U.S. Department of Justice
Drug Enforcement Administration

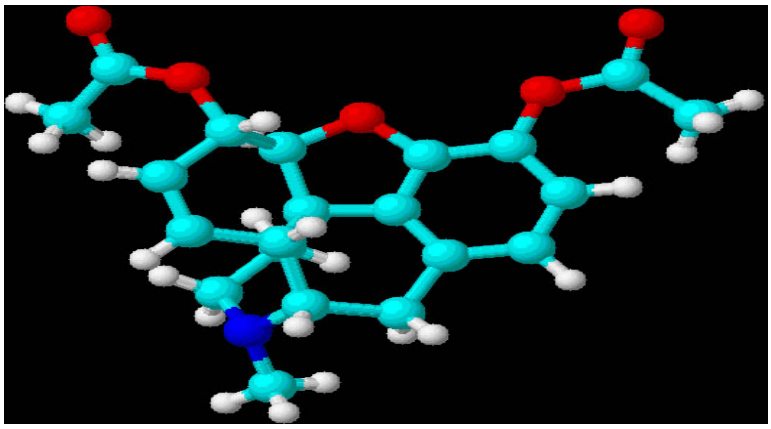
www.dea.gov

Microgram

Journal

To Assist and Serve Scientists Concerned with the Detection and Analysis of Controlled Substances and Other Abused Substances for Forensic / Law Enforcement Purposes.

Published by:
The Drug Enforcement Administration
Office of Forensic Sciences
Washington, DC 20537



Volume 1
Numbers 1-2
January - June 2003

Posted On-Line At:
www.dea.gov/programs/forensicsci/microgram/index.html

Contents

2003 Information and Instructions for *Microgram Journal* 3

Disclaimers 7

Osmolality - A Novel and Sensitive Tool for Detection of Tampering of Beverages Adulterated with Ethanol, γ-Butyrolactone, and 1,4-Butanediol, and for Detection of Dilution-Tampered Demerol Syringes 8
James F. Wesley

***Psychotria Viridis* –A Botanical Source of Dimethyltryptamine (DMT)** 18
Robert D. Blackledge and Charlotte M. Taylor

Evaluation of Ninhydrin Analogues and Other Electron-Deficient Compounds as Spray Reagents for Drugs on Thin Layer Chromatograms 23
Myriam Azoury , Avraham Zelkowicz , Zafrir Goren , and Joseph Almog

Instrumental Separation of 3,4-Methylenedioxyamphetamine (MDA) from 1-(3,4-Methylenedioxyphenyl)-2-propanol, a Co-Eluting Compound 32
Barbara A. Vohlken and Stephen M. Layton

Potency of Cannabis Seized in Central Florida During June 2002 37
Christina J. Newell

A Study of Acids Used for the Acidified Cobalt Thiocyanate Test for Cocaine Base 40
Anna L. Deakin

1,4-Butanediol (BD) - Forensic Profile 44
Agnes D. Garcia and Allen J. Catterton

Detection and Analysis of Drugs of Forensic Interest, 1992 - 2001; A Literature Review 55
Robert F.X. Klein and Patrick A. Hays

Cover Art: "Ball and Stick" Model of Heroin (Courtesy of Patrick A. Hays, DEA Special Testing and Research Laboratory, Dulles, VA)

2003 Information and Instructions for *Microgram Journal*

[Editor's Preface: The following information and instructions are derived from the *Microgram* website < http://www.dea.gov/programs/forensicsci/microgram/index.html >, and are provided here for the convenience of those subscribers who do not have access to the Internet. Updates of this material will henceforth be published only in the respective January issues for each year.]

General Information

Microgram Journal is a quarterly periodical published by the U.S. Drug Enforcement Administration's Office of Forensic Sciences, and is intended to assist and serve scientists concerned with the detection and analyses of controlled substances and other abused substances for forensic/law enforcement purposes.

Subscriptions to *Microgram Journal*

Microgram Journal is unclassified, and is published on the DEA public access website (see the above URL). **Private citizens should use the website to access *Microgram Journal*.** Professional scientific and law enforcement personnel may either use the website or request a subscription. Subscriptions are available electronically and in hard copy. Electronic subscriptions require Internet access. The publications themselves will not be sent electronically to any subscriber; rather, an email notification will be sent to the subscriber when the respective issue is posted on the website. Requests for hard copies are strongly discouraged, and should be limited to those offices that do not have access to the Internet, require hard copies for their libraries, or have some other valid reason (Note: "For my personal collection" is not considered to be a valid reason). Requests for hard copies are limited to one per office, and should also include formal justification. Note that due to publication delays beyond the control of the Office of Forensic Sciences, hard copies will arrive from 30 to 90 days after electronic posting on the website.

Requests to be added to the subscription list should be submitted via email to the *Microgram* Editor at: microgram_editor@mailsnare.net If email submission is not possible, requests should be mailed to: *Microgram* Editor, Drug Enforcement Administration, Office of Forensic Sciences, 2401 Jefferson Davis Highway, Alexandria, VA 22301. All requests to be added to the *Microgram* mailing list should include the following **Subscriber Contact Information**:

* The Full Name and Mailing Address of Submitting Laboratory or Office;

* The Full Name, Title (Laboratory Director, Assistant Special Agent in Charge, Librarian, etc.), Phone Number, FAX Number, and Preferred email Address of the Submitting Individual (Note that subscriptions are mailed to titles, not names, in order to avoid subscription problems arising from future personnel changes);

* If available, the generic email address for the Submitting Laboratory or Office;

* If a generic email address is not available, **one** official or private email address for an individual who is likely to be a long-term employee, who has a stable email address, and who will be responsible for forwarding *Microgram* information to all of the other employees in the requestor's Office (Note that only one email address per Office will be honored); and

* If requesting a hard copy mailing, justification.

Requests to be removed from the *Microgram* subscription list, or to change an existing subscription, should also be sent to the *Microgram* Editor. Such requests should included all of the pertinent Subscriber Contact Information detailed above, and also should provide the email and/or hard mail address currently being utilized for the requestor's subscription.

Note that, due to mailing delays and/or publication timeframes, subscription requests/changes may take as long as 90 days to implement.

Subscription Costs
Subscriptions to *Microgram Journal* are free.

Submissions to *Microgram Journal*
Microgram Journal presents peer reviewed, full length Scientific Research Articles and Technical Notes on the detection and analyses of controlled substances and other abused substances for forensic/law enforcement purposes.

Manuscripts are accepted both from within and outside of DEA, and reviewers for the *Journal* are both internal (from within DEA) and external.

All submissions must be in English. Because *Microgram Journal* is unclassified, **case sensitive information should not be submitted!** All submissions should, whenever possible, be submitted electronically, as straight email or as an IBM® PC-compatible Corel WordPerfect® or Microsoft Word® attachment, to: microgram_editor@mailsnare.net *Current* versions of Corel WordPerfect® or Microsoft Word® (defined as having release dates less than 5 years old) should be utilized. If electronic (email) submission is not possible, submissions may be mailed to: Microgram Editor, Drug Enforcement Administration, Office of Forensic Sciences, 2401 Jefferson Davis Highway, Alexandria, VA 22301. Hard-copy manuscripts should be submitted in triplicate, and should also be accompanied by an electronic version (written in either Corel WordPerfect® or Microsoft Word®) on a 3 ½ inch IBM® PC-compatible diskette, 100 MB iomega® zip diskette, or an IBM® PC-compatible compact disk. **Note that diskettes should be mailed in an irradiation-proof protective sleeve, and the mailing envelope should be marked: "Warning - Contains Electronic Media - Do Not Irradiate."** Hard-copy manuscripts should be printed in black ink using a laser or ink jet printer, double-spaced, on one side of 8 1/2" x 11" or A4 high quality white bond paper. A Times New Roman/12-point font is preferred for all submissions (electronic or hard copy). Each page, including illustrations, should have a one-inch (25 mm) margin on all sides. The pages should be numbered, but not stapled together.

Note that mailed submissions may be subject to lengthy handling delays beyond the control of the Office of Forensic Sciences, and electronic media sent through the mail may be destroyed en route by sanitizing procedures, despite protective measures and written warnings.

All submissions should include the following **Author Contact Information**: The Full Name and Address of Submitting Laboratory or Office, and the Full Name, Phone Number, FAX Number, and Preferred email Address of the Submitting Author.

Scientific Research Articles are formal, full length reports detailing original research in the detection and analysis of suspected controlled substances for forensic/law enforcement purposes, excluding in post-ingestion human/animal biological matrices (blood, urine, meconium, sweat, hair, etc.) **Technical Notes** are shorter communications concentrating on a specific drug (or drug class), unusual case, novel procedure or method, or minor original research. Each article/note should be a "stand-alone" work; serial publications will not be considered. Similarly, articles/notes which essentially duplicate existing literature will not be considered unless the presented data reflect significant advances in instrumentation made since the original publication(s) (however, see: Dual Publications, below). All submissions will be subjected to full peer review, and authors will be notified of the results of the review(s) within three months after the manuscript is received by the Office of Forensic Sciences.

The following guidelines should be used for all Articles (Technical Notes should follow an abbreviated version as appropriate):

Cover Letter - Provide the Author Contact Information and pertinent correspondence (if any) for the Editor.

Title - Should be specific and amenable to indexing; they should not include acronyms or abbreviations except for very common instrumental technique acronyms (e.g., GC/MS or HPLC) and/or very common drug acronyms (e.g., MDMA or PCP). Titles should be sufficiently informative that the readership should not have to read the Abstract or the Introduction to understand the focus of the article. If the manuscript reflects work previously presented at a scientific meeting, a statement detailing that presentation should be included as a footnote to the Title.

Author(s)/Affiliation(s) - The author's full name (including middle initial(s)) and title, and the full name and address of the laboratory or office should immediately follow the title. The author's degree level may be included if desired, but is not required (however, multiple authors should all include or all exclude this information). If there are several authors from two or more laboratories or offices, each set of authors should be listed separately, followed by their corresponding laboratory name and address (that is, Authors I, Laboratory I, Authors II, Laboratory II, etc.) Excessive authorship should be avoided. If there is more than one author, the primary author should be indicated with a superscripted asterisk. The name, phone numbers (Voice and FAX), preferred email address, and (if different from the laboratory or office address) the full mailing address of the contact person should be included on the title page. [Note that the provided email address will be listed under the primary author's address information.]

Abstract - State the purpose, procedures, and principal findings of the paper, in 120 words or less. Avoid the use of abbreviations, and use only common acronyms as defined under "Titles". Note that the abstract will be provided to *Chemical Abstracts*.

Keyword List - A minimum of five (maximum ten) abstracting keywords should be included.

Introduction - Briefly state the issue or problem. Detail existing practice in the topic area, and explain the shortcomings (if any) in what has been previously reported and/or what is being currently done in the field; that is, compare and contrast the selected methodology with previous and/or existing methods. Provide theoretical and practical background for novel or rarely utilized experimental or instrumental methods. Include pertinent references (avoid "Personal Communications").

Experimental (Chemicals, Instrumentation, Procedures) - Detail the chemicals, instruments, and procedures utilized (including experimental parameters). However, **USE CAUTION IN DETAILING SYNTHESES OF CONTROLLED OR ABUSED SUBSTANCES**, especially novel syntheses to known controlled substances, or syntheses of novel substances that may be subject to abuse, that are not yet well known in the scientific and/or underground literature. [In such cases, a simple statement should be included to the effect that: "Experimental details on this synthesis are not provided, in accordance with *Journal* policy."] Similar cautions should be followed when discussing commercial sources of abused substances.

Results and Discussion - Present findings in a logical, easily followed sequence. Describe what was done, and where appropriate what conclusions can be drawn. Compare and contrast the findings with previous studies and/or current practice. Discuss any problems and/or unresolved issues.

Conclusions - Optional - Summarized results should be included only for complex articles. Conclusions should not merely duplicate the Abstract or a summary paragraph in the Results and Discussion section.

Acknowledgments - Should be brief, and include the full name, affiliation, and specific contribution made by each cited individual.

References - Articles and notes should have all textual citations collected in an endnotes list. Within the text, references should be consecutively numbered either with superscripted Arabic numerals or in-line with Arabic numerals within parentheses (author's choice), in accordance with their first appearance. Multiple references

should be comma delineated. Within the endnotes list, references should be consecutively numbered with Arabic numerals, as follows: Number, Period, Indent, Citation. Reference format should adhere to the *Uniform Requirements for Manuscripts Submitted to Biomedical Journals* (Note: This is the same reference format utilized in the Selected Reference Citations in *Microgram Bulletin*, and also by the *Journal of Forensic Sciences*). Journal titles may be either spelled out in full or abbreviated using standard CASSI abbreviations. Due to their inherently transitory nature, use of website URL's as references are discouraged (but permitted if absolutely necessary). As previously noted, Personal Communications should not be utilized; however, if unavoidable, utilize the following format: Full Name, Title, Affiliation (Laboratory or Office), Location (City and State, plus Nation if not the United States), Personal Communication, Year.

Table and Figures - All Tables and Figures should be appended onto the end of the article (not imbedded in the text). Tables and Figures should be consecutively numbered with Arabic numerals, in accordance with their first citation in the text. Each Table and Figure should be "stand-alone"; that is, include sufficient descriptive information such that the reader will not have to refer back to the text to understand the Table or Figure. The Header should include the Table or Figure number and a concise title. Explanatory material, definitions of acronyms and/or abbreviations, and/or references within the Table or Figure should be designated by superscripted, lower case letters in alphabetical order, and included in dedicated footnotes at the bottom of the respective Table or Figure. Unless color is needed to enhance differentiation of the depicted material, all Tables and Figures should be in black and white (that is, avoid frivolous use of color for "artistic" purposes). Figures of spectra, chromatograms, charts, graphs, etc., should have clear and legibly labeled axes, but should not include instrument generated printoffs of experimental parameter lists.

Manuscripts submitted to *Microgram Journal* are required to be finished, professional quality efforts. Authors should ensure clarity, brevity, and pertinence of all information. Attention to detail in formatting, grammar, and spelling is as important as the accuracy of the presented facts. Authors are specially cautioned to conduct careful literature reviews prior to submission. At the Editor's discretion, “rough drafts” or otherwise clearly substandard and/or inappropriate manuscripts will be returned to the author(s) without review.

Manuscripts will not be retyped, but "final" versions are subject to minor to moderate Editorial rewrite to improve presentation clarity or to reformat to current *Microgram Journal* style.

Dual Publication - Re-publication of articles or notes of particular interest to the *Microgram Journal* readership will be considered if the article was originally published in a journal that is not easily accessed, and the primary author has obtained explicit, written copyright exclusion from the original publisher and consent from all co-authors. Examples include exact English translations of articles or notes originally published in a non-English language journal, unclassified and non-sensitive articles or notes originally published in a restricted journal or on a password protected website, or unclassified and non-sensitive articles or notes originally published in limited distribution newsletters or Proceedings. In general, any article or note that was published in English in a mainstream journal is *not* a candidate for re-publication in *Microgram Journal*. Authors interested in re-publishing previously published articles or notes in *Microgram Journal* should discuss the issue with the *Microgram* Editor *before* submitting.

Note that re-published articles should not be included as "new" articles in the respective author(s)' *Curriculum Vitae*.

Publication Costs - There are no costs (to the contributor) associated with publication in *Microgram Journal*.

Reprints - *Microgram Journal* does not provide reprints to authors. However, articles in *Microgram Journal* are not copyrighted and may be photocopied as needed.

DISCLAIMERS

1) All material published in *Microgram Journal* is reviewed prior to publication. However, **the reliability and accuracy of all published information are the responsibility of the respective contributors, and publication in *Microgram Journal* implies no endorsement by the United States Department of Justice or the Drug Enforcement Administration.**

2) Due to the ease of scanning, copying, electronic manipulation, and/or reprinting, **only the posted copies of *Microgram Journal* (on www.dea.gov) are absolutely valid.** All other copies, whether electronic or hard, are necessarily suspect unless verified against the posted versions.

3) **WARNING!:** Due to the often lengthy time delays between the actual dates of seizures and their subsequent reporting in *Microgram Journal*, and also because of the often wide variety of seizure types with superficially similar physical attributes, published material cannot be utilized to visually identify controlled substances currently circulating in clandestine markets. **The United States Department of Justice and the Drug Enforcement Administration assume no liability for the use or misuse of the information published in *Microgram Journal*.**

* * * * *

Osmolality - A Novel and Sensitive Tool for Detection of Tampering of Beverages Adulterated with Ethanol, γ-Butyrolactone, and 1,4-Butanediol, and for Detection of Dilution-Tampered Demerol Syringes

James F. Wesley
Monroe County Public Safety Lab
524 Public Safety Building
Rochester, NY 14614
[email: jwesley@hushmail.com]

ABSTRACT: Freezing point osmometry, an analytical tool used by clinical hospital laboratories and the consumer product and food industries, is investigated for its utility as a forensic screening method for detection of adulteration of commercial beverages with ethanol, γ-butyrolactone, or1,4-butanediol, and for detection of dilution of Demerol® syringes. A comprehensive list of baseline osmolality values for various commercially available beverages, eye drops, and mouthwashes is provided. Additional potential forensic applications are discussed.

KEYWORDS: Osmolality, Forensic Chemistry, Product Tampering, γ-Butyrolactone, GBL, 1,4-Butanediol, BD, Demerol

Introduction

Forensic drug testing laboratories have validated procedures in place for dealing with solid dosage samples and are well versed in the analysis of these types of cases. However, liquid samples containing relatively small percentages of low molecular weight substances can present analytical challenges - particularly if the supporting liquid matrix is itself a complex mixture (e.g., soda or beer). In the past, the only liquid samples submitted to this laboratory were small dropper bottles usually found to contain dilute solutions of LSD - a relatively trivial forensic challenge. More recently, however, the explosion of the "Rave/Club Drug" culture has resulted in the introduction of several different drugs and/or industrial chemicals which are also delivered in liquid form, including γ-hydroxybutyric acid (GHB) or butyrate (GHB^-), γ-butyrolactone (GBL), and 1,4-butanediol (BD). These may be submitted either as dilute solutions in commercial beverages or as concentrated or pure solutions in "dosing" bottles. In addition, laboratories may receive soda-type beverages, fruit drinks, or even mouthwashes seized from students and suspected of having ethanol added to them. Finally, recent terrorist events have increased public anxiety and suspicion, resulting in increased submissions of beverages suspected of having been adulterated with unknown poisons.

Many laboratories have already developed specific and robust methods for detection and identification of a few of the more commonly encountered compounds, e.g., GHB. However, there are no general methods in widespread use in forensic laboratories that are capable of rapidly and reliability detecting the presence of *any* soluble, low molecular weight compound (including novel compounds) in aqueous solutions. For example, the GHB substitutes 4-hydroxyvalerate (4-methyl-GHB), γ-hydroxybutyraldehyde, tetrahydrofuran (THF), and γ-aminobutyric acid (GABA) are already in use in illicit circles, but are not being tested for by most forensic laboratories. Future drug seizure cases and so-called Drug Facilitated Sexual Assault (DFSA) cases will undoubtedly involve these and still other compounds, and it is therefore important that forensic and toxicology laboratories be able to quickly detect their presence. A rapid screening method which could quickly identify "like" solutions would make it easier to separate exhibits into groups for statistical sampling and (where implicated) more advanced analytical testing. Osmolality offers the basis for such a technique.

Principles of Freezing Point Osmometry [1]

When a solute is dissolved in a pure solvent (e.g., water), the physical/chemical properties of the solvent are changed. The freezing point is depressed, the boiling point is elevated, the vapor pressure is lowered, and the osmotic pressure is increased [these are the so-called colligative properties.] In actual practice, therefore, one mole [gram-molecular weight] of a non-dissociating solute dissolved in 1 kg of water decreases the freezing point by 1.86ºC while exerting an osmotic pressure of about 17,000 mm Hg. There is no practical method for measuring osmotic pressure, however, freezing point depression is easily measured and has thus been a clinical and analytical tool for over 50 years. A solution with a measured freezing point depression of 1.86ºC would be said to have an osmolality of 1 Osmol/kg or 1000 milliosmols/kg, expressed as 1000 mOsm/kg.

An osmometer is a device for extremely accurate and precise determinations of the concentration of homogeneous solutions by means of freezing-point measurement. This is typically done by supercooling the target solution to several degrees below its presumed freezing point and then mechanically inducing the sample to freeze. The heat of fusion liberated during the freezing process causes the sample temperature to rise to a temporary plateau where a liquid/solid equilibrium is briefly maintained. This equilibrium temperature is, by definition, the freezing point of the solution. Osmometers include a highly accurate and precise electronic thermometer to continuously determine sample temperature and measure the freezing point of the sample.

The most common current use of osmometry is in hospital toxicology laboratories, for testing serum and urine to determine electrolyte balance, diabetic acidosis, lactic acidosis, shock, stroke, and intoxication from ethanol, methanol, isopropanol, and ethylene glycol. Osmometry is also useful for monitoring rehydration therapy for treatment of severe diarrhea or to assist in recovery after collapse from over-strenuous, dehydrating exercise (such as marathons).

An Advanced 3D3 Osmometer was utilized in the present study (see additional information under Experimental). In a typical analysis, 0.25 mL of a homogeneous liquid sample is pipetted into a disposable sample cup, which is then placed into the freezing chamber maintained at -7ºC. At the start of the experiment, a probe containing a thermistor and stir wire descends into the sample. Over the next minute, the sample is supercooled below its freezing point. The stir wire then vibrates, causing rapid freezing. The equilibrium temperature (i.e., the freezing point) is measured, and a microprocessor converts the freezing point to osmolality and displays the result in mOsm/kg.

Since the increase in osmolality is proportional to the molality of the solution, small molecular weight substances (i.e., with molecular weights less than 100), even when present in relatively low concentrations (1 - 5 percent) will detectably alter the osmolality. This makes osmometry an ideal general screening technique for substances such as GHB, GHB^-, GBL, and BD. However, “classical” drugs of abuse (cocaine, heroin, LSD, etc.) have molecular weights that are too large to noticeably effect the osmolality of typical solutions.

Experimental

An Advanced 3D3 Osmometer was utilized for all osmolality experiments. Osmolality calibration standard solutions of 100 mOsm/kg and 1500 mOm/kg were utilized this study. An American Optical T/S [Total Solids] Meter was used to measure the specific gravity of the solutions in the Demerol theft case. This (hand-held) instrument measures the refractive index of a liquid and provides a visual scale for conversion to specific gravity. It has a working measurement range of 1.000 to 1.035, which is adequate to measure dilute aqueous solutions. Commercial beverages, alcoholic beverages, mouthwashes, eye drops, and breath drops were purchased locally and used without any modification. Controlled substances and other abused substances were from laboratory stocks or seized exhibits.

Advanced 3D3 Osmometer Evaluation: [2]

Because most forensic chemists are unfamiliar with osmometry, the following details on the Advanced 3D3 Osmometer utilized in this study are provided as background. This instrument occupies approximately one square foot of counter space and weighs 25 lbs. It is solid state, consumes 150 watts an hour during operation, and has a small volume cooling bath design that allows for calibration and analysis within 15 minutes after powering up. The calibration is stored in RAM if power is disconnected.

The usable measurement range is 0 - 4000 mOsm/kg (more concentrated solutions can be measured after dilution). A full range of calibration standard solutions of known osmolality are supplied and validated by the manufacturer.

The instrument uses disposable 0.25 mL cuvettes (reusable cuvettes are also available). There is no auto-carousel on this model, but higher level models and other manufacturers provide this feature (some can handle up to 30 samples per hour). A typical experiment takes 2-3 minutes start to finish, and uses 0.25 mL sample. The sample is not destroyed by the osmolality analysis, and can be thawed and reanalyzed.

Results and Discussion

Linearity

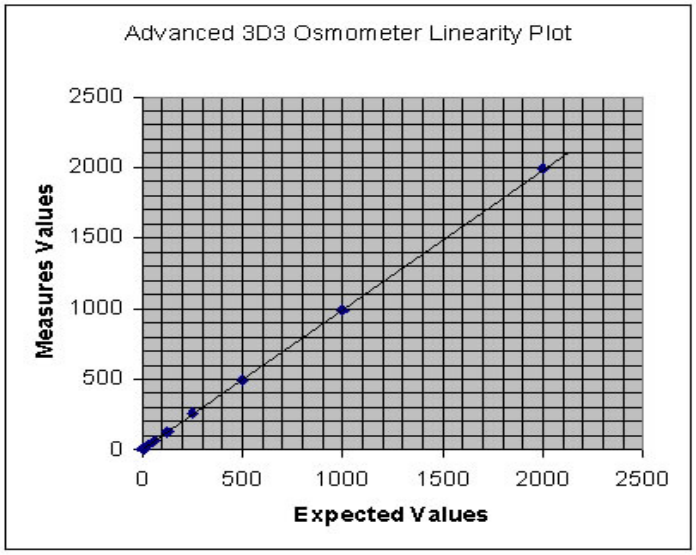
A linearity study was completed using the calibration standards; results are reported in Table 1 and Figure 1.

Table 1 - Linearity

Expected	Measured
2000	1991
1000	988
500	494
250	261
125	128
62.5	67
31.25	36
15.62	20
7.81	11
3.90	7
1.95	5
0.98	4

R = 0.9999
Slope: 0.9916
Intercept: 3.89

Figure 1



In-Run Precision [2]

Ten same lot samples of Mountain Dew and Diet Mountain Dew were run, alternating between the two types to check precision as well as carry-over. Results are given in mOsm/kg (see Table 2, next page). The low Coefficient of Variation (C.V.) values at both ends of the measurement range demonstrate excellent reproducibility.

Table 2 - Within-Run Precision

Advanced 3D3 Osmometer Within Run Precision		
Sample #	Diet Mt. Dew	Mt. Dew
1	27	804
2	27	801
3	27	808
4	27	807
5	27	806
6	26	806
7	26	805
8	27	805
9	26	808
10	27	809
CV	**1.7%**	**0.3%**

Beverage Baseline Database [2,3,4]

A comprehensive osmolality beverage database was needed as the first step in investigating beverage tampering with low molecular weight psychoactive substances. 146 beverages were tested. Whenever possible, 16 - 20 oz plastic, screw cap beverages were selected, as these are the most likely to be adulterated for illicit purposes. 8 oz "energy drinks" in non-resealing metal cans were also tested. [Note: The full database of results is available as an Excel Spreadsheet for download (contact the author if interested).]

Sports beverage results were interesting. Although producers of sports beverages claim their products are "isotonic" (approximately equal to serum values of 275 - 295 mOsm/kg), none of the tested beverages were actually in this “physiological range”. One sports beverage had a value of 190 mOsm/kg. The remaining eleven ranged from 361 - 428 mOsm/kg. Summarized results are reported in Table 3.

Table 3 - Beverage Osmolality Database [mOsm/kg]			
Beverage Type	Range	Average	Number
Water; Purified, Mineral, Tap	0-28	7	10
Diet; Sodas, Teas	13-44	29	19
Fruit Waters	24-39	36	5
Brewed Coffee [Black]	28-53	39	7
Sports Beverages	190-428	390	12
Sugar Containing Sodas, Fruit Drinks	537-1112	760	95
Energy Drinks; Red Bull, etc	673-1030	878	5

Most commercial beverages are produced at multiple locations across the country - and in some cases, across the world. To determine the validity of using baseline data across the U.S., several different lots of each beverage from different bottling locations were checked. Data for Pepsi and Diet Pepsi are reported in Table 4 (next page). The results show some variability, but good overall consistency. However, when possible, using a control beverage in order of preference: Same lot number / same bottling location / same country is (slightly) preferred when analyzing a specific beverage tampering cases. [Note: International variability was not checked in this study, and may be significant due to different formulations in use outside the U.S.]

Table 4 - Beverage Osmolality Database [mOsm/kg]							
Beverage	Osmol	Date	City, State	Beverage	Osmol	Date	City, State
Pepsi [2]	711	10/01	Augusta, ME	Diet Pepsi [2]	13	10/01	Buffalo, NY
Pepsi [2]	713	11/01	Rochester, NY	Diet Pepsi [2]	14	11/01	Rochester, NY
Pepsi [4]	726	6/01	Rochester, NY	Diet Pepsi [2]	15	11/01	Rochester, NY
Pepsi [2]	726	11/01	Buffalo, NY	Diet Pepsi [2]	20	10/01	Augusta, ME
Pepsi [2]	737	10/01	Portland, ME	Diet Pepsi [4]	27	6/01	Rochester, NY
				Diet Pepsi [2]	32	10/01	Portland, ME

Consumer Products Database [2]

A sampling of mouthwashes, breath drops, and eye drops were tested to determine if osmolality might be useful for forensic cases. LSD is often dosed from small dropper bottles that originally contained eye drops or breath drops. Results are reported in Table 5. Because LSD (a very high molecular weight substance) would have minimal osmolality, the finding of a very low osmolality value for a submitted exhibit of these products would indicate probable possible substitution of a water-based fluid containing LSD for the original product. Note that to prevent swelling or shrinking of the eye, eye drops are formulated to match the osmolality of natural tears; this explains their relatively low average osmolality value versus mouthwashes and breath drops. However, even this low value is much higher than a dilute aqueous solution of LSD.

Table 5 - Consumer Products Osmolality Database [mOsm/kg]			
Type	Range	Average	Number
Mouthwash	2660-4900	3683	6
Breath Drops	13950-14130	14040	2
Eye Drops	270-293	285	3

Estimated Osmolality Increases from Substances of Forensic Interest

The osmolality of an adulterated beverage will be increased above its baseline in proportion to the concentration of the agent used and that agent's molecular weight. Estimated osmolality values are reported in Table 6 (next page). Note that (where applicable) the presented results apply only to the free acid form of the material. Because of the dissociation of salt forms in solution, their actual osmolality values would be expected to be higher, in proportion to the molecular weight and concentration of each of the components. For example, a 10 percent solution of sodium γ-hydroxybutyrate, MW=126.1, completely dissociated in an aqueous solution, produces 18.2 grams of sodium cation and 81.8 grams of γ-hydroxybutyrate anion per liter. The resulting expected osmolality would therefore be 1577 mOsm/kg.

Beverage Tampering with GBL, BD [2]

To determine the effect of GBL and BD on the osmolality of beverages, 20 percent V/V solutions of GBL and BD in distilled water were prepared. Using Mountain Dew and Diet Mountain Dew as test beverages, each was spiked with concentrations of GBL and BD to give final solutions ranging from 0.5 - 10 percent. The osmolalities were measured and compared to the average beverage baseline measurements. The results are reported in Tables 7 and 8 (both on next page).

Table 6 - Estimated Osmolality Values [mOsm/kg]			
Substance	MW	1% Solution	10% Solution
Methanol	32.04	312	3121
Ethanol	46.07	217	2170
Acetone	58.08	172	1722
Isopropanol	60.09	164	1664
Ethylene Glycol	62.07	161	1611
GBL [γ-butyrolactone]	86.09	116	1161
GHB-Aldehyde [γ- hydroxybutyraldehyde]	88.11	113	1135
1,4-BD [1,4-Butanediol]	90.12	110	1110
GABA [γ-Aminobutyric Acid]	103.12	97	970
GHB [γ-hydroxybutyrate]	104.11	96	961
Methyl-GHB [4-hydroxyvalerate]	118.13	85	846

Table 7 - Mountain Dew				
GBL Spike	mOsm/kg		1,4-BD Spike	mOsm/kg
10%	1856		10%	Over-range
5%	1378		5%	1376
2%	1042		2%	1036
1%	930		1%	925
0.5%	868		0.5%	867
Baseline	805		Baseline	805

Table 8 - Diet Mountain Dew				
GBL Spike	mOsm/kg		1,4-BD Spike	mOsm/kg
10%	1332		10%	1358
5%	699		5%	671
2%	299		2%	279
1%	168		1%	152
0.5%	100		0.5%	91
Baseline	33		Baseline	33

Illicit use of these chemicals for recreation or for facilitation of sexual assault typically involves ingestion of 1 - 3 grams. “Dosing bottles” are usually diluted to about 30 percent of the psychoactive material; thus, a 6 mL "capful" from a "dosing bottle” contains one dosage unit. At this concentration, the “dosing bottle” solution would need to be diluted 1:5 with distilled water for testing purposes, as a 30 percent solution would exceed the osmometer’s upper measurement limit. At the lower concentrations, however, the results verify that adulterating a beverage with GBL or BD even at a level of only 0.5 percent will cause a measurable increase in the osmolality. This verifies that addition of one “dose” (1 - 3 grams) from a “dosing bottle” to a 16 - 20 oz. beverage will be detectable. This is important, because dilution into beverages is a typical route of administration for purposes of sexual assault, as the beverage flavor tends to disguise the “plastic” taste of the chemical (which has been described as akin to the taste of water from a garden hose left out on a hot day).

Ethanol in Soda-Type Beverages [2]

Numerous reports have indicated that some high school students occasionally "spike" their lunch beverages with alcoholic beverages. We therefore investigated the effect of ethanol on beverage osmolality. One oz [30 mL] of 80 proof vodka was added to 20 oz [590 mL] bottles of Mountain Dew and Diet Mountain Dew. Vodka was selected because it has almost no odor, and it is therefore the alcoholic beverage of choice for surreptitious adulteration by underage drinkers. One oz was selected as the minimum amount of alcohol that would probably be used, as being equivalent to one mixed bar drink. Actual adulteration amounts would likely be higher. The results are as follows:

Mountain Dew:	Baseline - 807 mOsm/kg,	With Vodka Spike - 1174 mOsm/kg
Diet Mountain Dew:	Baseline - 26 mOsm/kg,	With Vodka Spike - 332 mOsm/kg

The Case of the Missing Demerol [3]

Theft of Demerol and other controlled substances by health care professionals is a recurring problem across the U.S. In June 1989, the author (working at the toxicology lab of St. Mary's Hospital in Rochester, New York) received a call from the Drug Enforcement Administration (DEA) regarding a Demerol theft investigation. A number of patients at a local hospital were complaining that they still had pain even after receiving their Demerol injections. Toxicology studies suggested that they had not in fact received any Demerol, implying diversion/theft by a nurse or other health-care professional. Hundreds of nurses were working at any one time, and they often worked on different nursing stations. To identify a suspect, the case agent systematically switched all nurses' floor schedules over several days. This process demonstrated that the patient complaints only occurred when a certain nurse was on duty. The case involved 75 mg Demerol syringes. The agent reasoned that the Demerol was being removed and used by the nurse, and a unknown liquid placed back in the syringe for patient injection. Because no patient became ill, it was felt that the nurse was using one of four sterile solutions as the replacement. The agent wanted to know exactly which of the four solutions was being used so that he could confront the suspect from a basis of fact and thereby elicit a confession. The available solutions included two normal salines and two sterile waters. Osmolality and specific gravity testing were performed on a control (untampered) Demerol syringe solution, on a suspect (tampered) Demerol syringe solution, and on all four sterile solutions. An independent quantitative analysis on the suspect Demerol solution confirmed that it only had 3.9 mg of Demerol remaining - consistent with a single plunger removal of Demerol and refill with one of the sterile solutions. The osmolality and specific gravity results are reported in Table 8.

Table 8 - Osmolality and Specific Gravity Measurements in the Missing Demerol Case

Sample	Osmolality [mOsm/kg]	Spec. Gravity
75 mg Demerol Control Syringe	429	1.037
75 mg Demerol Suspect Syringe	**381**	1.011
Abbott Bacteriostatic Saline	**374**	1.010
Lyphomed Saline	291	1.004
Quad Bacteriostatic Water	93	1.005
Abbott Sterile Water	1	1.000

As the results show, the specific gravity testing had limited usefulness because it could not unambiguously differentiate between all solutions. However, the osmolality testing demonstrated that Abbott Bacteriostatic Saline was most likely used to refill the syringe. The observed 381 mOsm/kg result in the suspect syringe (slightly higher than the Abbott solution), was probably due to the slight effect of the 3.9 mg of Demerol still remaining in the solution. Upon confrontation with the evidence, the nurse admitted her guilt. With the

exception of osmolality, no other laboratory method available at that time could have been employed to differentiate between different brands of saline and water. Osmolality would clearly be a useful technique for similar, current cases of controlled substance thefts from hospitals, pharmacies, doctors' offices, and similar stocks.

Additional Potential Forensic Applications

Identification of Sugar-Based Beverages Substituted for Diet Beverages [2,4]

The accidental or purposeful substitution of a sugar-based beverage for a diet (sugarless) beverage can be harmful to a diabetic individual. Several different lots of Pepsi and Diet Pepsi were tested to determine if it would be possible to differentiate the sugar based beverage from the diet beverage. The results are as follows:

Pepsi:	711-737 mOsm/kg	(n=5)
Diet Pepsi:	13-32 mOsm/kg	(n=6)

Although only 11 different lots were tested, there is clearly enough difference between the two types of beverages to allow a reasonable determination of diet versus sugar-based.

Poisoning of Domestic Pets' Water with Ethylene Glycol

Dogs and cats are very sensitive to the poisonous effects of antifreeze (which contains ethylene glycol). Fatal amounts are 1.4 mL/kg for cats and 6.6 mL/kg for dogs [5]. The sweet odor and taste of ethylene glycol makes it very attractive to animals, and it is therefore a particularly insidious poison. Osmolality is a very useful initial screen for suspect solutions in that it will detect the presence of ethylene glycol (and also other alcohols) at very low levels in water. Based on ethylene glycol's molecular weight of 62.02, a 1 percent solution in water would read 161 mOsm/kg, versus a typical tap water value of approximately 3 mOsm/kg.

Identification of Water [2,3,4]

Water is submitted on occasion to crime laboratories. Although osmolality cannot detect the presence of large molecular weight compounds in water at low concentrations [i.e., most "classic" street drugs], it is an excellent tool to identify that a submitted solution is water. Most waters tested ranged from 0 - 8 mOsm/kg. Only high-mineral content spring waters had higher values, up to 28 mOsm/kg. Non-water solvents will not freeze and no result will be obtained. Any polar solvent mixed into water will greatly increase its osmolality. Acids and bases that have been added to the water will increase the osmolality and also give a pH change. For example, a solution of 1 mL of Chlorox [5 percent hypochlorite] in 100 mL of distilled water, has a pH of 10.5 and an osmolality of 43 mOsm/kg. A solution of 1 mL of 12N HCl in 100 mL of distilled water has a pH of 1.0 and an osmolality of 243 mOsm/kg. A 1 percent solution of ethanol in distilled water has a osmolality of 158 mOsm/kg.

Field Testing

With results available within 15 minutes after plug-in, on only 0.25 mL of sample, the Advanced 3D3 Osmometer instrument used in this study (or any equivalent osmometer) can be easily adapted for field testing at large concert events from police D.U.I. vans. This would allow rapid beverage screening before submission of case samples to the crime lab.

Limitations

"Date-Rape" Benzodiazepines in Solution [2]

As previously mentioned, the high molecular weight of common "classic" street drugs, and their low concentration in submitted solutions, makes osmolality an ineffective screening tool for their identification. For example, a single methylphenidate (Ritalin) tablet containing 5 mg of active drug and weighing 91 mg, produced a measured osmolality of only 11 mOsm/kg when dissolved in 30 mL distilled water. Therefore, osmolality is not viable for detection of drink tampering with, e.g., flunitrazepam (Rohypnol) or other sedative benzodiazepines that are employed for drug facilitated sexual assault.

Urine in Beverages [6]

Beverages are occasionally maliciously adulterated with urine. The osmolality of an individual's urine varies widely [50 - 1400 mOsm/kg] and greatly depends on the person's degree of hydration. Urea, the compound of highest concentration in the urine, varies from 0.7 - 3.3 g/100 mL, and is a better indicator of tampering than osmolality. Although a typical random urine volume of 4 - 8 oz [118 - 237 mL] may be produced, let us assume 1 oz [30 mL] was introduced into a 50 oz pot of coffee[1480 mL]. The resulting urea levels would be 14 - 67 mg/100 mL. This is easily measured with a typical urea analysis method, which usually have a dynamic range of 2 - 212 mg/100 mL.

Saliva in Beverages [3]

Similarly, beverages are occasionally maliciously adulterated with saliva. Amylase, which is present in very high levels in saliva [20,000 units/100 mL], is a better indicator of beverage adulteration with saliva versus osmolality. A typical 0.5 mL "spit" volume in an 8 oz [237 mL] cup of coffee would result in a measured amylase of 422 units/100 mL. This is easily measured with an amylase method having a dynamic range of 1-200 units/100 mL.

Conclusions

With ever increasing case loads and limited personnel resources, crime laboratories need efficient new tools to process the disturbing increases in liquid sample submissions. Osmolality, an effective analytical tool of the hospital laboratory and food and consumer products industries, is a low cost, rapid, facile, and non-destructive screening tool for forensic chemists and toxicologists.

Acknowledgements

Special thanks to Don Wiggin from Advanced Instruments for the loan of the 3D3 osmometer, and to the Rochester Institute of Technology and Drug ID Systems for providing the samples for testing.

References

1. The Advanced Osmometer Model 3D3 User's Guide, Advanced Instruments Inc, Norwood, MA (2000).

2. J. Wesley, Unpublished Data, Drug ID Systems, Inc., Rochester, NY using an Advanced 3D3 Osmometer (2001).

3. J. Wesley, Unpublished Data, St. Mary's Hospital Toxicology Lab, Rochester, NY using an Advanced 3D2 Osmometer (1985-1990).

4. T. Senosi, Rochester Institute of Technology, Rochester, NY using an Advanced Wide Range 3W2 Osmometer (2000-2001).

5. L. Tilley, The Five Minute Veterinary Consultant, 2nd Ed. (2000).

6. N. Tietz, Fundamentals of Clinical Chemistry, 3rd Ed, W.B. Saunders Co. p. 961 (1987).

* * * * *

Psychotria Viridis - A Botanical Source of Dimethyltryptamine (DMT)

Robert D. Blackledge, M.S.*
Naval Criminal Investigative Service Regional Forensic Laboratory
3405 Welles Street, Suite 3
San Diego, CA 92136-5018
[e-mail: rblackle@ncis.navy.mil]

Charlotte M. Taylor, Ph.D.
Missouri Botanical Garden
P.O. Box 299
St. Louis, MO 63166-0299
[e-mail: charlotte.taylor@mobot.org]

ABSTRACT: Dimethyltryptamine was identified by GC/MS in a sample of dried leafy material that was subsequently identified as *Psychotria viridis* (Rubiaceae), a tropical shrub native to Central and South America that has ethnobotanical use as a hallucinogen by many indigenous peoples of tropical South America. The botanical characteristics of *Psychotria viridis* are illustrated and described.

KEYWORDS: *Psychotria viridis*, Dimethyltryptamine, DMT, *Banisteriopsis caapi*, *Ayahuasca*

Introduction

The Naval Criminal Investigative Service Regional Forensic Laboratory (NCISRFL) in San Diego, California recently received several items that investigators had obtained from a U.S. Marine stationed in Yuma, Arizona. Item A (see Figure 1) consisted of a self-sealing plastic bag containing dried whole leaves mostly still attached

Figure 1 - A Portion of the Sample as Received

to stem pieces. Analysis by macro and microscopic examination indicated that the material clearly was not marijuana, nor were there any visible signs that anything had been added to the leaves.

Experimental

Approximately 1 gram of dried leaf material was placed in a glass beaker and covered with about 3 mLs of methanol. The beaker was then heated on a hot plate in a fume hood. When the methanol volume had been reduced to about 0.5 mL, the beaker was removed from the hot plate and 1µL of the remaining extract was injected into a Hewlett-Packard 5890 Gas Chromatograph (Palo Alto, CA) equipped with a 5971 Mass Selective Detector and fitted with an HP-1 capillary column (crosslinked methyl silicone, 20 m x 0.25 mm i.d. x 2.65 µm film thickness). The column oven temperature was programmed from an initial temperature of 70˚ C (held for 2 min) to 200˚ C at 10˚ C/min, then held at 200˚ C for the final 2 minutes.

Results

The total ion chromatogram revealed just one strong peak above the background, as shown in Figure 2. The mass spectrum of this peak is shown in Figure 3. A library search gave N,N – dimethyltryptamine (DMT) as the

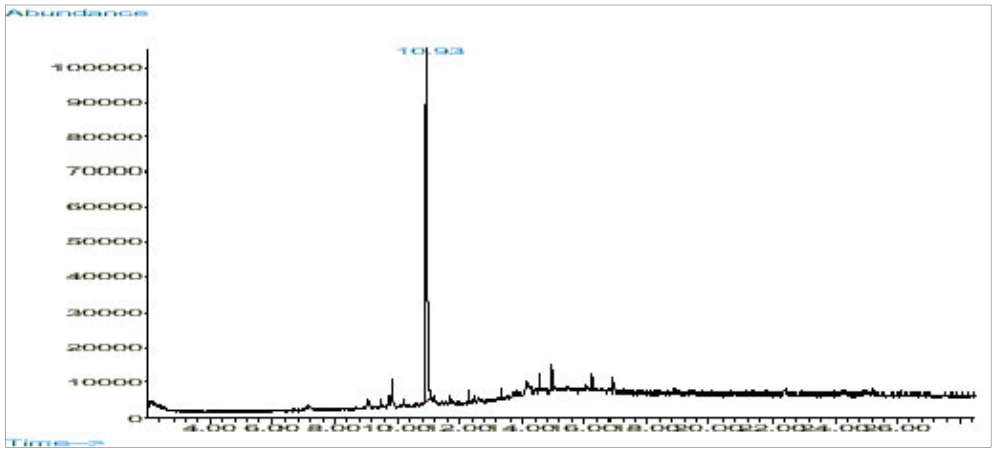


Figure 2 - Total Ion Chromatogram of a Methanol Extract

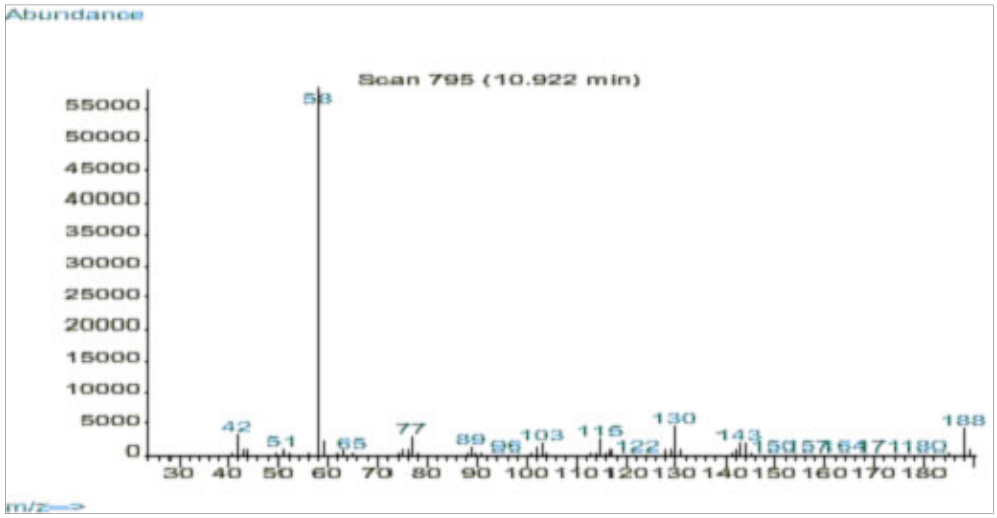


Figure 3 - Mass Spectrum of Dimethyltryptamine (Major Peak)

closest hit. The identification of DMT was confirmed when subsequent injection of a DMT standard produced a matching spectrum at the same retention time. DMT, an hallucinogen, is a Schedule I Controlled Substance. The dried leaves and stems were in good condition for botanical evaluation, and were matched to reference specimens of *Psychotria viridis* from Peru. DMT is known to be present in *Psychotria viridis* (1,2).

Ethnobotanical Use of Psychotria viridis

A narcotic drink often called *ayahuasca* or *caapi* is made from an infusion of the bark of the so-called "Spirit Vine", *Banisteriopsis caapi* [(Spruce ex Griseb.) C.V. Morton, Malpighiaceae] and related species of tropical rainforest lianas, by many indigenous peoples of the Amazon River basin and northwestern South America (2,3). *Ayahuasca* contains several hallucinogenic alkaloids, including harmine and harmaline, and is widely used in traditional medical rites and mystical and religious ceremonies as a purgative, a magic hallucinogen, and for prophecy, diagnosis, and telepathy. Other plants are frequently added to the infusion to alter and/or enhance the effects of the *Banisteriopsis* hallucinogens. A commonly used admixture is another plant containing DMT, which reportedly increases the intensity and duration of the *ayahuasca* intoxication. DMT is found in several plant species that grow in the same region as *Banisteriopsis*, including *Psychotria viridis*. Schultes and Hoffmann have detailed the botany, ethnobotany, and chemistry of *ayahuasca* and its common admixtures (3), and Casale and Koles have detailed the forensic analysis of a typical sample (4).

Botanical Identification

Psychotria is a large genus of shrubs and small trees found in tropical regions around the world (including about 1400 species, with perhaps 700 in the New World), and its taxonomy is somewhat complicated. Not surprisingly, several other New World tropical species are morphologically similar to *Psychotria viridis*, and at least some of these may also be used as admixtures in *ayahuasca* (3).

Psychotria viridis [Ruiz & Pav., Rubiaceae] can be recognized by a combination of features found on the vegetative portions of the plant, listed below and shown in Figure 1, although reproductive structures provide conclusive identification [see Figure 4 (next page) for illustrations of the reproductive characters]. *Psychotria viridis* grows naturally in wet lowland tropical forests in Cuba and northern Central America through western and central South America; it appears to be most common in Amazonian Peru and Bolivia. Because the genus *Psychotria* includes a large number of morphologically similar species, and there are other genera of the same plant family that are similar, the presence of all the characteristics listed below is needed to conclusively identify *Psychotria viridis*. Botanical identification of shredded or powdered material, or even leaves without stems, would be challenging.

· **Stems.** In the middle and lower parts of the stem, situated between the insertion points of the two opposite leaves there is a horizontal scar 0.3-1 mm wide that extends between the leaves (or leaf scars) and sometimes also connects over the tops of these scars, and along the top side of this scar there is a dense, usually furry line of fine trichomes (i.e., plant hairs) usually 0.5-1 mm long that are reddish brown when dried (Figure 4A). This combination of features is diagnostic for many species in the genus *Psychotria*, though not for any individual species [i.e., these features distinguish *Psychotria* L. Subg. *Psychotria*; other subgenera of *Psychotria* lack the well developed reddish brown trichomes inserted above the stipule scars]. On the upper stems of *Psychotria viridis* these features are obscured by a stipule (see below), which covers the trichomes; the scar actually marks the point where this structure has fallen off.

· **Stipules.** These are leafy structures that cover and protect the young developing leaves, then fall off leaving scars on the stem. The stipules are produced in pairs, and their form is distinctive for *Psychotria viridis*: They are 5-25 x 4-12 mm, elliptic in outline, sharply angled at the apex, papery to [continued on page 22]

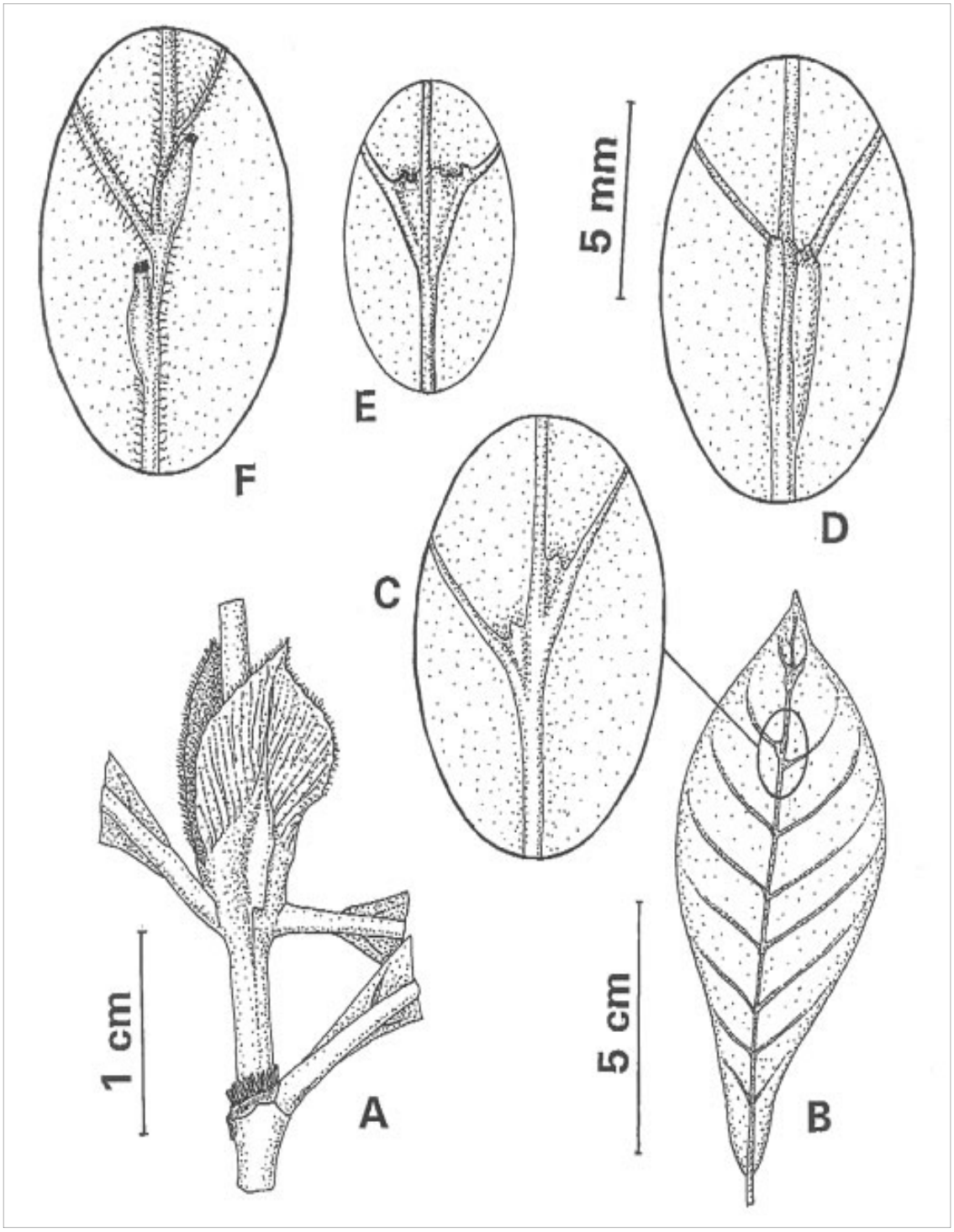


Figure 4 - Vegetative characters of *Psychotria viridis*. A, Portion of upper stem showing, from top, a pair of well developed stipules, the bases of a pair of leaves, a stipule scar with a fringe of trichomes above it, the base of another leaf, and the scar of this last leaf's pair that has fallen off. B, Leaf, underside view with a pair of foveolae circled. C, Enlarged view of foveolae from leaf shown in B. D, Enlarged view of foveolae from the forensic sample discussed in this article. E, Enlarged view of foveolae from a different botanical specimen of *Psychotria viridis*. F, Enlarged view of a different botanical specimen of *Psychotria viridis*. C, D, E, F to 5-mm scale. A, B, C based on *N. Ritter and Wood 3702* (MO), from Bolivia; E, *Gentry and Jaramillo 57585* (MO), Peru; and F, *Solomon and Urcullo 14103* (MO), Bolivia.

membranaceous in texture, ciliate (i.e., fringed) along the upper margins, and longitudinally flanged or winged along the middle (Figure 4A). However, stipule shape and size is quite variable among different plants, and also depends on the stipule's developmental stage and other factors such as whether the stem that produced it is reproductive or vegetative.

