



CROMATOGRAFÍA BÁSICA ORIENTADA A LA INDUSTRIA REGIONAL

ÁREA TECNOLOGÍA QUÍMICA
PLATAFORMA DE ANÁLISIS Y SERVICIOS EN QUÍMICA

TEMARIO

- 1. Marco del curso
- 2. Enfoque
- 3. Alcance
- 4. Visión general del análisis cromatográfico: ejemplos



MARCO: EXPERIENCIA «REGIONAL»



ENFOQUE: ENTORNO DE TRABAJO



VISIÓN “PRÁCTICA”

ALCANCE: CRONOGRAMA RESUMIDO

Fecha	Duración	Sesión	Profesor	Lugar
16-ago	2 HS	Cromatografía: Presentacion y contexto	Boschetti	Aula graduados
23-30-ago	2 HS	Cromatografía gaseosa	Silva	Aula graduados
6-13-sep	2 -4 Hs	Cromatografía gaseosa	Millán/Azcárate	Lab ATQ
20-27-sep	2 HS	Cromatografía Líquida de alta eficiencia	Azcárate	Aula graduados
4-11-oct	2 -4 Hs	Cromatografía Líquida de alta eficiencia	Millán/Azcárate	Lab ATQ
18-oct	2 HS	Preparación de muestras	Silva	Aula graduados
25-oct, 1-nov	2 -4 Hs	Preparación de muestras	Millán/Azcárate	Lab ATQ
8-nov	2 HS	Validación de métodos en la industria Veterinaria	Sallovitz	Aula graduados
15-nov	2 HS	Validación de métodos en la industria Farmacéutica	Ambrogio	Aula graduados
22-nov	2 HS	Cromatografía acoplada a detectores de masa	Tagliafico	Aula graduados

REGIÓN GRAN ROSARIO

Aceiteras

Crushing

Puertos

Biodiesel

Alimenticias

Farmoquímicas

Agroquímicos

Petroquímicas

Laboratorios



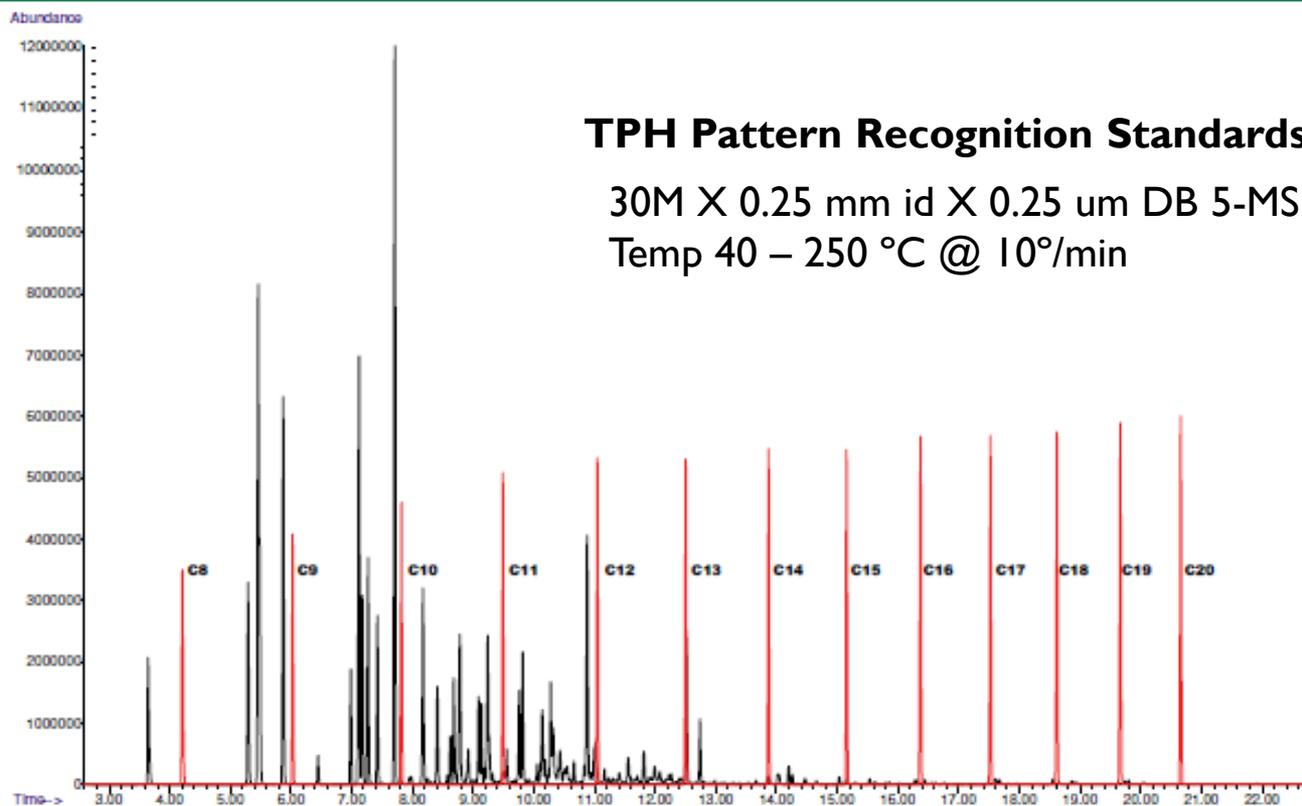
HIDROCARBUROS Y DERIVADOS

- TPH (Total Petrol Hydrocarbons) – EPA 8015C: NONHALOGENATED ORGANICS BY GAS CHROMATOGRAPHY (<https://www.intertek.es/medioambiente/hidrocarburos/determinacion-tph/>)
- Los TPH incluyen una variedad de mezclas que contienen de cientos a miles de compuestos de hidrocarburos, entre los que se encuentran los compuestos alifáticos y los aromáticos. La determinación de los hidrocarburos totales de petróleo (TPH) es usada para la evaluación de sitios contaminados por hidrocarburos. El uso de concentraciones máximas de TPH para establecer los niveles de limpieza de muestras de suelo o agua contaminados con hidrocarburos es un enfoque común implementado por autoridades reglamentarias.
- SCOPE AND APPLICATION: This method may be used to determine the concentrations of various nonhalogenated **volatile organic compounds** and **semivolatile organic compounds** by gas chromatography. This method may be applicable to the analysis of other analytes, including triethylamine and petroleum hydrocarbons. The petroleum hydrocarbons include gasoline range organics (**GRO**) and diesel range organics (**DRO**).

TOTAL PETROL HYDROCARBONS

Red Peaks are a n-alkane overlay used as a marker. Not included in the sample

Gasoline, Premium (Cat. No. GA-003-40X)



HIDROCARBUROS Y DERIVADOS

■ HEXANO

- **CAA:** El disolvente que se utilice para la extracción de aceites alimenticios deberá ser hexano, proveniente de la redestilación de naftas de “Topping”, con exclusión absoluta de naftas de “Cracking”.
- Definición: Fracción de hidrocarburos parafínicos del petróleo compuesta principalmente por n-hexano, 2-metilpentano, 3-metilpentano, con cantidades menores de otros hidrocarburos parafínicos de 5, 6 y 7 carbonos, ciclohexano y metilciclopentano.
- Hidrocarburos aromáticos, Máx 0,2 % v/v
- Absorbancia en el ultravioleta (Hidrocarburos aromáticos polinucleares): No se deberán superar los siguientes límites de absorbancia para 1 cm de espesor....
- PAH: EPA 8310 (HPLC-DAD-FLD); EPA 610 (GC-FID); EPA 8270 (GC-MS)

HEXANO + HC AROMÁTICOS

- Especificación: aromáticos totales 80 ppm máx. (Bz, Tol, Arom C8)
- Método: GC-FID, columna DB-Wax 30 m,

Boiling Point Order

C5 = Pentane

C6 = Hexane

B = Benzene

C7 = Heptane

T = Toluene

C8 = Octane

EB = Ethylbenzene

pX = p-Xylene

mX = m-Xylene

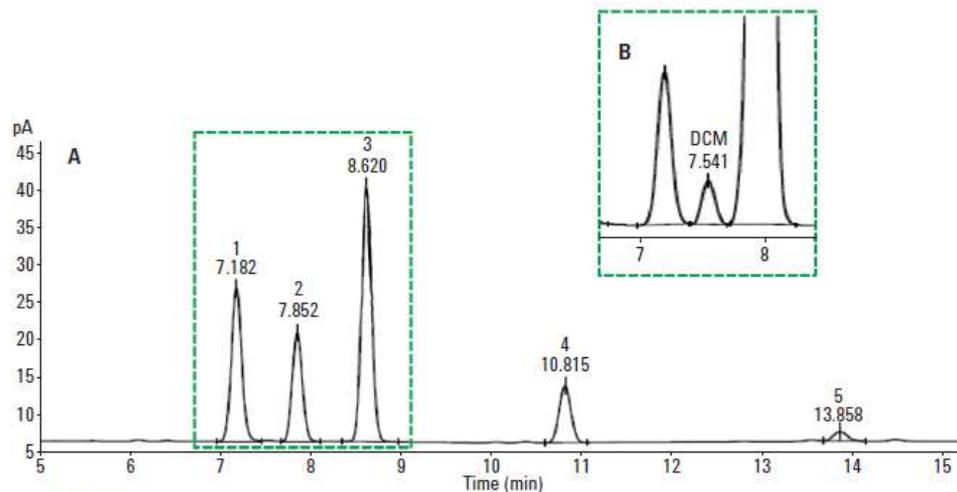
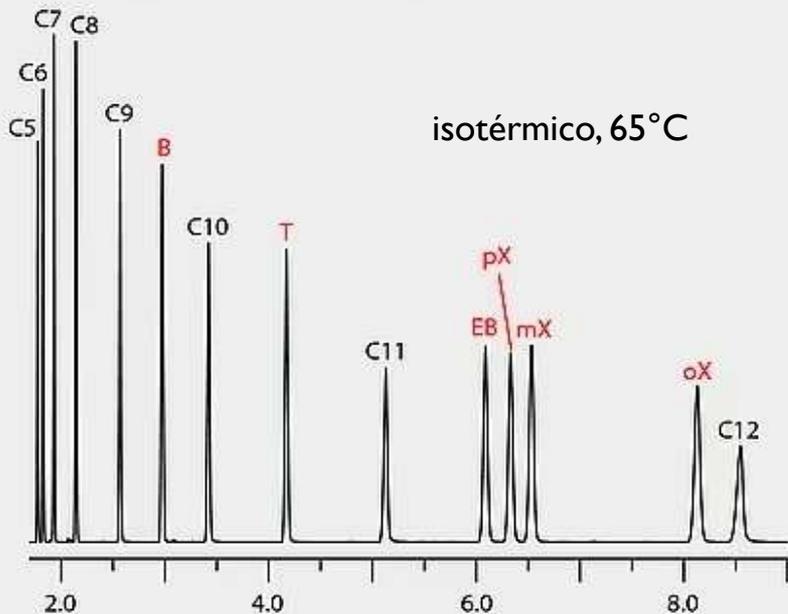
oX = o-Xylene

