



GAS

气相色谱 - 离子迁移谱联用系统 (GC-IMS)

气相色谱-离子迁移谱联用系统 (GC-IMS)



常压下的TOF设计理念, 专注痕量VOCs快速检测:

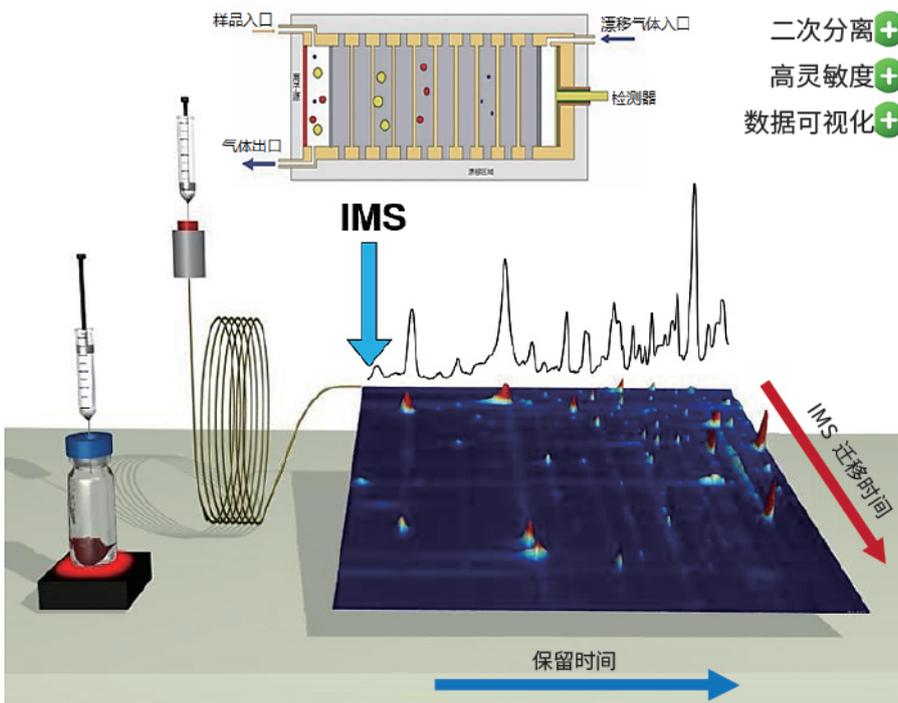
- 气 / 液 / 固样品无需前处理
- 气相色谱和离子迁移谱实现二次分离, 提高分离效果
- 检出限可低至 ppbv 级别
- 三维可视化图谱
- 定性定量精准便捷
- 数据处理“一键式”操作
- 软件内置三款插件, 分别用于谱图间直接对比 (Reporter 插件), 指纹图谱对比 (Gallery Plot 插件) 以及样品聚类分析 (PCA 插件)
- 操作简便, 日常维护成本低, 除 GC 耗材外无其他消耗品

02

气相色谱-离子迁移谱技术

离子迁移谱 (IMS) 是基于不同离子在电场中迁移速率的差异对物质进行分离表征的技术, 离子迁移谱仪具有很高灵敏度, 检出限可低至ppbv级别, 但分离能力较差。气相色谱 (GC) 具有良好的分离能力, 但往往检出限不够低, 故当处理基质复杂的样品时, 将气相色谱和离子迁移谱联用 (GC-IMS) 成为了最佳选择, 可兼得高分离度与低检出限的分析需求。

待测样品经气相色谱柱预分离后, 进入离子迁移管并在电场的作用下进行迁移, 法拉第盘接收信号后进行分析, 由于IMS的测量速度非常快 (30毫秒/频谱), 在高分辨状态下可连续快速地记录分析物的信号峰, 经G.A.S.公司开发的强大功能软件处理后可给出包括气相保留时间、离子迁移时间和信号峰强度的三维色谱图。



气相色谱-离子迁移谱原理示意图



扫描二维码观看
GC-IMS技术原理介绍视频

03

软件

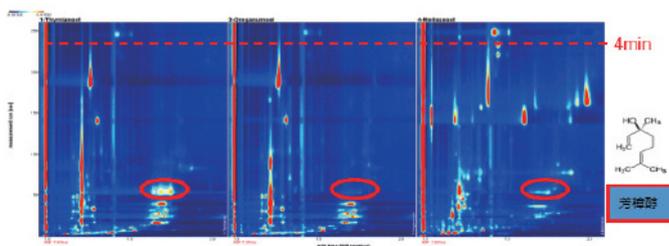
公司开发的VOCal软件具有强大的分析功能,可对待测物中痕量挥发性有机物进行分析,中英德文三种语言随意切换,简单易用,直观方便,满足不同客户的习惯需求。

可视化的VOCal软件

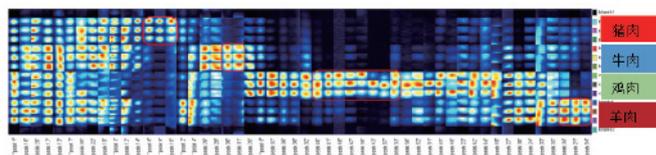
VOCal软件用于气相离子迁移谱图数据分析与信息提取,集成了数据查看、定性分析和定量分析的功能,三款插件分别用于直接对比样品挥发性有机物的差异、给出直观可视的指纹图谱及样品的聚类分析结果。此外软件还可与Windows系统的数据提取程序相兼容,如将.meaf格式转化为.csv格式后使用windows系统进行数据处理。

VOCal软件的五大功能

- **差异对比分析:**气相离子迁移谱图中的每组信号峰对应整个样品的顶空成分,VOCal软件安装的“Reporter”插件可对参考样品与待测未知样品进行对比,用户一眼便可看出样品间VOCs的差异。
- **可视化指纹图谱分析:**“Gallery-plot”插件在比较样品VOCs差异时更为直观,可用来比较不同样品中各顶空成分的有无及信号峰的强度,据此鉴别样品的相似度、真伪等。

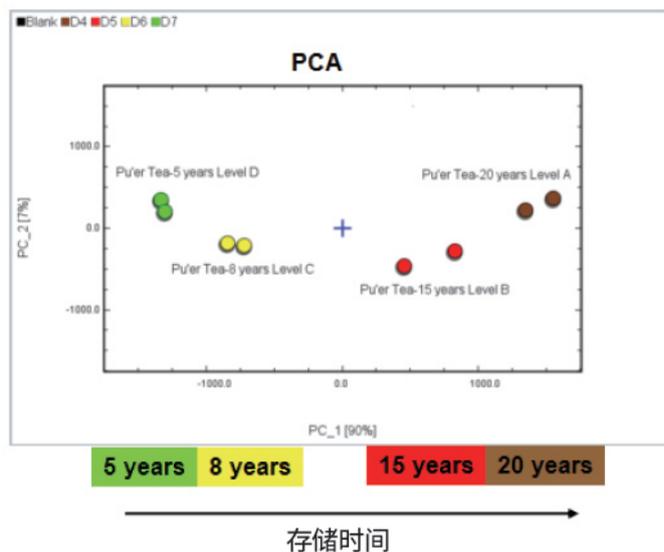


不同样品的气相离子迁移谱对比图 (Reporter)



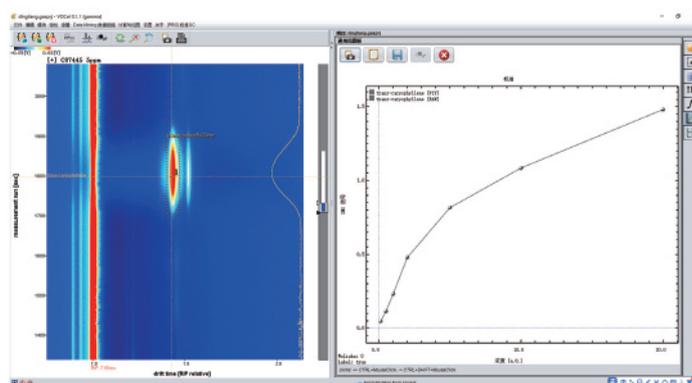
不同品种肉类挥发性有机物的指纹图谱 (Gallery-Plot)