· **Leaves.** These (Figure 4B) are opposite in arrangement (i.e., produced in pairs along the stems), generally 5-15 x 2-6 cm, in outline generally elliptic or often widest above the middle, usually sharply angled at base and apex, papery in texture, overall smooth or infrequently with microscropic plant hairs on the lower surface, have 5-10 pairs of secondary veins, and on the lower surface usually have foveolae (see next item). The leaves are borne on petioles (i.e., leaf stalks) generally 1-10 mm long. When dry, the leaves of *Psychotria viridis* usually are gray or reddish brown. The leaves of *Psychotria viridis* are similar to a few other New World species of *Psychotria*.

· **Foveolae.** These are small pockets found on the lower leaf surface near the junction of the secondary (i.e., side) veins with the central vein. They function as shelter for tiny invertebrates such as mites that live on the plant leaf. These mites apparently often are symbiotic with the plant, taking shelter in these structures and eating fungi and herbivorous invertebrates that can damage the leaf. The foveolae (also called domatia) are distinctive for *Psychotria viridis* and a few related species: They are generally 1.5-5 mm long and 0.5-1 mm wide at the top, conical and tapered to a closed base, open and truncate or variously ornamented at the top, and situated along the sides of the central vein with the opening usually near a secondary vein (Figure 4C). These foveolae vary in shape among different plants (Figure 4C, 4D, 4E, 4F), and in number on individual leaves, and may not even be present on some leaves. Most often each leaf bears at least one pair of foveolae, which may be close to the apex; the foveolae are often more numerous on leaves from vegetative stems than on those from reproductive stems.

Conclusions

How does a U.S. Marine obtain plant material that grows in the Amazon basin? The suspect refused to cooperate, but an Internet sales contact was the most likely source. *Psychotria viridis* leaves in various forms (whole, broken, finely powdered, shredded) reportedly exported from Peru are offered for sale on the Internet.

References

1. Bruneton J. Pharmacognosy Phytochemistry Medicinal Plants, 2nd. ed. Lavoisier Publishing Inc. (c/o Springer-Verlag), Secaucus, NJ, 1999 (transl. C.K. Hatton).

2. Duke JA, Vásquez, R. Amazonian Ethnobotanical Dictionary. CRC Press, Boca Raton, FL, 1994.

3. Schultes RE, Hoffmann A. The Botany and Chemistry of Hallucinogens, 2nd ed. Charles C. Thomas, Springfield, IL, 1980.

4. Casale JF, Koles JE. Analysis of ayahuasca ('Santo Daime'). Microgram 1995;28(9):296.

Evaluation of Ninhydrin Analogues and Other Electron-Deficient Compounds as Spray Reagents for Drugs on Thin Layer Chromatograms

Myriam Azoury*, Avraham Zelkowicz, and Zafrir Goren
Division of Identification and Forensic Sciences
Analytical Chemistry Laboratory
Israel Police National Headquarters
Jerusalem 91906, Israel
[email: miriama@vms.huji.ac.il]

Joseph Almog
Casali Institute of Applied Chemistry
The Hebrew University of Jerusalem, Israel

ABSTRACT: Twenty-four electron-deficient compounds were evaluated as potential spray color-reagents for basic drugs on TLC plates. Two of them, 4-chloro-7-nitro-2,1,3-benzoxadiazole and 5,6-dimethoxyninhydrin, were superior to ninhydrin with respect to sensitivity and selectivity, and offer considerable potential.

KEYWORDS: Thin Layer Chromatography, TLC, Spray Reagents, Ninhydrin, Illicit Drugs

Introduction

Since the discovery by Dutt and Teo[1] that spraying thin layer chromatographic (TLC) plates bearing drug spots with ninhydrin produces a variety of colors that can distinguish between many drugs, this reagent has been intensively used in this laboratory. The colors that are produced with ninhydrin, when correlated with the specific migration values (R_f) for each spot on specific TLC plates and using select solvent systems, greatly enhance the specificity of TLC for various drugs.

In forensic laboratories, the main use of ninhydrin as a spray reagent has been for detection of fingerprints, especially on porous surfaces such as paper and cardboard.[2-4] However, despite its great utility, research has continued to develop even more sensitive or selective reagents. Over the last two decades a significant number of ninhydrin analogous and similar, electron deficient compounds have been synthesized and evaluated as fingerprint reagents. Some of these new reagents have displayed superior properties versus ninhydrin in their sensitivity to amino acids and latent fingerprints, particularly in the fluorescence mode.[2-7]

The aim of the present study was to evaluate some of these new fingerprint detection reagents for drug detection on TLC plates. The development of new, more intense, or fluorescent colors for various drugs would increase the overall specificity and sensitivity of drug-screening TLC. Such reagents could also discriminate between drugs that produce the same color with ninhydrin.

Experimental

Drugs

The controlled substances examined in this study included the following pharmaceutical and illicit drugs: Cocaine HCl and morphine HCl (Merck, Germany), diazepam, flunitrazepam, codeine phosphate, and methadone

HCl (Teva, Israel), lysergic acid diethylamide (LSD) (Sigma, Israel), amphetamine (Assia Chem Laboratory, Israel), heroin base, opium, and 3,4-methylenedioxymethamphetamine (MDMA) HCl (from DIFS case files), and methamphetamine, 3,4-methylenedioxyamphetamine (MDA) HCl, and 3,4-methylenedioxyethylamphetamine (MDEA) HCl (synthesized at DIFS). Similar aliquots (same concentration) of each drug were deposited on TLC plates for comparison.

Imaging Reagents

Twenty-four potential imaging reagents were tested (see Table 1, on pages 25 - 27, for names, sources, and structural formulas). Like ninhydrin, all the compounds that were studied are molecules with electron-deficient cores. Also like ninhydrin, most of them possess the indane-dione skeleton; the remainder have quininoid or cyclobutenedione type structures. All reagents were dissolved in 95% ethanol to reach testing concentrations from 0.5 - 10%.

TLC, Elution Solvents, and Spray Reagents

TLC was carried out on standard silica gel plates (10 x 20 cm) containing a fluorescent indicator (254 nm) on aluminum support (Macherey-Nagel, Germany). A dioxane:xylenes:ethanol:ammonia (40:30:5:5) solvent mixture was used as the mobile phase in the developing tank. After the solvent elution, the plates were dried in an oven at 120ºC for 3 - 4 minutes, then cooled to room temperature. The plates were then sprayed with the reagent solution, then heated again for 10 minutes. The colors of the spots as well as background interferences were immediately recorded and photographed.

Methods

1st Stage

At the first evaluation stage, all 24 reagents were tested on TLC plates against five basic drugs: Heroin, cocaine, MDMA, diazepam, and flunitrazepam. At this stage the plates were not processed in the solvent system; rather, the drugs were spotted on the plates and the spots were treated with the reagents (5 - 10% w/v) via direct application using a pipette or cotton swab. When a color reaction was noted using these initial reagent concentrations, a lower concentration solution (0.5%) of the target reagent was attempted.

2nd Stage

At the second evaluation stage, only those reagents that had produced colored spots with at least one drug were investigated. At this stage, the selected color reagents were evaluated for all 14 of the above listed target drugs. In addition, in the second stage, each TLC plate bearing the drug spots was eluted using above specified the TLC solvent system, then sprayed with the reagent solution, then heated to 120ºC. The results were compared versus those obtained by the ninhydrin solution routinely used in the laboratory.

3rd Stage

In the third stage, experimental parameters were optimized for the successful color reagents identified at the second stage. The principal optimization parameters were reagent concentration and color development temperature. Ethanolic solutions of six concentrations (0.5, 1, 2, 3, 4 and 5% v/w) were prepared for each one of the successful reagents. Each successful reagent at each given concentration was tested against each drug that it had displayed a colored spot with in Stage 2, and after elution evaluated at different development temperatures (80, 100, 120, 130, 140, 160 and 200ºC). It was noted that while high reagent concentrations produced more intense colors, they also usually resulted in development of significant background colorations. High temperatures had a similar effect. Colors developed and background interferences were recorded for each set of experiments.

Table 1. Names, Sources, and Structural Formulas for Imaging Reagents
(continued on pages 21 - 22).

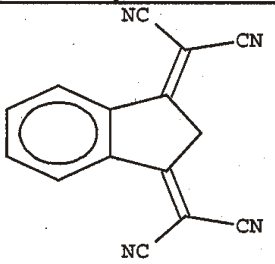
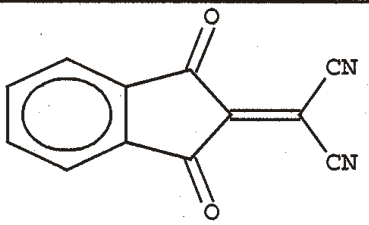
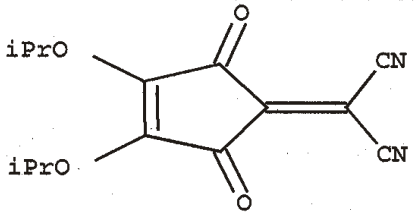
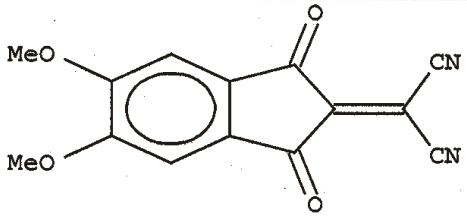
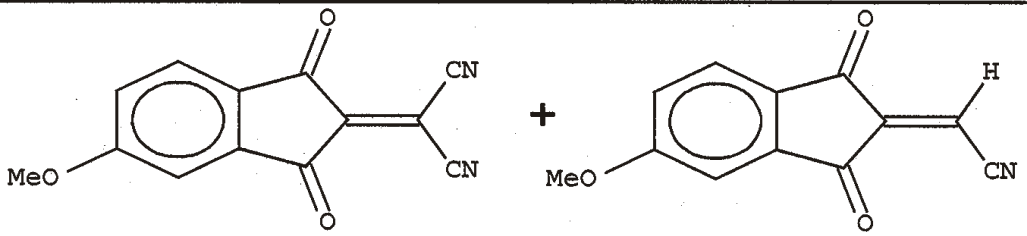
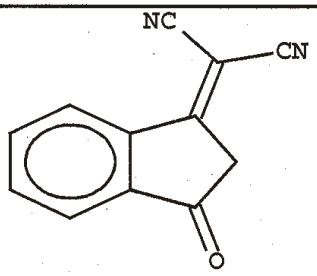
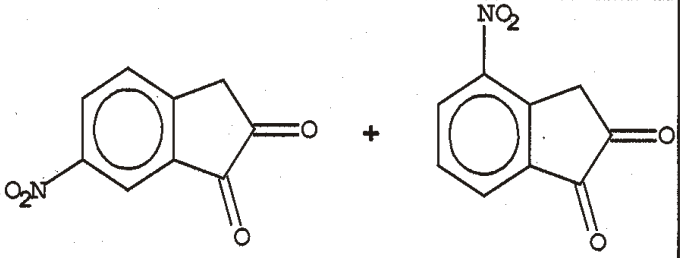
(A) [3-(dicyanomethylene)-2,3-dihydro-1H-inden-1-ylidene] malononitrile *source*: DIFS - synthesis[8]	**(B)** (1,3-dioxo-1,3-dihydro-2H-inden-2-ylidene) malononitrile *source*: DIFS - synthesis[8]
	
(C) (3,4-dimethyl-2,5-dioxocyclopent-3- en-1-ylidene) malononitrile *source*: DIFS - synthesis[8]	**(D)** (5,6-dimethoxy-1,3-dioxo-1,3-dihydro-2H-inden-2-ylidene) malononitrile *source*: DIFS - synthesis[8]
	
(E) (5-methoxy-1,3-dioxo-1,3-dihydro-2H-inden-2-ylidene) malononitrile + (2Z)-2-(5-methoxy-1,3-dioxo-1H-inden-2(3H)-ylidene) propanenitrile (mixture of 2 compounds) *source*: DIFS - synthesis[8]	
	
(F) (3-oxo-2,3-dihydro-1H-inden-1-ylidene) malononitrile *source*: DIFS - synthesis[8]	**(G)** A mixture of 4- and 6-nitro-1,2-indanediones *source*: DIFS – synthesis[12]
	

Table 1 (continued).

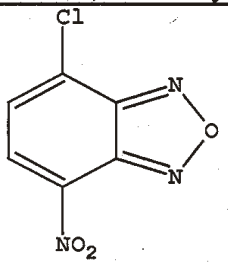
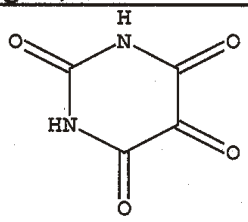
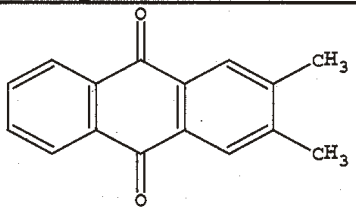
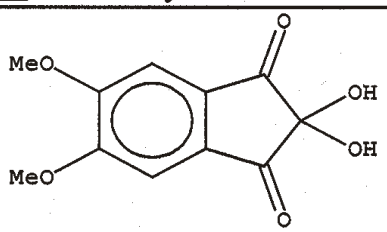
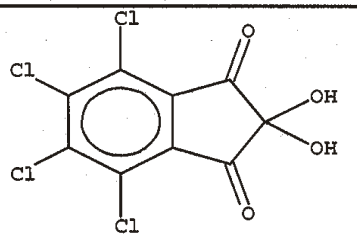
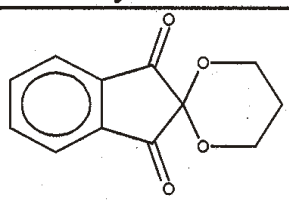
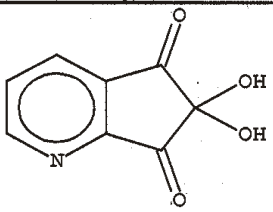
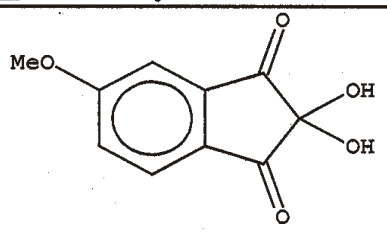
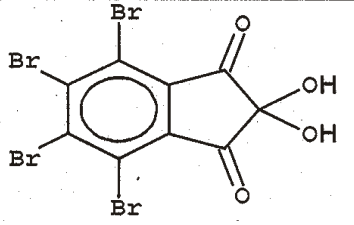
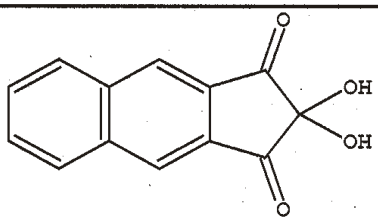
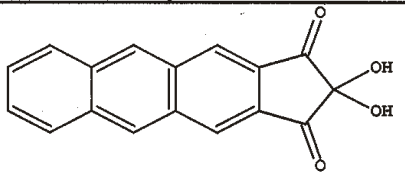
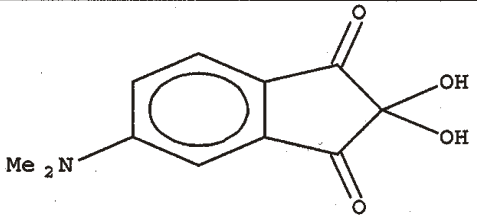
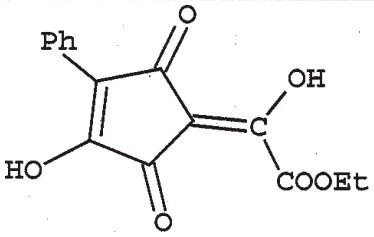
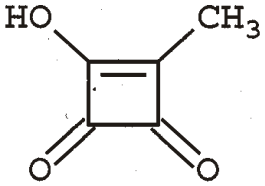
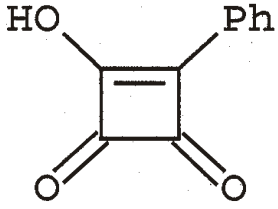
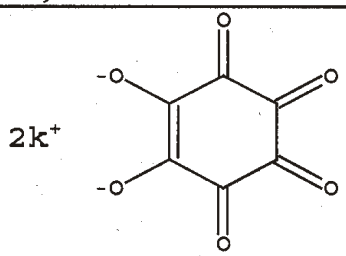
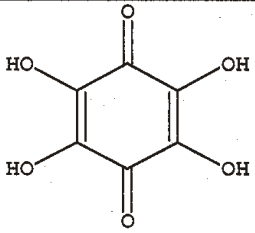
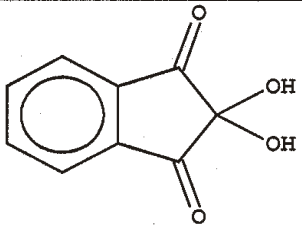
(H) 4-chloro-7-nitro-2,1,3-benzoxadiazole (*NBD-chloride*) *source*: Aldrich, Germany	**(I)** alloxan *source*: Sigma, Israel
	
(J) 2,3-dimethylanthraquinone *source*: Sigma, Israel	**(K)** 5,6-dimethoxyninhydrin *source:* DIFS - synthesis[9]
	
(L) 4,5,6,7-tetrachloroninhydrin *source*: Dr. A.A. Cantu, US Secret Service	**(M)** spiro[2,5-dioxacyclohexane-1,2'-indene]-1',3'-dione *(ninhydrin-2-trimethyleneketal)* *source*: DIFS - synthesis[10]
	
(N) pyridine analogue of ninhydrin *source*: DIFS – synthesis[12]	**(O)** 5-methoxyninhydrin *source*: DIFS - synthesis[11]
	
(P) 4,5,6,7-tetrabromoninhydrin *source*: Dr. A.A. Cantu, US Secret Service	**(Q)** benzo[f]ninhydrin *source*: DIFS - synthesis[12]
	

Table 1 (continued).

(R) naphtho[f]ninhydrin *source*: Prof. E.R. Menzel, Texas Tech. University, Lubbock, TX, USA	**(S)** 5-dimethylaminoninhydrin *source*: DIFS - synthesis[12]
	
(T) ethyl (2E)-hydroxy[3-hydroxy-2,5-dioxo-4-phenylcyclopent-3-en-1-ylidene]acetate *source*: Prof. R.C. West, Dept. of Chemistry, University of Wisconsin, Madison, USA	**(U)** 2-methyl-3,4- dioxocyclobut-1-en-1-ol *source*: Prof. R.C. West, Dept. of Chemistry, University of Wisconsin, Madison, USA
	
(V) 3,4-dioxo-2-phenylcyclobut -1-en-1-ol *source*: Prof. R.C. West, Dept. of Chemistry, University of Wisconsin, Madison, USA	**(W)** potassium rhodizonate *source*: Prof. R.C. West, Dept. of Chemistry, University of Wisconsin, Madison, USA
	
(X) 3,6-dioxocyclohexa-1,4-diene-1,2,4,5-tetrol *source*: Prof. R.C. West, , Dept. of Chemistry, University of Wisconsin, Madison, USA	**(Y)** ninhydrin *source*: Spectrum, USA.
	

Results and Discussion

Five of the twenty-four reagents examined at the first evaluation stage yielded a color reaction with at least one drug (see Table 2, next page). These were reagents **E** (mixture of 5-methoxy-1,3-dioxo-1,3-dihydro-2H-inden-2-ylidene) malononitrile and (2Z)-2-(5-methoxy-1,3-dioxo-1H-inden-2(3H)-ylidene) propanenitrile, **F** (3-oxo-2,3-dihydro-1H-inden-1-ylidene) malononitrile, **H** (4-chloro-7-nitro-2,1,3-benzoxadiazole), **K** (5,6-dimethoxy-ninhydrin), and **O** (5-methoxyninhydrin). Seven of the twenty-four compounds gave no visible reaction, and the remainder were rejected because of the development of intense background coloration.

At the second stage, the five preliminarily successful reagents listed above were evaluated for all 14 drugs. The results are summarized in Table 3 (see page 30), and are detailed below:

Reagent E (a mixture of 5-methoxy-1,3-dioxo-1,3-dihydro-2H-inden-2-ylidene)malononitrile and (2Z)-2-(5-methoxy-1,3-dioxo-1H-inden-2(3H)-ylidene)propanenitrile), at working concentrations of 1 - 5% w/v: A yellow background is observed and the sensitivity is low; therefore, the colored spots are weak in comparison with the background.

Reagent F ((3-oxo-2,3-dihydro-1H-inden-1-ylidene)malononitrile), at a working concentration of 2% w/v: Intense brown-red spots are observed, mostly with amphetamines. In contrast, opiates (heroin, morphine) and cocaine produce only low intensity red colored spots. No reaction is observed with LSD. At low drug concentrations, the red colored background interferes with the colored spots.

Reagent H (4-chloro-7-nitro-2,1,3-benzoxadiazole), at working concentrations of 1.5 - 2% w/v: Intense brown-purple spots are formed with amphetamines, yellow spots with narcotine and papaverine in opium, blue spots with heroin, and brown spots with cocaine. An intense color reaction is also observed with LSD. In general, the colors obtained are very similar to the colors developed with ninhydrin, but the sensitivity of **H** is higher; therefore, a lower reagent concentration is required.

Reagent K (5,6-dimethoxyninhydrin), at a working concentration of 0.5% w/v: Very intense spots are formed with amphetamines, LSD and methadone. Opiates (heroin, morphine) produce weak purple spots. Strong purple spots are formed by MDMA and MDEA. Amphetamine and MDA yield milky-yellow spots.

Reagent O (5-methoxyninhydrin), at a working concentration of 2.5% w/v: Intense purple spots are formed with amphetamines, while opiates and LSD produce only very weak purple spots. In addition, a pink background discoloration is observed.

Of the five above reagents, **H** and **K** showed better performance versus the other three, and were therefore selected for further investigation. Optimization trials were carried out with both **H** and **K** at various concentrations and color development temperatures. The optimized parameters for **H** are: A 3% solution (w/v) with color development at 120ºC. Under these conditions, opiates (heroin, morphine) can also be detected. The optimized conditions for **K** are: A 0.5-1% solution (w/v) with color development at 120ºC. Under these conditions, only amphetamines show strong color reactions. It is noted for comparison that ninhydrin is typically utilized as a 10% solution.

Conclusions

4-Chloro-7-nitro-2,1,3-benzoxadiazole and 4,6-dimethoxyninhydrin both show good potential as spray reagents for drugs on chromatographic plates. Both reagents show some advantage over ninhydrin in their reactivity, developing more intense colors at lower reagent concentrations. Furthermore, 5,6-dimethoxyninhydrin also produces two different colors with different amphetamines: Purple spots are formed by (continued on page 30)

Table 2. Results Correlated Against Structures.

Negative Results. No Color Development, and No Background Interference		Colored Spots with Background Discoloration				Colored Spots Without Background Interference			
U	B	R	A	L	C	E	K	F	O
V	D	S	J	N	T	H	P	G	Q
W	M	X	I						

Table 3. Correlation of Results of Most Successful Reagents Against 14 Selected Drugs.

Drug	Reagent					
	E 1%	**F** 2%	**H** 1-2.5%	**K** 0.5%	**O** 2.5%	**ninhydrin** 10%
Heroin	-	Red	Blue	-	Purple	Blue
Cocaine	-	Red	Brown	-	Purple	Beige
Diazepam	-	-	-	-	-	-
Flunitrazepam	-	-	-	-	-	-
LSD	-	-	Blue	Purple	Purple	Blue
Morphine	-	Red	Brown-purple	Purple	Purple	Blue
Codeine	-	Red	Brown-purple	Purple	Purple	Blue
Opium	-	-	5 compounds yellow/purple	Undefined color	Undefined color	5 compounds yellow/purple
Methadone	-	Red	Brown-purple	Purple	Purple	Brown
Methamphetamine	-	Red	Brown-purple	Purple	Purple	purple
Amphetamine	-	Purple	Brown-purple	Milky yellow	Purple	Beige-brown
MDMA	-	Brown-red	Brown-purple	Purple	Purple	Purple
MDA	-	Brown-red	Brown-purple	Milky yellow	Purple	Purple
MDEA	-	Brown-red	Brown-purple	Purple	Purple	Purple

methamphetamine, MDMA, and MDEA, and milky yellow spots are formed by amphetamine and MDA. A mechanistic study of these color formation reaction may lead to a rational design of even better reagents of this family.

Acknowledgments: The authors are indebted to Dr. Antonio A. Cantu, Chief Chemist, US Secret Service, to Professor Robert C. West of the Chemistry Department, University of Wisconsin, Madison, and to Professor E. Roland Menzel, Director of the Center for Forensic Studies, Texas Tech University, Lubbock, for kindly providing them with some of the compounds for testing. The authors also gratefully acknowledge Ms. Lital Cohen for her technical assistance.

References

1. Dutt MC, Teo TP. Use of ninhydrin as a spray reagent for the detection of some basic drugs on thin-layer chromatograms. J Chromatography 1980;195:133.

2. Joullie MM, Thompson TR, Nemeroff NH. Ninhydrin and ninhydrin analogues. Syntheses and applications. Tetrahedron 1991;47:8791 (and references therein).

3. Almog J. Fingerprint development by ninhydrin and its analogues. Advances in Fingerprint Technology, 2nd ed. Lee and Gaensslen, Editors, CRC Press, 2001 (and references therein).

4. Kent T, Editor. Manual of Fingerprint Development Techniques, 2nd ed. Sandridge, Home Office, 1998.

5. Lennard CJ, Margot PA, Stoilovic M, Warrener RN. Applications of ninhydrin analogues to the development of latent fingerprints on paper surfaces. Presented at the International Forensic Symposium on Latent Prints, FBI Academy, Quantico, Virginia, July 1987.

6. Lee HC, Gaensslen RE. Methods of latent fingerprint development. Advances in Fingerprint Technology, 2nd ed. Lee and Gaensslen, Editors, CRC Press, 2001 (and references therein).

7. Hark RR, Hauze DB, Petrovskaia O, Joullie MM. Synthetic studies of novel ninhydrin analogs. J Org Chem 2001;79:1632.

8. Fatiadi AJ. New applications of malononitrile in organic chemistry. Synthesis 1978(Part 1):165.

9. Almog J. Reagents for chemical development of latent fingerprints: Vicinal triketones - Their reaction with amino acids and with latent fingerprints on paper. J Forensic Sci 1987;32(6):1565.

10. Schonberg A, Singer E, Eschenhof B, Hoyer GA. Reaction of ninhydrin and of 1,2,3-indanetrione with compounds with two functional groups. A contribution to the formation of spiro compounds from ninhydrin. Chem Ber 1978;111:3058.

11. Almog J, Hirshfeld A. 5-Methoxyninhydrin: A reagent for chemical development of latent fingerprints that is compatible with the copper-vapor laser. J Forensic Sci 1988;33:1027.

12. Almog J, Hirshfeld A, Frank A, Sterling J, Leonov D. Aminoninhydrins: Fingerprint reagents with direct fluorogenic activity-preliminary studies. J Forensic Sci 1991;36(1):104.

* * * * *

Technical Note

Instrumental Separation of 3,4-Methylenedioxyamphetamine (MDA) from 1-(3,4-Methylenedioxyphenyl)-2-propanol, a Co-Eluting Compound

Barbara A. Vohlken* and Stephen M. Layton
Florida Department of Law Enforcement
Tampa Regional Crime Laboratory
4211-A North Lois Avenue
Tampa, FL 33614
[email: barbaravohlken@fdle.state.fl.us]

ABSTRACT: Analysis of a set of mixed-component Ecstasy tablets by GC/MS indicated an apparent mixture of 3,4-methylenedioxymethamphetamine (MDMA) and 3,4-methylendioxyamphetamine (MDA); however, the mass spectrum for the MDA did not exactly match an MDA standard. Additional work confirmed that the presumed MDA was actually a co-eluting mixture of MDA and 1-(3,4-methylenedioxyphenyl)-2-propanol. The latter alcohol has a mass spectrum that is highly similar to MDA, but displays a molecular weight peak of 180 (versus 179 for MDA). Varying the temperature programming of the normal GC/MS run separated the alcohol.

KEYWORDS: 3,4-Methylenedioxymethamphetamine, MDMA, 3,4-Methylenedioxyamphetamine, MDA, 1-(3,4-Methylenedioxyphenyl)-2-propanol, Ecstasy, GC/MS, Co-Elution

Introduction

Over the past few years, so-called "Ecstasy" tablets have undergone a dramatic transition in their composition. Five years ago, most Ecstasy tablets contained either 3,4-methylenedioxymethamphetamine (MDMA), 3,4-methylenedioxyamphetamine (MDA), or (less commonly), a mixture of MDMA and MDA. More recently, however, Ecstasy tablets have often contained complex mixtures of controlled substances, control substance analogues, alternate abused substances, adulterants, diluents, and manufacturing impurities and byproducts. These mixed component tablets can offer unusual analytical challenges.

In late 2001, this laboratory received an exhibit consisting of 11 white tablets with a three-point crown imprint on one side and unmarked on the other side (photo not available), total net mass 3.3 grams. The exhibit was seized just north of Tampa, Florida, but had no other associated source information. Analysis was conducted by color testing (Marquis, cobalt thiocyanate, and Dille-Koppanyi), thin layer chromatography (TLC) (Clarke's TB developer, visualized with acidified iodoplatinate), and gas chromatography/mass spectrometry (GC/MS). The color test results were consistent with typical (MDMA) type preparations. The Marquis test showed the usual purple, blue, and green colors, and the cobalt thiocyanate gave a slight blue reaction. After elution, spraying, and development, the TLC showed two spots consistent in both color and R_f to MDMA and MDA; however, a third spot was also noted. The first GC/MS run revealed four peaks, one with a retention time and mass spectrum corresponding to MDMA, a second with a retention time and mass spectrum very similar to MDA but with an apparent molecular ion at 180 instead of the expected 179 (for MDA), and two unknowns that did not correspond to any known controlled substances and were therefore not further analyzed. Closer examination of the "MDA" mass spectrum indicated that the fragment ion ratios at 135 relative to 136, and at 106 relative to 105, both appeared to be slightly higher than normally expected for MDA. The sample was then injected on a second GC/MS to determine if the anomalous results were an instrumental variation or a glitch of some type in the run. The second GC/MS run again revealed the same four peaks (see Figure 1, next page); the first compound (designated "A1" on Figure 1) had a retention time and mass spectrum very similar to MDA but still with the

apparent molecular ion at 180 instead of the expected 179. The second peak (designated "A2" on Figure 1) had a retention time and mass spectrum corresponding to MDMA. The two additional peaks ("A3" and "A4" on Figure 1) were also still present, but were not identified. The mass spectra of A1 through A4 are shown in Figures 2 - 5.

Figure 1.
Total Ion Chromatogram

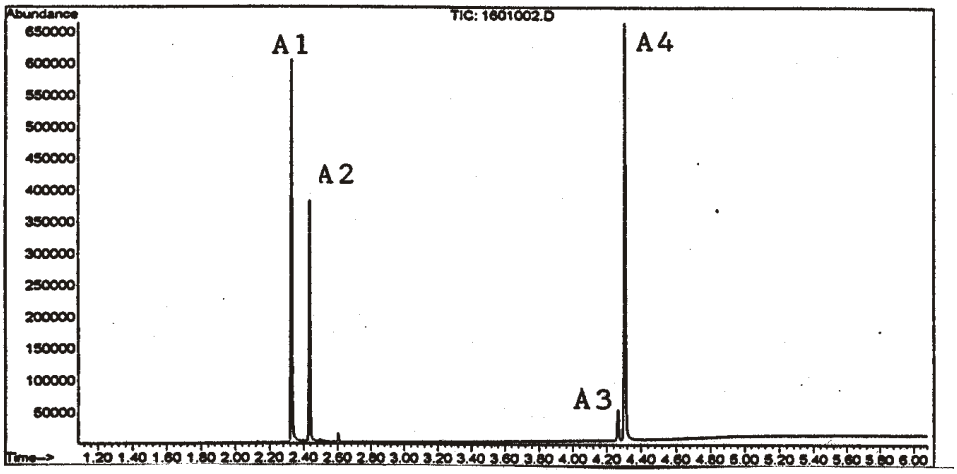


Figure 2.
Mass Spectrum of Compound A1 (Anomalous MDA).

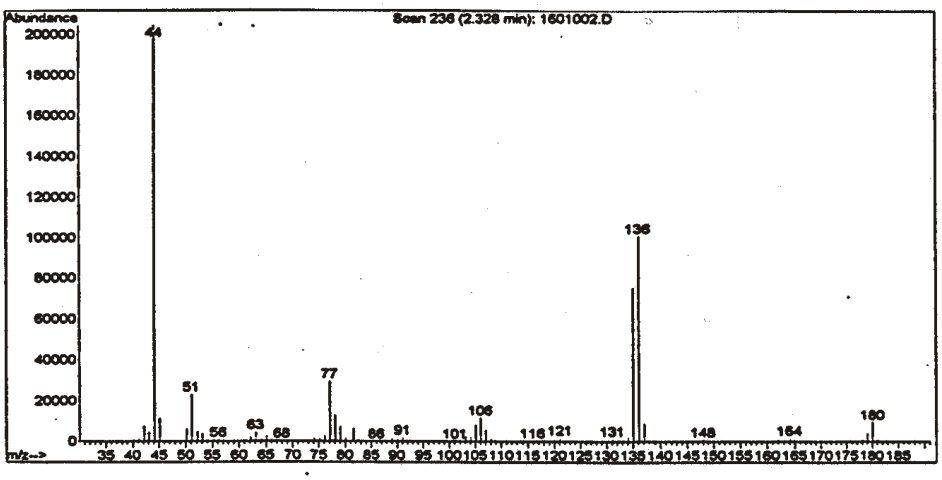


Figure 3.
Mass Spectrum of Compound A2 (MDMA)

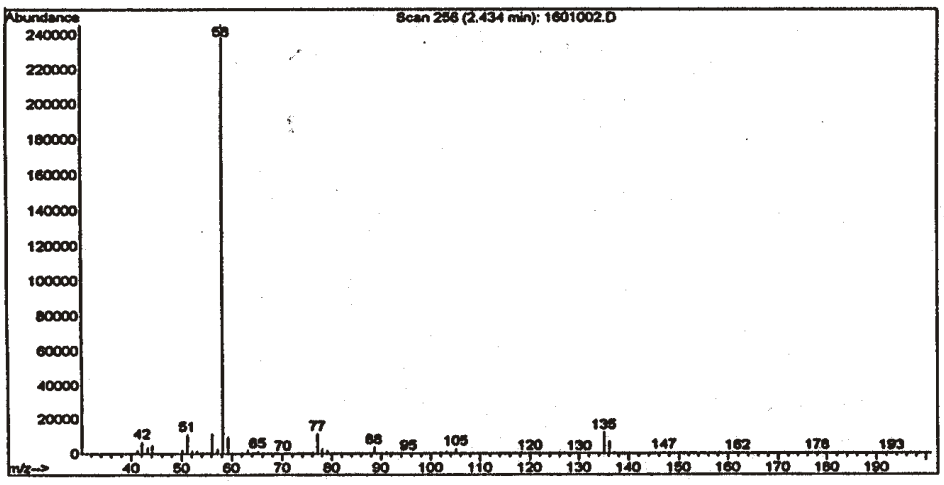


Figure 4.
Mass Spectrum of Compound A3 (Unknown)

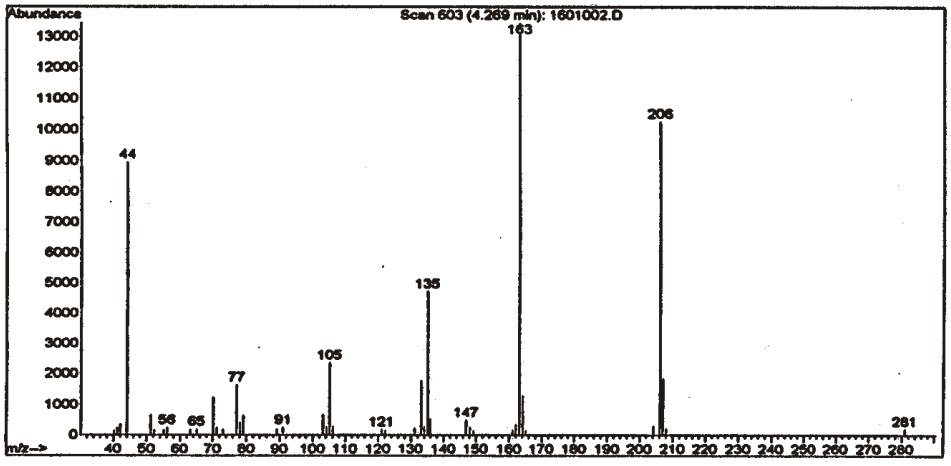
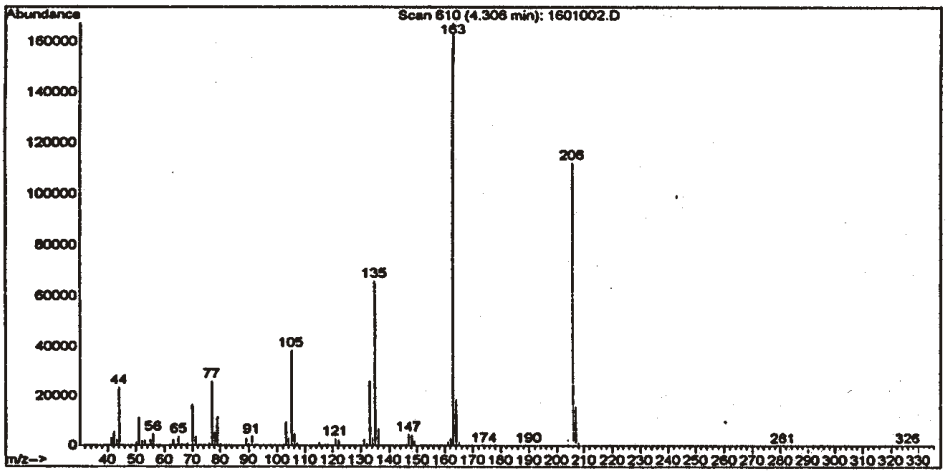
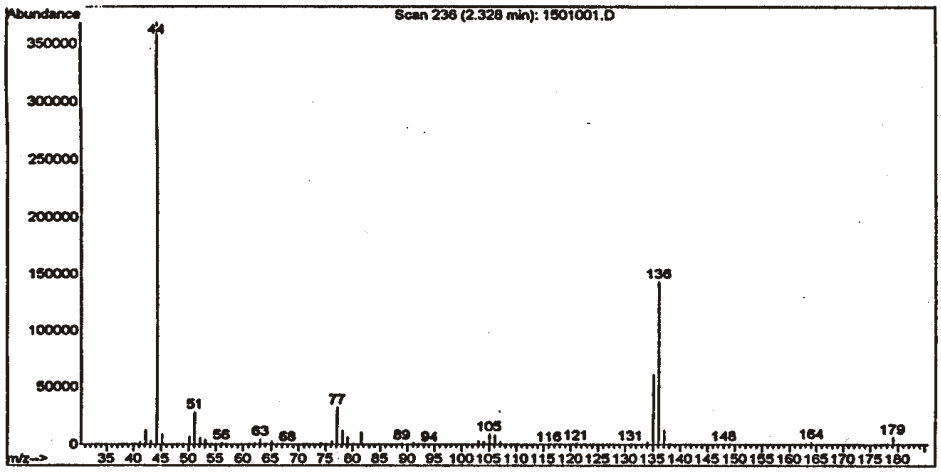


Figure 5.
Mass Spectrum of Compound A4 (Unknown; expanded to display possible molecular ion at m/z = 326)



A standard of MDA was then run on the second GC/MS, and the resulting spectra was found to be normal (i.e., displaying a typical MDA spectrum with a "proper" 179 molecular ion (See Figure 6). Since the mass spectrum of standard MDA run on the same instruments in the same time frame did not match the unknown, it was clear

Figure 6.
Mass Spectrum of MDA Standard Under Identical Conditions



that this could not be a simple instrumental variation of the MDA spectrum. A literature search of mass spectra found no matches. The question then arose: Was the second component actually an unknown substance, or was the anomalous spectrum the result of a compound co-eluting with MDA? The presence of a third compound by TLC analysis suggested the possibility of a co-eluter.

Experimental

Two GC/MS instruments were utilized in the study. The first was an Agilent 5973 Mass Spectrometer interfaced with an Agilent 6890 Gas Chromatograph equipped with a 12 meter capillary column of 0.20 mm i.d. and having a 0.33 µm film thickness of methyl silicone. The temperature program was 100ºC held for one minute, then ramped at 75ºC per minute to 200ºC, then ramped at 50ºC per minute to 325ºC, held for one minute. The second was a Hewlett Packard 5971A Mass Spectrometer interfaced with a Hewlett Packard 5890 Gas Chromatograph also equipped with a 12 meter capillary column of 0.20 mm i.d. and having a 0.33 µm film thickness of methyl silicone. The temperature program was 100ºC with no hold, ramped at 5ºC per minute to 200ºC, then ramped at 25ºC per minute to 325ºC, held for two minutes.

Results and Discussion

The color testing, TLC, and GC/MS results excluded common manufacturing byproducts or "mistakes" such as N-hydroxy-3,4-methylenedioxymethamphetamine or 1-(3,4-methylenedioxyphenyl)-2-propanone-oxime. However, an unusual impurity 1-(3,4-methylenedioxyphenyl)-2-propanol had been identified in another recent case seen in this laboratory. This compound can result from reduction of excess 1-(3,4-methylenedioxyphenyl)-2-propanone in botched clandestine syntheses. 1-(3,4-Methylenedioxyphenyl)-2-propanol has a molecular weight of 180, and a base peak of 135. The mass units for the remaining peaks are nearly identical to MDA, though their abundances vary. To determine if the MDA mass spectrum anomaly was in fact the result of a co-elution with 1-(3,4-methylenedioxyphenyl)-2-propanol, the sample was injected onto the Hewlett Packard 5971A mass spectrometer with a much slower temperature programming (i.e., 5ºC per minute from 100 to 200ºC, then ramped at 25ºC per minute to 325ºC, held for two minutes). There still appeared to be a single peak for the MDA area on the ion chromatogram (see Figure 7), but the mass spectrum of the suspected MDA (taken at the peak) was now normal. However, by expanding the peak on the computer screen, a shoulder became visible (see Figure 8). The mass spectrum of this shoulder (Figure 9) was that of 1-(3,4-methylenedioxyphenyl)-2-propanol, confirmed by comparison to a spectrum copy obtained from Drug Enforcement Administration's Southeast Laboratory (Miami, Florida). Though the peaks did not fully resolve even using the slower temperature programming, they were separated enough to obtain identifiable mass spectra for both MDA and 1-(3,4-methylenedioxyphenyl)-2-

Figure 7.
Total Ion Chromatogram at Slow Temperature Programming

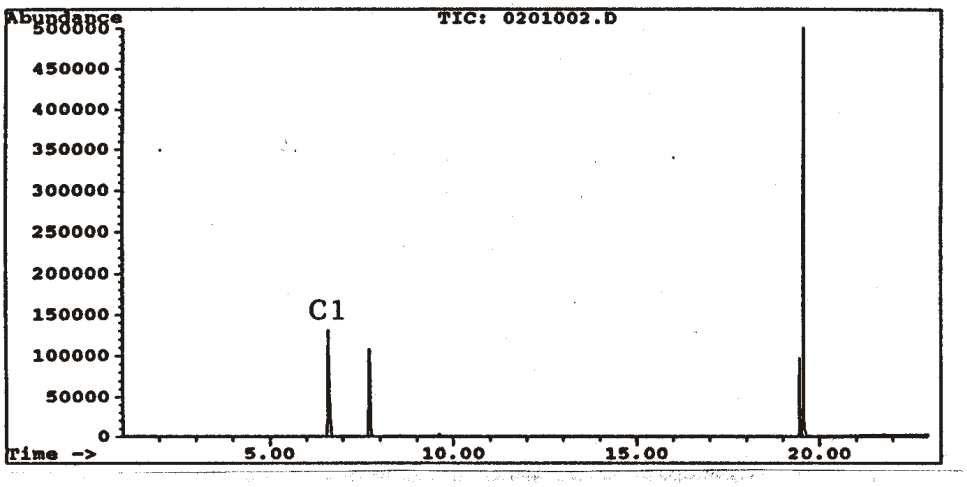


Figure 8.
Expanded Total Ion Chromatogram at at Slow Temperature Programming

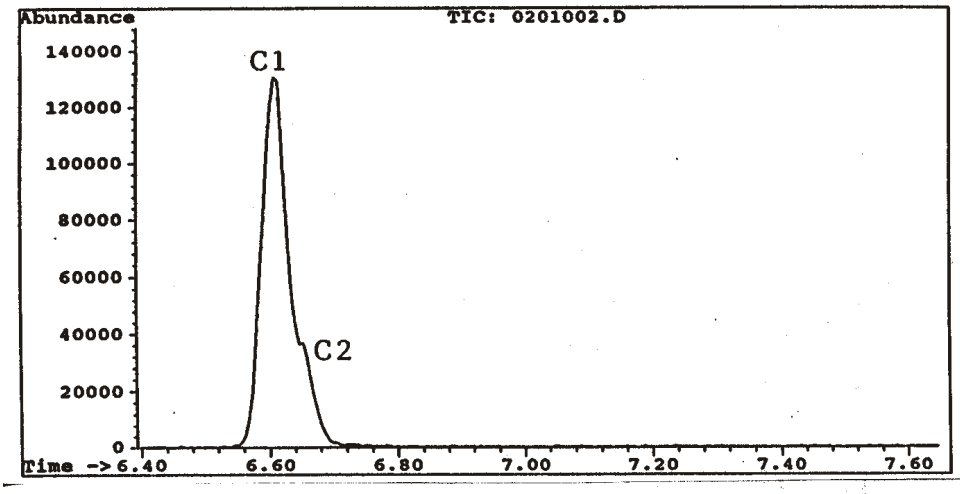
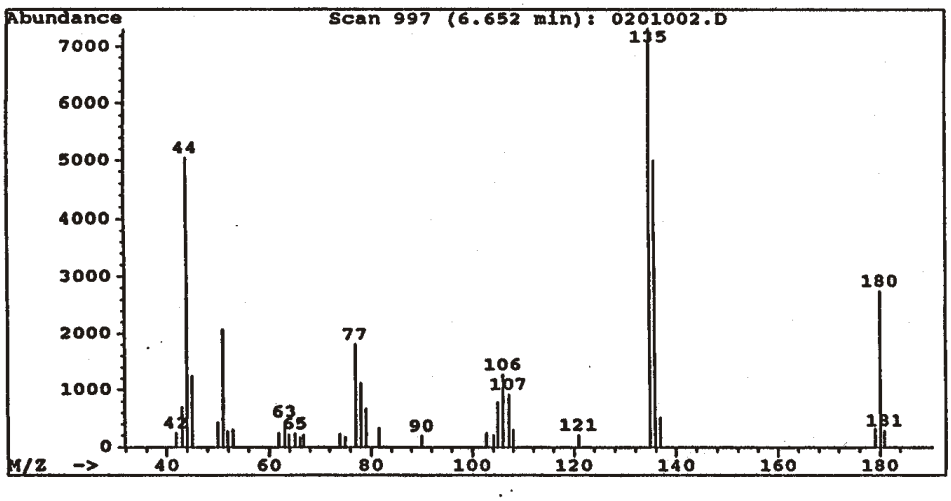


Figure 9.
Mass Spectrum of 1-(3,4-methylenedioxy-phenyl)-2-propanol



propanol, allowing for a positive identification of the controlled substance. Since the alcohol is not controlled, further analyses (e.g., acid/base shakeouts or derivatization studies) were not required; however, such procedures could be useful for other laboratories who encounter similar mixtures or who wish to more formally isolate and identify 1-(3,4-methylenedioxyphenyl)-2-propanol.

Based on the peak heights as measured by the Agilent 5973 (total ion chromatogram), the extracted components in the mixture were approximately 22% MDMA, 35% MDA, and 3% 1-(3,4-methylenedioxyphenyl)-2-propanol, and 40% other, unidentified components (there may also have been other components which did not extract). To date no other samples of this particular mixture have been encountered at this laboratory.

* * * * *

Technical Note

Potency of Cannabis Seized in Central Florida During June 2002

Christina J. Newell
Florida Department of Law Enforcement
Orlando Regional Crime Laboratory
500 West Robinson Street
Orlando, FL 32801
[email: ch319427@pegasus.cc.ucf.edu]

ABSTRACT: The potency of cannabis seized in central Florida during the month of June, 2002, is reported. Δ^9-Tetrahydrocannabinol (Δ^9–THC) was extracted from cannabis seizures with a mixed methanol chloroform solution, and then analyzed with gas chromatography using an external standard. The average Δ^9–THC concentration was found to be 6.20%.

KEYWORDS: Δ^9-Tetrahydrocannabinol, Δ^9–THC, Marijuana, Cannabis, Gas Chromatography

Introduction

Cannabis remains one of the most frequently submitted substances for analysis to the Florida Department of Law Enforcement's Orlando Regional Crime Laboratory. Δ^9-Tetrahydrocannabinol (Δ^9–THC) is the substance responsible for most of the psychopharmacological effects that cannabis has on humans. According to the University of Mississippi's Potency Monitoring Project, the non-normalized average potency of cannabis seizures has steadily increased since measurement began in the 1970's. The average Δ^9–THC potencies were 0.90% in 1977, 2.93% in 1987, 4.53% in 1997, and 6.19% in 2002 (1). In this study, samples were collected from seizures made in central Florida and submitted for laboratory analysis during June 2002, and their respective Δ^9–THC contents determined by gas chromatography (GC) using an external standard.

Experimental

Instruments and Materials

A Hewlett Packard 5890 Gas Chromatograph (GC) with a flame ionization detector was used for all analyses. The GC was equipped with an Alltech (AT-1) fused silica 10-meter capillary column with an internal diameter of 0.25 mm and having a film thickness of 0.20 µm of methyl silicone. A Mettler AE260 DeltaRange electronic analytical balance was used for weighing the samples. The external Δ^9–THC standard employed was from Alltech (Lot Number 281). Methanol and chloroform (both Fisher Scientific) were used as received. A total of 36 cannabis samples obtained from 36 separate cases submitted to the laboratory in June 2002 were examined in this study. All samples were dry.

Analytical Protocol

After removing seeds and large stem pieces, the samples (roughly 200 mg) were weighed on an analytical balance (see Table 1, page 39, for exact dry weights), then covered and soaked overnight in 5 mL of methanol/chloroform 9:1 to exhaustively extract the Δ^9–THC from the plant material (2). Because of the small size of the autosampler vials used on the GC, a 1.5 mL aliquot of the extract of each sample was evaporated to dryness in an autosampler

vial, and another 1.5 mL aliquot of extract was added and the vials were sealed; this doubled the concentration of the extract. The Δ^9–THC external standard was prepared to a final concentration of 1.0 mg/mL.

The GC was operated at a split ratio of 50:1. The helium flow rate was 1 mL/minute. The temperature program started at 100˚C and was increased at a rate of 50˚C/minute to 325˚C, with a final hold for 2.25 minutes. The samples were bracketed between two standards in groups of ten. Each sample was injected in triplicate with a volume of 1 µL per injection, and the average of the three peak areas for each sample was used for quantitation. Five already extracted samples were chosen randomly and the extraction and analysis procedures were repeated on them to ensure that all of the samples had been exhaustively extracted (which they were).

Results and Discussion

The amount of Δ^9–THC found in the samples ranged from 1.41% to 12.62% by dry weight (see Table 1, next page). The average Δ^9–THC content was 6.20%, which is almost identical to the 2002 value reported by the University of Mississippi's Potency Monitoring Project. Since there have been no other known studies of this type for cannabis seizures in central Florida, these values cannot be compared with local data to show a trend in cannabis potency. However, the results clearly suggest that local cannabis potencies are closely tracking national averages.

Acknowledgments

Thanks to the members of the Chemistry Section of the Florida Department of Law Enforcement Orlando Regional Crime Laboratory for their assistance with sample collection for this project. Special thanks to Dr. Frank Davis, Orlando Regional Crime Laboratory, for assistance with formulation of experimental methods and interpretation of results.

References

1. ElSohly MA, Ross SA. Potency Monitoring Project, Quarterly Report #80. National Center for Natural Products Research, School of Pharmacy, University of Mississippi, University, MS 38677.

2. ElSohly MA, Ross SA, Mehmedic Z, Arafat R, Yi B, Banahan BF. Potency trends of Δ^9-THC and other cannabinoids in confiscated marijuana from 1980-1997. J Forensic Sci 2000; 45(1):24-30.

Table 1. Amount of Δ^9-THC found in Central Florida Cannabis Samples

Sample #	Sample Weight (grams)	Percent THC by Dry Weight
1	0.2095	6.59
2	0.2254	9.83
3	0.2154	3.79
4	0.2188	11.46
5	0.1609	6.64
6	0.1770	5.24
7	0.1447	6.02
8	0.1928	1.41
9	0.2079	2.20
10	0.1413	4.61
11	0.1549	4.46
12	0.2231	6.87
13	0.2185	8.59
14	0.2056	5.32
15	0.1585	4.74
16	0.2259	9.12
17	0.1230	3.57
18	0.1560	6.88
19	0.2315	3.94
20	0.1975	4.42
21	0.2168	7.81
22	0.1568	10.92
23	0.1685	9.82
24	0.1874	6.16
25	0.2202	6.77
26	0.1438	2.59
27	0.2159	8.69
28	0.2175	3.23
29	0.2219	12.62
30	0.1828	4.05
31	0.1990	8.56
32	0.1805	6.08
33	0.2217	5.86
34	0.2161	5.67
35	0.2226	2.23
36	0.1686	6.58
Mean THC Content (by Dry Weight) :		**6.20%**

Technical Note

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

Anna L. Deakin
Florida Department of Law Enforcement
Tampa Regional Crime Laboratory
4211 North Lois Avenue
Tampa, FL 33611
[email: annadeakin@fdle.state.fl.us]

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

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

Introduction

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

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

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

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

Experimental

Chemicals

Chemicals were purchased from the following vendors.

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

Prepared Reagents

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

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

Procedure

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

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

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

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

4. Observe color changes (if any).

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

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

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

Results and Discussion

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

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

1. Results of Cobalt Thiocyanate + Acid

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

(NR = No Reaction)

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

Table 2. Effects of Hydrochloric Acid Dilution

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

Acknowledgements

Thanks to Sandy Kassner and the members of the Chemistry Section at the Florida Department of Law Enforcement, Tampa Regional Crime Laboratory, for their help and contributions to this project.