C9 = Nonane

C10 = Decane

C11 = Undecane

C12 = Dodecane



Peak ID

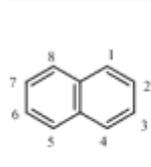
1. 2-Methylpentane
2. 3-Methylpentane
3. n-Hexane
4. Methylcyclopentane
5. Cyclohexane

Conditions

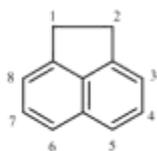
Oven: 40 °C
Split ratio: 1:5
Inj. vol: 1 mL
Flow: N₂, 1 mL/min, constant

<https://www.agilent.com/cs/library/applications/5991-6144EN.pdf>

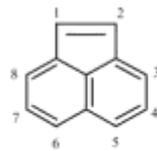
HIDROCARBUROS POLICÍCLICOS AROMÁTICOS



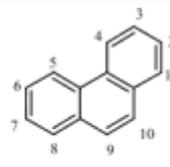
Naphthalene



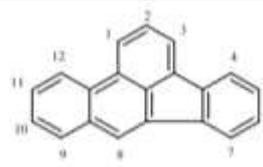
Acenaphthene



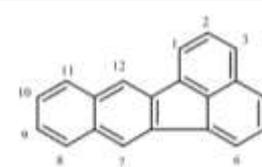
Acenaphthylene



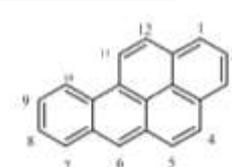
Phenanthrene



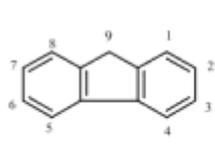
Benzo[*b*]fluoranthene



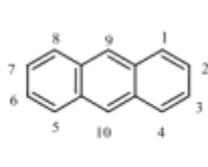
Benzo[*k*]fluoranthene



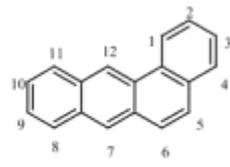
Benzo[*a*]pyrene



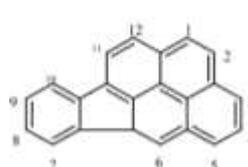
Fluorene



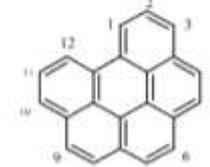
Anthracene



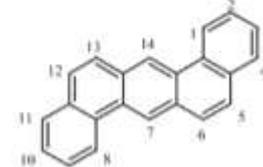
Benz[*a*]anthracene



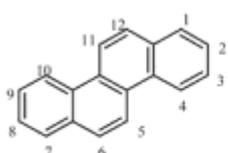
Indeno[1,2,3-*cd*]pyrene



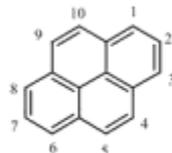
Benzo[*ghi*]perylene



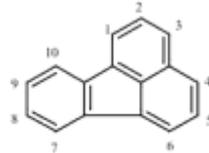
Dibenz[*a,h*]anthracene



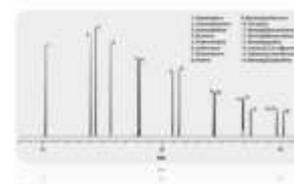
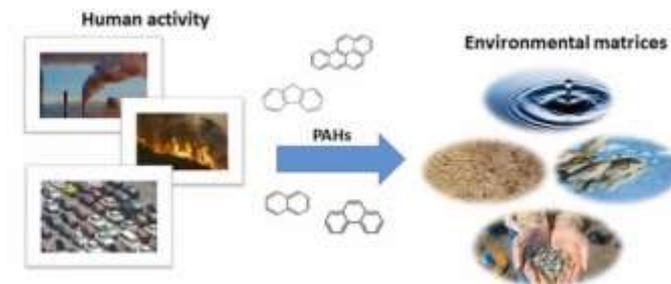
Chrysene