- **主成分分析:**“Dynamic PCA” 动态主成分分析作为插件内置于软件中, 选择信号峰后一键点击即可获得样品的分类信息, 并可据此对样品进行原产地溯源、等级区分、货架期判断及真伪的识别等。



不同存储年限茶叶的PCA分析图

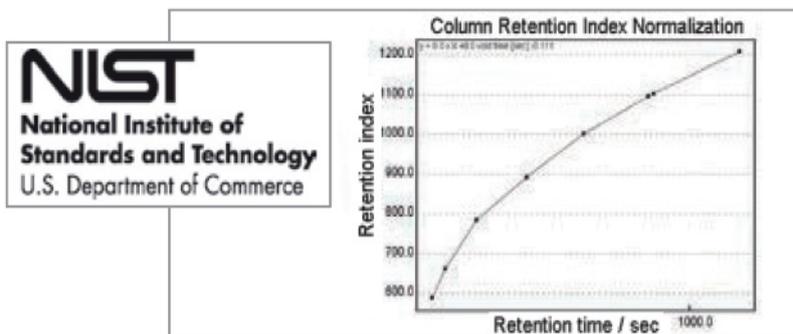
- **定量分析:**VOCal软件采用外标法进行定量分析。使用已知浓度的标准品建立标准曲线后, 可对待测物中该物质的浓度进行自动计算。



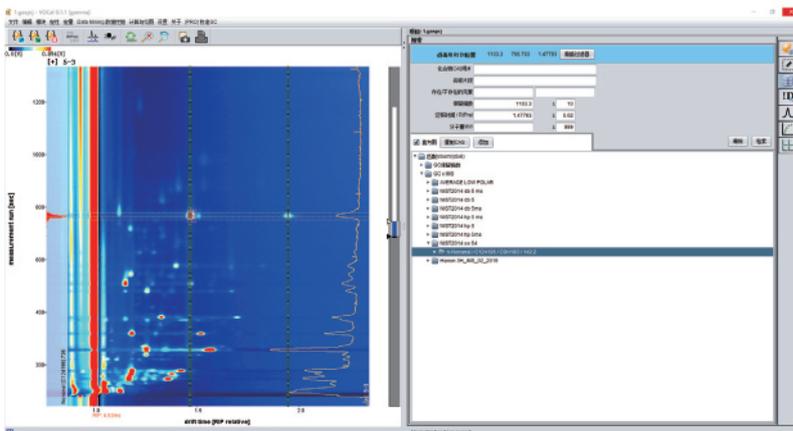
苯、甲苯和二甲苯的标准曲线及定量结果

- **定性分析:** VOCal软件可简单快速的对待测物中未知挥发性有机化合物 (VOCs) 进行定性。软件内置NIST气相保留指数数据库和G.A.S.迁移时间数据库, 两个数据库相结合使得化合物的定性更加准确。

VOCal Library Editor软件用于扩展保留指数和迁移时间数据库, 用户可以建立本行业的专属风味数据库。



采用C4-C10醛酮类校准保留指数



通过保留指数和迁移时间对目标物进行二维精准定性

04

应用领域

风味分析

随着生活质量的提高,人们对食品品质的要求也越来越高,相关行业如香精香料、酒类饮品、茶叶及烟草等对风味及感官分析的需求也愈发凸显。

使用FlavourSpec®风味分析仪,顶空进样后可分析固/液体中的痕量挥发性有机物,该方法无需萃取、浓缩、热解析等繁杂的前处理,即可得到ppbv级的检测结果,经可视化的软件处理后得出的数据,可为感官评价提供公正客观的结果支撑,在很多应用领域均有重要用途,如:

- 食品风味研究
- 原材料等级区分
- 食品的真伪鉴别
- 产品的工艺优化
- 生产过程中异味溯源
- 地理标识性产品的保护
- 医学代谢物的分析

FlavourSpec®风味分析仪特点:

- 无需富集浓缩、直接顶空进样
- 无需真空,开机稳定30min即可实验
- ppbv级别检出限,捕捉痕量挥发性有机物
- GC与IMS联用,二次分离、获得三维数据
- 可视化的分析软件,给出直观的差异化数据
- 操作简单、日常维护成本低,除顶空瓶外几乎无其他耗材



FlavourSpec®风味分析仪



为满足客户多种应用需求, G.A.S. 公司为用户提供一款即插即用的IMS检测器, 作为GC的检测器使用。与 FlavourSpec® 相比, 除成本上的优势外, IMS检测器可根据用户的具体要求选配气相色谱, 如作为安捷伦 7890、8890 系列或者岛津的 2010、2030 系列气相色谱的检测器使用。此外进样方式多样化, 如可使用阀进样、热解吸方式和固相微萃取 (SPME) 方式进样。

IMS检测器使用的氙源强度低于 GB18871-2002 《电离辐射防护与辐射源安全基本标准》附录A 豁免中规定的豁免界限。输入电源为24V直流电, 通过USB2.0高速数字界面输出数据。漂移气体和载气(通常为氮气或合成空气)的导入通过3mm的Swagelok接头实现。样品则用1/16英寸的样品线导入, 模块可加热到100°C, 分辨率高达100。模块的参数通过电脑软件控制, 样品分析后经数据处理后亦可给出直观可视化的数据。

IMS检测器特点:

- 无需真空条件, 常压下即可工作
- 检出限低至ppbv级别
- 正负模式可切换
- 重复性好(峰强度RSD<3%, 漂移时间RSD<1%)
- 载气、漂移气为氮气或合成空气, 费用低
- 使用简单、即插即用
- 模块无需特殊维护
- 配备独立的数据采集软件和GC-IMS三维数据分析软件



搭配GC系统使用的IMS检测器

泛环境气体分析

GC-IMS环境气体分析仪, 专注环境气体中痕量VOCs的检测, 在无需吸附/热脱附的情况下检出限可低至ppbv级别; 仪器内置自动采样装置(电动六通阀), 进样方式灵活多变, 可“一键式”手动进样, 亦可自动取样, 以实现在线连续监测的目的; 软件可内置待测分析物标准曲线, 亦可设置报警阈值, 检测后屏幕实时显示目标物浓度, 超出阈值后仪器自动报警; 仪器体积小、重量轻、便携性能好, 在线监测仅需简单的界面操作, 即可提供实时可靠的分析数据, 在很多领域均有重要用途, 如:

- 封闭/半封闭VOCs在线分析
- 整车及部件VOCs快速检测
- 厂界异味/恶臭气体溯源
- 天然气中硫化物在线分析
- 天然气无硫加臭剂含量分析
- 有毒有害危化品泄漏在线监测
- 垃圾填埋场硅氧烷在线分析

GC-IMS环境气体分析仪特点:

- 无需真空系统、开机稳定时间短、日常维护成本低
- 气体样品直接进样, 进样方式灵活可变(手动或自动)
- 正负模式可切换, 检测范围范围广
- 样品检测速度快、检出限低至ppbv级别
- 便携性能好, 配备车载电源或充电电源即可使用
- 可配备CGFU循环气体单元、无需载气钢瓶
- 结实耐用、小巧轻便、可实现在线连续检测
- 操作简单, 使用方便, 一线工人即可操作



GC-IMS环境气体分析仪



氨纶厂GC-IMS异味溯源现场图

A-IMS离子迁移谱无气相色谱系统,是单纯的离子迁移谱仪,其检测速度极快,单次测量仅需30ms,即可得到ppbv甚至pptv级别的检测结果。对于简单基质中单一或少量目标物质的检测非常适用,如:

