

# CBS

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**Topic: HPTLC for investigation of food for unauthorized dye additions**

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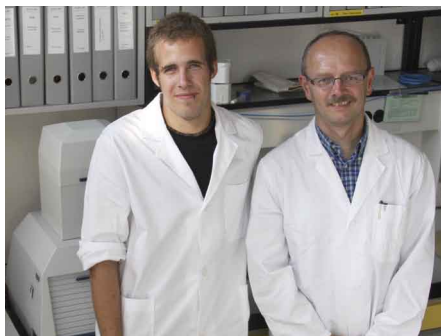
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# CAMAG

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# HPTLC determination of illegal dyes in chili, paprika und curry



Left to right: Matthias Bleisch and Dr. Helmut Kandler

The State Laboratory in Zürich is the official food control authority for the Zurich Canton. To ensure food safety the laboratory is very open minded to new and/or improved, yet reliable analytical methods. For several years Dr. Helmut Kandler, Head of the Laboratory Unit Food Analyses, and his team have been using HPTLC as a valuable addition to other techniques. In collaboration with Dr. Eike Reich and Valeria Widmer at the CAMAG laboratory in Muttenz, Switzerland, a rapid and reliable method for determination of illegal dyes in spices was developed and validated.

## Introduction

In recent years several European countries have detected the azo dyes Sudan I-IV in chili powder. These red and orange dyes are classified as carcinogens and, therefore, their use in food is illegal. In order to purport higher quality products, these adulterants are used to artificially enhance the natural color of spices.

**This validated reversed phase HPTLC method has been successfully used under routine conditions by the State Laboratory, Zurich since 2007. Particularly chili, paprika, curry powder and spice mixtures were screened for the illegal dyes Sudan I, II, III, IV, Sudan Red B, Sudan Red 7B, Sudan Red G, Para Red, FD&C Orange 2, Butter Yellow, Citrus Red 2, Toluidine Red, and Disperse Orange 11 by visual evaluation in daylight. Following the screening, additional confirmation and/or quantification of positive samples was performed by scanning densitometry using matrix calibration. Adulterated spice products typically show contamination of more than 100 mg/kg.**

## Standard solutions

20 mg of Para Red, Sudan III, Sudan IV, Toluidine Red, and Sudan Red 7B each, and 20 mg of Sudan I, Sudan II, Citrus Red 2, Butter Yellow, Sudan Red B, FD&C Orange 2, Sudan Red G, and Disperse Orange 11 each were dissolved in acetone and in acetonitrile, respectively, and filled up to 100 mL each (200 µg/mL stock solutions). 5 mL of stock solutions for the respective dye mixture were collected and evaporated to dryness (50 °C, 120 hPa), then redissolved with 10 mL of acetonitrile (concentration of dyes: 100 µg/mL each in Mix 1 and Mix 2 standard solution).

## Sample preparation

5 g of homogenized sample were extracted with 50 mL of acetonitrile by stirring for 10 min, followed by filtration. To 10 mL of the filtrate FeCl<sub>3</sub> solution (5 mg/mL in acetonitrile) was added drop wise until the color changed from red to green (ca. 0.3–0.8 mL). The solution was evaporated to dryness, the residue was taken up in 1 mL of basic dichloromethane (250 mL methylene chloride shaken out with 10 mL ammonia 25% and separated) and purified through a silica gel SPE-cartridge. The eluate was evaporated to dryness and the residue was taken up with 1 mL of acetonitrile.

## Spiked samples

In 100 mL Erlenmeyer flasks 5 g each of a non contaminated blank sample were spiked in duplicate with 0.5, 1.5, 3, 4.5, and 6 mL of Mix 1 or Mix 2 standard solution, then made up to 50 mL with acetonitrile and prepared as described above (concentration of spiked sample: 10–120 mg/kg).

## Layer

HPTLC plates RP18 F<sub>254s</sub> 10 x 10 cm and 20 x 10 cm, Merck

## Sample application

Bandwise with Linomat 5, band length 8 mm, distance from lower edge 8 mm, distance from left and right edge min. 15 mm, track distance min. 10 mm, application volumes 10 µL for samples and 1–12 µL for standard solutions (3–15 µL after 1:10 dilution)

## Chromatography

In the Automatic Developing Chamber ADC2 with acetonitrile – ammonia 25% 19:1, migration distance (from lower edge of plate) 60 mm

## Documentation

With DigiStore 2 or TLC Visualizer documentation system under white light in reflectance mode.

Mix 1	R <sub>F</sub>	R <sub>rel</sub>			R <sub>rel</sub>	R <sub>F</sub>	Mix 2
Para Red	0.60	1.22			1.38	0.66	Disp. Orange 11
Citrus Red 2	0.54	1.10			1.23	0.59	Butter Yellow
Sudan I*	0.49	1.00			1.10	0.53	Toluidine Red
Sudan II	0.33	0.67			1.00	0.48	Sudan Red G*
Sudan III	0.23	0.47			0.83	0.40	FD&C Orange 2
Sudan IV	0.16	0.33			0.44	0.21	Sudan Red 7B
-	-	-			0.31	0.15	Sudan Red B

\*arbitrarily used as reference for the relative R<sub>F</sub>

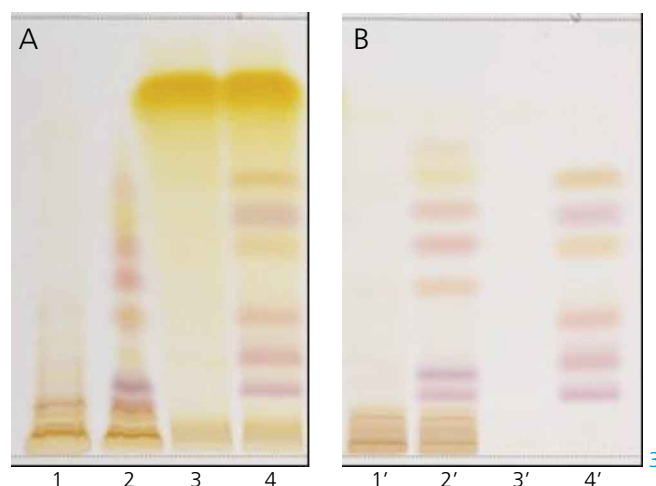
## Densitometry

Multi wavelength scan with TLC Scanner 3 and winCATS software at the absorption maximum of the individual dyes:

Dye	λ <sub>max</sub> (nm)	Dye	λ <sub>max</sub> (nm)
Sudan I	495	Sudan Red G	514
Sudan II	508	Sudan Red B	533
Sudan III	523	FD&C Orange 2	502
Sudan IV	534	Butter Yellow	453
Para Red	498	Toluidine Red	522
Citrus Red 2	529	Disperse Orange 11	488
Sudan Red 7B	551		

## Results and discussion

Sample extraction was a key step of the analysis. Selective extraction of synthetic dyes was achieved through oxidation of the natural spice pigments to colorless derivatives by adding an iron(III) chloride solution. With an additional clean-up by solid phase extraction the influence of the sample matrix was further reduced.

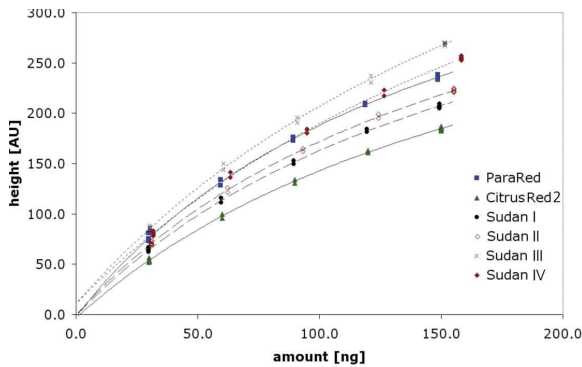


Influence of the oxidation step on chromatography: A: without oxidation; B: oxidation with iron(III) chloride; 1, 1': paprika blank; 2, 2': paprika spiked with 50 mg/kg of standard solution Mix 2; 3, 3': curry blank; 4, 4': curry spiked with 50 mg/kg of standard solution Mix 1

The method (as used under routine conditions) was validated regarding quality of the calibration function, quality of the function for matrix calibration, precision of the method, and detection limits. Initially low level (30–150 ng/zone) and high level (100–1200 ng/zone) calibration curves were established and the data was fitted with a Michaelis-Menten type 2 function.



4 Chromatogram of Mix 1: The lowest and the highest concentrations were applied 5 times (center of the plate), the whole calibration range was applied in duplicate (on left and right side)

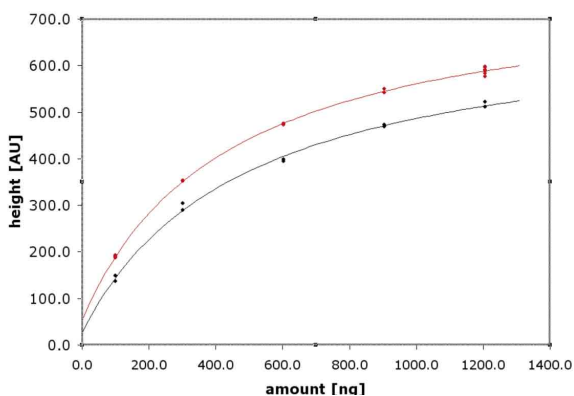


5 Calibration curves for all components of Mix 1 at low level

Calibration of 13 dyes (Mix1, Mix2)	%RSD at lowest concentration	%RSD at highest concentration	sdv* (%)
Low level calibration	2.3–6.7	0.5–2.9	1.2–3.8
High level calibration	0.7–6.4	0.3–4.3	0.5–4.8

\*sdv= relative residual standard deviation of calibration curves

Matrix calibration was investigated using paprika and curry samples spiked with 10–120 mg/kg. The calibration curves for matrix calibration and direct calibration of standard solutions were comparable. Lower values were in accordance with a certain substance loss during sample preparation. In a few cases, however, higher values were obtained because of minor matrix interferences (i.e. Sudan I in paprika).



6 Comparison of calibration curves: Standard solution Sudan Red B (red curve) and Sudan Red B in curry powder (black curve)

The observed matrix effects indicated that reliability of recovery was limited. Therefore a detailed investigation and determination of individual recoveries was not performed.

For the determination of the method precision (0.4–7.0 %) 6 samples each of paprika and curry were spiked with 50 mg/kg of standard solutions Mix 1 and Mix 2, respectively, and quantified using matrix calibration.

Actual detection limits (LOD) were estimated based on a matrix calibration (range 1–17 mg/kg) of spiked paprika and curry samples. In comparison with visual evaluation densitometric analysis provided a detection limit for paprika and curry lower by a factor of two.

	LOD (visual)	LOD (by densitometry)
Curry	ca. 3 mg/kg (5 mg/kg Sudan I, 7 mg/kg Butter Yellow, 13 mg/kg Disperse Orange)	1–3 mg/kg (7 mg/kg Disperse Orange)
Paprika	ca. 3 mg/kg (5 mg/kg Sudan I and Butter Yellow, 12 mg/kg Disperse Orange)	1–3 mg/kg

Investigation of real market samples showed that contamination of spices with illegal dyes typically exceeds 100 mg/kg. Contamination at the low mg/kg level is not relevant here because at this level the desired color enhancement of the sample is not achieved. In conclusion the presented HPTLC method is suitable for the rapid, sensitive, and reproducible analysis of spices contaminated with illegal dyes.

Further information is available on request from the authors.

[1] H. Kandler, M. Bleisch, V. Widmer, E. Reich, J. Liq. Chromatogr. Related Technol. 32 (2009) 1273

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## Analysis of water-soluble food dyes



Claudia Oellig

At the Institute of Food Chemistry, University of Hohenheim, Stuttgart, Germany planar chromatography is used for food analysis due to its advantages. For her diploma thesis Claudia Oellig employed the technique for the analysis of water-soluble food dyes.

### Introduction

In the endeavour to enhance food safety the number of approved food colorings has been dramatically reduced in recent years. The approximately 40 food colorings remaining are being regulated through EG94/36 which specifies their use and the maximum permissible amounts. Rapid quantitative methods are necessary to ensure strict adherence to these regulations, since some food colorings are considered to be carcinogenic. Previous TLC/HPTLC methods were generally aimed at and somewhat limited to separating 9 to 12 food dyes. However, this study focused on the much more daunting task of developing a method for the separation of the most frequently used water-soluble food dyes, not 9–12 but up to 25.

**Compared to existing methods for analysis of food dyes, the new HPTLC method is a reliable, rapid and cost-effective quantitative alternative [1–3]. It allows a high sample throughput of 1000 runs/day at moderate costs with an overall time per run of 1.5 min and a solvent consumption of 200  $\mu\text{L}$ . As the analytical objective becomes clear, the basis for interpretation can be chosen from visual inspection of the plate to spec-**

**tral correlation of the absorbance spectra to HPTLC-ESI/MS spectra. The analyst can proceed as far as necessary.**

### Sample preparation

Commercially available food samples were just diluted with methanol – ammonium acetate buffer (pH 6.8) 1:1 and, if necessary, degassed.

### Standard solutions

The dyes were dissolved in methanol – ammonium acetate buffer (pH 6.8) 1:1 in the following concentrations:

Mix 1			Mix 2			Mix 3		
Dye	Concentr. [ng/ $\mu\text{L}$ ]	$hR_f$	Dye	Concentr. [ng/ $\mu\text{L}$ ]	$hR_f$	Dye	Concentr. [ng/ $\mu\text{L}$ ]	$hR_f$
E 100	30	93	E 103	50	86	E101	30	72
E 101b	45	5	E 104	100	55	E102	20	19
E 110	20	57	E 120	70	0	E 105	25	53
E 122	20	71	E 121	125	93	E 129	15	60
E 124	15	27	E 123	8	25	E 133	8	26
E 126	30	10	E 125	60	72	E 141Na	860	86
E 127	10	93	E 151	15	15	E 141Cu	200	97
E 131	10	40				E 163	300	0
E 132	200	0						
E 142	8	23						

### Chromatogram layer

HPTLC plates silica gel 60 F<sub>254</sub> (Merck), 20 × 10 cm, prewashed by chromatography with methanol – water 4:1

### Sample application

Bandwise with Automatic TLC Sampler 4, 18 tracks, band length 7.5 mm, track distance 9 mm, distance from the side 24 mm, distance from lower edge 8 mm (5 mm for development from both sides), application volume 2  $\mu\text{L}$  (samples) and 1–4  $\mu\text{L}$  (standard mixture solutions)

### Chromatography

In the twin-trough chamber with 8 mL ethyl acetate – methanol – water – acetic acid 65:23:11:1, migration distance max. 50 mm, migration time 12 min; alternatively the ADC2 or, especially for a high sample throughput, the HDC was used.

## Documentation

With TLC Visualizer at UV 254, UV 366 nm and white light illumination

## Densitometry

- Digital image evaluation by VideoScan software (Savitsky Golay filter width of mostly 7 or 9, lowest slope as baseline correction mode and different electronic filters for evaluation) or
- Evaluation by TLC scanner 3 and winCATS Software, absorbance measurement via multi wavelength scan at 11 different wavelengths [1]

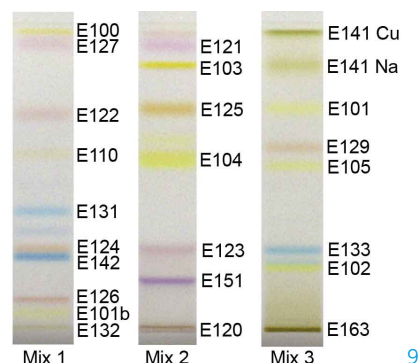
## Spectra recording (Vis, MS)

- Recording of Vis-spectra (400–800 nm) and calculation of the spectra correlation (sample versus standard) with TLC Scanner 3 and winCATS software or/and
- Recording of HPTLC/ESI mass spectra using a prototype of the TLC-MS interface (extraction solvent methanol, flow rate 0.2 mL/min)

## Results and discussion

Separation on silica gel plates was best using ethyl acetate – methanol – water – acetic acid 65:23:11:1 as mobile phase. The 1%-acid concentration was crucial to obtain sharp zones. Referred to other literature, the food dyes were divided into dye mixtures for improved quantification.

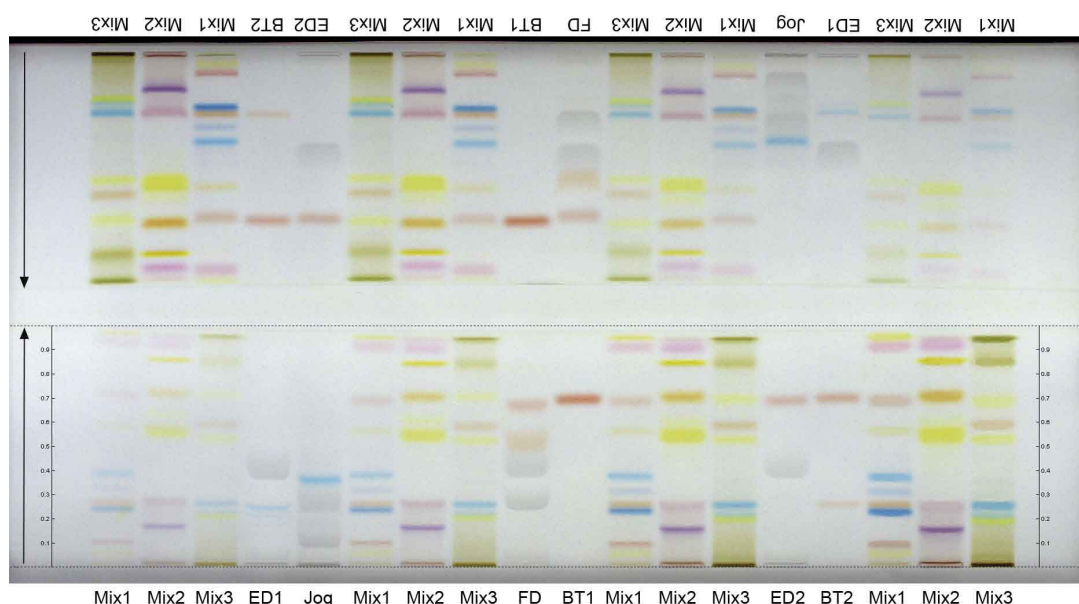
For a migration distance of max. 50 mm, the required separation time was 12 min. From both



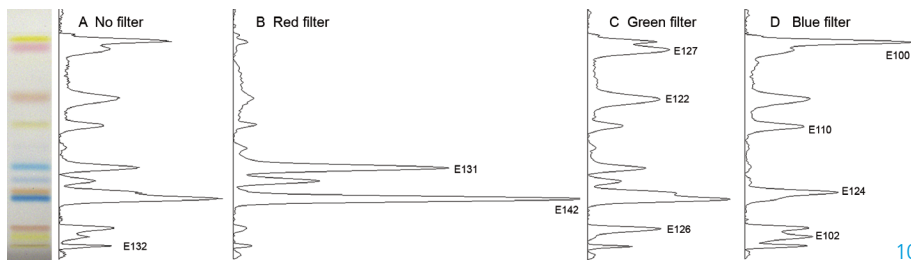
9 Separation of 25 water-soluble food dyes divided into 3 mixtures (partially dyes were just 50 or 85 % pure)

sides, 36 runs were developed isochronally under identical conditions. If calculated per sample, the development time was 20 s and the solvent consumption 220  $\mu$ L; disposal costs were significantly below 0.01 Cent. The analysis time (incl. sample preparation, sample application and digital image evaluation) was 1.5 min which is exceptional even in this age of ultra-rapid chromatographic methods.

At a high matrix load, area application and/or dilution of the sample as well as a powerful digital image evaluation was precondition. In the infrequent case of dyes found in samples at  $hR_f$ -value 0 (E120, E132, E163), the plate was developed again in a mobile phase of a slightly higher elution power, e.g. in the ratio 45:35:18:2 for a twofold development over 1 cm (6 s each). Quantification was performed by absorbance measurement using the multi wavelength scan in the UV/Vis-range or by digital quantification of the plate image.

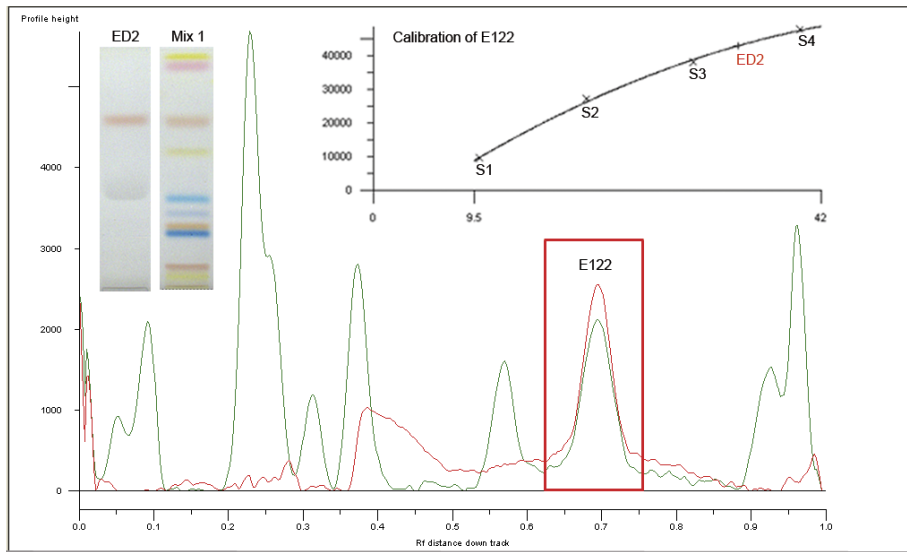


8 Analysis of 12 food samples (energy drink (ED), yoghurt (Jog), fruit drink (FD), bakery ink formulation (BT)) for 25 water-soluble food dyes by anti-parallel development in 12 min



Digital image evaluation using electronic filters (B-D) for improved post-chromatographic resolution of dyes (Mix 1)

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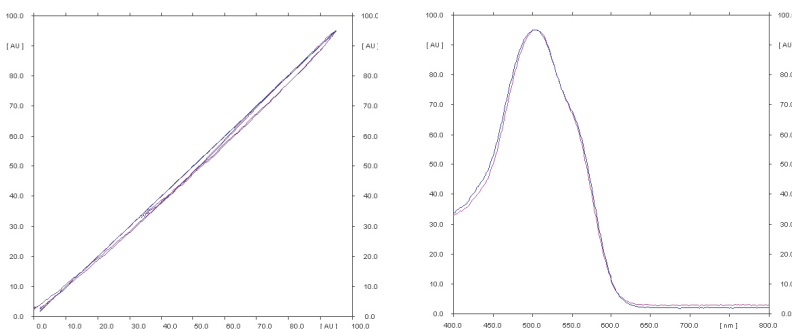


Digital image evaluation (without filter) of the diluted energy drink sample 2 (ED2), which contained the red dye E122 (Mix 1); overlay of the sample curve (red) and Mix 1 (green) as well as polynomial calibration function (peak area)

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Depending on the task at hand, analysis procedures can be selected as required, from visual inspection of the plate, to review of recorded absorbance spectra to MS. Hence, the offline system is optimal in that it provides cost savings, and has the flexibility of handling a large sample throughput.

Sample	Dyes found	Concentration calculated	%RSD (n=2)	Identity	
				Spectra correlation (400–800 nm) of standard and sample	Mass signal(s) (full scan, m/z 100–900)
Bakery ink formulation	122	66.4 g/L	0.0	$\geq 0.99996$	228 [M-2Na] <sup>2-</sup>
	124	13.3 g/L	2.1	$\geq 0.99957$	279 [M-2Na] <sup>2-</sup> 178 [M-3Na] <sup>3-</sup>
Energy drink 1	133	9.1 mg/L	0.1	$\geq 0.99964$	373 [M-2Na] <sup>2-</sup>
Energy drink 2	122	76.2 mg/L	3.6	$\geq 0.99958$	228 [M-2Na] <sup>2-</sup>



Correlation of Vis-spectra of standard zone E122 and the respective zone in energy drink 2

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continuation on page 9



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## Change in the financial management



14

**Mr Christian Gfeller** has been with CAMAG since 1966. For 42 years he has been Chief Financial Officer (CFO) and through good times and more difficult times, has contributed decisively to the management of our company. Since 1992 he has been a member of the Board of Directors and since 2003 has been Chairman. In mid 2008 he turned over the duties and responsibilities as CFO to Ms Sabine Bühler.

We look forward to having Christian Gfeller as Chairman of the Board for many years to come.



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**Ms Sabine Bühler** joined CAMAG December 1, 2007. She earned a management diploma from the Ecole Supérieur de Commerce in Neuchatel in 1987 and has furthered her education by taking courses in business administration, personnel management, controlling and business management as well. She has acquired practical experience with Swiss and international companies in the management of business administration, finance and personnel.

Since joining CAMAG she has shown competence, a rapid grasp of technical matters in our quite specialised business, and a particularly, impeccable trustworthiness. So Mr. Gfeller can pass on the baton to Ms Bühler with good faith and confidence.



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PLANAR CHROMATOGRAPHY**

**CBS**

Liebe Freunde

Die Weichen für das nächste International Symposium on High Performance Thin-Layer Chromatography sind gestellt: Es wird stattfinden vom 6. bis 8. Juli 2011, und zwar in Basel.

Damit wird die Reihe der Veranstaltungen fortgesetzt, die mit dem Symposium 1980 in Bad Dürkheim ins Leben gerufen wurde und deren bisher letzte 2006 in Berlin und 2008 in Helsinki stattfanden. Bitte reservieren Sie sich den Termin und überlegen Sie, ob Sie einen Vortrag oder ein Poster anmelden wollen. Das erste Zirkular mit Call for Papers wird Ende dieses Jahres herausgehen und im nächsten CBS wiederholt werden.

Die Beiträge der weissen Seiten des vorliegenden CBS-Hefts, die die Analyse von Farbstoffzusätzen in Lebensmitteln thematisieren, belegen wiederum eindrucksvoll, wie man mit der HPTLC schnell und kostengünstig anspruchsvolle, analytische Aufgaben lösen kann. U.a. werden für den Nachweis unzulässiger Farbstoffe in Gewürzen alternativ zwei Methoden dargestellt, die sich durch Probenvorbereitung und das chromatographische System unterscheiden, jedoch gleichermassen die analytische Fragestellung lösen.

Der Beitrag Schwack/Pellissier schliesst die rasche Identifizierung durch UV/Vis-Spektrensuche und HPTLC-MS-Spektren mit ein. Dabei wird eine interessante MS-Software angesprochen, mit der die Massengenauigkeit verbessert und die Trefferquote für die richtige Summenformel erhöht werden.

Sie sehen, die Planar-Chromatographie bewegt sich auf wissenschaftlich anspruchsvollem Gebiet.

Mit freundlichen Grüssen

*Gerda Morlock*

Gerda Morlock  
cbs@camag.com

Dear friends

Preparations for the next International Symposium on High Performance Thin-Layer Chromatography are already in progress. It will be held in Basel, 6<sup>th</sup>–8<sup>th</sup> of July 2011. It will continue the series of international conferences that began with the symposium in Bad Dürkheim, Germany in 1980, the latest two being held in Berlin 2006 and Helsinki 2008. Please reserve the date and start planning your participation, whether it will be a paper or a poster presentation or just attending. The first circular with a call for papers will go out at the end of this year and will also be included in the spring edition of CBS.



The contributions on the white pages of this CBS focusing on the analysis of illegal dyes in food prove once more the suitability of HPTLC for solving demanding analytical tasks rapidly and cost effectively. Two applications describe the identification of unauthorized dyes in spices by two alternative methods, each employing different ways of sample cleanup und different chromatographic systems. Both are solving the analytical task.

The contribution of Schwack/Pellissier includes the rapid identification by HPTLC-MS spectra and by UV/Vis spectra search. In this paper an interesting MS software is employed which significantly improves mass accuracy, thus greatly enhancing the score rate for a correct sum formula.

You see, planar chromatography is well established in scientifically demanding fields.