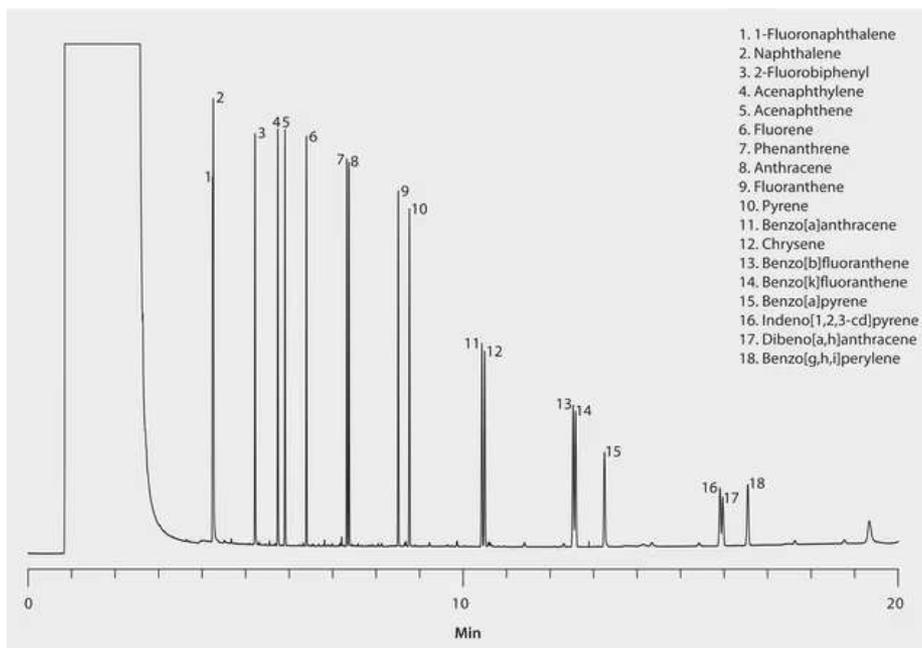
Pyrene



Fluoranthene

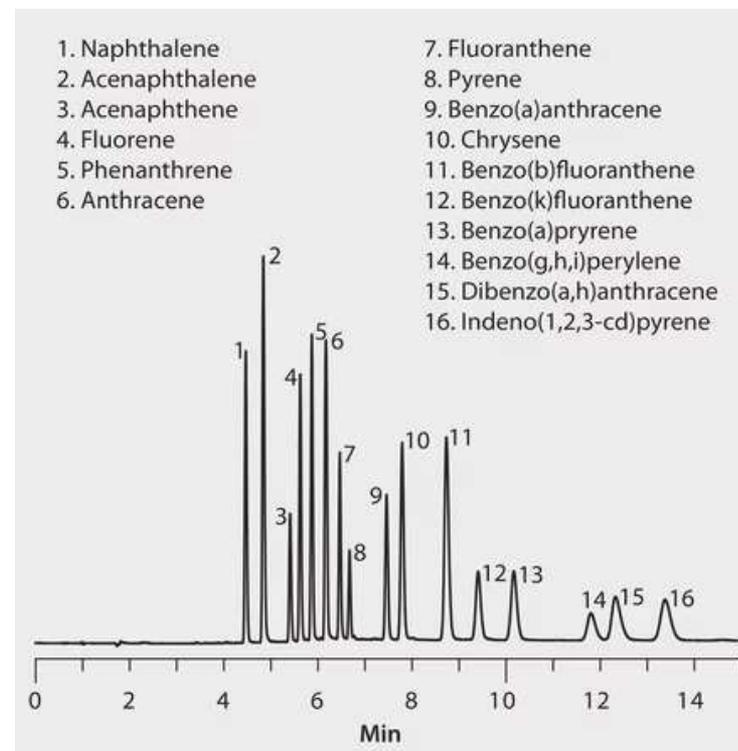


PAH: GC VS HPLC



SLB-5ms, 30 m x 0.25 mm I.D., 0.25 μ m

SUPELCOSIL™ LC-PAH HPLC 5 μ m particle size, L x I.D. 15 cm x 4.6 mm



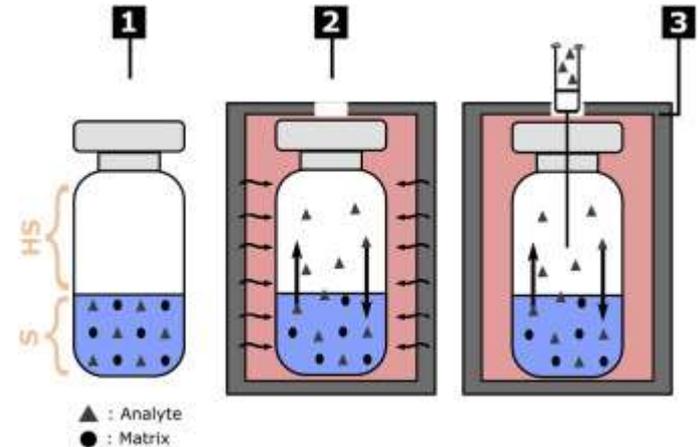
INDUSTRIA ACEITERA

■ Hexano residual – ISO 8892:1987

HEADSPACE

7.3.2 Test

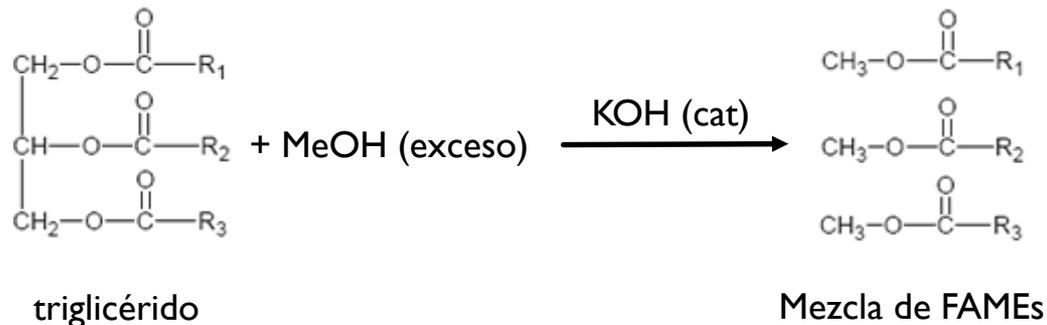
Using the gas syringe (5.3) previously heated to between 50 and 60 °C, take exactly 0,5 ml of the gaseous phase and inject quickly into the chromatograph.



Jeringa para gases, con
émbolo de teflón y
válvula en la aguja
(Hamilton Gastight)

INDUSTRIA ACEITERA

- Composición de triglicéridos? ----- Determination of Fatty Acids in Edible Oils and Fats by Capillary GLC: AOCS Method Ce 1e-91
- FAME: ésteres metílicos de ácidos grasos
 - Derivatización con KOH metanólico



- Análisis: GC-FID, columna moderadamente polar, temp. 80°C → 220°C

ANÁLISIS DE ÁCIDOS GRASOS METILADOS

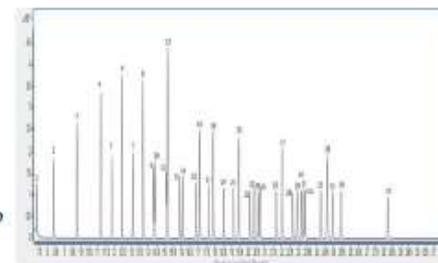
Supelco®

www.sigmaaldrich.com

Certificate of Analysis - Certified Reference Material

Supelco 37 Component FAME Mix

Product no.:	CRM47885
Lot no.:	LRAD3869
Expiry Date:	January 2026
Manufacturing Date:	January 2023
Storage:	FREEZER
Solvent/Matrix:	METHYLENE CHLORIDE
Certificate version:	LRAD3869.01 <i>(Note: Certificates may be updated due to the availability of new data. Check our website at: www.sigma-aldrich.com for the most current version.)</i>



METHOD: GC (IN-HOUSE)

Column: SP-2560, 100 m × 0.25 mm I.D., 0.20 µm film thickness

Carrier Gas: He Flow Rate: 2.2 mL/min

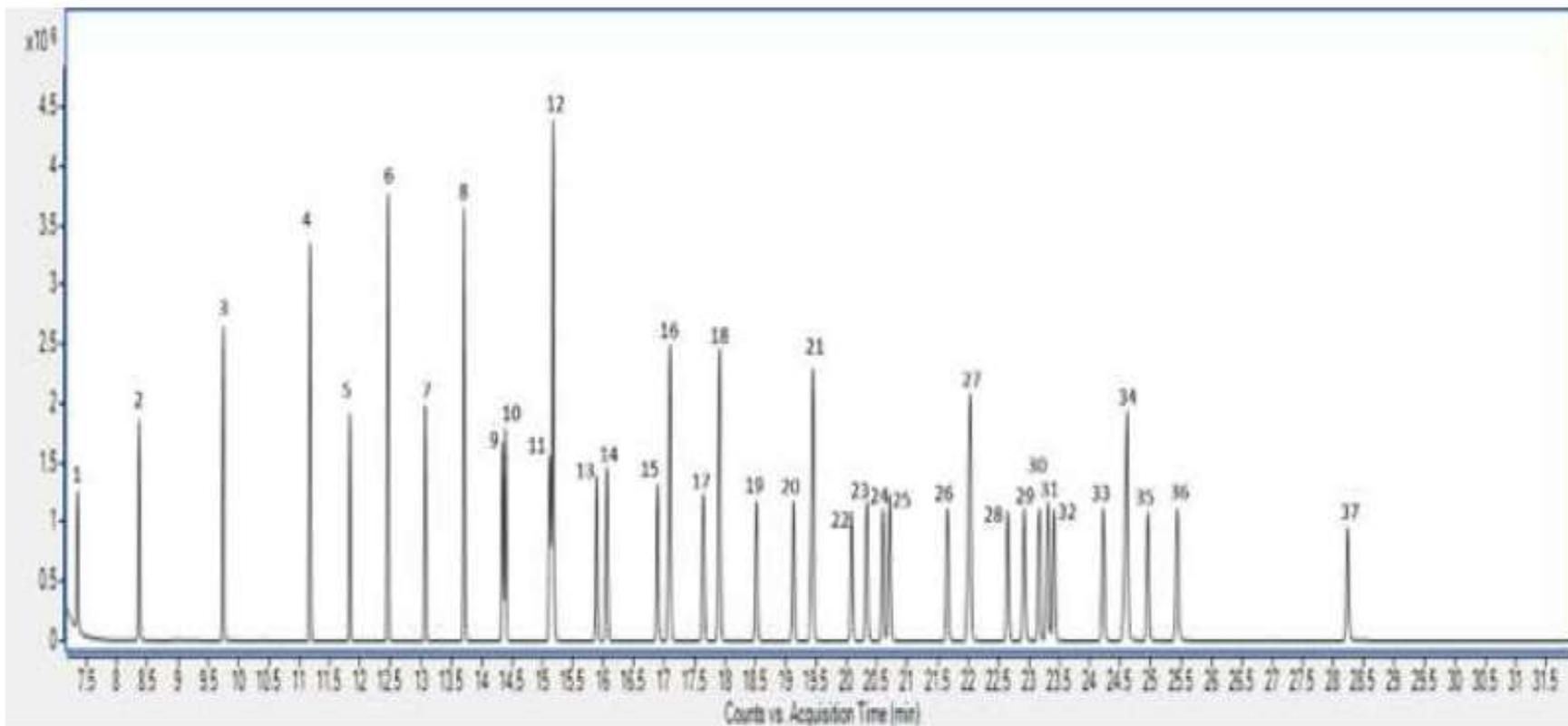
Inlet Temperature: 220 °C Injection Volume: 1 µL

Injection Mode: Split Ratio: 20:1

Temperature Program: 100 °C (Hold 4 min) @ 25 °C/min to 200 °C (Hold 8 min) @ 5 °C/min to 250 °C (Hold 6 min)

Detector: MSD, Mode: Full scan, 40-400 m/z, Solvent delay: 6.95 min Temperature: Transfer line: 250 °C, Ion source: 230 °C, Quadrupole: 150 °C

37 FAME MIX



I. Methyl Butyrate

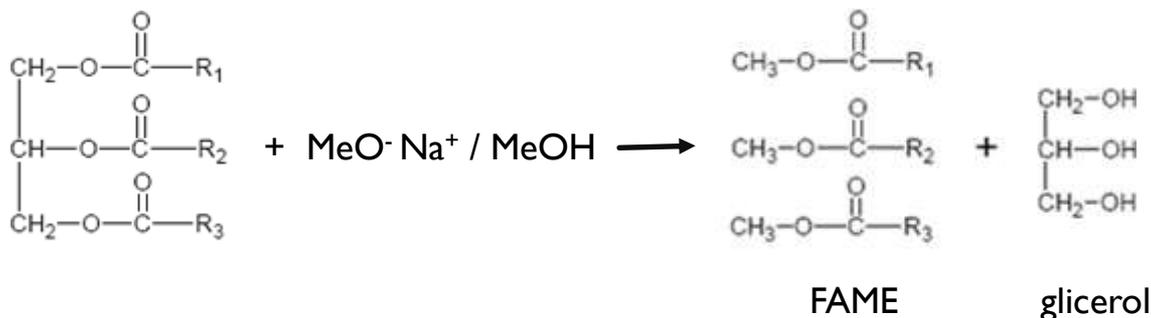
37. Methyl cis-4,7,10,13,16,19-docosaenoate ($C_{23}H_{34}O_2$)

BIODIESEL

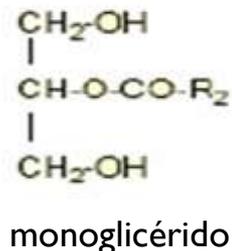
■ Metanol en Biodiesel – EN14110

- EN 14110 requires a headspace GC method, based on either polar or non-polar columns, and is applicable for a concentration range from 0.01% m/m to 0.5% m/m of methanol

■ Mono-, di-, trigliceridos – EN14105



intermedios
(reacción incompleta):



EN 14105 – EQUIVALENTE A ASTM D6584

2 Principle

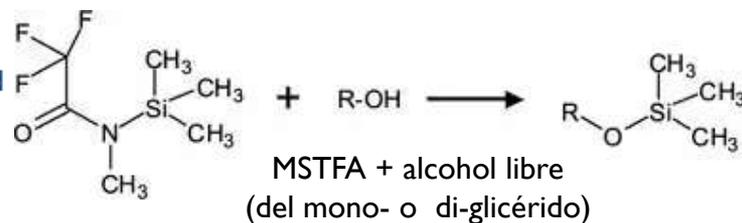
Transformation of the glycerol and of the mono- and diglycerides into more volatile and stable silyl derivatives in presence of pyridine and of N-methyl-N-trimethylsilyltrifluoroacetamide (MSTFA).