- 生产安全监测
- 生产质量控制
- 溶剂残留检测
- 洁净室洁净度分析
- 有毒有害危化品泄漏在线监测



A-IMS离子迁移谱仪

A-IMS离子迁移谱仪特点:

- 分析速度极快(21-30ms),检出限低至ppbv级别
- 正负模式可切换
- 可使用外部气源或CGFU循环气体单元
- 仪器小巧轻便,便携性能好
- 软件功能强大,数据直观可视化
- 操作简便、日常维护成本低

呼气分析

人体呼气根据营养状态,包括疾病与药物、细菌感染和个人口腔卫生在内的代谢状态不同而包含数百种不同组成成分。某种特殊代谢物的存在与否可作为疾病早期诊断的依据,如果特定物质被证明与某种疾病或药物有直接联系,治疗控制也可用这种物质的存在与否来进行检测。呼气分析作为一种非侵入性诊断技术,可提供血液或尿液分析所不能给出的临床诊断信息,如通过检测呼气中的一氧化氮含量可以协助诊断哮喘病。



BreathSpec®呼气和呼吸分析仪

气相离子迁移谱联用仪灵敏度高(ppbv级)、检测速度快(10分钟内)且可配备CGFU循环气体单元和充电电源,适合在线监测,对于呼气中的挥发性有机物检测非常适用。BreathSpec®呼气和呼吸分析仪是专门设计用于人体释放气体分析的仪器,其采样方式灵活多变,适用于鼻腔,口腔和皮肤等多部位痕量VOCs的检测。主要应用方向为:

- 新型冠状病毒患者的筛查
- 口腔加工学的研究
- 呼气中VOCs标记物与肺部疾病关系研究
- 伤口细菌感染类型的快速确定
- 手术中通过呼气分析在线监测麻醉剂代谢程度
- 人体皮肤释放的气体检测
- 药物代谢过程的监测研究
- 香水在皮肤留香时间研究

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BreathSpec®呼气和呼吸分析仪特点:

- 灵敏度高,无需富集即可检测样品中痕量VOCs
- 操作简便,检测过程无需复杂操作
- 稳定快速,10-20min即可得到结果
- 多种选择,进样方式灵活多样
- 小巧便携,可灵活移动,满足多场景下POCT需求

05

附属设备

为满足气相色谱-离子迁移谱技术在线监测、现场分析的供气需求及环境VOCs检出限更低(ppbv)的要求, G.A.S. 公司开发了相关的配套设备。

氮气发生器

仪器用途:为气相离子迁移谱产品提供载气和漂移气;
配置接口:“即插即用”, 方便快捷;
选配原则:野外实验、现场监测时不方便使用氮气钢瓶时配置。



配备MicroTD的GC-IMS+氮气发生器

微型热脱附解析设备 (Micro TD)

配件用途:物质的检测限可低至ppt级别;
配件优势:在线富集/解析物质, 与分析同步进行;减少中间储运带来的误差。

CGFU循环气体单元

仪器用途:为GC-IMS/A-IMS/BreathSpec*提供载气和漂移气;
配置接口:“即插即用”, 方便快捷;
选配原则:野外实验、现场监测时不方便使用氮气钢瓶时配置。



配备CGFU的GC-IMS痕量气体分析仪

06

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可视化的风味分析

--- GC-IMS技术在风味研究中的应用

可视化的风味分析

--- GC-IMS技术在风味研究中的应用

食品中风味物质浓度通常较低，大多数风味物质的含量在ppb级别，目前的检测技术如GC、GC-MS需要顶空固相微萃取的方式进行样品前处理，因萃取头材质的不同，仪器检测到的结果并非样品原有真实的气味；此外风味成分在食品加工、贮藏、提取分离过程中的变化也是目前检测技术亟待解决的问题；从食品风味的角度来看，并非所有仪器检测到的挥发性有机物都是同等重要的，有时我们只需找出有差异的成分进行分析即可。

FlavourSpec®风味分析仪结合了气相色谱的高分离度和离子迁移谱的高灵敏度，无需样品前处理，直接顶空进样分析固体或液体样品的顶空成分，检出限可达到ppbv级别。仪器可对单一化合物/标记物进行定性定量分析，亦可对样品的挥发性有机物进行快速与结果导向的分析，其原理如图1所示。



扫描二维码观看
GC-IMS技术原理介绍视频

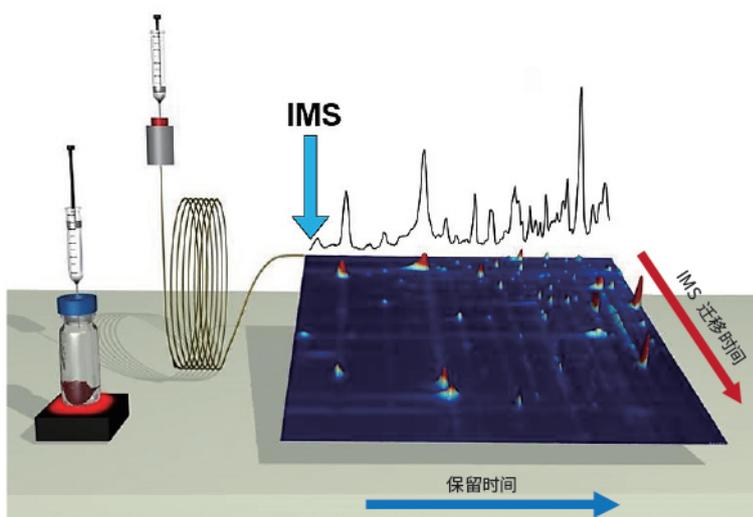


图1. 气相色谱-离子迁移谱原理示意图

GC-IMS技术在风味分析中的特点

- 无需富集浓缩, 超高灵敏度, 痕量挥发性有机物“尽在掌握”;
- 无真空系统, 开机稳定时间短, 20min便可工作;
- 数据处理简单易操作;
- 可视化的软件, 得到“看得见”的数据:
 - 1) Reporter插件在得到数据后可快速查看样品间风味物质的差异;
 - 2) GalleryPlot插件可得到产品/原材料的指纹图谱, 数据直观可视化、风味差异“看得见”, 适用于食品加工工艺的优化选择;
 - 3) PCA插件, 用于聚类分析, 帮助产品品控或分级, 建立分类模型后可用于产品原产地的保护。

示例: M1-M5为不同浓度混标溶液(5ppb、20ppb、50ppb、75ppb、100ppb), 经过仪器快速分析后, 软件直接给出样品之间对比的气相离子迁移谱图, 如图2左下图所示; 将样品中的挥发性有机物选取后, 处理得到样品的挥发性有机物指纹图谱, 如图2中右上图所示。

