Feasibility study of perfume authentication by GC-MS and GC×GC-MS

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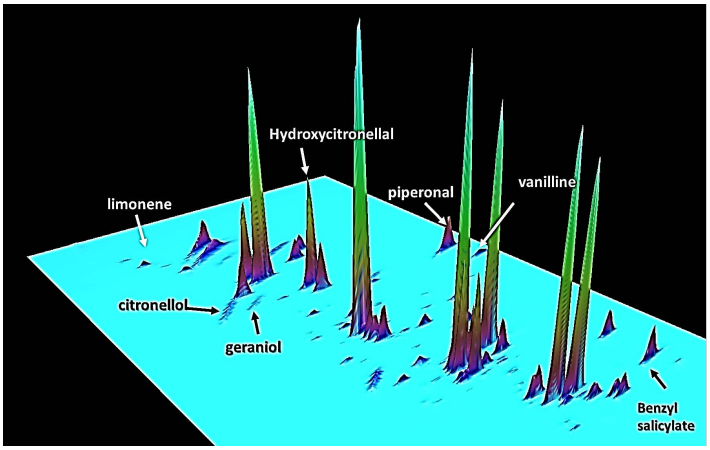
Introduction

Nowadays perfumes are complex mixtures that can consists of hundreds of natural and synthetic compounds. They often include several fragrance-key components present in low amounts. This makes chemical profiling an analytical challenge. However, the demand for suitable methods by the fragrance industry is very strong. These are necessary for quality control, to monitor allergens and to detect counterfeits. The latter aspect is very significant for its commercial impact. It is estimated that fraudulent imitations, including perfumes, cause the cosmetic industry a loss of €4.7 billion/year across Europe[1]. Moreover, detecting fake products can help preventing harmful products from entering the market. Here we show the use of GC-MS and GC×GC-MS to profile perfumes and propose their use as authentication test. GC×GC-MS is the ideal tool match the complexity of the perfume samples thanks to its great peak capacity and enhanced sensitivity.



3D visualization of the separation and identification of potential fragrance-key compounds in a perfume.

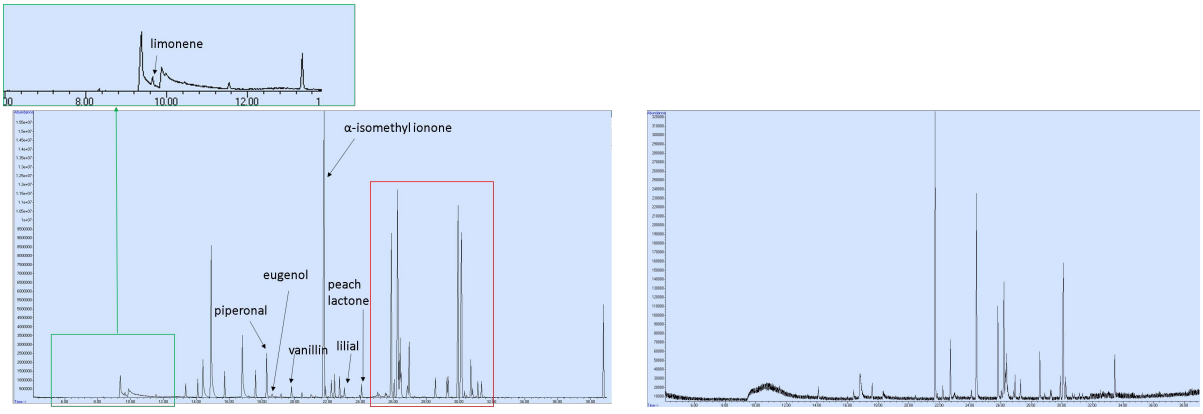
Samples

The samples were an authentic Eau de parfum of a commercial brand purchased in a local store and its fake counterpart. These were analyzed directly, no pre-treatment was performed.

Instrumentation and software

All chromatograms were performed with an Agilent 7890B equipped with a Zoex ZX2 cryogen-free thermal modulator and an Agilent 5977A MS detector. All 2D data were displayed and analyzed using the Zoex GC Image software.

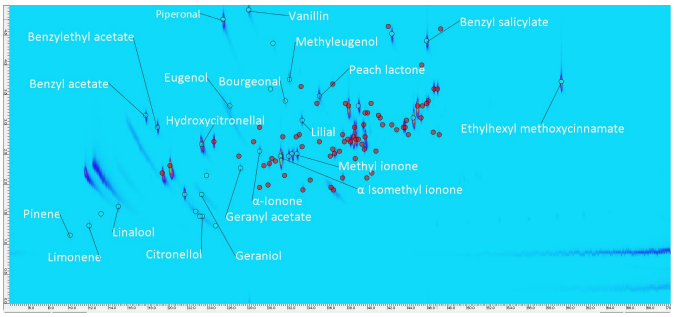
Results



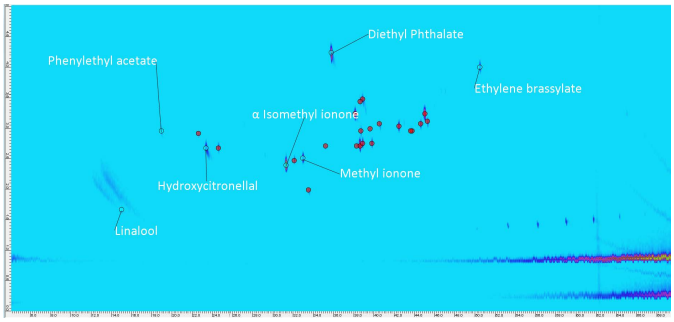
1D-GC-MS chromatograms for the commercial (left) and fake (right) perfume. Some unresolved areas are pointed out.

The imitation can be easily identified from the original already with 1D-GC. However, since imitations can have different origins and are not subject to any control or standard, it cannot be assumed that other counterfeits are comparable. It should be expected that some might be much more similar to the original.

1D cannot achieve complete separation of the complex, authentic sample. Only few of the expected components are found. For an accurate chemical profiling GC×GC is required. The high peak capacity has the potential for discrimination also for better imitations.



2D plots (TIC) of the authentic perfume.



2D plots (TIC) of the counterfeit perfume.

Compound	Authentic perfume	Imitation
Limonene	+	-
Vanillin	+	-
Piperonal	+	-
α isomethyl ionone	+	+
Geraniol	+	-
Linalool	+	+
Hydroxycitronellal	+	+
Diethyl phtalate	-	+
Ethylene brassylate (Musk T)	-	+

Examples of differences in potential fragrance-key components and suspected allergens detected by GC×GC. The (+) and (-) signs indicate that the compound was detected or not in the sample, respectively

Conclusions

- The imitation available can be differentiate by 1D-GC.
- 1D-GC does not provide sufficient resolution for the authentic perfume. Information is lost.
- GC×GC-MS delivers a much more detailed separation of the authentic fragrance. Several potential fragrance-key components and suspected allergens are identified.
- A chiral dimension would allow enantiomer separation. This would help correlating composition and fragrance and detecting fraud by differentiating natural and synthetic compounds.
- 2D plots can be compared by qualitative visual analysis, with minimal pre-processing and no need for identification.
- GC×GC-MS is a powerful tool for the chemical profiling and authentication of fragrances.

References:

[1] http://www.italy24.ilsole24ore.com/print/ABAxaHBD/0

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