References (Not Cited in Text)

Drug Enforcement Administration, Basic Training Manual for Forensic Chemists, p. 4-8.

Velapoldi RA, Wicks MS. The use of chemical spot test kits for the presumptive identification of narcotics and drugs of abuse. Journal of Forensic Science 1974;19(3):636-656.

* * * * *

1,4-Butanediol (BD) - Forensic Profile

Agnes D. Garcia, B.S.*
Drug Enforcement Administration
Special Testing and Research Laboratory
22624 Dulles Summit Court
Dulles, VA 20166
[email: cation1072@aol.com]

Allen J. Catterton, B.S.
Drug Enforcement Administration
Southeast Laboratory
5205 NW 84th Avenue
Miami, FL 33166

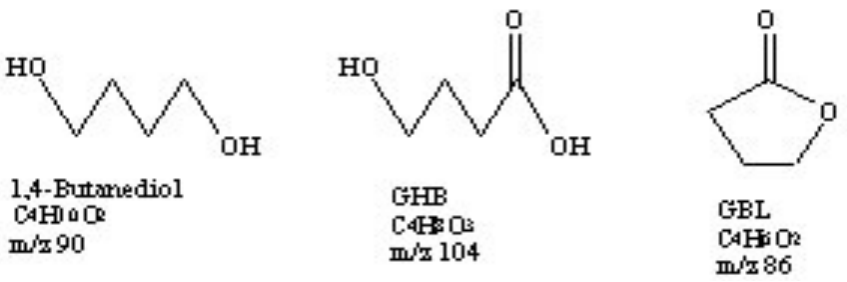
ABSTRACT: 1,4-butanediol (BD), an analog and "pro-drug" of *gamma*-hydroxybutyric acid (GHB), is increasingly being added to so-called dietary, health, sleep aid, or sports (bodybuilding) supplements, and is also being sold on the Internet and on underground markets for purposes of illicit abuse. When so intended for human consumption, BD meets the definition of a controlled substance analog under the Controlled Substances Act, Title 21, and can be prosecuted as a Schedule I substance. A comprehensive analytical profile for BD is presented, including GC/MS, FTIR, NMR, GC/IRD, and GC/FID. Analytical parameters for the quantitative analysis of BD are also presented, along with linearity and reproducibility data.

KEYWORDS: 1,4-Butanediol, *gamma*-Hydroxybutyric Acid, *gamma*-Butyrolactone, BD, 1,4-BD, GHB, GBL, Analogs, Pro-Drug

Introduction

The widespread, illicit abuse of *gamma*-hydroxybutyric acid (GHB) is due to its euphoric, sedative, hallucinogenic, and alleged steroidal effects (1). Recently, GHB abusers have been switching to related compounds in an attempt to circumvent the Federal controls on GHB (2,3,4,5,6). 1,4-Butanediol (BD) and *gamma*-butyrolactone (GBL) (Figure 1) are the two most commonly encountered such compounds, and are considered to be both analogs and "pro-drugs" of GHB, since their chemical structures are substantially similar to GHB and they are metabolized into GHB upon ingestion and therefore produce the same psychopharmacological effects as GHB (2,3,4,5,6).

Figure 1: Diagram of Structures.



BD is an important industrial solvent and precursor with numerous applications; for this reason, it is widely available. On the underground market, BD is most commonly seen in illicit dietary, health, sleep aid, or sports (bodybuilding) "supplements", and also as the primary ingredient or a major component in various "solvents" of nebulous makeup and dubious claimed applications. Some examples include "Dream On", "Soma" (Photo 1), and "Rejoov" (Photo 2). Soma, for example, is labeled as a dietary supplement and sold in 32 oz bottles, and is marketed as a "sleep aid". The label on the bottle itself states that 2.0 grams of BD have been added per 1 fluid oz. Although various warning and/or disclaimer labels are usually present on such products, there is no mention that BD is a Schedule I controlled substance if intended/sold for human consumption. All of these various supplements and solvents are commonly obtained through Internet (usually from foreign sources) and on the underground drug market, especially at "Raves" and concerts, but also at gymnasiums and similar sports/body-building venues. Not surprisingly, BD (like GHB and GBL) has also been implicated in drug facilitated sexual assaults.

Photo 1

Photo 2

Abusers of BD indicate that its ingestion results in some unpleasant side effects, including a hangover (7). Therefore, some clandestine laboratories convert BD to GBL, which is the lactone of GHB and therefore a more direct pro-drug of GHB. Methods for conversion of BD to GBL have been published in various venues [Details and methodologies not provided, per *Journal* policy]. However, the most commonly seen clandestine laboratories working with BD are simple "re-packaging" operations. In these laboratories, clandestine chemists dilute industrial-grade BD with water and/or other components such as flavoring agents, coloring dyes, and/or sugars, then repackage the resulting mixtures in small bottles with homemade labels on them. Such laboratories usually consist of drums of BD, flavoring agents, coloring dyes, sugars, volume dispensing pumps, and various other chemicals (see Photos 3a - 3d, next page).

The forensic analysis of BD has been previously reported (2,4,8); however, these previous studies were published in law enforcement restricted venues. Herein is reported detailed procedures and techniques that can be utilized for the comprehensive analysis of BD.

Photo 3a - 55-Gallon Drum of Industrial BD

Photo 3b - Various Compounds Typically Added to BD

Photo 3c - Coloring Dyes

Photo 3d - Flavoring Agents

Experimental

Reagents

1,4-Butanediol standard and octane ($C_8H_{18,}$ used as an internal standard) were obtained from Aldrich. Other solvents (such as high purity methanol and chloroform) were obtained from Baxter.

GC/MS

Gas chromatography/mass spectrometry analyses were performed on a Hewlett Packard (HP) 6890 GC interfaced with a Hewlett Packard 5973 Mass Selective Detector (MSD), using a scan acquisition from 35 to 500 amu. A crosslinked 5% phenyl methyl siloxane column (HP-5), with 0.25 mm internal diameter x 30 m and 0.25 µm film thickness, was utilized. The injection port temperature was 260ºC and the detector and transfer line temperatures were 280ºC. The GC oven temperature was held at 50ºC initially for 2 minutes, then ramped at 35ºC/min to 290ºC, with a final hold of 4 minutes.

FTIR/ATR

A Nicolet Nexus 470 with a potassium bromide (KBr) beamsplitter and a deuterated triglycine sulfate (DTGS) KBr detector, equipped with a Durascope Dicomp ATR accessory with a 3-bounce diamond ATR element, was

utilized for attenuated total reflectance IR analyses. The resolution was set at 4.000 cm^{-1}, with 32 scans between 4000 cm^{-1} and 550 cm^{-1}. The mirror velocity was 0.6329 cm per second. BD (neat) was prepared on a KBr pellet and analyzed using the same parameters, except that the wavenumbers were set between 4000 cm^{-1} and 400 cm^{-1}.

Aqueous samples were easily analyzed by allowing a portion of the sample to evaporate at low heat on the heating plate of the ATR instrument. However, many BD-containing "supplements" also contain color dyes, flavoring agents, and sugars. These added components form a residue with BD during evaporation, thereby making it difficult to obtain clean IR spectra. A chloroform extraction is recommended for such samples.

GC/FTIRD

Vapor phase infrared spectra were obtained with a HP 6890 GC/BioRad IRD II Infrared Detector using a HP 5% phenyl methyl siloxane, 25 m x 0.32 mm x 0.52 μm (HP-5) column. The temperature program was set at 50˚C for 1.5 minutes, then ramped up at 35˚C/min to 290˚C , with a final hold of 3 minutes. Column flow was 1.5 mL per minute with an average velocity of 28 cm/sec. The inlet was set at a splitless mode with an initial temperature of 260˚C. The purge gas was nitrogen at 50.0 mL per minute.

NMR

FT-NMR spectra were obtained using a Varian Gemini 300 nuclear magnetic resonance spectrometer, operating at 300 MHz for proton. A standard ^{1}H-NMR was performed, with 64 transients. Deuterated water, deuterated methanol, or deuterated chloroform can be used as solvents for BD; however, only spectra in deuterated water and deuterated chloroform are presented in this study.

Quantitation by GC/FID

Serial dilutions of standard were prepared in methanol, ranging in concentration from 0.0869 mg/mL to 20.67 mg/mL. The internal standard solution was prepared by dissolving octane in methanol, for a final concentration of 2.00 mg/mL. For analysis, an aliquot of the standard solution was mixed with an equal amount of the internal standard solution.

GC analyses were performed on a Hewlett Packard 6890 Gas Chromatograph with a flame ionization detector, using a 0.25 mm internal diameter x 30 m HP-5 column with a 0.25 μm film thickness. An isothermal method (90ºC for 2.5 minutes) was used. One μL of the standard and each sample solution were injected using an autosampler. The injection port and detector temperatures were maintained at 260ºC and 270ºC, respectively.

Results and Discussion

GC/MS

The mass spectrum of BD is shown in Figure 2 (next page). Figures 3a-3g (next two pages) show a suggested fragmentation scheme. The mass spectrum has a base peak at m/z 42 and the [M-1] (molecular weight minus a hydrogen) ion at m/z 89 (Figures 3a, 3b). The peak at m/z 57 results from a loss of 32 from the M-1 fragment via a 1,3 hydride shift to form (+OH=CH-CH=CH_2) at m/z 57 (Figure 3c). The second most abundant fragment (at m/z 44) results from the cleaving of the BD molecule to form (·+OH-CH=CH_2) (Figure 3a). The loss of a water molecule from BD, followed by H-rearrangement leads to the formation of a ring (Figure 3d). When the ring cleaves, radical and charge stabilization become important (9). Thus, a second H-rearrangement occurs to yield a stable product (Figure 3e). Furthermore, the intense peak at m/z 71 is a result of several possible fragments (Figure 3f). Other peaks at m/z 42 and m/z 43 are shown below (Figures 3a, 3g).

Figure 2: The Mass Spectrum of BD Standard.

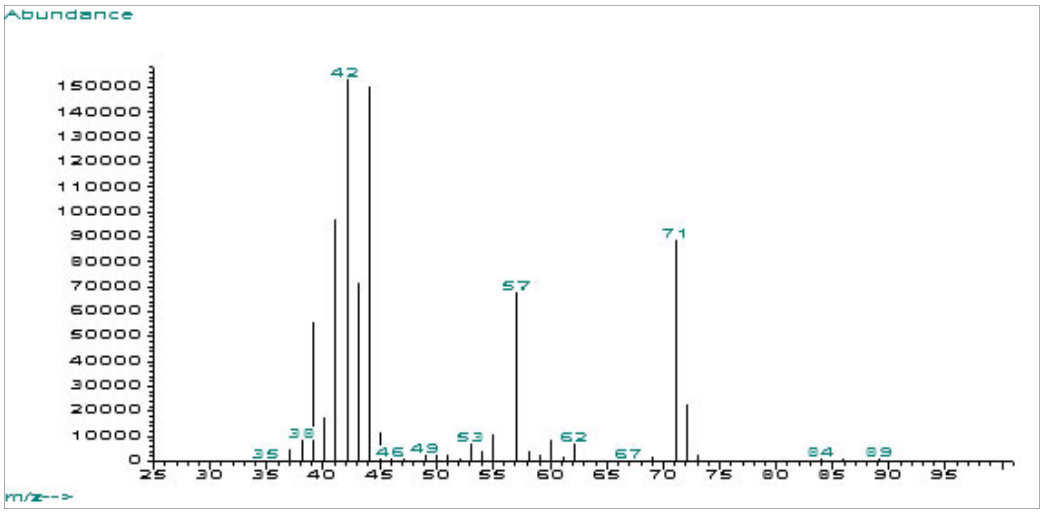


Figure 3a:

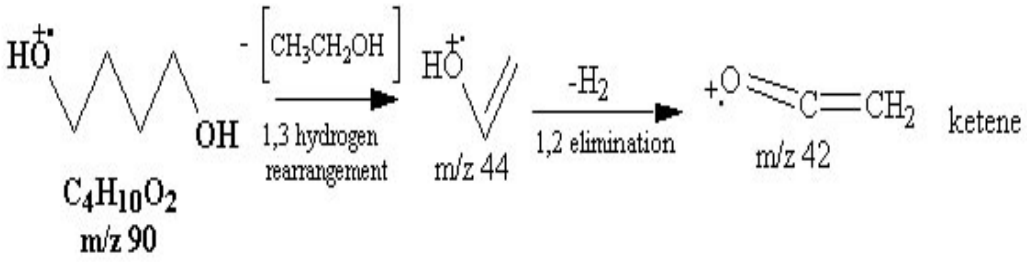


Figure 3b:

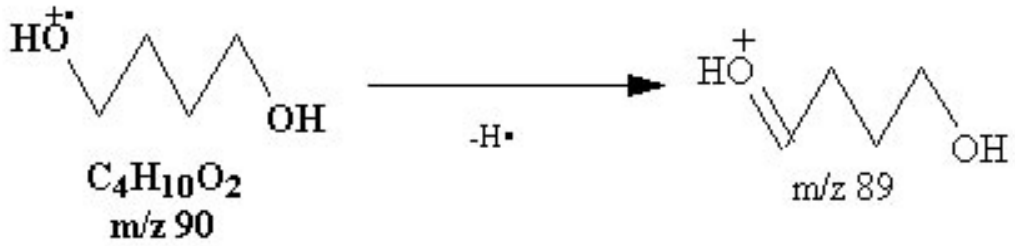


Figure 3c:

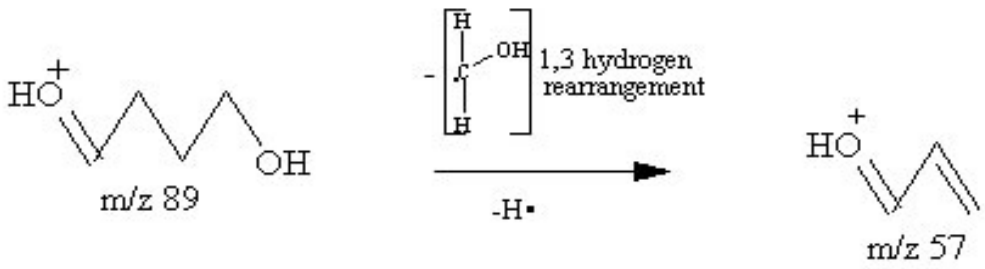


Figure 3d:

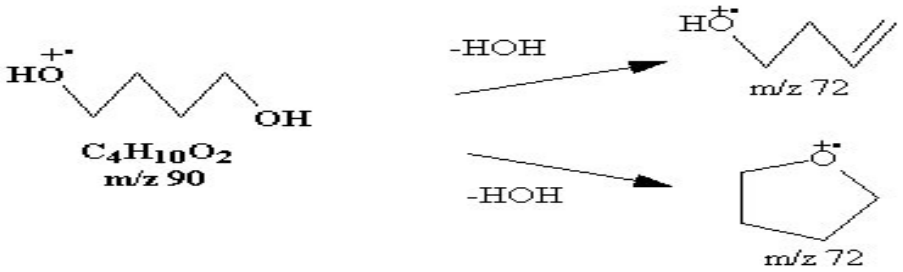


Figure 3e:

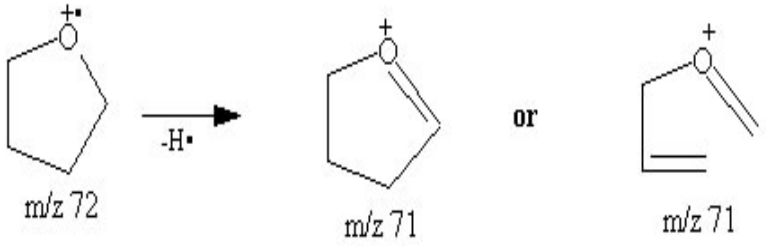


Figure 3f:

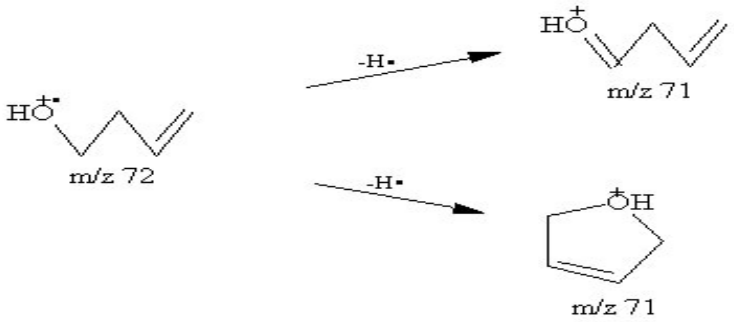


Figure 3g:

FTIR/ATR

The FTIR/ATR spectrum of BD (Figure 4a, next page) has significant bands at 2936 and 2867 cm^{-1}. The 2936 cm^{-1} peak is due to the asymmetric stretching of the methylene groups, while the symmetric stretching of the methylene groups causes the weaker 2867 cm^{-1} peak. Wagging of the methylene groups causes a series of bands from 1380 to 1150 cm^{-1}. The broad band at 3300 cm^{-1} is due to inter- and intramolecular hydrogen bonding. The most prominent peak is at 1048 cm^{-1} and is due to the two primary alcohol groups (10).

When utilizing an ATR, depth of penetration in the sample can affect peak intensities. The depth of penetration of the infrared beam in the sample is a function of wavelength, i.e., the longer wavelengths will show more absorbance. This is a characteristic in ATR analyses versus analyses using the traditional KBr matrices. A sample of BD was analyzed as a neat liquid on a KBr pellet to show this difference (Figure 4b).

Figure 4a: The FTIR/ATR Spectrum of BD Standard.

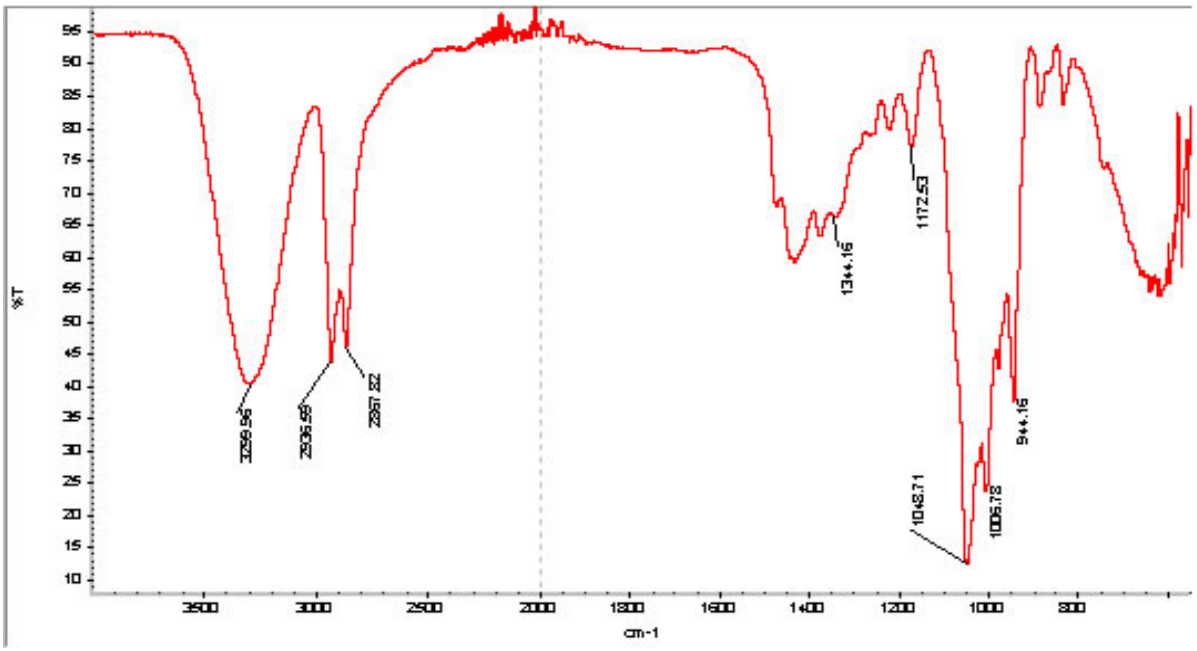
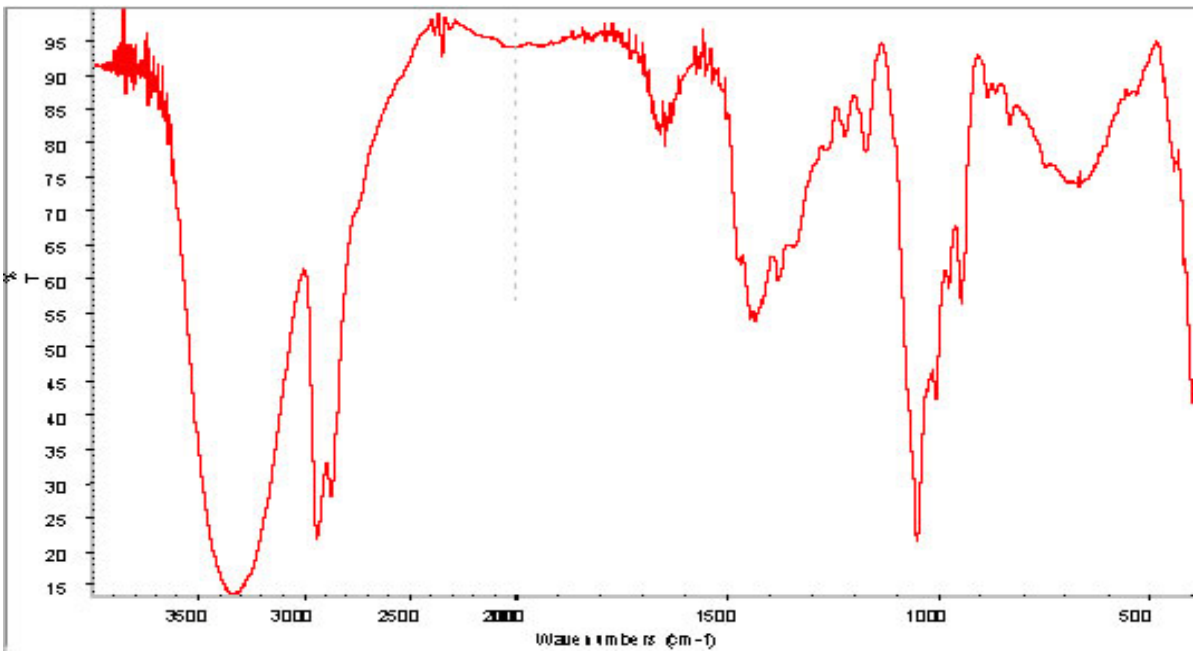


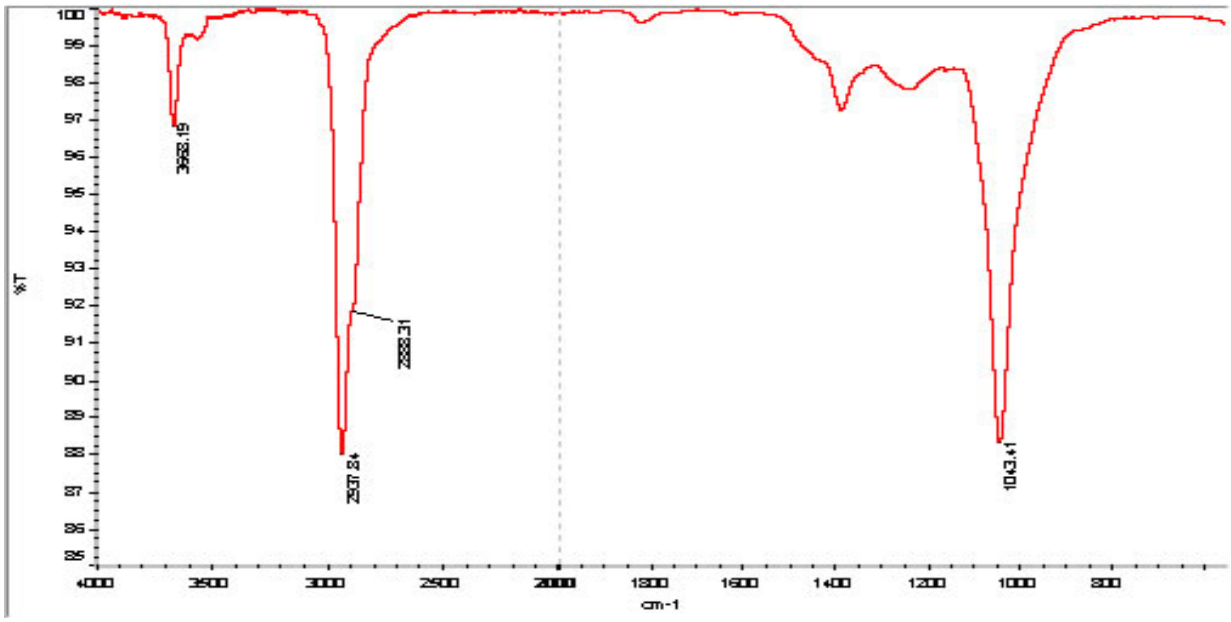
Figure 4b: The FTIR Spectra of BD as a Neat Liquid on KBr Plate



GC/FTIRD

The vapor phase infrared spectrum of BD is considerably simplified (Figure 5). The primary bands at 2938, 2888, and 1043 cm^{-1} represent the same bands seen at approximately the same wavelengths in the FTIR/ATR spectrum. However, the -O-H stretch at 3300 cm^{-1} in the FTIR/ATR spectrum shifts to 3668 cm^{-1} in the vapor phase, suggesting little or no hydrogen bonding (10).

Figure 5: The GC/FTIRD Spectra of BD Standard.



NMR

The proton spectra in $CDCl_3$ showed singlet peaks at 1.4 (C2/C3 methylenes), 3.4 (C1/C4 methylenes), and 4.7 (hydroxyl protons) ppm (Figure 6). When the sample was run in D_2O, chemical shift increases of 0.2 ppm were observed for all peaks, i.e., singlets were found at 1.6, 3.6, and 4.8 ppm, respectively (Figure 7, next page).

Figure 6: The Proton NMR spectra of BD standard in $CDCl_3$.

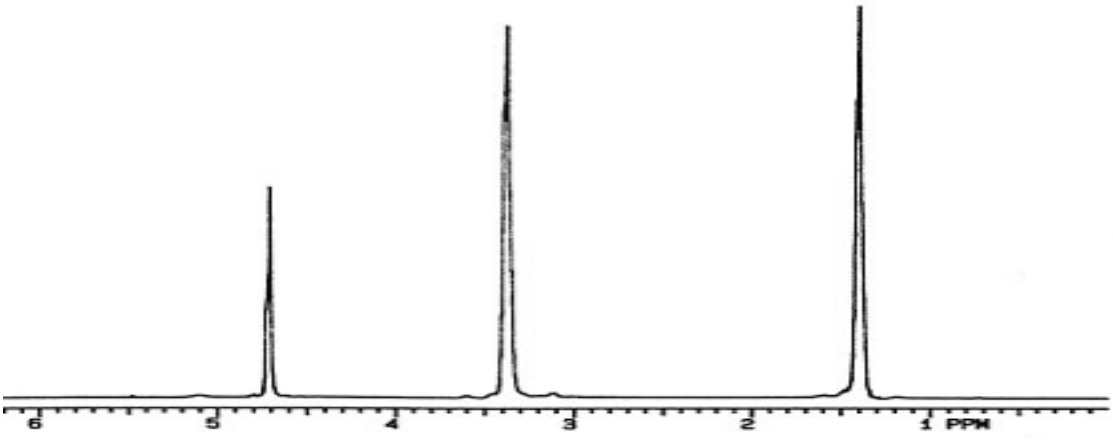
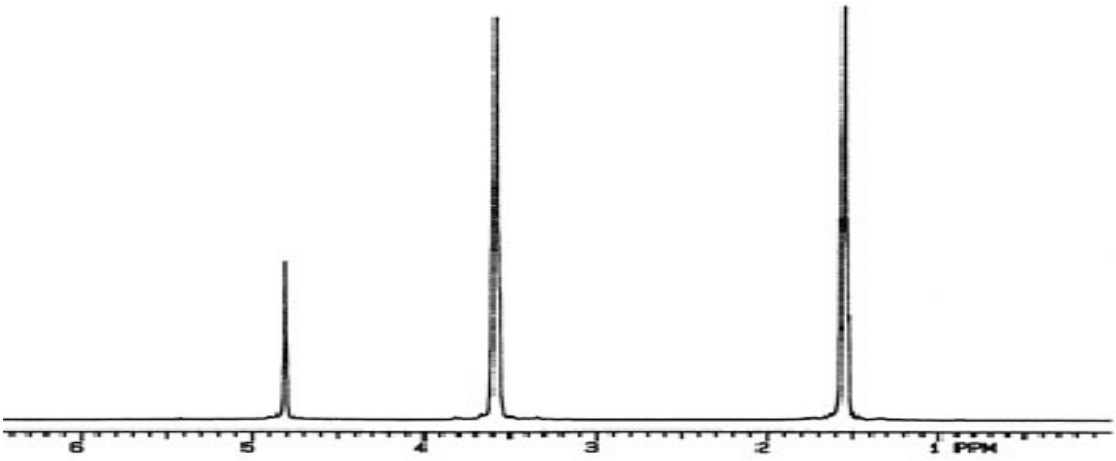


Figure 7: The Proton NMR spectra of BD in D_2O.



GC/FID

Using the specified GC/FID parameters, BD had a retention time of 1.862 minutes, while octane (I.S.) had a retention time 1.457 minutes (see Figure 8). Area ratios of the standard/internal standard were plotted against the corresponding BD concentrations. Linear responses for BD were found to be from 0.87 mg/mL to 10.64 mg/mL (Figure 9). The correlation coefficient was 0.9997, indicating a highly linear relationship. Reproducibility for both area counts and retention times were below 2.3% RSD (Table 1).

Samples of BD could contain GBL or GHB. GHB, however, converts to GBL in heated injection ports under standard GC operating conditions, so only a GBL peak would be observed for exhibits containing GBL and/or GHB. For this reason, GBL was added to a sample of BD (to ensure that they do not co-elute), and was found to have a retention time of 1.678 minutes.

Figure 8: The GC/FID Chromatogram of BD Standard.

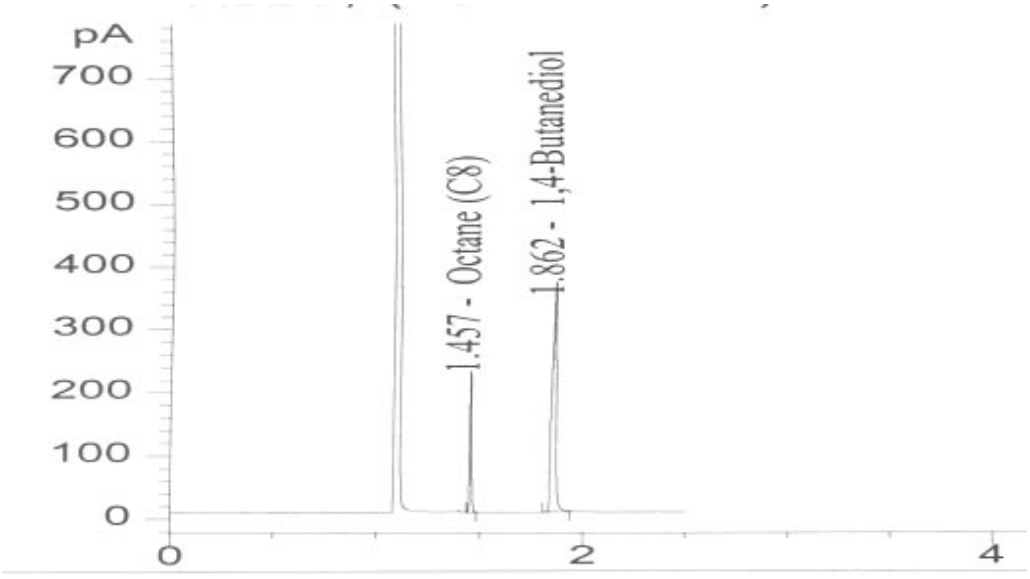


Figure 9: Linearity of BD.

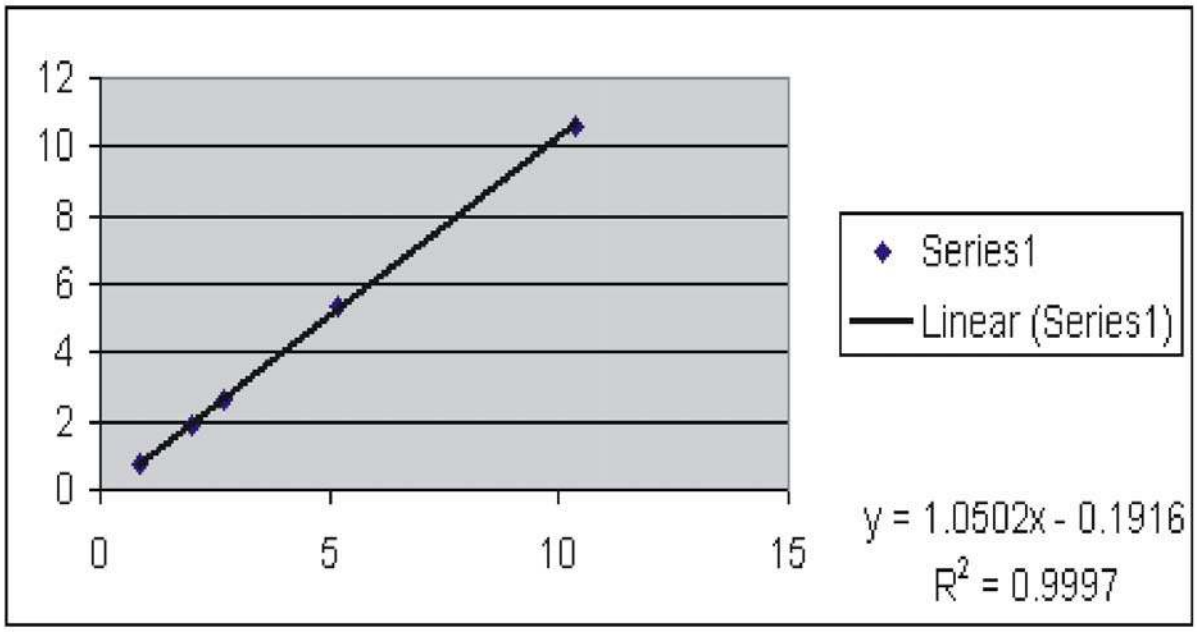


Table 1: Reproducibility Data of BD and Octane.

	Octane Retention Time (minutes)	Area	1,4-butanediol Retention Time (minutes)	Area	Area STD/ Area ISTD
	1.460	204.453	1.853	139.819	0.684
	1.460	208.700	1.854	139.204	0.667
	1.461	216.972	1.856	144.346	0.665
	1.460	212.846	1.854	144.476	0.679
	1.461	212.209	1.855	142.213	0.670
average	1.460	211.036	1.854	142.012	0.673
std. dev.	0.00	4.71	0.00	2.46	0.01
%RSD	0.04	2.23	0.06	1.73	1.19

Conclusions

A variety of techniques can be used for the analysis of BD, including GC/MS, FTIR, NMR, GC/IRD, and GC/FID. The more difficult BD samples to analyze are illicit dietary supplements and commercial solvents, due to the presence of additional components. In these instances, a chloroform extract is recommended.

Acknowledgements

The authors would like to thank Christine Sannerud (Deputy Chief, Drug and Chemical Evaluation Section, Drug Enforcement Administration (DEA)), for sharing her expertise in GHB and related samples. The authors would

also like to acknowledge Senior Forensic Chemist Donald Cooper (DEA Special Testing and Research Laboratory, Dulles, VA) and Forensic Chemist Walter Rodriguez (DEA Southeast Laboratory, Miami, FL), for their time and expertise in helping interpret the mass spectrum of BD. Special thanks also goes to Task Force Officer Brian Ballard (Atlanta, GA) for supplying Rejoov and BD clandestine laboratory pictures and valuable information on Internet purchases. Gratitude also goes to Forensic Chemist Amy Bederka (County Bureau of Identification, Raleigh City, NC) for useful conversations and pictures regarding Rejoov samples.

References

1. For a general review, see: Hornfeldt CS, Lothridge K, Downs JCU. Forensic Science Communications 2002;4(1):(No Page Numbers); reprinted in: Microgram 2002;35(4):102.

2. Chew S. 1,4-Butanediol in Liquid Exhibit. Microgram 1997;30(7):154-159.

3. Morris JA. Analogs of GHB. Part 1: Theoretical perspective. J Clan Lab Invest Chem Assoc 2000;10(2):18-20.

4. Morris JA. Analogs of GHB. Part 2: Analytical perspective. J Clan Lab Invest Chem Assoc 2001;11(1):16.

5. Anonymous. Information Bulletin: GHB Analogs - GBL, BD, GHV, and GVL. NDIC Publication 2002-L0424-003 www.usdoj.gov/ndic/pubs/1621/index.htm

6. 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.

7. Ballard B (Task Force Officer, Drug Enforcement Administration, Atlanta Division), Personal Communication, 2000.

8. Walker L. Maple syrup and 1,4-butanediol. J Clan Lab Invest Chem Assoc 2000;10(3):13-16.

9. McLafferty FW. Interpretation of Mass Spectra 3rd Edition University Science Books:1980.

10. Colthup NB, Daly LH, Wiberley SE. Introduction to Infrared and Raman Spectroscopy, 2nd Ed., Academic Press, Inc.:1975, pp. 220-320.

* * * * *

Detection and Analysis of Drugs of Forensic Interest, 1992 - 2001; A Literature Review

Robert F.X. Klein, Ph.D.*
U.S. Drug Enforcement Administration
Office of Forensic Sciences
Laboratory Support Section
2401 Jefferson Davis Highway
Alexandria, VA 22301
[email: microgram_editor@mailsnare.net]

Patrick A. Hays, B.S.
U.S. Drug Enforcement Administration
Special Testing and Research Laboratory
22624 Dulles Summit Court
Dulles, VA 20166

ABSTRACT: The scientific literature of the detection and analysis of drugs of forensic interest, as published from 1992 through 2001, is reviewed. 1,377 references are included.

KEYWORDS: Forensic Chemistry, Analytical Chemistry, Illicit Drugs, Controlled Substances, Review

Introduction

This review presents a 10 year survey of the detection and analysis of drugs of forensic interest, as published in the mainstream scientific literature from 1992 through 2001. Analyses of drugs in post-ingestion biological matrices are not included, except for select studies which provide structural, spectral, and/or analytical data above and beyond routine toxicological "screening" techniques. In addition, due to their inherently transitory nature, Internet references are not included. Finally, forensic association newsletters and "underground" publications are not included.

Articles are first organized by overall focus, and subcategorized (where applicable) by specific drug or drug class, or instrumental technique. The focus categories are as follows:

* Previous Reviews and Overviews
* Analyses of Specific Drugs and Drug Groups
    - Illicit Drugs
    - Select Adulterants and Diluents
    - Occluded Solvents
* Simultaneous Analyses of Drugs in the Presence of Select Adulterants and Diluents
* Instrumentation Focus
* Analytical Artifacts
* Qualitative Tests
* Sampling Plans
* Source Determination/Impurity Profiling
* Source Determination/Stable Isotope Analyses
* Comparative Analyses
* Reference Standards

* Clandestine Laboratories
* Clandestine Laboratory Appraisals and Safety
* Portable Instrumentation/Trace Detection
* Surveys
* Miscellaneous Topics

Abbreviations

The authors have utilized common abbreviations throughout the review; however, all terms are defined in order to avoid ambiguity with some of the more crowded or obscure acronyms, as follows:

AA	Atomic Absorption
AP	Atmospheric Pressure
C-13	Carbon-13
CE	Capillary Electrophoresis
CEC	Capillary Electrochromatography
CGC	Capillary Gas Chromatography
CI	Chemical Ionization
CZE	Capillary Zone Electrophoresis
DAD	Diode Array Detection
DSC	Differential Scanning Calorimetry
ECD	Electron Capture Detection
EKC	Electrokinetic Chromatography
EI	Electron Impact
FID	Flame Ionization Detection
FT	Fourier Transform
GC	Gas Chromatography
GLC	Gas Liquid Chromatography
HPLC	High Performance Liquid Chromatography
HPTLC	High Performance Thin Layer Chromatography
IMS	Ion Mobility Spectrometry
IR	Infrared Spectroscopy
IRD	Infrared Detector
IRMS	Isotopic Ratio Mass Spectrometry
ITD	Ion Trap Detector
LC	Liquid Chromatography
MECC	Micellar Electrokinetic Capillary Chromatography
MEKC	Micellar Electrokinetic Chromatography
MS	Mass Spectroscopy
MSD	Mass Selective Detector
MS-MS	Tandem Mass Spectroscopy
NMR	Nuclear Magnetic Resonance (Spectroscopy)
NPD	Nitrogen Phosphorus Detection
PDA	Photodiode Array
RP	Reverse Phase
SFC	Supercritical Fluid Chromatography
SHS	Static Headspace
SPME	Solid Phase Microextraction
TD	Thermal Desorption
TLC	Thin Layer Chromatography
UV	Ultraviolet (Spectroscopy)
Vis	Visible (Spectroscopy)

Previous Reviews and Overviews

The forensic analysis of illicit drugs has been the subject of a number of minor review articles and monographs over the past 10 years (1,2,3,4,5,6,7,8,9). In addition, several articles have given more general overviews of the field (10,11). Systematic approaches to substance identification have also been presented (12,13,14), and a number of scientific working groups are currently establishing national/international standards for forensic analysis of illicit drugs (15,16,17(see also:18)). Finally, forensic chemistry has been the subject of several textbooks and chapters in textbooks (19,20,21,22,23,24,25,26).

Analyses of Specific Drugs and Drug Groups

An immense amount of analytical data has been published over the past 10 years for drugs of abuse. "Comprehensive" data compilations (defined in this context as three or more analytical profiles in a specific study) have been previously provided for virtually all "traditional" drugs of abuse, but a number of updated compilations have been provided which reflect improvements in existing instrumentation and/or the advent of new instrumental techniques. In addition, "comprehensive" data compilations have been provided for a number of new drugs of abuse; these include previously unknown "designer," "analog," or "homolog" drugs, and also various pharmaceuticals or industrial chemicals which either had not been previously subject to abuse, or had been only rarely encountered in illicit settings. Furthermore, hundreds of studies which analyzed either specific drugs of abuse or groups of structurally related drugs of abuse, but only by one or two select analytical techniques, have also been provided. [Note that multiple citations are organized as follows: reviews, then overviews, then comprehensive studies, then by specific analytical techniques (alphabetized), and finally in reverse date order (most recent citation first).]

Controlled Substances: Over the past 10 years, the following substances were the subjects of moderate to comprehensive analytical profiling: **alkyl nitrites** (inhalants) (comprehensive) (27), by GC-IR (28), and by headspace GC/MS (29); ***Amanita Muscaria*** by ion-interaction HPLC (30); **amphetamine** by CE (31), by CE and LC (32), by GC-MS (role of self-protonation) (33), by HPLC (after acetylation) (34), by HPLC using chiral crown ether coated reversed-phase packing (35), and by HPLC using a two-dimensional column-switching chromatographic system with on-line derivatization (36); **amphetamine and methamphetamine** - (general review of the syntheses and analyses of phenylacetone, amphetamine, and methamphetamine) (37), in abuser's clothing by HPLC with UV and fluorescence detection (38), by CE with cyclodextrins to determine isomers (39), by GC and GC-MS versus internal standards (40), by GC-CI/MS (following derivatization with perfluorinated acid chlorides) (41), by headspace sampling and GC-MS (analysis of betel) (42), by HPLC (43,44), by HPLC for quantitation of clandestinely produced mixtures (45,46), by MS (47), by micro-Raman scattering (48), by surface enhanced Raman scattering detection after modification with 2-mercaptonicotinic acid (49), and by UV/Vis spectrophotometry after derivatization with 1,2-naphthoquinone-4-sulfonic acid (50); **amphetamines** (review of biological/forensic issues (includes amphetamine and methamphetamine analogues)) (51), by CE (52,53), by CE (chiral) (54), by CE with added anionic chiral selectors (55), by CE and LC (56), by color tests, TLC, GC/MS, GC/IR, plus GC/IR/MS of N-acetyl derivatives (differentiation of side chain isomers of ring-substituted amphetamines (4-Me, 4-OMe, 3,4-MD- amphetamine and methamphetamine)) (57), by CZE (58), by CZE with added cyclodextrins (59), by EI-MS (N-substituted amphetamines) (60), by GC (61), by GC, HPLC, and MS (62), by GC-FTIR (63), by GC/MS (64,65), by GC-MS (differentiation of acylated derivatives of methamphetamine and regioisomeric phenethylamines) (66,67), by HPLC with added cyclodextrins and using a chiral stationary phase (68), by HPLC with fluorimetric detection (69), by HPLC after derivatization with chloroformates (70), by LC with fluorimetric detection after precolumn derivatization with (+)-1-(9-fluorenyl)ethylchloroformate (71), by MECC (72), by negative-ion CI-MS (73), by carbon dioxide negative-ion CI-MS (74), by SFC (75), by SFC, HPLC, GC, and CZE (76), by TLC with diazonium salts as visualization reagents (77), and by GC/FID using n-alkanes and other indirect reference standards when no internal standard is available (78); **ayahuasca** by GC and GC/MSD (79); **barbiturates** by HPLC with PDA-UV detection (80), by HPLC using 3-(18-naphthalimido)-propyl-modified silyl silica gel as a stationary phase (81), by micro-HPLC with post-column photochemical derivatization (82), by ion-trap and quadrupole MS (83), by IR and MS (84), by mercurimetric potentiometric

determination using a solid-state iodide ion-selective electrode (85), by micellar LC (86,87), by SPME and CE (88), by SPME and ion-trap GC-MS (89), by a thermally tuned tandem column (separation of barbiturates and phenylthiohydantoin amino acids) (90), and by two-dimensional overpressured layer chromatography (91); **benzodiazepines** by CE (92), by electrospray probe/MS (93), by free zone electrophoresis (94), by FT-Raman and FT-IR (95), by HPLC (nitrazepam, diazepam, and medazepam) (96), by HPLC (clorazepate, diazepam, and diltiazem in pharmaceuticals) (97), by HPLC-DAD (98,99), by HPLC using diode-array, electrochemical, and thermospray MS detection (100), by HPLC/electrospray MS-MS (101), by HPTLC (diazepam, chlordiazepoxide, and midazolam) (102), by MECC (103,104), by SERS after adsorption on the Ag colloidal surface (diazepam and nitrazepam) (105), by LC (alprazolam) (106), by microcolumn LC using a cholesteryl-10-undecenoate bonded phase (107), by RP-LC (flurazepam) (108), and by automated SPME-LC/EI-MS (109); **1-benzyl-1-*n*-butyl-barbituric acid** (comprehensive) (110); **bromazepam** by flow injection stopped-flow kinetic determination (111); **4-bromo-2,5-dimethoxyphenethylamine** (2C-B or NEXUS) and related compounds (overview) (112), (comprehensive) (113,114), by GC/MS and HPLC (115), by GC-MS and NMR (including analysis of derivatized samples) (116), and by LC and GC/MS (117,118,119); **bufotenine** (comprehensive) (120,121), and by GC/MS after BSTFA derivatization (122); **bufotenine, psilocybin and related indole alkaloids** by CE (123), by GC/CI-MS (124), by GC/IRD (125,126), by GC/MS (includes general overview) (127), and by MS (128); [**"Love Stone"** (contains bufotenine) (overview) (129), (overview and GC/MS) (130), and by GC/MS (comparison with Chinese "Chan Su") (131)]; **cathinone** (*alpha*-aminopropiophenone) (review with 79 refs) (132), (comprehensive) (133), by NMR (enantiomeric determination of N-acetylcathinone) (134), and by spectrophotometric detection (135); **2-chloro-4,5-methylenedioxymethamphetamine** (comprehensive) (136); **clenbuterol** by CE (chiral analysis with added CD's) (137), by EKC (epinephrine, terbutaline, clenbuterol, and salbutamol) (138), by flow-injection fluorimetry (139), by GC after derivatization and electrospray MS (140), and by RP-HPLC (141); **cocaine** by CE (simultaneous analysis of coca alkaloids and sugars in illicit cocaine) (142), by free-zone CE (143), by DSC (and GC/FID) (144), by FT-IR and HPTLC (145), by flow injection analysis with amperometric detection (146), by FTIR, GC/MS, and quantitative GC (cocaine HCl in wax) (147), by GC (cocaine base) (148), by GC/MS after field testing (149), by HPLC (150,151), by HPLC and GLC (152), by an ISFET device, GC, and UV (153), by LC/AP-CI-MS (154), by MS (evaluation of fragmentation patterns (155), by collision induced dissociation MS (156), by MECC (157), by Raman microspectroscopy (158,159), by SPME/GC/MS (methylbenzoate from cocaine) (160), by TLC, GC, UV, and GC/MS (identification of cocaine in samples in the presence of other local anesthetics) (161), and by transmission and internal reflection IR (cocaine base versus HCl) (162,163); **cocaine analogs** by NMR (164), **cocaine base** (comprehensive) (165); **cocaine-N-oxide** by LC and MS (166); **coca tea** by solid-phase extraction followed by GC-MS (167); **codeine** by chemiluminescence (168), by LC and LC-MS/MS (169), and by NMR (170); **codeine pharmaceuticals** by CE (171), by free solution CE (172), and by HPLC (173); **creatine** (comprehensive) (174,175), and by TLC/densitometry (176); **cyclofenil** (comprehensive) (177); **cyclohexyl nitrite** (comprehensive) (178); **dexfenfluramine** by HPLC on a chiral column (179); **diazepam** by ion-trap and quadrupole mass spectroscopy (180), and by polarography (181); **dihydroetorphine** and **etorphine** (comprehensive) (182); **2,5-dimethoxy-4-ethylthiophenethylamine** (2CT-2) by IR, GC/IRD, and GC/MS (183); **2,5-dimethoxy-4-(N)-propylthio-phenethylamine** (2C-T-7) (comprehensive) (184); **dimethpramide** (comprehensive) (185,186,187); **dimethylaminorex** (comprehensive) (188); **dimethylamphetamine** by GC, IR, and UV/VIS (stability study) (189), by GC/MS, HS-GC/MS, and LC-ESI/MS (analysis of dimethylamphetamine pyrolysis products) (190); **dragon's blood incense** (overview) (191), and by GC/MS (192); **ergot alkaloids** (review) (193), determination and isolation by LC (194), by LC with fluorescence detection (195), and determination of ergonovine maleate by flow injection analysis with chemiluminescence detection (196); **etonitazene** (comprehensive) (197); **fenethylline** by IR, UV, and TLC (198), and by TLC, UV/VIS, and toolmarks (199); **fentanyl** (review) (200), and by cyclic voltametry (201); **fentanyl and fentanyl analogs** (review) (202), by RP-HPLC (203), and by GC, GC/MS, and IR (204); ***Flos Daturae*** by CE (205); **flunitrazepam** (Rohypnol) (overview) (206), (comprehensive) (207,208), by color testing (screening) (209), by derivatization followed by TLC with fluorescence detection (urine screening focus) (210), by FTIR, FT-Raman, and NMR (degradation study) (211), and by screening techniques (overview) (212); **4-fluorophenylacetone**, **4-fluoroamphetamine** and **4-fluoromethamphetamine** (comprehensive) (213); ***para*-fluorofentanyl** (comprehensive) (214), **heroin** by bioluminescent assay (215), by CZE (216), by rapid GC (217), by GC/MS, FTIR, and TLC (for determination of heroin base in heroin citrate) (218), by HPLC (degradation study) (219), by IR and TLC (220), by continuous flow IRMS (221), by MECC

(222,223), by NMR (224), and by TLC (225); **heroin and related morphine alkaloids** by HPCE (226); **heroin and amphetamine** by CE (227); **human chorionic gonadotropin** (*beta* subunit*)* by MS (228); ***gamma*-hydroxybutyric acid** (GHB) or ***gamma*-hydroxybutyrate** (review) (229), (overview) (230), (comprehensive) (231,232,233), by free zone CE with direct UV detection of GHB (234), by color testing (235), by FTIR and color testing (236), by GC/MS after extraction on a SPME fiber and derivatization with BSTFA (237), by ICP-atomic emission and MS (includes ephedrine) (238), by IR using a 3-bounce diamond ATR element (239), by microcrystal testing with cupric nitrate/silver nitrate solution (240), by NMR (241), and by SPME - GC/quadrupole ion trap spectrometry (242); ***gamma*-hydroxybutyric acid (GHB) and *gamma*-butyrolactone (GBL)** (interconversion study) (243,244), by CE and HPLC (245), by GC/MS with BSTFA derivatization (246), by HPLC (247), by HPLC/UV-VIS and HPLC/thermospray MS (248), ***gamma*-butyrolactone** in wine by GC/MS (249); ***gamma*-hydroxybutyric acid (GHB), *gamma*-butyrolactone (GBL), 1,4-butanediol (BD), tetrahydrofuran (THF), and/or GHB/GBL analogs** (overview, comprehensive) (250), (overview of analysis of GHB, GBL, and BD) (251), (overview of GHB, GABA, and various analogs) (252), by CE (253), (comprehensive) (BD in a liquid exhibit) (254), and by GC/MS and FT-IR (BD) (255); **N-(2-hydroxyethyl)-amphetamine** (comprehensive) (256,257); **N-hydroxy-3,4-methylenedioxyamphetamine** by GC-FTIR after derivatization (258); **N-hydroxy-3,4-methylenedioxymethamphetamine** (comprehensive) (259), and by GC and GC/MS (260); **imazalil** (comprehensive) (261); **imipramine** by flow-injection extraction - spectrophotometric determination with methyl orange (262); **jimson weed** (overview and analysis by GC/MS: 263); **ketamine** (comprehensive) (264), and by GC and GC/MS (265); **khat** (*Catha Edulis*) by GC and GC/MS after derivatization with (R)-(+)-*alpha*-methoxy-*alpha*-(trifluoromethyl)phenylacetic acid (266), by GC/MS (267,268,269), by GC/MS/MS (270), by HPLC and TLC (271), and by NMR (272); **lorazepam** by UV (273); **lysergic acid diethylamide** (LSD) (review) (274), (overview, comprehensive) (275), (comprehensive) (276), by enzyme immunoassay and immunoaffinity extraction and HPLC-MS (277), by GC (278), by GC/MS using electronic pressure controls and pulsed split injection (279), by GC/MS/FTIR (280), by GLC (281), by HPLC (282), by HPLC and GLC (283), by MECC (284), by NMR (285), and by automated TLC (286); **LSD and psilocin** - by GC/MS and GC/MS-MS (287); **marijuana and related cannabinoids** by botanical and microscopic examination and GC/FID (288), by CEC (289,290), by DNA analysis (291,292), by the Duquenois-Levine test (on charred marijuana residue) (293), by fluoroimmunoassay (294), by GC and GC-FTIR (includes ephedrine and pseudoephedrine) (295,296), by GC, HPLC, and TLC (297), by GC/FID (versus cannabidiol as a reference standard (298), (versus cannabinol as a reference standard) (299), by GC/MS (300,301), by HPLC (302,303), by HPLC (seeds) (304), by HPLC of neutral cannabinoids of marijuana and hashish after supercritical fluid extraction (305), by LC/MS and LC/MS-MS (306), by plant propagation (determination of viability of stem cuttings) (307), by SFC/AP-CI-MS (308), by TLC and botanical characterization of morphological features (309), by monoclonal antibody (against tetrahydrocannabinolic acid) (310), and by GC/MS (butyl cannabinoids in marijuana) (311); **mescaline** in hallucinogenic *Cactaccae* by ion-interaction HPLC (312), and in peyote by GC/MS (comparison of 6 different extraction procedures) (313); **methamphetamine** (and related compounds) comprehensive (314), by CE (chiral analysis) (315), by diasteriomeric salt formation (316), by FT-Raman (317), by GC, HPLC, and/or CE following derivatization (for enantiomer determination) (318), by full scan GC-ion trap EI- and CI-MS (319), by GC/MS (improving ion mass ratio performance at low concentrations through internal standard selection) (320), by HPLC with circular dichroism detection for determination of enantiomers (321), by IR (chiral analysis) (322,323), by NMR (chiral analysis) (324), by TD-IMS and SIMPLISMA (325), and by CE with UV and LIF detection (326); **methaqualone** (review) (327), and by color testing (includes mecloqualone) (328); **methcathinone** (ephedrone) (review) (329), (comprehensive) (330), by GC and GC/MS (methcathinone and some designer analogues) (331), by GC and GC/MS after chiral derivatization with S-(-)-(trifluoroacetyl)-prolyl chloride (332), by GC/MS (333), and by animal testing (potency comparison of enantiomers; includes syntheses) (334); **methcathinone** and **cathinone** (comprehensive) (335); **4-methoxyamphetamine** (PMA) and **4-methoxymethamphetamine** (PMMA) (comprehensive) (336), and **2-**, **3-**, **4-PMA, PMMA, and P2P** (comprehensive) (337); **3-methoxy-4,5-methylenedioxyamphetamine** (comprehensive) (338,339); **2,3-methylenedioxyamphetamines** (comprehensive) (340); **2,3- and 3,4-methylenedioxyamphetamines** (combined studies) by GC/MS-MS (341,342), by LC and MS (343,344); **3,4-methylenedioxyamphetamines** (MDA's) (general review of the syntheses and analyses of MDA's and precursors and related compounds) (345), (comprehensive) (346), by C-13 solid-state NMR (347), by CE (348,349), by field testing (350), bt FT-IR (for tablets) (351), by FT-IR microscope (352), by FTIR and GC/MS (353), by GC (tablets) (354), by GC and GC/MS