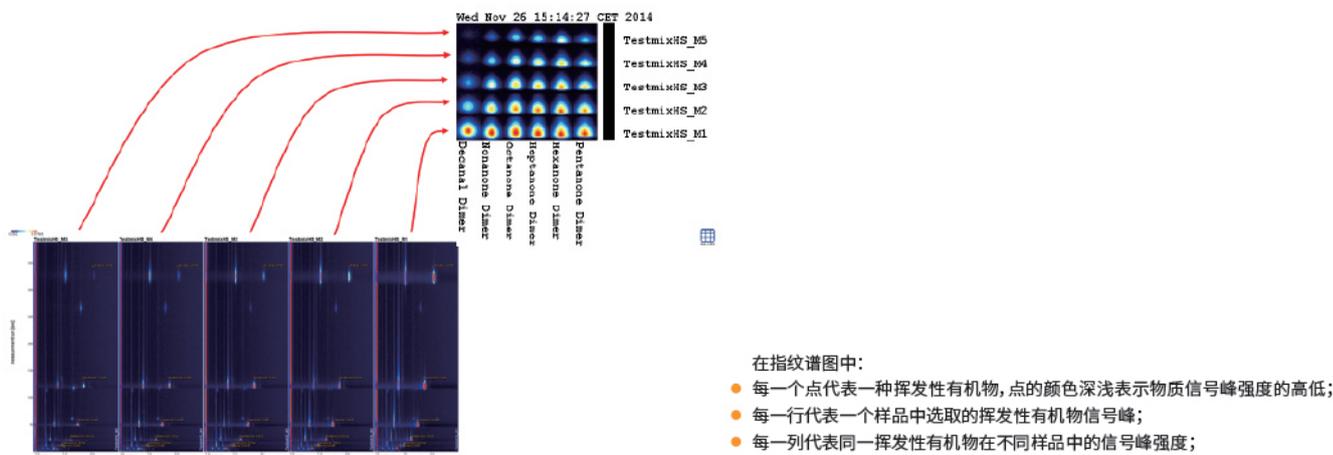


图2. 混标样品的气相离子迁移谱图和指纹谱图

图2中左下图为混标样品挥发性有机物的气相离子迁移谱图; 右上图为M1-M5混标中选取的戊酮、己酮、庚酮、辛酮、壬酮、癸醛的指纹谱图;

由指纹谱图可知: M5中6种醛酮含量最低, M1中醛酮含量最高, 从M5至M1, 醛酮含量逐渐升高, 建立标准曲线后可对任一醛酮物质进行定量分析。

4) 软件内置NIST气相保留指数 (RI) 数据库和G.A.S.迁移时间 (Dt) 数据库, 定性时采用二维定性, 数据更精准, 且两个数据库均可扩展, 用户可建立行业专有数据库。

例如: 鸡肉中定性出的部分物质如下表:

Count 编号	Compound 化合物	CAS号	Formula 分子式	MW 分子量	RI 保留指数	Rt [sec] 保留时间	Dt [RIPrel] 相对迁移时间
1	hexanal	C66251	C6H12O	100.2	796.0	200.11	1.2763
2	Heptanal	C111717	C7H14O	114.2	894.5	255.983	1.3444
3	n-Nonanal	C124196	C9H18O	142.2	1103.0	488.847	1.4932
4	Benzaldehyde	C100527	C7H6O	106.1	953.5	301.545	1.1439
5	methional	C3268493	C4H8OS	104.2	902.9	261.977	1.0835
6	1-Octen-3-ol	C3391864	C8H16O	128.2	978.8	323.506	1.1552
7	Ethyl methyl ketone	C78933	C4H8O	72.1	608.3	137.499	1.0589
8	Ethanol	C64175	C2H6O	46.1	455.2	103.337	1.043
9	Dimethyl ketone	C67641	C3H6O	58.1	494.1	111.101	1.1213
10	3-Methylbutanal	C590863	C5H10O	86.1	667.4	153.532	1.1825
11	1-Pentanol	C71410	C5H12O	88.1	769.2	188.801	1.2554
12	4-methyl-2-pentanone	C108101	C6H12O	100.2	735.6	176.061	1.1789
13	Acetoin	C513860	C4H8O2	88.1	713.5	168.144	1.0772
14	1-Hexanol	C111273	C6H14O	102.2	868.0	239.386	1.3274
15	Butyl methyl ketone	C591786	C6H12O	100.2	783.9	194.643	1.1916
16	acetophenone	C98862	C8H8O	120.2	1059.4	421.648	1.1873
17	octanal	C124130	C8H16O	128.2	1002.5	347.745	1.4239
18	Maltol	C118718	C6H6O3	126.1	1088.0	464.496	1.2261
19	(E)-2-octenal	C2548870	C8H14O	126.2	1054.0	414.02	1.3312
20	2-Ethylhexanol	C104767	C8H18O	130.2	1028.8	380.208	1.4177
21	methyl hexanoate	C106707	C7H14O2	130.2	920.8	275.385	1.2729
22	2-Heptanone	C110430	C7H14O	114.2	886.0	250.32	1.2614
23	Pentanal	C110623	C5H10O	86.1	695.7	162.027	1.1992
24	2-Pentanone	C107879	C5H10O	86.1	691.6	160.652	1.3624
25	(E)-2-hexen-1-ol	C928950	C6H12O	100.2	849.2	228.414	1.1794
26	2-pentyl furan	C3777693	C9H14O	138.2	987.7	331.679	1.25

GC-IMS技术在风味研究中的应用

- 地理标识性产品的保护
- 产品品种、品质的区分
- 产品真伪的鉴别
- 产品新鲜度和货架期的评估
- 产品加工适用性的选择
- 产品加工过程中风味的变化研究



FlavourSpec®风味分析仪

1. 靶向区分广陈皮/陈皮, 用于地理标识性产品的保护

“橘生淮南则为橘，生于淮北则为枳”，柑橘因种植的产地水土不同，得到的陈皮的挥发性有机物亦不同，直接称取0.2g陈皮粉置于顶空瓶中，经过仪器分析后，软件处理得到可视化的指纹图谱，如下图所示。

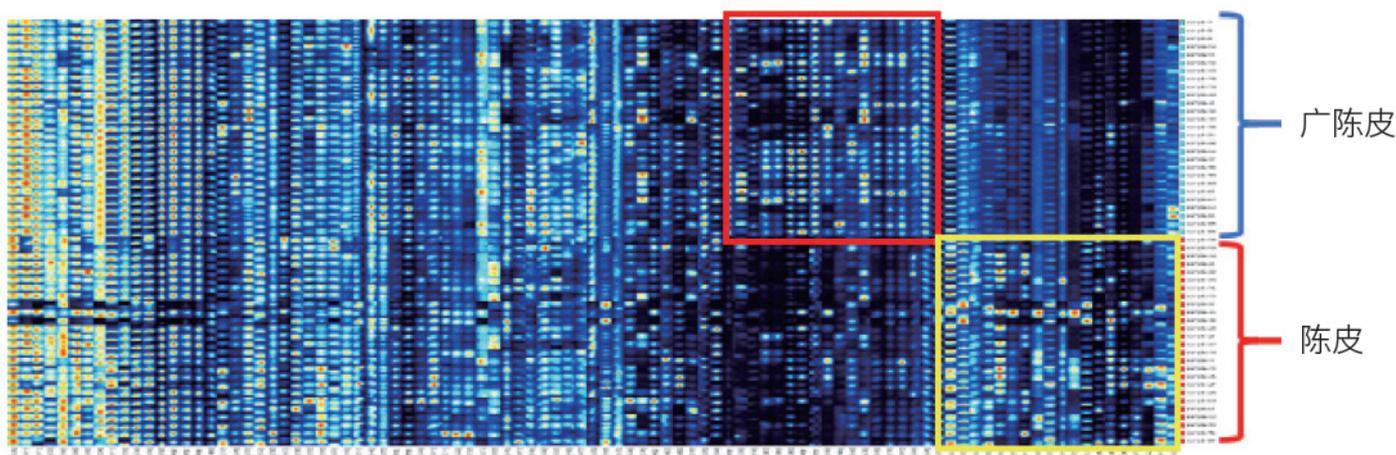


图3.广陈皮和陈皮中挥发性有机物指纹图谱

其中红框中的物质在广陈皮中含量很高，黄框中的物质在陈皮中含量很高。分别采用SE-54、1701和WAX三种不同极性的色谱柱进行分析，分别找到区别两种陈皮的12种、12种和14种特征挥发性有机物。