Sincerely,

*Gerda Morlock*

Gerda Morlock  
cbs@camag.com

**CAMAG**

SEPTEMBER  
2009

**103**

# THE CBS CLASSIFICATION SYSTEM

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- 1. Reviews and books**
  - a) Books on TLC
  - b) Books containing one or several chapters on TLC
  - c) Books containing frequent TLC information spread over several chapters of other information
- 2. Fundamentals, theory and general**
  - a) General b) Thermodynamics and theoretical relationship
  - c) Relationship between structure and chrom. behaviour
  - d) Measurement of physico-chemical and related values
  - e) Optimization of solvent systems
  - f) Validation of methods
- 3. General techniques** (unless they are restricted to the application within one or two classification sections)
  - a) New apparatus/techniques for sample preparation
  - b) Separation material
  - c) New apparatus for sample application/dosage
  - d) New apparatus/techniques for chromatogram development
  - e) New apparatus/techniques for pre- or post-chromatographic derivatization
  - f) New apparatus/techniques for quantitative evaluation
  - g) New apparatus/techniques for other TLC steps (distinguished from section 4)
- 4. Special techniques**
  - a) Automation of sample preparation/application
  - b) Automation of complex chromatogram developing techniques
  - c) Automation, computer application in quantitative chromatogram evaluation
  - d) Combination of TLC with other chromatographic techniques
  - e) Combination of TLC with other (non-chromatographic) techniques...MS, IR...etc.
- 5. Hydrocarbons and halogen derivatives**
  - a) Aliphatic hydrocarbons
  - b) Cyclic hydrocarbons
  - c) Halogen derivatives
  - d) Complex hydrocarbon mixtures
- 6. Alcohols**
- 7. Phenols**
- 8. Substances containing heterocyclic oxygen**
  - a) Flavonoids
  - b) Other compounds with heterocyclic oxygen
- 9. Oxo compounds, ethers and epoxides**
- 10. Carbohydrates**
  - a) Mono- and oligosaccharides, structural studies
  - b) Polysaccharides, mucopolysaccharides, lipopolysaccharides
- 11. Organic acids and lipids**
  - a) Organic acids and simple esters
  - b) Prostaglandins
  - c) Lipids and their constituents
  - d) Lipoproteins and their constituents
  - e) Glycosphingolipids (gangliosides, sulfatides, neutral glycosphingolipids)
- 12. Organic peroxides**
- 13. Steroids**
  - a) Pregnane and androstane derivatives
  - b) Estrogens
  - c) Sterols
  - d) Bile acids and alcohols
  - e) Ecdysones and other insect steroid hormones
- 14. Steroid glycosides, saponins and other terpenoid glycosides**
- 15. Terpenes and other volatile plant ingredients**
  - a) Terpenes
  - b) Essential oils
- 16. Nitro and nitroso compounds**
- 17. Amines, amides and related nitrogen compounds**
  - a) Amines and polyamines
  - b) Catecholamines and their metabolites
  - c) Amino derivatives and amides (excluding peptides)
- 18. Amino acids and peptides, chemical structure of proteins**
  - a) Amino acids and their derivatives
  - b) Peptides and peptidic proteinous hormones
- 19. Proteins**
- 20. Enzymes**
- 21. Purines, pyrimidines, nucleic acids and their constituents**
  - a) Purines, pyrimidines, nucleosides, nucleotides
  - b) Nucleic acids, RNA, DNA
- 22. Alkaloids**
- 23. Other substances containing heterocyclic nitrogen**
  - a) Porphyrins and other pyrroles
  - b) Bile pigments
  - c) Indole derivatives
  - d) Pyridine derivatives
  - e) other N-heterocyclic compounds
- 24. Organic sulfur compounds**
- 25. Organic phosphorus compounds** (other than phospholipids)
- 26. Organometallic and related compounds**
  - a) Organometallic compounds
  - b) Boranes, silanes and related non-metallic compounds
  - c) Coordination compounds
- 27. Vitamins and various growth regulators** (non-peptidic)
- 28. Antibiotics, Mycotoxins**
  - a) Antibiotics
  - b) Aflatoxins and other mycotoxins
- 29. Pesticides and other agrochemicals**
  - a) Chlorinated insecticides
  - b) Phosphorus insecticides
  - c) Carbamates
  - d) Herbicides
  - e) Fungicides
  - f) Other types of pesticides and various agrochemicals
- 30. Synthetic and natural dyes**
  - a) Synthetic dyes
  - b) Chloroplasts and other natural pigments
- 31. Plastics and their intermediates**
- 32. Pharmaceutical and biomedical applications**
  - a) Synthetic drugs
  - b) Pharmacokinetic studies
  - c) Drug monitoring
  - d) Toxicological applications
  - e) Plant extracts, herbal and traditional medicines
  - f) Clinico-chemical applications and profiling body fluids
- 33. Inorganic substances**
  - a) Cations
  - b) Anions
- 34. Radioactive and other isotopic compounds**
- 35. Other technical products and complex mixtures**
  - a) Surfactants
  - b) Antioxidants and preservatives
  - c) Various specific technical products
  - d) Complex mixtures and non-identified compounds
- 36. Thin-layer electrophoresis**
- 37. Environmental analysis**
  - a) General papers
  - b) Air pollution
  - c) Water pollution
  - d) Soil pollution
- 38. Chiral separations**

## 1. Reviews and books

- 103 001 J. SHERMA (Department of Chemistry, Lafayette College, Easton, Pennsylvania 18042, USA; shermaj@lafayette.edu): Planar chromatography. *Anal. Chem.* 80, 4253-4267 (2008). This review covers the literature of TLC and HPTLC found by computer-assisted searching in Chem. Abstr. and the ISI Web of Science from November 1 2005 to November 1 2007 augmented by Analytical Abstracts and the following journals: *J. Chromatogr. A and B*, *J. Chromatogr. Sci.*, *Chromatographia*, *Anal. Chem.*, *J. Liq. Chromatogr. Relat. Technol.*, *J. AOAC Int.*, *J. Planar Chromatogr.*, *Acta Chromatographica*, books, and reviews with the following chapters (number of citations): history (22), theory and fundamental studies (19); chromatographic systems (28); apparatus and techniques (32); detection and identification (46): chemical detection, biological detection, TLC/mass spectrometry, TLC coupled with other spectrometric methods; quantitative analysis (56): technique and instruments as well as applications; preparative layer chromatography (4); radiochromatography (6).

review

1

- 103 002 L.R. SNYDER (LC Resources, 26 Silverwood Ct, Orinda, CA 94563, USA; snyder0036@comcast.net): Solvent selectivity in normal-phase TLC. *J. Planar Chromatogr.* 21, 315-323 (2008). The role of the mobile phase in controlling selectivity for adsorption chromatography - with either thin-layer plates or columns - is reviewed and expanded. The use of different solvent mixtures of varying selectivity in normal-phase chromatography is now on a firm theoretical and practical basis. The choice of a more polar component (B-solvent) of a binary solvent mixture (A/B) largely determines relative retention and resolution. Maximum differences in selectivity are achieved by the use of two mobile phases where the B-solvent is either very polar (requiring a lower % B for desirable values of k) or relatively nonpolar (requiring a higher % B).

review

1, 2e

## 2. Fundamentals, theory and general

- 103 003 V.G. BEREZKIN (A. V. Topchiev Institute of Petrochemical Synthesis, Russian Academy of Sciences, Leninskii pr. 29, Moscow, 117912 Russia; berezkin@ips.ac.ru): Development of nontraditional planar chromatographic methods. *J. Planar Chromatogr.* 21, 325-329 (2008). Development and systematization of nontraditional TLC methods, in which the chromatographic process occurs in a closed absorption layer on a standard TLC plate. The advantages and limitations of the methods were assessed and the expediency of their further development and wider use in practical TLC was proved.

review

2a

- 103 004 T. DZIDO\*, P. PLOCHARZ, P. SLAZAK, Aneta HALKA (\*Department of Physical Chemistry, Medical University, Staszica 6, 20-081 Lublin, Poland, tadeusz.dzido@am.lublin.pl): Progress in planar electrochromatography. *Anal. Bioanal. Chem.* 391, 2111-2118 (2008). Review of developments in planar electrochromatography in open (PEC) and closed (PPEC) systems regarding the progress in chamber construction for planar electrochromatography, separating system performance, equilibration of the PPEC process, separation time and selectivity, and the general advantages, disadvantages and prospects of this separation mode. PPEC of 4-cholesten-3-one, 4-androsten-17 $\alpha$ -ol-3-one acetate, 17 $\beta$ -acetoxyprogesterone, androstenedione, 4-pregnen-11 $\beta$ -ol-3,20-dione, benzanilide, o-nitroaniline, hydrocortisone alcohol, and benzamide on RP-18 with 55 % aqueous acetonitrile containing 5 mM acetate buffer (pH 4.7) at 9 kV and under a pressure of 63 atm.

review, planar electrochromatography

2a

- 103 005 J.D. FAIR\*, CH.M. KORMOS (\*Department of Chemistry, University of Connecticut, 55 North Eagleville Road, Unit 3060, Storrs, CT 06269-3060, USA): Flash column chromatograms estimated from thin-layer chromatography data. *J. Chromatogr. A* 1211 (1-2), 49-54 (2008). Present-

tation of a spreadsheet that provides information on the amount of silica gel needed, the optimal fraction size, and the degree of separation to be expected before flash chromatography is attempted. Information is based on sample mass and TLC data given. This is the first utility of its kind to accurately estimate the retention volume and band volume of analytes, as well as the fraction numbers expected to contain each analyte, and the resolution between adjacent peaks. The information allows users to select optimal parameters for preparative-scale separations before the flash column itself is attempted; ensuring a successful first separation.

preparative TLC, flash chromatography

2d

- 103 006 Jolanta FLIEGER\*, R. SWIEBODA, M. TATARCZAK (\*Department of Inorganic and Analytical Chemistry, Medical University of Lublin, 20-081 Lublin, Staszica 6, Poland): Chemometric analysis of retention data from salting-out thin-layer chromatography in relation to structural parameters and biological activity of chosen sulphonamides. *J. Chromatogr. B* 846 (1-2), 334-340 (2007). Salting-out TLC of sulphonamides on silica gel with aqueous solutions of salts (sulphates, chlorides, nitrates, phosphates, acetates, and thiocyanates) showed that the applied salts have different effects on the retention of sulphonamides according to Hofmeister's classification (e.g. kosmotropes, chaotropes and neutral). Parameters of the linear regression analysis were compared with QSAR data of dependences between the RM values and salt concentration. Chromatographic data obtained by salting-out TLC showed not only the physico-chemical properties of the examined compounds but also information about their activity. The method was suitable for prediction and classification of sulphonamide drugs by localization of other structurally similar compounds with antagonistic activity towards sulphonamides.

doping, HPTLC, quantitative analysis, qualitative identification

2c

- 103 007 L. KOMSTA (Department of Medicinal Chemistry, Skubiszewski Medical University, Jaczewskiego 4, 20-090 Lublin, Poland): Prediction of the retention in thin layer chromatography screening systems by atomic contributions. *Anal. Chim. Acta* 593 (2), 224-237 (2007). Presentation of a novel atomic-contribution system for predicting RM values by TLC on silica gel with 13 screening systems where the large experimental datasets (198-761 RM values) are available. RM values could be predicted with less than 0.5 % error in the majority of solutes (besides several outliers), which corresponds to an hRf value difference of 28 in the worst case. Validation of the system by dividing the data into training and validation datasets, proving its accuracy. The main reason for outliers were large conjugated heterocycles, quarternary ammonium cations, large amount of polar atoms or very simple but unique molecules. The method involves easy manual calculation and no need for a software. It was applied to predict retention of new compounds in existing chromatographic screening systems.

cosmetics, HPTLC, qualitative identification

2c

- 103 008 S. NYIREDY (Research Institute for Medicinal Plants, Budakalász, Hungary): Multidimensional planar chromatography. *LC-GC Europe Applications* 16, 2-9 (2003). Overview of various multidimensional planar chromatography (MD-PC) techniques: Comprehensive two-dimensional PC (PC x PC), targeted or selective two-dimensional PC (PC x PC), modulated two-dimensional PC (nPC), coupled-layer PC (PC-PC), combined MD-PC methods (cMD-PC).

comparison of methods, review

2a

- 103 009 J. SHERMA (Department of Chemistry, Lafayette College, Easton, Pennsylvania 18042, USA): Planar chromatography. *Anal. Chem.* 76, 3251-3262 (2004). This review covers the literature of TLC/HPTLC found in Chemical Abstracts and ICI Web of Science from November 1, 2001 to November 1, 2003. Review Contents: 1. History, Student Experiments, Books, and Reviews; 2. Theory and Fundamental Studies; 3. Chromatographic Systems (Stationary and Mobile Phases); 4. Apparatus and Techniques; 5. Detection and Identification of Separated Zones; 6. Quantitative Analysis; 7. Preparative-Layer Chromatography and Thin-Layer Radiochromatography 8. Literature Cited:

review, preparative TLC, quantitative analysis, qualitative identification, postchromatographic derivatization

2a

- 103 010 J. SHERMA (Department of Chemistry, Lafayette, College, Easton, Pennsylvania 18042, USA): Planar chromatography. *Anal. Chem.* 74, 2653-2662 (2002). This review covers the literature of TLC/HPTLC found in Chemical Abstracts and ICI Web of Science from November 1, 1999 to November 1, 2001. Review Contents: 1. History, Student Experiments, Books, and Reviews; 2. Theory and Fundamental Studies; 3. Chromatographic Systems (Stationary and Mobile Phases); 4. Apparatus and Techniques; 5. Detection and Identification of Separated Zones; 6. Quantitative Analysis; 7. Preparative-Layer Chromatography and Thin-Layer Radiochromatography 8. Literature Cited.

review, preparative TLC, quantitative analysis, qualitative identification, postchromatographic derivatization 2a

- 103 002 L.R. SNYDER, see section 1

### 3. General techniques

- 103 011 Virginia COMAN\*, S. KREIBIK. M. VLASSA (\*"Babes-Bolyai" University, „Raluca Ripan" Institute for Research in Chemistry, Fântânele 30, 400294 Cluj-Napoca, Romania; coman\_virginia@yahoo.com): Planar dielectrochromatography in a vertical chamber. *J. Planar Chromatogr.* 21, 373-378 (2008). TLC of a lipophilic test dye mixture (indophenol blue, Sudan red G, 4-dimethylaminoazobenzene) on aluminum oxide in a vertical planar dielectrochromatography chamber with toluene and benzene. Evaluation by densitometric absorbance measurement at 506 nm. In classical TLC the mobile phase is drawn by capillary forces therefore its flow velocity is inversely related to the distance migrated by the solvent front. For this reason classical TLC may be time-consuming. To improve the separation selectivity suitable transverse alternating electric fields were used in planar electrochromatography to modify the mobile phase front velocity and the migration distance of solutes. Resolution was improved in the countercurrent arrangement of the instrument.

densitometry

3d

- 103 012 Y. LI (Li Yulan)\*, L. LI (Li Li), J. XU (Xu Jianan) (\*Zhejiang Parm. Coll., Ningbo, Zhejiang 311100, China): (Study on temperature controlled apparatus and its application in pharmaceutical analysis) (Chinese). *Chinese J. Modern App. Pharm.* 25 (4), 348-350 (2008). Description of an apparatus for the temperature control of the TLC separation process. The operational temperature below room temperature is adjusted by using semi-conductor refrigeration. Temperatures above room temperature are controlled by hot thread heating. Good reproducibility of  $R_f$  values is obtained with the apparatus.

temperature controlled development

3d

- 103 124 O. MORINAGA et al., see section 32e

- 103 013 D. NUROK \*, J. KOERS, A. NOVOTNY, M. CARMICHAEL, J. KOSIBA, R. SANTINI, G. HAWKINS, R. REPLOGLE (\*Department of Chemistry, Indiana University-Purdue University, 402 N. Blackford Street, Indianapolis, Indiana 46202, USA): Apparatus and initial results for pressurized planar electrochromatography. *Anal. Chem.* 76, 1690-1695 (2004). Pressurized planar electrochromatography (PPEC) is a new planar chromatographic technique in which the mobile phase is driven by electroosmotic flow, while the sorbent layer is pressurized in a manner that allows heat to flow from the layer through an electrically insulating, thermally conducting sheet of aluminum nitride ceramic. Separation in a PPEC prototype apparatus is faster than by conventional TLC, and an example is presented of a 24-fold enhancement in the speed of separation. PPEC was performed on TLC and HPTLC RP-18 phases which required conditioning at elevated temperature before use. Solute migration velocity increases with temperature. The flow rate increases in a linear manner with increasing voltage and diminishes in a nonlinear manner with increasing pressure. Both electrical current and Joule heating diminish with increasing pressure,

and the diminution of flow at high pressure can be compensated by an increase in voltage. PPEC is more efficient than classical TLC. Theoretical plate heights diminish with increasing  $hR_f$  and are in the range 29-21 and 55-27  $\mu\text{m}$  for the HPTLC and TLC, respectively. PPEC retains the advantages of classical TLC, but has the ability to separate a substantially higher number of samples. An example is presented on the separation of nine samples in 1 min.

HPTLC, pressurized planar electrochromatography

3d

- 103 014 T. TANG (Tang Tie-Xin)\*, H. WU (Wu Hong) (\*Center for Medicinal Plants Research, South China Agricultural University, 510642 Guangzhou, China): Research on color channel selection, three-dimensional visualization, and acquisition time of computerized image analysis for one-dimensional planar separation. *Chromatographia* 70 (1-2), 305-308 (2009). Description of color channel selection, three-dimensional visualization, and acquisition time of computerized image analysis for one-dimensional planar separation, known as computerized image analysis or video densitometry. This is an efficient, low-cost technique for quantitative and qualitative analysis of planar separations, e.g. planar chromatography and gel electrophoresis. The image of the TLC plate is captured in black and white, then the proper color channel of the image is selected in order to enhance the signal-to-noise ratio. To facilitate image evaluation a three-dimensional visualization of the planar image was applied by use of OpenGL technology. It was found that the sensitivity is increased by use of longer acquisition times whereas linearity of quantitative analysis is reduced.

doping, pharmaceutical research, HPTLC, quantitative analysis, densitometry, qualitative identification

3f

- 103 015 E. TYIHAK\*, Á. M. MORICZ, P. G. OTT (\*Plant Protection Institute, Hungarian Academy of Sciences, Herman Ottó Str. 15, P. O. B. 102, 1525 Budapest, Hungary; [etyih@nki.hu](mailto:etyih@nki.hu)): Use of the BioArena system for indirect detection of endogenous ozone in spots after TLC or OPLC separation. *J. Planar Chromatogr.* 21, 77-82 (2008). Ozone can be detected indirectly in TLC or OPLC zones by use of the bioautographic BioArena system and ozone-eliminating molecules (e.g. d-limonene and indigo carmine) in the culture medium. TLC and OPLC of test substances (trans-resveratrol, aflatoxin B1) on silica gel with a variety of mobile phases (e. g. chloroform - methanol 10:1). The developed and dried TLC plates were immersed in a bacterial suspension of *Pseudomonas savastanoi* for 20 s. Visualization of the chromatograms with MTT was performed either after a short draining period or after overnight incubation.

qualitative identification, bioautography

3e

- 103 016 R. ZAKRZEWSKI\*, W. CIESIELSKI, A. ULANOWSKA, R. MARTINEZ (\*Department of Instrumental Analysis, University of Lodz, Lodz, Poland, [robzak@chemul.uni.lodz.pl](mailto:robzak@chemul.uni.lodz.pl)): 2,4,6-triphenylpyrylium cations as derivatization reagents for sulfide ions detection in TLC. *Phosphorus, Sulfur Silicon Relat. Elem.* 184, 1139-1148 (2009). The new TLC system for sulfide ions detection is based on the use of 2,4,6-triphenylpyrylium salts as pre-chromatographic derivatization reagents. The cations L1 (2,4,6-triphenylpyrylium) or LN1 (4-[p-(N,N-dimethylamino) phenyl]-2,6-diphenylpyrylium) were used in the derivatization reactions in a tube or directly on the TLC plate before the developing step. TLC of L1 on silica gel with methanol - dichloromethane 1:5. TLC of LN1 on cellulose with phosphoric buffer (pH 6.0) - acetonitrile - 1,4-dioxane 4:2:1. The detection procedure allows selective and sensitive detection for sulfide anions at several dozen pmol/spot.

environmental, quantitative analysis

3e

#### 4. Special techniques

- 103 017 W. CHAI\*, Christine LETEUX, A. LAWSON, M. STOLL (\*MRC Glycosciences Laboratory, Imperial College School of Medicine, Northwick Park Hospital, Watford Road, Harrow, Middlesex HA1 3UJ, U.K., [w.chai@ic.ac.uk](mailto:w.chai@ic.ac.uk)): On-line overpressure thin-layer chromatographic separation and electrospray mass spectrometric detection of glycolipids. *Anal. Chem.* 75, 118-125

(2003). Online TLC separation and electrospray mass spectrometry (TLC/ESI-MS) by direct linking of a commercial overpressure TLC instrument, OPLC 50, and a Q-TOF mass spectrometer. Separation on silica gel with dichloromethane - methanol - water 60:35:8. A sensitivity of 5 pmol of glycosphingolipid was readily demonstrated for TLC/ESI-MS and 20 pmol for TLC/ESI-MS/MS production scanning to derive the saccharide sequence and long chain base/fatty acid composition of the ceramide. Initial preconditioning of TLC plates is necessary to achieve high sensitivity detection by reducing chemical background noise. Plates can be used repeatedly (at least 10 times) for analysis, although this may result in a minor reduction in TLC resolution. Following solvent development, separated components on the TLC plates can be detected in the conventional way by nondestructive staining or UV absorption or fluorescence and can be stored for on-line TLC/ESI-MS analysis at a later stage without reduction in mass spectrometric detection sensitivity and chromatographic resolution. Aspects for further improvement of OPLC instrumentation include use of narrower TLC plate dimensions and refined design of the eluate exit system.

qualitative identification, HPTLC, OPLC

4e, 11e

- 103 018 Irena CHOMA (Department of Chromatographic Methods, M. Curie-Sklodowska University, Lublin, Poland): The use of thin-layer chromatography with direct bioautography for antimicrobial analysis. *LC-GC Europe* 18, 482-488 (2005). Contact Bioautography: Antimicrobials diffusion from a TLC plate to an inoculated agar plate. The chromatogram is placed face down onto the inoculated agar layer and left for some minutes or hours for diffusion. After removing the plate the inhibition zones are observed on the agar surface in the places where the spots of antimicrobials are stuck to the agar. The method resembles a disk assay. Immersion Bioautography: The chromatogram is covered with a molten, seeded agar medium. After solidification, incubation and staining (usually with tetrazolium dye) the inhibition or growth bands are visualized. Direct Bioautography: A developed plate is dipped in the suspension of microorganisms growing in a suitable broth or this suspension is sprayed onto the plate. The plate is incubated and microorganisms grow directly on it. It can be performed with *Photobacterium phosphoreum* (*Vibrio fischeri*) suspension. Bioautography systems and coupling possibilities are presented.

food, analysis, qualitative identification, comparison of methods, bioautography 4e

- 103 019 Anna CRECELIUS\*, M. CLENCH, D. RICHARDS (\*Biomedical Research Centre, Sheffield Hallam University, Sheffield, UK): TLC-MALDI in pharmaceutical analysis. *LC-GC Europe* 16, 2-5 (2003). Overview of utility of the technique for the identification and quantification of pharmaceutical compounds and related substances such as UK-137,457 (C<sub>31</sub>H<sub>31</sub>NO<sub>5</sub>) and UK-124,912 (C<sub>27</sub>H<sub>25</sub>NO<sub>3</sub>). Several of the issues that have arisen in the development of TLC-MALDI-MS methods for the successful analysis of pharmaceuticals were addressed in this article. Electrospray deposition method, which was found to be superior to other methods studied and was successfully applied to a range of compounds presented, concerns a method for the deposition of the MALDI matrix onto the TLC plate. Post-source decay analysis can be performed directly on the TLC spots, to aid in structural evaluation of the analyzed compounds. The generation of quantitative data using a structural analogue as internal standard and incorporation into the mobile phase has also been demonstrated. Outlook for next step development of TLC-MALDI-MS in pharmaceutical analysis for more widespread use in industry: enhance sensitivity, mass resolution and reproducibility, availability of commercial instruments that allow the scanning of whole TLC plates rapidly with data-imaging software.

pharmaceutical research, quantitative analysis, qualitative identification, TLC-MALDI-MS

4e

- 103 020 K. DREISEWERD\*, J. MUTHING, A. ROHLFING, Iris MEISEN, Zeljka VUKELIC, Jasna PETER-KATALINIC, F. HILLENKAMP, S. BERKENKAMP (\*Institute of Medical Physics and Biophysics, Westfälische Wilhelms-Universität Münster, 48149 Münster, Germany, Klaus.Dreisewerd@uni-muenster.de): Analysis of gangliosides directly from thin-layer chromatography plates by infrared matrix-assisted laser desorption/ionization orthogonal time-of-flight mass spectrometry with a glycerol matrix. *Anal. Chem.* 77, 4098-4107 (2005). Novel method for direct

coupling of HPTLC with matrix-assisted laser desorption/ionization mass spectrometry (MALDI-MS) for the analysis of biomolecules. HPTLC of gangliosides on silica gel with chloroform - methanol - water 24:17:4 containing 2 mM calcium chloride, with chamber saturation for 20 min. Detection by dipping for 10 s in 0.3 % (w/v) orcinol in 3 M sulfuric acid, followed by heating at 110 °C. Use of a glycerol as matrix, which provides a homogeneous wetting of the silica gel and a simple and fast preparation protocol. Use of an Er:YAG infrared laser, which ablates layers of 10 µm thickness of analyte-loaded silica gel and provides a soft desorption/ionization of even very labile analyte molecules. The orthogonal time-of-flight mass spectrometer employed in this study, finally provides a high accuracy of the mass determination, which is independent of any irregularity of the silica gel surface. The method is demonstrated by the compositional mapping of a native GM3 (II3-r- Neu5Ac-LacCer) ganglioside mixture from cultured Chinese hamster ovary cells. The analysis is characterized by a high relative sensitivity, allowing the simultaneous detection of various major and minor GM3 species directly from analyte bands. The lateral resolution of the direct HPTLC-MALDI-MS analysis is defined by the laser focus diameter of currently 200 µm. This allows one to determine mobility profiles of individual species with a higher resolution than by reading off the chromatogram by optical absorption.

HPTLC, MALDI-MS

4e, 11e

- 103 021 Beate FUCHS, J. SCHILLER\*, Rosmarie SÜSZ, M. SCHÜRENBERG, D. SUCKAU (\*Faculty of Medicine, Institute of Medical Physics and Biophysics, University of Leipzig, Härtelstr. 16-18, 04107 Leipzig, Germany, juergen.schiller@medizin.uni-leipzig.de): A direct and simple method of coupling matrix-assisted laser desorption and ionization time-of-flight mass spectrometry (MALDI-TOF MS) to thin-layer chromatography (TLC) for the analysis of phospholipids from egg yolk. *Anal. Bioanal. Chem.* 389, 827-834 (2007). A total extract of hen egg yolk is used as phospholipid mixture to demonstrate the capabilities. TLC of phosphatidylcholine, lysophosphatidylcholine, sphingomyelin, phosphatidylethanolamine, lysophosphatidylethanolamine and phosphatidylinositol on silica gel with chloroform - ethanol - water - triethylamine 5:5:1:5. Detection under UV 366 nm after spraying with primuline (Direct Yellow 59) reagent. Direct coupling MALDI-TOF MS and TLC can be easily implemented on commercially available MALDI-TOF devices. Roughly clean spectra without major contributions from fragmentation products and matrix peaks were obtained. This approach was sensitive enough to detect the presence of phospholipids at levels of less than 1 % of the total extract.

clinical chemistry research, food, analysis, qualitative identification, coupling TLC/MALDI-TOF MS

4e, 11c

- 103 022 Beate FUCHS, J. SCHILLER\*, Rosmarie SÜSZ, M. ZSCHARNACK, A. BADER, P. MÜLLER, M. SCHÜRENBERG, M. BECKER, D. SUCKAU (\*Faculty of Medicine, Institute of Medical Physics and Biophysics, University of Leipzig, Härtelstrasse 16-18, 04107 Leipzig, Germany, juergen.schiller@medizin.uni-leipzig.de): Analysis of stem cell lipids by offline HPTLC-MALDI-TOF MS. *Anal. Bioanal. Chem.* 392, 849-860 (2008). HPTLC of cell lipids on silica gel with chloroform - ethanol - water - triethylamine 5:5:1:5. Detection under UV 366 nm after spraying with primuline (Direct Yellow) reagent. Coupling with MALDI-TOF-MS which is traditionally used for proteomics, but is also a useful tool for lipid analysis. Depending on the applied matrix, however, some lipid classes are more sensitively detected than others and this may even lead to suppression effects if complex mixtures are analyzed. Therefore, a previous separation into the individual lipid classes is necessary. Using artificial lipid mixtures or easily available tissue extracts, it has already been shown that lipids can be conveniently analyzed by MALDI-TOF MS directly on the TLC plate. An initial TLC-MALDI-TOF-MS study of the lipid composition of ovine mesenchymal stem cells is presented. Due to the complex composition of these cells, data are also compared to lipids extracted from human erythrocytes. Even very minor lipid classes can be easily detected and with much higher sensitivity than by common staining protocols. clinical chemistry research, HPTLC, qualitative identification, MALDI-TOF MS

4e, 11c

- 103 055 R. HADDAD et al., see section 17



103 023 F.L. HSU, C.H. CHEN, C.H. YUAN, J. SHIEA\* (\*Department of Chemistry, National Sun Yat-Sen University, Kaohsiung, Taiwan, jetea@mail.nsysu.edu.tw): Interfaces to connect thin-layer chromatography with electrospray ionization mass spectrometry. *Anal. Chem.* 75, 2493-2498 (2003). Development of two interfaces to connect small-size thin-layer chromatography with electrospray ionization mass spectrometry (ESI-MS) for the continuous analysis of organic mixtures. The interfaces were 1) two bound optical fibers inserted into the RP-18 particles at the exit of a small TLC channel; 2) a small commercial TLC strip with a sharpened tip. A reservoir continuously supplied a makeup solution to the tip of the TLC channel. The high voltage required for electrospray ionization was introduced into the makeup solution or mobile phase through a Pt wire, and electrospray was generated at the tip of the bonded optical fibers and at the sharp end of the TLC strip. Since small-size TLC channels were used, the elution time was short and less than 0.2  $\mu\text{L}$  of sample solution and 200  $\mu\text{L}$  of solvent were required.

HPTLC, qualitative identification, ESI-MS

4e

103 101 W. HUANG et al., see section 32e

103 024 Vera IVLEVA, Y. ELKIN, B. BUDNIK, Susanne MOYER, P. O'CONNOR, Catherine COSTELLO\* (\*Mass Spectrometry Resource, Cardiovascular Proteomics Center, and Department of Biochemistry, Boston University, School of Medicine, 715 Albany Street R-806, Boston, Massachusetts 02118-2526, USA, cecmsms@bu.edu): Coupling thin-layer chromatography with vibrational cooling matrix-assisted laser desorption/ionization fourier transform mass spectrometry for the analysis of ganglioside mixtures. *Anal. Chem.* 76, 6484-6491 (2004). TLC on silica gel with chloroform - methanol - 0.2 % calcium chloride 11:9:2 or chloroform - 2-propanol - 50 mM potassium chloride 10:67:23 for separation of glycolipids, oligosaccharides, lipids, and compounds of environmental and pharmaceutical interest with coupling to an external ion source MALDI-Fourier transform (FT) MS instrument without compromising mass accuracy and resolution of the spectra. Furthermore, when the FTMS, with >70 000 resolving power, has a vibrationally cooled MALDI ion source, fragile glycolipids can be desorbed from TLC plates without fragmentation, even to the point that desorption of intact molecules from „hot“ matrixes such as *a*-cyano-4-hydroxycinnamic acid is possible. TLC of whole brain gangliosides derivatized with orcinol-sulfuric acid reagent. The positions of the fractions on a parallel developed plate were determined; the TLC plates were attached directly to the MALDI target using double-sided adhesive tape or the strip cut from TLC plate. Different matrixes were tested.

MALDI-MS

4e, 11e

103 168 J.P. LAFLEUR et al., see section 33a

103 025 M. LOPPACHER\*, R. ROLLI (\*CAMAG, Sonnenmattstr. 11, 4132 Muttenz, Switzerland, matthias. loppacher@camag.com): The new TLC-MS interface. *CBS* 102, 2-3 (2009). A semi-automatic interface for hyphenation of TLC with mass spectrometry, which was based on the ChromeXtractor by Luftmann, is introduced. The interface is connected to a HPLC pump and the MS. By means of an extraction piston any target zone can be eluted from a TLC/HPTLC plate directly into the MS. Example: for identification of the zone at  $R_f$  15 in a standard mixture of caffeine, paracetamol, and acetylsalicylic acid the mass spectrum of the zone is recorded. After subtraction of a background spectrum a mass spectrum free from system peaks is obtained, which shows mainly substance signals - here the mass signal  $m/z$  195  $[M+H]^+$  for caffeine.