(355), by GC/MS (356), by HPLC with fluorimetric detection (357), by HPLC with fluorometric detection, using added cyclodextrins (chiral analysis) (358), by HPTLC using 0-benzenesulfonamido-*p*-benzoquinone for detection (359), by LC (360), by ion trap MS (361), by LC-MS with thermospray, electrospray, and APCI interfaces (362), by RP-LC, GC, and EI-MS methods (363), by NIR and HPLC (of tablets, including MDEA and amphetamines) (364,365), by NMR (366,367), by Raman (368,369), and by SERS (370); **methylenedioxy-cathinones** (comprehensive) (371), and by melting points (372); **methylenedioxyethylamphetamine** (MDEA) (comprehensive) (373,374,375); **methylenedioxymethamphetamine** (MDMA) (comprehensive) ("crystal" MDMA) (376), by CE (377), by FTIR (for determination of hydration polymorphism) (378 and 379), by C-13 NMR (380), by FTIR (MDMA phosphate) (381), by HPLC (382), and by X-ray crystallography (383); **(3,4-methylenedioxyphenyl)-2-butanamines** (MBDB's) (comprehensive) (384), by GC/MS and LC (385,386,387,388), and a comparative study of N,N-dimethyl-3,4-methylenedioxyamphetamine and N-methyl-1-(3,4-methylenedioxyphenyl)-2-butanamine (389); **3-methylfentanyl** (comprehensive) (390); **4-methylfentanyl** (comprehensive) (391); **methylmethaqualone** by NMR (392); **methylphenidate** by CE (393); **1-(4-methyl-phenyl)ethylamine** (comprehensive) (394); **N-methyl-1-phenylethylamine** (comprehensive) (395,396); **4-methylthioamphetamine** (comprehensive) (397,398), by GC/MS and FTIR (399), and by LC-MS/MS (400); **midazolam** by UV/Vis (401); **morphine** by aqueous and nonaqueous CE (for quantitative determination of morphine in pharmaceuticals) (402), by flow-injection analysis with spectrophotometric determination (403), by HPLC with chemiluminescence detection (404), with a fluoride-selective electrode following derivatization with 1-fluoro-2,4-dinitrobenzene (405), and by displacement TLC (406); **nandralone-*para*-hexyloxyphenyl-propionate** (comprehensive) (407); **nootropics/"smart drugs"** (overview) (408); **opiate alkaloids** by CEC (409), by high-resolution electrospray ionization – IMS/MS (evaluation of opiate separation) (410), by HPLC (hydrocodone in Tussionex) (411), and by HPTLC (oxycodone in pharmaceutical solutions) (412); **opium** (overview of characterization methodologies: 413), by CE (414), by non-aqueous CE (415), by CE-TOF-MS (416), by GC (quantitative determination of opium alkaloids in opium) (417), by GC/MS (narcotine and papaverine in seeds) (418), by HPLC (419), by RP-HPLC on a base-deactivated stationary phase (420), by HPLC of Sep-Pak C-18 cartridge extracts (421), by MECC (422), by pyrolysis-GC (423), by synchronous excitation spectrofluorimetry (424), by TLC-UV densitometric and GC-MSD methods (425), by UV/VIS (for morphine in opium) (426), and by GC/FID, GC/MS, and GC/FTIR (headspace constituents of opium) (427); **opium alkaloids** by CE with acidic potassium permanganate chemiluminescence detection (428), by CZE (429), by flow-injection analysis using soluble manganese(IV) for chemiluminescence detection (430), by GC/MS after oxime-TMS derivatization (431), by GC/MS (6-acetylmorphine) (432), by HPLC using porous and non-porous stationary phases (433), by HPLC-DAD (stability of morphine containing solutions) (434), by RP-HPLC (codeine and ethyl morphine HCl in pharmaceutical tablets) (435), by LC (for acetylsalicylic acid, caffeine, and codeine phosphate in pharmaceuticals) (436), (for acetylsalicylic acid, caffeine, codeine, paracetamol, pyridoxine, and thiamine in pharmaceuticals) (437), (for paracetamol, caffeine, and codeine phosphate in pharmaceuticals) (438), by RP-LC (papaverine in tablets) (439), by spectrofluororimetric detection (acetylsalicylic acid and codeine in pharmaceuticals) (440), and by spectrophotometric detection (of noscapine with bromocresol green in chloroform) (441); **opium**, **morphine**, and **heroin** (combined study) (comprehensive) (442); **oxazepam** by automatic kinetic determination (443); **pentobarbital** by GC/MS (444), and by HPLC (445); **phencyclidine** (and **1-piperidinocyclohexane-carbonitrile**) (review) (446), by IMS (447), and by IR after liquid-liquid extraction from case samples (448); ***alpha*-phenethylamine** (comprehensive) (449,450), ***beta*-phenethylamine** (overview) (451,452), and by GC/MS, FTIR, and GC/IR (453); **phenobarbital** by CE (tablets) (454), by LC (for determination of scopalamine, hyoscyamine and phenobarbital in tablets) (455), by multivariate spectrophotometric calibration (for simultaneous determination of phenobarbital and phenytoin in tablets) (456), and by spectrophotometric determination (457); **phenylpropylmethylamine** (comprehensive) (458); **piperazines** (comprehensive) (459); ***psilocybe* mushrooms** by DNA (460,461), by IMS and GC/MS (462), by GC/MS and HPLC/UV (463), by morphological, microscopic, microchemical, and HPLC with 266 nm UV detection (464), by TLC, GC/MS, and LC/MS (465), and by TLC and GC/MS (psilocin and psilocybin in developmental mushrooms) (466); ***Salvia Divinorum*** by GC/MS (467); **secobarbital** using C-13 labelled secobarbital as an internal standard (468); **sibutramine** (comprehensive) (469); **steroids** (overview) (470), (overview, comprehensive) (471), (comprehensive) (472), by EI, CI, and CI/tandem MS (473), by GC (474), by GC/MS (475), by GC/MS after SFC isolation from aqueous matrices (476), by GC-MS and NMR after derivatization with N-methyl-N-alkylsilyltrifluoroacetamide-I-2 (477), by GLC (478), by HPLC with cyclodextrin coated columns (479), by

HPLC with UV/Vis-particle beam MS (480), by HPLC-FTIR (481), by HPTLC and HPLC (482), by MS (of *tert*-butyldimethylsilyl ether derivatives) (483), by MS/MS (484), by quadrupole ion trap tandem MS (485), by 13C - NMR (486), by MECC (487), by MECC, gradient HPLC, and capillary GC (488), by capillary SFC with FID and ECD (489), and by TLC (490); **telazol** (comprehensive) (491,492); **terbinafine** (comprehensive) (493), and by UV and nonacqueous voltametry (494); **triazolam** by TD-GC (495); **tricyclic antidepressants** - by electrogenerated chemiluminescence (496); and **tryptamines** by chemiluminescence (497).

Adulterants, Diluents and Precursors (general overviews of essential chemicals and precursors) (498,499), by GC, HPLC, and CE (500), by LC (for determination of non-UV detectable organic impurities) (501), by various analytical techniques (for determination of "secondary" drugs present in cocaine, heroin, marijuana and phencyclidine) (502); **acetaminophen** by Raman microprobe spectroscopy (503); **acetic acid** (in acetic anhydride) by NMR (504), **dextromethorphan** by MEKC (dextromethorphan, pseudoephedrine and guaifenesin) (505); **diethylaminoethylaniline** (comprehensive) (506), ***cis*- and *trans*-2,5-dimethoxy-4,*beta*-dimethyl-*beta*-nitrostyrenes** by FTIR/Raman (507); **dimethylsulfone** (overview) (508), (removal by sublimation) (509,510), by GC/MS, IR and GC/IR (in amphetamine and methamphetamine samples) (511); **dimethyl terephthalate** (and **dimethyl phthalate**) (comprehensive) (512), differentiation of **dimethylterephthalate** from **dimethyliso-phthalate** by GC/FTIR (513), identification of **dimethyl terephthalate** in cocaine samples (comprehensive) (514); **dipyrone** in pharmaceuticals with a flow cell containing gold electrodes (515); **ephedrine/pseudoephedrine** comprehensive (516), by CE, UV, NMR, and MS (for chiral recognition of the enantiomers of ephedrine derivatives) (517), by CE on a chip with amperometric detection (for chiral analysis) (518), by acetonitrile modified CZE (for ephedrine in *ephedra callus*) (519), by derivative spectrophotometry and ratio spectra derivative spectrophotometry (for simultaneous determination of pseudoephedrine, dexbrompheniramine, and loratadine) (520), by differential-derivative spectroscopy (assay of ephedrine/theophylline containing pharmaceuticals) (521), by an ephedrine based electrode (522), by a double-membrane ephedrine selective electrode (523), by flow injection - pulse amperometric detection (524), by GC (for determination of pseudoephedrine and diphenhydramine) (525), by GC/MS (for determination of ephedrine alkaloids and tetramethylpyrazine in *ephedra sinica* Stapf) (526), by HPLC (for determination of ephedrine, pseudoephedrine, norephedrine, and methylephedrine in Chinese folk medications) (527), by HPLC using chiral stationary phases (for separation of the enantiomers of ephedrine, norephedrine, and pseudoephedrine) (528), by HPLC and CE (discrimination of ephedrine and pseudoephedrine) (529), by HPTLC (for simultaneous determination of pseudoephedrine and cetirizine in pharmaceuticals) (530), by LC (for N-methylephedrine, after derivatization with 9-fluorenylmethyl chloroformate) (531), by LC (for determination of pseudoephedrine and carbinoxamine pharmaceuticals) (532), by proton NMR (for determination of ephedrine, pseudoephedrine, and norephedrine in bulk and dosage mixtures) (533), by RP-HPLC-UV (with data analysis to handle quantitation of overlapping peaks) (534), by SPE-LC/UV (for determination of 7 ephedrine alkaloids in herbal products) (535), by TLC and FTIR (for determination of pseudoephedrine in a pseudoephedrine/chlorpheniramine pharmaceutical) (536), and by impregnated TLC (for direct resolution of (+/-)-ephedrine and atropine) (537); **ethoxy-1-(2-nitro-1-propenzyl)benzenes** by FTIR and Raman (538); **guaifenesin** by HPLC (539); **3-hydroxy-N-phenyl-2-naphthalene carboxamide** (comprehensive) (540); **lactitol** in cocaine by NMR and IR (541); **4-(N-methyl-acetamido)-antipyrine** (comprehensive) (542); **paracetamol** by FTIR (543), by ion chromatography (544), by reflectance NIR spectroscopy (545), by NIR transmittance spectroscopy (546), and by simultaneous stopped-flow determination and FTIR (for paracetamol, acetylsalicylic acid and caffeine in pharmaceutical formulations) (547); **pheniramines** by CZE (for pheniramine, chlorpheniramine, and brompheniramine) (548), and by an imprinted sensor (for chlorpheniramine) (549); **phenylpropanolamine** by HPLC in pharmaceutical preparations (using 4-dimethylaminobenzaldehyde) (550); **procaine** by spectrophotometry (using *p*-dimethylaminobenzaldehyde) (551); **quinine** by flow-injection chemiluminescence (552), and by HPLC with polarimetric detection (553); **safrole** by SFC extraction and GC/MS (for determination of safrole and related allylbenzenes in sassafras) (554); **sugars** by GC after derivatization with trimethylsilylimidazole (for quantitation of sugars in drug samples) (555), **theophylline** by adsorptive cathodic stripping voltammetry (556), by a flow fluoroimmunosensor (557), by micellar LC and spectrophotometric detection (558), and by UV and HPLC (559); **thiamine** by cathodic stripping voltametry (560), by cyclic voltametry and HPLC with amperometric detection (561), by flow injection turbidimetric determination using silicotungstic acid (562), and by spectrofluorometry (563); and **triprolidine** by a kinetic method based on oxidation w/ KMnO4, with spectrophotometric determination (564).

Occluded Solvents in **cocaine** by GC/MS (565), in **cocaine and heroin** by headspace - GC/FID and GC/MS (566), and by SHS-GC/MS (567); in **methamphetamine** by SPME/GC-MS (characterization of volatile components) (568); and in **pharmaceuticals** (overview, emphasizing headspace - CGC and impurity profiling) (569), by CGC (570), by wide-bore CGC (571), by CGC-ITD (572), and by automated SHS - CGC-MS (573).

Simultaneous Analyses of Drugs and Adulterants/Diluents

A number of studies have been reported which allow simultaneous identification and quantitation of mixtures of controlled substances and adulterants without separating them into individual components. In general, such techniques may be only employed in select geographical areas in which the submitted exhibits are reasonably consistent (that is, routinely the same adulterants and diluents, at or below a threshold percentage). In most cases, they allow much more rapid sample analysis and throughput without unduly compromising the identification of the controlled substance. Such techniques have been utilized for: **cocaine** by IR (574,575), by Raman (576,577), by spectrometric methods (578), and by sequential second-derivative spectroscopy (579); and **pharmaceuticals** by NIR and Raman (580), and by spectrophotometry in conjunction with PLS-1 and PLS-2 data processing methods (581); and for determination of interferences by common diluents in street-level drugs by micro-FTIR (582).

Instrumentation Focus

In addition to the above studies which concentrated on specific drugs or drug groups, there have been a large number of studies which focused on specific instrumental techniques, analyzing two or more unrelated drugs or drug types in order to illustrate the utility of the described methodology, including: **capillary electrophoresis:** (general reviews) (583,584,585,586,587,588,589,590,591, 592,593,594,595,596,597), (general overview and reviews) (598,599), (general overview, comparing various CE techniques) (600), (review for court admissibility) (601), for separation and permanganate chemiluminescence on-line detection of some alkaloids with *beta*-cyclodextrin as an additive (602), for on-chip separation of amphetamine and related compounds labeled with 4-fluoro-7-nitrobenzofurazane (603), for enantioselective separations of various amphetamines and methylenedioxyamphetamines using cyclodextrins (604,605), for analysis and confirmation of synthetic anorexics in adulterated traditional Chinese medicines (606), for chiral analysis of drugs (607), for chiral identification of drug isomers (608), for chiral analysis of basic drugs using oligosaccharides (609), for chiral separation of basic drug racemates using linear, neutral polysaccharides (610), for chiral resolution of cationic drugs of forensic interest with mixtures of neutral and anionic cyclodextrins (611), for chiral separation of enantiomers of drugs using *beta*-cyclodextrin (612), for chiral separation of drug stereoisomers with cyclodextrins (613), for chiral separation of basic drugs using ionic and neutral polysaccharides (614), for ultra-fast chiral separation of basic drugs (615), for illicit drug seizures (616), for CE-TOF/MS of drugs of abuse (617,618), for separation of enantiomers of basic drugs (by affinity CE using a partial filling technique and α1-acid glycoprotein as chiral selector) (619), for separation and identification of amphetamines, methadone, venlafaxine, and tropane alkaloids by CE-electrospray MS (620), for separation and identification of designer drugs with CE-ionspray MS (621), for determination of drug-related impurities (622), for analysis of heroin and amphetamine (623), for simultaneous chiral analysis of methamphetamine and related compounds (624), for routine analysis of methamphetamine, amphetamine, MDA, MDMA, MDEA and cocaine with dynamically coated capillaries (625), for analysis of basic pharmaceuticals by CE in coated capillaries with on-line MS detection (626), for quantitation of common illicit drugs (627,628), for chiral separation of selegiline, methamphetamine, and ephedrine using a neutral *beta*-cyclodextrin epichlorhydrin polymer (629), for tropane alkaloids in a plant extract (630), for CE-DAD-electrospray MS of tropane alkaloids, hyoscyamine, scopolamine, and plant extracts (631), CEC: (introductory overview) (632), for simultaneous separation of acidic, basic, and neutral organic compounds, including strong and moderate acids and bases (633), for analysis of drugs of forensic interest (634); CZE: characterization of drugs of forensic interest by CZE/electrospray ionization MS (635), for chiral separation of amphetamine and phenylephrine, using cyclodextrins (636), for chiral separation of basic drugs using cyclodextrins (637), and for chiral separation of some basic drugs (influence of the buffer organic cation) (638); EKC: for chiral separation of

drugs by electrokinetic chromatography (639), for separation of enantiomers and geometric isomers using a charged cyclodextrin (640), and for chiral separation of neutral and basic enantiomers using anionic cyclodextrins (641); MECC: (general review) (642), for chiral differentiation of pharmacologically active substances by cyclodextrin-modified MECC using a bile salt (643), for analysis of controlled substances, using different micelles (644), and for analysis of phenethylamines (645); MEKC: for separation of sympathomimetic amines of abuse and related compounds (646); non-aqueous CE: for analysis of drugs (647,648,649,650), for analysis of drugs by nonaqueous CE with electrochemical detection (651), and for analysis of tropane alkaloids and amphetamine derivatives (652); polymethod: characterisation of retention in micellar HPLC, in MEKC and in MEKC with reduced flow (653), complementary use of CZE and MECC for mutual confirmation of results in forensic drug analysis (654), and the study of the CZE behavior of selected drugs and its comparison with other analytical techniques for their formulation assay (655); general: CE using polyacrylamide-coated columns (656,657), effect of methanol in sample solution on an electropherogram (658), evaluation of the use of cyclodextrins in chiral separation of basic drug substances by CE (659), improved chiral separation of basic compounds using *beta*-cyclodextrin and tetraalkylammonium reagents (660), quantitative aspects of the application of CE to the analysis of pharmaceuticals and drug related impurities (661), separation selectivity in chiral and achiral CE with mixed cyclodextrins (662), and use of large-volume sample stacking for selected drugs of forensic significance (663); **fluorescence spectroscopy** (review) (664); **gas chromatography** and **gas chromatography/mass spectrometry:** (general reviews (books)) (665,666), to distinguish amphetamine, methamphetamine, and 3,4-methylenedioxymethamphet-amine from other sympathomimetic amines following derivatization with propyl chloroformate (GC/CI-MS) (667), to distinguish and quantify the enantiomers of amphetamines, phenol alkylamines, and hydroxyamines following stereospecific derivatization (CGC/MS) (668), for enhanced detection of trace-level controlled substances using GC/MS with pulsed splitless injections (669), for the quantitation of cocaine, heroin, diazepam, methaqualone, codeine, and oxycodone (GC) (670), forensic analysis by GC with dual MS and NPD detection (671), by GC with surface ionization detection (672), using isotopic analogues as internal standards (673,674,675), by MS and electrospray ionization MS (676), with a programmable temperature vaporizing injector and cold on-column injector (677) by rapid GC (678), by secondary electrospray IMS/MS (679), by TLC and GC/MS (680), by wide-bore column GC-NPD (681), a dual internal standard method for screening by GLC at the one percent level (682), internal quality control of a general GC drug screen in forensic toxicology (683), use of MSD's for identification of unknowns (684), normalization of residual ions after removal of the base peak in EI-MS (polydrug study) (685), practical determination of GC–MS limits of detection (686), sample concentrator for sensitivity enhancement in chromatographic analyses (687), SPME-GC (review) (688), and trace analysis by splitless GC/MS (689); **high-performance liquid chromatography** (and tandem HPLC techniques)**:** general overview (690), (recent progress in HPLC analyses for drugs of abuse) (691), for analyses of barbiturates, LSD, MDA, and psilocybin (HPLC using continuous on-line post-elution photoirradiation with diode-array UV or thermospray-MS detection) (692), to separate and identify cocaine, morphine, heroin, codeine, papaverine, benzocaine, procaine, and lidocaine (HPLC-DAD) (693), for the rapid analysis of illicit heroin and cocaine samples (HPLC-DAD and CGC/NPD) (694), for assaying morphine and hydromorphone in pharmaceuticals (695), for direct chiral resolution of phenylalkylamines (using a crown ether chiral stationary phase (includes amphetamine and cathinone)) (696), for the simultaneous determination of triprolidine, pseudoephedrine, paracetamol, and dextromethorphan (697), for drug screening (698), for analysis of drugs of forensic interest (RP-HPLC) (699), for analysis of alkaloid drugs of forensic interest (RP-HPLC-PDA) (700), for analysis of some alkaloids on unmodified silica gel with aqueous-organic solvent mixtures (701), for determination of alkaloids in foods (multi-detector HPLC) (702), for detection in the forensic sciences (LC-PDA) (703), to determine the enantiomeric composition of abused drugs (704), for determination of illicit drugs and related substances (HPLC with an electrochemical coulometric-array detector) (705), for forensic analyses (on-line HPLC/FAB-MS) (706), for purity testing for tropane alkaloids (707), for resolution of racemic drugs (using a new chiral column based on silica-immobilized cellobiohydrolase) (708), to study the effects of chromatographic conditions on the retention indices of forensically relevant substances (RP-HPLC) (709), and for analysis of pharmaceuticals and drugs (HPLC using unmodified silica and polar solvents) (710); **HPLC retention indices:** (711,712,713); **infrared and Raman spectroscopy**: (minor review of IR and Raman for detection of narcotics) (714), (general review of Raman of narcotics and explosives) (715), FTIR and microcrystal tests for rapid identification of drugs (716), FTIR microspectrophotometry of illicit drugs (sample preparation) (717), FT-NIR for validation of controlled substance identifications (718), NIR for identification of

drugs and various adulterants/diluents (719), NIR, FT-Raman, and DR-FTIR for non-destructive identification of Chinese traditional drugs (720), GC-FTIR for screening of hallucinogenic and stimulant amphetamines (721), vapor-phase FTIR for identification of novel illicit amphetamines (722), HPTLC-FTIR for identification of LSD, MBDB and atropine (723), use of a diamond anvil cell with a beam condenser and an FTIR microscope for analyses of some particulate drug mixtures (including cocaine, heroin, and methamphetamine) (724), internal reflectance spectra library (725), FT-Raman for nondestructive determination of raw plant medicinal drugs (726), filtered fiber optic Raman probes for analysis of illicit drugs (727), micro-Raman for identification of narcotics (including opium alkaloids) (728), SERRS for drug analysis (729), and evaluation of silver substrates for SERRS of cocaine and other stimulant drugs (730); **ion chromatography:** for determination of ionic compounds, exicipients, and contaminants in drug evidence (731); **microscopy:** (general overview) (732), and videomicroscopy (733); **nuclear magnetic resonance spectroscopy:** (general review) (734), for assessing drug enantiomeric composition (including amphetamine) (735), for chiral identification and determination of ephedrine, pseudoephedrine, methamphetamine, and methcathinone (includes GC analyses) (736), to identify impurities in drug substances (by LC-NMR) (737), and for routine analyses (738,739); **phosphorimetry:** of barbital, codeine, morphine, and practolol after labelling with dansyl chloride (740); **robotics** and/or **specialized computer programs:** (overview and review) (741), for automated CGC heroin analysis (742), combined Rf and UV library search software for TLC and RPTLC (743), a computerized IR search system (744), for optimized analysis of heroin by RP-HPLC (745), to evaluate an HPLC column's performance (746), and to optimize gradient and isocratic HPLC analyses (747); **supercritical fluid chromatography:** (general reviews) (748,749), and for extraction of tropane alkaloids (including cocaine) from E. coca extracts (750); **thin layer chromatography:** (general review) (751), TLC/DAD for forensic analyses (752), overpressured TLC (for determination of morphine, codeine, heroin, opium alkaloids, nicotine, amphetamine, cocaine, and LSD) (753), TLC for separation of cocaine, pramocaine, fentanyl, and diphenhydramine (754), and TLC with a special visualization reagent for tertiary amines (including dimethylamphetamine, flunitrazepam, methamphetamine, methaqualone, nicotine, theophylline, triazolam, and others) (755); and **miscellaneous:** Comparison of IR and MS for drug analyses (756).

Analytical Artifacts

GC and GC/MS are the current methods of choice for routine screening, identification and quantitation of controlled substances. However, the use of high-temperature injectors can produce artifacts via unimolecular rearrangements of and/or intermolecular reactions between the various components (including even the injection solvent). Artifacts are also possible in other techniques. Over the past 10 years, artifacts have been reported for: **cannabinoids:** nitrites in cannabinoid analyses (urine testing focus) (757,758,759); **cocaine:** determination of ecgonidine methyl ester vapor pressure (760), identification of methyl esters of ecgonine as injection port produced artifacts from cocaine base (crack) exhibits (761); **heroin:** identification of a heroin/chloroform-impurity reaction product (762); **morphine and codeine:** hydromorphone and hydrocodone interference in GC/MS assays for morphine and codeine (763); **phenethylamines:** artifacts in the GC analysis of amphetamine and MDA (764), GC/MS identification of amine-solvent condensation products formed during analysis of drugs of abuse (from ethanol with amphetamine, MDA, and *beta*-phenethylamine) (765,766), conversion of ephedrine to methamphetamine and methamphetamine-like compounds during and prior to GC/MS analyses of heptafluorobutyrate and carbethoxyhexafluorobutyrate derivatives (urine testing focus) (767) identification of a GC/MS artifact peak as methamphetamine (768), matrix effects in the IR of methamphetamine salts (769,770), and a procedure for eliminating interferences from ephedrine and related compounds in the GC/MS analysis of amphetamine and methamphetamine (771); **piperonal:** an artifact in the GC analysis of piperonal (772); and **miscellaneous:** influence of large amounts of drugs on the peak areas of their coinjected deuterated analogues measured with APCI-LC-MS (773), and a simple software procedure to determine if a GC/MS blank injection is contaminated (774).

Qualitative Tests

Spot tests are a mainstay of forensic analysis of controlled substances, and offer a reliable means for very rapid screening of submitted exhibits. Over the past 10 years, the following qualitative testing studies were reported: (general overview) (775), (textbook) (776), (review of color comparisons in forensic science, including drug color tests) (777), for anhydrous ammonia (778), for cocaine (mechanistic study of the Scott Ruybal test) (779), for drugs of abuse (12 spot tests) (780), for lithium (781), for pemoline, fenozolone, and thozalinone (color tests) (782), and for red phosphorus (783,784,785).

Sampling Plans

Large drug seizures are almost invariably comprised of multiple units of a standard container size (for example, several thousand 1 kilogram packages of cocaine). Comprehensive analysis of such seizures is a daunting and prodigiously labor intensive task; therefore, statistically based sampling plans are utilized that enable valid assessment of an entire shipment based on analyses of a select number of representative, randomly selected exhibits. The classic study in this field (by Frank, Hinkley, and Hoffman) was reported in 1991, but is included here as critical background (786). Over the past 10 years, the following additional studies were reported: (overviews and general discussions) (787,788,789,790,791), a case studies of heroin (792,793,794).

Source Determination/Impurity Profiling

Determination of synthetic route origin (including processing variants) and/or geographical origin is important for developing tactical and strategic intelligence. Historically, source determination has been conducted by in-depth impurity profiling; that is, determining discriminatory marker compounds and/or ratios of marker compounds which are characteristic of origin. More recently, trace element analyses and (especially) stable isotope analyses (*vide infra*) have increased the confidence of geographical sourcing; this aspect of source determination is rapidly expanding. Finally, increasingly sophisticated pattern recognition techniques (often neural network based) have been employed to handle the enormous databases generated by source determination programs. A large number of source determination studies have been reported over the past 10 years: (general discussions) (795,796), (pattern recognition techniques screening for drugs of abuse (illicit amphetamines) with GC-FTIR) (797); **amphetamines:** systematic approach to profiling amphetamines (798), automated GC method for amphetamine profiling (799), amphetamine profiling in the UK (800), from arylpropenes with acetonitrile and sulfuric acid (Ritter reaction) (801), of Leuckardt amphetamine (802,803,804,805), from 1-phenyl-2-nitropropene (806,807), improved data processing for amphetamine profiling (808), from phenylacetone synthesized from phenylacetic acid (Leukardt reaction) (809), and a pan-European method for profiling amphetamines (810); **amphetamines and marijuana:** of impurities (811); **cocaine:** reviews (812,813,814), comprehensive profiling (815,816,817,818), of 2-carbomethoxy-3-alkyloxy- and heteroaroyloxy substituted tropanes in cocaine (819), of 2-carbomethoxy-3-oxo analogs in cocaine (820,821), of chlorinated cocaines from cocaine treated with bleach (822, see also:823), of cuscohygrine in cocaine (824), of heteroaroyl analogs in cocaine (825), of 1-hydroxy-tropacocaine in cocaine (826), of hygrine in cocaine (827), of hygrine and cuscohygrine in cocaine (828), of norcocaine in cocaine (829), of occluded solvents in cocaine (effects of microwave radiation on solvent profiles) (830), of pharmaceutical cocaine (831), of pseudococaine in cocaine (832), of trace metals in cocaine (833), of trimethoxy analogs of cocaine, cinnamoylcocaine, and tropacocaine in cocaine (834), of truxillines in cocaine (835), of truxillines and similar high molecular weight impurities in cocaine (836), of illicit cocaine by X-ray Diffractometry (also GC and GC/MSD) (837); **cocaine and heroin**: (combined studies) of trace metals in cocaine and heroin (838,839,840,841,842,843,844,845,846), and by palynology (pollen analysis) (847); of occluded solvents in cocaine and heroin (848); **ephedrine:** by microscopic examination (849); **fentanyl:** prepared from 1-phenethyl-4-piperidone (850); **heroin:** overview (851), (review) (852), of acid and neutral impurities in heroin (853), of anions and cations in heroin (854,855), of basic byproducts and adulterants in heroin (856), of impurities in heroin (857,858,859,860,861), of metal contamination in heroin (862), of O6-monoacetylmorphine in "homebake" heroin (863), of trace elements in heroin by ICP-MS (864,865), of trace organic impurities (866);

marijuana: of cannabidiol and delta-9-THC in stored marijuana (867), of impurities in hashish (868,869), of impurities in marijuana (870,871,872), of natural constituents in marijuana (reviews) (873,874), and of marijuana DNA (875,876,877,878,879,880,881,882,883); **methamphetamine:** review (UNDCP) (884), overview (885), generic articles on impurity profiling (886,887), of N-acetylmethamphetamine in illicit methamphetamine (888), of chloroephedrine and aziridines in methamphetamine (889), of impurities in methamphetamine (890,891), of inorganic impurities in methamphetamine (892), of methamphetamine synthesized from allylbenzene (893,894,895), of impurities in methamphetamine synthesized via HI/red P (896), of methamphetamine synthesized via HI/red P (focusing on reaction byproducts of common cold tablet ingredients) (897,898), of methamphetamine containing a hydrocarbon wax (899), of methamphetamine synthesized from pseudoephedrine tablets (900), of trace elements in methamphetamine (901), of methamphetamine seized in Australia (overview and development of a national database) (902), of methamphetamine seized in Japan (903,904, and overview: 905), and of methamphetamine seized in Korea (906); **4-methoxyamphetamine:** of impurities (907); **methylenedioxyamphetamines:** overview of approach in Australia (908), of impurities in methylenedioxymethamphetamine (909,910), of precursors, intermediates, and reaction byproducts for methylenedioxymethamphetamine (911), of impurities in methylenedioxymethamphetamine and amphetamine (912), of impurities in methylenedioxyamphetamine and methylenedioxymethamphetamine (913,914), determination of synthetic route markers for methylenedioxyamphetamine and methylenedioxymethamphetamine (915), of methylenedioxymethamphetamine tablets by logo and headspace comparisons (916), of commercially available methylenedioxyphenylacetone (917), from the Ritter reaction (using safrole) (918), of methylenedioxyphenylacetone and methylenedioxyamphetamine synthesized from isosafrole (919,920), and of methylenedioxyamphetamine synthesized from nitoethane and piperonal (921); **nicotine:** (overview of tobacco smoke) (922); **opium:** of opium alkaloids (for origin determination) (923), of proteins in opium latex (924); **pharmaceuticals:** overview (925), of impurities (926,927,928); **phenyl-2-propanone:** of illicit phenylacetone synthesized from phenylacetic acid with acetic anhydride versus lead (II) acetate (929); **precursors:** of essential oils used as precursors in the synthesis of phenethylamine-type designer drugs (930), and **testosterone undecanoate:** of impurities (931).

Source Determination/Stable Isotope Analyses

Historically, processing origin could be reasonably correlated with geographical origin. However, the expansion of drug producing regions and the concommitant convergence of processing techniques, along with the international exchange or sale of precursors (for example, 3,4-methylenedioxyphenylacetone) or crudely refined controlled substances (for example, morphine or heroin base) across the world, have mandated more sophisticated analyses. Because the natural abundances of the stable isotopes of hydrogen, carbon, nitrogen, and oxygen vary across the world, and their incorporation into natural products is unaffected by subsequent illicit processing, stable isotope analyses offer a powerful tool for determining "true" geographic origin (that is, not indirectly inferred based on processing methodology). Recent advances in instrumentation (notably isotopic ratio mass spectrometry and high field nuclear magnetic resonance spectroscopy) have enabled the determination of the isotopic makeup of controlled substances with reasonable precision and accuracy. To date, only cocaine and heroin have been subjected to comprehensive studies; however, this field is expected to expand to other controlled substances over the next decade. Recent reports include: (overviews) (932,933,934); **cocaine:** by carbon-13 isotope analysis: (935,936), by IRMS and trace alkaloid analysis (937); **cocaine and heroin:** by IRMS (938), by site specific deuterium-NMR (939); and **heroin:** by GC/IRMS (940), and by GC/MS and GC/IRMS (941).

Comparative Analyses

Establishing commonality of origin between 2 or more exhibits requires systematic application of detailed impurity profiling. Comparative analysis does not require formal determination of synthetic, processing, or geographical origin, but rather determination of "degree of match" between profiles (usually trace-level chromatographic analyses; however, establishment of synthetic, processing, or geographical origin is a common spinoff of comparative analysis protocols). Studies reported over the past 10 years include: (general overviews)

(942,943); **amphetamine:** computerized comparisons of Leuckart amphetamine (944); **cocaine:** (overview of methodologies) (945), database for comparison (946), by CGC/ECD (947), by CGC/NPD (948), comparison of crack cocaine by matching fracture lines between pieces (949), cocaine comparison court case (950), by rapid GC (951), by HPLC-DAD (952), by a neural network (953); **hashish:** by HPLC, GC, and AA (954); **heroin**: (general overview) (955), by CGC (956), computerized comparison (957), predictive model (958), harmonization study for retrospective comparisons (959,960), of SWA heroin by GC (961); **marijuana:** comparison by RAPD and HPLC (962); **methaqualone:** tablets by NIR reflectance spectra (963); **methylenedioxymethamphetamine:** by natural isotope abundances (964); **opium:** by RAPD, HPLC, and ELISA (965), **pharmaceuticals:** evaluation of neural networks (966); and **tablets and capsules:** indices of physical characteristics (967,968).

Reference Standards

Accurate analyses of controlled substances and related analogs require high purity standards, including isotopically labelled analogs. Structurally related compounds are also needed as internal standards for chromatographic analyses. Reports over the past 10 years include: (general reviews) (969,970); **bufotenine** (and related tryptamines)**:** (971), **butalbital:** (972); **cannabinoids:** (973,974); **cocaine:** (975,976), aza analogs of cocaine (977), deuterium-labelled cocaine, cocaethylene and metabolites (978), cocaine by one step esterification of benzoylecgonine (979), 6- and 7-hydroxylated cocaines (980), C-3 alkyl analogs of cocaine (981); **lysergic acid diethylamide** (982,983); **d- and l-methamphetamine:** via optical resolution (984), "Ice" methamphetamine (985); **methcathinone:** (986); **methohexital:** (987); **morphine:** (988,989); **polydrug:** (N-ethylmethylenedioxyamphetamine, N-hydroxymethylenedioxyamphetamine, mecloqualone, 4-methylaminorex, phendimetrazine, and phenmetrazine) (990), (O6-monoacetylmorphine, methamphetamine, methylenedioxyamphetamine, methylenedioxymethamphetamine, methylenedioxyethylamphetamine, and N-methyl-3,4-methylenedioxyphenyl-2-butanamine, from seized drugs) (991), and a reference garden of hallucinogenic and narcotic plants in Australia (992); **(1S,2S)-pseudoephedrine:** (993); and **psilocybin** and O-acetyl psilocybin (994).

Clandestine Laboratories

The illicit production of drugs is a dynamic and constantly changing field. Reports over the past 10 years included: (general review) (995), amphetamine (996,997,998), failed synthesis of amphetamine (999), amphetamine in methamphetamine (1000), analyses of inorganic components found in clandestine drug laboratory evidence (1001), arsenic oxide (potential reagent in methamphetamine synthesis) (1002), Birch reduction (general review) (1003) (overview of developments in the midwestern US (1004), cocaine (1005,1006), concealment and trafficking (1007), 2,5-dimethoxy-4-ethylthiophenethylamine (2C-T-2) (1008), ephedra (1009,1010), ephedrine and/or pseudoephedrine (1011,1012), etonitazene (1013), fentanyl (1014), freons in methamphetamine production (1015,1016,1017), hash oil (1018,1019), heroin (acetylated opium) (1020), heroin (review) (1021), hydriodic acid for methamphetamine production (1022,1023,1024), hypophosphorus acid for methamphetamine production (1025), inorganic acids (1026,1027), iodine (GC/MS identification) (1028,1029), lysergic acid amide from morning glory seeds (1030), lysergic acid diethylamide (1031), marijuana (1032,1033), methadone (1034), methamphetamine (1035,1036,1037,1038,1039,1040,1041), methamphetamine (by dissolving metal reduction) (1042,1043,1044), methamphetamine in Taiwan (1045), methaqualone and analogs (1046), methcathinone (1047), methylenedioxymethamphetamine (1048), methylenedioxyphenethylamines (1049), morphine (by dealkylation of codeine) (1050), overview of illicit drug production in the Czech Republic from the 70's through the 90's (1051), phencyclidines (1052,1053,1054), phenylacetone and methylenedioxyphenylacetone (1055,1056), piperonal (1057), polydrug (methamphetamine, phenylacetone, methylenedioxyamphetamine, and methaqualone) (1058), steroids (1059), substitution of white phosphorus for red phosphorus in hydriodic acid reduction laboratories in Idaho (1060), *delta*-9-THC precursors (1061), *delta*-9-THC acetate (1062), unusual defense to charge of MDMA manufacture (1063), and an unusual designer drug laboratory (polydrug) (1064).

Clandestine Laboratory Appraisals and Safety

The rapid expansion of clandestine laboratories in the US over the past 15 years has resulted in a large number of studies concerning proper assessment and safe dismantling, including reports on: assessment and remediation of contaminated sites (1065), clandestine laboratory production capabilities (1066), confined space laboratories (1067,1068,1069,1070), decontamination of biohazardous evidence (1071), determination of occupational exposure to cocaine by crime lab personnel (1072), determination of volumes in clandestine laboratory reaction vessels (1073), environmental impact and adverse health effects of the clandestine manufacture of methamphetamine (1074), field methods to render safe pressurized tanks of ammonia at clandestine labs (1075,1076), hydrogen sulfide fatality (1077), OSHA and NIOSH regulations (1078,1079), phosphine gas exposure from a methamphetamine laboratory investigation (1080), phosphine gas fatalities (1081,1082), phosphine gas detection and monitoring instrumentation (1083), safety training for clandestine laboratory investigators (1084,1085), supplier of 22-liter flasks put on notice (1086), training (1087,1088), triacetonetriperoxide causes explosion during analysis (1089), and useful websites for personnel involved in forensic laboratories and/or clandestine laboratories (1090).

Portable Instrumentation/Trace Detection

New world trade agreements and the easing of formerly restrictive national and international borders have resulted in dramatic increases in cargo transshipping and personal travel, thereby complicating drug inspection and interdiction efforts at POE's. The need for rapid and accurate screening, and high sample throughput, requires on-site equipment capable of assessing humans, animals, and a vast array of shipping containers. In addition, on-site equipment is needed for proper assessment of clandestine laboratories. However, the typical size and operational requirements of most laboratory instrumentation preclude their use in field settings. This has resulted in a growing industry dedicated to development of man-portable, field rugged equipment for detection and identification of controlled substances. Many of the pertinent studies are proprietary, but a large number have nonetheless been reported over the past 10 years: **general:** (reviews) (1091,1092,1093,1094,1095), (general assessments) (1096,1097,1098,1099), appraisal of drug detection scenarios - operational analysis for drug detection (1100), and determination of high-risk cargo (1101); **amperometric assay:** for opiates (1102); **biosensor technologies** for the detection of illegal drugs (1103,1104,1105,1106,1107), antibody-based field kits for cocaine and heroin (1108), a fiber-optic cocaine biosensor (1109), an ISFET device for cocaine analysis (1110), the use of heroin esterase in the development of a biosensor (1111), and use of recombinant DNA in the design of a heroin sensor (1112); **calibration standards:** for narcotics detection devices (1113); **correlated column micro-GC:** for the detection of contraband drugs in cargo containers (1114); **field ion spectrometry:** (1115); **gamma ray detectors:** (1116,1117,1118); **gas sensor arrays** for drug "aroma" detection (1119); **immunoassay based detection systems:** (1120,1121) and similar technologies (1122); **DRUGWIPE:** (1123); **ion mobility spectrometers:** (1124,1125,1126,1127,1128), detection of cocaine and heroin by a custom built IMS (1129), detection of drugs of abuse in Customs scenarios using IMS (1130), use of fluorescence spotting to identify areas for IMS (1131), detection of methamphetamine and ephedrine in abandoned clandestine laboratories with IMS (1132), differentiation of methamphetamine versus nicotine using IMS (1133), DSP techniques for narcotic detection using IMS (1134), field applications of IMS (1135,1136), and use of SPME with IMS (1137); **ion trap mobility spectrometers:** (1138,1139,1140); **laser-based near- and mid-IR:** (1141); **neutron-based technologies:** (1142,1143,1144,1145,1146,1147,1148,1149,1150,1151), combined neutron and gamma ray detection (1152), evaluation of neutron techniques for illicit substance detection (1153,1154,1155), and pulsed fast neutron analysis (1156,1157); **N-14 nuclear quadrupole resonance:** (1158,1159,1160,1161); **particle detection:** cocaine phenomenology study (1162), confidence in the detection of cocaine particulates by IONSCAN and SENTOR systems (1163), particle generators for testing of particle detection equipment (1164), particle size distribution of cocaine HCl (1165), particle size analysis of six illicit heroin preparations seized in the UK (1166), use of methylene blue as a simulant for cocaine HCl and heroin HCl (1167), test material for narcotics detection equipment (1168), and voltametric determination of cocaine microparticles (1169); **piezoelectric ringing:** (1170); **portable GC/MS:** for clandestine laboratory investigations (1171,1172); **Raman spectroscopy:** (1173,1174,1175), minor review of applications (1176), near-IR Raman to identify illegal drugs in

solid mixtures (1177), and Raman microscopy for direct 2-D imaging of explosives and drugs (1178); **human screening:** of internal body packers by magnetic resonance (1179), of internal body packers by X-ray scanning (1180), of packages on persons by X-ray imaging (1181,1182), of prisoners in the Canadian Correctional Service by IMS and ion trap mobility spectroscopy (1183), and a survey of current portal technology for screening people for illicit substances (1184); **SENTOR:** recent developments (1185); **solid-state gas sensors:** (1186); **surface ionization detection:** (1187); **surface acoustic wave (SAW) detectors:** detection of taggants and volatiles by SAW/GC (1188), and portable detection system for illicit materials based on SAW resonators (1189); **surface sampling:** detection of drugs on vehicle surfaces (general study) (1190), and study of surface sampling procedures for improved sampling/detection protocols (1191); **tandem mass spectrometry (CONDOR):** (1192,1193); **testbeds:** chemical vapor test-beds (1194), and a nonintrusive inspection technology testbed (1195); **TOF-MALDI mass spectrometry:** (1196); **vapor detection:** analysis of volatiles from cocaine (1197,1198,1199), analysis of vapors from cocaine and heroin with the aid of SPME (1200), cocaine and heroin vapor pressures (1201), detection of cocaine in cargo containers by high volume vapor sampling (field test) (1202), and formation of methyl benzoate from cocaine HCl under different temperatures and relative humidities (1203); and **X-ray technologies** (1204,1205).

Surveys

Critical to total threat assessments and the monitoring the effectiveness of counter-narcotics efforts are surveys of drug use and related topics. Over the past 10 years, surveys have been reported for: **amphetamine:** of global amphetamine abuse (1206,1207), and of amphetamine type drugs used in Bulgaria (1208); **cocaine:** of adulterants in cocaine in Rome in 1996 and 1997 by GC and GC/MS (1209), of cocaine seized in Spain 1985-1993 (1210), of intralaboratory precision of cocaine analysis by CGC (1211), and of occluded solvents in cocaine 1986 - 1991 (1212); **designer drugs:** (review) (1213), of amphetamine-type designer drugs in Europe (1990-1996) (1214), of designer drugs in Canada (1215), of designer drugs in the European Union (1216,1217), and of designer drugs in Italy (1218); **drug use (general):** global trends - 2000 (1219), global trends - 1999 (1220), of drug abuse in Hungary (1221), of Irish drug seizures (1222), of drug usage in San Diego County 1990-1997 (1223), of drug contents of powders and other illicit preparations in the UK (1224), of drugs imported into the UK (1225), and of drug abuse in Western Denmark during the eighties (1226); **flunitrazepam:** of Rohypnol Tablets (1227); **heroin:** of heroin in Australia (in Sydney in 1997) (1228), of heroin in Denmark, 1981-1992 (1229), of heroin seized in France (1230), of heroin in Israel during 1992 (1231), of noscapine in heroin in Slovenia, 1997 - 1999 (1232), of heroin seized in Spain (1233), of heroin in Andaluza, Spain (1234), of heroin in the UK, 1984 to 1989 (1235), of retail level heroin purchases in the US during 1992 (1236), of the cutting of heroin in the US in the 1990's (1237), and of cutting of heroin in New York City (1238); **LSD:** of LSD blotter papers logos (1239); **marijuana:** of the THC content of cannabis cultivated in Austria (1240), of recent developments in Europe concerning licit cultivation of cannabis (1241), of the cannabinoid content of marijuana seized in Greece (1242), of *delta*-(9)-THC content in cannabis of Greek origin (1243), the potency of cannabis in New Zealand, 1976 to 1996 (1244), of cannibis resin and cannibis seized in the Republic of Ireland (1245), of trends in illicit cannabis cultivation in the UK and Northern Ireland (1246), of potency trends of Δ9-THC and other cannabinoids in confiscated marijuana from 1980-1997 in the US (1247), of the global situation of cannabis consumption, trafficking, and production (1248), and of recent developments in cultivation and quality of illicit cannabis (worldwide) (1249); **methylenedioxyamphetamines:** of MDMA, MDA, MDEA, NEXUS, and MBDB tablets seen in southwestern Spain (1250,1251), and of MDMA, MDEA, and MBDB tablets seen in the United States (1252,1253,1254,1255); **polydrug:** of heroin, cocaine, and cannabis from British Columbia (1256), and of heroin and cocaine seized in a Swiss town (1257); **UNDCP Reports** (by year)**:** World Drug Report - 2000 (1258), List of Narcotic Drugs under International Control (INCB "Yellow List") - 1999 (1259), (INCB "Green List") - 1999 (1260), (INCB "Red List") - 1999 (1261), Report of the International Narcotics Control Board - 1999 (1262), Manufacture of Narcotic Drugs, Psychotropic Substances, and their Precursors - 1999 (1263), Narcotic Drugs Estimated World Requirements - 1999 (1264), Precursors and Chemicals Frequently Used in the Illicit Manufacture of Narcotic Drugs and Psychotropic Substances - 1999 (1265), Psychotropic Substances - Statistics - 1999 (1266), Terminology and Information on Drugs - 1999 (1267), the World Drug Report - 1997 (1268), and Supply of and Trafficking in Narcotic Drugs and Psychotropic Substances - 1996 (1269);

miscellaneous: of adolescents' use of embalming fluid with marijuana and tobacco (1270), and of crime laboratory proficiency testing results 1978-1991 (1271).

Miscellaneous Topics

The following topics of peripheral interest to the analysis and detection of drugs of forensic interest were also reported from 1992 - 2001: **angel trumpet:** overview (1272); **amphetamine:** a review of U.S. statutes on methamphetamine and how they led to an increase in illicit amphetamine production (1273); **ayahuasca:** notes on an Ayahuasca court case in Holland (1274,1275); **barbiturates:** charge transfer complexes with phenytoin (1276); **canines:** use of activated charcoal to circumvent canine detection of concealed narcotics (1277), analysis of volatile drug components and their relevance to canine alerts (1278), characterization of the Auburn Olfactometer (1279), of cocaine on currency (1280), drug money and detection by canines (1281,1282), scientific protocol to evaluate and certify odor detection by canines (1283), and sensitivity of canines to cocaine HCl and methylbenzoate (1284); **(traditional) Chinese medications:** overview (1285), manufacturing flaws and misuse of Chinese herbal medicines (1286), determination of some active components in Chinese medicial preparations by CE (1287), screening of Chinese proprietary medications for undeclared therapeutic substances by HPLC and GC/MS (1288), identification of Western medicines as adulterants in Chinese herbal medicines by HPLC and GC/MS (includes diazepam) (1289), screening for chemical drugs used to adulterate in rheumatic and analgesic traditional Chinese medicine by HPLC-DAD (includes diazepam and phenylbutazone) (1290), determination of adulterated chemical drugs in rheumatic and analgesic traditional Chinese medicine by MEKC (includes diazepam and phenylbutazone) (1291), determination of clobenzorex HCl and diazepam adulterated in anorexiant traditional Chinese medicines by MECC (1292), and determination of fluoxymesterone, methyltestosterone and testosterone in adulterated Chinese herbal preparations by HPLC (1293); **cocaine:** alkaloid content in *Erythroxylum Coca* tissue during reproductive development (1294), the base-catalyzed C-2 exchange and epimerization of 3-*beta* substituted 8-methyl-8-azabicyclo[3.2.1]octane-2-carboxylates (1295), biomass accumulation and alkaloid content in leaves of *Erythroxylum Coca* and *Erythroxylum Novogranatense* Var *Novogranatense* grown in soil with varying pH (1296), effects of cyanoacrylate processing (for fingerprinting) on cocaine HCl trace analysis (1297), gas phase detection of cocaine by means of immunoanalysis (1298), protest against cocaine base sentencing (1299), SFC extraction of cocaine from coca leaf (1300), solubility of cocaine in gasoline (1301), and stability of cocaine in *Agua Rica/Agua Madre* (1302); **(analysis for) controlled substances on currency:** comprehensive review (covers cocaine, heroin, THC, and phethylamines) (1303), cocaine on currency (1304,1305), cocaine on currency by GC-MS (1306), cocaine on currency by IONSCAN IMS and LC/MS with electrospray ionization or by GC-ITD/MS (1307), analysis of drugs on currency by GC/MS (1308), by MS/MS, TD-MS, and APCI-MS (1309), by tandem MS (CONDOR) (1310,1311), and screening of currency by TD/APCI-MS (1312); **designer drugs (unusual):** dihydrobenzofuran analogues of hallucinogens (1313), lactam analogs of fentanyl (1314), methylenedioxyisoquinolines (1315), synthesis and pharmacological evaluation of ring-methylated 3,4-methylenedioxyamphetamines (1316), reference directory of designer drugs (1317), 1,2,3,4-tetrahydro-isoquinoline analogs of phenylalkylamine stimulants and hallucinogens (1318,1319), and the texts by Ann and Alexander Shulgin (1320,1321); **dextromethorphan:** (overview) (1322); **dimethylamphetamine**: mechanistic study of preparation from methylephedrine (1323); **ephedrine:** extraction of ephedrine from ephedra by SFC (1324); **heroin:** homogenization of illicit heroin samples prior to analysis (1325); **inhalants:** general discussions of inhalants and solvent abuse (1326,1327,1328); **Internet:** discussion of internet resources for forensic science (1329,1330); **lysergic acid diethylamide:** detection of LSD on blotter papers after processing for fingerprints (1331), and stability of LSD under various storage conditions (1332); **marijuana:** botanical considerations for forensic investigation of marijuana (1333), embalming fluid-soaked marijuana (**compare to Elwood/Fry article)** (1334), filtering effects of various household fabrics on the pollen content of hash oil (1335), identification and quantitation of 11-nor-delta(9)-tetrahydrocannabivarin-9-carboxylic acid (1336), manufacture of *Cannabis Sativa* for legitimate applications (1337), mineral nutrition of *Cannabis Sativa L.* (1338), and comments on the naming of the Duquenois and related tests for cannabis (1339); **mass spectrometry:** archive of mass spectral data files on CD-ROM and a computerized database (1340), ion ratio instability of a GC/MS system (1341), and poor reproducibility of in-source collisional AP MS of drugs (1342); **methadone:** claim that DEA chemists erred in calculating quantity of methadone that could be synthesized from precursor chemicals (1343; and response: 1344); **nightshade alkaloids:** historical review (1345); **opium:** historical review (1346), biodiversity of *Papaver*

Somniferum L. (1347), and determination of loss on drying of opium samples using microwave ovens (1348); **oxycodone:** overview (1349); **phencyclidine:** ionic associates of phencyclidine with sulfophthaleins and azo dyes (1350); **polydrug:** hypnotics and sedatives not belonging to the classes of barbiturates and benzodiazepines (1351); **poppy tea:** case study/overview (1352); **thebaine:** synthesis from codeine methyl ether (1353); **other topics:** analysis of clandestine drug records (1354), analysis of drugs in unconventional samples (1355), analysis of false positives in drug proficiency testing (1356), analysis of a fruit juice extract that was suspected to be a narcotic beverage by GC/MS (1357), analysis of plastic packaging to trace the source of illicit drugs (1358), computerized management of a forensic analytical laboratory (1359,1360), considerations for planning and site preparation for modern laboratory instrumentation (1361,1362), development of a forensic evidence protection kit (1363), drug smuggling techniques and problems associated with analysis (1364), drug smuggling by internal body carries (1365), environmental impact of illicit narcotics cultivation and processing (1366,1367), expert evidence and forensic misconceptions of the nature of exact science (1368), GC/MS guide to ignitable liquids (1369), modification of an extraction procedure for acidic and neutral drugs (1370), neural networks in forensic science (overview/general discussion) (1371), protecting group chemistry (1372), separation and identification of drugs of abuse in drug cottons by HPLC coupled with electrochemical array detectors (1373), solid phase extraction for systematic toxicological analysis (1374), the UNDCP Dictionary of Narcotics (1375, and addendum: 1376); and an overview of the United Nations International Narcotics Control Board (1377).