Analysis of the sample after silylation, by gas chromatography on a short capillary column with thin film thickness, with an on-column injector or equivalent device, and flame ionization detection.

After a calibration procedure, the quantification of glycerol is carried out in presence of the internal standard 1,2,4-butanetriol.

Mono-, di- and triglycerides are directly evaluated in presence of an internal standard category:

- glyceryl mononadecanoate (Mono C19) for monoglycerides;
- glyceryl dinadecanoate (Di C38) for diglycerides;
- glyceryl trinadecanoat

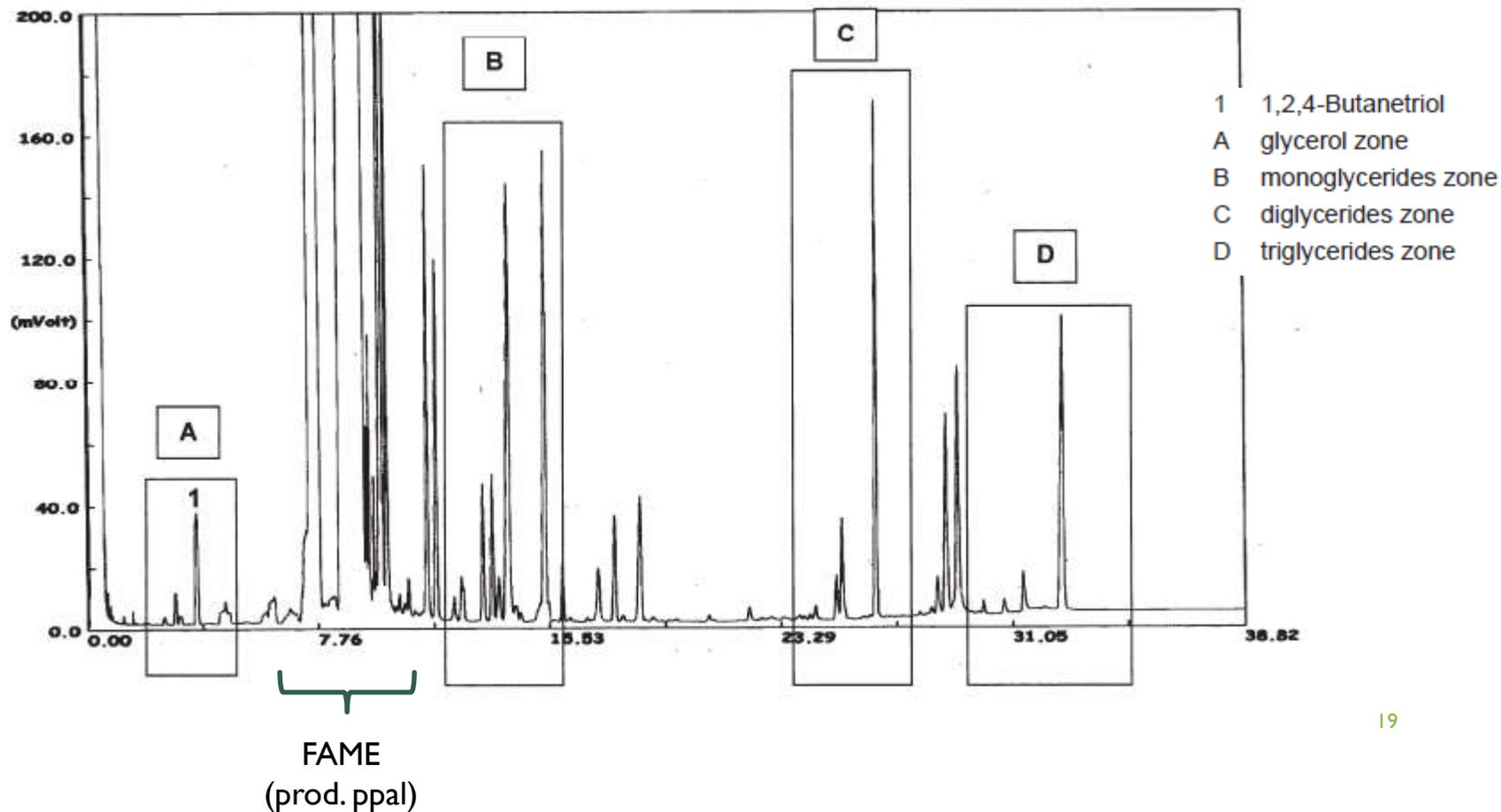


4.1 Gas chromatograph, equipped with an on-column injector or equivalent device, a temperature-programmable oven and a flame ionization detector.

4.2 Capillary column, capable of being programmed up to 400 °C ("high temperature" type) for which the following characteristics are advised:

- 100 % dimethylpolysiloxane or 95 % dimethyl-5 % diphenylpolysiloxane stationary phase;
- length 15 m;
- internal diameter 0,32 mm;
- film thickness 0,1 μm .

EN 14105 - CROMATOGRAMA



INDUSTRIA ALIMENTICIA

■ FACTORES NUTRICIONALES

- Perfil de ácidos grasos (GC-FID)
- Vitaminas, Tocoferoles, Aminoácidos (HPLC)
- Azúcares
- Colorantes, saborizantes

■ CONTAMINANTES

- Pesticidas clorados (GC-ECD)
- Piretroides (GC-ECD)
- Aflatoxinas (HPLC-FLD)
- Residuos de antibióticos (HPLC-DAD)

AMINOÁCIDOS (DERIVATIZACIÓN)

Separación de aminoácidos estándar en Eclipse Plus C18

Columna: Eclipse Plus C18
959763-902
2,1 x 150 mm, 3,5 µm

Fase móvil: A: Na₂HPO₄ 10 mM, Na₂B₄O₇ 10 mM, NaN₃ 0,5 mM, pH 8,2
B: acetonitrilo:metanol:agua (45:45:10) (v/v/v)

Velocidad de flujo: 0,42 ml/min

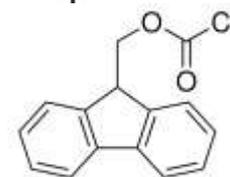
Temperatura: 40 °C

Detector: UV, 338 nm y cambio a 280 nm en 15,7 min

Muestra: 900 pmol, aminoácidos con patrones de aminoácidos e internos ampliados (500 pmol)

Derivación: OPA/FMOC, automatizado, en línea

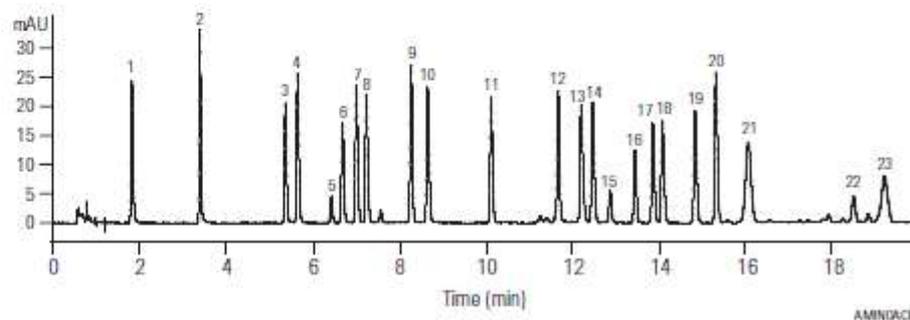
o-Phthaldialdehyde
2-mercaptoethanol
Fmoc: 9-Fluorenylmethoxycarbonyl



Gradiente

Tiempo (min)	% B
0	2
0,5	2
20	57
20,1	100
23,5	100
23,6	2
25	Parada

- | | | |
|--------|---------|---------|
| 1. ASP | 9. ARG | 17. PHE |
| 2. GLU | 10. ALA | 18. ILE |
| 3. ASN | 11. TYR | 19. LEU |
| 4. SER | 12. CY2 | 20. LYS |
| 5. GLN | 13. VAL | 21. HYP |
| 6. HIS | 14. MET | 22. SAR |
| 7. GLY | 15. NVA | 23. PRO |
| 8. THR | 16. TRP | |



POLIFENÓLES: PREPARACIÓN DE LA MUESTRA?

Separación de componentes del té verde en StableBond SB-C8 de resolución rápida

Columna: ZORBAX SB-C8
863953-906
4,6 x 150 mm, 3,5 µm

Fase móvil: 75% 0,1% TFA : 25% MeOH

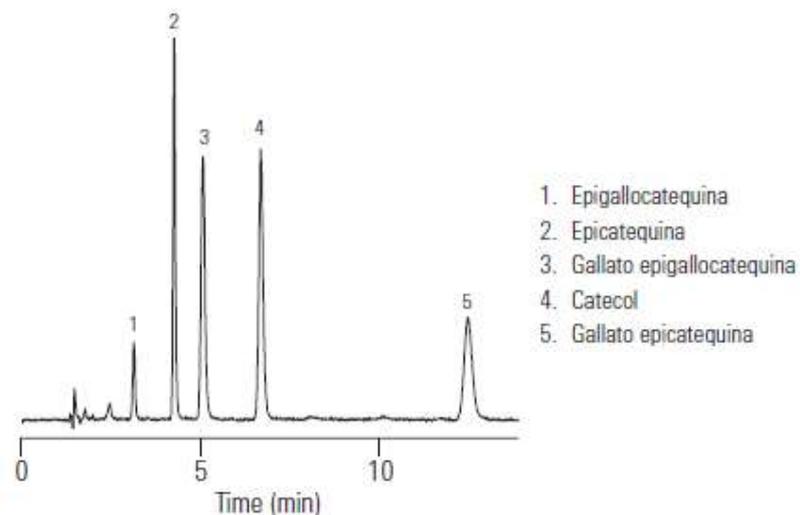
Velocidad de flujo: 1,0 ml/min

Temperatura: 40 °C

Detector: 280 nm

Muestra: Té verde

Los nutraceuticos, como los componentes del té verde, se separan rápidamente en una columna StableBond SB-C8 de resolución rápida.