HPTLC

4e

103 073 Iris MEISEN et al., see section 28b

103 026 Gertrud MORLOCK\*, Ute JAUTZ (\*University of Hohenheim, Institute of Food Chemistry, Garbenstrasse 28, 70599 Stuttgart, Germany; gmorlock@uni-hohenheim.de): Comparison of two

different plunger geometries for HPTLC-MS coupling via an extractor-based interface. *J. Planar Chromatogr.* 21, 367-371 (2008). HPTLC of harmine (1-methyl-9H-pyrido[3,4-b]indole) and Glu-P-1 (2-amino-6-methyldipyrido[1,2-a:3',2'-d]imidazole) on silica gel (prewashed with methanol) in a flat-bottom chamber with diethyl ether - methanol 49:1 at a relative humidity of 42 % and a temperature of 26 °C. Before development, the activity and pH of the silica gel were adjusted in a saturated twin trough chamber with 20 % aqueous ammonia (25 %) for 15 min. Quantitative determination by fluorescence measurement at UV 366/>400 nm. HPTLC-MS coupling via an extractor-based interface using a circular and an oval plunger for extraction of the adjacent heterocyclic amines. The circular plunger was easier to position, however the oval plunger was shown to be optimal (more selective) for adjacent bands.

qualitative identification, quantitative analysis, HPTLC

4e

- 103 027 T. MROCZEK\*, Karine NDJOKO-IOSET, K. GLOWNIAK, Agnieszka MIETKIEWICZ-CAPALA, K. HOSTETTMANN (\*Department of Pharmacognosy with Medicinal Plants Laboratory, Medical University, 1 Chodzki St., 20-093 Lublin, Poland): Investigation of Symphytum cordatum alkaloids by liquid-liquid partitioning, thin-layer chromatography and liquid chromatography - ion trap mass spectrometry. *Anal. Chim. Acta* 566 (2), 157-166 (2006). Extraction of pyrrolizidine alkaloids from the alkalisated crude extract of Symphytum cordatum (L.) W.K. roots as free tertiary bases and polar N-oxides by one-step liquid-liquid partitioning and pre-fractionation by preparative multiple-development TLC on silica gel with chloroform - methanol - 25 % ammonia 50:5:1. Three alkaloid fractions of different polarities were obtained which showed different retention on silica gel: the most polar N-oxides had the highest retention, the tertiary bases had medium retention, and diesterified N-oxides had the lowest retention. Purification of the former fraction, which was reduced into free bases by sodium hydrosulfite, by liquid-liquid partitioning on Extrelut-NT3 cartridge. Further analysis by HPLC - ion-trap MS.

preparative TLC

4d, 22

- 103 028 G. VAN BERKEL\*, J. LLAVE, M. DE APADOCA, M. FORD (\*Organic and Biological Mass Spectrometry Group, Chemical Sciences Division, Oak Ridge National Laboratory, Oak Ridge, Tennessee 37831-6131, USA, vanberkelgj@ornl.gov): Rotation planar chromatography coupled on-line with atmospheric pressure chemical ionization mass spectrometry. *Anal. Chem.* 76, 479-482 (2004). Coupling of a rotation preparative layer chromatography system on-line with mass spectrometry using a simple plumbing scheme and a self-aspirating heated nebulizer probe of a corona discharge atmospheric pressure chemical ionization (APCI) source. The self-aspiration of the heated nebulizer delivers approx. 20 µL/min of the 3.0 mL/min eluate stream to the mass spectrometer, eliminating the need for an external pump in the system. The viability of the coupling is demonstrated with a three-dye mixture composed of fat red 7B, solvent green 3, and solvent blue 35 separated and eluted from a silica gel-coated rotor using toluene. The real-time characterization of the dyes eluting from the rotor is illustrated in positive ion full-scan mode. Other self-aspirating ion source systems including atmospheric pressure photoionization, electrospray ionization, and inductively coupled plasma ionization, for example, might be configured and used in a similar manner coupled to the chromatograph to expand the types of analytes that could be ionized, detected, and characterized effectively.

HPTLC, preparative TLC, APCI-MS

4e

- 103 029 G. VAN BERKEL\*, M. FORD, M. DEIBEL (\*Organic and Biological Mass Spectrometry Group, Chemical Sciences Division, Oak Ridge National Laboratory, Oak Ridge, Tennessee 37831-6131, USA, vanberkelgj@ornl.gov): Thin-layer chromatography and mass spectrometry coupled using desorption electrospray ionization. *Anal. Chem.* 77, 1207-1215 (2005). Desorption electrospray ionization (DESI) was demonstrated as a means to couple TLC with mass spectrometry. HPTLC of rhodamines on RP-2 and RP-8 with methanol - water 4:1 containing 200 mM ammonium acetate. HPTLC of FD&C dyes on RP-18 with water - acetone 7:3 containing 500 mM ammonium acetate. HPTLC of aspirin, acetaminophen and caffeine on silica gel with acetate - acetic acid 99:1. Tracks were scanned by moving the plate under computer control while directing the stationary DESI emitter charged droplet plume at the plate surface. Positioning of the DESI emitter,

plate surface, and the atmospheric sampling orifice of the mass spectrometer were found to be crucial for obtaining maximum analyte signal levels. Desorption ionization from all TLC phases was not equivalent.

HPTLC, DESI-MS

4e

103 064 G. VAN BERKEL et al., see section 22

103 161 G. XU et al., see section 32e

## 5. Hydrocarbons and halogen derivatives

103 030 Irena MALINOWSKA\*, M. STUDZINSKI, H. MALINOWSKI (\*Faculty of Chemistry, Department of Planar Chromatography, M. Curie-Sklodowska University, M. Curie-Sklodowska Sq. 3, 20-031 Lublin, Poland; irena.malinowska@poczta.umcs.lublin.pl): The effect of a magnetic field on the retention of polyaromatic hydrocarbons in planar chromatography. *J. Planar Chromatogr.* 21, 379-385 (2008). Magnetic fields can affect the retention and shape of the chromatographic bands of the solutes investigated. The effect depends on the type of mobile phase, the properties of the adsorbent layer and the mode of development of the chromatogram (development distance). TLC and HPTLC of diphenyl, pyrene, benzo[a]pyrene, phenanthrene, fluoranthene, and chrysene on silica gel with n-hexane, n-octane, carbon tetrachloride, cyclohexane, benzene, and toluene, and n-hexane - benzene and n-hexane - toluene binary mobile phases. Evaluation under UV light.

qualitative identification

5b

## 7. Phenols

103 031 T.H. DZIDO\*, P.W. PLOCHARZ, A. KLIMEK-TUREK, A. TORBICZ, B. BUSZEWSKI (\*Department of Physical Chemistry, Medical University, Lublin, Poland; tadeusz.dzido@am.lublin.pl): Pressurized planar electrochromatography as the mode for determination of solvent composition - retention relationships in reversed-phase systems. *J. Planar Chromatogr.* 21, 295-298 (2008). HPTLC of a test compound [1-(4-hydroxyphenylazo)-2-naphthol] on RP-18 (prewashed with methanol) with acetonitrile - water - buffer (pH 4.8) in the desired volume ratio in a horizontal developing chamber saturated for 15 min. Quantitative determination by absorbance measurement with a diode array TLC scanner. The retention-composition relationship obtained with TLC is similar to those of pressurized planar electrochromatography and HPLC in the modifier concentration range 60-80 % but deviates substantially at higher modifier concentrations.

comparison of methods, qualitative identification, HPTLC, physicochemical, organic chemistry

7

103 032 Vesna GLAVNIK\*, Breda SIMONOVSKA, Irena VOVK (\*National Institute of Chemistry, Laboratory for Food Chemistry, Hajdrihova 19, 1000 Ljubljana, Slovenia): Densitometric determination of (+)-catechin and (-)-epicatechin by 4-dimethylaminocinnamaldehyde reagent. *J. Chromatogr. A* 1216(20), 4485-4491 (2009). TLC of (+)-catechin and (-)-epicatechin on cellulose with water. Detection with 4-dimethylaminocinnamaldehyde in HCl produced blue bands. Detection with vanillin reagent produced quickly fading red spots. Quantitative determination by absorbance measurement at 655 nm. Linearity was between 2 to 12 ng/zone and a polynomial regression fit from 2 to 30 ng/zone. The repeatability of the separation of 20 ng/zone was 3.5 % (% RSD, n = 6). The visible limit of detection of both standards was 1 ng/zone, the densitometric limit of detection was 0.2 ng/zone. The optimized 4-dimethylaminocinnamaldehyde reagent is superior to the more frequently used vanillin reagent and is applicable also for determination of mixtures containing other catechins, such as (-)-catechin, (-)-epicatechin gallate, (-)-epigallocatechin gallate, procyanidin A2, procyanidin B1 and procyanidin B2.

herbal, HPTLC, densitometry

7

- 103 033 Monika WAKSMUNDZKA-HAJNOS\*, H. SMOLARZ, R. NOWAK (\*Department of Inorganic and Analytical Chemistry, Medical Academy, Staszica 6, 20-081 Lublin, Poland: Chromatographic separations of phenolic acids by normal-phase-TLC. Retention behaviour on polar adsorbents (silica gel, alumina, polyamide) with non-aqueous mobile phase. *Acta Chromatographica* 9, 38-54 (1999). TLC of salicylic acid, 3-hydroxybenzoic acid, 4-hydroxybenzoic acid, gentisic acid, protocatechuic acid, alpha-resorcylic acid, beta-resorcylic acid, gamma-resorcylic acid, gallic acid, vanillic acid, syringic acid, 3,5-dimethoxybenzoic acid, homoprotocatechuic acid, homogentisic acid, 4-coumaric acid, 2-coumaric acid, 3-coumaric acid, caffeic acid, ferulic acid, 3,4-dimethoxycinnamic acid, 2,5-dimethoxycinnamic acid, phloretic acid, hydrocaffeic acid, cinnamic acid on silica gel, alumina and polyamide layers with non-aqueous ternary mobile phases comprising a non-polar diluent (n-heptane), a polar modifier (2-propanol, dioxane, tetrahydrofuran or ethyl acetate) and 2 % glacial acetic acid to suppress the ionization of the solutes after preconditioning for 15 min in the mobile phase vapor. Detection at UV 254 nm and after derivatization by spraying with diazotized sulphanilic acid in 10 % sodium bicarbonate solution, or with a 2 % solution of iron chloride. The separation selectivity for benzoic acid derivatives was best on alumina for all the mobile phases investigated, especially for hydroxy derivatives. When methoxy derivatives of benzoic acid or cinnamic acid derivatives are separated the best selectivity was usually obtained on polyamide layers.

pharmaceutical research, herbal

7

## 8. Substances containing heterocyclic oxygen

- 103 034 Ildiko BROS\*, M.L. SORAN, R.D. BRICIU, S.C. COBZAC (\*National Institute for Research and Development of Isotopic and Molecular Technologies, 65-103 Donath Street, 400293 Cluj-Napoca, Romania; ildikobros@yahoo.com): HPTLC quantification of some flavonoids in extracts of *Satureja hortensis* L. obtained by use of different techniques. *J. Planar Chromatogr.* 22, 25-28 (2009). HPTLC of flavonoids (rosmarinic acid and luteoline) on silica gel with ethyl acetate - formic acid - water 136:5:6, ethyl acetate - methanol - water 77:13:10, ethyl acetate - diethyl ether 4:1, n-hexane - ethyl acetate - formic acid 60:40:3, chloroform - methanol - formic acid 882:60:47, and chloroform - acetone - formic acid 19:4:2. The mobile phase chosen for quantification was chloroform - ethyl acetate - formic acid 60:40:3. Detection by spraying with natural products reagent, followed by polyethylene glycol 400 reagent. Quantitative determination by densitometry at 328 nm (rosmarinic acid) and 349 nm (luteoline).

HPTLC, quantitative analysis, densitometry

8a

- 103 035 A. GUERRINI, R. BRUNI, S. MAIETTI, F. POLI, D. ROSSI, G. PAGANETTO, M. MUZZOLI, L. SCALVENZI, G. SACCHETTI\* (\*Department of Biology and Evolution, AgriUnife Center, University of Ferrara, C.so Ercole I d'Este 32, 44100 Ferrara, Italy, scg@unife.it): Ecuadorian stingless bee (*Meliponinae*) honey: A chemical and functional profile of an ancient health product. *Food Chem.* 114, 1413-1420 (2009). HPTLC of methanolic fractions of stingless bee honey samples and commercial samples from *Apis mellifera* (European honey bee) on silica gel with a five step development with two different mobile phases: ethyl acetate - formic acid - acetic acid - water 100:11:11:27 and toluene - ethyl acetate - acetic acid 10:9:1. Detection by fluorescence measurement at 400 nm and absorbance measurement at 240 nm, after fluorescence induction at 365 nm with a mercury vapor lamp. Detection of flavonoids by spraying with an aqueous solution of 4 % aluminium sulphate. Flavonoids and coumarins were identified by comparison with commercial standards.

food analysis, HPTLC, quantitative analysis, qualitative identification

8a

- 103 036 M. LIGOR, O. KORNYSOVA, A. MARUSKA, B. BUSZEWSKI\* (\*Chair of Environmental Chemistry and Bioanalysis, Faculty of Chemistry, Nicolaus Copernicus University, 7 Gagarin St, 87 100 Torun, Poland; bbusz@chem.uni.torun.pl): Determination of flavonoids in tea and Rooibos extracts by TLC and HPLC. *J. Planar Chromatogr.* 21, 355-360 (2008). TLC of flavonoids (myricetin, rutin, catechin, quercetin, and kaempferol) on silica gel in a horizontal chamber with acetone - chloroform - water 8:2:1. Detection by dipping in natural products reagent followed by dipping in

PEG reagent (polyethylene glycol 400 in ethanol). Evaluation under UV 254 and 366 nm.

food analysis, qualitative identification

8a

- 103 037 K. WANG (Wang Kunbo), Z. LIU\* (Liu Zhonghua), J. HUANG (Huang Jianan), D. FU (Fu Donghe), F. LIU (Liu Fang), Y.GONG (Gong Yushun), X. WU (Wu Xiasong) (\*Laboratory of Tea Science of the Ministry of Education, Hunan Agricultural University, Furong District, Changsha, Hunan, 410128, China; zhonhualiu163@163.com): TLC separation of catechins and theaflavins on polyamide plates. *J. Planar Chromatogr.* 22, 97-100 (2009). TLC of (+)-catechin, (-)-epicatechin, (-)-epigallocatechin, (-)-epicatechin gallate, (-)-epigallocatechin gallate, theaflavin, theaflavin 3-gallate, theaflavin 3'-gallate, and theaflavin 3,3'-digallate on polyamide phase in a horizontal chamber (saturated for 15 min) by twofold development with chloroform - methanol 2:3 or n-butanol - acetone - acetic acid 5:5:3. Separation of the flavonols myricetin, quercetin, kaempferol, rutin and the phenolic acids gallic acid, chlorogenic acid, and caffeic acid was achieved by twofold development with chloroform - methanol 2:3. Detection by spraying with iron(III) chloride solution and evaluation under daylight. Quantitative determination by absorbance measurement at 600 nm.

food analysis, quantitative analysis, qualitative identification, densitometry

8a

## 10. Carbohydrates

- 103 038 D. CLINE, B. FRIED, J. SHERMA\* (\*Department of Chemistry, Lafayette College, Easton, PA 18042, USA): TLC and GC-MS identification of glucose and maltose in *Biomphalaria glabrata* (Gastropoda), and use of quantitative TLC to determine the effect of starvation on the amounts of these carbohydrates. *Acta Chromatographica* 9, 79-86 (1999). HPTLC (TLC) of glucose, maltose, sucrose and trehalose on silica gel with acetonitrile - water 17:3 and ethyl acetate - acetic acid - methanol - water 12:3:3:2 for three times with chamber saturation; on amino plates with ethyl acetate - pyridine - water - acetic acid 12:6:2:1 and on cellulose plates with ethyl acetate - pyridine - water 2:1:2, both in a non-equilibrated chamber; on RP-18 with tetrahydrofuran - water 44:6 in a pre-equilibrated chamber. All plates were prewashed, e.g. by chromatography with dichloromethane - methanol 1:1. Detection by 4-aminobenzoic acid reagent, 1-naphthol-sulfuric acid reagent or aniline-DPA reagent, each followed by heating at 110 °C for 10 min. The combined results from comparison of *R<sub>f</sub>* values for two different mobile phases on silica gel, on cellulose, amino phase and C18-bonded layers with diverse separation mechanisms, spiking experiments on silica gel, detection with selective reagents, and GC-MS analysis definitely proved the presence of maltose and glucose and the absence of trehalose in digestive gland-gonad complex and hemolymph samples from *B. glabrata*. Earlier papers reporting the presence of trehalose were undoubtedly in error.

HPTLC, densitometry, quantitative analysis, qualitative identification, postchromatographic derivatization

10a

- 103 039 Gertrud MORLOCK\*, Shashi PRABHA (\*Institute of Food Chemistry, University of Hohenheim, Garbenstrasse 28, 70599 Stuttgart, Germany, gmorlock@uni-hohenheim.de): Analysis and stability of sucralose in a milk-based confection by a simple planar chromatographic method. *J. Agric. Food Chem.* 55, 7217-7223 (2007). HPTLC of sucralose in burfi, a milk-based confection, on amino phase with acetonitrile - water 4:1 in a horizontal chamber up to a migration distance of 70 mm. Detection by thermal in situ derivatization, drying the plate for at least 5 min, followed by heating at 190 °C for 20 min. Quantitative determination by fluorescence measurement at UV 366/>400 nm. The within-run precision of sucralose determination in the matrix was 4.2 % and the mean recovery rate was 88 %. The limit of detection was 6 ng/band for standard solutions and 1 mg/kg for milk-based matrix. It was demonstrated that over 300 runs can be performed within a day of labor with cost-effective instrumentation.

food analysis, HPTLC, quantitative analysis

10a

- 103 040 Katarina REIFFOVA\*, Radomira NEMCOVA (\*University of P.J. Safarik, Faculty of Natural Sci-

ences, Institute of Chemistry Sciences, Moyzesova 11, 040 01 Kosice, Slovak Republic): Thin-layer chromatography analysis of fructooligosaccharides in biological samples. *J. Chromatogr. A* 1110 (1-2), 214-221 (2006). Presentation of a rapid, simple and inexpensive method for the analysis of fructooligosaccharides as feed additives (prebiotics) in complicated biological samples with minimal pre-treatment. TLC of fructooligosaccharides in dietetic products and in samples from intestinal tract of monogastric animals on silica gel (impregnated with sodium acetate) with butanol - ethanol - water 5:3:2 with chamber saturation. Detection by spraying with diphenylamine - aniline - phosphoric acid in acetone. Quantitative determination by absorbance measurement at 370 nm.

quality control, clinical chemistry research, HPTLC, densitometry, qualitative identification, quantitative analysis, fructooligosaccharides 10

- 103 041 J. SHERMA\*, D. ZULICK (\*Department of Chemistry, Lafayette College, Easton, PA 18042-1782, USA): Determination of fructose, glucose and sucrose in beverages by high-performance thin-layer chromatography. *Acta Chromatographica* 6, 7-14 (1996). HPTLC of fructose, glucose and sucrose on a channeled silica gel plate with concentration zone with acetonitrile - water 17:3 for three times (freshly prepared each time, taking 15 min per run) with chamber saturation for 10-15 min. Before, just the silica gel layer was impregnated by spraying with 0.10 M sodium bisulfate solution, and subsequently with citrate buffer (1:10 dilution of citrate buffer with water, pH 4.8), each followed by drying. Detection by spraying with 1-naphthol-sulfuric acid reagent, followed by heating at 100-110 °C for 5-10 min. Quantitative determination by absorbance measurement at 515 nm. The hRf values of fructose, glucose and sucrose were 47, 43, and 28, respectively, and selectivity regarding matrix was given. No zones other than the sugars were detected in sample chromatograms because of the selectivity of the detection reagent and the retention of the beverage components in the preadsorbent. Correlation coefficients (r) for linear regression of the calibration curves typically ranged from 0.90-0.99, with an average of 0.97. The precision in matrix was 2.5 % (n = 5). The mean reproducibility of the twofold sample analyses was 4 %, ranged between 0.45 % and 7.5 %. The accuracy of the method was 94.6 %, 97.0 % and 90.8 % for sucrose, glucose and fructose, respectively. Sugar concentrations in the samples ranged from 18.4-34.3 mg/mL.

food analysis, HPTLC, densitometry, quantitative analysis, qualitative identification, postchromatographic derivatization 10a

- 103 042 Elena TAMBURINI\*, T. BERNARDI, E. BIANCHINI, P. PEDRINI (\*Agro-tech and Pharmaceutical Research Laboratory, Department of Evolutive Biology, University of Ferrara, Ferrara, Italy; tme@unife.it): Fermentation monitoring based on HPTLC-OPLC. The effect of a complex biological matrix on quantitative performance. *J. Planar Chromatogr.* 22, 9-14 (2009). HPTLC-OPLC of fructose, glucose, galactose, sucrose, lactose, 1-kestose, raffinose, nystose, and fructosil-nystose on silica gel with acetonitrile - water 17:3. After development and drying, the separated bands were derivatized by a thermal in-situ reaction on a hot plate. The plates were immersed in lead(IV) acetate-dichlorofluorescein reagent for 9 s and heated at 105 °C for 3 min. Quantitative determination by fluorescence measurement at 313 nm.

food analysis, quality control, densitometry, HPTLC, quantitative analysis 10a

## 11. Organic acids and lipids

- 103 017 W. CHAI et al., see section 4e

- 103 043 U. DISTLER, M. HÜLSEWIG, J. SOUADY, K. DREISEWERD, J. HAIER, N. SENNINGER, A. W. FRIEDRICH, H. KARCH, F. HILLENKAMP, S. BERKENKAMP, J. PETER-KATALINIC, J. MÜTHING\* (\*Institute of Medical Physics and Biophysics, University of Münster, 48149 Münster, Germany; jm@uni-muenster.de): Matching IR-MALDI-o-TOF mass spectrometry with the TLC overlay binding assay and its clinical application for tracing tumor-associated glycosphingolipids in hepatocellular and pancreatic cancer. *Anal. Chem.* 80, 1835-1846 (2008). HPT-

LC of neutral glycosphingolipids on silica gel with chloroform - methanol - water 120:70:17 and 120:85:20, both supplemented with 2 mM calciumchloride solution. Detection by treatment with orcinol. Quantitative determination by absorbance measurement at 544 nm (orcinol) and 630 nm (indolyphosphate). A TLC overlay assay was performed, the TLC immunodetection procedure used glycosphingolipid antibodies and toxins in conjunction with antitoxin antibodies.

clinical chemistry research, HPTLC quantitative analysis, qualitative identification 11e

103 020 K. DREISEWERD et al., see section 4e

103 044 B. FUCHS, J. SCHILLER\*, R. SÜSS, A. NIMPTSCH, M. SCHÜRENBERG, D. SUCKAU (\*Universität Leipzig, Medizinische Fakultät, Institut für Medizinische Physik und Biophysik, Härtelstr. 16-18, 04107 Leipzig, Germany; juergen.schiller@medisin.uni-leipzig.de): Capabilities and disadvantages of combined matrix-assisted laser-desorption/ionization time-of-flight mass spectrometry (MALDI-TOF MS) and high-performance thin-layer chromatography (HPTLC): Analysis of egg yolk lipids. *J. Planar Chromatogr.* 22, 35-42 (2009). HPTLC of phospholipids (lyso-phosphatidylcholine, sphingomyelin, phosphatidylcholin, lyso-phosphatidylethanolamine, phosphatidylinositol, phosphatidylethanolamine, phosphatidylserine, phosphatidic acid, and triacylglycerol) on silica gel with chloroform - ethanol - water - triethylamine 5:5:1:5. Detection by spraying with a solution of primulin (Direct Yellow 59). Evaluation under UV 366 nm. Detection by MALDI-TOF MS directly on the plates.

pharmaceutical research, clinical chemistry research, HPTLC, qualitative identification 11c

103 021 Beate FUCHS et al., see section 4e

103 022 Beate FUCHS et al., see section 4e

103 024 Vera IVLEVA et al., see section 4e

103 045 D.R. MASSA, J.D. VASTA, B. FRIED, J. SHERMA\* (\*Department of Chemistry, Lafayette College, Easton, PA, USA; shermaj@lafayette.edu): High-performance thin-layer chromatographic analysis of the polar lipid content of human urine and urine from BALB/c mice experimentally infected with *Echinostoma caproni*. *J. Planar Chromatogr.* 21, 337-341 (2008). HPTLC of phospholipids (cholesterol, phosphatidylethanolamine, phosphatidylcholine, and lysophosphatidylcholine) on silica gel plates with a concentration zone (prewashed with dichloromethane - methanol 1:1) with chloroform - methanol - water 65:25:4 in a saturated twin trough chamber. Detection by spraying with aqueous copper sulfate reagent followed by heating. Quantitative determination by absorbance measurement at 370 nm. Ninhydrin spray reagent was used to confirm the presence of phosphatidylethanolamine. The limit of quantification was 250 ng/spot.

HPTLC, quantitative analysis, densitometry 11c

03 046 A. ROHLFING, J. MÜTHING, G. POHLENTZ, U. DISTLER, J. PETER-KATALINIC, S. BERKENKAMP, K. DREISEWERD\* (\*Institute of Medical Physics and Biophysics, Westfälische Wilhelms-Universität Münster, Robert-Koch-Strasse 31, 48149 Münster, Germany; Klaus.Dreiseverd@uni-muenster.de): IR-MALDI-MS analysis of HPTLC-separated phospholipid mixtures directly from the TLC plate. *Anal. Chem.* 79, 5793-5808 (2007). HPTLC of phospholipids (phosphatidylcholine, phosphatidylethanolamine, phosphatidylglycerol, phosphatidic acid, cardiolipin, sphingomyelin) on silica gel in a saturated chamber with chloroform-methanol - 2-propanol - triethylamine - 0.25 % potassium chloride solution 30:9:23:18:6. Detection by dipping in molybdenum blue reagent for 1 s and quantitative evaluation by densitometry. The sensitivity was in the range of 10 to 150 pmol/spot (depending on phospholipid acidity, hRf value, and ion polarity).

