: The Essentials of Forensic Science*. White, P, Ed. Royal Society of Chemistry:1998 (London).



385. Cole RK. Drug usage in San Diego County 1990-1997. *J Forensic Sci* 1998;43(5):1101.
386. Elwood WN. TCADA research brief: Fry: a study of adolescents' use of embalming fluid with marijuana and tobacco. *J Clan Lab Invest Chem Assoc* 1998;8(3):17.
387. King LA, Poortman-van der Meer AJ. New synthetic drugs in the European Union. *J Clan Lab Invest Chem Assoc* 1998;8(3):13.
388. Stefanidou M, Dona A, Athanaselis S, Papoutsis I, Koutselinis A. The cannabinoid content of marijuana samples seized in Greece and its forensic application. *Forensic Sci Int* 1998;95(2):153.
389. United Nations International Drug Control Programme. Monograph: Clandestine Manufacture of Substances under International Control - Revised in 1998. New York, NY:1998.
390. Valter K, Arrizabalaga P. Designer Drugs Directory. Elsevier Science:1998 (NY).
391. Bone C, Waldron SJ. New trends in illicit cannabis cultivation in the United Kingdom of Great Britain and Northern Ireland. *Bull Narc* 1997/1998;(49(1,2)/50(1,2)):117.
392. Mignoni G. Cannabis as a licit crop: recent developments in Europe. *Bull Narc* 1997/1998;(49(1,2)/50(1,2)):23.
393. Szendrai K. Cannabis as an illicit crop: recent developments in cultivation and product quality. *Bull Narc* 1997/1998;(49(1,2)/50(1,2)):1.
394. UNDCP Research Section. Cannabis as an illicit crop: a review of the global situation of cannabis consumption, trafficking, and production. *Bull Narc* 1997/1998;(49(1,2)/50(1,2)):45.

**Other:**

395. Adelaars A. Freedom of religion versus the psychotropic substance treaty: Notes on the Ayahuasca court case in Holland. *J Clan Lab Invest Chem Assoc* 2001;11(2):3.
396. Ford SL, Steiner RR, Thiericke R, Young R, Soine WH. Dragon's blood incense: misbranded as a drug of abuse? *Forensic Sci Int* 2001;115(1-2):1.
397. Liu SY, Woo SO, Koh HL. HPLC and GC-MS screening of Chinese proprietary medicines for undeclared therapeutic substances. *J Pharm Biomed Anal* 2001;24(5-

- 6):983.
398. Morris TA, Michiels AS. Effects of cyanoacrylate processing on cocaine HCl trace analysis. *Microgram* 2000;33(5):97.
  399. Sleeman R, Burton R, Carter J, Roberts D, Hulmston P. Drugs on money. *Analytical Chemistry* 2000;72(11):397A.
  400. Vu D-T. On the use of activated charcoal to circumvent canine detection of concealed narcotics - Part I. *Microgram* 2000;33(4):68.
  401. Walton J, Hsu Y-L, Lopez C, Almirall JR, Rose S, Lothridge K, Furton KG. Development of a scientific protocol to evaluate and certify the sensitivity and reliability of chemical(s) odor detection by canines. *Proceedings of the American Academy of Forensic Sciences* 2000;6:22.
  402. Acton B, Kelly R. Development of a forensic evidence protection kit. *Proc SPIE - Int Soc Opt Eng* 1999;3576:14.
  403. Banerjee S, Agnihotri A, Das G, Chouhan RS, Harit V. Determination of loss on drying or consistency of opium samples using microwave ovens. *Bull Narc* 1999;51(1,2):119.
  404. Huettl P, Koester S, Hoffer L, Gerhardt GA. Separation and identification of drugs of abuse in drug cottons by high performance liquid chromatography coupled with electrochemical array detectors. *Electroanalysis* 1999;11(5):313.
  405. Fraser DB. Chinese herbal medicines - manufacturing flaws and misuse. *Forensic Sci Rev* 1998;10(2):67.
  406. Müller JL. Love potions and the ointment of witches: historical aspects of the nightshade alkaloids. *Clinical Toxicol* 1998;36(6):617.
  407. Newman R, Gilbert M, Lothridge K. *GC-MS Guide to ignitable liquids*. CRC Press, New York, 1998.
  408. United Nations International Drug Control Programme (Scientific Section). *Monograph: Multilingual dictionary of narcotic drugs and psychotropic substances under international control. Addendum 1*. United Nations (New York, NY):1998.