High resolution ion mobility spectrometry-mass spectrometry (IMS-MS) for separation of isomers in natural products and complex mixtures

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Overview
- The analysis of natural products is a major analytical challenge due to their high chemodiversity. Current separation and identification techniques such as fast LC-MS or ultra-high resolution MS are often insufficiently powerful, slow or ambiguous, especially for isomers.
- High resolution ion mobility spectrometry-mass spectrometry (IMS-MS) can be used for separation of isomers without adding experimental complexity across many substance classes.
- Isomers are separated based on differences in their ion-neutral collision cross sections which define their hydrodynamic "shape".
- IMS-MS can be used as a high-throughput screening technique to determine food quality and authenticity, for flavor and aroma analysis and for fingerprinting applications.

Methods and Instrumentation
- All measurements were carried out on a TOFWERK IMS-TOF. The system consists of two 60 cm drift tubes (diameter 10 mm), a 15 cm drift tube (diameter 6.3 mm) and a TOFWERK IT TOFMS.
- Drift and drift tubes were thermocycled between 35-100°C with nitrogen as the buffer gas.
- For mobility separation, capillary was replaced at reduced drift voltages of 1, 2, 3 V. Difference pressure was set between ambient and 0.2 V drift (hinge).
- Measurements were carried out in both positive and negative ion mode (acetic acid/methanol 1:1, V/V).
- Nine different wines were analysed by direct infusion IMS-MS.

Results
- **Flavonoids**
  - Flavonoids are ubiquitous in flowering plants. Interesting due to their medicinal properties (anti-oxidant, anti-inflammatory).
  - Multiple isomeric species for aglycones and glycosides which are difficult to separate.
  - Aglycones can already be separated by direct infusion IMS-MS.
  - Glycosides are only partially separated by LC-MS (3 of 4, overlapping peaks).
- **Beer**
  - The ratio of cis and trans isoforms can be used as an indicator of beer freshness. The ratio isomers can be used for quick differentiation.
  - The ratio of cis/trans isohumulone can be used as an indicator of beer freshness (trans isomer is labile).
- **Wine**
  - Nine different wines were analysed by direct infusion IMS-MS.
  - Grape varieties can be distinguished after PCA and linear discrimination analysis of 622 dominant features.
- **Cannabis**
  - The separation of cannabinol and THC is required to enable distinction between recreational and medicinal cannabis.
- **Whisky**
  - Characteristic aroma and flavor of whisky depend on the ratio of isomeric substances.
  - Direct infusion IMS-MS allows rapid differentiation through baseline separation of the isomers.
- **GOOD BEER**
  - Good beer: trans/cis = 0.4
- **BAD BEER**
  - Bad beer: trans/cis = 0.1

Flavonoids were either analysed as pure standards (Schuchardt, Germany) or obtained from Ginkgo Biloba extracts.

Beer, wine, and whisky samples were obtained from local supermarkets and diluted in methanol prior to analysis.