References

1. Klein RFX, Hays PA. Research on drug evidence. Proceedings, 13th INTERPOL Forensic Science Symposium, Lyon, France (2001).

2. Brettell TA, Inman K, Rudin N, Saferstein R. Forensic science. Anal Chem 2001;73(12):2735.

3. Brettell TA, Inman K, Rudin N, Saferstein R. Forensic science. Anal Chem 1999;71(12):235R.

4. Klein RFX, Hays PA. Research on drug evidence. Proceedings, 12th INTERPOL Forensic Science Symposium, Lyon, France (1998).

5. Brettell TA, Saferstein R. Forensic science. Anal Chem 1997;69(12):123R.

6. Klein RFX. Research on drug evidence. Proceedings, 11th ICPO-INTERPOL Forensic Science Symposium, Lyon, France (1995).

7. Brettell TA, Saferstein R. Forensic science. Anal Chem 1995;67(12):273.

8. Brettell TA, Saferstein R. Forensic science. Anal Chem 1993;65(12):293r.

9. Sobol SP. Research on drug evidence. Proceedings, 10th ICPO-INTERPOL Forensic Science Symposium (1992).

10. Moffat AC. Drugs of abuse. Science Justice 2000;40(2):89.

11. Malcolm M, Gutfriend M. Chemistry against crime. Can Chem News 1996;48(9):13.

12. Hartstra J, Franke JP, de Zeeuw RA. How to approach substance identification in qualitative bioanalysis. J Chromatogr B 2000;739:125.

13. United Nations International Drug Control Programme. Monograph: Rapid Testing Methods of Drugs of Abuse - 1995. New York, NY:1995.

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

15. Anonymous. The Scientific Working Group for the Analysis of Seized Drugs (SWGDRUG). Microgram 2001;34(6):136. (Note: Most current iteration within review timeframe; updates many previous reports not listed here.)

16. 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. (Note: Most current iteration within review timeframe; updates many previous reports not listed here.)

17. United Nations International Drug Control Programme. Monograph: Recommended Guidelines for Quality Assurance and Good Laboratory Practices - 1995. New York, NY:1995.

18. United Nations International Drug Control Programme. Monograph: Glossary of Terms for Quality Assurance and Good Laboratory Practices - 1995. New York, NY:1995.

19. Saferstein R. Criminalistics: An introduction to Forensic Science, Seventh Ed., Prentice Hall, 2001.

20. Liu RH, Gadzala DE. Handbook of drug analysis: Applications in forensic and clinical laboratories. American Chemical Society Publications, Washington, DC, 1997.

21. Cole, MD. Drugs of Abuse, in: Crime Scene to Court: The Essentials of Forensic Science. White, P, Ed. Royal Society of Chemistry:1998 (London).

22. Europol Drugs Unit. Manual of the Production of Synthetic Drugs. 1998 (The Hague).

23. Cole MD, Caddy B. The Analysis of Drugs of Abuse: An Instruction Manual. Ellis-Horwood:1995 (New York).

24. Saferstein R. Criminalistics: An introduction to forensic science. 6th Ed. Englewood Cliffs, NJ. Princeton Hall:1997.

25. Adamovics JA. Analysis of addictive and misused drugs. New York, NY. Marcel Dekker, Inc.:1995.

26. Mills T, Roberson JC, McCrudy H, Wall W. Instrumental data for drug identification. 2nd Ed. Vol. 5. New York, NY. Elsevier:1992.

27. Juhala JA. The identification of alkyl nitrites. J Can Soc Forensic Sci 1992;25(1):17.

28. Kurz ME, Witherspoon JR, Savage S, Johns S. Analysis of alkyl nitrites by gas chromatography-infrared spectroscopy. J Forensic Sci 1992;37(6):1662.

29. Ripani L, Nichetti D, Rossi A, Schiavone S. In-depth headspace GC/MS analysis of alkyl nitrites. J Can Soc Forensic Sci 1999;32(4):141.

30. Gennaro MC, Giacosa D, Gioannini E, Angelino S. Hallucinogenic species in *Amanita Muscaria* determination of muscimol and ibotenic acid by ion-interaction HPLC. J Liq Chromatogr & Rel Tech 1997;20(3):413.

31. Trenerry VC, Robertson J, Wells RJ. Analysis of illicit amphetamine seizures by capillary electrophoresis. J Chromatogr A 1995;708:169.

32. Sadeghipour F, Varesio E, Gilroud C, Rivier L, Veuthey JL. Analysis of amphetamine by capillary electrophoresis and liquid chromatography: Application to drug seizures and

cross-validation. Forensic Sci Int 1997;86(1-2):1.

33. 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.

34. Veress T. Determination of amphetamine by HPLC after acetylation. J Forensic Sci 2000;45(1):161.

35. Makino Y, Ohta S, Hirobe M. Enantiomeric separation of amphetamine by high-performance liquid chromatography using chiral crown ether coated reversed-phase packing: Application to forensic analysis. Forensic Sci Int 1996;78(1):65.

36. Pastor-Navarro MD, Porras-Serrano R, Herraez-Hernandez R, Campins-Falco P. Automated determination of amphetamine enantiomers using a two-dimensional column-switching chromatographic system for derivatization and separation. Analyst 1998;123(2):319.

37. Clandestine Laboratory Investigating Chemists Association. Monograph: Review of the Syntheses and Analyses of P2P, Amphetamine, and Methamphetamine. Fresno, CA:1993.

38. AlDirbashi OY, Ikeda K, Takahashi M, Kuroda N, Ikeda S, Nakashima K. Drugs of abuse in a non-conventional sample; detection of methamphetamine and its main metabolite, amphetamine in abusers' clothes by HPLC with UV and fluorescence detection. Biomed Chromatogr 2001;15(7):457.

39. Walker JA, Marche HL. Isomer determination of illicit methamphetamine and amphetamine street samples using cyclodextrin modified free zone capillary electrophoresis. Proceedings of the American Academy of Forensic Sciences 1997;3:23.

40. Valtier S, Cody JT. Evaluation of internal standards for the analysis of amphetamine and methamphetamine. J Anal Toxicol 1995;19:375.

41. Dasgupta A, Gardner C. Distinguishing amphetamine and methamphetamine from other interfering sympathomimetic amines after various fluoro derivatization and analysis by gas chromatography - chemical ionization mass spectrometry. J Forensic Sci 1995;40(6):1077.

42. Wang SM, Ling YC, Tsai LC, Giang YS. Headspace sampling and gas chromatographic mass spectrometric determination of amphetamine and methamphetamine in betel. J Chromatogr A 1995;715(2):325.

43. Longo M, Martines C, Rolandi L, Cavallaro A. Simple and fast determination of some phenethylamines in illicit tablets by base-deactivated reversed phase HPLC. J Liq Chromatogr 1994;17:649.

44. Sadeghipour F, Giroud C, Rivier L, Veuthey JL. Rapid determination of amphetamines by high-performance liquid chromatography with UV detection. J Chromatogr A 1997;761(1-2):71.

45. Malone JV. HPLC Quantitation of clandestinely manufactured mixtures of amphetamine and methamphetamine. J Clan Lab Invest Chem Assoc 1998;8(4):26.

46. Malone JV. HPLC Quantitation of clandestinely manufactured mixtures of amphetamine and methamphetamine. Microgram 1998;31(11):304.

47. Hideg Z, Dinya Z. A simple and rapid method for the identification of amphetamine and methamphetamine hydrochlorides by mass spectrometry. Anal Lett 1993;26:2637.

48. 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.

49. Sulk RA, Corcoran RC, Carron KT. Surface enhanced Raman scattering detection of amphetamine and methamphetamine by modification with 2-mercaptonicotinic acid. Appl Spectrosc 1999;53(8):954.

50. Falco PC, Legua CM, Cabeza AS, Serrano RP. Derivatization of amphetamine and methamphetamine with 1,2-naphthoquinone-4-sulfonic acid into solid-phase extraction cartridges. Determination of amphetamine in pharmaceutical and urine samples. Analyst 1997;122(7):673.

51. Logan BK. Amphetamines: An update on forensic issues. J Anal Toxicol 2001;25(5):400.

52. Varesio E, Veuthey J-L. Chiral separation of amphetamines by high-performance capillary electrophoresis. J Chromatogr A 1995;717(1-2):219.

53. 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.

54. Varesio E, Gauvrit JY, Longeray R, Lanteri P, Veuthey JL. Central composite design in the chiral analysis of amphetamines by capillary electrophoresis. Electrophoresis 1997;18:931.

55. Lurie IS, Odeneal II NG, McKibben TD, Casale JF. Effects of various anionic chiral selectors on the capillary electrophesis separation of chiral phenethylamines and achiral neutral impurities present in illicit methamphetamine. Electrophoresis 1998;19:2918.

56. 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.

57. Soine WH, Duncan W, Lambert R, Middleberg R, Finley H, O'Neil DJ. Differentiation of side chain isomers of ring-substituted amphetamines using gas chromatography/infrared/mass spectrometry (GC/IR/MS). J Forensic Sci 1992;37(2):513.

58. Esseiva P, Lock E, Gueniat O, Cole MD. Identification and quantification of amphetamine and analogues by capillary zone electrophoresis. Science Justice 1997;37(2):113.

59. Cladrowarunge S, Hirz R, Kenndler E, Rizzi A. Enantiomeric separation of amphetamine related drugs by capillary zone electrophoresis using native and derivatized *beta*-cyclodextrin as chiral additives. J Chromatogr A 1995;710(2):339.

60. Kaufman MS, Hatzis AC. Electron impact mass spectrometry of N-substituted amphetamines. Microgram 1996;29(7):179.

61. Van Bocxlaer JF, Lambert WE, Thienpont L, De Leenheer AP. Quantitative determination of amphetamine and *alpha*-phenethylamine enantiomers in judicial samples using capillary gas chromatography. J Anal Toxicol 1997;21(1):5.

62. Madden JE, Pearson JR, Rowe JE. Differentiation of side chain isomers of methamphetamine using gas chromatography, high-performance liquid chromatography, and mass spectrometry. Forensic Sci Int 1993;61(2,3):169.

63. 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.

64. Melgar R, Kelly RC. A novel GC/MS derivatization method for amphetamines. J Anal Toxicol 1993;17:399.

65. 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.

66. Clark CR, Valaer AK, Noggle FT, DeRuiter J. GC-MS Differentiation of acylated derivatives of methamphetamine and regioisomeric phenethylamines. Microgram 1995;28:118.

67. Clark CR, DeRuiter J, Valaer AK, Noggle FT. GC-MS analysis of acylated derivatives of methamphetamine and regioisomeric phenethylamines. J Chromatogr Sci 1995;33(9):485.

68. Rizzi AM, Hirz R, Cladrowa-Runge S, Jonsson H. Enantiomeric separation of amphetamine, methamphetamine, and ring substituted amphetamines by means of a *beta*-cyclodextrin-chiral stationary phase. Chromatographia 1994;39:131.

69. 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.

70. Herraez-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.

71. Chen Y-P, Hsu M-C, Chien CS. Analysis of forensic samples using precolumn derivatization with (+)-1-(9-fluorenyl)ethylchloroformate and liquid chromatography with fluorimetric detection. J Chromatogr A 1994;672:135.

72. Lurie IS. Micellar electrokinetic capillary chromatography of the enantiomers of amphetamines, methamphetamine, and their hydroxyphenethylamine precursors. J Chromatogr 1992;605:269.

73. Kaufman MS, Hatzis AC, Stuart JG. Negative-ion chemical ionization of amphetamine derivatives. J Mass Spec 1996;31(8):913.

74. Thurbide KB, Elson CM, Sim PG. Discrimination of structural isomers of amphetamine using carbon dioxide negative-ion chemical ionization mass spectrometry. Spectroscopy 1997;13(2):151.

75. Cole MD, McAvoy Y. The analysis of amphetamines by supercritical fluid chromatography with silica gel and poly-(styrenedivinylbenzene) packed columns. Proceedings of the American Academy of Forensic Sciences 1997;3:23.

76. 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.

77. Munro CH, White PC. Evaluation of diazonium salts as visualization reagents for the thin layer chromatographic characterization of amphetamines. Science Justice 1995;35:37.

78. Poortman Van Der Meer AJ, Van Egmond HE. Quantitation of amphetamine-type compounds for which no reference compound is available: The validation of a theoretical model. Science Justice 2001;41(3):185.

79. Casale JF, Koles JE. Analysis of ayahuasca ('Santo Daime'). Microgram 1995;28(9):296.

80. Ryan TW. Resolution of the non-specific spectra of barbiturates by UV-photodiode array detection II. Effects of sample concentration on spectral matching accuracy. J Liq Chromatogr 1993;16:33.

81. Kuroda N, Inoue K, Mayahara K, Nakashima K, Akiyama S. Application of 3-(18-naphthalimido) propyl-modified silyl silica gel as a stationary phase in high-performance liquid chromatography of barbiturates and diasteromeric compounds. J Liq Chromatogr Relat Technol 1996;19(1718):2867.

82. 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.

83. Roy M. Analysis of barbiturates using ion trap and quadrupole mass spectrometers: A comparison. J Can Soc Forensic Sci 1994;27:19.

84. Cai X-L, Wu G-P. Spectral research on the identification of a mixture of barbiturates. Guangpu Shiyanshi 2001;18(5):591.

85. Hassan SSM, Elnemma EM, El Naby EH. Mercurimetric potentiometric determination of barbiturates using a solid-state iodide ion-selective electrode. Anal Lett 1997;30(6):1081.

86. 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.

87. 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.

88. Li S, Weber SG. Determination of barbiturates by solid phase microextraction and capillary electrophoresis. Anal Chem 1997;69(6):1217.

89. Hall BJ, Brodbelt JS. Determination of barbiturates by solid-phase microextraction (SPME) and ion trap gas chromatography mass spectrometry. J Chromatogr A 1997;777(2):275.

90. Mao Y, Carr PW. Separation of barbiturates and phenylthiohydantoin amino acids using the thermally tuned tandem column concept. Anal Chem 2001;73(8):1821.

91. Fater Z, Szabady B, Nyiredy S. Two-dimensional overpressured layer chromatographic separation of barbiturate derivatives. J Planar Chromatogr 1995;8:145.

92. Tomita M, Okuyama T. Application of capillary electrophoresis to the simultaneous screening and quantitation of benzodiazepines. J Chromatogr B 1996;678(2):331.

93. 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.

94. Almirall JR, Garcia AD. Quantitative determination of common benzodiazepines by free zone electrophoresis. Proceedings of the American Academy of Forensic Sciences 2000;6:22.

95. Neville GA, Beckstead HD, Shurvell HF. A Fourier transform-Raman and infrared vibrational study of delorazepam, fludiazepam, flurazepam, and tetrazepam. J Pharm Sci 1994;83:143.

96. Sultan SM, El-Mubarak AH. High performance liquid chromatographic method for the separation and quantitation of some psychotherapeutic benzodiazepines optimized by the modified simplex procedure. Talanta 1996;43:569.

97. Gil-Agusti M, Carda-Broch S, Garcia-Alvarez-Coque M, Esteve-Romero J. Use of micellar mobile phases for the chromatographic determination of clorazepate, diazepam, and diltiazem in pharmaceuticals. J Chromatogr Sci 2000;38(12):521.

98. Shimamine M, Masunari T, Nakahara Y. Identification of drugs of abuse by diode-array detection I. Screening test and identification of benzodiazepines by HPLC-DAD with ICOS software system. Eisei Shikensho Hokoku 1993;111:47.

99. 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.

100. Lurie IS, Cooper DA, Klein RFX. High-performance liquid chromatographic analysis of benzodiazepines using diode-array, electrochemical, and thermospray mass spectrometric detection. J Chromatogr A 1992;598:59.

101. Kleinschnitz M, Herderich M, Schreier P. Determination of 1,4-benzodiazepines by high-performance liquid chromatography electrospray tandem mass spectrometry. J Chromatogr B 1996;676(1):61.

102. Saelzer R, Gody G, Vega M, De Diego M, Godoy R, Rios G. Instrumental planar chromatographic determination of benzodiazepines: Comparison with liquid chromatography and gas chromatography. JAOAC Int 2001;84(4):1287.

103. Boonkerd S, Detaevernier MR, Vindevogel J, Michotte Y. Migration behaviour of benzodiazepines in micellar electrokinetic chromatography. J Chromatogr A 1996;756(1-2):279.

104. Renougonnord MF, David K. Optimized micellar electrokinetic chromatographic separation of benzodiazepines. J Chromatogr A 1996;735(1-2):249.

105. 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.

106. Beaulieu N, Graham SJ, Sears RW, Lovering EG. Liquid chromatographic determination of alprazolam and related impurities in the drug substance. JAOAC Int 1992;75(5):801.

107. Catabay A, Taniguchi M, Jinno K, Pesek JJ, Williamsen E. Separation of 1,4-benzodiazepines and analogues using cholesteryl-10-undecenoate bonded phase in microcolumn liquid chromatography. J Chromatogr Sci 1998;36(3):111.

108. Bargo ES. Liquid chromatographic determination of flurazepam hydrochloride in bulk drug and dosage forms: Collaborative study. JAOAC Int 1992;75(2):240.

109. 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.

110. 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.]

111. Sultan SM. Flow injection stopped-flow kinetic determination of the anxiolytic sedative bromazepam in dosage forms. Analyst 1992;117(4):773.

112. Angelos SA, Raney JK. Analysis of samples of 4-bromo-2,5-dimethoxyphenethylamine (Nexus) an analogue of 4-bromo-2,5-dimethoxyamphetamine (DOB). Proceedings of the American Academy of Forensic Sciences 1996;2:18.

113. Noggle FT, DeRuiter J, Clark CR. Analytical profiles of 4-bromo-2,5-dimethoxy-phenethylamine (NEXUS) and related precursor chemicals. Microgram 1994;27:343.

114. 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.

115. 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.

116. deBoer D, Gijzels MJ, Bosman IJ, Maes RAA. More data about the new psychoactive drug 2C-B. J Anal Toxicol 1999;23(3):227.

117. 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.

118. DeRuiter J, Clark CR, Noggle FT. Analysis of the bromination products of the isomeric dimethoxyphenethylamines: Differentiation of 'Nexus' from five positional isomers. Microgram 1997;30(5):96.

119. DeRuiter J, Clark CR, Noggle FT. LC and GC-MS analysis of 4-bromo-2,5-dimethoxy-phenethylamine (Nexus) and 2-propanamine and 2-butanamine analogs. J Chomatogr Sci 1995;33(10):583.

120. Chamakura RP. Bufotenine - A hallucinogen in ancient snuff powders of South America and a drug of abuse on the streets of New York. Forensic Sci Rev 1994;6:1.

121. Chamakura RP. Bufotenine. Microgram 1993;26:185.

122. Burke AA, Liptak AD, Oberdorf CA. BSTFA derivatization of bufotenine. Proceedings of the American Academy of Forensic Sciences 1998;4:34.

123. Pedersen Bjergaard S, Rasmussen KE, Sannes E. Strategies for the capillary electrophoretic separation of indole alkaloids in *Psilocybe Semilanceata*. Electrophoresis 1998;19(1):27.

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

125. Phelan CP. Identification of psilocin and bufotenine via GC/IRD. Microgram 1999;32(2):83.

126. Phelan CP. Identification of psilocin and bufotenine via GC/IRD. Proceedings of the International Association of Forensic Sciences 15th Triennial Meeting 1999:66.

127. Chamakura RP. Tryptamines. Microgram 1994;27:316.

128. Vohlken BA. Bufotenine and psilocin mass spectral distinctions. Microgram 1993;26:233.

129. Chamakura RP. "Love stone" - A hallucinogenic, an aphrodisiac, and a deadly poison. Proceedings of the American Academy of Forensic Sciences 1996;2:48.

130. Chamakura RP. 'Love Stone' - A hallucinogen, an aphrodisiac, and a deadly poison. Microgram 1998;31(5):127.

131. Barry TL, Petzinger G, Zito SW. GC/MS Comparison of the West Indian aphrodisiac 'Love Stone' to the Chinese medication 'Chan Su': Bufotenine and related bufadienolides. J Forensic Sci 1996;41(6):1068.

132. Kalix P. Cathinone - a natural amphetamine. Pharm Toxicol 1992;70:77.

133. Lee MM. The identification of cathinone in khat (*Catha Edulis*): A time study. J Forensic Sci 1995;40(1):116.

134. Benshafrut R, Rothchild R. NMR studies of drugs. Enantiomeric excess determination of N-acetylcathinone with Eu(HFC)3 Spectrosc Lett 1992;25(7):1097.

135. Al Obaid AM, Al Tamrah SA, Aly FA, Alwarthan AA. Determination of (S)-(-)-cathinone by spectrophotometric detection. J Pharm Biomed Anal 1998;17(2):321.

136. Lewis RJ, Reed D, Service AG, Langford AM. The identification of 2-chloro-4,5-methylenedioxymethylamphetamine in an illicit drug seizure. J Forensic Sci 2000;45(5):1119.

137. Chankvetadze B, Lomsadze K, Bergenthal D, Breitkreutz J, Bergander K, Blaschke G. Mechanistic study on the opposite migration order of clenbuterol enantiomers in capillary electrophoresis with beta-cyclodextrin and single isomer heptakis(2,3-diacetyl-6-sulfo)-beta-cyclodextrin. Electrophoresis 2001;22(15):3178.

138. Garcia-Ruiz C, Marina ML. Fast enantiomeric separation of basic drugs by electrokinetic chromatography. Application to the quantitation of terbutaline in a pharmaceutical preparation. Electrophoresis 2001;22(15):3191.

139. Lopez-Erroz C, Vinas P, Cerdan FJ, Hernandez-Cordoba M. Determination of clenbuterol in pharmaceutical preparations by reaction with *o*-phthaldehyde using a flow-injection fluorimetric procedure. Talanta 2000;53(1):47.

140. Krawczeniuk AS. Identification of clenbuterol: GC-derivatization techniques and electrospray mass spectrometry. Microgram 1996;29(8):210.

141. Ozkan Y, Ozkan SA, AboulEnein HY. Determination of clenbuterol HCl in human serum, pharmaceuticals, and in drug dissolution studies by RP-HPLC. J Liq Chromatogr Rel Tech 2001;24(5):679.

142. Ishii H, Morishita M, Yamad 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.

143. Krawczeniuk AS, Bravenec VA. Quantitative determination of cocaine in illicit powders by free zone capillary electrophoresis. J Forensic Sci 1998;43(4):738.

144. Gueniat O, Hartmann S. Profiling of illicit cocaine samples by Differential Scanning Calorimetry (DSC). Proceedings of the International Association of Forensic Sciences 13th Triennial Meeting 1993;5:214.

145. Saha U, Mazumdar KK, Sanyal M, Chakraburty NN. Determination of cocaine in suspected narcotic substances by FTIR and HPTLC methods. Microgram 1996;29(3):64.

146. Fernandez-Abedul MT, Costa-Garcia A. Flow injection analysis with amperometric detection of cocaine in confiscated samples. Anal Chim Acta 1996;328(1):67.

147. Jellema R. Analysis of cocaine hydrochloride in wax. Microgram 2001;34(7):183.

148. Krueger ST. New application for the quantitation of cocaine base by gas chromatography. J Forensic Sci 1994;39(1):177.

149. LoDico CP, Lowe RH, Caplan YH. GC/MS confirmation of cocaine sampled by AccuPRESS Surface drug test kits. Proceedings of the American Academy of Forensic Sciences 1996;2:19.

150. Glass RL, Johnson EL. Comparison of high performance liquid chromatographic analyses of cocaine in *Coca* leaves. J Liq Chromatogr 1993;16:3543.

151. MacGregor RR, Fowler JS, Wolf AP. Determination of the enantiomeric composition of samples of cocaine by normal-phase high performance liquid chromatography with UV detection. J Chromatogr 1992;590:354.

152. Atay O, Oztop F. Quantitative determination by using HPLC and GLC methods for cocaine HCl in synthetic binary mixtures with procaine HCl, lidocaine HCl and caffeine. Anal Letters 1997;30(3):565.

153. Campanella L, Colapicchioni C, Tomassetti M, Dezzi S. Comparison of three analytical methods for cocaine analysis of illicit powders. J Pharm Biomed Anal 1996;14(8-10):1047.

154. Nishikawa M, Nakajima K, Tatsuno M, Kasuya F, Igarashi K, Fukui M, Tsuchihashi H. The analysis of cocaine and its metabolites by liquid chromatography/atmospheric pressure chemical ionization-mass spectrometry (LC/APCI-MS). Forensic Sci Int 1994;66:149.

155. Smith RM. The mass spectrum of cocaine. J Forensic Sci 1997;42(3):475.

156. Wang PP, Bartlett MG. Collision-induced dissociation mass spectra of cocaine, and its metabolites and pyrolysis products. J Mass Spec 1998;33(10):961.

157. Trenerry VC, Robertson J, Wells RJ. The determination of cocaine and related substances by micellar electrokinetic capillary chromatography. Electrophoresis 1994;15:103.

158. 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.

159. Brettell TA, Cole DA. The forensic identification of illicit cocaine by Raman microspectroscopy. Proceedings of the American Academy of Forensic Sciences 1999;5:28.

160. 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.

161. Pantea A, Pop A, Dogaru S. Identification of cocaine in samples also containing other local anesthetics. Rev Chim (Bucharest) 1996;47(6):580.

162. Koulis CV, Reffner JA, Bibby AM. Comparison of transmission and internal reflectance infrared spectra of cocaine. J Forensic Sci 2001;46(4):822.

163. 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.

164. Airaksinen AJ, Tuppurainen KA, Lotjonen SE, Niemitz M, Yu MX, Vepsalainen JJ, Laatikainen R, Hiltunen J, Bergstrom KA. Nuclear magnetic resonance and molecular orbital study of some cocaine analogues. Tetrahedron 1999;55(34):10537.

165. Elsherbini SH. Cocaine base identification and quantification. Forensic Sci Rev 1998;10(1):1.

166. Wang PP, Bartlett MG. Identification and quantitation of cocaine N-oxide: A thermally labile metabolite of cocaine. J Anal Toxicol 1999;23(1):62.

167. Jenkins AJ, Llosa T, Montoya I, Cone EJ. Identification and quantitation of alkaloids in *coca* tea. Forensic Sci Int 1996;77(3):179.

168. Christie TJ, Hanway RH, Paulls DA, Townsend A. Chemiluminescence determination of codeine by permanganate oxidation. Anal Proc 1995;32(3):91.

169. 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.

170. Nair NM, Jackson GE, Campbell WE. Structural assignment of the opium alkaloid codeine via 2D NMR techniques. Spec Letts 1997;30:497.

171. 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.

172. 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.

173. 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.

174. Churchill KT. Creatine; an analytical profile. Microgram 2000;33:223.

175. Chew S, Chappell J. Analytical update on creatine. Microgram 2001;34(2):33.

176. Wagner SD, Kaufer SW, Sherma J. Quantification of creatine in nutrition supplements by thin layer chromatography-densitometry with thermochemical activation of fluorescence quenching. J Liq Chromatogr Rel Tech 2001;24(16):2525.

177. Callahan SA, Latham DJ, Dawson BA, Black DB, Cyr TD, Ethier J-C, By AW, Neville GA. Identification of an unusual police exhibit as cyclofenil, a gonad-stimulating substance.

Microgram 1997;30(7):145.

178. Dearmore IK. Cyclohexyl nitrite encounter. J Forensic Sci 1999;44(1):197.

179. Ferretti R, Gallinella B, Latorre F, Lusi A. Direct high-performance liquid chromatography resolution on a chiral column of dexfenfluramine and its impurities in bulk raw drug and pharmaceutical formulations. J Chromatogr A 1996;731(1-2):340.

180. Fitzgerald RL, O'Neal CL, Hart BJ, Poklis A, Harold DA. Comparison of an ion trap and a quadrupole mass spectrometer using diazepam as a model compound. Anal Toxicol 1997;21(6):445.

181. Garcia MG, Garcia A, Gonzalez I. Extraction and electrochemical quantification of the active ingredient (diazepam) in pharmaceutical products. Talanta 1993;40(12):1775.

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

183. Stall J. 2,5-Dimethoxy-4-ethylthiophenethylamine (2C-T-2). J Clan Lab Invest Chem Assoc 1999;9(1):15.

184. Zimmerman MM. The identification of 2,5-dimethoxy-4-(N)-propylthiophenethylamine (2C-T-7). Microgram 2001;34(7):169.

185. Dawson BA, Black DB, Cyr TD, Neville GA, Shurvell HF. Spectroscopic characterization and proof of structure for dimethpramide. Can J App Spect 1995;40(5):131.

186. Dawson BA, Black DB, Cyr TD, Ethier J-C, By AW, Beckstead HD, Neville GA. Structural elucidation of unusual police exhibits. I. Dimethpramide (Dimetcarb). Forensic Sci Int 1995;71(3):169.

187. Latham D, Callahan S, Dawson BA, Black DB, Cyr T, Ethier JC, By A, Beckstead HD, Neville GA. Identification of an unusual police exhibit as dimethpramide. Microgram 1994;27:227.

188. Noggle FT, Clark CR, DeRuiter J. Liquid chromatographic and spectral analysis of the stereoisomers of dimethylaminorex. JAOAC Int 1992;75(3):423.

189. Bailey VA, Buer LO. The stability of dimethylamphetamine upon exposure to heat, air, and moisture. Microgram 1993;26:96.

190. Sato M, Hida M, Nagase H. Analysis of the pyrolysis products of dimethylamphetamine. J Anal Toxicol 2001;25(5):304.

191. 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

192. Steiner RR. Dragon's blood incense. Microgram 1997;30(11):258.

193. Flieger M, Wurst M, Shelby R. Ergot alkaloids - Sources, structures, and analytical methods. Folia Microbiologica 1997;42(1):3.

194. Ware GM, Price G, Carter Jr L, Eitenmiller RR. Liquid chromatographic preparative method for isolating ergot alkaloids, using a particle-loaded membrane extracting disk. JAOAC Int 2000;83(6):1395.

195. Scott PM, Lombaert GA, Pellaers P, Bacler S, Lappi J. Ergot alkaloids in grain foods sold in Canada. JAOAC Int 1992;75(5):773.

196. Mestre YF, Band BF, Zamora LL, Calatayud JM. Flow injection analysis - direct chemiluminescence determination of ergonovine maleate enhanced by hexadecyl-pyridinium chloride. Analyst 1999;124(3):413.

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

198. Al-Hussaini SR. Counterfeit Captagon: An analytical study. Science Justice 1996;36(3):139.

199. Al-Gharably N, Al-Obaid AR. The characterization of counterfeit Captagon tablets. J Forensic Sci Soc 1994;34:165.

200. Poklis A. Fentanyl: A review for clinical and analytical toxicologists. Clinical Toxicology 1995;33(5):439.

201. Guo H, Hu N, Lin S. Adsorptive stripping voltametric properties of fentanyl at Hg electrode. Talanta 1994;41(11):1929.

202. Clandestine Laboratory Investigating Chemists Association. Monograph: A Review of the Syntheses and Analyses of Fentanyl and its Analogues. Fresno, CA:1996.

203. Lurie IS, Allen AC. Reversed-phase high performance liquid chromatographic separation of fentanyl homologues and analogues II. Variables affecting hydrophobic group contribution. J Chromatogr 1992;292:283.

204. Ohta H, Suzaki 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.

205. Ye NS, Zhu RH, Gu XX, Zou H. Determination of scopolamine, atropine and anisodamine in Flos daturae by capillary electrophoresis. Biomedical Chromatography 2001;15(8):509.

206. Churchill KT. Roofies. Microgram 1995;28(10):329.

207. Chociay J, Szarka J, McBride C. Procedure for the identification of flunitrazepam tablets (Rohypnol). Microgram 1999;32(2):75.

208. Rucker C. Chemical screening and identification techniques for flunitrazepam. Microgram 1998;31(7):198.

209. McKibben T. Simple and rapid color screening tests for flunitrazepam (Rohypnol). J Forensic Sci 1999;44(2):396.

210. Rochholz G, Ahrens B, Schutz H. Modified screening procedure with fluorescence detection for flunitrazepam. Arzneimittel Forschung 1994;44(1):469.

211. Neville GA, Beckstead HD, Black DB, Dawson BA, Shurvell HF. Vibrational and NMR spectroscopic study of aged flurazepam mono- and dihydrochloride salts for content identity. J Pharm Sci 1994;83(9):1274.

212. Rucker CL. Chemical screening and identification techniques for flunitrazepam. Proceedings of the American Academy of Forensic Sciences 1999;5:40.

213. Alexander GL. Characterization of aromatic fluoro-analogs of phenylacetone, amphetamine, and methamphetamine. Microgram 1994;27:268.

214. Poortman-van der Meer AJ, Huizer H. First encounter with *p*-fluorofentanyl in the Netherlands. Toxichem + Krimtech 1996;63(1):7.

215. Holt P-J, Bruce NC, Lowe CR. Bioluminescent assay for heroin and its metabolites. Anal Chem 1996;68(11):1877.

216. Trenerry VC, Wells RJ. The analysis of illicit heroin seizures by capillary zone electrophoresis. J Chromatogr Sci 1994;32(1):1.

217. Hu SH, Liu YL, Ju JY. A method for the simultaneous quantitation of seized heroin using pyrene as internal standard and qualitative analysis of its adulterants by GC/MS. Proceedings of the American Academy of Forensic Sciences 1995;1:18.

218. Aizenman N, Ravreby M. Detecting heroin in heroin citrate residues. Microgram 1994;27:182.

219. Wijesekera ARL, Abeysinghe DMUJ, Pathirana KC. Studies of the degradation of heroin. Forensic Sci Int 1994;67(3):147.

220. Burla R, Avraham S, Glattstein, B, Levy S. Separation of heroin from several adulterants in illicit powders. Microgram 1995;28(9):300.

221. Besacier F. Isotope fingerprints of illicit heroin samples. Presentation - 5th Canadian Continuous-Flow Isotope Ratio Mass Spectrometry Workshop; Ottawa, Canada; 1998.

222. Lurie IS. Application of micellar electrokinetic capillary chromatography to the analysis of illicit heroin seizures. J Chromatogr A 1997;780:265.

223. Walker JA, Krueger ST, Lurie IS, Marche HL, Newby N. Analysis of heroin drug seizures by micellar electrokinetic capillary chromatography (MECC). J Forensic Sci 1995;40(1):6.

224. 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.

225. Kalia A, Sharm RM, Singh G, Kaur S, Verma RS. Analysis of heroin and its adulterants by thin layer chromatography. Indian J Forensic Sci 1992;6:95.

226. 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.

227. Krough M, Brekke S, Tonnesen F, Rasmussen KE. Analysis of drug seizures of heroin and amphetamine by capillary electrophoresis. J Chromatogr A 1994;674:235.

228. Liu CL, Bowers LD. Mass spectrometric characterization of the *beta*-subunit of human chorionic gonadotropin. J Mass Spec 1997;32(1):33.

229. Clandestine Laboratory Investigating Chemists Association. Monograph: GHB. Fresno, CA:2000.

230. Lewis A, Smith E. *gamma*-Hydroxybutyrate: From the 60's to the present. Proceedings of the American Academy of Forensic Sciences 2000;6:43.

231. Walker L. Identification of the potassium salt of *gamma*-hydroxybutyric acid (GHB). J Clan Lab Invest Chem Assoc 1999;9(1):17.

232. Bommarito C. Analytical profile of *gamma*-hydroxybutyric acid (GHB). J Clan Lab Invest Chem Assoc 1993;3:10.

233. Krawczeniuk A. The occurrence of *gamma*-hydroxybutyric acid (GHB) in a steroid seizure. Microgram 1993;26(7):160.

234. Krawczeniuk AS. Direct detection of *gamma*-hydroxybutyrate: A new recreational drug via free zone capillary electrophoresis. Proceedings of the American Academy of Forensic Sciences 1998;4:34.

235. Koppenhaver DJ. GHB color test. Microgram 1997;30(6):130.

236. Morris, JA. Extraction of GHB for FTIR analysis and a new color test for *gamma*-butyrolactone (GBL). Microgram 1999;32(8):215.

237. 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.

238. Wolnik KA, Keitkemper DT, Crowe JB, Barnes BS, Brueggemeyer TW. Application of inductively coupled plasma atomic emission and mass spectrometry to forensic analysis of sodium *gamma*-hydroxy butyrate and ephedrine hydrochloride. J Anal Atomic Spect 1995;10:177.

239. Catterton AJ. Identification of sodium *gamma*-hydroxybutyrate (NaGHB) by infrared spectroscopy, utilizing a 3 bounce diamond ATR element. Microgram 2001;34(1):15.

240. Andera KM, Evans HK, Wojcik CM. Microchemical identification of *gamma*-hydroxybutyrate (GHB). J Forensic Sci 2000;45(3):665.

241. Chew SL. Identification and quantitation of GHB by nuclear magnetic resonance spectroscopy. Proceedings of the American Academy of Forensic Sciences 1999;5:41.

242. 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.

243. Ciolino LA, Mesmer MZ, Satzger RD, Machal AC, McCauley HA, Mohrhaus AS. The chemical interconversion of GHB and GBL: Forensic issues and implications. J Forensic Sci 2001;46(6):1315.

244. 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.

245. 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.

246. 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.

247. 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.

248. Mesmer MZ, Satzger RD. Determination of *gamma*-hydroxybutyrate (GHB) and *gamma*-butyrolactone (GBL) by HPLC/UV-VIS spectrophotometry and HPLC/thermospray mass spectrometry. J Forensic Sci 1998;43(3):489 [published erratum appears in J Forensic Sci 1998;43(6):1259].

249. Vose J, Tighe T, Schwartz M, Buel E. Detection of gamma-butyrolactone (GBL) as a natural component in wine. J Forensic Sci 2001;46(5):1164.

250. Morris JA. Analogs of GHB. Part 2: Analytical perspective. J Clan Lab Invest Chem Assoc 2001;11(1):16.

251. 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.

252. Morris JA. Analogs of GHB. Part 1: Theoretical perspective. J Clan Lab Invest Chem Assoc 2000;10(2):18.

253. Northrop DM. GHB analysis by capillary electrophoresis. Proceedings of the American Academy of Forensic Sciences 2001;7:27.

254. Chew SL. 1,4-Butanediol in liquid exhibit. Microgram 1997;30(7):154.

255. Walker L. Maple syrup and 1,4-butanediol. J Clan Lab Invest Chem Assoc 2000;10(3):13.

256. Cyr T, Dawson B, By A, Neville G, Shurvell H. Structural elucidation of unusual police exhibits. II: Identification and spectral characterization of N-(2-hydroxyethyl)amphetamine hydrochloride. J Forensic Sci 1996;41(4):608.

257. Carpenter J, Hugel J, Weaver K. The identification of N-(2-hydroxyethyl)amphetamine. J Can Soc Forens Sci 1993;26:143.

258. Pakulniewicz KJ. The use of derivatives to identify N-hydroxy-3,4-methylenedioxy-amphetamine by GC-FTIR. Proceedings of the American Academy of Forensic Sciences 1995;1:22.

259. Noggle FT, Clark CR, DeRuiter J, Cain P. Analytical Properties of N-hydroxy-3,4-methylenedioxymethamphetamine ('Flea'): A Potential New Street Drug. Microgram 1996;29(1):10.

260. Smith RM, Koch MG. Thermal decomposition of N-hydroxy-3,4-methylenedioxyamphetamine during GC and GC/MS analysis. Microgram 1995;28:199.

261. Hays PA, Koles JE, Morello DR. Imazalil sulfate. Microgram 1995;28(12):389.

262. Perez-Ruiz T, Martinez-Lozano C, Sanz A, Alonso C. Flow-injection extraction - spectrophotometric determination of imipramine in pharmaceuticals with methyl orange. Talanta 1994;41(9):1523.

263. Koverman G. Identification of scopolamine and hyoscyamine in jimson weed (*Datura Stramonium*). Microgram 1993;26:122.

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

265. Licata M, Pierini G, Popoli G. A fatal ketamine poisoning. J Forensic Sci 1994;39(5):1314.

266. LeBelle M, Lauriault G, Lavoie A. Chiral carboxylic acids as derivatizing agents for the determination of the alkaloids of khat. Proceedings of the International Association of Forensic Sciences 13th Triennial Meeting 1993;5:238.

267. Ripani L, Schiavone S, Garofano L. GC/MS identification of *Catha Edulis* stimulant-active principles. Forensic Sci Int 1996;78(1):39.

268. LeBelle MJ, Lauriault G, Lavoie A. Gas chromatographic-mass spectrometric identification of chiral derivatives of the alkaloids of khat. Forensic Sci Int 1993;61(1):53.

269. Morselli O, Bovolenta A, Ripani L, Garofano L. Gas-chromatography/mass spectrometry determination of the active principles of *Catha Edulis*. African Vegetable. Microgram 1992;25:290.

270. Deters KS. Identification of khat using GC/MS/MS. Proceedings of the American Academy of Forensic Sciences 1997;3:22.

271. Mathys K, Brenneisen R. HPLC and TLC profiles of phenylalkylamines of khat (*Catha Edulis* Forsk) confiscated in Switzerland. Pharm Acta Helv 1993;5:53.

272. Dawson BA, Black DB, Lavoie A, LeBelle MJ. Nuclear magnetic resonance identification of the phenethylamine alkaloids of khat using a chiral solvating agent. J Forensic Sci 1994;39:1026.

273. Archontaki HA, Atamian K, Panderi IE, Gikas EE. Kinetic study on the acidic hydrolysis of lorazepam by a zero-crossing first-order derivative UV-spectrophotometric technique. Talanta 1999;48(3):685.

274. Clandestine Laboratory Investigating Chemists Association. Monograph: LSD. Fresno, CA:1999.

275. Paul BD, Smith ML. LSD - An overview on drug action and detection. Forensic Sci Rev 1999;11(2):157.

276. Kilmer SD. The isolation and identification of lysergic acid diethylamide (LSD) from sugar cubes and a liquid substrate. J Forensic Sci 1994;39:860.

277. Webb KS, Baker PB, Cassells NP, Francis JM, Johnston DE, Lancaster SL, Minty PS, Reed GD, White SA. The analysis of lysergide (LSD): The development of novel enzyme immunoassay and immunoaffinity extraction procedures together with an HPLC-MS confirmation procedure. J Forensic Sci 1996;41(6):938.

278. Ripani L, Schiavone S, Garofano L. GC quantitative determination of illicit LSD. J Forensic Sci 1994;39(2):512.

279. Blackwell TM. Identification of LSD on single blotter paper via GC/MS using electronic pressure controls and pulsed split injection. Microgram 1998;31(2):51.

280. Gilbert MW, Lothridge K. The differentiation of LSD and LAMPA by capillary GC/MS/FTIR. Proceedings of the International Association of Forensic Sciences 14th Triennial Meeting 1996;2:356.

281. Morales R. Quantitative analysis of lysergic acid diethylamide by gas liquid chromatography. Microgram 1993;26:129.

282. Veress T. Study of the extraction of LSD from illicit blotters for HPLC determination. J Forensic Sci 1993;38:1105.

283. Heagy JA, Moriwaki WM, Chan, KT. LSD extraction from blotter paper. Microgram 1995;28:85.

284. Djordjevic MN, Fitzpatrick F, Houdiere F. Separation of D-lysergic acid diethylamide derivatives using micellar electrokinetic capillary chromatography. Electrophoresis 2000;21(4):724.

285. Salamone S, Li Z, McNally AJ, Vitone S, Wu RS. Epimerization studies of LSD using ^{1}H nuclear magnetic resonance (NMR) spectroscopy. J Anal Toxicol 1997;21(6):492.

286. Jeger AN, Briellmann TA. Robotic TLC-sampling by quantification of LSD trips. Proceedings of the International Association of Forensic Sciences 13th Triennial Meeting 1993;5:262.

287. 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.

288. Moreno E, Roca I, Peso A, del Menendez M. Clandestine plantation of cannabis sativa in Spain. Microgram 2001;34(4):67.

289. Lurie IS, Meyers RP, Conver TS. Capillary electrochromatography of cannabinoids. Anal Chem 1998;70(15):3255.

290. Lurie IS, Meyers RP, Conver TS. Capillary electrochromatography of cannabinoids. Proceedings of the American Academy of Forensic Sciences. 1999;5:42.

291. Kohjyouma M, Lee I-J, Iida O, Sekita S, Satake M, Makino Y. DNA analysis of *Cannabis Sativa L*. DNA Takei 2000;8:87.

292. Linacre A, Thorpe J. Detection and identification of *cannabis* by DNA. Forensic Sci Int 1998;91:71.

293. Sochocki RE. Purifying charred marihuana residue for the Duquenois-Levine test. Microgram 1997;30(8):181.

294. 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.

295. Oulton SR. Separation and identification of ephedrine, pseudoephedrine, and methamphetamine mixtures. Microgram 1997;30(12):289.

296. Oulton SR. Separation and identification of ephedrine, pseudoephedrine, and methamphetamine mixtures. J Clan Lab Invest Chem Assoc 1997;7(4):19.

297. Debruyne D, Albessard F, Bigot MC, Moulin M. Comparison of three advanced chromatographic techniques for *Cannabis* identification. Bull Narc 1994;46(2):109.

298. Huizer H, Poortman-van der Meer AJ. A contribution to the improvement of accuracy in the quantitation of THC. Proceedings of the International Association of Forensic Sciences 15th Triennial Meeting 1999:64.

299. 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.

300. Doig MV, Andela R. Analysis of pharmacologically active cannabinoids by GC-MS. Chromatographia 2000;52(Suppl S):S101.

301. 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.

302. 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.

303. Rustichelli C, Ferioli V, Baraldi M, Zanoli 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.

304. Matsunaga T, Ano M, Watanabe K, Yamamoto I, Yoshimura H. Analysis of nitrogen containing compounds *p*-coumaroyltyramine and feruloyltyramine for discrimination of *Cannabis* seeds by HPLC. Jpn J Toxicol Environ Health 1997;43(4):215.

305. Veress T. Sample preparation by supercritical fluid extraction for quantitation. A model based on the diffusion layer theory for determination of extraction time. J Chromatogr A 1994;668:285.

306. 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.

307. Taylor R, Lydon J, Anderson JD. Anatomy and viability of *Cannabis Sativa* stem cuttings with and without adventitious roots. J Forensic Sci 1994;39:769.

308. Bäckström B, Cole MD, Carrott MJ, Jones DC, Davidson G, Coleman K. A preliminary study of the analysis of *Cannabis* by supercritical fluid chromatography with atmospheric pressure chemical ionization mass spectrometric detection. Science Justice 1997;37(2):91.

309. Hauber DJ. Marijuana analysis with recording of botanical features present and without the environmental pollutants of the Duquenois-Levine test. J Forensic Sci 1992;37(6):1656.

310. Tanaka H, Shoyama Y. Monoclonal antibody against tetrahydrocannabinolic acid distinguishes *Cannabis Sativa* samples from different plant species. Forensic Sci Int 1999;106:135.

311. Smith RM. Identification of butyl cannabinoids in marijuana. J Forensic Sci 1997;42(4):610.

312. Gennaro MC, Gioannini E, Giacosa D, Siccardi D. Determination of mescaline in hallucinogenic *Cactaccae* by ion-interaction HPLC. Anal Lett 1996;29(13):2399.

313. Maloney DC. Extraction of mescaline from peyote. Microgram 2001;34(8):205.

314. Yap ATW, Chen SX, Lee TK. An approach to the analysis of methamphetamine in illicit "ice" seizures. Proceedings of the International Association of Forensic Sciences 15th Triennial Meeting 1999:58.

315. Bokor I, Trenerry VC, Scheelings P. Separation and quantitation of optical isomers of methylamphetamine samples by capillary electrophoresis. Forensic Sci Int 1997;85(3):177.

316. Kozma D, Madarasz Z, Kassai C, Fogassy E. Optical resolution of N-methylamphet-amine via diastereomeric salt formation with 2R,3R-O,O'-di-p-toluoyltartaric acid. Chirality 1999;11(5-6):373.

317. Tsuchihashi H, Katagi M, Nishikawa M, Tatsuno M, Nishioka H, Nara A, Nishio E, Petty C. Determination of methamphetamine and its related compounds using Fourier transform Raman spectroscopy. Appl Spectrosc 1997;51(12):1796.

318. 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.

319. Wu AH, Onigbinde TA, Wong SS, Johnson KG. Identification of methamphetamine and over the counter sympathomimetic amines by full scan GC-ion trap MS with electron impact and chemical ionization. J Anal Toxicol 1992;16:137.

320. Urry FM, Kushnir M, Nelson G, McDowell M, Jennison T. Improving ion mass ratio performance at low concentrations in methamphetamine GC-MS assay through internal standard selection. J Anal Toxicol 1996;20(7):592.

321. Kobayashi K, Kanamori T, Iwata Y, Kishi T. Determination of methamphetamine and its related compounds enantiomer ratios by high performance liquid chromatography with circular dichroism (CD) detection. Proceedings of the International Association of Forensic Sciences 15th Triennial Meeting 1999:64.

322. Chappell JS. Infrared discrimination of enantiomerically enriched and racemic samples of methamphetamine salts. Analyst 1997;122(8):755.

323. Chappell JS. A novel infrared method for the determination of the enantiomeric composition of methamphetamine salts. Proceedings of the American Academy of Forensic Sciences 1998;4:32.

324. Kram TC, Lurie IS. The determination of enantiomeric composition of methamphetamine by ^{1}H-NMR spectroscopy. Forensic Sci Int 1992;55(2):131.

325. Reese ES, Harrington PdB. The analysis of methamphetamine hydrochloride by thermal desorption ion mobility spectrometry and SIMPLISMA. J Forensic Sci 1999;44(1):68.

326. 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.

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

328. United Nations International Drug Control Programme (Scientific Section). Monograph: Studies on Colour Tests for Field Detection of Narcotic Drugs and Psychotropic Substances Under International Control (No. II). Screening Colour Tests and Specific Colour Test for the Detection of Non-Barbiturate Sedatives and Hypnotics Methaqualone and Mecloqualone - 1996. New York, NY:1996.

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

330. Semkin EP, Sorokin VI, Savenko VG. Examination of ephedrone. Microgram 1993;26:11.

331. DeRuiter J, Hayes L, Valaer A, Clark CR, Noggle FT. Methcathinone and designer analogues: Synthesis, stereochemical analysis, and analytical properties. J Chromatogr Sci 1994;32(12):552.

332. Noggle FT, DeRuiter J, Hayes L, Clark CR. Stereochemical analysis of methcathinone prepared by oxidation of ephedrines and pseudoephedrines. Microgram 1994;27:119.

333. Noggle FT, DeRuiter J, Valaer A, Clark CR. GC-MS analysis of methcathinone and its major decomposition product. Microgram 1994;27:106.

334. Glennon RA, Young R, Martin BR, Dal Cason TA. Methcathinone ('Cat'): An enantiomeric potency comparison. Pharm Biochem Behav 1995;50:601.

335. Dal Cason TA. The identification of cathinone and methcathinone. Microgram 1992;25(12):313.

336. Dal Cason TA. The identification of 4-methoxyamphetamine (PMA) and 4-methoxymethamphetamine (PMMA). Microgram 2000;33(8):207.

337. Dal Cason TA. A re-examination of the mono-methoxy positional ring isomers of amphetamine, methamphetamine, and phenyl-2-propanone. Forensic Sci Int 2001;119(2):168.

338. Clark CR, Noggle FT, DeRuiter J. Analysis of methoxy MDA derivatives synthesized from nutmeg oil and 3-methoxy-4,5-methylenedioxybenzaldehyde. Microgram 1995;28(11):358.

339. Clark CR, DeRuiter J, Noggle FT. Analysis of 1-(3-methoxy-4,5-methylenedioxyphenyl)-2-propanamine (MMDA) derivatives synthesized from nutmeg oil and 3-methoxy-4,5-methylenedioxybenzaldehyde. J Chomatogr Sci 1996;34(l):34.

340. Casale JF, Hays PA, Klein RFX. Synthesis and characterization of the 2,3-methylenedioxy-amphetamines. J Forensic Sci 1995;40(3):391.

341. Borth S, Hansel W, Rosner P, Junge T. Synthesis of 2,3- and 3,4-methylenedioxyphenyl-alkylamines and their regioisomeric differentiation by mass spectral analysis using GC-MS-MS. Forensic Sci Int 2000;114(3):139.

342. 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.

343. 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.

344. DeRuiter J, Holston PL, Clark CR, Noggle FT. Liquid chromatographic and mass spectral methods of identification for the regioisomeric 2,3- and 3,4-methylenedioxyphenalkylamines. J Chromatogr Sci 1998;36(3):131.

345. Clandestine Laboratory Investigating Chemists Association. Monograph: Structure-Activity Relationships, Synthesis, Precursor Preparation, and Analysis of MDMA and its Analogs and

Homologues. Fresno, CA:1994.

346. Furnari C, Ottaviano V, Rosati F, Tondi V. Identification of 3,4-methylenedioxyamphetamine analogs encountered in clandestine tablets. Forensic Sci Int 1998;92:49.

347. Lee GSH, Taylor RC, Wilson M. C-13 Solid state nuclear magnetic resonance (NMR) spectroscopy - A non-destructive method for determining the nature and quality of illicit substances. Proceedings of the International Association of Forensic Sciences 15th Triennial Meeting 1999:60.

348. Garcia AD, Lurie IS. Quantitation of 3,4-methylenedioxymethamphetamine and related compounds using capillary electrophoresis. Proceedings of the American Academy of Forensic Sciences 2000;6:40.