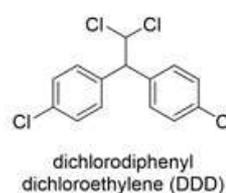
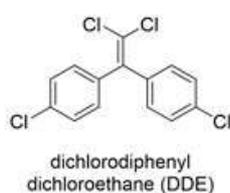
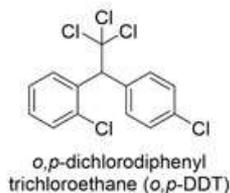
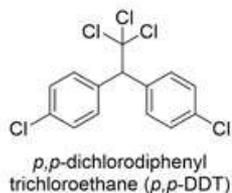


LCPC018

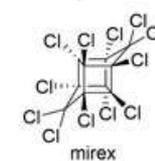
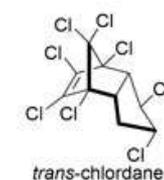
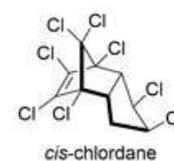
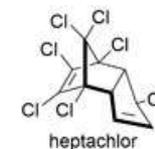
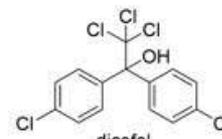
PESTICIDAS COMO CONTAMINANTES ALIMENTARIOS

■ PESTICIDAS: Desde GC-ECD hacia LC-MS

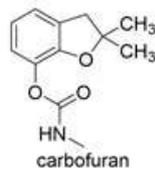
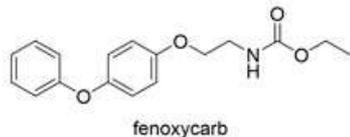
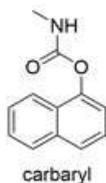
CATEGORY I: DDT AND RELATED ANALOGUES



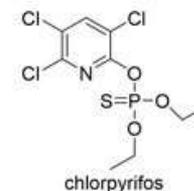
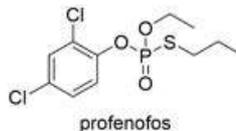
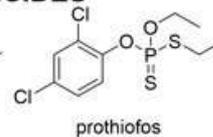
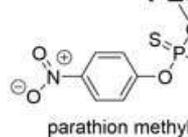
CATEGORY II: OTHER ORGANOCHLORINE PESTICIDES



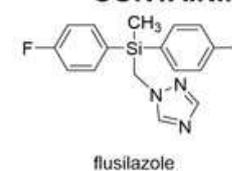
CATEGORY III: CARBAMATE PESTICIDES



CATEGORY IV: ORGANOPHOSPHATE PESTICIDES



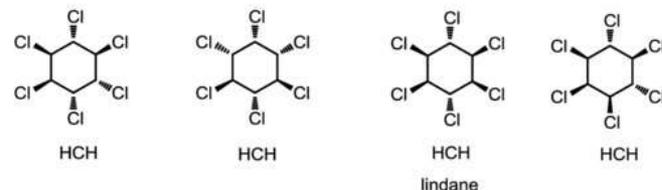
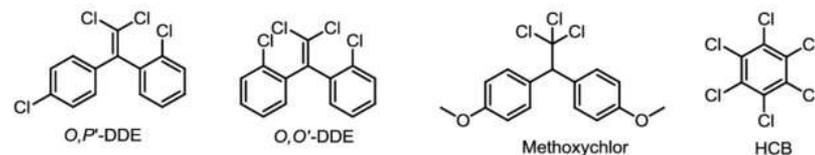
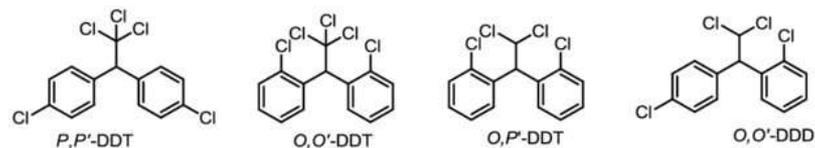
CATEGORY V: TRIAZOLE-CONTAINING PESTICIDES



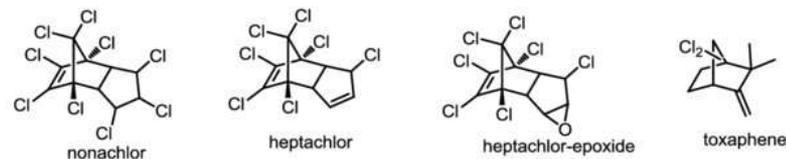
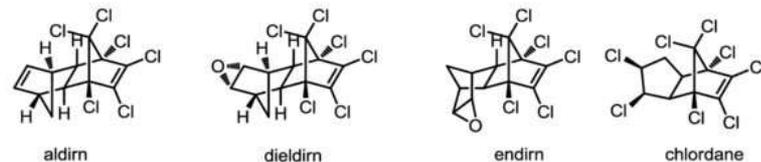
PESTICIDAS ORGANOCOLORADOS

- PESTICIDAS ORGANOCOLORADOS:
- Standard Methods for the Examination of Water and Wastewater: Method 6630 ORGANOCHELORINE PESTICIDES
- EPA METHOD 8081B ORGANOCHELORINE PESTICIDES BY GAS CHROMATOGRAPHY

“After cleanup, the extract is analyzed by injecting a measured aliquot into a gas chromatograph equipped with either a narrow-bore or wide-bore fused-silica capillary column, and an electron capture detector (GC/ECD).”



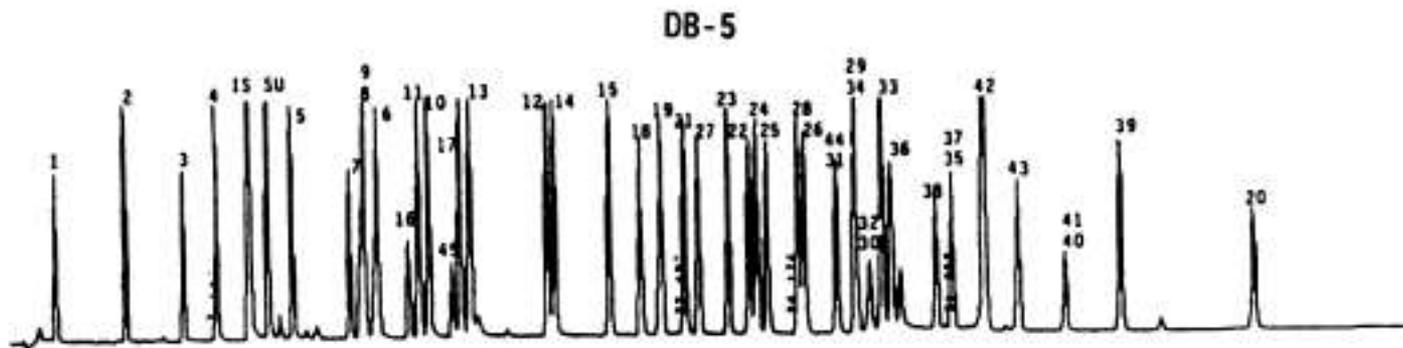
lindane



PESTICIDAS: GC-ECD

EXAMPLE GAS CHROMATOGRAM OF ORGANOCHLORINE PESTICIDES

Organochlorine pesticides analyzed on a DB-5/DB-1701 fused-silica open-tubular column pair. The GC operating conditions were as follows: 30-m x 0.53-mm ID DB-5 (0.83- μ m film thickness) and 30-m x 0.53-mm ID DB-1701 (1.0- μ m film thickness) connected to an 8-in. injection tee (Supelco Inc.). Temperature program: 140 EC (2 min hold) to 270 EC (1 min hold) at 2.8 EC/min.



patrón (catálogo)
vs
muestra (mundo real)

PESTICIDAS: QUECHERS + LC/MS

Anastassiades, M., Lehotay, S. J., Štajnbaher, D., & Schenck, F. J. (2003). *Journal of AOAC International*, 86(2), 412-431.

412 ANASTASSIADES ET AL. JOURNAL OF AOAC INTERNATIONAL VOL. 86, No. 2, 2003

RESIDUES AND TRACE ELEMENTS

Fast and Easy Multiresidue Method Employing Acetonitrile Extraction/Partitioning and “Dispersive Solid-Phase Extraction” for the Determination of Pesticide Residues in Produce

MICHELANGELO ANASTASSIADES¹ and STEVEN J. LEHOTAY²

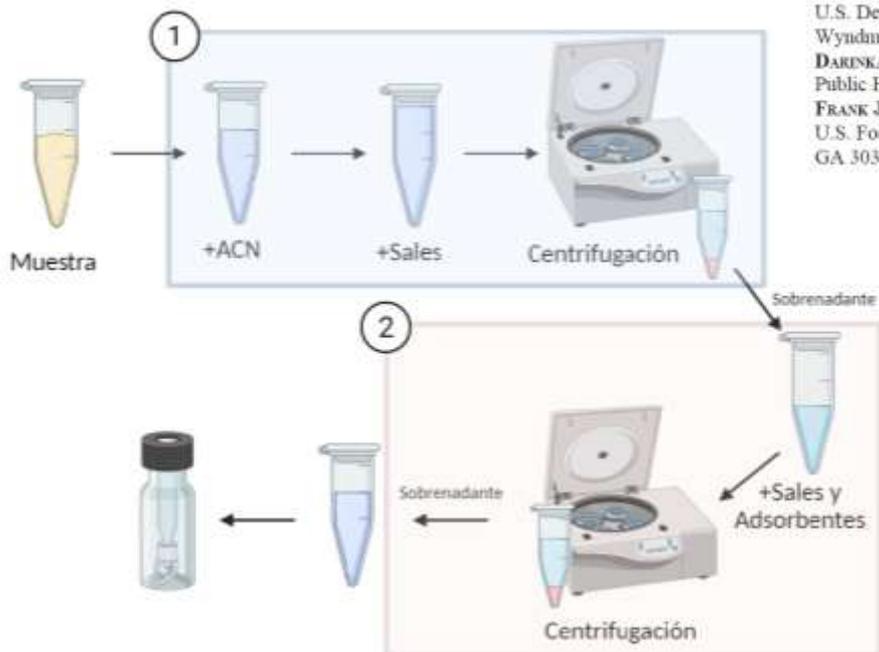
U.S. Department of Agriculture, Agricultural Research Service, Eastern Regional Research Center, 600 E. Mermaid Ln, Wyndmoor, PA 19038

DARINKA ŠTAJNBAHER

Public Health Institute, Environmental Protection Institute, Prvomajska 1, 2000 Maribor, Slovenia

FRANK J. SCHENCK

U.S. Food and Drug Administration, Office of Regulatory Affairs, Southeastern Regional Laboratory, 60 Eighth St, Atlanta, GA 30309



Perestrelo, R., Silva, P., Porto-Figueira, P., Pereira, J. A., Silva, C., Medina, S., & Câmara, J. S. (2019). QuEChERS-Fundamentals, relevant improvements, applications and future trends. *Analytica chimica acta*, 1070, 1-28.