HPTLC, quantitative analysis 11c

- 103 047 P.K. ZARZYCKI\*, M.A. BARTOSZUK (\*Toxicology and Bioanalysis Section, Department of Environmental Biology, Koszalin University of Technology, Sniadeckich 2, 75-453 Koszalin, Poland; pkzarz@wp.pl or pawel\_k\_z@hotmail.com): Improved TLC detection of prostaglandins by post-run derivatization with phosphomolybdic acid. *J. Planar Chromatogr.* 21, 387-390 (2008). TLC of prostaglandin PGE2 and PGF2a on silica gel and RP-18 in a saturated chamber with methanol - dichloromethane 1:9 and 100 % acetonitrile, respectively. Detection by spraying with phosphomolybdic acid (10 % in methanol) and heating at temperatures ranging from 80 to 100 °C (for silica gel) and below 80 °C (for RP-18). Densitometric evaluation; chromatographic spot quantification, however, was performed manually using the peak height above baseline method.
- pharmaceutical research, densitometry, qualitative identification 11b

### 13. Steroids

- 103 048 W. KRZYCZKOWSKI\*, E. MALINOWSKA, P. SUCHOCKI, J. KLEPS, M. OLEJNIK, F. HEROLD (\*Department of Drug Technology, Faculty of Pharmacy, The Medical University of Warsaw, Warsaw, Poland, wkrzyczkowski@wum.edu.pl): Isolation and quantitative determination of ergosterol peroxide in various edible mushroom species. *Food Chem.* 113, 351-355 (2009). HPTLC of ergosterol peroxide from the mycelia of *Hericium erinaceum* (lion's mane mushroom), *Lactiporus sulfureus* (chicken mushroom), and *Morchella esculenta* (common morel), as well as in the fruiting bodies of *Boletus edulis* (king bolete), *Suillus bovinus* (Jersey cow mushroom), and *B. badius* (bay bolete) on silica gel with n-hexane - ethyl acetate 1:1. Detection by spraying with an alcoholic solution of phosphotungstic acid, followed by heating at 100 °C for 5 min. Quantitative determination by absorbance measurement at 515 nm. The *hRf* value was between 30 and 32. Selectivity regarding matrix was given. Linearity was between 0.125 and 1.00 µg/spot. The limit of detection was 50 ng/spot.
- pharmaceutical research, food analysis, HPTLC, quantitative analysis 13c

- 103 049 P. ZARZYCKI\*, Magdalena ZARZYCKA (\*Section of Toxicology and Bioanalytics, Department of Environmental Biology, Koszalin University of Technology, Sniadeckich 2, 75-453 Koszalin, Poland, pkzarz@wp.pl): Application of temperature-controlled micro planar chromatography for separation and quantification of testosterone and its derivatives. *Anal. Bioanal. Chem.* 391, 2219-2225 (2008). HPTLC/TLC of testosterone and derivatives (methyltestosterone, testosterone propionate, testosterone isobutyrate, testosterone phenylpropionate, testosterone isocaproate, testosterone enanthate, testosterone caprate on silica gel, RP-18W and aluminium oxide with a whole range of binary mixtures such as methanol/water, acetonitrile/water, methanol/dichloromethane and acetone/hexane 0 - 100 % on the effect of temperature ranging from -20 to +60 °C under saturated and unsaturated chamber conditions. Detection by dipping in 10 % methanolic phosphomolybdic acid, followed by heating at 100 °C for 10 min. Evaluation under UV 366 and 254 nm. The best separation was observed on RP-18W with methanol/water mobile phases.
- quantitative analysis, HPTLC 13e

### 14. Steroid glycosides, saponins and other terpenoid glycosides

- 103 050 C. CHAICHAROENPONG\*, A. PETSOM (\*Institute of Biotechnology and Genetic Engineering, Chulalongkorn University, Bangkok 10330, Thailand, Chanya.C@Chula.ac.th): Quantitative thin layer chromatographic analysis of the saponins in tea seed meal. *Phytochem. Anal.* 20, 253-255 (2009). HPTLC of saponins in the tea seed meal of *Camellia oleifera* on silica gel with ethyl acetate - methanol - water 4:2:1. Quantitative determination by absorbance measurement at 214 nm. The *hRf* value of tea saponin was 40 and selectivity regarding matrix was given. The correlation coefficient was 0.9978 and the relative standard deviation 1.6 %. Linearity was between 0.9 and 22.2 µg/spot. The limit of detection and quantification was 870 ng and 2900 ng/spot, respectively.
- HPTLC, agricultural, quantitative analysis, densitometry 14



## 15. Terpenes and other volatile plant ingredients

- 103 051 M. CHANAMA, T. WUNNAKUP, W. DE-EKNAMKUL, S. CHANAMA\* (\*Department of Biochemistry, Faculty of Science, Chulalongkorn University, Bangkok 10330, Thailand; suchart.c@chula.ac.th): Improvement of thin-layer chromatography for enzyme assay of geranylgeraniol 18-hydroxylase from *Croton stellatopilosus* Ohba. *J. Planar Chromatogr.* 22, 49-53 (2009). TLC of geranylgeraniol and plaunotol on silica gel with chloroform - n-propanol 24:1 or 48:1, or with ethyl acetate, in saturated chambers. Quantitative determination by absorbance measurement at 210 nm. Detection of plaunotol by exposure to iodine vapor for 10 min. The acyclic diterpenoid plaunotol present in *Croton stellatopilosus* leaves is a hydroxylation product, catalyzed by the enzyme geranylgeraniol-18-hydroxylase. The activity of the enzyme in cell-free extracts of *C. stellatopilosus* leaves was previously reported. In this study a new mobile phase (ethyl acetate) was used for determination of geranylgeraniol-18-hydroxylase in the 20,000 g and 100,000 g precipitates of the crude extracts. In addition ethyl acetate successfully separated plaunotol from various cytochrome P-450 inhibitors (ancymidol, metyrapone, and miconazole) frequently used for biochemical characterization of the hydroxylase enzymes.
- pharmaceutical research, herbal, densitometry, qualitative identification 15a

- 103 052 P. RINTHONG, A. JINDAPRASERT, W. DE-EKNAMKUL\* (\*Department of Pharmacognosy, Faculty of Pharmaceutical Sciences, Chulalongkorn University, Bangkok 10330, Thailand; dwanchai@chula.ac.th): Simple densitometric TLC analysis of plaunotol for screening of high-plaunotol-containing plants of *Croton stellatopilosus* Ohba. *J. Planar Chromatogr.* 22, 55-58 (2009). TLC of plaunotol in leaves of *Croton stellatopilosus* Ohba, on silica gel with chloroform - n-propanol 24:1 in a twin trough chamber saturated for 30 min. Quantitative determination by absorbance measurement at 220 nm. Recovery was 98.7 %. The plaunotol content of the leaves of *C. stellatopilosus* was highly variable (0.14 to 0.79 % w/w of dry weight).
- herbal, traditional medicine, quality control, densitometry, quantitative analysis 15a

## 16. Nitro and nitroso compounds

- 103 053 T. WIDLA\*, M. SLIWIOK (\*Faculty of Law and Administration, Department of Criminalistics, Silesian University, 40-006 Katowice, Bankowa Street, Poland): Detection and determination of trotyl by HPTLC. *Acta Chromatographica* 6, 1-4 (1996). TLC of TNT (trotyl) on silica gel with hexane-benzene 1:1. Detection by spraying with phenol red, bromophenol blue, thymol blue, and bromothymol blue, separately, followed by heating at 100 °C for 10 min. These solutions were prepared immediately before spraying of the plates. The  $R_f$  value was 50 ( $\pm$  2). Linearity was between 2.5 and 10  $\mu\text{g}/\text{zone}$ . The correlation coefficient was 0.931. LOD (in average,  $n = 6$ ) was 1.0  $\mu\text{g}/\text{zone}$  (phenol red), 1.0  $\mu\text{g}/\text{zone}$  (bromophenol blue), 1.5  $\mu\text{g}/\text{zone}$  (thymol blue) and 1.5  $\mu\text{g}/\text{zone}$  (bromothymol blue).
- HPTLC, postchromatographic derivatization, explosives, TNT 16

## 17. Amines, amides and related nitrogen compounds

- 103 054 Zlatka BAJC\*, K.S. GACNIK (\*Institute for Food Hygiene and Bromatology, Veterinary Faculty, University of Ljubljana, Gerbiceva 60, 1000 Ljubljana, Slovenia; zlatka.bajc@vf.uni-lj.si): Densitometric TLC analysis of histamine in fish and fishery products. *J. Planar Chromatogr.* 22, 15-17 (2009). HPTLC of biogenic amines (spermidine, putrescine, cadaverine, histamine, and tyramine) on silica gel (with concentration zone) in a twin trough chamber saturated for at least 1 h with acetone - ammonia 19:1. Detection by heating at 75 °C for 2 min, followed by spraying with ninhydrin reagent (300 mg ninhydrin in 100 mL n-butanol - glacial acetic acid 97:3) and again heating at 75 °C for 2 min. Quantitative determination by absorbance measurement at 410 nm.
- food analysis, densitometry, quantitative analysis, HPTLC 17a

- 103 055 R. HADDAD, H.M.S. MILAGRE, R.R. CATHARINO, M.N. EBERLIN\* (\*Thomson Mass Spectrometry Laboratory, Institute of Chemistry, State University of Campinas, 13084-971,

Campinas SP, Brazil; eberlin@iqm.unicamp.br): Easy ambient sonic-spray ionization mass spectrometry combined with thin-layer chromatography. *Anal. Chem.* 80, 2744-2750 (2008). TLC of mixtures of semipolar nitrogenated compounds as well as pharmaceutical drugs (allyl phenylamine, phenylamine, ethylpyridine, propranolol hydrochloride, and amlodipine besylate) on silica gel with ethyl acetate - hexane 1:4; detection under UV 254 nm. On-spot detection and analyte characterization via easy ambient desorption and sonic-spray ionization (EASI) and (tandem) mass spectrometry detection.

quality control, qualitative identification

17, 4e

- 103 056 S. LIN (Lin Shuyao), M. HUANG (Huang Minzong), H. CHANG (Chang Huichiu), J. SHIEA (Shiea Jentaie)\* (\*Department of Chemistry, National Sun Yat-Sen University, Kaohsiung Medical University Joint Research Center, Kaohsiung, 80424 Taiwan; jetea@mail.nsysu.edu.tw): Using electrospray-assisted laser desorption/ionization mass spectrometry to characterize organic compounds separated on thin-layer chromatography plates. *Anal. Chem.* 79, 8789-8795 (2007). TLC of dyes, amines, extracts of drug tablets (erythroxine B, erioglaucine, fast green FCF, 2,2'-diaminodiethylamine, 3-quinolinamine, 2-acetylaniline; tablets containing DL-methylephedrin hydrochloride, caffeine, ethoxybenzamide, chlorpheniramine maleate, noscapine, acetaminophen) on RP-18 with 500 mM ammonium acetate - acetone 7:3. Separation of amines on silica gel with ethyl acetate - acetic acid - dichloromethane 98:1:1. The detection limit of TLC/ELDI/MS is 1  $\mu$ M. toxicology,

quantitative analysis, qualitative identification

17

## 18. Amino acids and peptides, chemical structure of proteins

- 103 057 Rania BAKRY\*, G.K. BONN, D. MAIR, F. SVEC (\*Institute of Analytical Chemistry and Radiochemistry, Leopold Franzens University, 6020 Innsbruck, Austria; Rania.Bakry@uibk.ac.at): Monolithic porous polymer layer for the separation of peptides and proteins using thin-layer chromatography coupled with MALDI-TOF-MS. *Anal. Chem.* 79, 486-493 (2007). TLC of methylene blue and methyl red on monolithic phase with ethyl acetate - ethanol - water 6:4:3 and 3:2:1 with chamber saturation for 30 min. After development the plates were dried and scanned with MALDI. TLC separation of fluorescamine labeled proteins (insulin, cytochrome c, lysozyme, and myoglobin) with 40 or 55 % aqueous acetonitrile and 0.1 % trifluoro acetic acid with chamber saturation for 30 min. Detection under UV 366 nm. Preparation of the monolithic layer: The polymerization mixture consisted of butyl methacrylate, ethylene dimethacrylate, 1-decanol, cyclohexanol, and 2,2-dimethoxy-2-phenyl-acetophenone.

qualitative identification, postchromatographic derivatization

18b

- 103 058 Irena BARANOWSKA\*, P. MARKOWSKI, A. WILCZEK, M. SZOSTEK, M. STADNICZUK (\*Department of Analytical and General Chemistry, Faculty of Chemistry, Silesian University of Technology, M. Strzody Street 7, 44-100 Gliwice, Poland; irena.baranowska@polsl.pl): Normal and reversed-phase thin-layer chromatography in the analysis of L-arginine, its metabolites, and selected drugs. *J. Planar Chromatogr.* 22, 89-96 (2009). TLC of L-arginine and its metabolites on silica gel with methanol - 50 % acetic acid 3:1 and on RP-18 with 5 % acetic acid - methanol - acetonitrile 50:36:15. TLC of selected drugs (dexamethasone, prednisolone, furosemide, vancomycin, amikacin, fluconazole, digoxin, captopril, dipyrone, metoprolol, and sildenafil) on silica gel with acetonitrile - water 2:3 with chamber saturation for 1 h. Detection of L-arginine and its metabolites by spraying with a 1 % ethanolic solution of ninhydrin, followed by heating at 60 °C for 15 min. Additional detection by exposure to iodine vapor.

pharmaceutical research, qualitative identification

18a

- 103 059 A. MOHAMMAD\*, A. ZEHRA (\*Analytical Research Laboratory, Department of Applied Chemistry, Faculty of Engineering and Technology, Aligarh Muslim University, Aligarh, India; mohammadali4u@rediffmail.com): Separation of coexisting tryptophan, alanine, and phenylalanine or tyrosine by silver ion high-performance thin-layer chromatography. *J. Planar Chromatogr.* 21,

299-304 (2008). HPTLC of 21 amino acids on silica gel impregnated with 5 % Ag ion with borate phosphate buffer pH 2.3. After drying at 50 °C detection by spraying with ninhydrin. With this system separation of alanine, phenylalanine and tryptophane could be achieved, as well as separation of alanine, tyrosine and tryptophan. Separation of these amino acids was neither achieved on conventional silical gel (without Ag impregnation) nor by addition of buffered 5 % silver nitrate solution (pH 2.3) to the mobile phase.

HPTLC, qualitative identification

18a

- 103 060 H.W. RAVN (Aarhus University, National Environmental Research Institute, Department of Terrestrial Ecology, PhytoChemLab, Vejlsøvej 25, P. O. Box 314, 8600 Silkeborg, Denmark, her@dmu.dk): Two new methods for early detection of the effects of herbicides in plants using biomarkers. *J. Planar Chromatogr.* 22, 65-71 (2009). Presentation of two simple and rapid HPTLC methods for early detection of the effects of herbicides using two different groups of plant biomarkers, which were developed as field tests (Herbicide Weed Response test - HWR-Test). Phytochemical changes can be detected before any morphological changes are visible on the plants. These changes are defined as biomarkers and can be detected by HPTLC-screening. After overall identification of the phytochemical biomarker pattern, two different biomarker groups, carbohydrates and amino acids, were detected using modified reagents for color reactions. Evaluation under daylight and videodensitometric analysis of digital images by VideoScan software. The screening method was previously described [H. W. Ravn, M. Hjorth, L. Lauridsen, P. Kudsk, S. K. Mathiassen, L. Mondolot, *Bull. Environ. Contam. Toxicol.* 75, 236-245 (2005)].

environmental, agricultural, HPTLC, qualitative identification

18a, 29d

## 21. Purines, pyrimidines, nucleic acids and their constituents

- 103 061 E. MINCSOVICS, K. PÁPAI, K. LUDÁNYI, Á. Z. DÁVID, M. BUDAI, I. ANTAL, I. KLEBOVICH\* (\*Semmelweis University, Department of Pharmaceutics, Högyes Endre Street 7, 1092 Budapest, Hungary; klebovich@gyok.sote.hu): Fully on-line hyphenation of an experimental OPLC separation unit with diode-array detection and mass spectrometry (OPLC-DAD-MS) for analysis of xanthine compounds. *J. Planar Chromatogr.* 21, 361-366 (2008). OPLC of xanthine standards (caffeine, theophylline, theobromine) and green tea extract on silica gel (prewashed with 15 mL acetonitrile - water 17:3) with chloroform - trifluoroacetic acid - acetonitrile - methanol 760:40:67:133. Quantitative determination by absorbance measurement at 280 nm. Xanthine standards were used as model compounds to test the connected systems OPLC-UV and OPLC-DAD-ESI-MS. Sensitivity of OPLC-UV or OPLC-DAD was increased by hyphenation with ESI-MS coupled in series. After background subtraction the extracted ion chromatogram ( $m/z = 181.1$  Da) yielded well measurable peaks for theophylline and theobromine in tea leaf extract. Analysis time was 10 min only.

densitometry, quantitative analysis

21a

## 22. Alkaloids

- 103 062 S. BERKOV\*, J. BASTIDA, M. NIKOLOVA, F. VILADOMAT, C. CODINA (\*Departament de Productes Naturals, Biologia Vegetal i Edafologia, Facultat de Farmàcia, Universitat de Barcelona. Av. Joan XXIII s/n, 08028 Barcelona, Catalonia, Spain; berkov@ub.edu): Rapid TLC/GC-MS identification of acetylcholinesterase inhibitors in alkaloid extracts. *Phytochem. Anal.* 19, 411-419 (2008). TLC of alkaloid extracts on silica gel with ethyl acetate - methanol - 25 % ammonia 30:10:1 and n-hexane - ethyl acetate - methanol - 25 % ammonia 30:30:10:1. Detection of the separated compounds with acetylcholinesterase inhibitory activity and by spraying with Dragendorff reagent.

herbal, qualitative identification, preparative TLC, bioautography

22

- 103 063 J. MÄDER\*, W. FISCHER, T. SCHNICK, L. W. KROH (\*Berlin University of Technology, Institute of Food Technology and Food Chemistry, Department of Food Analysis, Gustav-Meyer-Allee

25, 13355 Berlin, Germany; J.Maeder@TU-Berlin.de): Changes in glycoalkaloid composition during potato processing: Simple and reliable quality control by HPTLC. *J. Planar Chromatogr.* 22, 43-47 (2009). HPTLC of alpha-solanine and alpha-chaconine on silica gel with dichloromethane - methanol - 2.5 % ammonia 175: 75:11 in a horizontal chamber saturated for 15 min. After drying and heating at 90 °C for 25 min detection by dipping twice in modified Carr-Price reagent (antimony(III) chloride in acetic acid - dichloromethane), followed by heating at 110 °C for 3 min. Quantitative determination by absorbance measurement at 560 nm. Linearity was between 30 and 700 ng. The limit of detection was 5-20 ng/zone depending on the sample matrix, the limit of quantification was 30 ng/zone. The ratio of alpha-chaconine and alpha-solanine was between 4:1 to 2:1 for all analyzed samples.

food analysis, quality control, densitometry, quantitative analysis, HPTLC 22

103 027 T. MROCZEK et al., see section 4d

103 064 G. VAN BERKEL\*, B.A. TOMKINS, V. KERTESZ (\*Organic and Biological Mass Spectrometry Group, Chemical Sciences Division, Oak Ridge National Laboratory, Oak Ridge, Tennessee 37831-6131, USA; vanberkel@ornl.gov): Thin-layer chromatography/desorption electrospray ionization mass spectrometry: Investigation of Goldenseal alkaloids. *Anal. Chem.* 79, 2778-2789 (2007). TLC of alkaloids (berberine chloride, palmatine chloride, hydrastine, tetrahydroberberine, hydrastinine hydrochloride and jatrorrhizine) on silica gel with ethyl acetate - methanol - formic acid - water 50:10:6:3. Detection under UV 254 nm. Detection levels were 5 ng/zone each or 14-28 pmol. Desorption electrospray ionization mass spectrometry was investigated as a means to qualitatively identify and to quantify analytes directly from developed normal-phase TLC plates.

food analysis, herbal, qualitative identification, quantitative analysis 22, 4e

### 23. Other substances containing heterocyclic nitrogen

103 065 B.B. DAUNDKAR, M.K. MALVE, R. KRISHNAMURTHY\* (\*Directorate of Forensic Science Laboratories, Home Dept., State of Maharashtra, Hans Bhugra Marg, Kalina, Vidyanagari, Santa Cruz (E), Mumbai 400098, India; dfs1@gmail.com): A specific chromogenic reagent for detection of diazepam among other benzodiazepines from biological and nonbiological samples after HPTLC. *J. Planar Chromatogr.* 21, 249-250 (2008). HPTLC of diazepam, oxazepam, nitrazepam, lorazepam, chlordiazepoxide, and flurazepam on silica gel in a saturated twin trough chamber with chloroform - methanol 9:1. Detection by spraying with 5 % sodium hydroxide solution followed by 1 % m-dinitrobenzene in dimethyl sulfoxide. Violet bands were obtained for diazepam, the other compounds did not react. The sensitivity of this reagent for diazepam is approx. 5 µg/spot.

toxicology, qualitative identification, HPTLC 23e

103 066 D. DI GREGORIO, H. HARNETT, J. SHERMA\* (\*Department of Chemistry, Lafayette College, Easton, PA 18042, USA): Quantification of dextromethorphan hydrobromide and clemastine fumarate in pharmaceutical caplets, gelcaps and tablets by HPTLC with ultraviolet absorption densitometry. *Acta Chromatographica* 9, 72-78 (1999). HPTLC of dextromethorphan hydrobromide (DH) and clemastine fumarate (CF) on silica gel (prewashed by chromatography with dichloromethane - methanol 1:1) with ethyl acetate - methanol - ammonia 17:1:2 for DH, and dichloromethane - methanol - ammonia 90:10:1 for CF, both with chamber saturation. Quantitative determination by absorbance measurement at 225 nm (DH) and 216 nm (CF). The hRf value of DH was 55, and of CF 62. Selectivity regarding matrix was given. Linear correlation coefficient values were in the range of 0.990-0.999. The amount of DH in the analyzed caplets and gelcaps ranged from 100 to 114 % of the label values, precision (% RSD) ranged from 1.2 to 1.9 %, and recovery of spiked samples averaged 99.4 %. For CF, tablets assayed at 99.0-103 % relative to the label value, precision (% RSD) was 2.2 %, and recovery from a spiked sample was 97.9 %.

pharmaceutical research, HPTLC, densitometry, quantitative analysis 23e

- 103 067 J. HABDAS, Marzena PODGÓRNA\* (\*Insitute of Chemistry, University of Silesia, 9, Szkolna St., 40-006 Katowice, Poland; marzenapodgorna@wp.pl): Assessment of the lipophilic properties of selected porphyrins by thin-layer chromatography. *J. Planar Chromatogr.* 21, 259-261 (2008). TLC of 6 porphyrins (5,10,15,20-tetra-(4N-pyridyl)porphyrin, 5-(4-acetamidophenyl)-10,15,20-tri-(4N-pyridyl)porphyrin, 5,10-di-(4-acetamidophenyl)-15,20-di-(4N-pyridyl)porphyrin, 5,15-di-(4-acetamidophenyl)-10,20-di-(4N-pyridyl)porphyrin, 5,10,15-tri-(4-acetamidophenyl)-20-(4N-pyridyl)porphyrin, and 5,10,15,20-tetra-(acetamidophenyl)porphyrin) on RP-18 with methanol - chloroform 7:3. Visual detection. The lipophilic properties of the porphyrins were expressed by use of log P Recker, HLB (hydrophilic-lipophilic balance), and HK (determines the percentage contribution to hydrophilicity of one or more functional amido groups (-NH-CO-CH<sub>3</sub>))  
physicochemical organic chemistry 23a
- 103 068 Ute JAUTZ, M. GIBIS, Gertrud MORLOCK\* (\*Institute of Food Chemistry, University of Hohenheim, Garbenstrasse 28, D-70599 Stuttgart, Germany, gmorlock@uni-hohenheim.de): Quantification of heterocyclic aromatic amines in fried meat by HPTLC/UV-FLD and HPLC/UV-FLD: a comparison of two methods. *J. Agric. Food Chem.* 56, 4311-4319 (2008). HPTLC of the heterocyclic aromatic amines (HAA) most frequently found in fried meat: 2-amino-1-methyl-6-phenylimidazol[4,5-b]pyridine (PhIP), 2-amino-3,8-dimethylimidazol[4,5-f]quinoxaline (MeIQx), 2-amino-3,4,8-trimethylimidazo[4,5-f]quinoxaline (4,8-DiMeIQx), 9H-pyrido[3,4-b]indole (norharman), and 1-methyl-9H-pyrido[3,4-b]indole (harman) using a previously validated method. Concentrations obtained by HPTLC were in a similar range as such obtained by HPLC with correlations of both methods between 0.8875 and 0.9751. The precision in meat matrix was between 7 and 49 % (HPTLC) and between 5 and 38 % (HPLC) at the very low µg/kg-levels formed during heating. Cost and time comparison showed that HPTLC is 4 times faster and 3 times less expensive than the HPLC reference method.  
food analysis, HPTLC, quantitative analysis, comparison of methods 23e
- 103 069 P.K. SALO, S. VILMUNEN, H. SALOMIES, R.A. KETOLA, R. KOSTIAINEN\* (\*Faculty of Pharmacy, Division of Pharmaceutical Chemistry, and Drug Discovery and Development Technology Center, University of Helsinki, Helsinki, Finland; risto.kostiainen@helsinki.fi): Two-dimensional ultra-thin-layer chromatography and atmospheric pressure matrix-assisted laser desorption/ionization mass spectrometry in bioanalysis. *Anal. Chem.* 79, 2101-2108 (2007). TLC of benzodiazepines (midazolam, diazepam, lorazepam, oxazepam, N-desalkyl-flurazepam, triazolam, nitrazepam) on monolithic UTLC phase (prewashed with methanol) with dichloromethane - acetone 93:7 for one-dimensional and toluene - acetone - ethanol - 25 % ammonia 70:20:3:1 for two-dimensional separation in a saturated chamber. Developing distance 2 cm; separation time for 1-D chromatography 2-6 min, for 2-D 4-12 min. Quantitative determination by absorbance measurement at 254 nm; for visual detection the analytes were derivatized by spraying with Dragendorff reagent. Identification of the separated compounds by AP-MALDI-MS. The limits of detection were in the picomole range and thus low enough for bioanalysis.  
clinical chemistry research, qualitative identification, postchromatographic derivatization 23e
- 103 070 F. TELLIER\*, R. FRITZ, L. KERHOAS, P. DUCROT, J. EINHORN, A. SINCLAIR, P. LEROUX (\*Department of Chemistry, Versailles Saint-Quentin-en-Yvelines University, 78001 Versailles, France, ftellier@versailles.inra.fr): Characterization of metabolites of fungicidal cymoxanil in a sensitive strain of *Botrytis cinerea*. *J. Agric. Food Chem.* 56, 8050-8057 (2008). HPTLC of [2-<sup>14</sup>C]-cymoxanil in the cultures (medium and mycelium) and in the cell-free extracts of *Botrytis cinerea* on silica gel with hexane - ethyl acetate - acetic acid 70:30:1. The most polar products were separated on RP-18 (impregnated with a methanolic solution of tetrabutylammonium bromide 70 mM and dried at 80 °C for 5 min) with phosphate buffer (0.01 M, pH 6) - methanol 11:9. Detection by autoradiography. The hRf value of cymoxanil was 35 on silica gel. Different metabolites were detected using both stationary phases.  
agricultural, HPTLC, autoradiography, radioscaning, postchromatographic derivatization 23e

## 27. Vitamins and various growth regulators

- 103 071 I. BARANOWSKA\*, A. KADZIOLKA (\*Department of Analytical and General Chemistry, Silesian Technical University, Gliwice, Poland): RPTLC and Derivative Spectrometry for the Analysis of Selected Vitamins. *Acta Chromatographica* 6, 1-4 (1996). TLC of 5 water-soluble vitamins (vitamin C, nicotinic acid, nicotinamide, vitamin B1, rutin) on RP-18 with with water-methanol 5:4 and water-acetic acid 7:1, and of 4 fat-soluble vitamins (A-acetate, E, E-acetate and D3) on RP-18 with acetonitrile - benzene - chloroform 10:10:1. Detection of vitamin C, nicotinic acid, nicotinamide and vitamin B1 with a solution of potassium hexaiodoplatinate(IV) (10 % potassium iodide with 5 % hexachloroplatinic acid in the ratio 9:1). Detection of rutin with 25 % lead(II)acetate. Detection of fat-soluble vitamins with a 10 % solution of antimony chloride. The hRf value of water-soluble vitamins (water - methanol 5:4; water - acetic acid 7:1) was 94 and 91 (vitamin C), 76 and 57 (nicotinic acid), 71 and 40 (nicotinamide), 0 and 68 (vitamin B1), and 28 and 0 (rutin). The hRf value of fat-soluble vitamins was 80 (vitamin E and vitamin E-acetate), 62 (vitamin D3), and 86 (vitamin A-acetate). Derivative spectrophotometry (up to fifth-order spectra) was applied to the determination of vitamins B1, B6 and A-acetate in mixtures with other vitamins.

pharmaceutical research, food analysis

27

- 103 072 Alina PYKA (Department of Analytical Chemistry, Faculty of Pharmacy, Medical University of Silesia, Jagiellonska 4, 41-200 Sosnowiec, Poland; alinapyka@wp.pl; apyka@sum.edu.pl): Evaluation of the lipophilicity of fat-soluble vitamins. *J. Planar Chromatogr.* 22, 211-215 (2009). TLC of fat soluble vitamins (ergocalciferol, cholecalciferol, (+/-)-alpha-tocopherol, tocopherol acetate, retinol, retinol acetate, retinol palmitate, menadione, and phytonadione) on RP-8 and RP-18 (prewashed with methanol) with methanol - water in different volume proportions, with chamber saturation for 20 min at ambient temperature. Determination of hRf values by densitometry. Linear relationships were obtained between the RM values of the fat-soluble vitamins and the volume fraction of methanol in the mobile phase.

pharmaceutical research, qualitative identification, physicochemical organic chemistry 27

## 28. Antibiotics, Mycotoxins

- 103 073 Iris MEISEN\*, U. DISTLER, J. MÜTHING, S. BERKENKAMP, K. DREISEWERD, W. MATHYS, H. KARCH, M. MORMANN (\*Institute for Hygiene, University of Muenster, Robert-Koch-Str. 41, 48149 Muenster, Germany; meisen@uni-muenster.de): Direct coupling of high-performance thin-layer chromatography with UV spectroscopy and IR-MALDI orthogonal TOF MS for the analysis of cyanobacterial toxins. *Anal. Chem.* 81, 3858-3866 (2009). HPTLC of microcystin LR and nodularin on silica gel with 1-propanol - ethyl acetate - water 3:5:2 with 5 % acetic acid. Detection and quantification by UV spectroscopy at 232 nm and direct identification of separated analytes on the HPTLC plate by IR-MALDI-o-TOF MS. The detection limit was 3-5 ng/zone. For detection of peptides, plates were cut and sprayed with a solution of p-anisaldehyde, followed by heating at 105 °C until purple-blue peptide spots appeared.

toxicology, agricultural, HPTLC, quantitative analysis

28b, 4e

## 29. Pesticides and other agrochemicals

- 103 074 M. GÖCER, K. HOFERER, J. ZIPFEL, B. SPANGENBERG\* (\*University of Offenburg, Institute of Process Engineering, Badstrasse 24, 77652 Offenburg, Germany; Spangenberg@FH-Offenburg.de): A new TLC method for quantification of paraquat, diquat, difenzoquat, mepiquat, and chloromequat in water. *J. Planar Chromatogr.* 22, 59-63 (2009). HPTLC of paraquat, diquat, difenzoquat, mepiquat, and chloromequat on LiChrospher silica gel with 1-propanol - methanol - 2.5 M aqueous sodium chloride 1:1:3. Detection by immersion for 2 s in a solution of 50 mg sodium tetraphenyl borate in 50 mL of water containing 50 µL concentrated hydrochloric acid. The wet plate was illuminated for 5 min with UV light at 254 nm which resulted in the formation of fluorescing spots corresponding to mepiquat, chloromequat, and difenzoquat. Immediately after illuminating at 254 nm all spots were illuminated for 10 min with UV light at 365 nm, which

converted all compounds into fluorescent derivatives. Then the dry plate was dipped into ethylene glycol - methanol 1:1 for 2 s, which enhanced the fluorescence by a factor of two. Detection by fluorescence measurement and averaged densitograms were obtained in the emission wavelength range from 440 to 480 nm.

environmental, toxicology, food analysis, HPTLC, quantitative analysis, densitometry 29d

- 103 075 Malgorzata JANICKA\*, E. TYIHÁK, À. M. MÓRICZ, B. OSZIK-MENDYK (\*Faculty of Chemistry, Maria-Sklodowska University, M. Curie-Sklodowska Sq. 3, 20-031 Lublin, Poland; mjanicka@hermes.umes.lublin.pl): Crucial role of formaldehyde and its reaction products in the antiproliferative activity of some potential pesticides. *J. Planar Chromatogr.* 21, 161-166 (2008). TLC of 13 newly synthesized potential herbicides (N-aryltrichloroacetamides or 2-(chlorophenoxy)acyl derivatives) on silica gel or RP-18 in saturated sandwich chambers at 20 °C with hexane - 1,2-dichloroethane 2:3. Detection in UV light at 254 nm. The lipophilicity of the substances was described by retention factors in water, log k<sub>w</sub>, both calculated from experimental RP-TLC data, and by log P values calculated by use of software. Biological activity was determined with the BioArena system. Antibacterial action against *Pseudomonas savastanoi* pv. *phaseolicola* bacterial cells and the role of formaldehyde were investigated. Additionally the effect of formaldehyde capturers (L -arginine and reduced glutathione) and Cu<sup>2+</sup> ions was evaluated in regard of bioactivity and toxicity. Formaldehyde and its reaction products are crucial in the action mechanism of these substances.

agricultural, qualitative identification

29a

- 103 076 K.V. KULKARNI\*, D.B. SHINDE, D.V. MANE, M.V. GARAD (\*Regional Forensic Science Laboratory, Dindori Road, Panchvati, Nasik 431004, India; krishnakulkarni96@yahoo.com): A new chromogenic spray reagent for detection and identification of monocrotophos. *J. Planar Chromatogr.* 22, 133-135 (2009). HPTLC of monocrotophos on silica gel with chloroform - acetone 7:3 with chamber saturation. Detection by spraying with 20 % sodium carbonate followed by acidic methanolic iron chloride reagent. Evaluation of purple spots, while organophosphorus, organochlorine, carbamate, and pyrethroid insecticides were not detected as purple spots. Alkaline hydrolysis of monocrotophos yields one molecule each of O,O-dimethylphosphoric acid and N-methylacetoacetamide. After acidification N-methylacetoacetamide yields the enol form of monomethylamide which reacts with ferric ions to a purple complex. The detection limit for monocrotophos is 0.5 µg/zone.

agricultural, toxicology, HPTLC, qualitative identification

29b

- 103 060 H.W. RAVN, see section 18a

- 103 077 U. TAMRAKAR, V.K. GUPTA, A.K. PILLAI\* (\*Chemistry Department, Government V.Y.T. P.G. Autonomous College, Durg (Chhattisgarh) 491001, India; drajaipillai@gmail.com): Spectrophotometric analysis of carbamate pesticides after thermal gradient separation. *J. Planar Chromatogr.* 22, 77-82 (2009). Detection of carbamates (carbaryl, propoxur, and carbosulfan) on silica gel activated at 110 °C for 5 min in the oven. After application the pesticide solutions were hydrolyzed by addition of 2 µL of 2 M sodium hydroxide solution. After 5 min, 5 µL diazotized p-aminoacetanilid was applied onto the spots to form the colored derivatives - red, yellow, and yellow-orange for carbaryl, propoxur, and carbosulfan, respectively. The plates were then placed horizontally in an oven at 110 °C and the colored derivatives migrated as concentric rings under the influence of the temperature gradient.

agricultural, qualitative identification

29b

### 30. Synthetic and natural dyes

- 103 078 C.L. BROSSEAU, A. GAMBARDELLA F. CASADIO, C.M. GRZYWACZ, J. WOUTERS, R.P. VAN DUYNE\* (\*Department of Chemistry, Northwestern University, 2145 Sheridan Road,

Evanston, Illinois 60208, USA; vanduyne@northwestern.edu): Ad-hoc surface-enhanced raman spectroscopy methodologies for the detection of artist dyestuffs: thin-layer chromatography-surface enhanced raman spectroscopy and in situ on the fiber analysis. *Anal. Chem.* 81, 3056-3062 (2009). TLC of organic dyes and pigments (alizarin, purpurin, carminic acid, lac dye, crocin, Cape jasmin) on silica gel with toluene - acetic acid - methanol 9:2:2. After sample application a centrifuged citrate-reduced silver colloid was spotted on top of the applied zones. SER spectra were recorded soon after application of the colloids.

environmental

30a, 4e

- 103 079 J.E. CLARK, Susan V. OLESIK\* (\*Department of Chemistry, The Ohio State University, 100 West 18th Ave, Columbus, Ohio 43210, USA; olesik@osu.edu): Technique for ultra thin layer chromatography using an electrospun, nanofibrous stationary phase. *Anal. Chem.* 81, 4121-4129 (2009). The polymer used for electrospinning the new stationary phase was polyacrylonitrile with a molecular weight of ca.150.000 in dimethylformamide as solvent; the substrate for the fibers was aluminium foil. The new material showed fiber diameters that are 400 nm. The most efficient layer thickness was 25  $\mu\text{m}$ . The electrospun plate, which was a cut, rectangular plate roughly sized  $3 \times 6$  cm, was compared to (1) TLC on silica gel with acetonitrile - methanol 3:2 for mixtures of laser dyes (sulforhodamine 640, pyrromethene 597, rhodamine 610 perchlorate, rhodamine 610 chloride, rhodamine 590 chloride, rhodamine 101, and kiton red), and (2) TLC on cyano phase with water - acetone 7:3 for steroidal compounds (androsterone, cholesterol, and cortisone), both with chamber saturation for 10 min. The development time was comparatively faster. Detection under UV light and by spraying with molybdenum phosphoric acid and heating at 120 °C for 10 min. Plate heights (Note: referred to the migration distance of the solvent front instead of substance zone) of max. 120.000 per meter resulted and were comparatively better. Two-dimensional TLC had a similar efficiency compared to one-dimensional separation (no major peak broadening was observed).