349. Varesio E, Gauvrit JY, Longeray R, Lanteri P, Veuthey JL. Optimization of fast CE analyses of ecstasy derivatives by use of experimental designs. Chromatographia 1999;50(3/4):195.

350. Wesley JF. Cops and crime lab unite to improve street MDMA identification. Proceedings of the American Academy of Forensic Sciences 2001;7:29.

351. Rashed AM, Anderson RA, King LA. Ecstasy profiling using Fourier transform infrared spectroscopy. Proceedings of the International Association of Forensic Sciences 15th Triennial Meeting 1999:59.

352. Fox J. The analysis of ecstasy (MDMA analogs and homologs) using an FT/IR spectrophotometer with microscope attachment. Microgram 1998;31(12):344.

353. 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.

354. 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.

355. Morselli O, Bovolenta A, Ripani L, Garofano L, Schiavone S. Designer drugs in the Italian clandestine market: Situation and new analytical problems. Microgram 1994;27(1):28.

356. Baudot P, Dresch M, Dzierzynski M, Vicherat A. Identification of 3,4-methylenedioxy-amphetamine derivatives by capillary gas chromatography-mass spectrometry with an ion trap detector. Ann Falsif Expert Chim Toxicol 1996;89(937):255.

357. Sadeghipour F, Veuthey JL. Sensitive and selective determination of methylenedioxylated amphetamines by high-performance liquid chromatography with fluorimetric detection. J Chromatogr A 1997;787(1-2):137.

358. Sadeghipour F, Veuthey JL. Enantiomeric separation of four methylenedioxylated amphetamines on *beta*-cyclodextrin chiral stationary phases. Chromatographia 1998;47(5-6):285.

359. Pisternick W, Guendisch D, Kovar K-A. HPTLC discrimination of 3,4-methylenedioxy-amphetamines of the ecstasy group using 0-benzenesulfonamido-*p*-benzoquinone as detection reagent. J Planar Chromatogr-Mod TLC 1996;9(4):286.

360. Herraez-Hernandez R, Campins-Falco P, Verdu-Andres J. Sensitive determination of methylenedioxylated amphetamines by liquid chromatography. Analyst 2001;126(5):581.

361. 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.

362. Verweij AMA, Lipman PJL. Comparison of mass spectrometric ionization techniques for the analysis of phenethylamines. J Chromatogr Sci 1996;34(8):379.

363. 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.

364. Sondermann N, Kovar K-A. Identification of ecstasy in complex matrices using near-infrared spectroscopy. Forensic Sci Int 1999;102(2-3):133.

365. Sondermann N, Kovar K-A. Screening experiments of ecstasy street samples using near infrared spectroscopy. Forensic Sci Int 1999;106(3):147.

366. Burns DT, Lewis RJ, Stevenson P. Determination of 3,4-methylenedioxyamphetamine analogues ("Ecstasy") by proton nuclear magnetic resonance spectroscopy. Anal Chim Acta 1997;339(3):259.

367. Dal Cason TA, Meyers JA, Lankin DC. Proton and carbon-13 NMR assignments of 3,4-methylenedioxyamphetamine (MDA) and some analogues of MDA. Forensic Sci Int 1997;86(1-2):15 (published erratum appears: Forensic Sci Int 1997;87(2):175).

368. Bell SEJ, Burns DT, Dennis AC, Speers JS. Rapid analysis of ecstasy and related phenethylamines in seized tablets by Raman spectroscopy. Analyst 2000;125(3):541.

369. Bell SEJ, Burns DT, Dennis AC, Matchett LJ, Speers JS. Composition profiling of seized ecstasy tablets by Raman spectroscopy. Analyst 2000;125(10):1811.

370. Sagmuller B, Schwarze B, Brehm G, Schneider S. Application of SERS spectroscopy to the identification of (3,4-methylenedioxy)amphetamine in forensic samples utilizing matrix stabilized silver halides. Analyst 2001;126(11):2066.

371. Dal Cason TA. The characterization of some 3,4-methylenedioxycathinone (MDCATH) homologs. Forensic Sci Int 1997;87(1):9.

372. Dal Cason TA, Young R, Glennon RA. Cathinone: An investigation of several n-alkyl and methylenedioxy- substituted analogs. Pharmacol Biochem Behav 1997;58(4):1109.

373. Dawson BA, Black DB, Cyr TD, Ethier J-C, By AW, Neville GA, Shurvell HF. Structural elucidation of unusual police exhibits. III. Identification of 3,4-methylenedioxyethyl-amphetamine (MDEA) hydrochloride in "Ecstasy" street tablets. Can J Anal Sci Spectrosc 1997;42(3):84.

374. Callahan SA, Latham DJ, Dawson BA, Black DB, Cyr TD, Ethier J-C, By AW, Neville GA. Identification of 3,4-methylenedioxyethylamphetamine hydrochloride in street tablets. Microgram 1996;29(5):119.

375. Veress T, Gal T, Nagy G, Nagy J, Korosi A. Analytical study on illegally produced 3,4-methylenedioxy-N-ethylamphetamine. Microgram 1994;27(2):48.

376. Soltis BH, Panusky DD, Pedrini D. Crystal MDMA. Microgram 2001;34(3):59.

377. Frost M, Kohler H, Blaschke G. Analysis of ecstasy by capillary electrophoresis. Int J Legal Med 1996;109:53.

378. Chappell J, Lee M. Hydration polymorphism of 3,4-methylenedioxymethamphetamine hydrochloride. Microgram 1999;32(5):159.

379. 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.

380. Lee GSH, Craig DC, Kannangara GSK, Dawson M, Conn C, Robertson J, Wilson MA. Analysis of 3,4-methylenedioxy-N-methylamphetamine (MDMA) in "ecstasy" tablets by 13C solid state nuclear magnetic resonance (NMR) spectroscopy. J Forensic Sci 1999;44(4):761.

381. Chappell JS. Identification of the phosphate salt of 3,4-methylenedioxymethamphet-amine. Microgram 1999;32(4):143.

382. Chan KB. A normal phase HPLC method for the quantitation of MDMA in illicit ecstasy tablets. Microgram 2001;34(9):237.

383. Morimoto BH, Lovell S, Kahr B. Ecstasy: 3,4-Methylenedioxymethamphetamine (MDMA). Acta Crystallogr C 1998;54:229.

384. Rosner P, Junge T. N-Methyl-1-(3,4-methylenedioxyphenyl)-2-butanamine, a representative of a new class of street drugs. Microgram 1994;27:411.

385. Clark CR, DeRuiter J, Valaer A, Noggle FT. Gas chromatographic-mass spectrometric and liquid chromatographic analysis of designer butanamines related to MDMA. J Chromatogr Sci 1995;33(6):328.

386. Clark CR, DeRuiter J, Noggle Jr FT, Valaer A. Identification of 1-(3,4-methylenedioxy-phenyl)-2-butanamines related to MDMA. Microgram 1995;28:154.

387. Clark CR, DeRuiter J, Noggle FT. Chromatographic and mass spectrometric methods for the differentiation of N-methyl-l-(3,4-methylenedioxyphenyl)-2-butanamine from regioisomeric derivatives. J Chromatogr Sci 1996;34(5):230.

388. Noggle FT, Clark CR, DeRuiter J. Chromatographic and mass spectrometric analysis of N-methyl-1-(3,4-methylenedioxyphenyl)-2-butanamine and regioisomeric derivatives. Microgram 1995;28(10):321.

389. Bovolenta A, Morselli O. Italian clandestine drug market: MDEA, MDMMA, and MBDB in street tablets. Microgram 1997;30(1):14.

390. Sorokin VI, Semkin EP, Savilov AP. Expert examination of 3-methylfentanyl. Microgram 1994;27:221.

391. Micovic IV, Ivanovic MD, Vuckovic SM, Prostan MS, Dosen-Micovic L, Kiricojevic VD. The synthesis and preliminary pharmacological evaluation of 4-methylfentanyl. Bioorg Med Chem Lett 2000;10(17):2011.

392. Angelos SA, Lankin DC, Meyers JA, Raney JK. The structural identification of a methyl analog of methaqualone via 2-dimensional NMR techniques. J Forensic Sci 1993;38(2):455.

393. Denk OA, Watson DG, Skellern GG. Chiral analysis of methylphenidate and dextromoramide by capillary electrophoresis. J Chromatogr B 2001;761(1):61.

394. Groombridge CJ, Hooker RH. The identification of 1-(4-methylphenyl)ethylamine in a drug seizure. Microgram 1996;29(2):38.

395. Serennes G, Chabrillat M, Deyris I, Bettochi A. N-methyl-1-phenylethylamine in tablets. Microgram 1998;31(2):44.

396. Clark CC. The identification of N-methyl-1-phenylethylamine. Microgram 1993;26:90.

397. Poortman AJ, Lock E. Analytical profile of 4-methylthioamphetamine (4-MTA), a new street drug. Forensic Sci Int 1999;100(3):221.

398. Groombridge CR. The identification of 4-methylthioamphetamine in a drug seizure. Microgram 1998;31(5):150.

399. Poortman-van der Meer AJ. The identification of 4-methylthioamphetamine. Microgram 1998;31(6):174.

400. Decaestecker T, DeLetter E, Clauwaert K, Bouche MP, Lambert W, VanBocxlaer J, Piette M, VandenEeckhout E, VanPeteghem C, DeLeenheer A. Fatal 4-MTA intoxication: Development of a liquid chromatographic-tandem mass spectrometric assay for multiple matrices. J Anal Toxicol 2001;25(8):659.

401. Pfendt LB, Janjic TJ, Popovic GV. Study of protolytic, hydrolytic and solubility equilibria of midazolam. Analyst 1995;120(8):2145.

402. Bjornsdottir I, Hansen SH. Comparison of aqueous and nonaqueous capillary electrophoresis for quantitative determination of morphine in pharmaceuticals. J Pharm Biomed Anal 1997;15:1083.

403. Fitsev IM, Garifzyanov AR. Spectrophotometric determination of morphine by flow-injection analysis. Anal Chem 1998;53(2):195.

404. Amiott E, Andrews ARJ. Morphine determination by HPLC with improved chemiluminescence detection using a conventional silica based column. J Liq Chromatogr Relat Technol 1997;20(2):311.

405. Hassan SS, El-Naby EH, Elnemma EM. Kinetic determination of morphine in illicit powders using a fluoride-selective electrode based on the reaction with 1-fluoro-2,4-dinitrobenzene. Mikrochim Acta 1996;124(1-2):55.

406. Kalasz H, Hosztafi S, Csermely T, Gotz H, Szabo MG. Displacement thin layer chromatography of morphine and its semi-synthetic derivatives. J Liq Chromatogr & Rel Tech 1996;19(1):23.

407. Shepherd III EJ. Analysis of nandralone-*p*-hexyloxyphenylpropionate. Microgram 1995;28:111.

408. Chamakura RP. Nootropics/smart drugs. Proceedings of the American Academy of Forensic Sciences 1997;3:22.

409. Lim JT, Zare RN, Bailey CG, Rakestraw DJ, Yan C. Separation of related opiate compounds using capillary electrochromatography. Electrophoresis 2000;21(4):737.

410. Matz LM, Hill HH. Evaluation of opiate separation by high-resolution electrospray ionization – ion mobility spectrometry/mass spectrometry. Anal Chem 2001;73(8):1664.

411. Hadzija BW, Shrewsbury RP, Cody JT. Determination of hydrocodone in Tussionex extended-release suspension by high-performance liquid chromatography (HPLC). J Forensic Sci 1996;41(5):878.

412. Salomies HEM, Salo PK. Determination of oxycodone hydrochloride in oral solutions by high-performance thin-layer chromatography/densitometry. JAOAC Int 2000;83(6):1497.

413. Remberg B, Nikiforov A, Buchbauer G. Fifty years of development of opium characterization methods. Bull Narc 1994;46(2):79.

414. Bjornsdottir I, Hansen SH. Determination of opium alkaloids in opium by capillary electrophoresis. J Pharm Biomed Anal 1995;13:687.

415. Bjornsdottir I, Hansen SH. Determination of opium alkaloids in crude opium using non-aqueous capillary electrophoresis. J Pharm Biomed Anal 1995;13(12):1473.

416. Lazar IM, Naisbitt G, Lee ML. Capillary electrophoresis time-of-flight mass spectrometry of an opium powder. Chromatographia 1999;50(3-4):188.

417. Mandal S, Naqvi AA, Thakur RS. A gas chromatographic method for the quantitative determination of opium alkaloids from plant. Indian J Pharm Sci 1993;55(1):25.

418. Paul BD, Dreka C, Knight ES, Smith ML. Gas chromatographic/mass spectrometric detection of narcotine papaverine and thebaine in seeds of *Papaver Somniferum*. Planta Medica 1996;62:544.

419. Budvari Barany Z, Szasz G, Gyimesi Forras K. Optimized and validated HPLC methods for compendial quality assessment. 2 Opium alkaloids. J Liq Chromatogr & Rel Tech 1997;20(19):3257.

420. 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.

421. Zhanpin W. A simple and rapid method for the extraction of five major alkaloids from opium. Forensic Sci Int 1994;64(2,3):103.

422. Trenerry VC, Wells RJ, Robertson J. Determination of morphine and related alkaloids in crude morphine poppy straw and opium preparations by micellar electrokinetic capillary chromatography. J Chromatogr A 1995;718(1):217.

423. Mitsui T, Hida M, Fujimura Y. Determination of the total amount of morphine alkaloids in opium by pyrolysis-gas chromatography using principal component analysis. J Anal Appl Pyrolysis 1995;32:205.

424. Baudot P, Bourbonneux C, Viriot ML, Carre MC, Andre JC. Synchronous excitation spectrofluorimetry of morphine derivatives and opium II: Papaverine, noscapine, and codeine. Ann Falsif Expert Chim Toxicol 1995;88(930):19.

425. 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.

426. 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.

427. Buchbauer G, Remberg B, Nikiforov A. Headspace constituents of opium. Planta Medica 1994;60(2):181.

428. 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.

429. Proksa B. Separation of morphine and its oxidation products by capillary zone electrophoresis. J Pharm Biomed Anal 1999;20(1-2):179.

430. Barnett NW, Hindson BJ, Lewis SW, Jones P, Worsfold PJ. Soluble manganese(IV); A new chemiluminescence reagent. Analyst 2001;126(10):1636. [Note: Includes morphine and codeine.]

431. 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.

432. 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.

433. 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.

434. 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.

435. Degim T, Akay C, Buyukafsar K, Cevheroglu S. Simultaneous determination of codeine and ethyl morphine HCl in tablet formulations using LC. J Pharm Biomed Anal 2001;26(1):15.

436. 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.

437. Ramos-Martos N, Aguirre-Gomez F, Molina-Diaz A, Capitan-Vallvey LF. Application of liquid chromatography to the simultaneous determination of acetylsalicylic acid, caffeine, codeine, paracetamol, pyridoxine, and thiamine in pharmaceutical preparations. JAOAC Int 2001;84(3):676.

438. Kartal M. LC method for the analysis of paracetamol, caffeine and codeine phosphate in pharmaceutical preparations. J Pharm Biomed Anal 2001;26(5-6):857.

439. 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.

440. Martos NR, Diaz AM, Navalon A, Capitan-Vallvey LF. Spectrofluororimetric determination of acetylsalicylic acid and codeine mixtures in pharmaceuticals. Anal Lett 2001;34(4):579.

441. Saad B, Sultan SM, Suliman FEO. Ion-association method for the spectrophotometric determination of the antitussive drug noscapine. Talanta 1997;44:53.

442. United Nations International Drug Control Programme (Scientific Section). Monograph: Recommended methods for testing opium, morphine, and heroin. New York, NY:1998.

443. Carmona M, Silva M, Perez-Bendito D. Automatic kinetic determination of oxazepam by the continuous addition of reagent technique. Talanta 1992;39(9):1175.

444. Liu RH, Foster G, Cone EJ, Kumar SD. Selecting an appropriate isotopic internal standard for gas chromatography/mass spectrometry analysis of drugs of abuse - Pentobarbital example. J Forensic Sci 1995;40(6):983.

445. Morley JA, Elrod L. Determination of pentobarbital and pentobarbital sodium in bulk drug substance and dosage forms by high performance liquid chromatography. J Pharm Biomed Anal 1997;16(1):119.

446. Clandestine Laboratory Investigating Chemists Association. Monograph: PCP. Fresno, CA:1995.

447. Brown PA, Skinner HF. Application of ion mobility spectrometry for the detection of phencyclidine and intermediate, 1-piperidinocyclohexane-carbonitrile. Proceedings of the American Academy of Forensic Sciences 1997;3:12.

448. Summerhays LR, Best WM. An effective liquid-liquid extraction procedure for isolating PCP from case samples. Proceedings of the American Academy of Forensic Sciences 1995;1:20.

449. King LA, Poortman-van der Meer AJ, Huizer H. l-Phenylethylamines: A new series of illicit drugs? Forensic Sci Int 1996;77(3):141.

450. Meyer E, Van Bocxlaer J, Lambert W, Thienpont L, De Leenheer A. *alpha*-Phenethylamine identified in judicial samples. Forensic Sci Int 1995;76(2):159.

451. Massetti J. β-Phenethylamine: 4th quarter - 1998. J Clan Lab Invest Chem Assoc 1999;9(1):11.

452. Massetti J. *beta*-Phenethylamine in suspected methamphetamine samples. Proceedings of the International Association of Forensic Sciences 15th Triennial Meeting 1999:57.

453. Massetti J. β-Phenethylamine. J Clan Lab Invest Chem Assoc 1998;8(3):10.

454. 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.

455. Ting S. Liquid chromatographic determination of scopalamine, hyoscyamine and phenobarbital in tablets. JAOAC Int 1997;80(2):331.

456. Goicoechea HC, Olivieri AC. Simultaneous determination of phenobarbital and phenytoin in tablet preparations by multivariate spectrophotometric calibration. Talanta 1998;47(1):103.

457. Prasad CVN, Gautam A, Bharadwaj V, Parimoo P. Differential derivative spectrophotometric determination of phenobarbitone and phenytoin sodium in combined tablet preparations. Talanta 1997;44:917.

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

459. de Boer D, Bosman IJ, Hidvegi E, Manzoni C, Benko AA, dos Reys LJAL, Maes RAA. Piperazine-like compounds: A new group of designer drugs-of-abuse on the European market.

Forensic Sci Int 2001;121(1-2):47.

460. 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.

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

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

463. Mahler, H, Daldrup T. Quick detection of psilocin in mushroom culture substrates. GTFCh-Symposium: Toxikologische Aspekte der Sterbehilfe - Neue Drogen: Chemische, Analytische und Toxikologische Aspekte, Beitraege zum Symposium der Gesellschaft fuer Toxikologische und Forensische Chemie, 12th, Mosbach, Germany, Apr. 26 - 28, 2001 2001;(Pub 2001):242.

464. 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.

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

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

467. Giroud C, Felber G, Augsburger 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.

468. Chang W-T, Lin D-L, Low I-A, Liu RH. $^{13}C_4$-Secobarbital as the internal standard for the quantitative determination of secobarbital - A critical evaluation. J Forensic Sci 2000;45(3):659.

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

470. Bono JP, Tolliver JM. Chemical and pharmacological aspects of anabolic steroids. Proceedings of the American Academy of Forensic Sciences 1995;1:21.

471. Koverman G. Analysis of anabolic steroids. Microgram 1993;26:248.

472. Chiong DM, Consuegra-Rodriguez E, Almirall JR. The analysis and identification of steroids. J Forensic Sci 1992;37(2):488.

473. Cairns T, Siegmund EG, Rader B. Analysis of testosterone esters by tandem mass spectrometry. JAOAC Int 1993;76(2):306.

474. Maroge W. Use of acetone in GC quantitation of some anabolic steroids in vegetable oils. Microgram 1994;27:356.

475. Musshoff F, Daldrup T, Ritsch M. Black market in anabolic steroids - analysis of illegally distributed products. J Forensic Sci 1997;42(6):1119.

476. 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.

477. 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.

478. Clark CC. The GLC quantitation of some anabolic steroids in vegetable oil preparations. Microgram 1992;25:255.

479. Caerhati T, Forgacs E. Effect of *beta*-cyclodextrin derivatives on the retention of steroidal drugs. J Chromatogr B 1996;681(1):205.

480. Mesmer MZ, Satzger RD. Determination of anabolic steroids by HPLC with UV/Vis-particle beam mass spectrometry. J Chromatogr Sci 1997;35(1):38.

481. Dwyer J, Chapman AE, Liu X. Analysis of steroids by combined chromatography-infrared spectroscopy. LC-GC 1995;13:240.

482. Nascimento ES, Salvadori MC, Ribeiro-Neto LM. Determination of synthetic estrogens in illegal veterinary formulations by HPTLC and HPLC. J Chromatogr Sci 1996;34(7):330.

483. Steffenrud S. Mass spectrometry of anabolic steroids as their *tert*-butyldimethylsilyl ether derivatives. Rapid Commun Mass Spectrom 1996;10:1698.

484. Cairns T, Siegmund EG, Rader B. Analysis of testosterone esters by tandem mass spectrometry. JAOAC Int 1993;76:306.

485. Bowers LD, Borts DJ. Separation and confirmation of anabolic steroids with quadrupole ion trap tandem mass spectrometry. J Chromatogr B 1996;687(1):69.

486. Guiney LB. Quantitation of testosterone propionate and boldenone by 13C - NMR. Microgram 1995;28(9):285.

487. Lin WC, Sue CC, Kuei CH. Separation of anabolic steroids by micellar electrokinetic capillary chromatography. Chromatographia 1999;49(7/8):454.

488. Lurie IS, Sperling AR, Meyers RP. The determination of anabolic steroids by MECC, gradient HPLC, and capillary GC. J Forensic Sci 1994;39(1):74.

489. Baiocchi C, Giacosa D, Roggero MA, Marengo E. Analysis of steroids by capillary supercritical fluid chromatography with flame-ionization and electron-capture detectors. J Chromatogr Sci 1996;34(9):399.

490. Morley M, Matkovich C. Screening of steroids by thin layer chromatography. Microgram 1993;26:214.

491. Gagliano A, Smith PR, Hays PA, Cooper DA, Moore JM. The analysis of telazol: A tiletamine/zolazepam mixture. Microgram 1999;32(1):26.

492. 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.

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

494. Cardoso SG, Schapoval EES. UV spectrophotometry and nonacqueous determination of terbinafine hydrochloride in dosage forms. JAOAC Int 1999;82(4):830.

495. Hida M, Mitsui T, Ohtani H, Tsuge S. Determination of triazolam in a drug tablet by thermal desorption gas chromatography. J Chromatogr A 1997;761(1-2):332.

496. Greenway GM, Dolman SJL. Analysis of tricyclic antidepressants using electrogenerated chemiluminescence. Analyst 1999;124(5):771.

497. Cepas J, Silva M, Perez-Bendito D. Sensitive peroxyoxalate chemiluminescence determination of psychotropic indole derivatives. Analyst 1996;121(1):49.

498. United Nations International Drug Control Programme (Scientific Section). Monograph: Basic Information on Essential Chemicals/Precursors of the 1988 Convention for Use by Law Enforcement Oficers - 1995. New York, NY:1995.

499. United Nations International Drug Control Programme (Scientific Section). Monograph: Data Sheets on Substances Frequently Used in the Illicit Manufacture of Psychotropic Substances - 1993. New York, NY:1993.

500. Walker JA, Geer L, Matkovich C. Screening for the presence of adulterants in illicit drug samples: Comparing and contrasting GC, HPLC and CE. Proceedings of the American Academy of Forensic Sciences 1998;4:33.

501. 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.

502. Mauterer C, Sparks MF, Liu, RH. Frequency and trend of secondary drugs present in cocaine, heroin, marijuana, and phencyclidine samples. Proceedings of the American Academy of Forensic Sciences 1998;4:38.

503. Pestaner JP, Mullick FG, Centeno JA. Characterization of acetaminophen: Molecular microanalysis with Raman microprobe spectroscopy. J Forensic Sci 1996;41(6):1060.

504. Hays PA, Cooper DA. Determination of the weight percent of acetic acid in acetic anhydride by 1H-nuclear magnetic resonance (NMR) spectroscopy. Microgram 2000;33(8):160.

505. 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.

506. Knox ME, Fukayama B, Haas JS, Alcaraz A, Andresen BD. Identification of diethylaminoethylaniline in a clandestine laboratory reaction mixture. Microgram 1993;26:28.

507. By A, Neville GA, Shurvell HF. Fourier transform infrared/Raman differentiation and characterization of *cis*- and *trans*-2,5-dimethoxy-4,*beta*-dimethyl-*beta*-nitrostyrenes: Precursors to the street drug STP. J Forensic Sci 1992;37(2):503.

508. Goldberg G. Dimethylsulfone: The most common diluent in today's methamphetamine. Proceedings of the International Association of Forensic Sciences 15th Triennial Meeting 1999:66.

509. Morales R. The use of heat to eliminate dimethyl sulfone from amphetamine and methamphetamine hydrochloride samples. Microgram 1999;32(1):10.

510. Sorgen GJ. Sublimation of dimethyl sulfone. Microgram 1998;31(11):308.

511. Ely RA, Ed. Dimethyl sulfone identified in amphetamine and methamphetamine samples. J Clan Lab Invest Chem Assoc 1996;6(1):12.

512. Cooper SD, Toske SG. Identification and differentiation of dimethyl terephthalate and its geometrical isomer dimethyl phthalate. Microgram 1996;29(12):307.

513. Blackwell TM. The differentiation of dimethylterephthalate from dimethylisophthalate via GC/FTIR. Microgram 1998;31(2):62.

514. Matkovich CE. Identification of dimethyl terephthalate in cocaine samples. Microgram 1996;29(12):316.

515. Munoz RAA, Matos RC, Angnes L. Amperometric determination of dipyrone in pharmaceutical formulations with a flow cell containing gold electrodes from recordable compact disks. Journal of Pharmaceutical Science 2001;90(12):1972.

516. Betz JM, Gay ML, Mossoba MM, Adams S, Portz BS. Chiral gas chromatographic determination of ephedrine-type alkaloids in dietary supplements containing *Ma Huang*. JAOAC Int 1997;80(2):303.

517. 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.

518. Schwarz MA, Hauser PC. Rapid chiral on-chip separation with simplified amperometric detection. J Chromatogr A 2001;928(2):225.

519. Li G, Zhang Z, Chen X, Hu Z, Zhao Z, Hooper M. Analysis of ephedrine in ephedra callus by acetonitrile modified capillary zone electrophoresis. Talanta 1999;48(5):1023.

520. Onur F, Yucesoy C, Dermi S, Kartal M, Kokdil G. Simultaneous determination of pseudoephedrine sulfate, dexbrompheniramine maleate and loratadine in pharmaceutical preparations using derivative spectrophotometry and ratio spectra derivative spectrophotometry. Talanta 2000;51(2):269.

521. Erk N. Assay of ephedrine hydrochloride and theophylline in pharmaceutical formulations by differential-derivative spectroscopy. J Pharm Biomed Anal 2000;23(2-3):255.

522. Chamorro PR, Diaz RC. Determination of ephedrine in pharmaceutical preparations with a double-membrane selective electrode based on ephedrine-5-nitrobarbiturate. Analyst 1992;117(12):1905.

523. Chamorro PR, Diaz RC. A double-membrane ephedrine selective electrode based on ephedrine-tetraphenylborate in poly(vinyl chloride) resin. Talanta 1993;40(9):1461.

524. Cookeas EG, Efstathiou CE. Flow injection - pulse amperometric detection of ephedrine at a cobalt phthalocyanine modified carbon paste electrode. Analyst 2000;125(6):1147.

525. Raj SV, Kapadia SU, Argekar AP. Simultaneous determination of pseudoephedrine hydrochloride and diphenhydramine hydrochloride in cough syrup by gas chromatography (GC). Talanta 1998;46(1):221.

526. Li HX, Ding MY, Lv K, Yu JY. Separation and determination of ephedrine alkaloids and tetramethylpyrazine in ephedra sinica Stapf by gas chromatography-mass spectrometry. J

Chromatogr Sci 2001;39(9):370.

527. 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.

528. Zhang XH, Ouyang J, Yang YP. A simple method for chiral separation of ephedrines using (R)-1-naphthylglycine and 3,5-dinitrobenzoic acid as stationary phase. Anal Lett 2001;34(11):1851.

529. 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.

530. 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.

531. Herraez-Hernandez R, Campins-Falco P. Derivatization of tertiary amphetamines with 9-fluorenylmethyl chloroformate for liquid chromatography: Determination of N-methylephedrine. Analyst 2000;125(6):1071.

532. Mansour AM. Determination of pseudoephedrine hydrochloride and carbinoxamine maleate in combination drug formulation by liquid chromatography. JAOAC Int 1998;81(5):958.

533. Hanna GM. Determination of ephedrine, pseudoephedrine, and norephedrine in mixtures (bulk and dosage forms) by proton nuclear magnetic resonance spectroscopy. JAOAC Int 1995;78(4):946.

534. Verdu-Andres J, Herraez-Hernandez R, Campins-Falco P. Analysis of enantiomers giving partially overlapped peaks by using different treatments of the chromatographic ultraviolet signals: Quantification of pseudoephedrine enantiomers. J Chromatogr A 2001;930(1-2):95.

535. Hurlbut JA, Carr JR, Singleton ER, Faul KC, Madson MR, Storey JM, Thomas TL. Solid-phase extraction cleanup and liquid chromatography with ultraviolet detection of ephedrine alkaloids in herbal products. JAOAC Int 1998;81(6):1121.

536. Moses AJ. Determination of pseudoephedrine from a mixture of pseudoephedrine and chlorpheniramine. J Clan Lab Invest Chem Assoc 1998;8(4):11.

537. Bhushan R, Martens J, Arora M. Direct resolution of (+/-)-ephedrine and atropine into their enantiomers by impregnated TLC. Biomed Chromatogr 2001;15(3):151.

538. Neville GA, By A, Shurvell HF. FTIR and Raman differentiation and characterization of cis-(Z)- and trans-(E)-monoethoxy-1-(2-nitro-1-propenzyl) benzenes - Precursors to the monoethoxyamphetamine "designer" street drugs. J Can Soc Forensic Sci 1992;25(1):31.

539. 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.

540. Carr S, Cooper D. 3-Hydroxy-N-phenyl-2-naphthalene carboxamide. Microgram 1992;25:182.

541. Groombridge CJ. Diet "Coke"? Identification of lactitol as an unusual cocaine cutting substance. Microgram 2001;34(7):174.

542. MacLaren F, Cooper D. 4-(N-Methylacetamido)-antipyrine. Microgram 1992;25:164.

543. Bouhsain Z, Garrigues S, de la Guardia M. Flow injection - Fourier transform infrared spectrometric determination of paracetamol in pharmaceuticals. Analyst 1996;121(5):635.

544. Perez JL, Bello MA. Determination of paracetamol in dosage forms by non-suppressed ion chromatography. Talanta 1999;48(5):1199.

545. Trafford AD, Jee RD, Moffat AC, Graham P. A rapid quantitative assay of intact paracetamol tablets by reflectance near-infrared spectroscopy. Analyst 1999;124(2):163.

546. Eustaquio A, Graham P, Jee RD, Moffat AC, Trafford AD. Quantification of paracetamol in intact tablets using near-infrared transmittance spectroscopy. Analyst 1998;123(11):2303.

547. Bouhsain Z, Garrigues S, de la Guardia M. Simultaneous stopped-flow determination of paracetamol, acetylsalicylic acid and caffeine in pharmaceutical formulations by Fourier transform infrared spectrometry with partial least squares data treatment. Analyst 1996;121(12):1935.

548. Wu H-L, Huang C-H, Chen S-H, Wu S-M. Chiral quantitation of pheniramine, chlorpheniramine, and brompheniramine maleates by capillary zone electrophoresis. J Chromatogr Sci 1999;37(1):24.

549. Chen W, Liu F, Zhang X, Li KA, Tong S. The specificity of a chlorphenamine-imprinted polymer and its application. Talanta 2001;55(1):29.

550. Rind FMA, Khuhawar MY, Rajper AD. HPLC determination of phenylpropanolamine in pharmaceutical preparations using 4-dimethylaminobenzaldehyde as a derivatizing reagent. J Pharm Biomed Anal 2001;26(2):331.

551. Liu LD, Liu Y, Wang HY, Sun Y, Ma L, Tang B. Use of *p*-dimethylaminobenzaldehyde as a colored reagent for determination of procaine hydrochloride by spectrophotometry. Talanta 2000;52(6):991.

552. Li B, Zhang Z, Wu M. Flow-injection chemiluminescence determination of quinine using on-line electrogenerated cobalt(III) as oxidant. Talanta 2000;51(3):515.

553. Sanchez FG, Diaz AN, Pareja AG, Montiel GC. Determination of (-)-quinine and (+)-quinidine by liquid chromatography with diode-laser polarimetric detection. JAOAC Int 1999;82(6):1308.

554. Heikes DL. SFE with GC and MS determination of safrole and related allylbenzenes in sassafras teas. J Chromatogr Sci 1994;32(7):253.

555. Fuelster RG. Quantitation of sugars in street drug samples. J Forensic Sci 1992;37(1):77.

556. Shubietah RM, Zuhri AZA, Fogg AG. Adsorptive cathodic stripping voltammetric determination of theophylline at a hanging mercury drop electrode. Analyst 1994;119(9):1967.

557. Rico CM, Fernandez MdP, Gutierrez AM, Conde MCP, Camara C. Development of a flow fluoroimmunosensor for determination of theophylline. Analyst 1995;120(10):2589.

558. Perez Martinez I, Sagrado S, Medina Hernandez MJ. Determination of theophylline in pharmaceuticals by micellar liquid chromatography and spectrophotometric detection. J Liq Chromatogr & Rel Tech 1996;19(12):1957.

559. Abdel-Hay MH, El-Din MS, Abuirjeie MA. Simultaneous determination of theophylline and guaiphenesin by third-derivative ultraviolet spectrophotometry and high-performance liquid chromatography. Analyst 1992;117(2):157.

560. Ciszewski A, Wang J. Determination of thiamine by cathodic stripping voltametry. Analyst 1992;117(6):985.

561. Hart JP, Norman MD, Tsang S. Voltametric behaviour of Vitamin B1 (Thiamine) at a glassy carbon electrode and its determination in multivitamin tablets using anion-exchange liquid chromatography with amperometric detection under basic conditions. Analyst 1995;120(4):1059.

562. Costa-Neto CO, Pereira AV, Aniceto C, Fatibello-Filho O. Flow injection turbidimetric determination of thiamine in pharmaceutical formulations using silicotungstic acid as precipitant reagent. Talanta 1999;48(3):659.

563. Chen Q-Y, Li DH, Yang HH, Zhu QZ, Zheng H, Xu JG. Novel spectrofluorometric method for the determination of thiamine with iron(III) tetrasulfonatophthalocyanine as a catalyst. Analyst 1999;124(5):771.

564. Metwally FH. Kinetic spectrophotometric methods for the quantitation of triprolidine in bulk and in drug formulations. J Pharm Biomed Anal 2001;26(2):265.

565. Dejarme LE, Lawhon SJ, Ray P, Kuhlman MR. Analysis of the volatile organic compounds in seized cocaine. Proc SPIE-Int Soc Opt Eng 1997;2937 (Chemistry- and Biology-Based. Technologies for Contraband Detection):2.

566. Cartier J, Gueniat O, Cole MD. Headspace analysis of solvents in cocaine and heroin samples. Science Justice 1997;37(3):175.

567. Morello DR, Meyers RP. Qualitative and quantitative determination of residual solvents in illicit cocaine HCl and heroin HCl. J Forensic Sci 1995;40(6):9.

568. Vu D-TT. SPME/GC-MS characterization of volatiles associated with methamphetamine: Toward the development of a pseudomethamphetamine training material. J Forensic Sci 2001;46(5):1014.

569. Mulligan KJ, Brueggemeyer TW, Crockett DF, Schepman JB. Review: Analysis of organic volatile impurities as a forensic tool for the examination of bulk pharmaceuticals. J Chromatogr B 1996;686:85.

570. Li QC, Cohen KA, Zhuang G. A capillary gas chromatographic procedure for the analysis of nine common residual solvents in water-insoluble bulk pharmaceuticals. J Chromatogr Sci 1998;36(3):119.

571. Kersten BS. Drug matrix effect on the determination of residual solvents in bulk pharmaceuticals by wide-bore capillary gas chromatography. J Chromatogr Sci 1992;30(4):115.

572. Schuberth J. Volatile organic compounds determined in pharmaceutical products by full evaporation technique and capillary gas chromatography ion-trap detection. Anal Chem 1996;68(8):1317.

573. Mulligan K, McCauley H. Factors that influence the determination of residual solvents in pharmaceuticals by automated static headspace sampling coupled to capillary GC-MS. J Chromatogr Sci 1995;33(1):49.

574. 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.

575. López-Artíguez M, Cameán A, Repetto M. Unequivocal identification of several common adulterants and diluents in street samples of cocaine by infrared spectroscopy. J Forensic Sci 1995;40(4):602.

576. 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.

577. Carter JC, Brewer WE, Angel SM. Raman spectroscopy for the *in situ* identification of cocaine and selected adulterants. Appl Spectrosc 2000;54:1876.

578. Atay O, Oztop F. Quantitative determination for cocaine HCl in synthetic binary mixtures by using spectrophotometric methods. Anal Letters 1998;31(15):2663.

579. Cruz A, Lopez-Rivadulla M, Bermejo AM, Sanchez I, Fernandez P. Sequential second-derivative spectroscopy of cocaine and adulterants in street drug samples. Part I: Cocaine, procaine, and lidocaine. Anal Lett 1994;27(14):2663.

580. 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.

581. Bautista RD, Jimenez AI, Jimenez F, Arias JJ. Resolution of ternary and quaternary mixtures of drugs in pharmaceutical preparations by use of spectrophotometric data in conjunction with PLS-1 and PLS-2 data processing methods. Anal Lett 1996;29(15):2645.

582. Wielbo D, Tebbett IR. The use of micro-Fourier ransform infrared spectroscopy for the rapid identification of street drugs: Determination of interference by common diluents. J Forensic Sci Soc 1993;33:25.

583. Lemos NP, Bortolotti F, Manetto G, Anderson RA, Cittadini F, Tagliaro F. Capillary electrophoresis: A new tool in forensic medicine and science. Science Justice 2001;41(3):203.

584. Lurie IS. Application of capillary electrophoresis to the analysis of seized drugs. Am Lab 1996;28(2):26.

585. Lurie IS. Capillary electrophoresis for drug analysis. Proc SPIE - Int Soc Opt Eng 1999;3576:125.

586. 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.

587. 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.

588. 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.

589. Thormann W, Caslavska J. Capillary electrophoresis in drug analysis. Electrophoresis 1998;19(16-17):2691.

590. Deyl Z, Mikšik I, Tagliaro F. Advances in capillary electrophoresis. Forensic Sci Int 1998;92(2-3):89.

591. Tagliaro F, Manetto G, Crivellente F, Smith FP. A brief introduction to capillary electrophoresis. Forensic Sci Int 1998;92:75.

592. Lurie IS. Application of capillary electrophoresis to the analysis of seized drugs. American Laboratory 1996;January:26.

593. Tagliaro F, Turrina S, Smith FP. Capillary electrophoresis: Principles and applications in illicit drug analysis. Forensic Sci Int 1996;77(3):211.

594. Tagliaro F, Smith FR. Capillary electrophoresis: A new analytical tool. Bulletin of the International Association of Forensic Toxicologists 1996;26(2):25.

595. Lurie IS. Analysis of seized drugs by capillary electrophoresis. In: Adamovics, JA, editor. Analysis of Addictive Misused Drugs. New York, 1995:151.

596. Northrup DM, McCord BR, Butler JM. Forensic applications of capillary electrophoresis. J Capillary Electrophor 1994;1:158.

597. Thormann W, Molteni S, Caslavska J, Schmutz A. Clinical and forensic applications of capillary electrophoresis. Electrophoresis 1994;15:3.

598. Thormann W, Lurie IS, McCord B, Marti U, Cenni B, Malik N. Advances of capillary electrophoresis in clinical and forensic analysis (1999-2000). Electrophoresis 2001;22(19):4216.

599. Marina ML, Torre M. Capillary Electrophoresis. Talanta 1994;41(9):1411.

600. Hilhorst MJ, Somsen GW, deJong GJ. Capillary electrokinetic separation techniques for profiling of drugs and related products. Electrophoresis 2001;22(12):2542.

601. Kuffner Jr CA, Marchi E, Morgado JM, Rubio CR. Capillary electrophoresis and Daubert: Time for admission. Anal Chem News and Features 1996 April 1;241A.

602. 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.

603. 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.

604. Salvador A, Varesio E, Dreux M, Veuthey JL. Binding constant dependency of amphetamines with various commercial methylated *beta*-cyclodextrins. Electrophoresis 1999;20:2670.

605. Garcia AD, Lurie IS. Simultaneous chiral determination and quantitation of methamphetamine and related compounds using capillary electrophoresis. Proceedings of the International Association of Forensic Sciences 15th Triennial Meeting 1999:58.

606. 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.

607. Fanali S, Aturki Z, Desiderio C. New strategies for chiral analysis of drugs by capillary electrophoresis. Forensic Sci Int 1998;92(2-3):137.

608. Fanali S. Identification of chiral drug isomers by capillary electrophoresis. J Chromatogr A 1996;735(1-2):77.

609. Dhulst A, Verbeke N. Chiral analysis of basic drugs by oligosaccharide-mediated capillary electrophoresis. J Chromatogr A 1996;735(1-2):283.

610. 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.

611. Lurie IS, Klein RFX, Dal Cason T, LeBelle M, Brenneisen R, Weinberger R. Chiral resolution of cationic drugs of forensic interest by capillary electrophoresis with mixtures of neutral and anionic cyclodextrins. Anal Chem 1994;66:4019.

612. Koppenhoefer B, Epperlein U, Christian B, Lin B, Ji Y, Chen Y. Separation of enantiomers of drugs by capillary electrophoresis. 3. *beta*-Cyclodextrin as chiral solvating agent. J Chromatogr A 1996;735(1-2):333.

613. Peterson TE. Separation of drug stereoisomers by capillary electrophoresis with cyclodextrins. J Chromatogr 1993;630:353.

614. Nishi H. Enantiomer separation of basic drugs by capillary electrophoresis using ionic and neutral polysaccharides as chiral selectors. J Chromatogr A 1996;735(1-2):345.

615. Aumatell A, Guttman A. Ultra-fast chiral separation of basic drugs by capillary electrophoresis. J Chromatogr A 1995;717(1-2):229.

616. Lurie IS. Capillary electrophoresis of illicit drug seizures. Forensic Sci Int 1998;92:125.

617. Naisbitt GH, Lazar JM, Lee ML. Analysis of drugs of abuse by capillary electrophoresis coupled to time-of-flight mass spectrometry. Proceedings of the American Academy of Forensic Sciences 1998;4:38.

618. Lazar IM, Naisbitt G, Lee ML. Capillary electrophoresis-time-of-flight mass spectrometry of drugs of abuse. Analyst 1998;123(7):1449.

619. Tanaka Y, Terabe S. Separation of the enantiomers of basic drugs by affinity capillary electrophoresis using a partial filling technique and α1-acid glycoprotein as chiral selector. Chromatographia 1997;43(3-4):119.

620. Cherkaoui S, Rudaz S, Varesio E, Veuthey JL. On-line capillary electrophoresis-electrospray mass spectrometry for the stereoselective analysis of drugs and metabolites. Electrophoresis 2001;22(15):3308.

621. Gaus H-J, Gögüs ZZ, Schmeer K, Behnke B, Kovar K-A, Bayer E. Separation and identification of designer drugs with capillary electrophoresis and on-line connection with ionspray mass spectrometry. J Chromatogr A 1996;735(1-2):221.

622. Altria KD. Determination of drug-related impurities by capillary electrophoresis. J Chromatogr A 1996;735(1-2):43.

623. Krogh M, Brekke S, Tonnesen F, Rasmussen KT. Analysis of drug seizures of heroin and amphetamine by capillary electrophoresis. J Chromatogr Adv 1994;674:235.

624. 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.

625. Lurie IS Bethea MJ, McKibben TD, Hays PA, Pellegrini P, Sahai R, Garcia AD, 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 2001;46(5):1025.

626. Belder D, Stockigt D. Analysis of basic pharmaceuticals by capillary electrophoresis in coated capillaries and on-line mass spectrometric detection. J Chromatogr A 1996;752(1-2):271.

627. Walker JA, Marché HL, Newby N, Bechtold EJ. A free zone capillary electrophoresis method for the quantitation of common illicit drug samples. J Forensic Sci 1996;41(5):824.

628. Walker JA, Marche HL, Newby N, Bechtold EJ. A free zone capillary electrophoresis method for the quantitation of common illicit drug samples. Proceedings of the American Academy of Forensic Sciences 1996;2:28.

629. Gavcik J, Stransky Z, Ingelse BA, Lemr K. Capillary electrophoretic enantioseparation of selegiline, methamphetamine, and ephedrine using a neutral *beta*-cyclodextrin epichlorhydrin polymer. J Pharm Biomed Anal 1996;14(8-10):1089.

630. 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.

631. 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.

632. Dittmann MM, Rozing GP. Capillary electrochromatography - A high-efficiency micro-separation technique. J Chromatogr A 1996;744:63.

633. Lurie IS, Conver 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.

634. Lurie IS, Conver TS, Meyers RP, Bailey CG, Anex DS. Capillary Electrochromatography of Drugs of Forensic Interest. Proceedings of the International Association of Forensic Sciences 15th Triennial Meeting 1999:59.

635. Curcuruto O, Zaramella A, Hamdan M. Capillary zone electrophoresis/electrospray ionization mass spectrometry for the characterization of drugs of forensic interest. Rapid Communication in Mass Spectrometry 1995;9:1487.

636. Wang Z, Sun YL, Sun ZP. Enantiomeric separation of amphetamine and phenylephrine by cyclodextrin-mediated capillary zone electrophoresis. J Chromatogr A 1996;735(1-2):295.

637. Nielen MWF. Chiral separation of basic drugs using cyclodextrin-modified capillary zone electrophoresis. Anal Chem 1993;65:885.

638. 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.

639. Nishi H. Enantiomer separation of drugs by electrokinetic chromatography. J Chromatogr A 1996;735(1-2):57.

640. Janini GM, Muschik GM, Issaq HJ. Electrokinetic chromatography in suppressed electroosmotic flow environment: Use of a charged cyclodextrin for the separation of enantiomers and geometric isomers. Electrophoresis 1996;17(10):1575.

641. Tanaka Y, Yanagawa M, Terabe S. Separation of neutral and basic enantiomers by cyclodextrin electrokinetic chromatography using anionic cyclodextrin derivatives as chiral pseudostationary phases. J High Resol Chromatogr 1996;19:421.

642. Nishi H, Terabe S. Micellar electrokinetic chromatography - Perspectives in drug analysis. J Chromatogr A 1996;735(1-2):3.

643. Aumatell A, Wells R. Enantiomeric differentiation of a wide range of pharmacologically active substances by cyclodextrin-modified micellar electrokinetic capillary chromatography using a bile salt. J Chromatogr A 1994;688:329.

644. Walker JA. The advantages of different micelles in the micellar electrokinetic capillary chromatography (MECC) of controlled substances. Proceedings of the American Academy of Forensic Sciences 1995;1:23.

645. 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.

646. 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.

647. Cherkaoui S, Geiser L, Veuthey JL. Rapid separation of basic drugs by nonaqueous capillary electrophoresis. Chromatographia 2000;52(7-8):403.

648. Bjornsdottir I, Hansen SH. Fast separation of 16 seizure drug substances using non-aqueous capillary electrophoresis. J Biochem Biophys Methods 1999;38:155.

649. Porras SP, Valko IE, Jyske P, Riekkola ML. Effect of electrolyte and solvent composition on capillary electropheretic separation of some pharmaceuticals in non-aqueous media. J Biochem Biophys Methods 1999;38:89.

650. Leung GNW, Tang HPO, Tso TSC, Wan TSM. Separation of basic drugs with non-aqueous capillary electrophoresis. J Chromatogr A 1996;738(1):141.

651. Backofen U, Matysik FM, HoffmanW, Lunte CE. Analysis of illicit drugs by nonaqueous capillary electrophoresis and electrochemical detection. Fresenius J Anal Chem 2000;367:359.

652. 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.

653. 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.

654. Tagliaro F, Smith FP, Turrina S, Equisetto V, Marigo M. Complementary use of capillary zone electrophoresis and micellar electrokinetic capillary chromatography for mutual confirmation of results in forensic drug analysis. J Chromatogr A 1996;735(1-2):227.

655. McGrath G, McClean S, Okane E, Smyth WF, Tagliaro F. Study of the capillary zone electrophoretic behaviour of selected drugs and its comparison with other analytical techniques for their formulation assay. J Chromatogr A 1996;735(1-2):237.

656. Jinno K, Han YH, Sawada H. Analysis of toxic drugs by capillary electrophoresis using polyacrylamide-coated columns. Electrophoresis 1997;18(2):284.

657. Jinno K, Han Y, Sawada H, Taniguchi M. Capillary electrophoretic separation of toxic drugs using a polyacrylamide-coated capillary. Chromatographia 1997;46(5-6):309.

658. Tomita M, Okuyama T. Analysis of drugs by capillary electrophoresis: Effect of methanol in sample solution on the electropherogram. Hochudoku 1993;11:140.

659. Bjornsdottir I, Hansen SH. Evaluation of the use of cyclodextrins in chiral separation of basic drug substances by capillary electrophoresis. Chirality 1995;7(4):219.

660. Quang C, Khaledi MG. Improved chiral separation of basic compounds in capillary electrophoresis using *beta*-cyclodextrin and tetraalkylammonium reagents. Anal Chem 1993;65:3354.

661. Altria KD. Quantitative aspects of the application of capillary electrophoresis to the analysis of pharmaceuticals and drug related impurities. J Chromatogr 1993;646:245.

662. Lurie IS. Separation selectivity in chiral and achiral capillary electrophoresis with mixed cyclodextrins. J Chromatogr A 1997;792:297.

663. McGrath G, Smyth WF. Large-volume sample stacking of selected drugs of forensic significance by capillary electrophoresis. J Chromatogr B 1996;681(1):125.

664. Siegel JA. Application of fluorescence spectroscopy to forensic science. Forensic Sci Rev 1996;8(1):1.

665. Cone EJ, Deyl Z, Eds. Toxicological and forensic applications of chromatography. Elsevier (Amsterdam, The Netherlands):1992.

666. Tebbet IR, Ed. Gas chromatography in forensic sciences. Chicester, UK. Ellis-Horwood Ltd.:1992.

667. Dasgupta A, Hart AP. Distinguishing amphetamine, methamphetamine, and 3,4-methylenedioxymethamphetamine from other sympathomimetic amines after rapid derivatization with propyl chloroformate and analysis by gas chromatography-chemical ionization mass spectrometry. J Forensic Sci 1997;42(1):106.

668. Shin H-S, Donike M. Stereospecific derivatization of amphetamines, phenol alkylamines, and hydroxyamines and quantification of the enantiomers by capillary GC/MS. Anal Chem 1996;68:3015.

669. Dallabetta-Keller T. Trace analysis by GC/MS using pulsed splitless injections. Proceedings - NOBCChE 2001;28:4.

670. Clark CC. A basic program for the quantitation of cocaine, heroin, diazepam, methaqualone, codeine, and oxycodone on the HP 5890A gas chromatograph. Microgram 1994;27:70.

671. 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.

672. Hattori H, Yamada T, Suzuki O. Gas chromatography with surface ionization detection in forensic analysis. J Chromatogr A 1994;674:15.

673. Chang W-T, Lin DL, Liu RH. Isotopic analogs as internal standards for quantitative analyses by GC/MS – Evaluation of cross-contribution to ions designated for the analyte and the isotopic internal standard. Forensic Sci Int 2001;121(3):174. [Note: Focus is on drugs and metabolites in biological matrices.]

674. 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.

675. Dent BR, Vannoort RW. GC-MS Analysis of drugs with deuterated internal standards - The New Zealand perspective. Forensic Toxicol Proc Int Meet Assoc Forensic Toxicol 26th 1992:57.

676. 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.

677. Japp M, Vinall M, Osselton MD. Assessment of a programmable temperature vaporizing (PTV) injector and cold on-column injector for analysis of drugs in forensic samples. Forensic Toxicol Proc Int Meet Assoc Forensic Toxicol 26th. 1992:222

678. Williams TA, Riddle M, Morgan SL, Brewer WE. Rapid gas chromatographic analysis of drugs of forensic interest. J Chromatogr Sci 1999;37(6):210.

679. Wu C, Siems WF, Hill HH. Secondary electrospray ionization ion mobility spectroscopy/mass spectrometry of illicit drugs. Anal Chem 2000;72(2):396.

680. Lillsunde P, Korte T. Thin-layer chromatographic screening and gas chromatographic/mass spectrometric confirmation in the analysis of abused drugs. Anal Addict Misused Drugs 1995:221.

681. Terada M, Shinozuka T, Yasuda M, Yanagida J, Wakasugi C. Simultaneous determination of acidic and neutral drugs by wide-bore column gas chromatography with nitrogen-phosphorus detection. Hochudoku 1992;10:142.

682. Echevarria PA. A dual internal standard method for screening by gas-liquid chromatography at a one percent level. Microgram 1995;28:54.

683. Malcolm MJ, Hudson JC, Proulx JGF, Sharp ME, Whiting C. Internal quality control of a general GC drug screen in forensic toxicology: Experience questions proposals. J Can Soc Forensic Sci 1995;28(3):215.

684. Stimpfl T, Vycudilik W. Identification of the general unknown. Application of mass selective detectors in forensic toxicology. J Anal Toxicol 2000;24(1):32.

685. 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.

686. Underwood PJ, Kananen GE, Armitage EK. A practical approach to determination of laboratory GC–MS limits of detection. Anal Toxicol 1997;21(1):12.

687. Galipo RC, Morgan SL, Brewer WE. A sample concentrator for sensitivity enhancement in chromatographic analyses. Anal Chem 1998;70(10):2191.

688. 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.

689. Dallabetta-Keller T. Trace analysis by GC/MS using pulsed splitless injections. Microgram 1999;32(5):168.

690. Machiroux R. Physics and chemistry in police investigations. Bulletin de la Societe Royale des Sciences de Liege 2001;70(3):137.

691. Nakahara Y. Recent progress in HPLC analysis for drugs of abuse. Jpn J Toxicol Environ Health 1993;39:369.

692. Lurie IS, Cooper DA, Krull IS. High-performance liquid chromatography using continuous on-line post-elution photoirradiation with subsequent diode-array UV or thermospray mass spectrometric detection. J Chromatogr 1993;629:143.

693. Dueñas EV, Forero ME. Standardized methods to separate and identify cocaine, morphine, heroin, codeine, papaverine, benzocaine, procaine, lidocaine by high-efficiency liquid chromatography with diode array detector (HPLC-DAD). Microgram 1996;29(8):207.