A. Santana-Mayor, R. Rodríguez-Ramos, A.V. Herrera-Herrera, B. Socas-Rodríguez, M.A. Rodríguez-Delgado. Updated overview of QuEChERS applications in food, environmental and biological analysis (2020–2023). *TrAC Trends in Analytical Chemistry*, Volume 169, 117375 (2023).

LC-MS/MS (TQ)

Thermo Scientific Application note 65684:
Multi-pesticide residues analyses of QuEChERS extracts using an automated online μ SPE clean-up coupled to LC-MS/MS

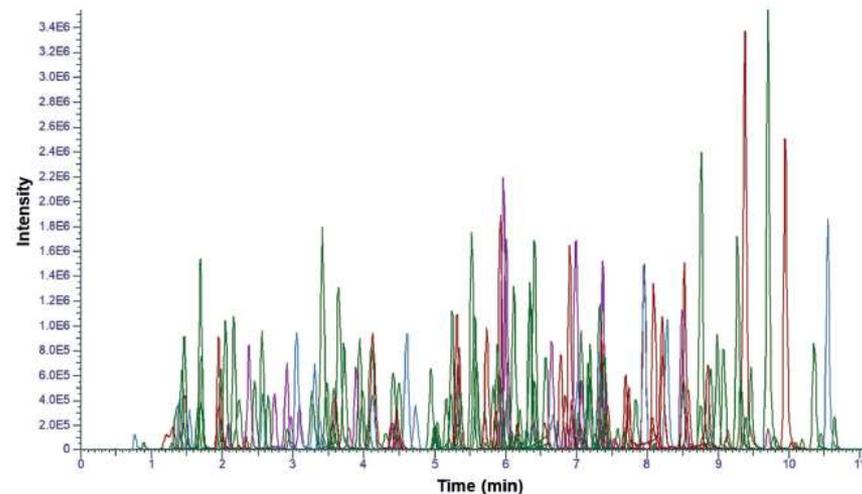
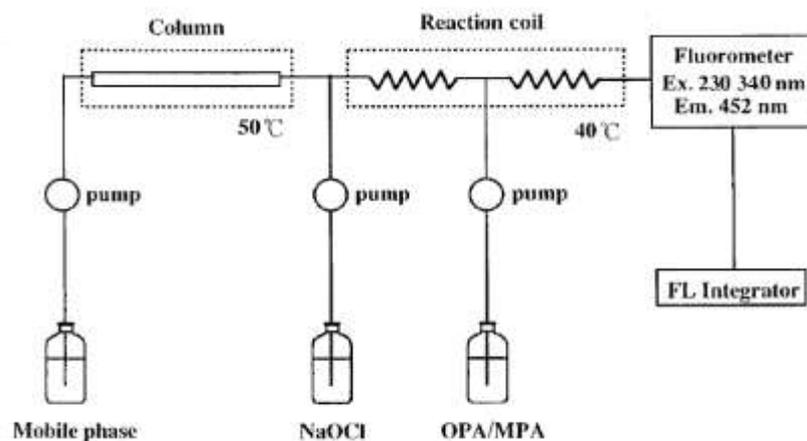
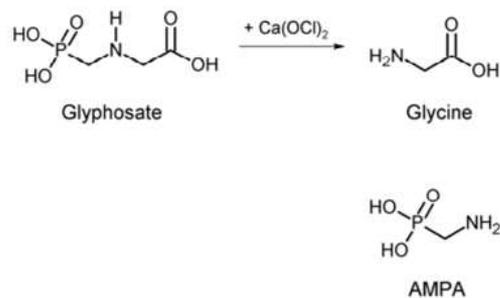


Figure 3. Overlaid chromatograms of all 195 pesticide compounds included in this method

GLIFOSATO

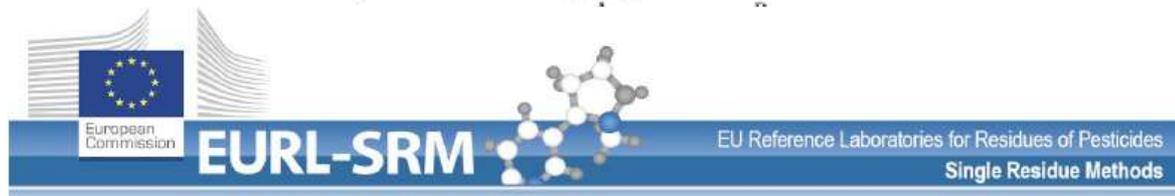
■ Standard Methods for the Examination of Water and Wastewater

■ 665 I GLYPHOSATE HERBICIDE: HPLC con derivatización post-columna y detector FLD



■ Opción: LC-MS/MS

https://www.eurl-pesticides.eu/userfiles/file/EurlSRM/EurlSrm_meth_QuPpe_PO_VI2.pdf



Quick Method for the Analysis of Highly Polar Pesticides in Food Involving Extraction with Acidified Methanol and LC- or IC-MS/MS Measurement
I. Food of Plant Origin (QuPpe-PO-Method)

INDUSTRIA FARMACÉUTICA/FARMOQUÍMICA

- IFA (ingrediente farmacéutico activo, API): pureza, título
- Impurezas
- Limpieza de equipos
- Solvente residual
 - GC, headspace-GC



HPLC: PRODUCTIVIDAD

**Mezcla de formulaciones para la tos:
separación rápida y eficaz**

Columna A: ZORBAX SB-CN
866953-905
4,6 x 75 mm, 3,5 µm

Columna B: ZORBAX SB-CN
883975-905
4,6 x 150 mm, 5 µm

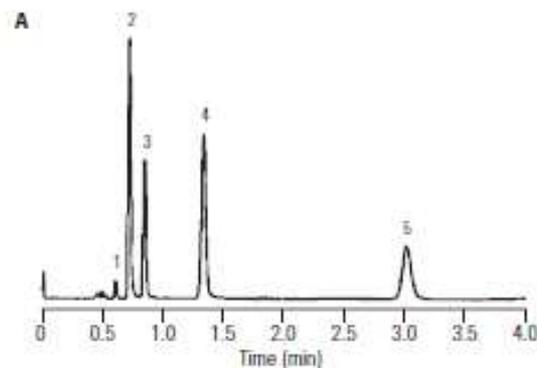
Fase móvil: 20/80, acetonitrilo/150 mM de citrato de sodio,
pH 2,6

Velocidad de flujo: 1,5 ml/min, 1,0 ml/min

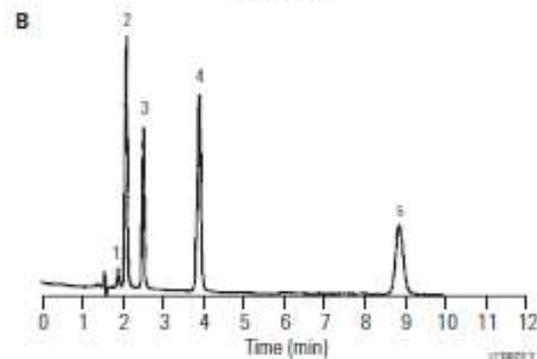
Temperatura: 35 °C

Detector: UV, 270 nm

Muestra: 2 µl, formulación para la tos



1. Ácido maleico
2. Pseudo-efedrina
3. Acetaminofén
4. Clorfeniramina
5. Dextrometorfano



MEDIO AMBIENTE

- AGUA, AIRE, SUELO
- Hazardous Waste Test Methods: EPA SW-846 Compendium (<https://www.epa.gov/hw-sw846/sw-846-compendium#8000series>)
- Purga y trampa
- SPME



<https://www.nemi.gov/home/>

COMPUESTOS ORGÁNICOS PURGABLES

Bulletin 865B

GC/HPLC Analyses of Organic Compounds in Drinking Water: US EPA Procedures

Method 524.2 – Purgeable Organics (GC/MS) (Replaces Method 524.1)