UTLC

30a, 3d

- 103 080 B.H. HAN, I. MANNERS, M.A. WINNIK\* (\*Department of Chemistry, University of Toronto, 80 St. George Street, Toronto, ON M5S 3H6, Canada): Phosphorescence quenching of dyes adsorbed to silica thin-layer chromatography plates. *Anal. Chem.* 77 (24), 8075-8085 (2006). Description of photoluminescence quenching experiments by oxygen for a series of transition metal dyes adsorbed on silica gel. The quenching kinetics showed differences regarding the behavior of the same dyes adsorbed to the well-defined surfaces of SBA-15 mesoporous silica particles and adsorbed to a thin layer-by-layer polymer film. Pore size and pore size distribution are larger for TLC silica than for mesoporous silica. On TLC silica the dye photoluminescence decay profiles show smaller deviations from an exponential form, and larger differences between the intensity and lifetime Stern-Volmer plots. Dyes adsorbed to TLC silica gel are three times more sensitive to quenching by oxygen.

photoluminescence quenching

30

- 103 081 Maria-Loredana SORAN\*, I. BROS, E. SURDUCAN, V. SURDUCAN (\*National Institute of Research and Development for Isotopic and Molecular Technology, 72-103 Donath Street, 400293 Cluj-Napoca, Romania; loredana\_soran@yahoo.com): Microwave assisted thin-layer chromatography - an improved separation technique. *J. Planar Chromatogr.* 21, 243-248 (2008) TLC plates were placed perpendicular or parallel to 2.45 +/- 0.5 GHz electromagnetic waves (microwaves) to improve chromatographic resolution. Perpendicular arrangements led to the greatest improvement. Compared with separation under normal conditions in microwave assisted TLC the migration distance of target compounds was increased, the migration distance of the mobile phase was decreased and the spot size was reduced. TLC of a lipophilic test dye mixture (indophenol blue, Sudan red G, 4-dimethylaminoazobenzene), a hydrophilic test mixture (brilliant black BN, amaranth S 75, fast yellow, chryosine) and a pesticide mixture (cymoxanil, kelthane, triadimefon, and trifluralin) on silica gel and cellulose with toluene, n-propanol - water in different ratios, and n-hexane - acetone 2:1. Detection of pesticides under UV light at 254 nm.

microwave assisted thin-layer chromatography

30a



### 32. Pharmaceutical and biomedical applications

- 103 082 E.A. ABOURASHED\*, M.M. HEFNAWY, H.I. EL-SUBBAGH (\*ElSohly Laboratories, 5 Industrial Park Drive, Oxford, MS 38655, USA; eabourashed@elsohly.com): HPTLC analysis of a new ultra-short-acting thiazolodiazepine hypnotic (HIE-124) in spiked human plasma. *J. Planar Chromatogr.* 22, 183-186 (2009). HPTLC of ethyl 8-oxo-5,6,7,8-tetrahydrothiazolo[3,2-a][1,3]diazepin-3-carboxylate (HIE-124) in plasma (with diazepam as internal standard) on silica gel with chloroform - ethyl acetate 4:1 with chamber saturation for 30 min. Quantitative determination by absorbance measurement at 265 nm. The limit of detection and quantification was 20 µg/L (40 ng/band) and 40 µg/L (80 ng/band), respectively.

pharmaceutical research, clinical chemistry research, HPTLC, quantitative analysis, densitometry  
32a

- 103 083 R. AN (An Rui)\*, S. ZHOU (Zhou Sili), L. YOU (You Lisha), X. WANG (Wang Xinhong) (\*Shanghai Univ. TCM, Shanghai 201203, China): (Study of the quality standard for compound Shenyi granules) (Chinese). *J. Chinese Trad. Patent Med.* 30 (12), 1781-1785 (2008). TLC of Shenyi granule extracts on silica gel with 1) dichloromethane - ethyl acetate - petroleum ether (60-90 °C) - methanol 20:14:6:1; 2) ethyl acetate - formic acid - glacial acetic acid - water 30:3:4:3; 3) toluene - ethyl acetate - formic acid 8:6:1; 4) chloroform - methanol - water 26:10:3. Detection 1) by spraying with 10 % sulfuric acid in ethanol and heating; 2) by spraying with iron(III) chloride solution; 3) by spraying with vanillin reagent. Identification by comparison with the standards glycyrrhizic acid and glycyrrhetic acid.

pharmaceutical research, traditional medicine, quality control, HPTLC, quantitative analysis, qualitative identification  
32e

- 103 084 S. CHOPRA\*, F.J. AHMAD, R.K. KHAR, S.K. MOTWANI, S. MAHDI, Z. IQBAL, S. TALEGAONKAR (\*Department of Pharmaceutics, Faculty of Pharmacy, Jamia Hamdard, Hamdard Nagar, New Delhi 110062, India): Validated high-performance thin-layer chromatography method for determination of trigonelline in herbal extract and pharmaceutical dosage form. *Anal. Chim. Acta* 577 (1), 46-51 (2006). HPTLC of trigonelline in herbal extracts and in pharmaceutical dosage forms on silica gel with n-propanol - methanol - water 4:1:4. Quantitative determination by absorbance measurement at 269 nm. Linearity was between 100 - 1200 ng/spot (via peak area) and the correlation coefficient was 0.9991. The trigonelline content of herbal extracts quantified and estimated from the formulation was found to be well within limits ( $\pm 5\%$ ) of the labeled content of the formulations. The method is reproducible and selective for the estimation of trigonelline by statistical analysis of the data.

pharmaceutical research, traditional medicine, quality control, HPTLC, densitometry, quantitative analysis, qualitative identification  
32e

- 103 085 V.P. CHOUDHARI\*, Anna P. NIKALJE (\*Maharashtra Institute of Pharmacy, MIT Campus, Paud Road, Kothrud, Pune, 411038, Maharashtra, India): Stability-indicating TLC method for the determination of dutasteride in pharmaceutical dosage forms. *Chromatographia* 70 (1-2), 309-313 (2009). TLC on silica gel with acetonitrile - methanol - dichloromethane 2:1:2. The  $R_f$  value of dutasteride was 64. Separation of dutasteride from its degradation products (produced by acid and alkali hydrolysis, oxidation, photo degradation, dry and wet heat treatment) was good. Quantitative determination by absorbance measurement at 244 nm. Linearity was in the range of 100 - 600 ng/band and the correlation coefficient was 0.9943 (via peak area) The limit of detection and quantitation was 7 and 23 ng/band.

quantitative analysis, qualitative identification, comparison of methods  
32c

- 103 086 L. CIESLA, A. PETRUCZYNIK, M. HAJNOS, A. BOGUCKA-KOCKA, Monika WAKSMUNDZKA-HAJNOS\* (\*Department of Inorganic Chemistry, Medical University, 20-081 Lublin, Poland; monika.hajnos@am.lublin.pl): Two-dimensional thin-layer chromatography of structural analogs. Part I: Graft TLC of selected coumarins. *J. Planar Chromatogr.* 21, 237-241

(2008). HPTLC of coumarins (present in extracts of *Archangelica officinalis*, *Pastinaca sativa* and *Heracleum sphondylium* fruits) on cyano phase with acetonitrile - water 3:7 (triple development) in the first dimension, and on silica gel with ethyl acetate - n-heptane 7:13 (triple development) in the second dimension. Good selectivity differences were also obtained on silica gel with ethyl acetate - n-heptane 7:13 (triple development) in the first dimension and on RP-18 phase with methanol - water 11:9 (triple development) in the second dimension. Detection and quantitative determination by fluorescence measurement at 366 nm.

food analysis, HPTLC, qualitative identification, densitometry 32e

103 087 S. CORAN\*, M. ALBERTI, V. GIANNELLINI, A. BALDI, G. PICCHIONI, F. PAOLI (\*Dept. of Science Pharmaceutical, University of Firenze, Via G. Capponi 9, 50121 Firenze, Italy): Development of a densitometric method for the determination of cephalexin as an alternative to the standard HPLC procedure. *J. Pharm. Biomed. Anal.* 18, 271-274 (1998). HPTLC of cephalexin on silica gel (prewashed with the mobile phase) with ethyl acetate - acetic acid - water 7:2:1. Quantitative determination by absorbance measurement at 263 nm. The method was linear in the range of 200-1600 ng/spot, average recovery was 101 %. The analytical results obtained by HPTLC were comparable with the HPLC method of USP XXIII. The HPTLC method was suggested as alternative to the USP method considering the high throughput.

pharmaceutical research, quality control, HPTLC, comparison of methods, quantitative analysis, densitometry 32a

103 088 S. DATTA\*, D. GUPTA, Pinki DATTA (\*Dept. of Pharmacy, Bharat Institute of Technology, Bypass road, Meerut 250103, India): Pharmacognostical studies on the leaves of *Viola odorata*. Abstract No. 9147, IHC (2009). HPTLC of quercetin in methanolic leaf extracts of *Viola odorata* on silica gel with ethyl acetate - formic acid - glacial acetic acid - water 100:11:11:26. Quantitative determination by absorbance measurement at 366/>400 nm for quantification. The extract contained 0.36 % quercetin.

pharmaceutical research, herbal, HPTLC, densitometry, quantitative analysis 32e

103 089 Namita DESAI\*, Purnima AMIN (\*Pharmaceutical Sciences & Technology Div., University Institute of Chemical Technology University of Mumbai, Mantunga, Mumbai 400019, India): Stability indicating HPTLC determination of meloxicam. *Ind. J. Pharm. Sci.* 70(5), 644-647 (2008). HPTLC of meloxicam on silica gel with ethyl acetate - cyclohexane - glacial acetic acid 325:175:1 with chamber saturation for 45 min. Quantitative determination by absorbance measurement at 353 nm. The method was linear in the range of 100-500 ng/zone, recovery was 100.3 %. The method was evaluated for stability (acid, base, thermal, oxidative, photodegradation) and degradation products were well separated from the main drug.

pharmaceutical research, quality control, HPTLC, densitometry, quantitative analysis 32a

103 090 S.R. DHANESHWAR\*, N.G. PATRE\*, M.V. MAHADIK (\*Bharati Vidyapeeth University, Poona College of Pharmacy, Department of Pharmaceutical Chemistry, Pune 411038, India): Stability-indicating HPTLC method for quantitation of quetiapine fumarate in the pharmaceutical dosage form. *Acta Chromatographica* 21 (1), 83-93 (2009). HPTLC of quetiapine fumarate on silica gel with toluene - methanol 4:1. The *R<sub>f</sub>* value of quetiapine fumarate was 37. Quantitative determination by absorbance measurement at 254 nm. There was no chromatographic interference from tablet excipients. The drug is susceptible to treatment with acid and alkaline hydrolysis, oxidation, and photodegradation. The method was able to separate the degradation products from the pure drug, it can be used for stability tests.

doping, pharmaceutical research, quality control, HPTLC, quantitative analysis, qualitative identification, densitometry, 32c

103 091 Virginie ESTERS\*, L. ANGENOT, Viviane BRANDT, M. FRÉDÉRICH, Monique TITS, CH.

VAN NERUM, J.N. WAUTERS, P. HUBERT (\*Laboratory of Pharmacognosy, Department of Pharmacy, University of Liège, CHU, B36, Avenue de l'Hôpital 1, 4000 Liège, Belgium): Validation of a high-performance thin-layer chromatography/densitometry method for the quantitative determination of glucosamine in a herbal dietary supplement. *J. Chromatogr. A* 1112 (1-2), 156-164 (2006). HPTLC of glucosamine in a dietary supplement containing dried extracts of the main plants traditionally used for rheumatic disorders, on silica gel with a saturated mixture of 2-propanol - ethyl acetate - ammonia (8 %) 1:1:1. Detection by dipping into a modified anisaldehyde reagent and heating at 120 °C for 30 min in a drying oven. Quantitative determination by absorbance measurement at 415 nm. Validation of the method by applying the novel validation protocol proposed by a commission of the Société Française des Sciences et Techniques Pharmaceutiques. Relative standard deviations for repeatability and intermediate precision were between 4.9 and 8.6 %, accuracy was good, the two-sided 95 % beta-expectation tolerance interval was within the acceptance limits of 85 and 115 % on the whole analytical range (800 - 1200 ng of glucosamine).

pharmaceutical research, quality control, traditional medicine, HPTLC, quantitative analysis, qualitative identification, densitometry, glucosamine 32e

103 092 A.R. FAKHARI\*, A.R. KHORRAMI, M. SHAMSIPUR (\*Department of Chemistry, Shahid Beheshti University, Tehran, Iran): Stability-indicating high-performance thin-layer chromatographic determination of levonorgestrel and ethinyloestradiol in bulk drug and in low-dosage oral contraceptives. *Anal. Chim. Acta*, 572 (2), 237-242 (2006). Presentation of a stability-indicating method for simultaneous determination of the steroidal hormones levonorgestrel and ethinyloestradiol both in bulk drug and in low-dosage oral contraceptives by HPTLC on silica gel with hexane - chloroform - methanol 4:12:1. The  $R_f$  value of levonorgestrel was 65 and of ethinyloestradiol 43. The compounds were well separated from their degradation products. Quantitative determination by absorbance measurement at 225 nm. Linearity of levonorgestrel and ethinyloestradiol was 200-800 and 40-160 ng/spot, respectively.

quality control, pharmaceutical research, qualitative identification, HPTLC, quantitative analysis, densitometry 32c

103 093 Izabela FECKA (Department of Pharmacognosy, Wrocław Medical University, pl. Nankiera 1, 50-140 Wrocław, Poland; izabela@farmgn.am.wroc.pl): Qualitative and quantitative determination of hydrolysable tannins and other polyphenols in herbal products from meadowsweet and dog rose. *Phytochem. Anal.* 20, 177-190 (2009). TLC and HPTLC of polyphenols (tellimagrandins I and II, rugosins A, B, D and E and other) in commercially available products of meadowsweet (*Filipendula ulmaria*) and dog rose (*Rosa canina*) on silica gel, LiChrospher Si 60, RP-18 and amino phase with tetrahydrofuran - acetonitrile - water 3:1:1, of tannins on amino phase with acetone - formic acid 3:1, of flavonols with acetone - formic acid 17:3, of tannins with diisopropyl ether - acetone - formic acid - water 4:4:1:1, and of flavonols with diisopropyl ether - acetone - formic acid - water 5:3:1:1. Detection of polyphenolic compounds under UV light at 254 and 366 nm before and after spraying with natural products reagent followed by polyethylene glycol reagent. Detection in white light after spraying with 1 % iron(III) chloride (for tannins and phenolic acids), vanillin-hydrochloric acid (flavonols) or bis-diazotised sulfanilamide (for all polyphenols). Quantitative determination of polyphenol contents by HPLC with UV detection. Meadowsweet flowers and rose hips with seeds yielded 55.5-124.8 and 0.4-1.3 mg/g of ellagitannins, respectively. The sum of detected polyphenols was 83.9-165.7 mg/g for *Filipendulae ulmariae* flos and 1.2-2.7 mg/g for *Rosae pseudo-fructus cum fructibus*.

herbal, traditional medicine, food, analysis, HPTLC, qualitative identification 32e

103 094 Jolanta FLIEGER\*, P. PANETH, K. GIELZAK-KOCWIN, M. TATARCZAK (\*Department of Inorganic and Analytical Chemistry, Medical University of Lublin, 20-081 Lublin, Staszica 6, Poland; j.flieger@am.lublin.pl): Micropreparative isolation of Cu(II) complexes of isoniazid and ethambutol and determination of their structures. *J. Planar Chromatogr.* 22, 83-88 (2009). TLC of isoniazid, pyrazinamide, ethambutol, and aminosalicic acid on RP-18 in a horizontal chamber at 20 °C with acetonitrile - water 3:7. The mobile phase was modified by adding copper(II) chlo-

ride to the mixture at a constant concentration of 0.05 M. Detection under UV light at 254 nm. Quantitative determination by absorbance measurement in the range 200 - 700 nm with a TLC scanner equipped with a diode-array detector.

pharmaceutical research, qualitative identification, densitometry, quantitative analysis 32a

- 103 095 M. GANDHIMATHI\*, T. K. RAVI (\*Department of Pharmaceutical Analysis, College of Pharmacy, Sri Ramakrishna Institute of Paramedical Sciences, Coimbatore 641 044, India; gands72@yahoo.co.in): Simultaneous densitometric analysis of tramadol hydrochloride and chlorzoxazone by high-performance thin-layer chromatography. *J. Planar Chromatogr.* 21, 305-307 (2008). HPTLC of tramadol hydrochloride and chlorzoxazone on silica gel, prewashed with methanol, in a twin trough chamber, saturated for 10 min, with ethyl acetate - toluene - ammonia 35:15:1. Quantitative determination by absorbance measurement at 273 nm.

quality control, HPTLC, densitometry, quantitative analysis 32a

- 103 096 M. GANDHIMATHI\*, T. K. RAVI (\*Dept. of Pharmaceutical Analysis, College of Pharmacy, Sri Ramakrishna Institute of Para Medical Sciences, Coimbatore 641044, India, gands72@yahoo.co.in): HPTLC method for the estimation of hydrochlorthiazide from its combined dosage forms. *Indian Drugs* 46(2), 150-153 (2009). HPTLC of hydrochlorthiazide (HZ) in combination with quinapril (QP) or candesartan (CD) on silica gel with toluene - ethyl acetate - glacial acetic acid 2:12:1 (for HZ and QP), or 20:50:1 (for HZ and CD), with chamber saturation for 30 min at room temperature. Quantitative determination by absorbance measurement at 273 nm. The method was linear in the range of 480-960 (HZ), 400-800 (QP) and 50-250 ng/spot (CD).

pharmaceutical research, quality control, HPTLC, densitometry, quantitative analysis 32a

- 103 097 C. GIAGINIS, Anna TSANTILI-KAKOULIDOU\* (\*Department of Pharmaceutical Chemistry, School of Pharmacy, University of Athens, Panepistimiopolis, Zografou, Athens 157 71, Greece; tsantili@pharm.uoa.gr): RPTLC retention indices of basic and neutral drugs as surrogates of octanol-water distribution coefficients. Effect of buffer constituents and pH. *J. Planar Chromatogr.* 22, 217-224 (2009). TLC of 26 structurally diverse basic and neutral drugs on RP-18 with phosphate buffer, or phosphate-buffered saline, or morpholinepropansulfonic acid at pH 7.4, or phosphate buffer at pH 11.0, or pure water, and different proportions of methanol. The use of n-octanol as mobile phase additive was also investigated. Detection under UV light at 254 nm.

pharmaceutical research, qualitative identification 32a

- 103 098 Rina GOKANI\*, Mamta SHAH (\*L.M. College of Pharmacy, Dept. of Pharmacognosy, Navrangpura, Ahmedabad 380009, India): Isolation and estimation of clerodendrin A in *Clerodendrum phlomidis* and *Ptemna integrifolia* root. *J. Pharm. Res.* 8(1), 9-11 (2009). HPTLC of clerodendrin A in *Clerodendrum phlomidis* and *Ptemna integrifolia* root on silica gel with n-hexane - ethyl formate 7:3. Detection by spraying with a 5 % aqueous solution of H<sub>2</sub>SO<sub>4</sub>, followed by heating at 110 °C. Quantitative determination by absorbance measurement at 396 nm. *Clerodendrum phlomidis* roots contained more clerodendrin A (0.07 %) than roots of *Ptemna integrifolia* (0.04 %).

pharmaceutical research, herbal, HPTLC, densitometry, quantitative analysis 32c

- 103 099 C. GREEN\*, S. HIBBERT, Y. SHAW, L. WILLIAMS, S. MITCHELL, E. GARRAWAY (\*Natural Products Unit, Product Research and Development Division, Scientific Research Council, Hope Gardens, Kingston, Jamaica, cheryl@src-jamaica.org): Extraction, processing, and storage effects on curcuminoids and oleoresin yields from *Curcuma longa* L. grown in Jamaica. *J. Agric. Food Chem.* 56, 3664-3670 (2008). HPTLC of curcumin from the rhizomes of *Curcuma longa* on silica gel with chloroform - ethyl acetate 19:1. Detection by spraying with ammonium molybdate 5 % in aqueous sulphuric acid and examination under UV 254 nm. The hRf value of curcumin was 57.

herbal, HPTLC, qualitative identification

32e

- 103 100 A. HAWRYL, D. CICHOCKI, Monika WAKSMUNDSKA-HAJNOS\* (\*Department of Inorganic Chemistry, Faculty of Pharmacy, Medical University, 6 Staszica, 20-081 Lublin, Poland; monika.hajnos@am.lublin.pl): Determination of the lipophilicity of some psychotropic drugs by RP-TLC. *J. Planar Chromatogr.* 21, 343-348 (2008). HPTLC of 12 psychotropic drugs (chlorpromazine, perazine, flupentixol, haloperidol, risperidon, alprazolam, midazolam, clomipramine, amitriptyline, doxepin, moclobemide, carbamazepine) on RP-18 in a horizontal chamber. The 10 mobile phases were prepared by mixing different amounts of water and the polar modifiers methanol, dioxane, acetone, acetonitrile, or tetrahydrofuran. Ammonia solution, acetate buffer (pH 4.75), or dodecyl sulfate was added to each of these mixtures. Detection under UV 254 nm.  
pharmaceutical research, HPTLC, qualitative identification 32a
- 103 101 W. HUANG (Huang Wenhua)\*, B. ZHAO (Zhao Bin), CH. XIE (Xie Chaoliang), J. LI (Li Jianli) (\*Sichuan Inst. TCM, Chengdu, Sichuan 610031, China): (Study of the quality standard for Hongjinchan granules) (Chinese). *J. Chinese Trad. Patent Med.* 30 (12), 1997-1800 (2008). TLC of Hongjinchan granule extracts on silica gel with 1) n-butanol - glacial acetic acid - water 7:1:2; and 2) chloroform - ethyl acetate 7:3. Detection 1) under UV 365 nm; 2) by spraying with 2 % iron(III) chloride in ethanol; 3) by exposure to ammonia vapor for approx. 15 min. Identification by comparison with the standards of the component drugs. Quantification of scutellarin by HPLC.  
quality control, traditional medicine, pharmaceutical research, quantitative analysis, qualitative identification 32e, 4d
- 103 102 T.W. INGLOT\*, K. DABROWSKA, A. GUMIENICZEK (\*Department of Medicinal Chemistry, Skubiszewski Medical University, Jaczewskiego 4, 20-090 Lublin, Poland; t.inglot@am.lublin.pl): The reversed-phase retention behavior of some angiotensin-II receptor antagonists. *J. Planar Chromatogr.* 22, 145-155 (2009). TLC of candesartan, eprosartan, telmisartan, losartan, and valsartan on RP-8 and RP-18 with mobile phases comprising 3:7 mixtures of phosphate buffer of different pH (2-8) and one of three modifiers, acetonitrile, methanol, or tetrahydrofuran, in horizontal chambers at ambient temperature. Detection under UV 254 nm. Quantitative determination by absorbance measurement. Separation of the five sartans was also achieved by TLC on RP-18 with dimethyl sulfoxide - phosphate buffer (pH 5.0) 4:1.  
pharmaceutical research, densitometry, qualitative identification 32a
- 103 103 N. JAIN\*, G.K. JAIN, F.J. AHMAD, R.K. KHAR (\*Department of Pharmaceutics, Faculty of Pharmacy, Hamdard University, Hamdard Nagar, New Delhi 110062, India): Validated stability-indicating densitometric thin-layer chromatography: Application to stress degradation studies of minocycline. *Anal. Chim. Acta* 599 (2), 302-309 (2007). HPTLC of minocycline on silica gel (impregnated with a 10 % (w/v) solution of disodium ethylene diaminetetraacetic acid (EDTA) with a pH of 9.0) with methanol - acetonitrile - isopropyl alcohol - water 10:8:1:1. Quantitative determination by absorbance measurement at 345 nm. The limit of detection was 3.7 ng/spot, recovery was 99.2 - 100.2 %, and precision was good with a % RSD of 0.4 %. The method was able to separate all degradation products (produced by acidic and basic degradation, oxidation and photodegradation) from the pure drug.  
quality control, pharmaceutical research, HPTLC, quantitative analysis, qualitative identification, densitometry 32c
- 103 104 A. JAMSHIDI\*, A. SHARIFI (\*Iran Polymer and Petrochemical Institute, Novel Drug Delivery Systems Department, P. O. Box 14185/458 Tehran, Iran; a.jamshidi@ippi.ac.ir): HPTLC analysis of tamoxifen citrate in drug-release media during development of an in-situ-cross-linking delivery system. *J. Planar Chromatogr.* 22, 187-189 (2009). HPTLC of tamoxifen citrate ((Z)-2-[4-(1,2-diphenylbut-1-enyl)phenoxy]ethyl dimethylamine citrate) on silica gel (prewashed with methanol - chloroform 1:1) by automated multiple development (AMD 2) using single-step isocratic development with toluene - methanol - glacial acetic acid 57:38:5. Detection under UV 254 nm. Quantitative determination by absorbance measurement at 256 nm. The limit of detection and

quantitation was 25 and 52 ng/band, respectively.

pharmaceutical research, HPTLC, densitometry, quantitative analysis, AMD 32a

- 103 105 W. JIANG (Jiang Weike)\*, T. ZHOU (Zhou Tao), P. GUO (Guo Peinan), Z. CHEN (Chen Zaifa) (\*Guiyang Coll. TCM, Guiyang, Guizhou 550002, China): (Study of the quality standard for Yinao pills) (Chinese). *J. Chinese Trad. Patent Med.* 30 (11), 1642-1646 (2008). TLC of Yinao pill extracts on silica gel with 1) toluene - ethyl acetate 9:1; 2) benzene - ethyl acetate 3:2; 3) toluene - ethyl acetate - formic acid 28:8:1. Detection 1) by spraying with 10 % phosphomolybdic acid in ethanol and heating at 105 °C; 2) by spraying with 10 % sulfuric acid in ethanol and heating at 105 °C.

quality control, traditional medicine, pharmaceutical research, quantitative analysis, qualitative identification, Chinese traditional medicine, 32e

- 103 106 R. KAKDE\*, N. BAWANE (\*Department of Pharmaceutical Sciences, RTM Nagpur University, Nagpur 440 033, Maharashtra, India; drkakde@yahoo.com; Nilesh.Bawane2000@gmail.com): High-performance thin-layer chromatographic method for simultaneous analysis of metoprolol succinate and amlodipine besylate in pharmaceutical preparations. *J. Planar Chromatogr.* 22, 115-119 (2009). HPTLC of metoprolol succinate and amlodipine besylate on silica gel (prewashed with methanol) with methanol - ethyl acetate - water - toluene - 25 % ammonia 15:50:3:30:3 in a twin trough chamber saturated for 20 min at 25 +/- 2 °C. Quantitative determination by absorbance measurement at 236 nm.

quality control, HPTLC, densitometry, quantitative analysis 32a

- 103 107 B. KALYANI, K.S. LADDHA\* (\*Medicinal Natural Product Laboratory, Pharmaceutical Division, University Institute of Chemical Technology, Matunga, Mumbai 400 019, India; ksladdha@udct.org, ksladdha@yahoo.co.in): Discriminating features of safed musli and shatavari. *J. Planar Chromatogr.* 22, 157-161 (2009). Safed musli is the common name for *Chlorophytum borivilianum*, whereas shatavari is *Asparagus racemosus*, both of the liliaceae family. HPTLC of saponins and sapogenins on silica gel with chloroform - methanol - water 32:25:5 for saponins and with petroleum ether - ethyl acetate 4:1 for sapogenins. Detection of saponins by spraying with anisaldehyde reagent and with Ehrlich's reagent, followed by densitometric analysis at 620 and 510 nm. Detection of sapogenins by spraying with Liebermann Burchard reagent, followed by densitometric analysis at 580 nm.

herbal, quality control, densitometry, qualitative identification, HPTLC, quantitative analysis 32e

- 103 108 S. KHATOON\*, N. SINGH, N. SRIVASTAVA, A. K. S. RAWAT, S. MEHROTRA (\*Pharmacognosy and Ethnopharmacology Division, National Botanical Research Institute, Rana Pratp Marg, Lucknow 226001, India, sayyadak@yahoo.com, sayyadak@nbri.res.in): Chemical evaluation of seven *Terminalia* species and quantification of important polyphenols by TLC. *J. Planar Chromatogr.* 21, 167-171 (2008). HPTLC of gallic acid and ellagic acid on silica gel with toluene - ethyl acetate - formic acid 5:5:1 and 40:25:4 in a twin trough chamber saturated for 30 min. Detection under UV light at 254 and 366 nm and under visible light after derivatization with anisaldehyde reagent. Quantitative determination by absorbance measurement at 272 nm.