694. Hernandez AF, Pla A, Moliz J, Gil F, Gonzalvo MC, Villanueva E. Application of the combined use of HPLC/diode array detection and capillary GC/nitrogen phosphorus detection for the rapid analysis of illicit heroin and cocaine samples. J Forensic Sci 1992;37:1276.

695. 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.

696. Aboul-Enein HY, Serignese V. Direct chiral resolution of phenylalkylamines using a crown ether chiral stationary phase. Biomed Chromatogr 1997;11(1):7.

697. Deorsi D, Gagliardi L, Bolasco A, Tonelli D. Simultaneous determination of triprolidine, pseudoephedrine, paracetamol, and dextromethorphan by HPLC. Chromatographia 1996;43(9-10):496.

698. 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.

699. Lurie IS. Reversed-phase high-performance liquid chromatography analysis of drugs of forensic interest. In: Adamovics, JA, editor. Analysis of Addictive Misused Drugs. New York, 1995:51.

700. Theodoridis G, Papadoyannis I, Vasilikiotis G, Tsoukali-Papadopoulou H. Reversed-phase high-performance liquid chromatography-photodiode-array analysis of alkaloid drugs of forensic interest. J Chromatogr 1995;668:253.

701. Golkiewicz W, Kuczynski J, Markowski W, Jusniak L. High-performance liquid chromatography of some alkaloids on unmodified silica gel with aqueous-organic solvent mixtures. J Chromatogr A 1994;686:85.

702. Lin LA. Detection of alkaloids in foods with a multi-detector high-performance liquid chromatographic system. J Chromatogr 1993;632:69.

703. Logan BK. Liquid chromatography with photodiode array spectrophotometric detection in the forensic sciences. Anal Chim Acta 1994;288:111.

704. Sellers JK, Duffitt GL, Gaines ML, Liu RH. High performance liquid chromatographic analysis of enantiomeric composition of abused drugs. Forensic Sci Rev 1996;8(2):91.

705. Achilli G, Cellerino GP, Deril GVM, Tagliaro F. Determination of illicit drugs and related substances by high-performance liquid chromatography with an electrochemical coulometric-array detector. J Chromatogr A 1996;729(1-2):273.

706. Sato K, Kumazawa T, Katsumata Y. On-line high-performance liquid chromatography-fast atom bombardment mass spectrometry in forensic analysis. J Chromatogr A 1994;674:127.

707. Szasz G, Budvari-Barany Z, Gyimesi-Forras 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.

708. Hermansson J, Grahn A. Resolution of racemic drugs on a new chiral column based on silica-immobilized cellobiohydrolase. Characterization of the basic properties of the column. J Chromatogr A 1994;687:45.

709. Wu MT, Aderjan R. The effect of chromatographic conditions on the retention indices of forensically relevant substances in reversed-phase HPLC. J Liq Chromatogr & Rel Tech 1996;19(12):1967.

710. Binder SR. High-performance liquid chromatography using unmodified silica with polar solvents. Anal Addict Misused Drugs 1995:133.

711. Hill DW, Kind AJ. Reversed-phase solvent-gradient HPLC retention indexes of drugs. Anal Toxicol 1994;18:233.

712. Bogusz M, Erkens M. Reversed-phase high-performance liquid chromatographic database of retention indices and UV spectra of toxicologically relevant substances and its interlaboratory use. J Chromatogr A 1994;674:97.

713. Bogusz M, Erkens M, Franke JP, De Zeeuw RA. Interlaboratory applicability of a retention index library of drugs for screening by reversed phase HPLC in systematic toxicological analysis. J Liq Chromatogr 1993;16:1341.

714. Kishi T, Ohtsuru O. Applications of IR and Raman spectroscopy in drug analysis. Nippon Sekigaisen Gakkaishi 1998;8(2):70.

715. 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.

716. Wielbo D, Tebbett IR. The use of microcrystal tests in conjunction with Fourier transform infrared spectroscopy for the rapid identification of street drugs. J Forensic Sci 1992;37(4):1134.

717. Gal T, Veress T, Ambrus I. Sample preparation of illicit drugs for FT-IR microspectrophotometry. Mikrochim Acta Suppl 1997;14:377.

718. Blackledge RD. Forensic application of FT-NIR in controlled substance validation. Proceedings of the American Academy of Forensic Sciences 1998;4:41.

719. Kohn WH, Jeger AN. Identification of drugs by their near infrared spectra. J Forensic Sci 1992;37(1):35.

720. 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.

721. 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.

722. 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.

723. Pfeifer AM, Kovar KA. Identification of LSD, MBDB and atropine in real samples with on-line HPTLC-FTIR coupling. J Planar Chromatogr 1995;8:388.

724. Suzuki EM. Fourier transform infrared analyses of some particulate drug mixtures using a diamond anvil cell with a beam condenser and an infrared microscope. J Forensic Sci 1992;37(2):467.

725. 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.

726. 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.

727. 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.

728. 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.

729. Horvath E, Mink J, Kristof J. Surface-enhanced Raman spectroscopy as a technique for drug analysis. Mikrochim Acta Suppl 1997;14 (Progress in Fourier Transform Spectroscopy):745.

730. 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.

731. Delaney P, Selavka CM. All charged up: Review and forensic applications of ion chromatography. Proceedings of the American Academy of Forensic Sciences 1997;3:10

732. 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.

733. Hueske EE, Weaver TW. The application of videomicroscopy to the analysis of controlled substances. Microgram 1992;25:189.

734. Groombridge CJ. NMR spectroscopy in forensic science. Annual Reports on NMR Spectroscopy 1996;32:215.

735. Thunhorst M, Holzgrabe U. Utilizing NMR spectroscopy for assessing drug enantiomeric composition. Mag Res Chem 1998;36(3):211.

736. LeBelle MJ, Savard C, Dawson BA, Black DB, Katyal LK, Zrcek F, By AW. Chiral identification and determination of ephedrine, pseudoephedrine, methamphetamine, and methcathinone by gas chromatography and nuclear magnetic resonance. Forensic Sci Int 1995;71(3):215

737. Roberts JK, Smith RJ. Use of liquid chromatography - nuclear magnetic resonance spectroscopy for the identification of impurities in drug substances. J Chromatogr A 1994;677:385.

738. Phelan CP. Quantitation of illicit drugs in routine forensic analysis via NMR. Microgram 1999;32(11):312.

739. Schafer T, Schonberger T. Computer assisted analysis and comparison of synthetic drug substances containing tablets by nuclear magnetic resonance spectroscopy. Proceedings of the International Association of Forensic Sciences 15th Triennial Meeting 1999:66.

740. Tong A-J, Wu Y-G, Li L-D. Room temperature phosphorimetry studies of some addictive drugs following dansyl chloride labelling. Talanta 1996;43:1429.

741. de Kanel J, Korbar T. Robotics and the analysis of drugs of abuse. In: Adamovics, JA, Editor. Analysis of Addictive Misused Drugs. New York, 1995:267.

742. Pakulniewicz KJ, Town J. A robotic procedure for the capillary gas chromatographic quantitation of heroin. LC-GC 1995;13:116.

743. Ojanpera I, Nokua J, Vuori E, Sunila P, Sippola E. Combined dual-system R_F and UV library search software: Application to forensic drug analysis by TLC and RPTLC. J Planar Chromatogr - Mod TLC 1997;10(4):281.

744. Davidson AW. Computerized infrared search system. Microgram 1992;25:298.

745. Grogg-Sulser K, Helmlin H, Clerc J. Qualitative and quantitative determination of illicit heroin street samples by reversed-phase high-performance liquid chromatography: Method development by CARTAGO-S. J Chromatogr A 1995;692:121.

746. Bravenec VA. A post run macro for the evaluation of an HPLC column's performance and reproducibility. Microgram 1995;28:220.

747. Wrisley L. Use of computer simulations in the development of gradient and isocratic high-performance liquid chromatography methods for analysis of drug compounds and synthetic intermediates. J Chromatogr 1993;628:191.

748. Cole MD, Janhunan KA. An evaluation of supercitical fluid chromatography as an analytical technique for forensic science. Proceedings of the American Academy of Forensic Sciences 1999;5:55.

749. 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.

750. 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. Analusis 1999;27:772.

751. Jeger AN, Briellmann TA. Quantitative applications of TLC in forensic science. J Planar Chromatogr - Mod TLC 1994;7 157.

752. Spangenberg B, Ahrens B, Klein KF. TLC analysis in forensic sciences using a diode array detector. Chromatographia 2001;53(Part 2, Suppl S):S438.

753. Pothier J, Galand N, Viel C. Determination of some narcotic and toxic alkaloidal compounds by overpressured thin-layer chromatography with ethyl acetate as eluent. J Chromatogr 1993;634(2):356.

754. Tandon R. Separation of cocaine pramocaine, fentanyl, and diphenhydramine, some common drugs, by thin layer chromatography. Microgram 1992;25:168.

755. Kato N, Ogamo A. A TLC visualization reagent for dimethylamphetamine and other abused tertiary amines. Science and Justice 2001;41(4):239.

756. Kalasinsky KS, Levine B, Smith ML, Platoff Jr GE. Comparison of infrared and mass spectroscopies for drug analysis. Crit Rev Anal Chem 1993;23:441.

757. 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.

758. Frederick DL. Improved procedure for overcoming nitrite interferences in GC-MS procedures for cannabinoids. J Anal Toxicol 1998;22(3):255.

759. El Sohly MA, Feng S, Kopycki WJ, Murphy TP, Jones AB, Davis A, Carr D. A procedure to overcome interferences caused by the adulterant 'Klear' in the GC-MS analysis of 11-nor-Delta-(9)-THC-9-COOH. J Anal Toxicol 1997;21(3):240.

760. Neudorfl N, Hupé M, Pilon P, Lawrence AH. Determination of ecgonidine methyl ester vapor pressure using a dynamic gas blending system and gas chromatographic analysis. Anal Chem 1997;69(20):4283.

761. Casale JF. Methyl esters of ecgonine: Injection-port produced artifacts from cocaine base (crack) exhibits. J Forensic Sci 1992;37(5):1295.

762. Clark JD. Identification of a heroin/chloroform-impurity reaction product. Microgram 1994;27:385.

763. Fenton J, Mummert J, Childers M. Hydromorphone and hydrocodone interference in GC/MS assays for morphine and codeine. J Anal Toxicol 1994;18:159.

764. Poortman-van der Meer AJ. Artifacts in the GC analysis of amphetamine and MDA. Microgram 1996;29(4):91.

765. Clark CR, DeRuiter J, Noggle FT. GC-MS Identification of amine-solvent condensation products formed during analysis of drugs of abuse. J Chromatogr Sci 1992;30:399.

766. Clark CR, Noggle FT, DeRuiter J. Alcohol-amine condensation products formed during the GC-MS analysis of drugs of abuse. Microgram 1992;25:330.

767. Wu AHB, Wong SS, Johnson KG, Ballatore A, Seifert, Jr WE. The conversion of ephedrine to methamphetamine and methamphetamine-like compounds during and prior to gas chromatographic/mass spectrometric analysis of CB and HFB derivatives. Biol Mass Spectrom 1992;21(6):278.

768. Hornbeck CL, Carrig JE, Czarny RJ. Detection of a GC/MS artifact peak as methamphetamine. J Anal Toxicol 1993;17:257.

769. Chappell JS. Matrix effects in the infrared examination of methamphetamine salts. Forensic Sci Int 1995;75(1):1.

770. Chappell J. Some aspects to the infrared identification of methamphetamine and other amine salts. Proceedings of the American Academy of Forensic Sciences 1995;1:20.

771. ElSohly MA, Stanford DF, Sherman D, Shah H, Bernot D, Turner CE. A procedure for eliminating interferences from ephedrine and related compounds in the GC/MS analysis of amphetamine and methamphetamine. J Anal Toxicol 1992;16:109.

772. Verweij AMA, Poortman-van der Meer AJ. A note about an artifact in GC analysis of piperonal. Microgram 1992;25:160.

773. Bogusz MJ. Large amounts of drugs may considerably influence the peak areas of their coinjected deuterated analogues measured with APCI-LC-MS. J Anal Toxicol 1997;21 246.

774. Waggoner Jr RW. A simple procedure that allows software to determine if a GC/MS blank injection is contaminated. J Forensic Sci 1996;41(4):681.

775. 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.

776. Jungreis E. Spot test analysis: Clinical, environmental, forensic, and geochemical applications. 2nd Ed. Wiley-Interscience:1996

777. Thornton JI. Visual color comparisons in forensic science. Forensic Sci Rev 1997;9(1):37. (Note: This is an extensive review, including drug color tests.)

778. 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.

779. 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.

780. 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.

781. Anderson OC. Lithium spot test. J Clan Lab Invest Chem Assoc 2000;10(3):11.

782. United Nations International Drug Control Programme (Scientific Section). Monograph: Screening Colour Tests for the Detection of Psychostimulants Pemoline, Fenozolone, and Thozalinone - 1995. New York, NY:1995.

783. Schieferecke J. Red phosphorus analysis using a gas chromatograph/mass spectrometer. J Clan Lab Invest Chem Assoc 2000;10(3):12.

784. Schieferecke J. Red phosphorus analysis using a gas chromatograph/mass spectrometer. Microgram 2000;33(12):339.

785. Christian D. Ammonium molybdate crystal test for phosphorus. J Clan Lab Invest Chem Assoc 1997;7:28.

786. Frank RS, Hinkley SW, Hoffman CG. Representative sampling of drug seizures in multiple containers. J Forensic Sci 1991;36:350.

787. Coulson SA, Coxon A, Buckleton JS. How many samples from a drug seizure need to be analyzed? J Forensic Sci 2001;46(6):1456.

788. Aitken CGG. Sampling - how big a sample? J Forensic Sci 1999;44(4):750.

789. Aitken CGG. Statistics and the evaluation of evidence for forensic scientists. John Wiley and Sons, Inc., Chicheter, UK:1995.

790. Colon M, Rodriguez G, Orlando-Diaz R. Representative sampling of 'street' drug exhibits. J Forensic Sci 1993;38:641.

791. Curran JM, Triggs CM, Buckleton J. Sampling in forensic comparison problems. Science Justice 1998;38:101.

792. Tzidony D, Ravreby M. A statistical approach to drug sampling: A case study. J Forensic Sci 1992;37(6):1541.

793. Azoury M, Grader-Sageev D, Avraham S. Evaluation of a sampling procedure for heroin street doses. J Forensic Sci 1998;43(6):1203.

794. Chow ST, Lee TK, Saw CG, Soon TW, Ng TL. The homogenization of illicit heroin samples: An empirical and statistical approach. J Forensic Sci 1993;38(4):885.

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

796. Wilson WL. Report of the consultative meeting on chemical characterization/profiling of drug seizures - Vienna, 30 November - 2 December 1992. United Nations International Drug Control Programme, Technical Services Division, 1992.

797. 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.

798. Pikkarainen A-L. Systematic approach to the profiling analysis of illicit amphetamine. Forensic Sci Int 1996;82(2):141.

799. Karkkainen M, Sippola E, Pikkarainen A-L, Rautio T, Himberg K. Automated gas chromatographic amphetamine profiling. Forensic Sci Int 1994;69(1):55.

800. King LA, Clarke K, Orpet AJ. Amphetamine profiling in the UK. Forensic Sci Int 1994;69(1):65.

801. Noggle FT, Clark CR, DeRuiter J. GC-MS and liquid chromatographic analysis of amphetamine and amphetamine-type products formed in the reaction of arylpropenes with acetonitrile and sulfuric acid. Microgram 1995;28:12.

802. Krawczyk W, Parczewski A. Application of chemometric methods in searching for illicit Leuckart amphetamine sources. Analytica Chimica Acta 2001;446:107.

803. Kirkbride KP, Ward AD, Jenkins NF, Klass G, Coumbaros JC. Synthesis of 4-methyl-5-arylpyrimidines: Route specific markers for the Leuckardt preparation of amphetamine, 4-methoxyamphetamine, and 4-methylthioamphetamine. Forensic Sci Int 2001;115(1-2):53.

804. Jonson CSL, Artizzu N. Factors influencing the extraction of impurities from Leuckart amphetamine. Forensic Sci Int 1998;93(2-2):99.

805. Jonson CSL, Stromberg L. Two-level classification of Leuckart amphetamine. Forensic Sci Int 1994;69(1):31.

806. DeRuiter J, Clark CR, FT. Gas chromatographic and mass spectral analysis of amphetamine products synthesized from 1-phenyl-2-nitropropene. J Chromatogr Sci 1994;32:511.

807. Noggle FT, DeRuiter J, Clark CR. GC-MS analysis of products by-products and impurities in the synthesis of amphetamine from 1-phenyl-2-nitropropene. Microgram 1994;27:153.

808. Jonson CSL. Amphetamine profiling - Improvements in data processing. Forensic Sci Int 1994;69(1):45.

809. Forbes IJ, Kirkbride KP. The origin of alkenes in illicit amphetamine: An examination of the illicit synthesis of phenyl-2-propanone. J Forensic Sci 1992;37(5):1311.

810. Ballany J, Caddy B, Cole M, Finnon Y, Aalberg L, Janhunen K, Sippola E, Andersson K, Bertler C, Dahlen J, Kopp I, Dujourdy L, Lock E, Margot P, Huizer H, Poortman A, Kaa E, Lopes A. Development of a harmonised pan-European method for the profiling of amphetamines. Science Justice 2001;41(3):193.

811. Cole MD, Backstrom B, Carrott MC, Jones DC. Profiling of drug samples using supercritical fluid chromatography. Proceedings of the American Academy of Forensic Sciences 1996;2:27.

812. Moore JM, Casale JF. Cocaine profiling methodology - Recent advances. Forensic Sci Rev 1998;10(1):13.

813. Casale JF, Morello DR, Moore JM. Signature profiling of trace components in illicit cocaine samples for tactical and strategic law enforcement purposes. Proceedings, Harnessing Technology to Support the National Drug Control Strategy, August 18-21, 1997, Chicago, Illinois; pps. 1317 - 1323.

814. Moore JM, Casale JF, Fodor G, Jones AB. Detection and characterization of cocaine and related tropane alkaloids in coca leaf, cocaine, and biological specimens. Forensic Sci Rev 1995;7(2):77.

815. Casale JF, Morello DR, Moore JM. Signature profiling of trace components in illicit cocaine samples for tactical and strategic law enforcement purposes. Proceedings of the International Association of Forensic Sciences 15th Triennial Meeting 1999:60.

816. Moore JM, Casale JF. In-depth chromatographic analyses of illicit cocaine and its precursor *Coca* leaves. J Chromatogr A 1994;674(1-2):165.

817. Moore JM, Casale JF, Klein RFX, Cooper DA, Lydon J. Determination and in-depth chromatographic analyses of alkaloids in South American and greenhouse-cultivated *Coca* leaves. J Chromatogr 1994;659(1):163.

818. Dang VB, Levillain P, Galliot M, Fabiani P, Lich NP. Analysis of cocaine in drug seizures. Ann Falsif Expert Chim Toxicol 1992;85:149.

819. Casale JF, Moore JM, Odeneal NG. Comparative determination of 2-carbomethoxy-3-alkyloxy- and heteroaroyloxy-substituted tropanes in illicit South American cocaine using capillary gas chromatography - single ion monitoring. J Forensic Sci 1998;43(l):125.

820. Casale JF, Moore JM. Lesser alkaloids of cocaine-bearing plants. Part III: 2-Carbomethoxy-3-oxo substituted tropane esters: Detection and gas chromatographic-mass spectrometric characterization of new minor alkaloids found in South American *Erythroxylum Coca* Var *Coca*. J Chromatogr A 1996;756(1-2):185.

821. Casale JF, Moore JM. Lesser alkaloids of cocaine-bearing plants. Part II: 3-Oxo-substituted tropane esters: Detection and mass spectral characterization of minor alkaloids found in South American *Erythroxylum Coca* Var *Coca*. J Chromatogr A 1996;749(1-2):173.

822. Casale JF, Moore JM, Cooper DA. Novel chlorinated tropanes derived from the treatment of cocaine with sodium hypochlorite. J Forensic Sci 1995;40:816.

823. Carpenter A, Laing RR. Cocaine in bleach: Destroying the evidence (Identification of degradation products). Microgram 1994;27:249.

824. Glass RL, Johnson MB. Analysis of cuscohygrine in *Coca* leaves by high performance liquid chromatography. J Liq Chromatogr & Rel Tech 1996;19(11):1777.

825. Moore JM, Casale JF. Lesser alkaloids of cocaine-bearing plants. Part I: Nicotinoyl-, 2'-pyrroloyl, and 2'- and 3'-furanoylecgonine methyl ester - Isolation and mass spectral characterization of four new alkaloids of South American *Erythroxylum Coca* Var *Coca*. J Forensic Sci 1997;42(2):246.

826. Moore JM, Hays PA, Cooper DA, Casale JF, Lydon J. 1-Hydroxytropacocaine: An abundant new alkaloid of greenhouse cultivated *Erythroxylum Novogranatense* Var *Novogranatense*. Phytochem 1994;36:357.

827. Moore JM, Casale JF, Hays PA, Klein RFX, Cooper DA. Hygrine, bona fide alkaloid or artifact: Its chemical reduction novel di-heptafluorobutyrylation and sensitive detection in South American coca leaves using capillary gas chromatography-electron capture detection. J Chromatogr A 1995;704:483.

828. Glass RL. Analysis of hygrine and cuscohygrine in *Coca* leaves using gas chromatography and high-performance liquid chromatography. J Agric and Food Chem 1997;45(8):3114.

829. Kumar A, Kiser WO. Identification and quantitation of norcocaine in illicit cocaine samples. J Forensic Sci 1995;40:464.

830. 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.

831. Casale JF, Moore JM. An in-depth analysis of pharmaceutical cocaine: Cocaethylene and other impurities. J Pharm Sci 1994;83:1186.

832. Casale JF, Moore JM. Detection and determination of pseudococaine in *Coca* leaves and illicit cocaine samples. J Forensic Sci 1994;39:1537.

833. 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.

834. Casale JF, Moore JM. 3',4',5'-Trimethoxy-substituted analogs of cocaine, *cis/trans*-cinnamoylcocaine and tropacocaine: Characterization and quantitation of new alkaloids in coca leaf, coca paste, and refined illicit cocaine. J Forensic Sci 1994;39(2):462.

835. Moore JM, Casale JF, Cooper DA. Comparative determination of total isomeric truxillines in illicit refined South American cocaine hydrochloride using capillary gas chromatography electron capture detection. J Chromatogr A 1996;756(1-2):193.

836. Lurie IS, Hays PA, Casale JF, Moore JM, Castell DM, Chan KC, Issaq HJ. Capillary electrophoresis analysis of isomeric truxillines and other high molecular weight impurities in illicit cocaine. Electrophoresis 1998;19(1):51.

837. Cortis G, Chessa C. The X-Ray Diffractometry, a method for cocaine samples classification. Proceedings of the International Association of Forensic Sciences 14th Triennial Meeting 1996;2:365.

838. Violante N, Quaglia MG, Lopez A, Caroli S. Characterization of cocaine and heroin samples as a function of their trace element content: An analytical pilot study. J Microchem 1992;45:79.

839. Bermejo-Barrera P, Moreda-Piñeiro A, Moreda-Piñeiro J, Bermejo-Barrera A. Application of rapid electrothermal atomic absorption spectrometric methods to the determination of Ag, Al, Cd and Mn in cocaine and heroin samples. Fresenius J Anal Chem 1997;358(7-8):844.

840. Bermejo-Barrera P, Moreda-Piñeiro A, Moreda-Piñeiro J, Bermejo-Barrera A. Direct determination of nickel in heroin and cocaine by electrothermal atomic absorption spectrometry using deuterium arc background correction combined with chemical modification. J Anal At Spectrom 1995;10:1011.

841. Bermejo-Barrera P, Moreda-Pineiro A, Moreda-Pineiro J, Bermejo-Barrera A. Determination of traces of chromium in cocaine and heroin by flameless atomic absorption spectrometry. Talanta 1996;43(1):77.

842. Bermejo-Barrera P, Moreda-Pineiro A, Moreda-Pineiro J, Bermejo-Barrera A. Effectiveness of palladium as a chemical modifier for the direct silver and manganese determination in cocaine and heroin by electrothermal atomic absorption spectrometry. Talanta 1996;43:1783.

843. Bermejo-Barrera P, Moreda-Pineiro A, Moreda-Pineiro J, Bermejo-Barrera A. Copper determination in cocaine and heroin by electrothermal atomic absorption spectrometry using palladium - magnesium nitrate and nitric acid as chemical modifiers. Quim Anal 1995;14:201.

844. Bermejo-Barrera P, Moreda-Pineiro A, Moreda-Pineiro J, Bermejo-Barrera A. Determination of traces of cadmium in cocaine and heroin by electrothermal atomic absorption spectrometry. Quim Anal 1997;16:35.

845. Bermejo-Barrera P, Moreda-Piñeiro A, Moreda-Piñeiro J, Bermejo-Barrera A. Determination of lead in illicit drugs by electrothermal atomic absorption spectrometry using palladium as chemical modifier. Anal Chim Acta 1995;310:355.

846. Bermejo-Barrera P, Moreda-Piñeiro A, Moreda-Piñeiro J, Bermejo-Barrera A. Determination of aluminum and strontium in illicit drugs by electrothermal atomic absorption spectrometry. Analusis 1996;24:263.

847. Stanley EA. Application of palynology to establish the provenance and travel history of illicit drugs. Microscope 1992;40:149.

848. Cole MD. Occluded solvent analysis as a basis for heroin and cocaine sample differentiation. Forensic Sci Rev 1998;10(2):113.

849. Crowe JB, Platek SF, Ranieri N, Heitkemper DT, Wolnik KA. Microscopic examination of ephedrine HCl; identifying sources of manufacturers. Proceedings of the American Academy of Forensic Sciences 1996;2:16.

850. Noggle FT, Andurkar SV, Clark CR, DeRuiter J. GC-MS analysis of fentanyl synthesized from 1-phenethyl-4-piperidone. Microgram 1993;26:285.

851. Cooper DA. The chemistry of heroin signature. Proceedings of the International Association of Forensic Sciences 15th Triennial Meeting 1999:61.

852. Esseiva P, Guéniat O. The concept of drug intelligence in heroin investigation: The problem of the evaluation of "profiling evidence." The proposal of a sequence of analysis and a scheme of interpretation for court purposes. Presentation - 1st European Meeting of Forensic Science; Lausanne, Switzerland; 1997.

853. Lurie IS, Chan KC, Spratley TK, Casale JF, Issaq HJ. Separation and detection of acid/neutral impurities in illicit heroin via capillary electrophoresis. J Chromatogr B, Biomed Applic 1995;669:3.

854. Lurie IS, Odeneal NG. The analysis of cations and anions in illicit heroin using capillary electrophoresis with indirect UV detection. Part II: Application to process determination. Proceedings of the American Academy of Forensic Sciences 1998;4:33.

855. Lurie IS. The analysis of cations and anions in illicit heroin using capillary electrophoresis with indirect UV detection. J Capillary Electrophor 1996;3:237.

856. Naess O, Rasmussen KE. Micellar electrokinetic chromatography of charged and neutral drugs in acidic running buffers containing a zwitterionic surfactant sulfonic acids or sodium dodecyl sulphate - Separation of heroin basic by-products and adulterants. J Chromatogr A 1997;760(2):245.

857. 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.

858. 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.

859. Neumann H. Vergleichende heroin analyse mit der capillar-GC: Bestimmung charakteristischer kenngressen. Toxichem Krimtech 1992;59:121.

860. Besacier F, Chaudron-Thozet H. Chemical profiling of illicit heroin samples. Forensic Sci Rev 1999;11(2):105.

861. Johnston A, King LA. Heroin profiling: Predicting the country of origin of seized heroin. Forensic Sci Int 1998;95(1):47.

862. Infante F, Dominguez E, Trujillo D, Luna A. Metal contamination in illicit samples of heroin. J Forensic Sci 1999;44(1):110.

863. Sibley JA. Formation of 0-6-acetylmorphine in the 'Homebake' preparation of heroin. Forensic Sci Int 1996;77(3):159.

864. Wells RJ, Skopec SV, Iavetz R, Robertson J. Trace element analysis of heroin by ICP-MS. Chemistry in Australia 1995;62(7):14.

865. Myors R, Wells RJ, Skopec SV, Iavetz R, Skopec Z, Crisp P, Ekangaki A, Robertson J. Preliminary investigation of heroin fingerprinting using trace element concentrations. Anal Commun 1998;35(12):403.

866. Myors RB, Crisp PT, Skopec SV, Wells RJ. Investigation of heroin profiling using trace organic impurities. Analyst 2001;126(5):679.

867. 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.

868. Rustichelli C, Ferioli V, Vezzalini F, Rossi MC, Ganberini G. Simultaneous separation and identification of hashish constituents by coupled liquid chromatography-mass spectrometry (HPLC-MS). Chromatographia 1996;43(3/4):129.

869. Hida M, Mitsui T, Minami Y, Fujimura Y. Classification of hashish by pyrolysis-gas chromatography. J Anal Appl Pyrolysis 1995;32:197.

870. Ross SA, Parker M, Arafat R, Lovett K, ElSohly MA. The analysis of confiscated marijuana samples for different cannabinoids using GC/FID. Amer Lab 1996;16;F.

871. 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.

872. Lehmann T, Brenneisen R. High performance liquid chromatographic profiling of *Cannabis* products. J Liq Chromatogr 1995;18:689.

873. Ross SA, ElSohly MA. Constituents of *Cannabis Sativa* L. XXVII, a review of the natural constituents: 1980 - 1994. Zagazig J Pharm Sci 1995;4(2):1.

874. Ross SA, ElSohly MA. Constituents of *Cannabis Sativa* L. XXVIII. A review of the natural constituents, 1980-1994. J Nat Prod 1996;59(1):49.

875. Gigliano GS, Caputo P, Cozzolino S. Ribosomal DNA analysis as a tool to identify specimens of *Cannabis Sativa* L. of forensic interest. Science Justice 1997;37:171.

876. Gigliano GS. Identification of *Cannabis Sativa* L. (Cannabaceae) using restriction profiles of the internal transcribed spacer II (ITS2). Science Justice 1998;38:225.

877. Gigliano GS, DiFinizio A. Approccio molecolare nelle indagini forensi su *Cannabis Sativa* L. Delpinosa ns 1994;36:15.

878. Gigliano GS. Restriction profiles of *trn*L (UAA) intron as a tool in *Cannabis Sativa* L. identification. Delpinosa ns 1995;37:85.

879. 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.

880. Gigliano GS. *trn*L (UAA) intron sequence: An ideal molecule for *Cannabis Sativa* L. identification in the forensic investigations. Delpinosa ns 1997;39:3.

881. 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.

882. Jagadish V, Robertson J, Gibbs A. RAPD analysis distinguishes *Cannabis Sativa* samples from different sources. Forensic Sci Int 1996;79(2):113.

883. Gigliano GS, DiFinizio A, Caputo P, Cozzolino S. *Cannabis* fingerprints by using random amplified polymorphic DNA (RAPD). Delpinosa ns 1995;37:35.

884. 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.

885. 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.

886. Inoue T. Discrimination of abused drug samples by impurity profiling analysis (chemical fingerprint). Jpn J Forensic Toxicol 1992;10:204.

887. Kobayashi K, Iwata Y, Kanamori T, Inoue H, Kishi T. Analysis of impurities in methamphetamine and impurity profiling. Reports of the National Research Institute of Police Science, Research on Forensic Science 1994;69:97.

888. Conn C, Dawson M, Baker A, Keegan J, Fryirs B. Identification of N-acetylmethamphetamine in a sample of illicitly synthesized methamphetamine. J Forensic Sci 1996;41(4):645.

889. 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.

890. 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.

891. Noggle FT, Clark CR, DeRuiter J. Characterization of methamphetamine and synthetic by-products in clandestine samples: A case report. Microgram 1994;27:253.

892. Marumo Y, Inoue T, Seta S. Analysis of inorganic impurities in seized methamphetamine samples. Forensic Sci Int 1994;69(1):89-95.

893. Noggle FT, Clark CR, DeRuiter J. Gas chromatographic and mass spectral analysis of methamphetamine synthesized from allylbenzene. J Chromatogr Sci 1995;33(4):153.

894. Noggle FT, Clark CR, DeRuiter J. GC-MS and LC of addition products formed from the reaction of allylbenzene and related arylpropenes with acetonitrile and sulfuric acid. J Chromatogr Sci 1995;33(5):256.

895. Noggle FT, Clark CR, DeRuiter J. Evaluation of allylbenzene as a precursor for the synthesis of methamphetamine. Microgram 1994;27:302.

896. Windahl KL, McTigue MJ, Pearson JR, Pratt SJ, Rowe JE, Sear EM. Investigation of the impurities found in methamphetamine synthesized from pseudoephedrine by reduction with

hydriodic acid and red phosphorus. Forensic Sci Int 1995;76(2):97.

897. Oulton SR, Skinner HF. Reaction byproducts of common cold tablet ingredients via hydriodic acid/red phosphorus. Microgram 1999;32(10):257.

898. 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.

899. DeFrancesco JV. Analysis of methamphetamine hydrochloride exhibits containing a hydrocarbon wax. Microgram 1999;32(12):357.

900. Melgoza L. Impurities in methamphetamine manufactured from over-the-counter pseudoephedrine tablet preparations. J Clan Lab Invest Chem Assoc 1999;9(2-3):21.

901. 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.

902. Perkal M, Ng YL, Pearson JR. Impurity profiling of methylamphetamine in Australia and the development of a national drug database. Forensic Sci Int 1994;69 77.

903. Tanaka K, Ohmori T, Inoue T, Seta S. Impurity profile analysis of illicit methamphetamine by capillary gas chromatography. J Forensic Sci 1994;39(2):500.

904. Tanaka K, Ohmori T, Inoue T, Seta S. Analysis of impurities in illicit methamphetamine. Forensic Sci Int 1992;56(2):157.

905. Inoue T, Tanaka K, Ohmori T, Togawa Y, Seta S. Impurity profiling analysis of methamphetamine seized in Japan. Forensic Sci Int 1994;69(1):97.

906. Yoo YC, Chung HS, Choi HK, Kim EM, Kim SC, Kim SW. Identification and profiles of impurities in illicit methamphetamine in Korea. Proceedings of the 35th TIAFT Meeting, Padova, 1997:183.

907. 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.

908. Dawson M, Armitage S, Roux C, Robertson J, Goulding J. An Australian approach to ecstasy profiling. Proceedings of the International Association of Forensic Sciences 15th Triennial Meeting 1999:61.

909. Rashed AM, Anderson RA, King LA. Solid-phase extraction for profiling of ecstasy tablets. J Forensic Sci 2000;45(2):413.

910. 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.

911. Renton RJ, Cowie JS, Oon MCH. A study of the precursors, intermediates, and reaction by-products in the synthesis of 3,4-methylenedioxymethylamphetamine and its application to forensic drug analysis. Forensic Sci Int 1993;60(1,2):189.

912. 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.

913. Verweij AMA. Impurities in illicit drug preparations: 3,4-(Methylenedioxy)amphetamine and 3,4-(methylenedioxy)methylamphetamine. Forensic Sci Rev 1992;4(2):137.

914. Bohn M, Bohn G. Weakly basic impurities in illegally manufactured 3,4-methylenedioxyamphetamine and 3,4-methylenedioxymethamphetamine. Proceedings of the International Association of Forensic Sciences 13th Triennial Meeting 1993;5:211.

915. Bohn M, Bohn G, Blaschke G. Synthesis markers in illegally manufactured 3,4-methylenedioxyamphetamine and 3,4-methylenedioxymethamphetamine. Int J Legal Med 1993;106:19.

916. Vu D-TV. Logo and headspace comparison for source determination of ecstasy seizures. Microgram 2001;34(9):244.

917. Verweij AMA, Sprong AGA. A note about some impurities in commercially available piperonylmethylketone. Microgram 1993;26:209.

918. Laing RR, Dawson B. Identification of the major product from the Ritter reaction using safrole. J Clan Lab Invest Chem Assoc 1997;7(2):22.

919. Clark CR, DeRuiter J, Andurkar S, Noggle FT. Analysis of 3,4-methylenedioxyphenyl-2-propanone and 3,4-methylenedioxyamphetamine prepared from isosafrole. J Chromatogr Sci 1994;32:393.

920. Clark CR, Noggle FT. GC-MS Analysis of products intermediates and by-products in the synthesis of MDA from isosafrole. Microgram 1994;27:188.

921. Verweij AMA. Verunreinigungen, die bei der herstellung von 3,4-methylendioxyamphetamin (MDA) durch kondensation von nitroethan und piperonal aufgefunden waren. Arch Kriminol 1992;190:24.

922. Rogers JC, Winkler LS, Borgerding MF. Chromatographic profiling as a tool in the comparison and evaluation of complex mixtures. J Chromatogr Sci 1997;35(5):193.

923. Remberg B, Krenn L, Kopp B, Buchbauer G, Nikiforov A. Principal component analysis (PCA) of opium alkaloid contents for origin determination. Pharmazie 1994;49:766.

924. 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.

925. Gorog S, Babjak M, Balogh G, Brlik J, Csehi A, Dravecz F, Gazdag M, Horvath P, Lauko A, Varga K. Drug impurity profiling strategies. Talanta 1997;44:1517.

926. Flurer CL, Wolnik KA. Chemical profiling of pharmaceuticals by capillary electrophoresis in the determination of drug origin. J Chromatogr A 1994;674:153.

927. Goosens EC, Stegman KH, Dejong D, Dejong GJ, Brinkman UAT. Investigation of on-line reversed-phase liquid chromatography gas chromatography mass spectrometry as a tool for the identification of impurities in drug substances. Analyst 1996;121(1):61.

928. Berridge JC. Impurities in drug substances and drug products: New approaches to quantification and qualification. J Pharm Biomed Anal 1995;14(1-2):7.

929. Allen AC, Stevenson ML, Nakamura SM, Ely, RA. Differentiation of illicit phenyl-2-propanone synthesized from phenylacetic acid with acetic anhydride versus lead (II) acetate. J Forensic Sci 1992;37(1):301.

930. Verweij AMA. Impurities in illicit drug preparations (XXIV): Spectroscopic properties of some compounds present in essential oils used as starting compounds in the synthesis of designer drugs of the phenethylamine type. Microgram 1995;28:224.

931. Somsen GW, Gooijer C, Brinkman UAT, Velthorst NH, Visser T. Coupling of LC and FT-IR: Impurity profiling of testosterone undecanoate. Appl Spectrosc 1992;46:1514.

932. Ihle E, Schmidt HL. Multielement isotope analysis on drugs of abuse. Possibility for their origin assignment. Isot Environ Health Stud 1996;32:226.

933. Ihle E, Schmidt HL. Multi element and on line stable isotope analysis in illicit drug characterisation. 1st European Meeting of Forensic Science, Lausanne, Switzerland, 1997.

934. Brazier JL. Use of isotope ratios in forensic analysis. In: Ynon Jehuda, Editor. Forensic Applications of Mass Spectrometry. Boca Raton: CRC Press Inc. 1995:259.

935. Besacier F, Guilluy R, Brazier JL, Chaudron-Thozet H, Girard J, Lamotte A. Isotopic analysis of ^{13}C as a tool for comparison and origin assignment of seized heroin samples. J Forensic Sci 1997;42(3):429.

936. Dautraix S, Guilluy R, Chaudron-Thozet H, Brazier JL, Lamotte A. C-13 Isotopic analysis of an acetaminophen and diacetylmorphine mixture. J Chromatogr A 1996;756(1-2):203.

937. Ehleringer J, Lott M, Casale J, Ford V. Tracing the geographic origin of cocaine. Nature 2000;408:311.

938. Ehleringer JR, Cooper DA, Lott MJ, Cook CS. Geo-location of heroin and cocaine by stable isotope ratios. Forensic Sci Int 1999;106:27.

939. 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.

940. Besacier F, Chaudron-Thozet H, Lascaux F, Rousseau-Tsangaris M. Application du couplage chromatographie gazeuse-spectrométrie de masse istopique de l'azote à l'analyse d'échantillons de drogues. Analusis 1999;27:17.

941. Desage M, Guilluy R, Brazier JL, Chaudron H, Girard J, Cherpin H, J Jumeau J. Gas chromatography with mass spectrometry or isotope-ratio mass spectrometry in studying the geographical origin of heroin. Anal Chim Acta 1991;247:249.

942. Huizer H. A contribution to comparison. Forensic Sci Int 1994;69(1):17.

943. Perillo BA, Klein RFX, Franzosa ES. Recent advances by the US Drug Enforcement Administration in drug signature and comparative analysis. Forensic Sci Int 1994;69(1):1.

944. Jonson CSL, Stromberg L. Computer aided retrieval of common-batch members in Leuckart amphetamine profiling. J Forensic Sci 1993;38(6):1472.

945. Meyers RP, Moore JM, Casale JF, Lurie IS. The use of multiple methods for cocaine comparison analysis. Proceedings of the American Academy of Forensic Sciences 1995;1:21.

946. Janzen KE, Fernando AR, Walter L. A database for comparison of illicit cocaine samples. Forensic Sci Int 1994;69(1):23.

947. Moore JM, Cooper DA. The application of capillary gas chromatography - electron capture detection in the comparative analyses of illicit cocaine samples. J Forensic Sci 1993;38(6):1286.

948. Janzen KE, Walter L, Fernando AR. Comparison analysis of illicit cocaine samples. J Forensic Sci 1992;37(2):436.

949. Ausili PT. Crack, cracked? or broken? Proceedings of the American Academy of Forensic Sciences 1996;2:17.

950. Moore JM, Meyers RP, Jimenez MD. The anatomy of a cocaine comparison case: A prosecutorial and chemistry perspective. J Forensic Sci 1993;38(6):1305.

951. Ensing JG, Racamy C, de Zeeuw RA. A rapid gas chromatographic method for the fingerprinting of illicit cocaine samples. J Forensic Sci 1992;37(2):446.

952. Stein K, Kraatz A. Comparative study of illegal cocaine samples with high pressure liquid chromatography and photodiode array detection. Arch Kriminol 1996;197:16.

953. Casale JF, Watterson JW. A computerized neural network method for pattern recognition of cocaine signatures. J Forensic Sci 1993;38(2):292.

954. Ferioli V, Rustichelli C, Pavesi G, Gamberini G. Analytical characterization of hashish samples. Chromatographia 2000;52(1-2):39.

955. Besacier F, Chaudron-Thozet H, Rousseau-Tsangaris M, Girard J, Lamotte A. Comparative chemical analyses of drug samples: General approach and application to heroin. Forensic Sci Int 1997;85(2):113.

956. Neumann H. Comparison of heroin by capillary gas chromatography in Germany. Forensic Sci Int 1994;69(1):7.

957. Klemenc S. In common batch searching of illicit heroin samples - evaluation of data by chemometrics methods. Forensic Sci Int 2001;115(1-2):43.

958. Janhunen K, Cole MD. Development of a predictive model for batch membership of street samples of heroin. Forensic Sci Int 1999;102:1.

959. 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.

960. Stromberg L, Lundberg L, Neumann H, Bobon B, Huizer H, van der Stelt NW. Heroin impurity profiling: A harmonization study for retrospective comparisons. Statens Kriminaltekniska Laboratorium (Sweden), Bundeskriminalamt (Germany), Gerechtelijk Laboratorium (The Netherlands) December l997.

961. Stromberg L. The retrospective retrieval of common-batch links in gas chromatographic profiling of southwest Asian street heroin. 1st European Meeting of Forensic Science, Lausanne, Switzerland, 1997.

962. Gillan R, Cole MD, Linacre A, Thorpe JW, Watson ND. Comparison of *Cannabis Sativa* by random amplification of polymorphic DNA (RAPD):and HPLC of cannabinoids: A preliminary

study. Science Justice 1995;35(3):169.

963. Van Zyl EF, Louw M. The differentiation of illicit methaqualone tablet formulations using principal component and soft independant modeling of class analogy analysis of their near-infrared reflectance spectra. J Forensic Sci 1995;40(6):1072.

964. Mas F, Beemsterboer B, Veltkamp AC, Verweij AMA. Determination of 'common batch' members in a set of confiscated 3,4-(methylenedioxy)methylamphetamine samples by measuring the natural isotope abundances: A preliminary study. Forensic Sci Int 1995;71(3):225.

965. 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.

966. Welsh WJ, Lin W, Tersigni SH, Collantes E, Duta R, Carey MS, Zielinski WL, Brower J, Spencer JA, Layloff TP. Pharmaceutical fingerprinting: Evaluation of neural networks and chemometric techniques for distinguishing among same-product manufacturers. Anal Chem 1996;68(19):3473.

967. 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) [Supercedes previous editions dated 1997, 1995, 1990, and 1988].

968. EUROPOL: Working-group precursors and synthetic drugs logo project synthetic drugs catalogue 1997 edition. EUROPOL Drugs Unit The Hague 1997; File No 2521-15r2.

969. Hays PA. Authentication procedures for reference drug standards. Microgram 1994;27:14.

970. Hays PA. Authentication of reference drug standards in the forensic laboratory. Proceedings of the American Academy of Forensic Sciences 1995;1:22.

971. 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.

972. Chang WT, Liu RH. Mechanistic studies on the use of H-2- and C-13- analogues as internal standards in selected ion monitoring GC-MS quantitative determination - Butalbital example. J Anal Toxicol 2001;25(8):659.

973. Harrington PE, Stergiades IA, Erickson J, Makriyannis A, Tius MA. Synthesis of functionalized cannabinoids. J Org Chem 2000;65(20):6576.

974. Kachensky DF. Preparation of racemic (-) and (+)-11-nor-delta(9)-tetrahydrocannabinol-9-carboxylic Acid. J Org Chem 1997;62(20):7065.

975. Lee JC, Lee K, Cha JK. Enantioselective synthesis of unnatural (S)-(+)-cocaine. J Organic Chem 2000;65(15):4773.

976. 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.

977. Teerhuis NM, Hiemstra H, Speckamp WN. Synthesis of enantiopure aza-analogues of cocaine. Tetrahedron Letters 1997;38(1):159.

978. 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.

979. Paul BD, Dreka C, Summers JL, Smith ML. One-step esterification of benzoylecgonine with dimethylformamide-dipropylacetal or dimethylformamide-disopropylacetal in the presence of pyridine. J Anal Toxicol 1996;20(6):506.

980. Kozikowski AP, Simoni D, Manfredini S, Roberti M, Stoelwinder J. Synthesis of the 6- and 7-hydroxylated cocaines and pseudococaines. Tetrahedron Letters 1996;37(30):5333.

981. Deng SM, Huang DW, Landry DW. Synthesis of C-3 alkyl analogs of cocaine. Tetrahedron Lett 2001;42(36):6259.

982. Neville GA, Beckstead HD, Black DB, Dawson BA, Ethier JC. USP Lysergic acid diethylamide tartrate (Lot 1): Authentic substance recharacterized for authentication of a house supply of lysergide (LSD) tartrate. Can J Appl Spectrosc 1992;37:149.

983. Li ZY, GocSzkutnicka K, McNally AJ, Pilcher I, Polakowski S, Vitone S, Wu RS, Salamone SJ. New synthesis and characterization of (+)-lysergic acid diethylamide (LSD): Derivatives and the development of a microparticle-based immunoassay for the detection of LSD and its metabolites. Bioconjugate Chemistry 1997;8(6):896.

984. Kozma D, Fogassy E. Solvent-free optical resolution of N-methylamphetamine by distillation after partial diastereoisomeric salt formation. Chirality 2001;13(8):428.

985. Rager K, Williams G, Traughber M, Melgoza L. "Ice" recrystallized from street methamphetamine samples. J Clan Lab Invest Chem Assoc 2000;10(2):13.

986. Cozzi NV, Ruoho AE. Radiosynthesis of [H-3]methcathinone, an inhibitor of nonamine reuptake transporters. J Labelled Compounds and Radiopharmaceuticals 1998;41(10):927.

987. Brunner H. Narcotic drug methohexital: Synthesis by enantioselective catalysis. Chirality 2001;13(8):420.

988. Mulzer J, Trauner D. Practical synthesis of (-)-morphine. Chirality 1999;11(5-6):475.

989. White JD, Hrnciar P, Stappenbeck F. Asymmetric synthesis of (+)-morphine; the phenanthrene route revisited. J Org Chem 1997;62(16):5250.

990. Shimamine M, Takahashi K, Nakahara Y. Identification of psychotropic substances. IX. Preparation and various analytical data of reference standards of new psychotropic substances: N-ethylmethylenedioxyamphetamine, N-hydroxymethylenedioxyamphetamine, mecloqualone, 4-methylaminorex, phendimetrazine, and phenmetrazine. Eisei Shikensho Hokoku 1993;111:66.

991. Cham KB. The identification, purification, and authentication of some reference drug standards. Microgram 2001;34(8):214.

992. Fiddian SE. The establishment of a research and reference garden for hallucinogenic and narcotic plants. Proceedings of the International Association of Forensic Sciences 13th Triennial Meeting 1993;5:242.

993. Reddy GV, Rao GV, Sreevani V, Iyengar DS. An enantioselective synthesis of (1S,2S)-pseudoephedrine. Tetrahedron Letters 2000;41(6):953.

994. 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.

995. United Nations International Drug Control Programme. Monograph: Clandestine Manufacture of Substances under International Control - Revised in 1998. New York, NY:1998.

996. Bakouri E, Van Rijn A. Dismantling of clandestine laboratory in Greece. Science Justice 2001;41(3):213.

997. Guiney LB. Synthesis of amphetamine via isopropyl nitrite. Microgram 1992;25 295.

998. Cody JT. Enantiomeric composition of amphetamine and methamphetamine derived from the precursor compound famprofazone. Forensic Sci Int 1996;80(3):189.

999. Angelos SA, Raney JK. An unsuccessful clandestine synthesis of amphetamine. Proceedings of the International Association of Forensic Sciences 14th Triennial Meeting 1996;2:310.

1000. Massetti J. Amphetamine in suspected methamphetamine samples. J Clan Lab Invest Chem Assoc 1995;5(4):9.

1001. McKibben T. Analyses of inorganic components found in clandestine drug laboratory evidence. J Clan Lab Invest Chem Assoc 1995;5(4):19.

1002. Culshaw PN. Arsenic oxide: A potential reagent in methylamphetamine synthesis? J Clan Lab Invest Chem Assoc 2001;11(2):13.

1003. Clandestine Laboratory Investigating Chemists Association. Monograph: A Review of the Birch Reduction Method. Fresno, CA:1998.

1004. Angelos SA, Raney JK. Methamphetamine by the Birch reduction. Proceedings of the International Association of Forensic Sciences 15th Triennial Meeting 1999:61.

1005. Casale JF. Illicit production of cocaine. Proceedings of the American Academy of Forensic Sciences Annual Meeting 1997;3:2a.

1006. Casale JF, Klein, RFX. Illicit production of cocaine. Forensic Sci Rev 1993;5(2):95.

1007. Reader B. Concealment and trafficking of illicit drugs. Science and Justice: 1995 Annual General Meeting of the Forensic Science Society (summary). 1996;36(2):123.

1008. 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.

1009. Andrews KM. Ephedra's role as a precursor in the clandestine manufacture of methamphetamine. J Forensic Sci 1995;40:551.

1010. Hutchinson K, Andrews KM. The use and availability of *Ephedra* products in the United States. Microgram 1995;28:256.

1011. 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.

1012. Willers-Russo LJ. Possible new pseudoephedrine source discovered. J Clan Lab Invest Chem Assoc 2000;10(2):14.

1013. Sorokin VI. Illegal synthesis of etonitazene. J Clan Lab Invest Chem Assoc 1999;9(2-3):20.

1014. Angelos SA, Raney JK. Clandestine manufacture of fentanyl. Proceedings of the International Association of Forensic Sciences 14th Triennial Meeting 1996;2:312.

1015. Oulton S. Dichlorofluoroethane in the clandestine manufacture of methamphetamine. Microgram 1996;29(10):261.

1016. Oulton S. Dichlorofluoroethane in the clandestine manufacture of methamphetamine. J Clan Lab Invest Chem Assoc 1996;6(4):16.

1017. Massetti J, Kalchik M. Freon solvent mixtures at clandestine methamphetamine laboratories. Proceedings of the American Academy of Forensic Sciences 1998;4:36.

1018. Hugel J, Pearson M. Marihuana extraction using a modified iso-2 apparatus. J Clan Lab Invest Chem Assoc 2000;10(1):27.

1019. Nolan SL, Bedford KR, Valentine MD. Making a hash of it. Proceedings of the International Association of Forensic Sciences 13th Triennial Meeting 1993;5:246.

1020. Sorokin VI, Orlova OS. The method of acetylated opium manufacturing. J Clan Lab Invest Chem Assoc 1996;6(1):14.

1021. Cooper DA. From the opium poppy field to heroin. Proceedings of the American Academy of Forensic Sciences 1999;5:3.

1022. Henderson BA, Comparin JH. Clandestine manufacture of hydriodic acid via iodine, red phosphorus, and hydrochloric acid. Microgram 1994;27:382.

1023. Skinner HF, Oulton SR. Identification and quantitation of hydriodic acid manufactured from iodine, red phosphorus, and water. J Clan Lab Invest Chem Assoc 1995;5(4):12.

1024. Skinner HF, Oulton SR. Identification and quantitation of hydriodic acid manufactured from iodine, red phosphorus, and water. Microgram 1995;29(11):349.

1025. Massetti J. Hypophosphorous acid use increases at California clandestine methamphetamine labs. J Clan Lab Invest Chem Assoc 1997;7(3):6.

1026. Oulton SR, Skinner HF. Identification of common inorganic acids encountered at clandestine laboratories. Microgram 1998;31(10):277.

1027. Oulton SR, Skinner HF. Identification of common inorganic acids encountered at clandestine laboratories. J Clan Lab Invest Chem Assoc 1998;8(4):17.

1028. Worley D, Schieferecke J, Baer J. GC/MS identification of iodine - Part one. Microgram 2001;34(5):110.

1029. Schieferecke J. GC/MS identification of iodine - Part two. Microgram 2001;34(5):112.

1030. Shanks KS. Clandestine extraction of lysergic acid amide (LSA) from morning glory seeds. J Clan Lab Invest Chem Assoc 2001;11(2):15.

1031. Hugel J. The planned manufacture of LSD from the fungus *Claviceps Paspali*. J Clan Lab Invest Chem Assoc 1998;8(1):27.

1032. Cain P, Yip S. Notification of a new presentation of *Cannabis* seized in the United Kingdom. Microgram 1997;30(10):2.

1033. Huizer H. Netherweed, hemp cultivation in the Netherlands. Proceedings of the International Association of Forensic Sciences 13th Triennial Meeting 1993;5:250.

1034. Angelos SA, Raney JK. Clandestine manufacture of methadone. Proceedings of the International Association of Forensic Sciences 14th Triennial Meeting 1996;2:374.

1035. Ely RA. Methamphetamine labs, syntheses and safety: A 1-year retrospect. Proceedings of the International Association of Forensic Sciences 15th Triennial Meeting 1999:56.