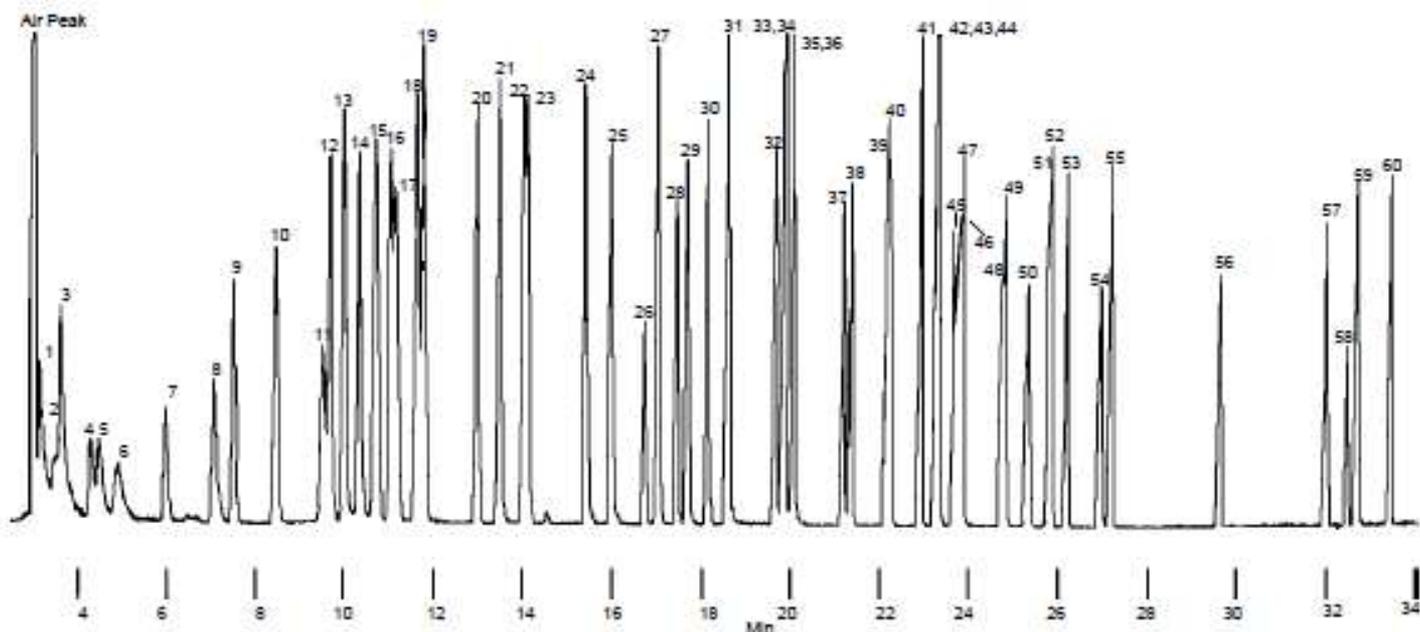
Figure J. Purgeable Organics by Method 524.2

(Using Tekmar® LCS 2000 Purge & Trap and GC/MS)

Column: VOCOL, 60m x 0.75mm ID, 1.5µm film
Oven: 10°C (4 min) to 170°C at 4°C/min
Carrier: 10mL/min
Det.: MS, scan range m/z=33-275, 1 scan/0.700 sec
Inj.: composite of VOC mixes, 100ppb each compound in 5mL water

1. Dichlorodifluoromethane	56. 1,1-Dichloropropene	51. 1,2-Dibromopropane	46. 1,2,4-Trimethylbenzene
2. Chloromethane	57. Tetrachloromethane	52. Chlorobenzene	47. 4-Chlorotoluene
3. Vinyl chloride	58. Benzene	53. 1,1,1,2-Tetrachloroethane	48. tert-Butylbenzene
4. Bromomethane	59. 1,2-Dichloroethane	54. Ethyl benzene	49. 1,2,4-Trimethylbenzene
5. Chloroethane	60. Trichloroethane	55. p-Xylene	50. sec-Butylbenzene
6. Trichlorofluoromethane	61. 1,2-Dichloropropane	56. m-Xylene	51. Isopropyltoluene
7. 1,1-Dichloroethane	62. Bromodichloromethane	57. o-Xylene	52. 1,3-Dichlorobenzene
8. Dichloromethane	63. Dibromomethane	58. Styrene	53. 1,4-Dichlorobenzene
9. trans-1,2-Dichloroethane	64. cis-1,3-Dichloropropene	59. Bromoform	54. Butylbenzene
10. 1,1-Dichloroethane	65. Toluene	60. Isopropylbenzene	55. 1,2-Dichlorobenzene
11. 2,2-Dichloropropane	66. trans-1,3-Dichloropropene	61. 1,1,2,2-Tetrachloroethane	56. 1,2-Dibromochloropropane
12. cis-1,2-Dichloroethane	67. 1,1,2-Trichloroethane	62. Bromobenzene	57. 1,2,4-Trichlorobenzene
13. Trichloromethane	68. Tetrachloroethane	63. 1,2,3-Trichloropropane	58. Hexachlorocyclopentadiene
14. Bromochloromethane	69. 1,3-Dichloropropene	64. Propylbenzene	59. Naphthalene
15. 1,1,1-Trichloroethane	70. Dibromochloromethane	65. 2-Chlorotoluene	60. 1,2,3-Trichlorobenzene

EPA METHOD 524-2



706-0204

Sample Preparation: Purge and trap using a VOCARB 4000 trap (8.5cm Carbopack C / 10cm Carbopack B / 6cm Carboxen 1000 / 1cm Carboxen 1001).

GC Column: VOCOL wide bore capillary column, 60m x 0.75mm ID borosilicate glass, 1.5 μ m phase film.

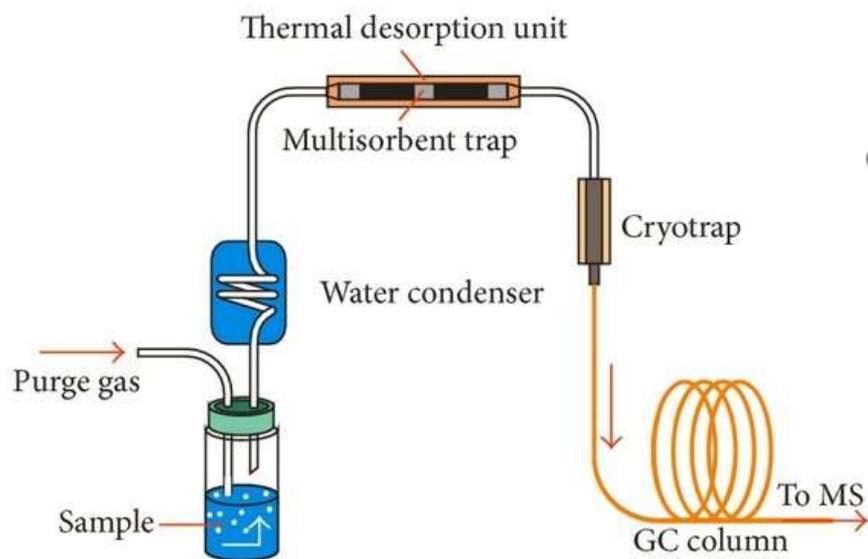
Confirmational Column: VOCOL wide bore capillary column, 30m x 0.53mm ID fused silica, 3 μ m phase film.

Detector: Mass spectrometer (70eV, 35-260amu scanning capability).

Chemical Standards: See page 14.

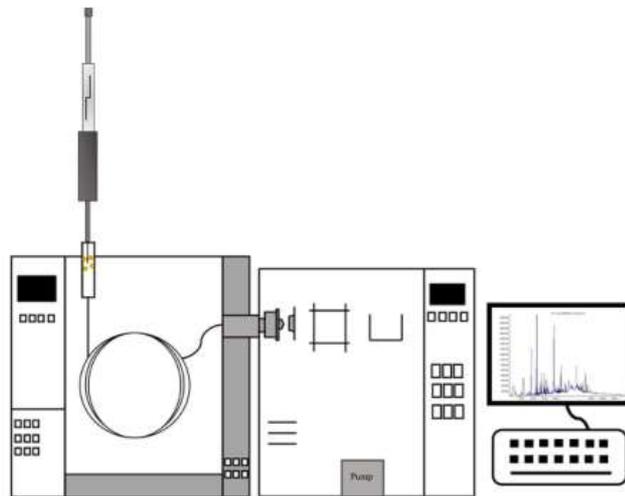
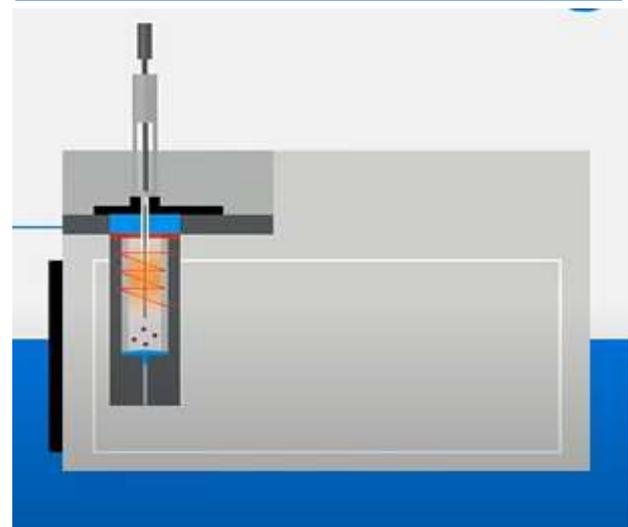
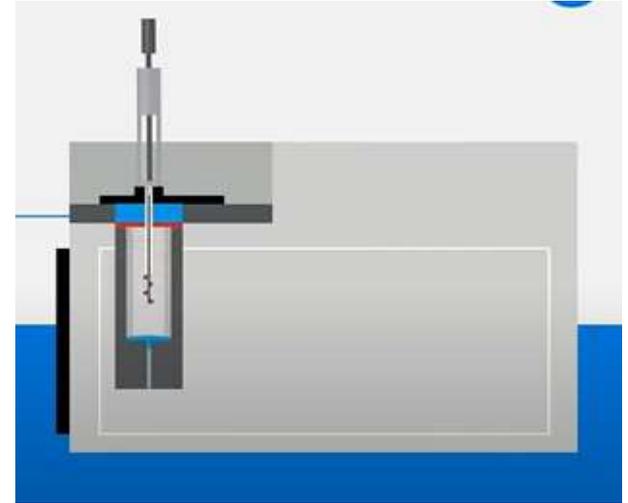
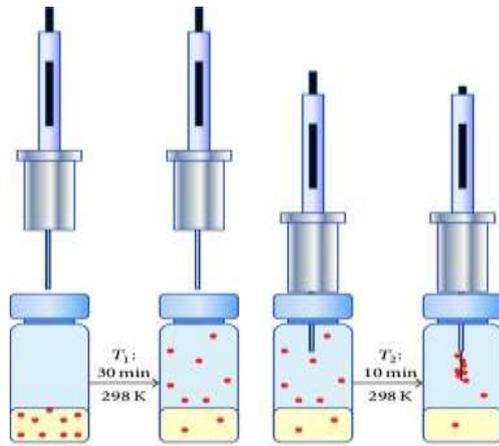
Qualifications: When used with this method, 30m x 0.53mm ID capillary columns must be cooled to temperatures below 10°C.