- 103 109 Katarzyna KULIG\*, B. MALAWSKA (\*Department of Physicochemical Drug Analysis, Faculty of Pharmacy, Jagiellonian University Medical College, Medyczna 9, 30-688 Kraków, Poland; mfkkulig@cyf-kr.edu.pl): RP-TLC determination of the lipophilicity of 1-substituted pyrrolidin-2-one derivatives. Correlation of lipophilicity with affinity for alpha-adrenoceptors. *J. Planar Chromatogr.* 22, 141-144 (2009). Determination of the relative lipophilicity of 14 1-substituted pyrrolidin-2-one by TLC on RP-18 with mixtures of acetonitrile and pH 7.0 Tris buffer with volume fractions of acetonitrile between 20 and 80 %, with chamber saturation for 2 h. Detection under UV light. Retention data obtained by this method were exponentially dependent on aceto-

nitrile concentration and enabled estimation of the relative lipophilicity corresponding to pH 7.0 Tris buffer as mobile phase.

pharmaceutical research, qualitative identification, physicochemical organic chemistry 32a

- 103 110 V. KUMAR, K. MUKHERJEE, S. KUMAR, M. MAL, P.K. MUKHERJEE\* (\*School of Natural Product Studies, Department of Pharmaceutical Technology, Jadavpur University, Kolkata 700032, India; Pknatprod@yahoo.co.in): Validation of HPTLC method for the analysis of taraxerol in *Clitoria ternatea*. *Phytochem. Anal.* 19, 244-250 (2008). HPTLC of taraxerol on silica gel in a saturated twin trough chamber with hexane - ethyl acetate 4:1. Detection by spraying with anisaldehyde reagent. Quantitative determination by absorbance measurement at 420 nm. Limits of detection and quantification were 31 and 105 ng/spot, respectively.

herbal, HPTLC

32e

- 103 111 N.S. KUMAR\*, M. VENKATESH, S. PONNUSANKAR, P. VENKATESH, A. GANTAIT, N. NEMA, S. BHADRA, D. MUKHERJEE, S. PANDIT, P. MUKHERJEE (\*School of Natural Product Studies, Dept. of Pharmaceutical Tech., Jadavpur University, Kolkata, India): Mahanimbine in *Murraya koenigi* - Marker analysis and acetyl cholinesterase enzyme inhibition. Abstract No. 0983, IHCBC (2009). HPTLC of mahanimbine (a carbazole alkaloid isolated from *Murraya koenigi*) on silica gel with petroleum ether - chloroform 13:7. The R<sub>f</sub> value of mahanimbine was 60. Quantitative determination by absorbance measurement at 254 nm. The method was linear in the concentration range of 50-250 ng/spot. Enzyme inhibition activity of methanol, petroleum ether, and chloroform extracts of the plant and of mahanimbine was evaluated using galantamine as standard inhibitor of the enzyme.

traditional medicine, herbal, HPTLC, densitometry, quantitative analysis

32e

- 103 112 S. KUMAR\*, R. MADAN, A. SHARMA (\*S. D. College of Pharmacy, Barnala 148101, India): Estimation of apigenin, an anxiolytic constituent, in *Turnera aphrodisiaca*. *Ind. J. of Pharma Sci.* 70(6), 847-851 (2008). HPTLC of apigenin in segregated parts (leaves, stems, flowers and fruits) of *Turnera aphrodisiaca* on silica gel with toluene - ethyl acetate 1:4. Quantitative determination by absorbance measurement at 336 nm. Flowers were found to contain maximum amount of apigenin whereas leaves contained the least. Apigenin contents in methanolic extracts of aerial plant parts were fourteen times lower than in acid hydrolyzed methanolic extracts, indicating the presence of most of apigenin in glycosidic form. The plant material collected in September showed maximum contents of apigenin.

pharmaceutical research, quality control, densitometry, HPTLC, quantitative analysis 32e

- 103 113 K.J. KUMAR\*, S. JAYARAMAN, S. NARASIMHAN (\*Department of Pharmaceutical Sciences, Birla Institute of Technology, Mesra, Ranchi 835215, India; jayaram\_res@yahoo.com): A simple and rapid method of estimation of nimbolide, an anticancer constituent in neem leaves. *J. Planar Chromatogr.* 21, 263-265 (2008). HPTLC of nimbolide on silica gel in a twin trough chamber with ethyl acetate - hexane 1:1. Quantitative determination by absorbance measurement at 254 nm. The limits of detection and quantification were 3.3 and 1.0 µg/spot, respectively.

traditional medicine, herbal, quantitative analysis, densitometry, HPTLC

32e

- 103 114 P.J. LOKHANDE, J. K. VERMA\* (\*Inorganic Chemistry Laboratory, K. J. Somaiya College of Science and Commerce, Vidyavihar, Mumbai 400 077, Maharashtra, India; jkverma7@rediffmail.com): Quantification of negundoside in *Vitex negundo* Linn. leaf by high-performance thin-layer chromatography. *J. Planar Chromatogr.* 22, 225-228 (2009). HPTLC of negundoside on silica gel (prewashed with methanol) with ethyl acetate - methanol - water - glacial acetic acid 78:12:7:3 in a twin trough chamber saturated for 20 min. Quantitative determination by absorbance measurement at 267 nm.

herbal, traditional medicine, quality control, HPTLC, densitometry, quantitative analysis  
32e

- 103 115 V. MADHAVAN\*, Hema BASNETT, A. CENDIL KUMAR, S. YOGANARASIMHAN (\*M.S. Ramaiah College of Pharmacy, Dept. of Pharmacognosy and Pharmaceutical Chemistry, Bangalore 60054, India): Fingerprinting of plumbagin in *Drosera burmannii* Vahl using high performance thin layer chromatography. *Ind. J. Pharma Sci.* 70(6), 798-800 (2008). HPTLC of plumbagin in *Drosera burmannii* Vahl on silica gel with toluene - glacial acetic acid 55:1 (for alcoholic extracts) and toluene - chloroform - glacial acetic acid 10:10:1 (for aqueous extracts) with chamber saturation for 60 min. Evaluation in visible light at 425 nm. The alcoholic extract showed seven components, the main zone with hRf value of 56 corresponded to plumbagin. The aqueous extract showed two zones but no plumbagin.

pharmaceutical research, quality control, herbal, HPTLC 32c

- 103 116 Manasi MANTRI\*, Nancy PANDITA (\*SVKM's, NMIMS University, Mumbai, India): Authentication of Hoodia and hang off capsules by TLC photo documentation. Abstracts No. 9156, IHCB (2009). TLC of Hoodia gordonii on silica gel with ethyl acetate - methanol - water 36:7:5. Photodocumentation and estimation was carried out by the DISTA method. The authentication of hang-off capsules, which contained several plant ingredients used to prevent hang-over, was performed by TLC on silica gel with toluene - ethyl acetate 9:1. Detection by spraying with vanillin-sulfuric acid reagent.

pharmaceutical research, quality control, herbal 32e

- 103 117 G. MATYSIK, Agnieszka SKALSKA-KAMINSKA\*, B. STEFANCZYK, M. WÓJCIAK-KOSIOR, D. RAPA (\*Department of Chemistry, Laboratory of Planar Chromatography, Medical University, Staszica 6, 20-081 Lublin, Poland; agnieszka@wp.pl): Application of a new technique in two-dimensional TLC separation of multicomponent mixtures. *J. Planar Chromatogr.* 21, 233-236 (2008). Connection of two-dimensional chromatography with multiple gradient development. 2D HPTLC of anthraquinone derivatives (1,8-dihydroxyanthraquinone, franguloemodin A, aloemodin, rhein, frangulin A, aloin, sennoside B) on silica gel. Bandwise application at the right and left corner of the plate, then development by use of multiple gradient development [G. Matysik, *Chromatographia* 43, 39-41 (2004)], e.g. for step 1 hexane - dichloromethane 1:1, for step 2 (hexane - dichloromethane - ethyl acetate - 80 % formic acid 50:40:10:1) and for step 3 hexane - dichloromethane - ethyl acetate - methanol - formic acid 40:40:20:5:1. After drying the plate was developed from the left and right edge with hexane - dichloromethane - formic acid 60:40:1 for step 1 and with hexane - dichloromethane - ethyl acetate - formic acid 60:35:5:1 for step 2. Quantitative determination by absorbance measurement at 440 nm. Detection of anthraquinoids in daylight and after derivatization with 10 % potassium hydroxide in methanol.

herbal, qualitative identification, HPTLC, densitometry 32e

- 103 118 S. MENNICKENT\*, R. FIERRO, M. VEGA, M. DIEGO, G. GODOY (\*Department of Pharmacy, Faculty of Pharmacy, University of Concepcion, Concepcion, Chile, smennick@udec.cl): Instrumental planar chromatographic method for determination of carbamazepine in human serum. *J. Sep. Sci.* 32, 1454-1458 (2009). HPTLC of carbamazepine in human serum on silica with ethyl acetate - toluene - methanol - glacial acetic acid 10:8:1:1. Detection by dipping in a solution of perchloric acid 60 % - ethanol - water 1:1:1, followed by heating at 120-150 °C for 5-10 min. Quantitative determination by fluorescence measurement at 366/>400 nm. The accuracy and precision did not exceed 3.2 % RSD at any level. The hRf value of carbamazepine was 55 and selectivity regarding matrix was given. Linearity was between 3 and 20 ng/μL. The intra-assay and inter-assay precision, expressed as the RSD, were in the range of 0.4 - 1.2 % (n = 3) and 2.2 - 3.2 % (n = 9), respectively. The limit of detection and quantification was 0.19 and 0.57 ng, respectively. Recovery (by standard addition) was between 99.0 and 102.0 %.

pharmaceutical research, clinical routine analysis, HPTLC, quantitative analysis, densitometry  
32c



- 103 119 D.B. MESHARAM\*, S.B. BAGADE, M.R. TAJNE (\*University Department of Pharmaceutical Sciences, RTM Nagpur University, Nagpur 440033, Maharashtra, India; dbmeshram@yahoo.com): TLC-densitometric analysis of clotrimazole and metronidazole in combined dosage forms. *J. Planar Chromatogr.* 21, 277-282 (2008). TLC of clotrimazole and metronidazole on silica gel in a twin trough chamber saturated for 10 min with toluene - ethyl acetate - methanol - acetic acid 55:2:6:1. Quantitative determination by absorbance measurement at 220 nm.  
quality control, densitometry, quantitative analysis 32a
- 103 121 Jadwiga MIELCAREK\*, P. GROBELNY, T. OSMALEK (\*Department of Inorganic and Analytical Chemistry, Poznan University of Medical Sciences, Grunwaldzka 6, 60-780 Poznan, Poland; jmielcar@amp.poznan.pl): Identification of photoproducts of fluvastatin in solutions. *J. Planar Chromatogr.* 22, 137-140 (2009). HPTLC of fluvastatin and photochemical decomposition products on RP-18 with phosphate buffer (pH 4.0) - methanol 3:17 at 4 +/- 0.5 °C with chamber saturation and under light protection. Before development the plates were thermostated for 10 min in the dry chamber. Detection of fluvastatin and its photoproducts under UV 254 nm. Isolation of photoproducts by preparative TLC on RP-18.  
quality control, HPTLC, qualitative identification, preparative TLC 32a
- 103 122 M.A.A. MOHAMMAD\*, N.H. ZAWILLA (\*Department of Pharmaceutical and Medicinal Chemistry, Faculty of Pharmacy, Cairo University, Kasr El-Aini 11562, Cairo, Egypt; mohammada-zim97@yahoo.com): Thin-layer and column-chromatographic methods for simultaneous analysis of ambroxol hydrochloride and doxycycline hyclate in a binary mixture. *J. Planar Chromatogr.* 22, 201-206 (2009). TLC of ambroxol hydrochloride and doxycycline hyclate on silica gel with ethyl acetate - ethanol - glacial acetic acid - water 90:40:5:10 with chamber saturation for 1 h. Detection under UV 254 nm. Quantitative determination by absorbance measurement at 254 nm for ambroxol hydrochloride and 270 nm for doxycycline hyclate.  
quality control, densitometry, quantitative analysis 32a
- 103 123 M. MORENO\*, A. VILORIA, D. HIDALGO (\*Simon Rodriguez University, Valencia, Venezuela, morenoalvarez@cantv.net): A new method for the isolation of betalaines by HPTLC. *Rev. Fac. Agron.* 21, 155-160 (2004). HPTLC of betaxantin and betacyanin in the roots of *Beta vulgaris* on cellulose in two one-dimensional developments with 1) isopropanol - ethanol - water - acetic acid 6:7:6:1 and 2) isopropanol - ethanol - water - acetic acid 11:4:4:1. Qualitative identification under UV light. Betaxantin and betacyanin showed maximum absorbances at 537 and 465 nm, respectively. The hRf values of betaxantin and betacyanin were 22 and 34, respectively. herbal, HPTLC, qualitative identification 32e
- 103 124 O. MORINAGA, T. UTO, S. SAKAMOTO, W. PUTALUN, S. LHIEOCHAIPHANT, H. TANAKA, Y. SHOYAMA\* (\*Faculty of Pharmaceutical Science, Nagasaki International University, 2825-7 Huis Ten Bosch, Sasebo, Nagasaki 859-3298, Japan; shoyama@niu.ac.jp): Development of eastern blotting technique for sennoside A and sennoside B using anti-sennoside A and anti-sennoside B monoclonal antibodies. *Phytochem. Anal.* 20, 154-158 (2009). TLC of the purgative constituents of rhubarb (sennoside A and sennoside B) on silica gel with 1-propanol - ethyl acetate - water - acetic acid 40:40:30:1. After drying detection by spraying with 10 % sulfuric acid and heating. For the eastern blotting assay the developed TLC plate was dried and sprayed with isopropanol - methanol - water 1:4:16. Transfer by using a PVDF membrane sheet for further treatment.  
herbal, traditional medicine, quality control, qualitative identification 32e, 3e
- 103 125 S.K. MOTWANI \*, R.K. KHAR, F.J. AHMAD, S. CHOPRA, K. KOHLI, S. TALEGAONKAR, Z. IQBAL (\*Department of Pharmaceutics, Faculty of Pharmacy, Jamia Hamdard, Hamdard Nagar, New Delhi 110062, India): Stability indicating high-performance thin-layer chromatographic determination of gatifloxacin as bulk drug and from polymeric nanoparticles. *Anal. Chim. Acta*, 576 (2), 253-260 (2006). Description of a simple, sensitive, selective, precise and stability

indicating method for determination of gatifloxacin both as a bulk drug and from polymeric nanoparticles by TLC on silica gel with n-propanol - methanol - 25 % ammonia 50:10:9. The hRf value of gatifloxacin was 60. Separation from degradation products (produced under acidic and basic conditions and upon wet and dry heat treatment) was good. Quantitative determination by absorbance measurement at 292 nm. Linearity was 400 - 1200 ng/spot, with a correlation coefficient of 0.9953. The limit of detection and quantitation was 3 and 8 ng/spot, respectively.

pharmaceutical research, quality control, densitometry, quantitative analysis, qualitative identification 32c

- 103 126 S. MURALIDHARAN\*, S.N. MEYYANATHAN, N. MURUGANANTHAM, S. RAJAN, K. KRISHNARAJ, B. SURESH (\*Department of Pharmaceutical Analysis, JSS College of Pharmacy, Rocklands, Ooty, Ootacamund 643 001, India; murali23pharm@rediffmail.com): Validated HPTLC method of analysis of dexibuprofen in its formulation. *J. Planar Chromatogr.* 22, 207-210 (2009). HPTLC of dexibuprofen on silica gel (prewashed with methanol) in a twin trough chamber with hexane - ethyl acetate - glacial acetic acid 15:5:1. Quantitative determination by absorbance measurement at 217 nm.

quality control, HPTLC, densitometry, quantitative analysis 32a

- 103 127 P.S. NAYAK\*, S.D. UPADHYAYA, A. UPADHYAYA (\*Department of Crop and Herbal Physiology, College of Agriculture, Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur M. P. 482004 India; preetisagarnayak@rediffmail.com): HPTLC method for analysis of withaferin-A in Ashwagandha (*Withania somnifera*). *J. Planar Chromatogr.* 22, 197-200 (2009). HPTLC of withaferin A on silica gel with toluene - ethyl acetate - formic acid 5:5:1 in a twin trough chamber saturated for 20 min at 25 +/- 2 °C and 50 +/- 5 % relative humidity. Detection under UV light and by dipping into freshly prepared p-anisaldehyde reagent, followed by heating at 110 °C for 10 min. Quantitative determination by absorbance measurement at 200 nm. The limit of detection and quantification was 100 and 800 ng/zone, respectively. The high sample throughput is useful for routine analysis of the preparation in industrial quality control and regulatory laboratories

traditional medicine, herbal, HPTLC, densitometry, quantitative analysis 32e

- 103 128 H.J. PANCHAL\*, B.N. SUHAGIA, N.J. PATEL, B.H. PATEL (\*S.S.K. Patel College of Pharmaceutical Education and Research, Ganpat Vidyanagar, Kherva, Mehsana-382711, Gujarat, India; hir\_143\_2003@yahoo.com): A simple and sensitive HPTLC method for quantitative analysis of pitavastatin calcium in tablets. *J. Planar Chromatogr.* 21, 267-270 (2008). HPTLC of pitavastatin calcium on silica gel (prewashed with methanol) in a twin trough chamber saturated for 30 min at room temperature with toluene - methanol - glacial acetic acid 190:59:1. Quantitative determination by absorbance measurement at 238 nm. The limits of detection and quantification were 7 and 20 ng/band, respectively.

quality control, HPTLC, quantitative analysis, densitometry 32a

- 103 129 S. PANDIT\*, S. PONNUSANKAR, M. VENKATESH, A. GANTAIT, A. BANDYOPADHYAY, P. MUKHERJEE (\*School of Natural Product Studies, Dept. of Pharmaceutical Tech., Jadavpur University, Kolkata, India): Standardization, validation and safety evaluation of *Emblica officinalis* Linn. Abstract No. 9148, IHCB (2009). HPTLC of gallic acid in *Emblica officinalis* (an important constituent of Triphala, a popular ayurvedic formulation) on silica gel with toluene - ethyl acetate - formic acid 10:10:3. The hRf value of gallic acid was 45. Quantitative determination by absorbance measurement at 254 nm. The method was linear in the range of 150-530 ng/spot. The extract was found to contain 7.5 mg/g of gallic acid.

quality control, herbal, HPTLC, densitometry, quantitative analysis 32e

- 103 130 M. PARAMASIVAM\*, R. POI, H. BANERJEE, A. BANDYOPADHYAY (\*Department of Agricultural Chemicals, Faculty of Agriculture, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur,

Nadia 741252, India, sivam25@gmail.com): High-performance thin layer chromatographic method for quantitative determination of curcuminoids in *Curcuma longa* germplasm. *Food Chem.* 113, 640-644 (2009). HPTLC of curcumin (1), demethoxycurcumin (2), and bisdemethoxycurcumin (3) from the rhizomes of *Curcuma longa* on silica gel with chloroform - methanol 24:1. Quantitative determination by absorbance measurement at 425 nm. The hRf values of (1), (2), and (3) were 66, 48, and 30, respectively. Selectivity regarding matrix was given. Linearity was between 1 and 20 µg/spot for all curcuminoids. The intermediate precision of the method was satisfactory. Recovery was 98.7 % for (1), 96.3 % for (2), and 97.2 % for (3). The limit of detection for the substances was 100 ng/spot.

herbal, HPTLC, quantitative analysis, comparison of methods

32e

- 103 131 S.K. PATEL\*, N. PATEL, P.U. PATEL, D.B. PATEL, A.M. PRAJAPATI, S.A. PATEL (\*College of Pharmaceutical Education and Research, Ganpat University, Kherva, Dist-Mehsana, Gujarat, India 382 711; skpatel\_2@rediffmail.com): Validation of a stability-indicating HPTLC method for analysis of duloxetine hydrochloride in capsule dosage form. Separation and analysis of duloxetine hydrochloride and olanzapine in a synthetic mixture. *J. Planar Chromatogr.* 22, 121-126 (2009). HPTLC of duloxetine hydrochloride (and degradation products after acidic and basic hydrolysis, oxidation and photodegradation) on silica gel with toluene - methanol - 10 % ammonia 60:26:1 in a twin trough chamber saturated at 25 °C. Quantitative determination by absorbance measurement at 231 nm. The hRf value was 39. Linearity was between 60-480 ng/band. The limit of detection and quantification was 20 and 60 ng/spot, respectively. For separation of duloxetine hydrochloride and olanzapine in a synthetic mixture HPTLC with acetone - methanol - triethylamine 10:6:1. Quantitative determination by absorbance measurement at 240 nm. The hRf values were 63 and 77, respectively. Linearity was between 100-800 ng/band.

quality control, HPTLC, densitometry, quantitative analysis

32a

- 103 132 M.B. PATEL\*, V.M. KADAKIA, S.H. MISHRA (\*Pharmacy Dept., Kalabhavan Faculty of Technology and Engineering, The M. S. University of Baroda, Vadodara 390001, India, shmishra48@rediffmail.com): Simultaneous estimation of andrographolide and wedelolactone in herbal formulations. *Ind. J. Pharm. Sci.* 70(5), 689-693 (2008). HPTLC of andrographolide and wedelolactone (active components of *Andrographis paniculata* respectively *Eclipta alba*) on silica gel with toluene - acetone - formic acid 9:6:1. Quantitative determination by absorbance measurement at 254 nm. The hRf of andrographolide was 52 and of wedelolactone 58. The method was linear in the range of 200-400 ng/spot (andrographolide) and 100-200 ng/spot (wedelolactone). The herbal formulation contained 1.4 mg andrographolide and 1.7 mg wedelolactone per tablet. The proposed method could be applied for routine analysis of both compounds.

herbal, HPTLC, densitometry, quantitative analysis

32e

- 103 133 Anna PELANDER, DANIEL BACKSTRÖM, I. OJANPERÄ\* (\*Department of Forensic Medicine, P.O. Box 40, University of Helsinki, 00014 Helsinki, Finland): Qualitative screening for basic drugs in autopsy liver samples by dual-plate overpressured layer chromatography. *J. Chromatogr. B* 857 (2), 337-340 (2007). OPLC of basic drugs in autopsy liver samples prepared by enzymatic digestion with trypsin and liquid - liquid extraction with butyl chloride. Separation by dual-plate analysis with trichloroethylene - methyl ethyl ketone - n-butanol - acetic acid - water 17:8:25:6:4 for OPLC 1 and butyl acetate - ethanol (96.1 %) - tripropylamine - water 340:37:20:3 for OPLC 2. Identification by automated comparison of corrected hRf values and in situ UV spectra with library values by dedicated software. Determination of the identification limit for 25 basic drugs in liver ranging from 0.5 to 10 mg/kg. The method is suitable for routine screening of basic drugs in post-mortem samples of varying quality, combining the benefit from moderately high separation power with the ease of disposable plates.

OPLC

32f

- 103 134 S. PONNUSANKAR\*, S. PANDIT, M. VENKATESH, A. BANDOPADHYAY, P. MUKHERJEE (\*School of Natural Studies, Jadavpur University, Kolkata 700032, India, and Molecular Endocri-

nology Lab, Indian Institute of Chemical Biology, Kolkata, India): Standardization, validation and safety evaluation of *Terminalia chebula* Retz. Abstract No. 9145, IHCBS (2009). *Terminalia chebula* (an important constituent of Triphala, a popular ayurvedic formulation) was standardized for gallic acid content by HPTLC on silica gel with toluene - ethyl acetate - formic acid 10:10:3. The  $hR_f$  value of gallic acid was 45. Quantitative determination by absorbance measurement at 254 nm. The method was linear in the range of 150-550 ng/spot. Hydroalcoholic extracts of the fruit pulp contained 10.5 mg/g gallic acid.

pharmaceutical research, quality control, herbal, HPTLC, densitometry 32e

- 103 135 O. POTTERAT\*, R. FELTEN, P. DALSGAARD, M. HAMBURGER (\*Institute of Pharmaceutical Biology, University of Basel, Klingelbergstrasse 50, Basel, Switzerland, olivier.potterat@unibas.ch): Identification of TLC markers and quantification by HPLC-MS of various constituents in noni fruit powder and commercial noni-derived products. *J. Agric. Food Chem.* 55, 7489-7494 (2007). HPTLC of fruit powder and commercial products of Noni (*Morinda citrifolia*) on silica gel with chloroform - methanol 9:1 or chloroform - methanol - water 13:6:1. Detection under UV 254 and 366 nm after spraying with vanillin reagent (1 % vanillin in ethanol containing 2 % sulphuric acid), followed by heating at 105 °C. The following compounds were identified as markers ( $hR_f$ ): ursolic acid (60), linoleic acid (55), scopoletin (53), 3-methyl-1,3-butanediol (27).

food analysis, herbal, HPTLC, qualitative identification 32e

- 103 136 K. RAVIKANTH\*, M. THAKUR, B. SINGH, M. SAXENA (\*Research and Development Centre, Ayurved Ltd., Katha, P.O. Baddi, Solan, HP, India): TLC based method for standardization of *Pongamia pinnata* (Karanj) using karanjin as marker. *Chromatographia* 69 (5-6), 597-599 (2009). TLC of karanjin in the seeds of *Pongamia pinnata* on silica gel with toluene - ethyl acetate 7:3. Quantitative determination by absorbance measurement at 260 nm. The limit of detection was 100 ng, linearity was 50 - 300 ng. Four samples of *P. pinnata* from different geographical locations were screened for their karanjin content.

pharmaceutical research, quality control, traditional medicine, herbal, quantitative analysis, qualitative identification, densitometry 32e

- 103 137 E. REICH\*, Valeria WIDMER (\*CAMAG Laboratory, Sonnenmattstr. 11, 4132 Muttenz, Switzerland, Lab@camag.com): HPTLC for rapid identification of Black Cohosh. *LC-GC Europe, The Applications* 19 (2006). HPTLC of actein, chlorogenic acid, caffeic acid, and isoferulic acid on silica gel with toluene - ethyl formate - formic acid 5:3:2 with chamber saturation for 20 min and at a relative humidity of 5 % (automatic development chamber ADC2 with molecular sieve). Detection by dipping in sulfuric acid reagent (20 mL of sulfuric acid in 80 mL of methanol) followed by heating at 100 °C for 5 min. Evaluation under daylight and under UV 254 and 366 nm.

herbal, HPTLC, qualitative identification, postchromatographic derivatization 32e

- 103 138 K.K. ROUT\*, S.K. MISHRA (\*Pharmacognosy and Phytochemistry Division, University Department of Pharmaceutical Sciences, Utkal University, Vani Vihar, Bhubaneswar 751004, Orissa, India; kd\_rout@yahoo.co.in): Efficient and sensitive method for quantitative analysis of 6-gingerol in marketed Ayurvedic formulation. *J. Planar Chromatogr.* 22, 127-131 (2009). HPTLC of 6-gingerol, extracts of Suprabha and market samples of ginger on silica gel (prewashed with methanol) with n-hexane - acetone 18:7 in a twin trough chamber saturated for 4 min at 20 +/- 4 °C and 36 +/- 3 % relative humidity. Quantitative determination by absorbance measurement at 286 nm. The limit of detection and quantification was 40 and 150 ng/band, respectively.

traditional medicine, herbal, food analysis, quality control, HPTLC, densitometry, quantitative analysis 32e

- 103 139 A. SAHU\*, A. GANTAIT, P. VENKATESH, P. MUKHERJEE (\*School of Natural Product Studies, Dept. of Pharmaceutical Technology, Jadavpur University, Kolkata 700032, India): A vali-

dated method for standardization of *Coccinia grandis* extract. Abstract No. 9154, IHCB (2009). Standardization of *Coccinia grandis* extract by HPTLC of taraxerol on silica gel with n-hexane - ethyl acetate 9:1 in a twin trough chamber. Detection by spraying with anisaldehyde reagent, followed by heating at 105 °C. Quantitative determination by absorbance measurement at 420 nm. The dichloromethane extract of the plant contained 3.7 % (w/w) of taraxerol.

pharmaceutical research, herbal, HPTLC, densitometry, quantitative analysis 32e

- 103 140 M.O. SALAZAR, R.L.E. FURLAN\* (\*Cátedra de Farmacognosia, Facultad de Ciencias Bioquímicas y Farmacéuticas, Universidad Nacional de Rosario, Suipacha 531, S2002LRK Rosario, Argentina; rfurlan@fbiof.unr.edu.ar): A rapid TLC autographic method for the detection of glucosidase inhibitors. *Phytochem. Anal.* 18, 209-212 (2007). Separation of extracts of *Solanum diflorum* and *Setaria parviflora* by TLC on silica gel, cellulose, and RP-18 and by HPTLC on cyano and diol phase with hexane - ethyl acetate 1:1 and n-butanol - formic acid - water 5:1:4 (upper phase). Detection after distribution of  $\beta$ -glucuronidase staining solution (52.5 mg agar and 0.9 mL 0.5 % iron(III) chloride solution). After solidification of the staining solution, the TLC plate was incubated for 120 min at 37 °C and immersed in a 0.2 % solution of esculin. Autography showed enzyme inhibition zones with hRf of 14 (*Solanum diflorum*) and 46 (*Setaria parviflora*).
- food analysis, qualitative identification, HPTLC, TLC autography 32e