1036. Fifka P. Pervitin (methamphetamine) production in Slovak Republic. J Clan Lab Invest Chem Assoc 1996;6(2):13.

1037. Popovich GL. Instant methamphetamine. J Clan Lab Invest Chem Assoc 1995;5(3):7.

1038. Popovich GL. A new reducing agent for ephedrine. Microgram 1995;28:79.

1039. Skinner HF. Methamphetamine synthesis via reductive alkylation hydrogenolysis of phenyl-2-propanone with N-benzylmethylamine. Forensic Sci Int 1993;60(1,2):155.

1040. Angelos SA, Raney JK. Lithium-ammonia reduction of pseudoephedrine to methamphetamine. Proceedings of the American Academy of Forensic Sciences 1998;4:35.

1041. Angelos SA, Raney JK. Sodium-ammonia reduction of ephedrine to methamphetamine. Proceedings of the American Academy of Forensic Sciences 1996;2:28.

1042. DeFrancesco JV, James KA, Kleekamp VA. The effect of reaction conditions on ring reduction in the clandestine laboratory Birch reduction of d-pseudoephedrine HCl to d-methamphetamine. Proceedings of the International Association of Forensic Sciences 15th Triennial Meeting 1999:63.

1043. Dal Cason TA. Perspectives on 'Nazi Dope' and the mythical 'Nazi Patent'. J Clan Lab Invest Chem Assoc 1997;7(2):13.

1044. Dawson N. The sodium-ammonia 'Nazi' method of methamphetamine synthesis: An historical overview, methodology, and case reviews. J Clan Lab Invest Chem Assoc 1995;5(3):12.

1045. Chen L, Wu SM. A study of clandestine synthesizing methods of illicit methamphet-amine in Taiwan - The 2nd report. Proceedings of the American Academy of Forensic Sciences 1995;1:23.

1046. van Zyl EF. A survey of reported synthesis of methaqualone and some positional and structural isomers. Forensic Sci Int 2001;122(2-3):142.

1047. Sorokin VI, Drozdov MA. Synthesis of aminopropiophenon in Russia. J Clan Lab Invest Chem Assoc 2000;10(1):16.

1048. Poortman A. Unusual manufacturing of MDMA in the Netherlands. J Clan Lab Invest Chem Assoc 1998;8(1):25.

1049. Pearson JR, Rowe JE. Explorations with ecstacy and amphetamine derivatives. J Clan Lab Invest Chem Assoc 1998;8(1):29.

1050. Conn C, Smith M, Dawson M. A study of the O-dealkylation reaction of codeine using pyridinium hydrochloride. Proceedings of the International Association of Forensic Sciences 15th Triennial Meeting 1999:62.

1051. Novakova E. Illicit drugs manufactured in Czech Republic. Analytical experiences. Proceedings of the International Association of Forensic Sciences 13th Triennial Meeting 1993;5:252.

1052. Haerer M, Kovar K. Designer-drugs of the phencyclidine series. Pharmazie in Unserer Zeit 1994;23(1):52.

1053. Allen AC, Robles J, Dovenski W, Calderon S. PCP: A review of synthetic methods for forensic clandestine investigation. Forensic Sci Int 1993;61(2,3):85.

1054. Lodge BA, Duhaime R, Zamecnik J, MacMurray P, Brousseau R. New street analogs of phencyclidine. Forensic Sci Int 1992;55(1):13.

1055. 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.

1056. Hanel HF. Substitute bases for sodium acetate in the clandestine synthesis of phenyl-2-propanone (P2P). Microgram 1992;25:236.

1057. Stein D. Use of heliotrope oil as a precursor source for piperonal. J Clan Lab Invest Chem Assoc 1996;6(3):17.

1058. Maloney BJ. Case study: Clandestine laboratory; Kansas City, Missouri. J Clan Lab Invest Chem Assoc 1999;9(1):13.

1059. Clacher F, Clark K. Illicit steroid laboratories. Science and Justice: 1995 Annual General Meeting of the Forensic Science Society (summary). 1996;36(2):123.

1060. Cutler R. White phosphorus replacing red phosphorus in Idaho. J Clan Lab Invest Chem Assoc 1998;8(1):3.

1061. Mitchell WJ, Pearson JR, White MJ. Clandestine manufacture of tetrahydrocannabinol precursors. J Clan Lab Invest Chem Assoc 1999;9(2-3):29.

1062. Valentine MD. *delta*-9-Tetrahydrocannabinol acetate from acetylation of *Cannabis* oil. Science Justice 1996;36(3):195.

1063. King LA, Clarke K, Scott RJ. Unusual defense to charge of MDMA manufacture. J Clan Lab Invest Chem Assoc 1995;5(3):6.

1064. Moriwaki W. An unusual "designer drug" laboratory. Proceedings of the American Academy of Forensic Sciences 1995;1:22.

1065. Lazarus B. Clandestine laboratory contaminated properties: Assessment and remediation strategies. J Clan Lab Invest Chem Assoc 2000;10(2):21.

1066. Angelos SA, Bono JP. Production capabilities of clandestine methamphetamine laboratories. Proceedings of the American Academy of Forensic Sciences. 1999;5:43.

1067. Counts JW. When is a confined space not a confined space? J Clan Lab Invest Chem Assoc 1997;7(1):19.

1068. Johnson LF. Confined spaces as training grounds. J Clan Lab Invest Chem Assoc 1997;7(2):4.

1069. Von Ruden D. Using ventilation blowers in confined spaces. J Clan Lab Invest Chem Assoc 1997;7(2):3.

1070. Lazarus B. OSHA amendments to the permit-required confined space standard. J Clan Lab Invest Chem Assoc 1999;9(2-3):14.

1071. Heagy JA. Decontamination of biohazardous evidence by autoclaving. Microgram 1992;25:238.

1072. Le SD, Taylor RW, Vidal D, Lovas JJ, Ting E. Occupational exposure to cocaine involving crime lab personnel. J Forensic Sci 1992;37(4):959.

1073. Lomonte JN. Determination of volumes in laboratory vessels. J Forensic Sci 1992;37(5):1380.

1074. Irvine GD, Chin L. The environmental impact and adverse health effects of the clandestine manufacture of methamphetamine. Substance Use & Misuse 1997;32(12/13):1811.

1075. Kummerlowe D. Field tested methods to render safe 5-gallon pressurized tanks of ammonia gas associated with clandestine drug labs. J Clan Lab Invest Chem Assoc 1997;7(2):14.

1076. Kummerlowe D. Initial considerations for handling 5-gallon pressurized tanks of ammonia gas associated with clandestine drug labs. J Clan Lab Invest Chem Assoc 1996;6(4):23.

1077. Anjaria MB. 'Cook' fails Chem 101; hydrogen sulfide fatality. J Clan Lab Invest Chem Assoc 1997;7(3):5.

1078. Lazarus B. The new revised OSHA respiratory protection standard. J Clan Lab Invest Chem Assoc 1998;8(4):13.

1079. Conibear SA. What NIOSH's new respirator certification regulation means for you. J Clan Lab Invest Chem Assoc 1997;7(1):21.

1080. Burgess JL. Phosphine exposure from a methamphetamine laboratory investigation. Clin Toxicol 2001;39(2):165.

1081. Willers-Russo LJ. Three fatalities involving phosphine gas, produced as a result of methamphetamine manufacturing. J Forensic Sci 1999;44(3):647.

1082. Willers-Russo LJ. Three fatalities involving phosphine gas produced as a result of methamphetamine manufacturing. Proceedings of the American Academy of Forensic Sciences 1998;4:37.

1083. 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.

1084. White MJ. Safety training for clandestine laboratory investigators. Australian Criminal Intelligence Digest 1994:44.

1085. Boyd V. Dealing with heat stress; basic precautions can prevent workers in hot environments from becoming victims of serious heat-related illnesses. J Clan Lab Invest Chem Assoc

1996;6(4):18.

1086. Hammer C. 22-Liter heating mantle manufacturer noticed. J Clan Lab Invest Chem Assoc 2000;10(3):5.

1087. Lazarus B. OSHA training requirements for clandestine laboratory enforcement teams. J Clan Lab Invest Chem Assoc 2000;10(1):19.

1088. White MJ. Clandestine drug laboratories: Impact and outcomes of state and national training initiatives. J Clan Lab Invest Chem Assoc 2000;10(4):11.

1089. White GM. An explosive drug case. J Forensic Sci 1992;37(2):652.

1090. Khadka S. Useful internet websites for safety and health professionals. Microgram 1998;31(3):90.

1091. Drolet G. Contraband detection program. Proc SPIE - Int Soc Opt Eng 1997;2937:162.

1092. McCready J, Su CW, Rigdon SW. U.S. Coast Guard: Overview of operational narcotic detection program. Proc SPIE - Int Soc Opt Eng 1997;2937:150.

1093. Fetterolf DD, Donnelly B, Lasswell LD. Portable instrumentation: New weapons in the war against drugs and terrorism. Proc SPIE-Int Soc Opt Eng 1994;2092:40.

1094. Moriwaki WM. Overview of trace evidence collection techniques. Proceedings of the American Academy of Forensic Sciences 1998;4:38.

1095. Fetterolf DD, Donnelly BD, Lasswell LD. Portable Instrumentation: New weapons in the war on drugs. Proceedings of the International Association of Forensic Sciences 13th Triennial Meeting 1993;5:232.

1096. Spradling ML, Hyatt R. Performance assessment of small-package-class non-intrusive inspection systems. Proc SPIE - Int Soc Opt Eng 1997;2936:166.

1097. Ulvick SJ, Cui J, Kunz TD, Hoglund DE, Pilon P, Lawrence AH, Drolet G, Su CW, Rigdon SW, Demirgian JC, Shier P. NDTA narcotics standard development. Proc SPIE - Int Soc Opt Eng 1997;2932:47.

1098. Hoglund DE, Lucero DP. Performance assessment of heroin and cocaine vapor particle detection systems. Proc SPIE - Int Soc Opt Eng 1994;2092:96.

1099. Hall JM, Morgan JF, Sale KE. Numerical modeling of nonintrusive inspection systems. Proc SPIE - Int Soc Opt Eng 1994;2092:342.

1100. Hoopengardner RL, Smith MC. Operational analysis for the drug detection problem. Proc SPIE - Int Soc Opt Eng 1994;2276:13.

1101. Morris LA, Smith DE, Khan SM. Determination of high-risk cargo. Proc SPIE - Int Soc Opt Eng 1994;2276:6.

1102. Holt PJ, Gray S, Bruce NC, Lowe CR. An amperometric opiate assay. Biosensors & Bioelectronics 1995;10:517.

1103. Bower EM. Biologically based detection systems: The time has come for use in contraband detection. Proc SPIE - Int Soc Opt Eng 1997;2937:174.

1104. Shrivastava P, McLean CJ, Aberl F, Bonenberger J, Berg RP, Zimmermann R. Immunosensor-based drug detectors for Customs and other operations. Proc SPIE - Int Soc Opt Eng 1997;2937:183.

1105. Kusterbeck AW, Gauger PR, Charles PT. Portable flow immunosensor for detecting drugs and explosives. Proc SPIE - Int Soc Opt Eng 1997;2937:191.

1106. Hilpert R, Binder F, Grol M, Hallermayer K, Josel HP, Klein C, Maier J, Oberpriller H, Ritter J, Scheller FW. Biosensor technology for the detection of illegal drugs (I): Objectives, preparatory work, and drug enrichment. Proc SPIE-Int Soc Opt Eng 1994;2276:120.

1107. Hilpert R, Bauer C, Binder F, Grol M, Hallermayer K, Josel HP, Klein C, Maier J, Makower A, Oberpriller H, Ritter J. Biosensor technology for the detection of illegal drugs (II): Antibody development and detection techniques. Proc SPIE-Int Soc Opt Eng 1994;2276:128.

1108. Fetterolf DD. Antibody-based field test kits for drugs and explosives. Proceedings of the International Association of Forensic Sciences 13th Triennial Meeting 1993;5:296.

1109. Devine PJ, Anis NA, Wright J, Kim S, Eldefrawi AT, Eldefrawi ME. A fiber-optic cocaine biosensor. Anal Biochem 1995;227:216.

1110. Campanella L, Colapicchioni C, Tomassetti M, Bianco A, Dezzi S. A new ISFET device for cocaine analysis. Sens Actuators B 1995;B24(1-3):188.

1111. Rathbone DA, Holt PJ, Lowe CR, Bruce NC. The use of heroin esterase in the development of an illicit drugs biosensor. Ann NY Acad Sci 1996;799:85.

1112. Rathbone DA, Holt PJ, Bruce NC, Lowe CR. The use of recombinant DNA technology in the design of a highly specific heroin sensor. Ann NY Acad Sci 1995;782:534.

1113. Hoglund D. The reliance of calibration standards for narcotics detection devices. Proceedings, Contraband Trace Chemical Phenomenology Workshop 1992:295.

1114. Holland PM, Mustacich RV, Everson JF, Foreman W, Leone M, Sanders AH, Naumann WJ. Correlated column micro gas chromatography instrumentation for the detection of contraband drugs in cargo containers. Proc SPIE-Int Soc Opt Eng 1994;2276:79.

1115. Carnahan BL, Day S, Kouznetsov V, Tarassov A. Field ion spectrometry: A new technology for cocaine and heroin detection. Proc SPIE - Int Soc Opt Eng 1997;2937:106.

1116. Hussein EM, Gokhale P, Arendtsz NV, Lawrence AH. Inspection of cargo containers using gamma radiation. Proc SPIE - Int Soc Opt Eng 1997;2936:210.

1117. Trower WP, Saunders AW, Shvedunov VI. Carbon camera detection of vehicular-transported bulk narcotics. Proc SPIE - Int Soc Opt Eng 1997;2936:58.

1118. Kirby JA, Lindquist RP. Development of marijuana and tobacco detectors using potassium-40 gamma-ray emissions. Proc SPIE - Int Soc Opt Eng 1994;2276:374.

1119. Barshick SA, Griest WH, Vass AA. Electronic aroma detection technology for forensic and law enforcement applications. Proc SPIE - Int Soc Opt Eng 1997;2941:63.

1120. Chiappini MW, Wendel GJ, Duquette PH, Hamilton MJ, Chudzik SJ, Chappa RA. Fieldable, real-time enzyme immunoassay kits for drugs on surfaces. Proc SPIE - Int Soc Opt Eng 1994;2092:196.

1121. Kusterbeck AW, Judd LL, Yu H, Myles J, Ligler FS. Flow immunosensor detection of explosives and drugs of abuse. Proc SPIE - Int Soc Opt Eng 1994;2092:218.

1122. Leginus JM. Portable sensors for drug and explosive detection. Proc SPIE - Int Soc Opt Eng 1994;2092:360.

1123. Aberl F, Bonenberger J, Berg RP, Zimmermann R, Sachs HW. Traces of illegal drugs on body surfaces: Indicator for consumption or dealing? Proc SPIE - Int Soc Opt Eng 1997;2932:16.

1124. Homstead J, Poziomek EJ. Contraband drug surface chemistry at nanogram levels. Proc SPIE - Int Soc Opt Eng 1997;2937:245.

1125. Brown PA. Field applications of ion-mobility spectrometry. Proc SPIE - Int Soc Opt Eng 1997;2937:154.

1126. Kim LH, Danylewich-May LL, Jadamec JR, Su CW, Rigdon SW, Norwood LJ, Hoglund DE. Cargo contraband screening. Proc SPIE - Int Soc Opt Eng 1994;2276:279.

1127. Ritchie RK, Kuja FJ, Jackson RA, Loveless AJ, Danylewich-May LL. Recent developments in ion mobility spectrometry detection technology. Proc SPIE - Int Soc Opt Eng 1994;2092:76.

1128. Ritchie RK, Thomson PC, Debono RF, Danylewich-May LL, Kim L. Detection of explosives, narcotics, and taggant vapors by an ion mobility spectrometry particle detector. Proc SPIE - Int Soc Opt Eng 1994;2092:87.

1129. Harnois J, Kovar J, Pilon P. Detection of cocaine and heroin using a custom built ion mobility spectrometer. Customs Lab Bull 1992;4(1):11.

1130. Fytche LM, Hupé M, Kovar JB, Pilon P. Ion mobility spectrometry of drugs of abuse in Customs scenarios: Concentration and temperature study. J Forensic Sci 1992;37(6):1550.

1131. Maberry JM, Dedeaux H. Forensic light source and ion mobility spectrometry search for controlled substances. Proceedings of the International Association of Forensic Sciences 15th Triennial Meeting 1999:67.

1132. Brown PA, Comparin JH. Application of the ionscan for the detection of methamphetamine and ephedrine in abandoned clandestine laboratories. NASA Conf Publ (Third International Workshop on Ion Mobility Spectrometry 1994) 1995;3301:245.

1133. DeTulleo A. Methamphetamine versus nicotine detection on the Barringer ion mobility spectrometer. Conf Proc 5th Int Workshop on Ion Mobility Spectrometry, 1996.

1134. Goubran RA, Lawrence AH. DSP techniques for narcotic detection using ion mobility spectrometry. IEEE Instrum Meas Technol Conf 1997;1:404.

1135. Brown PA. Field applications of ion mobility spectrometry. Proc SPIE-Int Soc Opt Eng 1997;2937 (Chemistry-:and Biology-Based Technologies for Contraband Detection):154.

1136. Sobotka AJ. The role of ion mobility spectrometry in the collection of traces of controlled substances by certified Special Agents. Proceedings of the American Academy of Forensic Sciences 1998;4:34.

1137. Orzechowska GE, Poziomek EJ, Tersol V. Use of solid phase microextraction (SPME) with ion mobility spectrometry. Anal Lett 1997;30(7):1437.

1138. McGann WJ. New high-efficiency ion-trap mobility detection system for narcotics. Proc SPIE - Int Soc Opt Eng 1997;2937:78.

1139. McGann WJ, Bradley V, Borsody A, Lepine S. New, high efficiency ion trap mobility detection system for narcotics and explosives. Proc SPIE - Int Soc Opt Eng 1994;2276:424.

1140. McGann WJ, Jenkins A, Ribiero K, Napoli J. New high-efficiency ion trap mobility detection system for narcotics and explosives. Proc SPIE - Int Soc Opt Eng 1994;2092:64.

1141. Clemmer RG, Kelly JF, Martin SW, Mong GM, Sharpe SW. Laser-based detection of chemical contraband. Proc SPIE - Int Soc Opt Eng 1997;2937:46.

1142. 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.

1143. Brown DR, Gozani T. Thermal neutron analysis technology. Proc SPIE - Int Soc Opt Eng 1997;2936:85.

1144. Turner TO, Su CW, Kaplan CR, Rigdon SW. Portable narcotics detector and the results obtained in field tests. Proc SPIE - Int Soc Opt Eng 1997;2936:95.

1145. Gozani T. Neutron-based nonintrusive inspection techniques. Proc SPIE - Int Soc Opt Eng 1997;2867:174.

1146. Rhodes EA, Dickerman CE, Frey M. Advances in associated-particle neutron probe diagnostics for substance detection. Proc SPIE - Int Soc Opt Eng 1995;2511:2.

1147. Miller TG, Krauss RA. Substance identification using neutron transmission. Proc SPIE - Int Soc Opt Eng 1995;2511:14.

1148. Micklich BJ, Fink CL, Sagalovsky L. Transport simulation and image reconstruction for fast-neutron detection of explosives and narcotics. Proc SPIE - Int Soc Opt Eng 1995;2511:33.

1149. Miller TG. Drug and tobacco detection using neutron transmission/attenuation. Proc SPIE - Int Soc Opt Eng 1994;2276:200.

1150. Turner TO, Pierce RM, Dotson KC, Jadamec JR, Su CW. Portable narcotics detector with identification capability. Proc SPIE - Int Soc Opt Eng 1994;2276:255.

1151. Khan SM. Comparison of neutron-based technologies for the detection of contraband. Proc SPIE - Int Soc Opt Eng 1994;2092:548.

1152. Turner TO, Su CW, Baritelle J, Rhoton B. Three-dimensional container and cargo inspection system. Proc SPIE - Int Soc Opt Eng 1997;2936:48.

1153. Fink CL, Micklich BJ, Yule TJ, Humm P, Sagalovsky L, Martin MM. Evaluation of neutron techniques for illicit substance detection. Nucl Instrum Methods Phys Res Sect B 1995;99(1-4):748.

1154. Womble PC, Schultz FJ, Vourvopoulos G. Nondestructive characterization using pulsed fast-thermal neutrons. Nucl Instrum Methods Phys Res Sect B 1995;99(1-4):757.

1155. Brown DR, Gozani T, Loveman R, Bendahan J, Ryge P, Stevenson J, Liu F, Sivakumar M. Application of pulsed fast neutrons analysis to cargo inspection. Nucl Instrum Methods Phys Res Sect A 1994;353:684.

1156. Brown DR, Coates A, Kuo SN, Loveman R, Pentaleri E, Rynes JC. Cargo inspection system based on pulsed fast neutron analysis. Proc SPIE - Int Soc Opt Eng 1997;2936:76.

1157. Brown DR. Cargo inspection system based on pulsed fast neutron analysis. Proc SPIE - Int Soc Opt Eng 1994;2092:254.

1158. Rayner TJ, West R, Garroway AN, Lyndquist R, Yesinowski JP. Quadrupole resonance spectroscopic study of narcotic materials. Proc SPIE - Int Soc Opt Eng 1997;2937:35.

1159. Rayner TJ, Thorson BD, Beevor S, West R, Krauss RA. Explosives detection with quadrupole resonance analysis. Proc SPIE - Int Soc Opt Eng 1997;2936:22.

1160. Shaw JD, Moeller CR, Magnuson EE, Sheldon AG. Quadrupole resonance scanner for narcotics detection. Proc SPIE - Int Soc Opt Eng 1994;2276:150.

1161. Garroway AN, Buess ML, Yesinowski JP, Miller JB. Narcotics and explosives detection by 14N pure nuclear quadrupole resonance. Proc SPIE - Int Soc Opt Eng 1994;2092:318.

1162. Su CW, Rigdon SW, Ricard S, Hoglund DE, Drolet G, Neudorfl P, Hupe M, Kunz TD, Ulvick SJ, Demirgian JC, Shier P, Wingo J. Cocaine phenomenology study: Results of a third in a series of field trials. Proc SPIE - Int Soc Opt Eng 1997;2932:4.

1163. Jadamec JR, Su CW, Rigdon SW, Norwood LJ, Kaplan CR. Confidence in the detection of cocaine particulates. Proc SPIE - Int Soc Opt Eng 1994;2276:24.

1164. Davies JP, Hallowell SF, Hoglund DE. Particle generators for the calibration and testing of narcotic and explosive vapor/particle detection systems. Proc SPIE - Int Soc Opt Eng 1994;2092:137.

1165. Kuhlman MR, Gooding RE, Kogan VG, Bridges C. Particle size distribution of cocaine hydrochloride. Proc SPIE - Int Soc Opt Eng 1997;2937:251.

1166. Holt P-J. Particle size analysis of six illicit heroin preparations seized in the UK. Forensic Sci Int 1996;81(1):17.

1167. Patrick JC, Orzechowska, GE, Poziomek EJ. Use of methylene blue as a simulant for the physical properties of cocaine HCl and heroin HCl. Proc SPIE - Int Soc Opt Eng 1997;2937:258.

1168. Pilon P, Hupé M, Chauhan M, Lawrence A. Development of test material for narcotics detection equipment: Sand/drug mixtures. J Forensic Sci 1996;4(3):371.

1169. Komorsky-Lovri E, Gali I, Penovski R. Voltametric determination of cocaine microparticles. Electroanalysis 1999;11(2):120.

1170. Rayner TJ, Magnuson EE, West R, Lyndquist R. Narcotics detection using piezoelectric ringing. Proc SPIE - Int Soc Opt Eng 1997;2936:31.

1171. Matejczyk RJ. Clandestine laboratory scene investigation and processing using portable GC/MS. Proc SPIE - Int Soc Opt Eng 1997;2941:140.

1172. Matejczyk RJ, Dempsey P. Clandestine laboratory investigation using portable GC/MS. Proceedings of the American Academy of Forensic Sciences 1996;2:17.

1173. Smith WE, White PC, Lacey RJ. Surface enhanced resonance Raman scattering: A sensitive and selective technique for contraband detection. Proc SPIE - Int Soc Opt Eng 1997;2937:66.

1174. Lacey RJ, Hayward IP, Sands HS, Batchelder DN. Characterization and identification of contraband using UV-resonant Raman spectroscopy. Proc SPIE - Int Soc Opt Eng 1997;2937:100.

1175. Lacey RJ. Some advances in the use of Raman spectroscopy in security screening applications. IEE Conf Publ 1997;437:10.

1176. Whitley A, Barnett S. Advances and useful applications of Raman spectroscopy, imaging, and remote sensing. Proc SPIE-Int Soc Opt Eng 1998;3261:250.

1177. 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.

1178. Batchelder DN, Cheng C, Hayward IP, Lacey RJ, Pitt GD, Sheldon TG. Raman microscopy and direct 2-D imaging of explosives and drugs. Contraband and Cargo Inspection Technology International Symposium, Washington, DC:1992.

1179. Burnett LJ, Magnuson EE, Sheldon AG, Kumar S. Screening technologies for detection of swallowed packages of narcotics. Proc SPIE - Int Soc Opt Eng 1997;2932:98.

1180. Bogusz M, Althoff H, Erkens M, Maier R, Hofmann R. Internally concealed cocaine: Analytical and diagnostic aspects. J Forensic Sci 1995;40(5):811.

1181. Smith GJ. Detection of contraband concealed on the body using x-ray imaging. Proc SPIE - Int Soc Opt Eng 1997;2932:115.

1182. Smith SW. SECURE personnel screening system: Field trials and new developments. Proc SPIE - Int Soc Opt Eng 1997;2932:121.

1183. Roberts J, Rochefort J. Strategies for the detection of drugs within the Correctional Service Canada: Research and development initiatives. Proc SPIE - Int Soc Opt Eng 1997;2937:138.

1184. Hallowell SF. Screening people for illicit substances: A survey of current portal technology. Talanta 2001;54(3):447.

1185. Wendel GJ, Jadamec JR, Su C-W. Recent developments in the SENTOR drug detection system. Proc SPIE-Int Soc Opt Eng 1994;2276:98.

1186. Grimaldi V, Politano JL. Illicit material detector based on gas sensors and neural networks. Proc SPIE - Int Soc Opt Eng 1997;2937:90.

1187. Nacson S, Walker H, Chang A, Siu T, McNelles L, Uffe M. Portable instrument for detection of illicit drugs. Proc SPIE - Int Soc Opt Eng 1997;2937:120.

1188. Staples EJ, Watson GW, McGuirre DS, Williams D. SAW/GC detection of taggants and other volatile compounds associated with contraband materials. Proc SPIE - Int Soc Opt Eng 1997;2937:57.

1189. Watson G, Horton W, Staples E. Portable detection system for illicit materials based on SAW resonators. Proc - IEEE Ultrason Symp 1992;1:269.

1190. Wilson R, Brittain AH. Study to investigate the trace levels of contamination on surfaces when narcotic contraband is concealed in a vehicle. Proc SPIE - Int Soc Opt Eng 1997;2932:27.

1191. Patrick JC, Poziomek EJ. Advancement of contraband drug detection through improved surface-sampling procedures. Proc SPIE - Int Soc Opt Eng 1997;2937:130.

1192. Stott WR, Davidson WR, Sleeman R. High-throughput real-time chemical contraband detection. Proc SPIE - Int Soc Opt Eng 1994;2092:53.

1193. Davidson WR, Stott WR, Sleeman R, Akery AK. Synergy or dichotomy: Vapor and particle sampling in the detection of contraband. Proc SPIE - Int Soc Opt Eng 1994;2092:108.

1194. Carlson RM, Bunney L, Williams DN. Hazardous chemicals detection experiment. Proc SPIE - Int Soc Opt Eng 1994;2092:244.

1195. Johnson AJ, Volberding RW, Reiter RF. ARPA nonintrusive (cargo) inspection technology testbed. Proc SPIE - Int Soc Opt Eng 1994;2276:192.

1196. Bryden WA, Benson RC, Ecelberger SA, Phillips TE, Cornish T, Cotter RJ. Tiny TOF-MALDI mass spectrometry for particulate drug and explosives detection. Proc SPIE - Int Soc Opt Eng 1995;2511:153.

1197. Dejarme LE, Lawhon SJ, Ray P, Kuhlman MR. Analysis of volatile organic compounds in seized cocaine hydrochloride. Proc SPIE - Int Soc Opt Eng 1997;2937:2.

1198. Brown ST, Bothe C, Landstrom D. Trace chemical vapors in illicit cocaine production and shipping. Proc SPIE - Int Soc Opt Eng 1994;2276:340.

1199. Robins WH, Wright BW. Analysis of volatile organic compounds from illicit cocaine samples. Proc SPIE - Int Soc Opt Eng 1994;2276:352.

1200. Orzechowska GE, Poziomek EJ, Tersol V, Homstead J. Evaluation of solid-phase microextraction in detection of contraband drug vapors. Proc SPIE - Int Soc Opt Eng 1997;2937:8.

1201. 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.

1202. Neudorfl P, Hupe M, Pilon P, Lawrence AH, Drolet G, Su CW, Rigdon SW, Kunz TD, Ulwick S, Hoglund DE, Wingo J, Demirgian JC, Shier P. Detection of cocaine in cargo containers by high-volume vapor sampling: Field test at Port of Miami. Proc SPIE - Int Soc Opt Eng 1997;2937:26.

1203. Dejarme LE, Goodling RE, Lawhon SJ, Ray P, Kuhlman MR. Formation of methyl benzoate from cocaine hydrochloride under different temperatures and humidities. Proc SPIE - Int Soc Opt Eng 1997;2937:19.

1204. Khan SM, Smith DE, Hoglund DE. Assessment of x-ray technology for narcotics detection. Proc SPIE - Int Soc Opt Eng 1994;2276:156.

1205. Khan SM, Smith DE. U.S. Customs Service imaging requirements for x-ray scanners. Proc SPIE - Int Soc Opt Eng 1994;2092:437.

1206. McGregor A. Global amphetamine abuse causes concern. Lancet 1996;348(9041):1579.

1207. United Nations International Drug Control Programme (Analysis and Statistics Section). Monograph: Amphetamine-Type Stimulants: A Global Review - 1996. New York, NY:1996.

1208. United Nations International Drug Control Programme (Scientific Section). Monograph: Psychotropic Substances of the Amphetamine Type Used by Drug Addicts in Bulgaria - Synthesis and Medicinal Forms; Analytical Methods of Identification - 1994. New York, NY:1994.

1209. Fucci N, De Giovanni N. Adulterants encountered in the illicit cocaine market. Forensic Sci Int 1998;95(3):247.

1210. Barrio G, Saavedra P, de la Fuente L, Royuela L and the Spanish Group for the Study of the Purity of Seized Drugs. Purity of cocaine seized in Spain 1985-1993: Variations by weight, province, and year of seizure. Forensic Sci Int 1997;85(1):15.

1211. Pakulniewicz KJ, Matkovich CE. Intralaboratory precision of cocaine analysis by capillary gas chromatography. Microgram 1993;26:71.

1212. Fortuna JJ. Statistical analysis of cocaine head-space vapors. Proc SPIE - Int Soc Opt Eng 1994;2092:120.

1213. Henderson G L. Designer drugs. Anal Toxicol Clin Forensic Pharm Chem 1997:685.

1214. King LA. Designer drugs related to amphetamine (1990-1996). J Clan Lab Invest Chem Assoc 1996;6(3):15.

1215. Lodge BA. Canadian designer drugs. Science and Justice: 1995 Annual General Meeting of the Forensic Science Society (summary). 1996;36(2):123.

1216. King LA. New synthetic drugs in the European Union. Science Justice 2001;41(3):200.

1217. King LA, Poortman-van der Meer AJ. New synthetic drugs in the European Union. J Clan Lab Invest Chem Assoc 1998;8(3):13.

1218. 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.

1219. United Nations International Drug Control Programme (Analysis and Statistics Section). Monograph: Global Illicit Drug Trends - 2000. New York, NY:2000.

1220. United Nations International Drug Control Programme (Analysis and Statistics Section). Monograph: Global Illicit Drug Trends - 1999. New York, NY:1999.

1221. Lasik A, Antal A, Paczi I. Substances to abuse in the households in Hungary. Proceedings of the International Association of Forensic Sciences 13th Triennial Meeting 1993;5:286.

1222. O'Connell D, Heffron JJA. Rapid analysis of illicit drugs by mass spectrometry: Results from seizures in Ireland. Analyst 1999;125(1):119.

1223. Cole RK. Drug usage in San Diego County 1990-1997. J Forensic Sci 1998;43(5):1101.

1224. King LA. Drug content of powders and other illicit preparations in the UK. Forensic Sci Int 1997;85:135.

1225. King LA. Estimating the proportion of UK drug consumption which is imported on the basis of Customs and Police seizures for particular drugs. Forensic Sci Int 1995;76(3):217.

1226. Kaa E. Drug abuse in Western Denmark during the eighties. I. Drugs of abuse. Forensic Sci Int 1992;55(1):67.

1227. Franzosa ES. Rohypnol Tablets Manufactured Worldwide. Microgram 1996;29(9):242.

1228. Dawson M, Tosi B, Maher L, Swift W. Physical and chemical analysis of street-level heroin seizures. Proceedings of the International Association of Forensic Sciences 15th Triennial Meeting 1999:68.

1229. Kaa E. Impurities, adulterants, and diluents of illicit heroin. Changes during a 12 year period. Forensic Sci Int 1994;64(2,3):171.

1230. Chaudron-Thozet H, Girard J, David JJ. Analysis of heroin seized in France. United Nations International Drug Control Programme Vienna. Bull Narc 1992;44(1):29.

1231. Levy R, Ravreby M, Meirovich L, Shapira-Heiman O. A survey and comparison of heroin seizures in Israel during 1992 by Fourier transform infrared spectrometry. J Forensic Sci 1996;41(1):6.

1232. Klemenc S. Noscapine as an adulterant in illicit heroin samples. Forensic Sci Int 2000;108(1):45.

1233. De La Fuente L, Saavedra P, Barrio G, Royuela L, Vicente J. Spanish group for the study of the purity of seized drugs: Temporal and geographic variations in the characteristics of heroin seized in Spain and their relation with the route of administration. Drug Alcohol Depend 1996;40:185.

1234. Dominguez E, Infante F, Luna A, Trujillo D. Los adulterantes y contaminantes de la heroina de venta callejera en la Communidad Autonoma Andaluza. ed. Sevilla: Junta de Andalucia, 1993.

1235. O'Neil PJ, Pitts JE. Illicitly imported heroin products (1984 to 1989); some physical and chemical features indicative of their origin. J Pharm Pharmacol 1992;44:1.

1236. Anonymous. Domestic monitor program: A partial report on retail level heroin purchases from calendar year 1992, including source areas, cost, purity, and composition. Microgram 1993;26:197

1237. Coomber R. The cutting of heroin in the United States in the 1990's. J Drug Issues 1999;29(1):17.

1238. Furst RT. The re-engineering of heroin: An emerging heroin "cutting" trend in New York City. Addiction Research 2000;8(4):357.

1239. Franzosa ES. Current LSD blotter paper designs. Microgram 1997;30(8):182.

1240. Neuninger H, Saukel J, Witzmann J. The tetrahydrocannabinol (THC) content of *Cannabis* plants cultivated in Austria. Influence of harvest time and weather. Sci Pharm 1992;60:105.

1241. Mignoni G. Cannabis as a licit crop: Recent developments in Europe. Bull Narc 1997/1998;(49(1,2)/50(1,2)):23.

1242. Stefanidou M, Dona A, Athanaselis S, Papoutsis I, Koutselinis A. The cannabinoid content of marihuana samples seized in Greece and its forensic application. Forensic Sci Int

1998;95(2):153.

1243. Stefanidou M, Athanaselis S, Alevisopoulos G, Papoutsis J, Koutselinis A. *Delta*-(9)-tetrahydrocannabinol content in cannabis plants of Greek origin. Chem Pharm Bull 2000;48(5):743.

1244. Poulsen HA, Sutherland GJ. The potency of cannabis in New Zealand from 1976 to 1996. Science Justice 2000;40(3):171.

1245. Buchanan BE, O'Connell D. Survey on cannibis resin and cannibis in unsmoked handrolled cigarettes seized in the Republic of Ireland. Science Justice 1998;38(4):221.

1246. 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.

1247. ElSohly MA, Ross SA, Mehmedic Z, Arafat R, Yi B, Banahan BF. Potency trends of Δ9-THC and other cannabinoids in confiscated marijuana from 1980-1997. J Forensic Sci 2000;45(1):24.

1248. 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.

1249. 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.

1250. Senac S, Dominguez A, Pujol EP. MDMA, MDA, MDEA, NEXUS, and MBDB tablets seen in southwestern Spain. Microgram 2000;33(12):340.

1251. Sanchez-Sennac C, Perez-Sirvent C, Perez-Carceles D, Osuna E, Sanchez-Quiles C, Luna A. Active compounds and adulterants in street illicit samples of designer drugs from the southwest of Spain. Proceedings of the International Association of Forensic Sciences 15th Triennial Meeting 1999:65.

1252. Franzosa ES. MDMA, MDEA & MBDB tablets seen in the US. Microgram 2001;34(4):80.

1253. Franzosa ES. MDMA, MDEA, and MBDB tablets seen in the US. Microgram 2000;33(6):121.

1254. Franzosa ES. MDMA, MDEA & MBDB tablets seen in the US. Microgram 1999;32(6):190.

1255. Franzosa ES. MDMA, MDEA & MBDB tablets seen in the US. Microgram 1996;29(11):285.

1256. 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.

1257. Guéniat O, Esseiva P, Ribaux O. The systematical profiling of heroin and cocaine seizures in a Swiss town: The elicitation, interpretation of links and the development of a computerized system to improve the investigation. Presentation - 1st European Meeting of Forensic Science; Lausanne, Switzerland; 1997.

1258. United Nations International Drug Control Programme. Monograph: World Drug Report - 2000. Northamptonshire, United Kingdom:2000.

1259. 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.

1260. 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.

1261. 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.

1262. United Nations International Drug Control Programme (International Narcotics Control Board). Monograph: Report of the International Narcotics Control Board - 1999. New York, NY:1999.

1263. 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.

1264. 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.

1265. 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.

1266. United Nations International Drug Control Programme (International Narcotics Control Board). Monograph: International Narcotics Control Board: Psychotropic Substances - Statistics - 1999. New York, NY:1999.

1267. United Nations International Drug Control Programme. Monograph: Terminology and Information on Drugs - 1999. New York, NY:1999.

1268. United Nations International Drug Control Programme. Monograph: UNDCP World Drug Report - 1997. Northamptonshire, United Kingdom:1997.

1269. United Nations International Drug Control Programme (Analysis and Statistics Section). Monograph: Supply of and Trafficking in Narcotic Drugs and Psychotropic Substances - 1996. New York, NY:1996.

1270. 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.

1271. Peterson JL, Markham PN. Crime laboratory proficiency testing results 1978-1991 I: Identification and classification of physical evidence. J Forensic Sci 1995;40(6):994.

1272. Churchill KT. Angel trumpet. Microgram 1995;28:250.

1273. Goldberg G. United States legislative controls and their effect on the revival of amphetamine. Proceedings of the International Association of Forensic Sciences 15th Triennial Meeting 1999:57.

1274. 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.

1275. Adelaars A. Court case in Holland against the use of ayahuasca by the Dutch Santo Daime Church. J Clan Lab Invest Chem Assoc 2001;11(3):12.

1276. Saleh GA. Charge-transfer complexes of barbiturates and phenytoin. Talanta 1998;46(1):111.

1277. Vu D-T. On the use of activated charcoal to circumvent canine detection of concealed narcotics - Part I. Microgram 2000;33(4):68.

1278. Furton KG, Hsu YA, Luo T, Lopez F, Rose S. Diffusion studies and SPME/GC/MS/MS analysis of volatile drug components and the relevance to detector dog alerts to suspected drug money. Proceedings of the American Academy of Forensic Sciences 1998;4:35.

1279. Hallowell SF, Davies JP, Gresham GL. Qualitative/semiquantitative chemical characterization of the Auburn olfactometer. Proc SPIE - Int Soc Opt Eng 1994;2276:437.

1280. Furton KG, Hsu YL, Luo T, Nayiby A, Lagos P. U.S. currency cocaine speciation and threshold levels of cocaine odor detection by K-9, man, and machines. Proceedings of the American Academy of Forensic Sciences 1997;3:21.

1281. Furton KG, Hong YC, Hsu YL, Rose S. Drug money and detection dogs - What are they really smelling and what does it mean? Proceedings of the American Academy of Forensic Sciences 1996;2:18.

1282. Furton KG, Hsu Y-L, Luo T, Wang J, Rose S. Odor signature of cocaine analyzed by GC/MS and threshold levels of detection for drug detection canines. Proceedings of the International Association of Forensic Sciences 14th Triennial Meeting 1996;2:328.

1283. 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.

1284. Waggoner LP, Johnston JM, Williams M, Jackson J, Jones M, Boussom T, Petrousky JA. Canine olfactory sensitivity to cocaine hydrochloride and methyl benzoate. Proc SPIE - Int Soc Opt Eng 1997;2937:216.

1285. Ciolino LA, Turner JA, Fraser DB. Traditional Chinese medicines: The analytical chemist's challenge or nightmare? Proceedings of the American Academy of Forensic Sciences 1998;4:32.

1286. Fraser DB. Chinese herbal medicines - manufacturing flaws and misuse. Forensic Sci Rev 1998;10(2):67.

1287. Liu HT, Wang KT, Zhang HY, Chen XG, Hu ZD. Electrophoretic behavior study and determination of some active components in Chinese medicial preparations by capillary electrophoresis. Analyst 2000;125(6):1083.

1288. 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.

1289. Lai SJ, Binder SR, Essien H, Wen KC. Identification of western medicines as adulterants in Chinese herbal medicines using a broad spectrum drug screening HPLC system. J Liq Chromatogr 1995;18:2861.

1290. Ku YR, Tsai MJ, Wen KC. Screening chemical drugs used to adulterate in rheumatic and analgesic traditional Chinese medicine by HPLC-DAD. J Food Drug Anal 1995;3:51.

1291. Ku YR, Tsai MJ, Wen KC. Study on adulterated chemical drugs in rheumatic and analgesic traditional Chinese medicine by MEKC. J Food Drug Anal 1995;3:185.

1292. Ku YR, Tsai MJ, Lin JH, Wen KC. Micellar electrokinetic capillary chromatography of clobenzorex HCl and diazepam adulterated in anorexiant traditional Chinese medicine. Chinese Pharm J 1996;48:157.

1293. Ku YR, Tsai MJ, Wen KC. Determination by high performance liquid chromatography of fluoxymesterone, methyltestosterone and testosterone in adulterated Chinese herbal preparations. J Food Drug Anal 1997;5:121.

1294. Johnson EL. Alkaloid content in *Erythroxylum Coca* tissue during reproductive development. Phytochemistry 1996;42(1):35.

1295. Casale JF, Lewin AH, Bowen JP. The base-catalyzed C-2 exchange and epimerization of 3-*beta* substituted 8-methyl-8-azabicyclo[3.2.1]octane-2-carboxylates. I. J Org Chem 1992;57(18):4906.

1296. Johnson EL, Foy CD. Biomass accumulation and alkaloid content in leaves of *Erythroxylum Coca* and *Erythroxylum Novogranatense* Var *Novogranatense* grown in soil with varying pH. J Plant Physiol 1996;149:444.

1297. Morris TA, Michiels AS. Effects of cyanoacrylate processing on cocaine HCl trace analysis. Microgram 2000;33(5):97.

1298. Ziegler T, Eikenberg O, Bilitewski U, Grol M. Gas phase detection of cocaine by means of immunoanalysis. Analyst 1996;121(2):119.

1299. McBay AJ. Cocaine sentencing. J Forensic Sci 1996;41(1):3 (published response appears: Heagy JA. J Forensic Sci 1996;41(6):1086).

1300. Brachet A, Christen P, Gauvrit JY, Longeray R, Lanteri P, Veuthey JL. Experimental design in supercritical fluid extraction of cocaine from coca leaf. J Biochem Biophys Methods 2000;43:353.

1301. O'Donnell JF, Paulson JD. Solubility of cocaine free base and cocaine hydrochloride in gasoline. Microgram 1998;31(2):67.

1302. Casale JF, Meyers RP. The stability of cocaine in *Agua Rica/Agua Madre*. Microgram 1996;29(7):175.

1303. Sleeman R, Burton R, Carter J, Roberts D, Hulmston P. Drugs on money. Analytical Chemistry 2000;72(11):397A.

1304. 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.

1305. Oyler J, Darwin WD, Cone EJ. Cocaine contamination of United States paper currency. J Anal Toxicol 1996;20:213.

1306. Negrusz A, Perry JL, Moore CM. Detection of cocaine on various denominations of United States currency. J Forensic Sci 1998;43(3):626.

1307. Jourdan TH, Wang D. Cocaine contamination of U.S. currency. Proceedings of the American Academy of Forensic Sciences 1997;3:20.

1308. Jenkins AJ. Drug contamination of US paper currency. Forensic Sci Int 2001;121(3):189.

1309. Roberts DJ, Carter JF, Sleeman R, Burton IFA. Application of tandem mass spectrometry to the detection of drugs on cash. Spectrosc Europe 1997;9(6):24.

1310. Bennett G, Sleeman R, Davidson WR, Stott WR. Airport trial of a system for the mass screening of baggage or cargo. Proc SPIE - Int Soc Opt Eng 1994;2276:363.

1311. Bennett G, Sleeman R. Hot money. Proc SPIE - Int Soc Opt Eng 1994;2276:383.

1312. 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(2):103.

1313. Monte AP, Maronalewicka D, Parker MA, Wainscott DB, Nelson DL, Nichols DE. Dihydrobenzofuran analogues of hallucinogens. 3. Models of 4-substituted (2,5-dimethoxyphenyl)alkylamine derivatives with rigidified methoxy groups. J Med Chem 1996;39(15):2953.

1314. Micovic IV, Roglic GM, Ivanovic MD, Dosenmicovic L, Kiricojevic VD, Popovic JB. The synthesis of lactam analogues of fentanyl. J Chem Soc - Perkin Trans 1996;1(16):2041.

1315. Robak DR. Identification of clandestinely produced methylenedioxyisoquinolines. Microgram 1995;28:46.

1316. 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.

1317. Valter K, Arrizabalaga P. Designer Drugs Directory. Elsevier Science:1998 (NY).

1318. Malmusi L, Dukat M, Young R, Teitler M, Darmani NA, Ahmad B, Smith C, Glennon RA. 1,2,3,4-Tetrahydroisoquinoline analogs of phenylalkylamine stimulants and hallucinogens. Med Chem Res 1996;6(6):400.

1319. Malmusi L, Dukat M, Young R, Teitler M, Darmani NA, Ahmad B, Smith C, Glennon RA. 1,2,3,4-Tetrahydroisoquinoline and related analogs of the phenylalkylamine designer drug MDMA. Med Chem Res 1996;6(6):412.

1320. Shulgin A, Shulgin A. PIHKAL: A Chemical Love Story. Transform Press:1992 (Berkeley).

1321. Shulgin A, Shulgin A. TIHKAL: The Continuation. Transform Press:1997 (Berkeley).

1322. Blackledge RD. "DXM" or dextromethorphan. Microgram 2000;33(1):10.

1323. Dawson M, Williamson K, Maynard P. Hydriodic acid/red phosphorus reduction of N,N-dimethyl-3-phenyl-3-hydroxypropylamine. Proceedings of the International Association of Forensic Sciences 15th Triennial Meeting 1999:61.

1324. Choi YH, Kim J, Kim YC, Yoo KP. Selective extraction of ephedrine from *Ephedra Sinica* using mixtures of CO2, diethylamine, and methanol. Chromatographia 1999;50(11-12):673.

1325. Chow ST, Lee TK, Saw CG, Soon TW, Ng TL. The homogenisation of illicit heroin samples: An emprical and statistical approach. Proceedings of the International Association of Forensic Sciences 13th Triennial Meeting 1993;5:221.

1326. Hindmarsh KW, Taylor A, Fandrey S. Solvent abuse - Changes in attitudes and knowledge? J Can Soc Forensic Sci 1997;30(1):17.

1327. Flanagan RJ, Ives RJ. Volatile substance abuse. Bull Narc 1994;46(2):49.

1328. United Nations International Drug Control Programme (Analysis and Statistics Section). Monograph: Volatile Substance Abuse - 1997. New York, NY:1997.

1329. Chamakura RP. Forensic science and the internet - Current utilization and future potential. Forensic Sci Rev 1997;9(2):97.

1330. Tessarolo AA, Marignani A. Forensic science and the internet. J Can Soc Forensic Sci 1996;29(2):87.

1331. Pulte L, Mayberry J. Fingerprint processing of blotter paper and its effect on LSD analysis. Microgram 1993;26:246.

1332. Li ZY, McNally AJ, Wang HY, Salamone SJ. Stability study of LSD under various storage conditions. J Anal Toxicol 1998;22(6):520.

1333. Gigliano GS. *Cannabis Sativa* L. - Botanical problems and molecular approaches in forensic investigations. Forensic Sci Rev 2001;13(1):1.

1334. Holland JA, Nelson L, Ravikumar PR, Elwood WN. Embalming fluid-soaked marijuana: New high or new guise for PCP? J Psychoactive Drugs 1998;30(2):215.

1335. Horrocks M, Bedford KR, Morgan-Smith RK. The filtering effects of various household fabrics on the pollen content of hash oil (cannabis extract). J Forensic Sci 1997;42(2):256.

1336. ElSohly MA, Feng SX, Murphy TP, Warrington AW, Ross S, Nimrod A, Mehmedic Z, Fortner N. Identification and quantitation of 11-nor-delta(9)-tetrahydrocannabivarin-9-carboxylic acid, a major metabolite of delta-9-tetrahydrocannabivarin. J Anal Toxicol 2001;25(6):476.

1337. Hutchinson K. The manufacture of *Cannabis Sativa* for legitimate applications. J Clan Lab Invest Chem Assoc 1996;6(4):20.

1338. Landi S. Mineral nutrition of *Cannabis Sativa L.* J Plant Nutr 1997;20(2-3):311.

1339. Mausolf N. The name of the test. Microgram 2001;34(9):235.

1340. 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.

1341. Joern WA. Ion ratio instability of a GC/MS system is related to fluctuations in room air flow. J Anal Toxicol 1993;17:122.

1342. 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.

1343. Zedeck M. Drug Enforcement Administration (DEA) chemists erred in calculating quantity of methadone that could be synthesized from precursor chemicals. J Forensic Sci 1997;42(2):349.

1344. Hatcher AP, Ryan CR. Response to claim of error by Drug Enforcement Administration (DEA) chemist in calculating quantity of methadone synthesized from precursor chemicals. J Forensic Sci 1997;42(5):963.

1345. Müller JL. Love potions and the ointment of witches: Historical aspects of the nightshade alkaloids. Clinical Toxicol 1998;36(6):617.

1346. Zenk MH, Tabata M. Opium - Its history, merits, and demerits. Nat Med 1996;50(2):86.

1347. Tetenyi P. Biodiversity of *Papaver Somniferum* L. (opium poppy). International Symposium on Medicinal and Aromatic Plants (Series: Acta Horticulturae) 1995;390:191.

1348. 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.

1349. Anonymous. Oxycodone (trade names: Tylox, Percodan, Oxycontin). Microgram 2001;34(3):48.

1350. Skalican Z, Kobliha Z, Halamek E. Ionic associates of phencyclidine with sulfophthaleins and azo dyes. Anal Lett 1997;30(7):1349.

1351. Brandenberger H. Hypnotics and sedatives not belonging to the classes of barbiturates and benzodiazepines. Anal Toxicol Clin Forensic Pharm Chem 1997:399.

1352. King MA, McDonough MA, Drummer OH, Berkovic SF. Poppy tea and the baker's first seizure. Lancet 1997;350:716.

1353. Singer RD, Scammells PJ. Alternative Methods for the MnO2 oxidation of codeine methyl ether to thebaine utilizing ionic liquids. Tetrahedron Lett 2001;42(39):6831.

1354. Jensen III CJ. The forensic analysis of clandestine drug records. Forensic Sci Int 1994;66(1):33.

1355. Inoue T, Seta S. Analysis of drugs in unconventional samples. Forensic Sci Rev 1992;4(2):89.

1356. Nichols RG. Drug proficiency test false positives: A lack of critical thought. Science Justice 1997;37(3):191.

1357. Ripani L, Lovera P, Muzi F, Schiavone S. GC/MS Analysis of a fruit juice extract that was suspected to be a narcotic beverage. Microgram 1994;27:149.

1358. 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.

1359. Azoury M, Meirovich L, Refael E. Computerized management of a forensic analytical laboratory. Microgram 1997;30(12):297.

1360. Smith JB, Jarzen RA. A computerized case management system for the crime laboratory. Proceedings of the American Academy of Forensic Sciences 1995;1:26.

1361. Rothchild R. Some considerations for planning and site preparation for modern laboratory instrumentation. J Clan Lab Invest Chem Assoc 1996;6(1):15.

1362. Rothchild R. Some considerations for planning and site preparation for modern laboratory instrumentation. Microgram 1996;29(3):69.

1363. Acton B, Kelly R. Development of a forensic evidence protection kit. Proc SPIE - Int Soc Opt Eng 1999;3576:14.

1364. O'Gorman M. Unique drug smuggling techniques and the problems associated with analyses. Proceedings of the American Academy of Forensic Sciences 1995;1:21.

1365. Kolusayin Z, Etun G, Seyhan M, Soysal Z, Ko S. Drug smuggling by internal bodily concealment. Proceedings of the International Association of Forensic Sciences 13th Triennial Meeting 1993;5:259.

1366. Armstead L. Illicit narcotics cultivation and processing: The ignored environmental drama. United Nations International Drug Control Programme Vienna. Bull Narc 1992;44(2):9.

1367. Dourojeanni M. Environmental impact of coca cultivation and cocaine production in the Amazon region of Peru. United Nations International Drug Control Programme Vienna. Bull Narc 1992;44(2):37.

1368. Evett IW. Expert evidence and forensic misconceptions of the nature of exact science. Science Justice 1996;36(2):118.

1369. Newman R, Gilbert M, Lothridge K. GC-MS guide to ignitable liquids. CRC Press, New York, 1998.

1370. Sharp ME, Voll LJ. Modification of an extraction procedure for acidic and neutral drugs. Can Soc Forensic Sci 1995;28:171.

1371. Kingston C. Neural networks in forensic science. J Forensic Sci 1992;37(1):252.

1372. McKibben T. Protecting group chemistry. J Clan Lab Invest Chem Assoc 1997;7(4):30.

1373. 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.

1374. Chen X-H, Franke J-P, de Zeeuw RA. Solid phase extraction for systematic toxicological analysis. Forensic Sci Rev 1992;4(2):147.

1375. United Nations International Drug Control Programme (Scientific Section). Monograph: Multilingual dictionary of narcotic drugs and psychotropic substances under international control. United Nations (New York, NY):1993.

1376. 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.

1377. Machata G. The International Narcotics Control Board (INCB or Board). Proceedings of the International Association of Forensic Sciences 13th Triennial Meeting 1993;5:228.