以SE-54色谱柱为例, 12种特征标记物指纹图谱如图4, 据此特征标记为做聚类分析结果如图5所示。

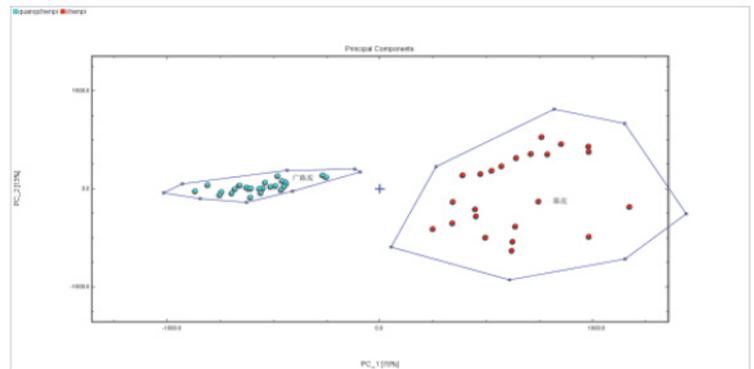
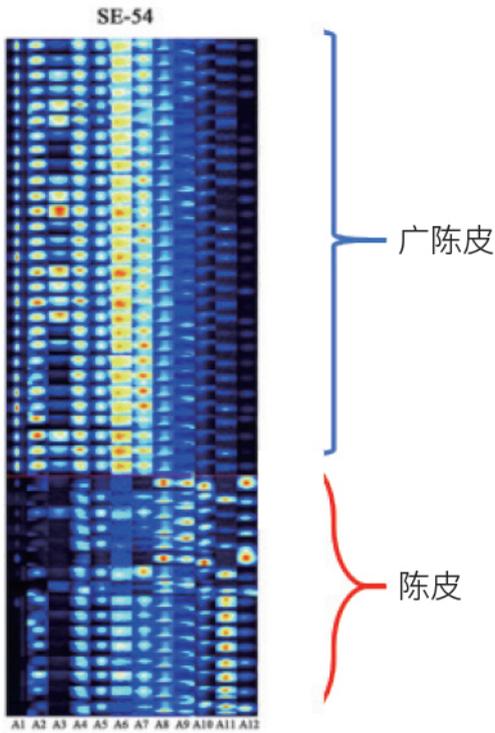


图4. SE-54色谱柱找到的12种特征标记物指纹图谱

图5. 广陈皮与陈皮的PCA分析图

从图5可知, 广陈皮样品聚集在PCA的左侧, 其他产地的陈皮在图谱的右侧。根据挥发性有机物信息建立真实产地的陈皮分类模型后, 可以用于广陈皮的道地区分。

Reference: Rapid discrimination of *Citrus reticulata* ‘Chachi’ by headspace-gas chromatography-ion mobility spectrometry fingerprints combined with principal component analysis. **Food Research International**. 131 (2020) 108985.

2. 快速捕捉挥发性有机物差异, 用于橄榄油等级的区分

根据GB 23347-2009橄榄油、油橄榄果渣油国家标准, 橄榄油主要分为初榨橄榄油、精炼橄榄油、果渣油三大类, 橄榄油的等级不同, 其价格不同。

根据挥发性有机物的信息, 可以对橄榄油进行等级区分, 图谱如下图所示。

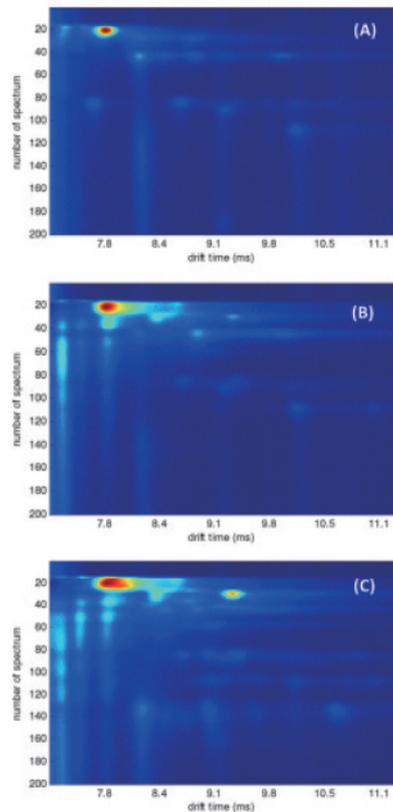


Fig. 5. Topographic plot of GC-IMS spectra. (A) Pomace olive oil, (B) olive oil and (C) extra virgin olive oil.

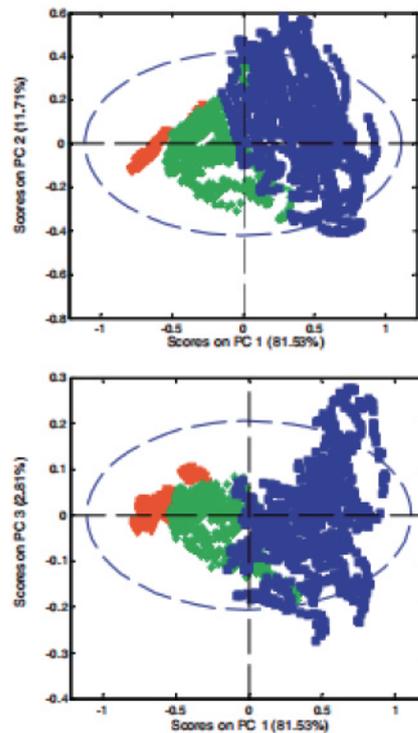


Fig. 3. PCA results for mean-centered data for the three types of oil as obtained with UV-IMS. Samples: Pomace olive oil (red triangles); olive oil (green asterisks); extra virgin olive oil (blue squares). (For interpretation of the references to color in this figure legend, the reader is referred to the web version of the article.)

图6.不同等级橄榄油的气相离子迁移谱图和PCA图

注: 样品信息: A.果渣橄榄油、B.橄榄油、C.特级初榨橄榄油。

从上图知: 特级初榨橄榄油 (EVOO) 产品中风味物质明显多于橄榄油 (OO) 和果渣橄榄油 (POO); 本文中采用两种技术 (GC-IMS和UV-IMS) 对EVOO、OO、和POO进行分类, 橄榄油等级区分的识别率高达95%。

Reference: Direct classification of olive oils by using two types of ion mobility spectrometers. *Anal. Chim. Acta* (2011). DOI: 10.1016/j.aca.2011.03.007.

