Sampling volatile organic compounds released from packaged meat

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Identifying the source of volatile chemicals giving rise to taints or off-flavours in meat is a considerable challenge for the analyst, but fortunately one that is readily addressed by gas chromatography-mass spectrometry (GC-MS). However, sample preparation for GC-MS can often be a major bottleneck in laboratory workflow, and there remains a need for a rapid and representative sampling technique. In this study, we used a manually operated 'grab'-sampler to capture volatiles from the headspace above packaged meat.

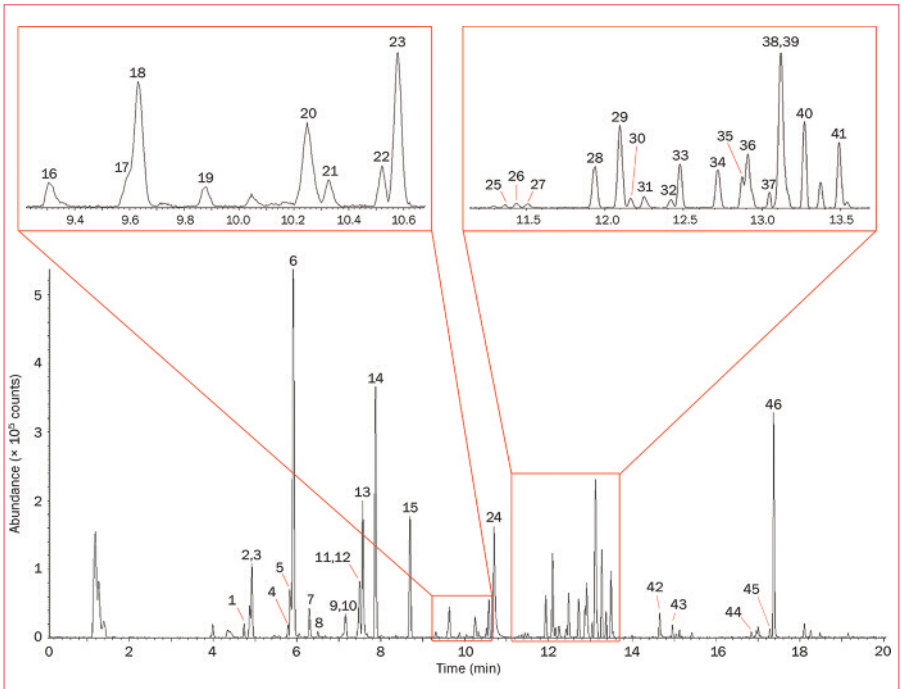
The volatiles were collected directly on to a sorbent tube, which was then analysed using thermal desorption (TD) pre-concentration, immediately followed by GC-MS analysis.

An inert-coated headspace needle was connected to a 3.5 inch three-bed sorbent tube, and this in turn was connected to a grab-sampler (Easy-VOC).

The packaging of a supermarket-purchased sirloin steak was pierced with the needle, and 100mL of headspace collected. The sorbent tube was loaded into the autosampler tray of an automated thermal desorber (TD-100).

Desorption of the tube (maximum 260°C) was followed by collection of the vapours onto a sorbent-packed focusing trap and desorption (maximum 300°C) followed by injection into the GC instrument (using a 60m × 0.25mm × 0.5µm DB-5 column with a run time of 36 minutes) and detection with a quadrupole MS (mass range 35-300 amu). Background compensation and compound identification was performed using TargetView software.

Fig. 1. Major peaks identified in the headspace of packaged sirloin steak, following grab-sampling onto a sorbent tube and analysis by TD-GC-MS.



1. Isobutane
2. Isobutene
3. Butane
4. Pent-1-ene
5. Acetone
6. Pentane
7. Dimethyl sulphide
8. Dichloromethane
9. 2,3-Dimethylbutane
10. 2-Methylpentane
11. Acetic acid
12. 3-Methylpentane
13. Butane-2,3-dione
14. Hexane
15. Methylcyclopentane
16. 3-Methylbutanal
17. Benzene
18. Cyclohexane
19. 3-Methylhexane
20. 2,2,4-Trimethylpentane
21. Pentane-2,3-dione
22. Heptane
23. 2-Ethylfuran
24. 3-Hydroxybutan-2-one
25. 2,5-Dimethylhexane
26. 2,4-Dimethylhexane
27. 2,2-Dimethylhexane
28. 2,3,4-Trimethylpentane
29. 2,3,3-Trimethylpentane
30. 2,3-Dimethylhexane
31. Pentan-1-ol
32. Toluene
33. 3-Methylheptane
34. 2,2,4-Trimethylhexane
35. 3-Methyleneheptane
36. 3-Ethylhex-3-ene
37. (E)-Oct-4-ene
38. (Z)-Oct-4-ene
39. Octane
40. (E)-Oct-2-ene
41. (Z)-Oct-2-ene
42. Hexan-1-ol
43. 2,2,4-Trimethylheptane
44. Benzaldehyde
45. 2-Pentylfuran
46. 2,2,4,6,6-Pentamethylheptane

Results and discussion

The emission profile obtained from the packaged meat headspace was queried against the NIST 11 database, which resulted in 46 components being identified.

The chromatogram shown in Fig. 1 demonstrates excellent peak shape, with no splitting or tailing of analyte peaks. A particular feature is the absence of interference from water, which can be a concern in GC-MS analysis of meat headspace samples due to their high humidity. The presence of water can result in problems such as broadened or split peaks, shifted retention times, damage to the analytical system and lowered detector sensitivity. Here, a relatively small sample volume, an ambient-temperature dry-gas purge of the tube before analysis, and splitting of the sample flow all helped to reduce the amount of water drawn into the sorbent tube.

The simplicity of the sampling and analytical method also eliminated time consuming sample preparation, as well as permitting a high degree of sensitivity across a wide analyte range. This helped to ensure that the chromatogram was as representative as possible of the real sample profile. Compounds of particular note found in this analysis include toluene, benzene and dichloromethane, which are possible migrants from the packaging, and unbranched short-chain alkanes and alkenes, which (along with the odorous sulphur compound dimethyl sulphide) may result from irradiation.

In conclusion, this is a technique that could easily be employed to sample the headspace above a range of packaged meats. By combining the convenience of rapid grab-sampling with the high sensitivity of TD-GC-MS, this method is especially valuable for confirming product quality and for investigations into product deterioration. ■