EQUIPO PURGA Y TRAMPA



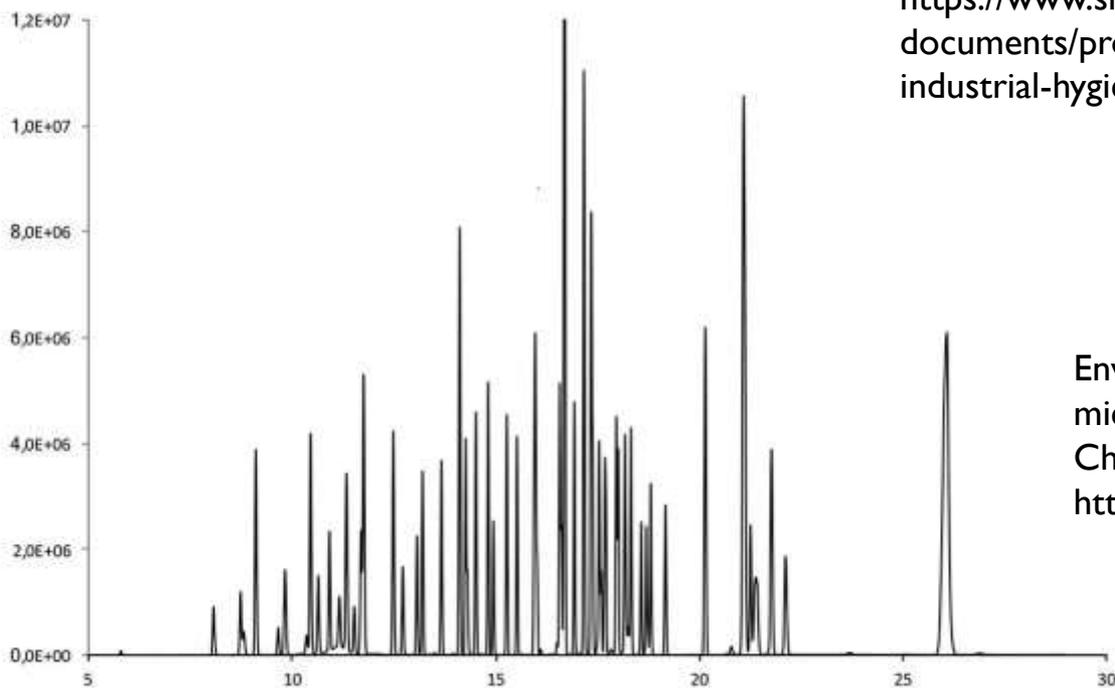
<https://www.teledynelabs.com/products/chromatography/gc-prep>

SPME (SOLID PHASE MICROEXTRACTION)



VOC POR SPME

ISO 17943:2016. Water quality — Determination of volatile organic compounds in water — Method using headspace solid phase micro-extraction (HS-SPME) followed by gas chromatography-mass spectrometry (GC-MS)



<https://www.sigmaaldrich.com/AR/es/technical-documents/protocol/environmental-testing-and-industrial-hygiene/drinking-water-testing/iso17943>

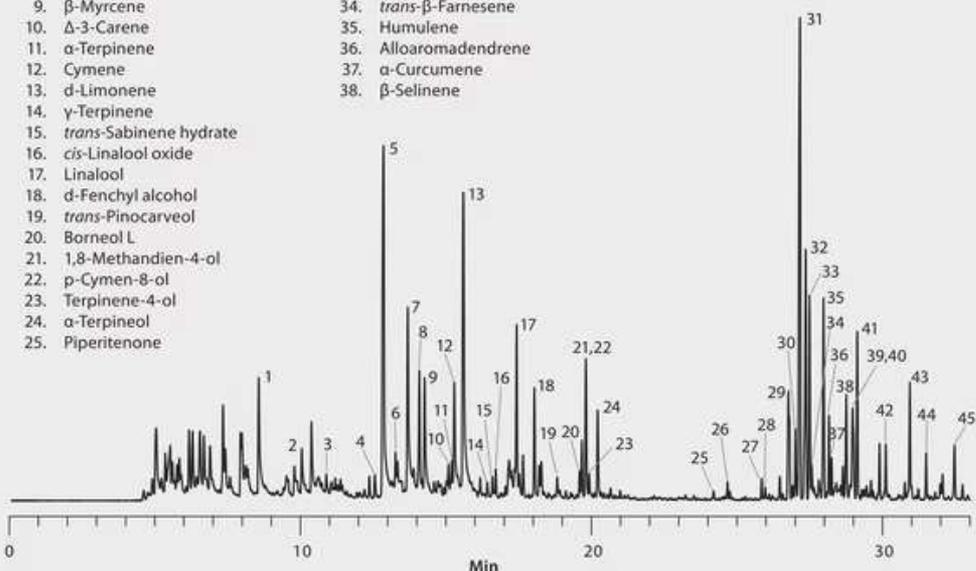
Environmental applications of solid-phase microextraction, TrAC Trends in Analytical Chemistry, Volume 112, 2019, Pages 1-12, <https://doi.org/10.1016/j.trac.2018.12.020>.

APLICACIONES SPME

(Sigma-Aldrich/Merck/Supelco)

GC Analysis of Terpenes in Cannabis on Equity™-I after Headspace SPME using 50/30 µm DVB/CAR/PDMS Fiber

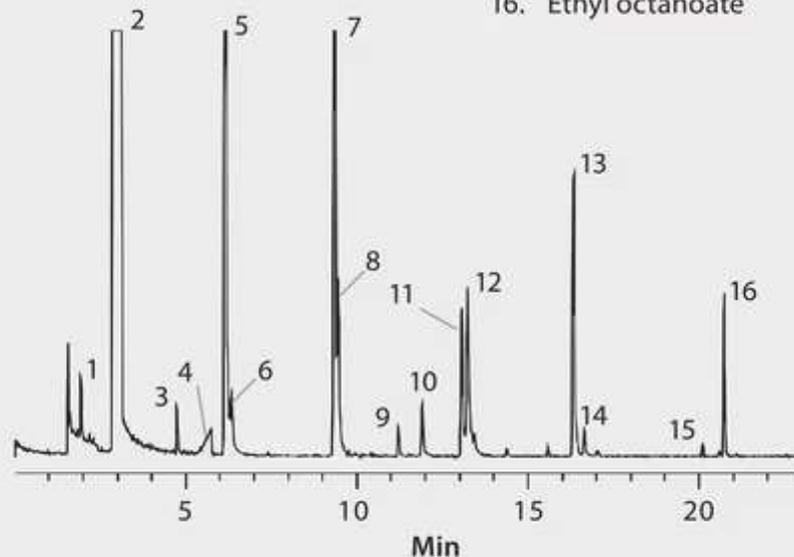
- | | | |
|------------------------------------|---|-------------------------------------|
| 1. Hexanal | 26. Piperitenone oxide | 39. α-Selinene |
| 2. Hexene-1-ol | 27. α-Ylangene | 40. β-Bisobolene |
| 3. 2-Heptanone | 28. α-Copaene | 41. α-Bulnesene |
| 4. α-Thujene | 29. γ-Caryophyllene | 42. Selina-3,7(11)-diene |
| 5. α-Pinene + unknown | 30. α-Santalene | 43. Caryophyllene oxide |
| 6. Camphene | 31. Caryophyllene | 44. Humulene oxide |
| 7. 6-Methyl-5-hepten-2-one | 32. <i>trans</i> -α-Bergamotene + unknown | 45. Caryophylla-3,8(13)-dien-5-ol A |
| 8. β-Pinene | 33. α-Guaiene | |
| 9. β-Myrcene | 34. <i>trans</i> -β-Farnesene | |
| 10. Δ-3-Carene | 35. Humulene | |
| 11. α-Terpinene | 36. Alloaromadendrene | |
| 12. Cymene | 37. α-Curcumene | |
| 13. d-Limonene | 38. β-Selinene | |
| 14. γ-Terpinene | | |
| 15. <i>trans</i> -Sabinene hydrate | | |
| 16. <i>cis</i> -Linalool oxide | | |
| 17. Linalool | | |
| 18. d-Fenchyl alcohol | | |
| 19. <i>trans</i> -Pinocarveol | | |
| 20. Borneol L | | |
| 21. 1,8-Methandien-4-ol | | |
| 22. p-Cymen-8-ol | | |
| 23. Terpinene-4-ol | | |
| 24. α-Terpineol | | |
| 25. Piperitenone | | |



Fibra SPME de divinilbenceno/carboxeno/ polidimetilsiloxano (DVB/CAR/PDMS)

Volatiles in white wine

- | | |
|-------------------|-----------------------|
| 1. Sulfur dioxide | 8. 2-Methyl-1-butanol |
| 2. Ethanol | 9. Ethyl butyrate |
| 3. Methyl formate | 10. 2,3-Butanediol |
| 4. Acetic acid | 11. Hexanol |
| 5. Ethyl acetate | 12. Isoamyl alcohol |
| 6. Isobutanol | 13. Ethyl hexanoate |
| 7. Isopentanol | 14. Hexyl acetate |
| | 15. Octanoic Acid |
| | 16. Ethyl octanoate |



CROMATOGRAFÍA BÁSICA ORIENTADA A LA INDUSTRIA REGIONAL



(continuará...)