3.直观看出蜂蜜风味的差异,用于蜜源的识别及掺伪区分

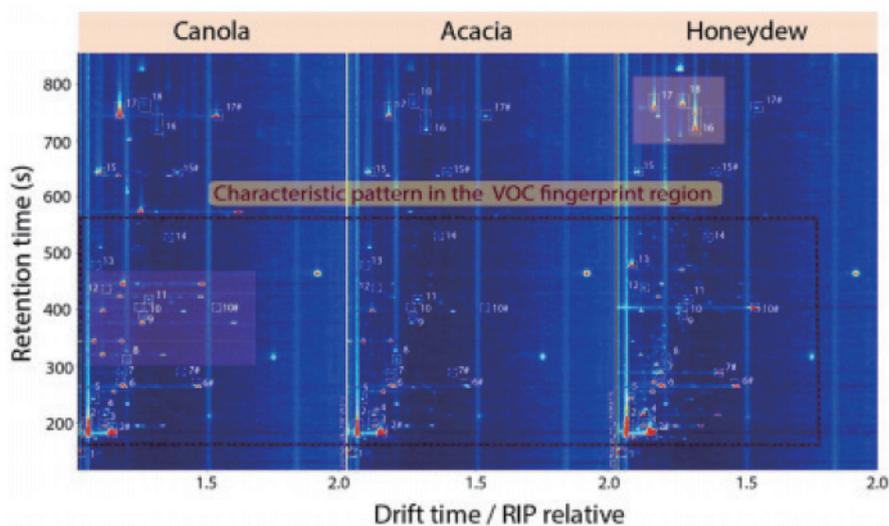


图7. 不同蜜源蜂蜜挥发性有机物的气相离子迁移谱图

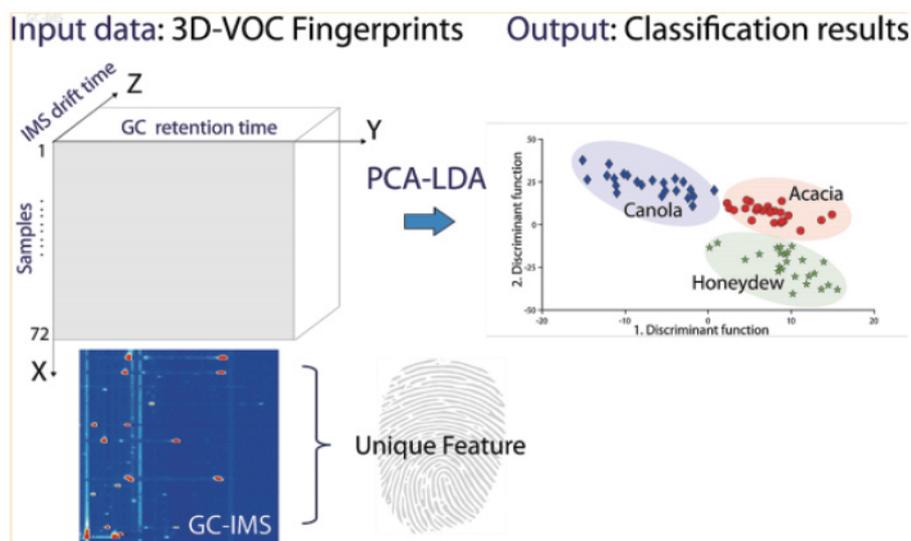


图8. 不同蜜源蜂蜜的PCA分析图

由上两图知:油菜花、金合欢花与蜜露蜂蜜挥发性有机物图谱差异明显;HS-GC-IMS技术可以作为¹H NMR蜂蜜样品溯源的可靠辅助工具。

Referenc: Volatile-Compound Fingerprinting by Headspace-Gas-Chromatography Ion-Mobility Spectrometry (HS-GC-IMS) as a Benchtop Alternative to ¹H NMR Profiling for Assessment of the **Authenticity of honey**. **Analytical Chemistry** DOI: 10.1021/acs.analchem.7b03748 (2017)

4.直观看出不同储存时间样品风味的变化,用于评估鸡蛋的新鲜度和货架期

不同存储时间鸡蛋的风味变化如下图所示:

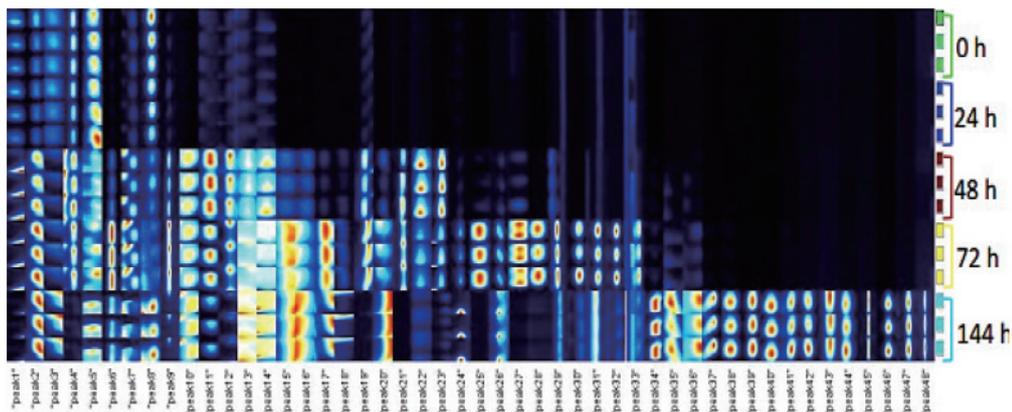


图9.不同存储时间的鸡蛋挥发性有机物指纹图谱

鸡蛋在室温下放置0-144h过程中气味逐渐发生变化;0-24h过程中,鸡蛋风味几乎不变,说明此阶段鸡蛋品质没有明显变化。

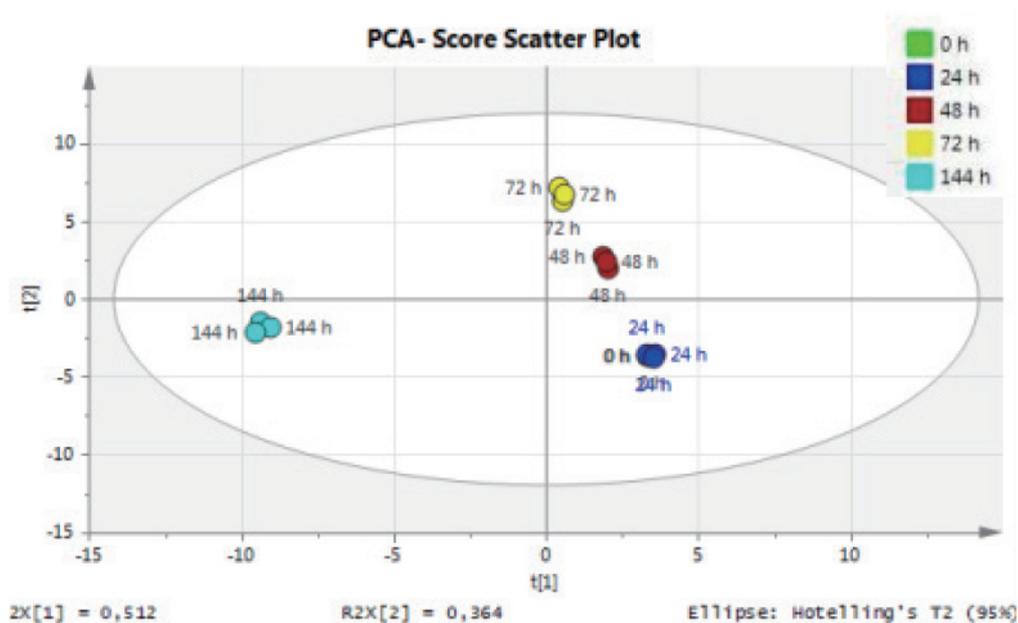


图10.不同存储时间的鸡蛋的PCA分析

建立不同存储时间鸡蛋的分类模型后,可用于快速判断鸡蛋的新鲜度。

Reference: Ion mobility spectrometry coupled to gas chromatography: A rapid tool to assess eggs freshness. *Food Chemistry*, 271 (2019) 691-696.