- 103 141 P.U. SANGANALMATH, K.M. SUJATHA, S.M. BHARGAVI, V.G. NAYAK, B.M. MOHAN\* (\*Toxicology Division, Forensic Science Laboratory, Madivala, Bangalore 560068, Karnataka State, India; mohandfsl@yahoo.co.in): Simple, accurate and rapid HPTLC method for analysis of theophylline in post-mortem blood and validation of the method. *J. Planar Chromatogr.* 22, 29-33 (2009). HPTLC of theophylline (extracted at pH 8.5 with chloroform - isopropanol 4:1 from post-mortem blood after acid hydrolysis) on silica gel in a twin trough chamber with chloroform - methanol 9:1. Quantitative determination by absorbance measurement at 277 nm. Polynomial regression in the range of 0.5-20  $\mu\text{g/mL}$ . The limit of detection was 0.5  $\mu\text{g/mL}$  (S/N = 3). Intra-day and inter-day repeatability was between 0.5-0.8 % and 0.5-1.3 %, respectively, for three different concentrations in the range of 0.5-10  $\mu\text{g/mL}$ . Recovery was 89.1-93.4 % at a concentration of 10  $\mu\text{g/mL}$  and pH 8.3-8.6. An average analytical recovery of 89.9 % was achieved at pH 8.5 with a relative standard deviation of 2.2 %. Theophylline was stable in methanolic solution and during chromatography.
- toxicology, densitometry, HPTLC, quantitative analysis 32d

- 103 142 R.S. SANGWAN\*, N.S. SANGWAN, P.K. SHARMA, N.D. CHAURASIYA, S.K. MISHRA, B.R. TYAGI, A.K. SRIVASTAVA (\*Central Institute of Medicinal and Aromatic Plants (CIMAP), PO CIMAP, Kukrail Picnis Spot Road, Lucknow 226015, India; sangwan.lab@gmail.com): Carbonate extraction process for the metabolic, isozymic and proteomic profiling of rose-scented geranium (*Pelargonium* sp.), a hyper-acidic plant. *Phytochem. Anal.* 19, 104-115 (2008). TLC of geraniol on silica gel with chloroform - methanol - water 97:24:2 and of geranylacetate with toluene - ethyl acetate 93:7. Detection by spraying with vanillin sulfuric acid reagent.
- herbal, qualitative identification 32e

- 103 143 A. SARASWATHY\*, D.S. NANDINI, D. RAMASAMY (\*Captain Srinivasa Murti Drug Research Institute for Ayurveda (CCRAS), Anna Hospital Campus, Arumbakkam, Chennai 600106, India, saraswathy20042000@yahoo.co.in): Chemical analysis of *Terminalia alata* and *Terminalia arjuna* stem bark. *Indian Drugs* 46(2), 109-112 (2009). HPTLC of chloroform extracts of stem bark of *Terminalia alata* and *Terminalia arjuna* on silica gel with chloroform - methanol 9:1. Arjunolic acid and maslinic acid were used as marker compounds. Detection by treatment with vanillin-sulphuric acid reagent. Quantitative determination by absorbance measurement at 254 nm. The fingerprint profile along with other physico-chemical data helped in the correct authentication and standardization of both plant species.
- traditional medicine, quality control, herbal, HPTLC, densitometry, qualitative identification 32e

- 103 144 S.B. SEGAN, D.M. OPSENICA, B.A. SOLAJA, Dusanka M. MILOJKOVIC-OPSENICA\* (\*Institute of Chemistry, Technology and Metallurgy, Njegoseva 12, 11000 Belgrade, Serbia; dusan-kam@chem.bg.ac.yu): Planar chromatography of cholic acid-derived cis-trans isomeric bis-steroidal tetraoxanes. *J. Planar Chromatogr.* 22, 175-181 (2009). TLC of 14 tetraoxanes on silica gel with ethyl acetate - toluene and ethyl acetate - petroleum ether, on cyano phase with methanol - water and acetone - water, and on RP-18 with water - organic modifier (methanol, acetone, or dioxane) in various combinations, with chamber saturation for 15 min at ambient temperature (22 +/- 2 °C). Detection by spraying with 50 % sulfuric acid, followed by heating until spots became visible.  
pharmaceutical research, qualitative identification 32a
- 103 145 S.A. SHAH\*, I.S. RATHOD, B.N. SUHAGIA, D.A. PATEL, V.K. PARMAR, B.K. SHAH, V.M. VAISHNAVI (\*Department of Quality Assurance, L. M. College of Pharmacy, Ahmedabad 380009, India): Estimation of boswellic acids from market formulations of *Boswellia serrata* extract and 11-keto-beta-boswellic acid in human plasma by high-performance thin-layer chromatography. *J. Chromatogr. B* 848 (2), 232-238 (2007). HPTLC of boswellic acids in *Boswellia serrata* extract and 11-keto-beta-boswellic acid in human plasma on silica gel with hexane - chloroform - methanol 10:10:1. Quantitative determination by absorbance measurement at 260 nm. The linearity range for 11-keto-beta-boswellic acid spiked in 1 mL of plasma was 29 - 146 ng/spot, with a recovery of 91.7 %. The limit of detection and quantification for 11-keto-beta-boswellic acid in human plasma was 9 and 29 ng/mL, respectively. The method was applied for the determination of 11-keto-beta-boswellic acid plasma levels in a clinical pilot study.  
quality control, pharmaceutical research, traditional medicine, herbal, HPTLC, quantitative analysis, qualitative identification, densitometry 32e
- 103 146 C. SHARMA\*, B. SUHAGIA, N. SHAH, R. SHAH (\*Shri B. M. Shah College of Pharmaceutical Education and Research, Modasa 383315, Gujarat India): Development and validation of a HPTLC method for the estimation of sumatriptan in tablet dosage forms. *Indian J. Pharma. Sci.* 70(6), 831-834 (2008). HPTLC of sumatriptan on silica gel (pre-washed) with methanol - water - glacial acetic acid 40:80:1 with chamber saturation for 10 min. Quantitative determination by absorbance measurement at 230 nm. The  $R_f$  value was 64. The method was linear in the range of 200-800 ng/spot.  
pharmaceutical research, quality control, HPTLC, densitometry, quantitative analysis 32a
- 103 147 A. SHIKOV\*, D. DEMCHENKO, Svetlana IVANOVA, Marina KARLINA, Vera KOSMAN, Olga POZHARITSKAYA, Irina URAKOVA (\*Saint Petersburg Institute of Pharmacy, 47/5, Piskarevsky prospect, 195067, St-Petersburg, Russia, spb.pharmacy@gmail.com): HPTLC determination of ginkgolides A, B, and C and bilobalide in *Ginkgo biloba*. *CBS* 102, 10-12 (2009). HPTLC of diterpene lactones (ginkgolides A, B, C, and bilobalide) in aqueous *Ginkgo biloba* leaf extracts on silica gel (impregnated by dipping into a 4 % solution of sodium acetate in methanol - water 3:2 for 5 s followed by drying at room temperature for 1 h) with toluene - acetone 7:3 with chamber saturation for 20 min. After twofold development over 60 mm the plate is heated at 150 °C for 1 h for detection of active compounds. Quantitative determination by absorbance measurement at 254 and 400 nm. The correlation coefficients of the calibration curves were  $\leq 0.9971$  and relative standard deviations were  $\leq 2.0$  %. Intraday precision was 1.1-1.2 %, interday precision 1.1-1.3 % and recovery 98.5-104.6 %. The average content in leaves was 0.078 (in % of dry weight) for ginkgolide A, 0.072 for ginkgolide B, 0.076 for ginkgolide C, 0.062 for bilobalide and 0.29 % for total diterpene lactones.  
herbal, HPTLC, qualitative identification 32e
- 103 148 A.A. SHIRKHEDKAR\*, S.J. SURANA (\*Department of Pharmaceutical Chemistry, R. C. Patel College of Pharmacy, Shirpur, Dist:Dhule (M.S.) 425 405, India; atulshirkhedkar@rediffmail.com): Application of a stability-indicating densitometric RP-TLC method for analysis of pioglitazone hydrochloride in the bulk material and in pharmaceutical formulations. *J. Planar*

Chromatogr. 22, 191-196 (2009). TLC of pioglitazone hydrochloride ((+/-)-5-{p-[2-(5-ethyl-2-pyridyl)ethoxy]benzyl}-2,4-thiazolidinedione hydrochloride and degradation products (after acid and alkaline hydrolysis, oxidation, photochemical and thermal treatment) on RP-18 with acetone - acetic acid - water 40:10:1 in a twin trough chamber saturated for 30 min at room temperature (25 +/- 2 °C). Quantitative determination by absorbance measurement at 225 nm. The limit of detection and quantification was 47 and 141 ng/zone, respectively.

quality control, densitometry, quantitative analysis

32a

- 103 149 R. SKIBINSKI\*, L. KOMSTA, I. KOSZTYLA (\*Department of Medicinal Chemistry, Medical University of Lublin, Jaczewskiego 4, 20-090 Lublin, Poland; robert.skibinski@am.lublin.pl): Comparative validation of quetiapine determination in tablets by NP-HPTLC and RP-HPTLC with densitometric and videodensitometric detection. J. Planar Chromatogr. 21, 289-294 (2008). HPTLC of quetiapine on silica gel with hexane - dioxane - propylamine 5:45:2 and on RP-8 with tetrahydrofuran - phosphate buffer (pH 9.0) 1:1 in horizontal chambers. Quantitative determination by absorbance measurement at 243 nm and by videodensitometry at 254 nm. The precision and accuracy of the four methods were fully comparable and no significant differences were observed.

quality control, HPTLC, quantitative analysis, densitometry

32a

- 103 150 T.G. SONI\*, N.P. CHOTAI, P.H. PATEL, L. HINGORANI, R. SHAH, N. PATEL, T. R. GANDHI (\*Anand Pharmaceutical College, Near Town Hall, Grid Chokdi, Anand, Gujarat, India; tejalsoni\_2973i@yahoo.com): Evaluation of an optimum regression model for high-performance thin-layer chromatographic analysis of aceclofenac in plasma. J. Planar Chromatogr. 22, 101-107 (2009). HPTLC of aceclofenac on silica gel (prewashed with methanol) with toluene - ethyl acetate - methanol - glacial acetic acid 70:20:20:1 in a saturated twin trough chamber. Quantitative determination by absorbance measurement at 270 nm. Linearity was between 0.8 and 14 µg/mL. Average relative residual at each calibration point combined with accuracy and precision were compared using the parameter rank approach. The 1/ x 2 weighted regression model provided best estimates with small relative residuals and the best accuracy and precision.

HPTLC, quantitative analysis, densitometry

32a

- 103 151 Malgorzata STAREK\*, J. KRZEK, M. STOCH (\*Jagiellonian University, Collegium Medicum, Department of Inorganic and Analytical Chemistry, Medyczna 9, Cracow, Poland; mstarek@interia.pl): Densitometric analysis of 2-arylpropionate derivatives in pharmaceutical preparations. J. Planar Chromatogr. 21, 251-258 (2008). TLC of tiaprofenic acid, ketoprofen, naproxen, dexibuprofen, flurbiprofen, alminoprofen, and ibuprofen on silica gel with chloroform - acetone - toluene 12:5:2 and chloroform - ethyl acetate 1:1. Quantitative determination by absorbance measurement at 225 nm (for naproxen, dexibuprofen, and ibuprofen) and at 270 nm (for tiaprofenic acid, ketoprofen, flurbiprofen, and alminoprofen).

quality control, densitometry, quantitative analysis, qualitative identification

32a

- 103 152 G.S. SUBRAMANIAN\*, A. KARTHIK, S. B. KAMATH, K. PRABAHAR, A. RANJITHKUMAR, S. PATHAK, N. UDUPA (\*Department of Pharmaceutical Quality Assurance, Manipal College of Pharmaceutical Sciences, Manipal, Karnataka 576104, India; ganrajesh@gmail.com): Stability-indicating HPTLC determination of capsaicin in the bulk drug. J. Planar Chromatogr. 21, 271-275 (2008). HPTLC of capsaicin and its degradation products (after acidic and alkaline hydrolysis, oxidation and thermal degradation) on silica gel with toluene - ethyl acetate 3:2. Quantitative determination by absorbance measurement at 280 nm. The limit of detection and quantification was 10 and 60 ng/band, respectively.

quality control, HPTLC, densitometry, quantitative analysis

32a

- 103 153 P. TENG (Teng Peng)\*, X. ZHANG (Zhang Xu), Y. DENG (Deng Yun) (\*Pharm. Coll., Chengdu Chinese Trad. & Pharm. Univ., Chengdu, Sichuan 610075, China): (Study of the quality standard

for Qufu Zhuanggu capsules) (Chinese). *Chinese J. Modern Appl. Pharm.* 25 (1), 66-69 (2008). TLC of Qufu Zhuanggu capsule extracts on silica gel with 1) n-hexane - ethyl acetate 4:1; 2) benzene - ethyl acetate 9:1; 3) chloroform - methanol 19:1; 4) cyclohexane - ethyl acetate 5:2; 5) n-hexane - acetone 3:1. Detection 1) under UV 365 nm; 2) by spraying with 10 % sulfuric acid in ethanol and heating at 105 °C until the spot were visualized; 3) by treatment with ammonia vapors for 10 min; 4) by spraying with 20 % HClO<sub>4</sub> in ethanol. Identification by comparison of the chromatograms with those of the standard psoralen.

quality control, traditional medicine, pharmaceutical research, HPTLC, quantitative analysis, qualitative identification 32e

- 103 154 A.K. THAKUR\*, P.D. HAMRAPURKAR (\*Department of Pharmaceutical Analysis, Prin. K. M. Kundanani College of Pharmacy, Jote Joy Building, Rambhau Salgaonkar Road, Cuff Parade, Mumbai 400005, Maharashtra, India; achalthakur@gmail.com): Quantitative densitometric HPTLC analysis of purpurin in the parts of *Rubia cordifolia* and in pharmaceutical dosage forms. *J. Planar Chromatogr.* 22, 109-113 (2009). HPTLC of purpurin on silica gel with toluene - ethyl acetate - formic acid 98:2:1 in a twin trough chamber saturated for 20 min at 25 +/- 2 °C. Quantitative determination by absorbance measurement at 255 nm. The limit of detection and quantification was 50 and 100 ng/band, respectively.

traditional medicine, herbal, quality control, HPTLC, densitometry, quantitative analysis 32e

- 103 155 R. TIAN (Tian RunTao)\*, P. XIE (Xie PeiShan), H. LIU (Liu HePing) (\*Chromap Institute of Herbal Medicine Research, Zhuhai, Guangdong, China): Evaluation of traditional Chinese herbal medicine: Chaihu (*Bupleuri Radix*) by both high-performance liquid chromatographic and high-performance thin-layer chromatographic fingerprint and chemometric analysis. *J. Chromatogr. A* 1216 (11), 2150-2155 (2009). Chaihu roots (*Bupleuri radix*), roots of *Bupleurum chinense* and *Bupleurum scorzonerifolium* are monographed in the Chinese Pharmacopoeia. Evaluation of the quality of 33 lots of authenticated Chaihu samples versus 31 lots of commercial samples by HPLC-ELSD and HPTLC analysis of the principal bioactive components (saikosaponins). Data acquired from HPLC fingerprints and HPTLC fluorescent images was analyzed by chemometrics for similarity and pattern recognition, including artificial neural networks, k-nearest neighbor (k-NN) and an expert's panel. The k-NN classifier showed good performance with sufficient flexibility for processing HPTLC fingerprint images. These images were otherwise not easily dealt with by other algorithms due to the shift of hRf values and varying hue/saturation of the band colors between different TLC plates. The two chromatographic fingerprint methods are complementary measures for quality control. Chaihu roots from different species of the genus *Bupleurum* could readily be distinguished from each other. Commercial samples of Chaihu can easily be classified by investigating the content of major saikosaponins.

herbal, traditional medicine, HPTLC, qualitative identification 32e

- 103 156 A. TILAY, M. BULE, J. KISHENKUMAR, U. ANNAPURE\* (\*Food Engineering and Technology Department, Institute of Chemical Technology, University of Mumbai, Matunga, Mumbai, India, usa@udct.org): Preparation of ferulic acid from agricultural wastes: its improved extraction and purification. *J. Agric. Food Chem.* 56, 7644-7648 (2008). HPTLC of ferulic acid from agricultural waste (maize bran, rice bran, wheat bran, wheat straw, sugar cane baggasse, pineapple peels, orange peels and pomegranate peels) on silica gel with benzene - dioxane - acetic acid 85:15:1. Detection under UV 254 nm. Purification by adsorption chromatography followed by preparative layer chromatography.

agricultural, HPTLC, preparative TLC 32e

- 103 157 P. TRIVEDI\*, K. PUNDARIKAKSHUDU (\*Department of Pharmaceutical Chemistry, K. B. Institute of Pharmaceutical Education and Research, Sector-23, GH-6, Gandhinagar, 382023, Gujarat, India): Novel TLC densitometric method for quantification of solasodine in various So-



lanum species, market samples and formulations. *Chromatographia* 65 (3-4), 239-243 (2007). TLC of solasodine in various *Solanum* species on silica gel with a developing solvent containing an organic acid to form ion pair complexes of solasodine with the acid dye. The resulting colored complex was quantified by absorbance measurement at 461 nm. Linearity was between 79 and 495 ng/spot with a correlation coefficient of 0.995. The method eliminates post derivatization steps and the problem of background interference. Application of the method to determine solasodine content in various herb samples, herb extract and their formulations showed an accuracy of  $98.5 \pm 2.8$  % without matrix interference.

quality control, pharmaceutical research, traditional medicine, herbal, densitometry, qualitative identification, quantitative analysis 32e

- 103 158 E. TYIHÁK\*, Á. MÓRICZ, P. G. OTT, M. L. HAJNOS, K. GLOWNIAK (\*Plant Protection Institute, Hungarian Academy of Sciences, Herman O. u. 15, POB 102, 1525 Budapest, Hungary; etyih@nki.hu): New approach to mechanism of action of paclitaxel by means of BioArena studies. *J. Planar Chromatogr.* 21, 331-336 (2008). TLC and OPLC of paclitaxel on silica gel with a variety of mobile phases, e. g. chloroform - methanol 9:1 with chamber saturation. After drying bioautography by immersion in the bacterial suspension of *Pseudomonas savastanoi* for 20 s. Visualization of the chromatograms with MTT was performed either after a short draining period or after an overnight incubation.

pharmaceutical research, qualitative identification, bioautography 32e

- 103 159 K. UNIKRISHNAN\*, S. RAJA, Indira BALACHANDRAN (\*Central for Medicinal Plants Research, Arya Vaidya Sala, Kottakkal, Malappuram 676503, India): A reverse phase HPLC-UV and HPTLC methods for determination of plumbagin in *Plumbago indica* and *Plumbago zeylanica*. *Ind. J. of Pharma Sci.* 70(6), 844-847 (2008). HPTLC of plumbagin in alcoholic root extracts of *Plumbago indica* and *Plumbago zeylanica* on silica gel with n-hexane - ethyl acetate 4:1. The  $R_f$  value of plumbagin was 67. Quantitative determination by absorbance measurement at 265 nm. *Plumbago indica* showed significantly higher plumbagin contents than *P. zeylanica*. The HPTLC method was the method of choice for simultaneous analysis of several samples, whereas the RP-HPLC method was very sensitive.

pharmaceutical research, HPTLC, comparison of methods, quantitative analysis, densitometry 32c

- 103 160 A. VENKATACHALAM\*, V.S. CHATTERJEE (\*Bhavan's College, Department of Chemistry, Andheri West, Mumbai 400058, India): Stability-indicating high performance thin layer chromatography determination of paroxetine hydrochloride in bulk drug and pharmaceutical formulations. *Anal. Chim. Acta* 598 (2), 312-317 (2007). TLC of paroxetine hydrochloride on silica gel with butanol - acetic acid - water 16:4:1. The  $R_f$  value of paroxetine HCl was 48 and separation from the degradation products (produced by acid and alkali hydrolysis, oxidation and photodegradation) was good. Quantitative determination by absorbance measurement at 295 nm. The linearity was in the range of 300 - 1500 ng/spot and the correlation coefficient was 0.9903. The limit of detection and quantitation was 50 and 150 ng/zone, respectively.

pharmaceutical research, quality control, densitometry, HPTLC, quantitative analysis, qualitative identification 32c

- 103 161 G. XU (Xu Guangying)\*, X. WANG (Wang Xun), X. DAI (Dai Xixi), M. CHEN (Chen Min) (\*Nanjing Univ. TCM, Nanjing 210046, China): (Study of the quality standard for Shujin Huoxue capsules) (Chinese). *J. Chinese Trad. Patent Med.*, 30 (11), 1638-1642 (2008). TLC of Shujin Huoxue capsule extracts on silica gel with 1) petroleum ether (60-90 °C) - ethyl formate - formic acid 15:5:1; 2) cyclohexane - ethyl acetate 9:1; 3) toluene - acetone - ethanol - ammonia 16:12:1:4. Detection 1) by exposure to iodine vapor; 2) under UV 365 nm; 3) under UV 254 nm. Identification by comparison with the standards of the component drugs. Quantification of paeo-

niflorin by HPLC.

quality control, traditional medicine, pharmaceutical research, HPTLC, quantitative analysis, qualitative identification 32e, 4d

- 103 162 H. YAN (Yan Hai)\*, J. ZHOU (Zhou Jieming), L. WANG (Wang Lisheng), B. ZHOU (Zhou Benhong) (\*Pharm. Coll., Wuhan Univ., Wuhan 430072, China): (Study on the quality standard for Sanjin Ganmao pills) (Chinese). *J. Chinese Trad. Patent Med.* 30 (11), 1635-1638 (2008). TLC of Sanjin Ganmao pill extracts on silica gel with 1) chloroform - methanol 17:3; 2) chloroform - methanol - formic acid 35:5:2; 3) chloroform - methanol - formic acid 90:10:1. Detection 1) by spraying with 10 % sulfuric acid in ethanol and heating; 2) by exposure to ammonia vapor. Identification by comparison with the standard hyperin and other standards of the component drugs.

quality control, pharmaceutical research, traditional medicine, HPTLC, quantitative analysis, qualitative identification 32e

- 103 163 X. YAN (Yan Xingdong)\*, H. NIU (Niu Huifen), J. XU (Xu Jiayi), G. BAI (Bai Guiying), L. PEI (Pei Lin) (\*Hebei Provin. Coll. Chinese Trad. Parm. & Med., Shijiazhuang, Hebei 050031, China): (Study of the quality standard for Tianbing Tiaodu capsules) (Chinese). *J. Chinese Trad. Patent Med.* 29 (4), 540-542 (2008). TLC of Tianbing Tiaodu capsule extracts on silica gel with cyclohexane - ethyl acetate 4:1. Detection 1) by spraying with vanillin reagent (5 % vanillin in sulfuric acid - ethanol 1:6) and heating until the zones were visualized; 2) under UV 365 nm. Identification by comparison of the chromatograms with that of the standard ferulic acid.

quality control, pharmaceutical research, traditional medicine, herbal, qualitative identification, HPTLC, quantitative analysis 32e

- 103 164 G. ZHANG (Zhang Guoxia)\*, P. LI (Li Ping), B. HAN (Han Biao) (\*No. 2 People's Hosp., Lanzhou Univ., Lanzhou 330030, China): (Study on the quality standard for Yangxue Fuzheng capsules) (Chinese). *J. Chinese Trad. Patent Med.* 29 (4), 536-540 (2007). TLC of Yangxue Fuzheng (a traditional Chinese patent medicine) capsule extracts on silica gel with 1) chloroform - methanol - water 13:7:2, 2) chloroform - ethyl acetate - methanol - water 15:40:22:10, 3) ethyl acetate - butanone - methanol - water 10:1:1:1, 4) chloroform - methanol 40:3, 5) petroleum ether (60-90 °C) - ethyl acetate 1:1. Detection 1) under UV 365 nm, 2) in daylight after spraying with 10 % sulfuric acid in ethanol and heating at 105 °C.

pharmaceutical research, traditional medicine, quality control, herbal, HPTLC, qualitative identification 32e

- 103 165 S. ZHANG (Zhang Songan)\*, Y. CAI (Cai Yaling), J. YUAN (Yuan Jinlan), X. WU (Wu Xiaohui), CH. FENG (Feng Chao), L. ZHOU (Zhou Lumin), Y. YAO (Yao Youqi), D. ZHOU (Zhou Daonian) (\*Pharm. Coll., Tongji Med. Inst., MidChina Univ. Technol., Wuhan, Hubei 430030, China): (Study of the quality standard for Fangji Guanjie pills) (Chinese). *J. Chinese Trad. Patent Med.* 30 (10), 1478-1482 (2008). TLC of Fangji Guanjie pill extracts on silica gel with 1) petroleum ether (60-90 °C) - ethyl acetate 10:1; 2) ethyl acetate - formic acid - glacial acetic acid - water 15:1:1:2; 3) petroleum ether (60-90 °C) - ethyl acetate 17:3; 4) chloroform - methanol - water 40:10:1; 5) diethyl ether - chloroform - methanol 4:2:1. Detection 1) under UV 254 nm; 2) by spraying with 10 % sulfuric acid in ethanol; 3) by spraying with dinitrophenylhydrazine in ethanol and heating at 105 °C; 4) by spraying with 5 % potassium iodobismuthate solution. Identification by comparison with the standards fangchinoline and tetrandrine.

quality control, pharmaceutical research, traditional medicine, qualitative identification, HPTLC, quantitative analysis 32e

- 103 166 B. ZHAO (Zhao Bin)\*, N. LI (Li Na), J. WU (Wu Jianming), J. LI (Li Jianzhi) (\*Sichuan Acad. TCM, Chengdu 610031, China): (Study on the quality standard for Baijian Cichuang suppository) (Chinese). *J. Chinese Trad. Patent Med.* 30 (10), 1475-1478 (2008). TLC of Baijian Cichuang

suppository extracts on silica gel with 1) n-butanol - glacial acetic acid - water 7:1:2; 2) chloroform - ethyl acetate - formic acid 6:4:1; 3) petroleum ether (60-90 °C) - diethyl ether - toluene 14:4:3. Detection 1) under UV 365 nm; 2) by spraying with 5 % vanillin in sulfuric acid, followed by heating. Identification by comparison with the standard berberine chloride and other standards of the component drugs.

quality control, pharmaceutical research, traditional medicine, HPTLC, quantitative analysis, qualitative identification 32e

### 33. Inorganic substances

- 103 167 Katharina HIEGEL, B. SPANGENBERG\* (\*University of Offenburg, Institute of Process Engineering, Badstrasse 24, 77652 Offenburg, Germany): New method for the quantification of dequalinium cations in pharmaceutical samples by absorption and fluorescence diode array thin-layer chromatography. *J. Chromatogr. A* 1216(25), 5052-5056 (2009). Diode array HPTLC of dequalinium chloride on silica gel with methanol - 7.8 % aqueous ammonium acetate 17:3. The  $R_f$  value was 58 for dequalinium chloride. Measurement of pure dequalinium chloride in the wavelength range from 200 to 500 nm showed several by-products. By densitometric scanning of a single track in absorption and fluorescence mode 600 spectra in the range from 200 to 1100 nm were measured within 30 s. Sample preparation for an ointment was done by dissolution in methanol. Quantitative determination by absorbance measurement from 315 to 340 nm, by fluorescence measurement from 355 to 370 nm, and by fluorescence measurement from 445 to 485 nm after derivatization with a solution of sodium tetraphenyl borate HCl in water. The linearity range of absorption and fluorescence measurements was between 10 and 2000 ng/zone. Sugar-containing preparations like liquids or lozenges can be reliably quantified only in fluorescence mode, otherwise further sample preparation is necessary.