5.精准快速捕捉松茸加工前后风味的变化, 用于加工适用性的优化选择

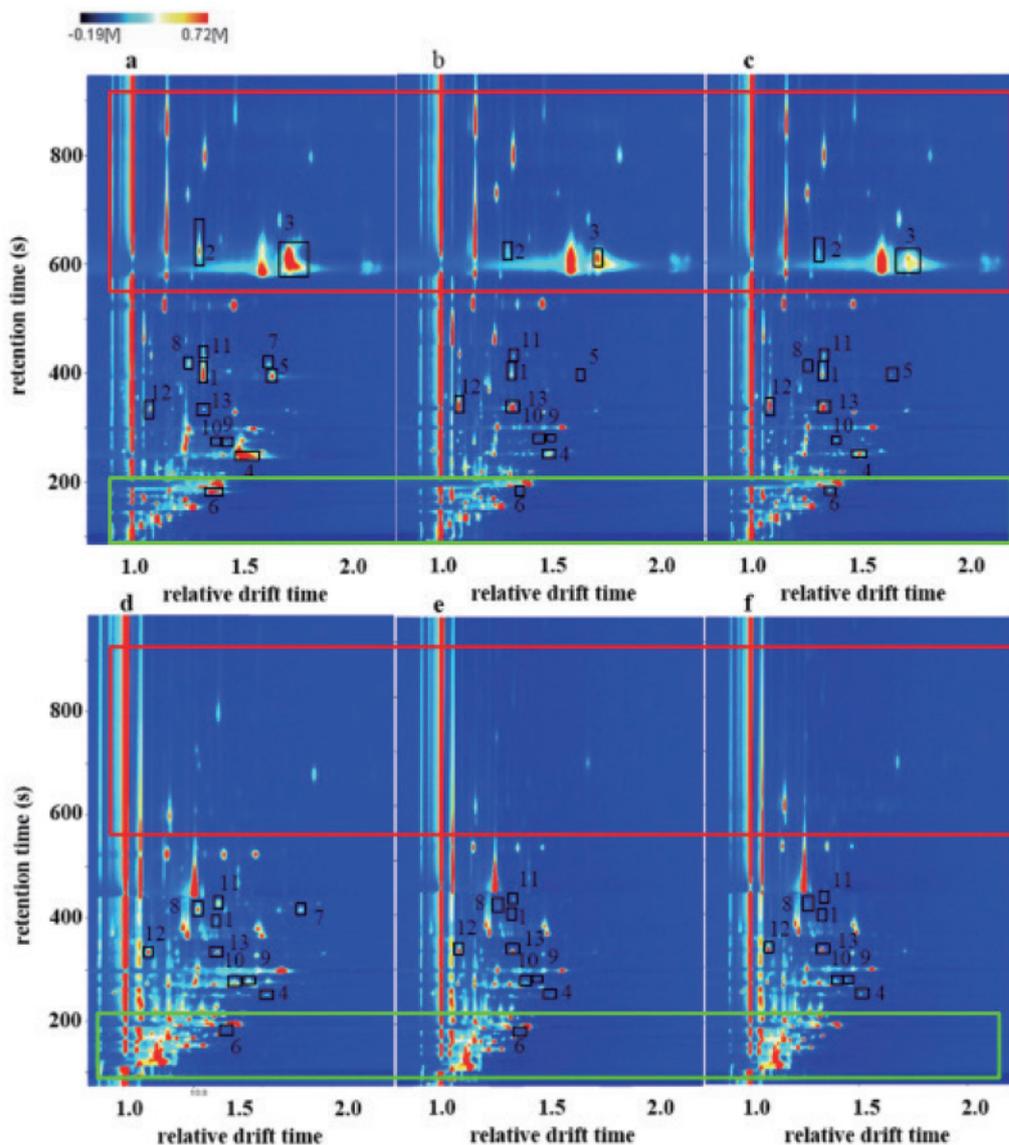


图11. 不同部位松茸烘干前后气相离子迁移谱图

注:a. 菌伞、b. 菌柄、c. 柄底;d. 烘干菌伞、e. 烘干菌柄、f. 烘干柄底;

经谱图对比可知, 松茸烘干后, 不同部位的松茸样品红框中的标出的物质如1-Octene-3-ol (蘑菇醇) 等消失。

将样品中挥发性有机物选取出来形成指纹图谱，如下图所示：

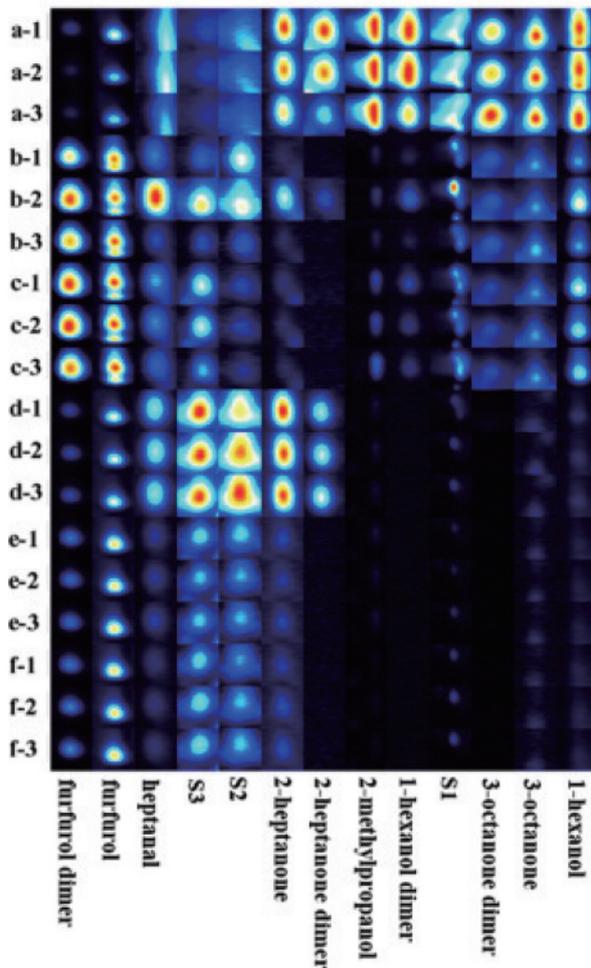


图12. 不同部位松茸烘干前后挥发性有机物指纹图谱

由左图知：

松茸部位不同，风味成分各不相同；菌伞中含
量最高的成分在烘干后均消失，这是导致烘
干前后松茸风味不同的主要原因。

根据加工前后不同部位松茸风味变化对比，
结合感官评价及理化指标的数据，可用于选
择最好的食材，亦可用于加工工艺的优化。

Reference: Characteristic volatiles fingerprints and changes of volatile compounds in fresh and dried *Tricholoma matsutake* Singer by HS-GC-IMS and HS-SPME-GC-MS. **Journal of Chromatography B**, 1099. (2018) 46-55.

6. 发酵过程中风味的差异变化, 用于优化发酵工艺及把控发酵时间

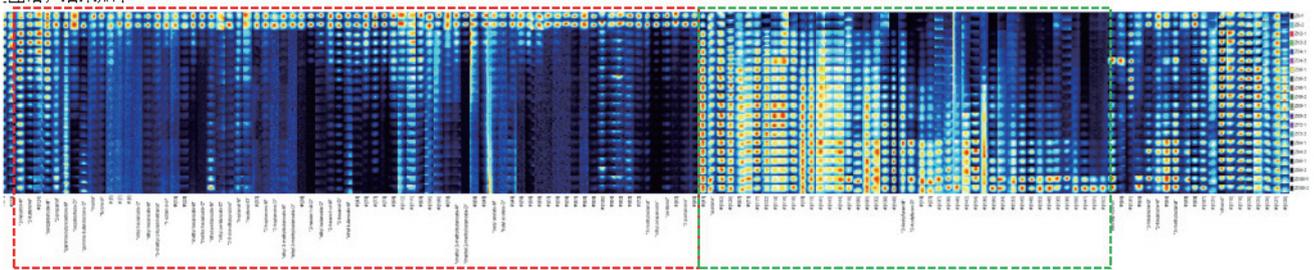


图13.不同发酵时间(每隔12h取样)红枣挥发性有机物的指纹图谱

红框中标出的物质随着发酵时间的延长, 风味物质的种类和含量大幅减少; 绿框中标出的物质随着发酵时间的延长, 风味物质的种类和含量逐渐增多; 结合感官评价和其他理化指标的检测, 可用于发酵时间的优化和过程把控。

Reference: Content variations in compositions and volatile component in jujube fruits during the blacking process. *Food Sci Nutr.* 2019;1-9.