HPTLC, diode array TLC

33a

- 103 168 J.P. LAFLEUR, E.D. SALIN\* (\*Department of Chemistry, McGill University, 801 Sherbrooke Street W. Montreal, Canada H3A 2K6; eric.salin@mcgill.ca): Speciation of chromium by high-performance thin-layer chromatography with direct determination by laser ablation inductively coupled plasma mass spectrometry. *Anal. Chem.* 80, 6821-6823 (2008). HPTLC of Cr<sup>3+</sup> and Cr<sup>6+</sup> on silica gel in a saturated chamber with distilled deionized water and Triton-X-100 in concentrations between 0.001 and 0.1%, which is around the critical micelle concentration. Separation was achieved in seconds over 1 cm. Laser ablation was used to volatilize the chromium species directly from the chromatographic material prior to ICP-MS detection. The reliability of calibration was satisfying with precisions between 3 - 30 % and detection limits in the low ng-range. Silicium, which is present in the silica gel plate, was discussed as suitable internal standard.

toxicology, HPTLC, quantitative analysis

33a, 4e

### 35. Other technical products and complex mixtures

- 103 169 Vera BAUMGARTNER\*, C. HOHL, U. HAURI (\*Kantonales Laboratorium Basel-Stadt, Department Non-Food, Kannenfeldstrasse 2, 4012 Basel, Switzerland; vera.baumgartner@bs.ch): Bioactivity-based analysis of sunscreens using the luminescent bacteria *Vibrio fischeri*. *J. Planar Chromatogr.* 22, 19-23 (2009). HPTLC of 26 UV filter substances and their photodegradation products on LiChrospher silica gel (prewashed with methanol) by automated multiple development with mixtures of tert-butyl ether - n-hexane. Detection under UV light at 254 and 366 nm. Bioassay by immersion of plates for 1 s in a suspension of *Vibrio fischeri* bacteria followed by evaluation in dark.

cosmetics, quality control, HPTLC, AMD

35c

- 103 170 Iva REZIC\*, D. KRSTIC, L. BOKIC (\*Laboratory of Analytical Chemistry, Department of Applied Chemistry, Faculty of Textile Technology, University of Zagreb, Prilaz baruna Filipovica 28a, 10000 Zagreb, Croatia; iva\_rezic@net.hr): Analysis of waxes on historical samples by thin-layer chromatography. *J. Planar Chromatogr.* 22, 171-173 (2009). TLC of waxes (carnauba, can-

dellia, lanolin, japanese, spermaceti, bees, and paraffin) on silica gel with petroleum ether - diethyl ether - acetic acid 90:10:1 with chamber saturation. Detection under UV 254 nm.

qualitative identification

35d

### 38. Chiral separation

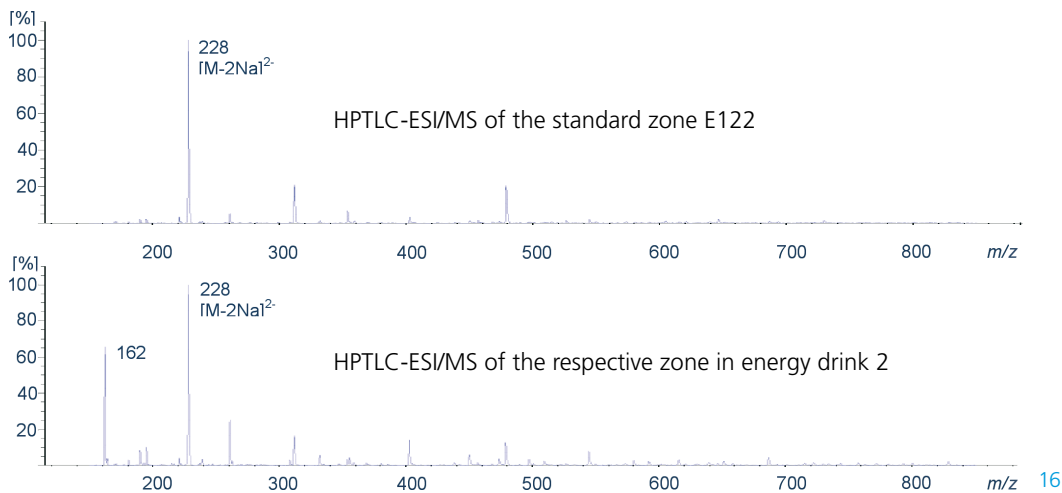
103 171 R. BHUSHAN\*, CH. AGARWAL (\*Department of Chemistry, Indian Institute of Technology Roorkee, Roorkee 247667, India): Direct enantiomeric TLC resolution of dl-penicillamine using (R)-mandelic acid and L-tartaric acid as chiral impregnating reagents and as chiral mobile phase additive. *Biomed. Chromatogr.* 22 (11), 1237-1242 (2008). TLC of dl-penicillamine on silica gel 1) impregnated with L-tartaric acid; 2) impregnated with (R)-mandelic acid; and 3) with no impregnation but with chiral modifier added to the mobile phase. The mobile phases used were 1) acetonitrile - methanol - water 5:1:1; 3) ethyl acetate - methanol - water 3:1:1; and 2) acetonitrile - methanol - 0.5 % aqueous L-tartaric acid (pH 5) - glacial acetic acid 70:10:11:7. Detection by exposure to iodine vapors. The limit of detection of both was 120 ng/zone by use of L-tartaric acid (either by impregnation or added to mobile phase), and 110 ng/zone by use of (R)-mandelic acid. (R)-mandelic acid was found to be successful as a chiral impregnating reagent.

pharmaceutical research, HPTLC, quantitative analysis, qualitative identification 38

103 172 M. SAJEWICZ, M. GONTARSKA, D. KRONENBACH, Teresa KOWALSKA\* (\*Institute of Chemistry, Silesian University, 9 Szkolna Street, 40-006 Katowice, Poland, kowalska@us.edu.pl): Thin-layer chromatographic and polarimetric investigation of the oscillatory in-vitro chiral inversion of S-(+)-ketoprofen. *J. Planar Chromatogr.* 21, 349-353 (2008) TLC of S-(+)-ketoprofen on silica gel (prewashed by development with methanol - water 9:1 and impregnated by dipping for 2 s in a solution of L-arginine in methanol) at 22 +/- 2 °C with acetonitrile - water 5:1 acidified with several drops of glacial acetic acid (to maintain the pH <4.8) in one-dimensional and two-dimensional modes. Quantitative determination by absorbance measurement at 252 nm.

qualitative identification, densitometry

38



HPTLC-ESI/MS spectra of standard zone E122 ( $m/z$  228  $[M-2Na]^{2-}$ ) and the respective zone in energy drink 2 ( $m/z$  162 from matrix, chromatography without acetic acid)

	HPLC [4]	HPTLC
Mobile phase	0.58	0.003
Stationary phase	0.64	0.11
Disposal	0.04	0.0001
<b>Operating costs/run (€)</b>	<b>1.26</b>	<b>0.11</b>
		<b>=&gt; 11 x lower</b>
Application/Injection		0.50
Run time	43	0.20
Detection		0.10
<b>Time/run (min)</b>	<b>43</b>	<b>0.80</b>
		<b>=&gt; 54 x faster</b>
thereof labor time/40 runs	none	5 min

Further information is available on request from the author.

- [1] G. Morlock, C. Oellig, J AOAC Int 92 (2009) 745
- [2] G. Morlock, W. Schwack, Die Aktuelle Wochenschau der GDCh (2009) week 21 and 26, [www.aktuelle-wochenschau.de/index09.htm](http://www.aktuelle-wochenschau.de/index09.htm)
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## Screening of unknown plant extracts by planar chromatography



Left to right: M. Schulz, S. Minarik, C. Wirth and M. Oberle

Merck employs planar chromatography for more than the quality control of the many TLC/HPTLC plates that they manufacture. The following article resulted from a cooperation between the thin-layer chromatography lab and the cosmetic lab of the R&D Department Performance & Life Science Chemicals.

### Introduction

Planar chromatography is frequently used in cosmetic applications, such as the screening of some active compounds and the quantification of others, like UV filters. Direct application of difficult sample matrices is another reason cosmetic chemists employ the technique. In the following, HPTLC is described as a screening method to identify botanicals whose extracts may have cosmetic-relevant compounds. The focus is twofold: One, plants are sought that contain compounds of cosmetic interest, yet with sufficient concentrations, and two, plants that have favourable flavonoids profiles, flavonoids being accepted as active natural compounds in cosmetic applications.

**The advantages of planar chromatography seem to be ideal for this field of application. Many samples can be analyzed in parallel, making analysis times short and costs low. The high flexibility in detection is effected by various derivatization reagents. Potential candidates for development of new cosmetic-relevant compounds can be readily identified and followed by further characterization with structure-elucidating methods.**

### Standard solution

Chlorogenic acid, hyperoside, rutin, quercetin and kaempferol in methanol (0.1 %)

### Sample preparation

The plant is chopped and processed to a raw extract. Via liquid/liquid extraction of the raw extract, three further extracts of different polarities were obtained.

### Stationary phase

HPTLC plates silica gel 60 F<sub>254s</sub> Merck, 20 x 10 cm

### Application

Bandwise with Automated TLC Sampler 4, band length 5 mm, track distance 10 mm, distance from the lower edge 10 mm, application volume 5 µL

### Chromatography

In the Twin-Trough Chamber 20 x 10 cm with ethyl acetate – formic acid – glacial acetic acid – water 100:11:11:27

### Post-chromatographic derivatization

Using the TLC/HPTLC Sprayer the following derivatization reagents are sprayed\*:

- Natural product reagent according to Neu (NSR): 1 % aminoethyl diphenylborate in methanol → UV 366 nm
- Anise aldehyde sulphuric acid reagent (AAS): 0.5 mL anise aldehyde in 85 mL methanol, 10 mL acetic acid and 8 mL conc. sulphuric acid (added ice-cooled) → Heating of the plate at 90–125 °C for max. 15 min → White light
- Diphenyl-2-picrylhydrazyl reagent (DPPH): 0.1 % diphenyl-2-picrylhydrazyl in methanol → Heating of the plate at 40 °C for max. 2 min → White light
- Rhodamine B reagent (RDB): 0.1 % rhodamine B in methanol → UV 366 nm
- Dragendorff reagent (DRR): Merck spray solution, commercially available → Heating of the plate at 40 °C for max. 2 min → White light

*\*Note: Automated dipping should be preferred to spraying for various reasons, like improved (more homogeneous) reagent application onto the layer, reduced load of the laboratory air and cleaner working station.*

## Results and discussion

For the two following examples, the raw extract of the plant (track 1) and the three extracts differing in polarity (fractions A–C with increasing polarities, tracks 2–4) were developed and detected with different derivatization reagents.

Reagent	detects
NSR (natural product reagent according to Neu)	Flavonoids, penicillin acids, carbohydrates, anthocyanidines
AAS (anise aldehyde sulphuric acid reagent)	Essential oils, terpenes, steroids, sapogenines, prostaglandines, antioxidants, antibiotics
DPPH (diphenyl-2-picrylhydrazyl reagent)	Essential oils
RDB (rhodamine B reagent)	Lipophilic substances, lipids, phenols, polyphenols, flavonols, tensids
DRR (Dragendorff reagent)	Alkaloids

### Example 1

With the NSR reagent, for example in extract A (track 2) the non polar chlorophylls were detected as red band in the solvent front region and in extract C (track 4) more polar substances like plant acids.

As main component, a plant acid was detected with slightly higher  $R_F$ -value compared to chlorogenic acid (track 5, bluish band with  $R_F$  0.5–0.6). This component was concentrated in extracts B and C (tracks 3 and 4). It reacted with the AAS reagent and very intensive with the DPPH reagent that generally indicates antioxidative properties. Furthermore the chlorophylls, which, apart from the NSR reagent, also react with the DRR reagent, were detected in the raw extract (track 1) and extract A and B (tracks 2 and 3). Except in extract A, additional substances with higher and lower  $R_F$ -values were detected as light bluish bands with the NSR reagent and as brownish bands with the AAS reagent.

### Example 2

In the second plant example, besides plant acids also flavonoids were detected as main components. This was evident with the NSR reagent via (1) the  $R_F$ -range and (2) the yellow, greenish or light blue coloration of the bands and (3) the enrichment in the extracts B and C (tracks 3 and 4). Furthermore, in extract B (track 3), a greenish zone was detected that indicated a kaempferol derivative and, near the solvent front, a yellow zone that indicated quercetin.



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### Chromatogram Immersion Device

Derivatization by automated dipping should be preferred to manual spraying. By maintaining a uniform vertical speed (selectable between 30 and 50 mm/s) and immersion time (selectable between 1 and 8 s and indefinitely), derivatization conditions can be standardized. Due to the homogeneous reagent application onto the layer, »tide marks«, which can interfere with densitometric evaluation, are avoided. The battery operated device can be set to handle 10 and 20 cm plate heights.

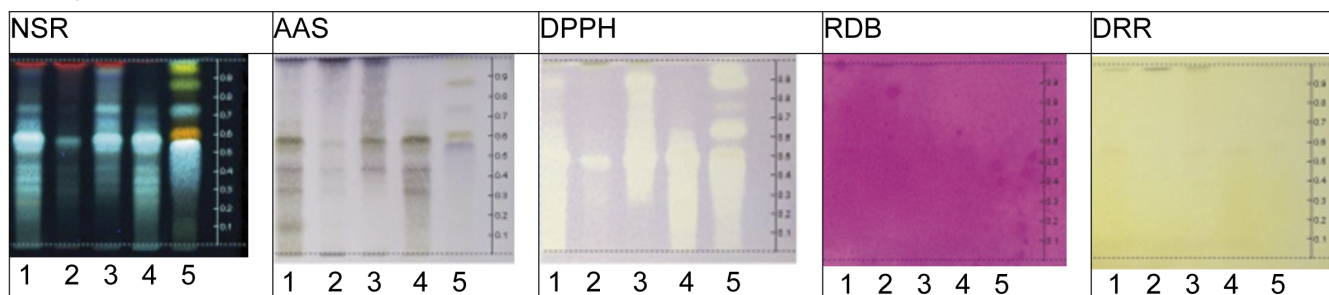


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### TLC Plate Heater

For many reactions controlled heating is required. The temperature of the TLC Plate Heater is selectable between 25 and 200 °C ensuring homogenous heating across the plate. The CERAN® heating surface has a grid to facilitate correct positioning of the TLC plate and is resistant to all common reagents and easily cleaned.

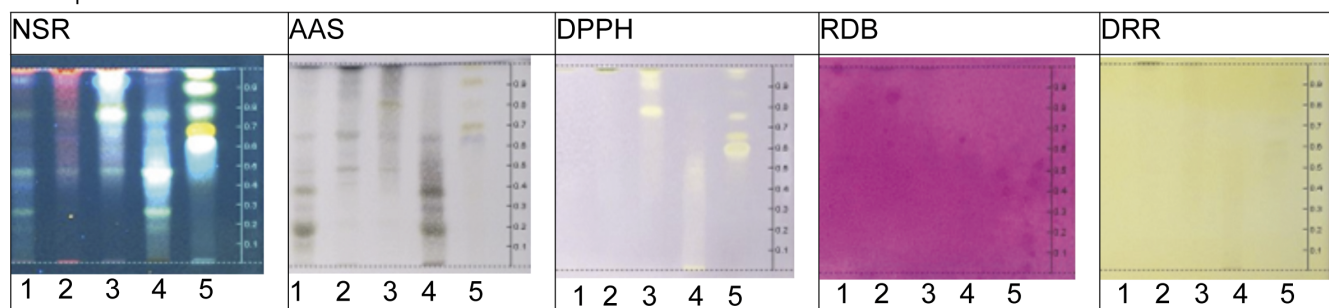
### Example 1



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Track 1: Raw extract  
 Track 2: Extract A (non polar)  
 Track 3: Extract B (middle polar)  
 Track 4: Extract C (polar)  
 Track 5: Standard mixture (with increasing  $R_F$ : Chlorogenic acid, hyperoside, rutin, kaempferol and quercetin)

### Example 2



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Track 1: Raw extract  
 Track 2: Extract A (non polar)  
 Track 3: Extract B (middle polar)  
 Track 4: Extract C (polar)  
 Track 5: Standard mixture (with increasing  $R_F$ : Chlorogenic acid, hyperoside, rutin, kaempferol and quercetin)

In extract C (track 4) several plant acids (blue bands) were present. Potential flavonoids showed with the DPPH reagent an intensive reaction.

Planar chromatography is an established analytical method for screening of plant extracts at Merck. First analytical characterisation of plant extracts to figure out substances at a high content is done with HPTLC. The high sample throughput and the variety of derivatization reactions make planar chromatography a powerful tool in the method pool. For further characterization the wavelength range of 210–400 nm, obtained by HPLC-DAD, is evaluated, and also an activity screening test for e.g. antioxidative compounds. Based on the screening results, active compound candidates were investigated further, e.g. by HPLC-MS\* and NMR for structure elucidation.

\*Note: By online extraction with the TLC-MS Interface the mass spectrum of a zone on the plate is directly obtained within half a minute.

Further information is available from the authors on request.

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## Determination of unauthorised fat-soluble azo dyes in spices by HPTLC



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Prof. Dr. Wolfgang Schwack and Elodie Pellissier

The article on pages 2-4 from the State Laboratory in Zürich and this article address the same objective but use different approaches. However, both approaches show clear advantages in comparison to the status quo for the analysis of azo dyes in foods. The analyst may decide which suits best to his task.

The work was performed during the bachelor thesis of Elodie Pellissier (University of Applied Sciences, Western Switzerland) at the Institute of Food Chemistry, University of Hohenheim in Stuttgart, Germany.

### Introduction

In 2003 Sudan I was detected by the French in a consignment of hot chili from India. This was the first alert to the EU Member States via the Rapid Alert System for Food and Feed (RASFF). Subsequently, more and more products were found to contain unauthorised fat-soluble azo dyes such as Sudan I-IV and Sudan Red 7B, classified as a category 3 carcinogen by the International Agency for Research on Cancer (IARC), Sudan Red B, Sudan Orange G and Para Red. For the year 2008 and the first semester of 2009, no less than 60 cases were reported by RASFF. [1]

**HPTLC is unrivaled in rapid and matrix-robust screening of many samples in parallel. In the case of azo dyes with strong absorption of visible light, a good capability of detection is generally given. Besides library UV/Vis spectra**

**comparison, coupling to mass spectrometry offers an improved chance to verify positive findings. Using MassWorks software enables the analyst to calculate exact masses and elemental compositions even from low resolution mass spectrometers. Therefore, a rapid and reliable HPTLC method for the identification and quantification of the relevant dyes was developed and tested on powders of individual spices and spice mixes (chili, curry, paprika etc.). The method is currently being validated, while expanding the sample source to pastes and sauces.**

### Standard solutions

Sudan I (I), Sudan II (II), Sudan Red B (B), Sudan Orange G (OR) and 4-dimethylaminoazobenzene (internal standard, IS) were individually (10 mg) dissolved in 5 mL acetone, and Sudan III (III), Sudan IV (IV), Sudan Red 7B (7B) and Para red (PR) in 15 mL acetone. The solutions were filled up to 20 mL with methanol (stock solutions of 0.5 mg/mL each). The standard mix solution was prepared by mixing 200  $\mu$ L each of the stock solutions and filling up to 10 mL with methanol (10 ng/ $\mu$ L of each dye). The same 1:50 dilution was applied for the internal standard solution used for overspraying.

### Sample preparation

The homogenized spice sample (1 g) was weighed into a 20-mL screw-capped centrifuge tube. After the addition of 1 mL internal standard stock solution and 4 mL acetone, the tube was vortexed for 1 min followed by the addition of 5 mL methanol. The tube was manually shaken for another minute and centrifuged at 4000 rpm. Without further cleanup, the supernatant was directly used for HPTLC.

### Layer

HPTLC plates NANO-SIL-PAH, 20  $\times$  10 cm, Macherey-Nagel (impregnated with caffeine)

*Note: Ready-to-use plates are convenient and highly recommended. In case of need, caffeine-impregnation can be self-made by dipping HPTLC plates silica gel 60 in a caffeine solution (1.7 g caffeine in 100 mL acetonitrile) for 20 min, followed by drying for 20 min at 120 °C.*

## Sample application

Bandwise with ATS4, band length 8 mm, track distance 10 mm, distance from lower plate edge 8 mm, distance from the left and right edges min. 15 mm, application volume 1–20  $\mu\text{L}$  for standard solutions, overspraying with 10  $\mu\text{L}$  internal standard solution, and 4  $\mu\text{L}$  for sample extracts.

## Chromatography

In the ADC2 with isohexane – methyl ethyl ketone 5:1 up to a migration distance of 68 mm, after tank saturation for 10 min. Plate activity was controlled by saturated potassium carbonate solution (45% relative air humidity) for 4 min.

## Documentation

In DigiStore 2 under white light illumination (reflectance and transmission)

## Densitometry

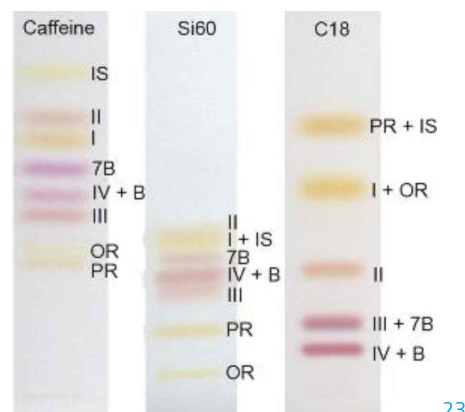
Absorption measurement via multi wavelength scan (390, 415, 500, 525 and 550 nm) and spectra recording (320–600 nm) with TLC Scanner 3 and winCATS software.

## Mass spectrometry

TLC-MS interface equipped with the oval elution head (4 x 2 mm) coupled to an Agilent 1100 LC/MSD system operating in positive ESI mode; zone extraction by methanol – 0.1% formic acid 95:5 at 0.2 mL/min. A Chromolith RP 18 column (50 x 4.6 mm, Merck) was connected between TLC-MS interface and MSD. Exact masses were calculated by MassWorks software (Cerno Bioscience, Danbury, CT, USA).

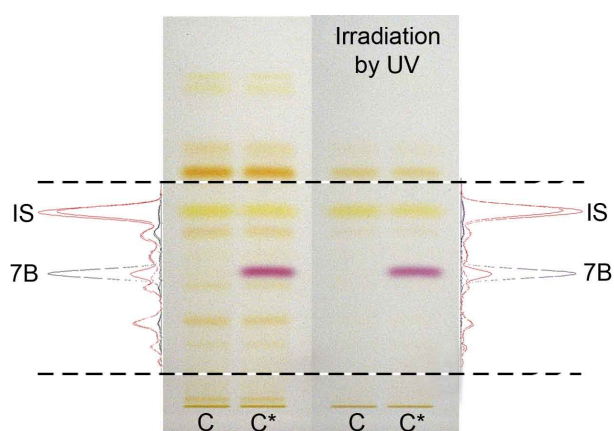
## Results and Discussion

The eight dyes most frequently found in spices and vegetable oils during the last few years [1] were best separated on caffeine impregnated silica gel plates. During method development, different chromatographic systems were investigated, nevertheless, chromatography was far superior on caffeine impregnated phases to the best separation obtained on normal and reversed phase layers. The regioisomers Sudan IV and Sudan Red B are hardly separated, however, this separation generally is highly challenging, even by LC/MS-MS [2].



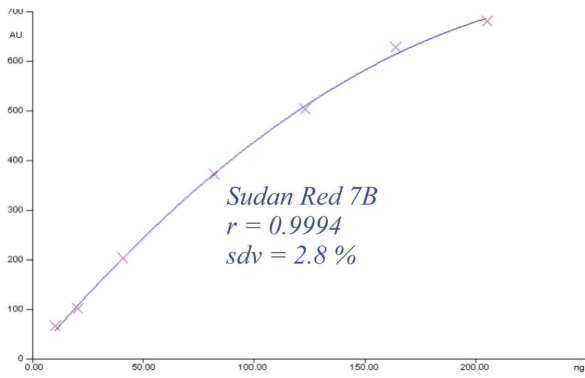
23 Separation of 8 azo dyes on caffeine-impregnated HPTLC plates NANO-SIL-PAH, HPTLC plates silica gel 60, and HPTLC plates RP 18 following [3]

Instead of time consuming cleanup steps described in literature, sample extracts were directly applied onto HPTLC plates and subjected to bleaching by exposing developed plates to strong UV light (600  $\text{W}/\text{m}^2$ ) for max. 5 min, resulting in baselines nearly free of matrix interferences.

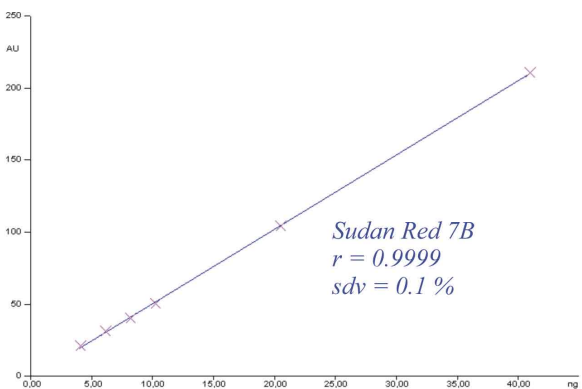


24 Effect of UV irradiation on the matrix background of the chromatogram for a native (C) and spiked (C\*, Sudan Red 7B, 500 mg/kg) chili powder extract

After multi wavelength scan at five selected wavelengths, a multi-level calibration using the internal standard mode, mainly for correction of the sample preparation, was used for quantification. The polynomial and linear regression was used for the high and low level working range, respectively. Following this sample preparation method, limits of detection (LOD) of approximately 10 mg/kg can be achieved, which is quite sufficient regarding unauthorized additions to be expected for color improvement of spices and spice mixtures. LOD can still be lowered applying samples volumes higher than 4  $\mu\text{L}$ .

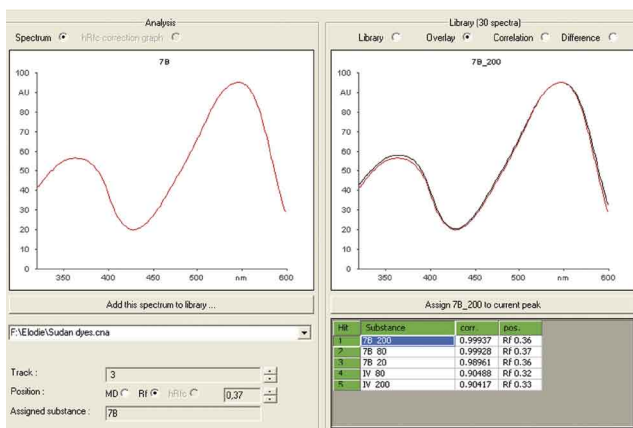


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Polynomial and linear calibration over a wide (10 to 200 ng/band) and narrow, low (4 to 40 ng/band, starting at LOD) calibration range, respectively, exemplarily shown for Sudan Red 7B

In order to prove the presence of suspected compounds in a sample, UV/Vis spectra can be compared to the spectra library elaborated from three concentration levels of each dye.

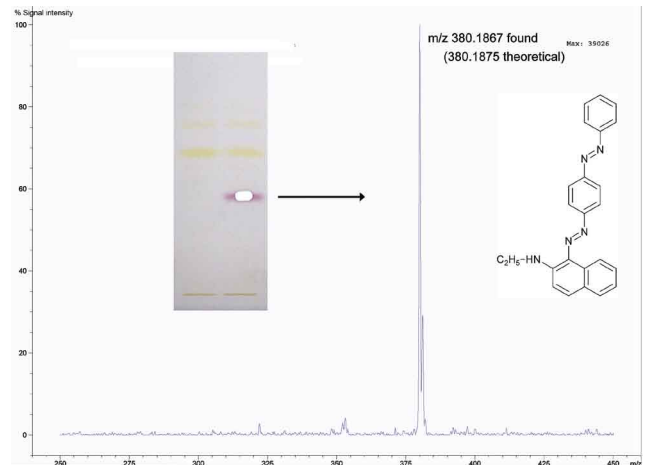


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Spectra comparison of Sudan Red 7B in a spiked sample (in red, 500 mg/kg Sudan Red 7B) against the first hit of the spectra library (correlation: 0.9994).

Additionally, mass spectra can be recorded from suspected zones by the TLC-MS interface to undoubtedly support positive findings. To extend mass

assignment confidence including empirical molecular formulae, exact masses can finally be calculated by MassWorks software, even using a single-quadropole mass spectrometer.



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HPTLC-MS spectrum of the suspected zone with exact mass calculated by MassWorks software as a second proof of the presence of Sudan Red 7B

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An orthogonal online HPTLC-HPLC-MS coupling was employed here for the first time. Apart from separating co-extracted caffeine of the layer impregnation from the azo dye, this simple hyphenation enabled a second dimension with regard to selectivity (C18 column versus silica gel plate). Hence, azo dye findings can be confirmed with ease by (1) UV/Vis spectra, (2) mass spectra and (3) a second chromatographic system of a different selectivity. All these confirmations can be obtained on demand from a single HPTLC run with many samples in parallel.

[1] Rapid Alert System for Food and Feed, [http://ec.europa.eu/food/food/rapidalert/index\\_en.htm](http://ec.europa.eu/food/food/rapidalert/index_en.htm)

[2] H. San, F. Wang, L. Ai, J Chromatogr A 1164 (2007) 120

[3] H. Kandler, M. Bleisch, V. Widmer, E. Reich, J Liq Chromatogr Rel Technol 32 (2009) 1273

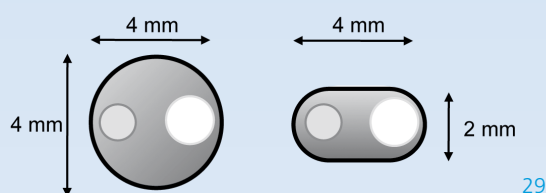
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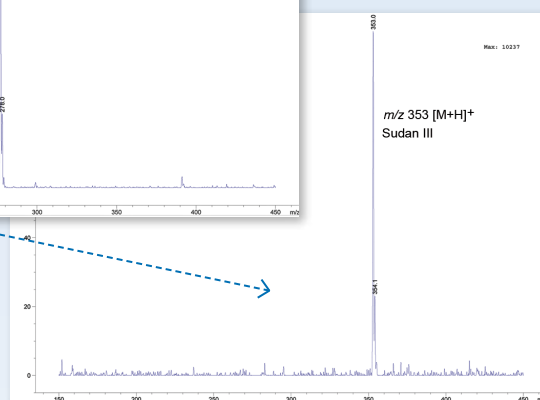
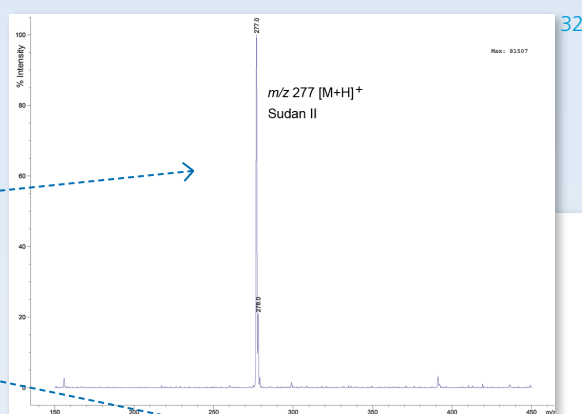
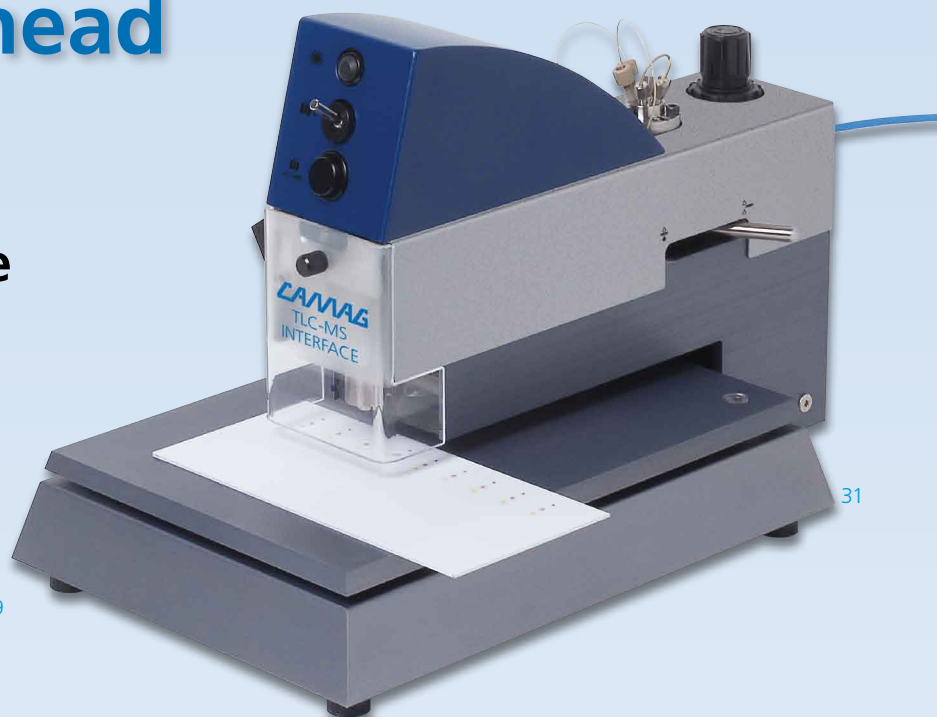
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