气相离子迁移谱(GC-IMS)技术在风味检测时, 无需固相微萃取, 快速捕捉样品的真实风味, 检出限可达ppbv级别, 软件给出直观可视的挥发性有机物指纹图谱, 风味差异“看得见”, 结合感官评价及其他理化指标的分析, 可为地理标志性产品的保护、产品品种/品质的区分、产品新鲜度及货架期的评估、加工工艺的优化等提供科学的数据指导。

气相-离子迁移谱型号简介

FlavourSpec®风味分析仪

进样方式:顶空进样

应用领域:食品中风味物质分析
液体样品中挥发性有机物分析



BreathSpec®呼气分析仪



进样方式:气泵进样、定量环定量

应用领域:人体呼出气分析
细菌性感冒/病毒性感冒的快速区分
癌症(如肺癌、胃癌等癌症)的早期筛查
肺部真菌感染类型的快速区分
口腔加工学研究

GC-IMS环境气体分析仪



进样方式:气泵进样、定量环定量

应用领域:非破坏性食品风味分析
在线VOCs连续监测
公共安全在线监测
厂界异味溯源

附录

可视化的风味分析应用列表

---气相离子迁移谱(GC-IMS)在风味分析中的应用

一. 产地区分文章(节选)

1. 我国东北稻米溯源技术的研究. **农业部环境保护科研监测所研究生院**. 2018.
2. 一种基于香气物质指纹图谱的GC-IMS梨果产地区分方法. **专利公布号:CN 111398470 A**. **山东省农业科学院农业质量标准与检测技术研究所**. 2020.
3. 新疆不同产区羊肉特征风味离子迁移色谱指纹谱的构建. **食品科学**. 2019.
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5. 基于矿质元素与挥发性物质的“大红袍”花椒产地判别研究. **山西师范大学**. 2019.
6. 基于顶空气相色谱-离子迁移谱的不同产地咖啡挥发性有机物指纹图谱分析. **食品科学**. 2019.
7. 一种基于GC-IMS对不同产地烟草香气的评价方法. **专利公布号:CN 110907556 A** **湖北中烟工业有限责任公司**. 2020.
8. Discrimination of Chinese Yellow Wine from Different Origins Based on Flavor Fingerprint. **Acta Chromatographica**. DOI: 10.1556/1326.2019.00613.
9. Rapid discrimination of Citrus reticulata ‘Chachi’ by headspace-gas chromatography-ion mobility spectrometry fingerprints combined with principal component analysis. **Food Research International**. 131 (2020) 108985. <https://doi.org/10.1016/j.foodres.2020.108985>.
10. Stable isotope signatures versus gas chromatography ion mobility spectrometry to determine the geographical origin of Fujian Oolong tea (Camellia sinensis) samples. **European Food Research and Technology** (2020) 246:955–964. <https://doi.org/10.1007/s00217-020-03469-0>

二. 品种区分文章(节选)

1. 一种不同企业生产的黄酒的气相离子迁移谱鉴别方法. **授权公告号:CN 109781918 B**. **浙江大学**. 2020.
2. GC-IMS 技术结合化学计量学方法在青稞分类中的应用. **中国粮油学报**. 2019.
3. 基于气相离子迁移谱和化学计量学方法判别肉的种类. **中国食品学报**. 2019.
4. 气相色谱—离子迁移谱分析不同植物油浸提的花椒油的挥发性成分. **中国油脂**. 2020.
5. Direct authentication of three Chinese materia medica species of the Lili Bulbus family in terms of volatile components by headspace-gas chromatography-ion mobility spectrometry. **Analytical Methods**. DOI: 10.1039/c8ay02338g.

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7. Untargeted and Targeted Discrimination of Honey Collected by *Apis cerana* and *Apis mellifera* Based on Volatiles Using HS-GC-IMS and HS-SPME-GC-MS. *Journal of Agricultural and Food Chemistry*. **J. Agric. Food Chem.** 2019, 67, 12144–12152.
8. Identification of terpenes and essential oils by means of static headspace gas chromatography-ion mobility spectrometry. **Anal Bioanal Chem** (2017) 409:6595–6603.
9. Volatile Metabolites of Goat Cheeses Determined by Ion Mobility Spectrometry Potential Applications in Quality Control. **Food Anal. Methods**. DOI 10.1007/s12161-014-0050-1.
10. Characterization of Arabica and Robusta Coffees by Ion Mobility Sum Spectrum. **Sensors** 2020, 20, 3123; doi:10.3390/s20113123.

三. 掺伪鉴别应用文章(节选)

1. 气相离子迁移谱法在羊奶粉和驴肉鉴别分析中的应用. **河北农业大学**. 2019.
2. 气相离子迁移谱分析市售燕盏挥发性物质成分. **食品工业科技**. 2020.
3. 一种鉴别卷烟真伪的方法. **专利公布号:CN 109655529 A**. 贵州中烟工业有限责任公司. 2017.
4. 一种检测菜籽粕中是否掺杂抗生素滤渣的方法. **专利公布号:CN 108693004 A**. 中国农业科学院农业质量标准与检测技术研究所. 2018.
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6. Target vs spectral fingerprint data analysis of Iberian ham samples for avoiding labelling fraud using headspace – gas chromatography–ion mobility spectrometry. **Food Chemistry**. 246 (2018) 65-73.
7. A green triple-locked strategy based on volatile-compound imaging, chemometrics, and markers to discriminate winter honey and sapium honey using headspace gas chromatography-ion mobility spectrometry. **Food Research International**. <https://doi.org/10.1016/j.foodres.2019.01.004>.
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10. Molecular Analysis for Determining Differences and Similarities of Perfume Dupes. **Global Ingredients & Formulations Gulde**. 2016.

四. 质量控制应用文章(节选)

1. 基于气相色谱与离子迁移谱的车内气味等级评价方法. 专利公布号:CN 111007176 A. 冲之智能科技(天津)有限公司. 2020.
2. 基于气相离子迁移谱技术的葵花籽油精炼程度的研究. **食品科学**. 2019.
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4. A robustness study of calibration models for olive oil classification: Targeted and non-targeted fingerprint approaches based on GC-IMS. **Food Chemistry**. 288 (2019) 315-324.
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7. Gas Chromatography-Ion Mobility Spectrometry Detection of Odor Fingerprint as Markers of Rapeseed Oil Refined Grade. **Journal of Analytical Methods in Chemistry**. <https://doi.org/10.1155/2019/3163204>.
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10. Characteristic volatiles fingerprints and profiles determination in different grades of coconut oil by HS-GC-IMS and HS-SPME-GC-MS. **International Journal of Food Science and Technology**. 2020. doi:10.1111/ijfs.14664.

五. 加工工艺应用文章(节选)

1. 基于气相色谱-离子迁移谱的不同加工工艺紫薯风味特性. **浙江农业科学**. 2019.
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<https://doi.org/10.1016/j.foodres.2020.109456>.
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9. Mechanism of aroma compounds changes from sea cucumber peptide powders (SCPPs) under different storage conditions. **Food Research International**. 128 (2020) 108757.
10. Changes in volatile flavor compounds of peppers during hot air drying process based on headspace-gas chromatography-ion mobility spectrometry (HS-GC-IMS). **J Sci Food Agric**. 2020; 100: 3087–3098.

六. 时间变化应用文章 (节选)

1. 气相离子迁移谱快速鉴别黄酒酒龄的建立方法以及应用. 授权公告号: CN 108445094 B. 浙江大学. 2020.
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7. Characterization of the aroma release and perception of white bread during oral processing by gas chromatography-ion mobility spectrometry and temporal dominance of sensations analysis. **Food Research International**. 123 (2019) 612-622.

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10. Ion Mobility Spectrometry versus Classical Physico-chemical Analysis for Assessing the Shelf Life of Extra Virgin Olive Oil According to Container Type and Storage Conditions. **J. Agric. Food Chem**. 2015, 63, 2179–2188.

七. 微生物应用文章(节选)

1. 臭鳊鱼低温发酵过程中品质及挥发性物质的变化. **中国食品学报**. 2020.
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10. Profiling and characterization of odorous volatile compounds from the industrial fermentation of erythromycin. **Environmental Pollution**. 255 (2019) 113130.

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