Phenomena of GC-O analysis
– training and validation of a sensory panel

Mareike Reindanz & Lina Müller; Thomas J. Simat*

Dresden University of Technology, Chair of Food Science and Food Contact Materials, Bergstr. 66, 01062 Dresden Germany, *contact: thomas.simat@tu-dresden.de

Summary

- Development of a **trainings mixture** of different odours
- Relevant for **food** and **consumer goods**

- **Reproducibility** of results
- **Individual differences** between panelists

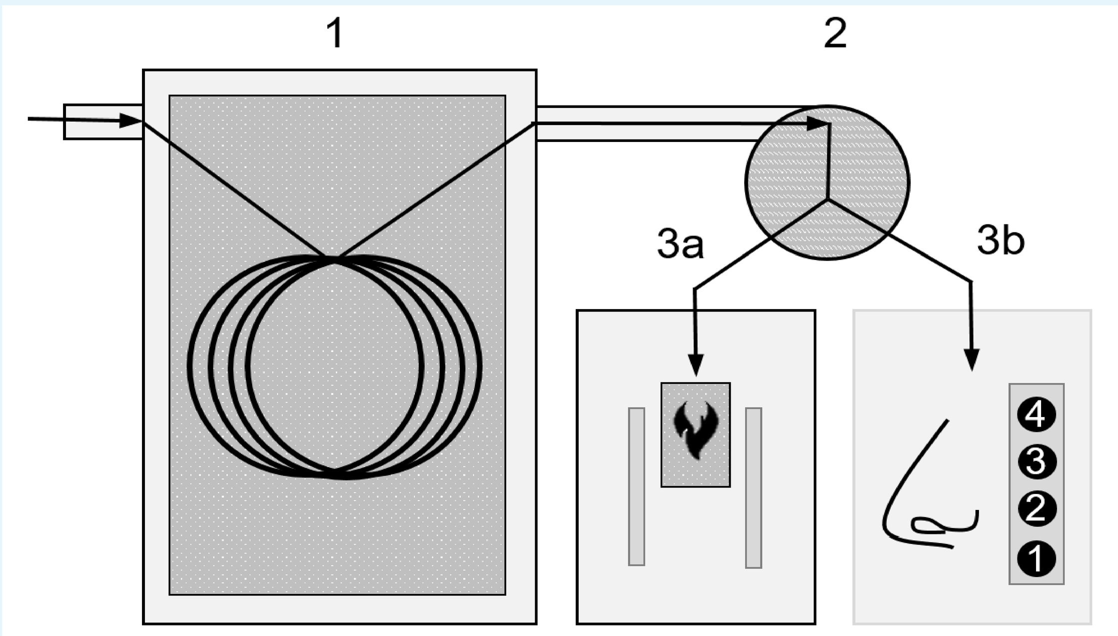
- **Improvement of sensory analysis by GC-O**

Aim of the study

This study deals with the scientific presentation and summary of the **phenomena of GC-O analysis**, as well as methods for the **validation and training** of a sensory panel.

GC-FID/ODP in general

- Gas chromatography-olfactometry (GC-O) uses the **human nose** to analyse **odour active substances** (olfactory active volatile organic compounds, oVOC).
- It's therefore relevant not only for the **analysis of oVOCs** in food, but also for the **detection of odours and taints from food contact materials and consumer goods.**
- From an analytical point of view, **GC-O is an important tool** and the method of choice for the **identification and quantification of oVOCs.**
- Not all VOC detectable in GC-FID/MS have a low **odour recognition threshold** and are therefore detectable in GC-O (becoming oVOC), on the other hand the human olfactory sense is for some substances much more sensitive than the common GC detectors: A smell is perceived without a visible peak. (Fig. 2)

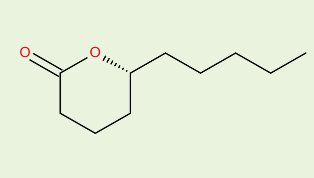


1 – GC oven with a polar GC column
2 – split port
3a – flame ionization detector (FID)
3b – olfactory detection port (ODP)
4- intense odour
3- clear odour
2-recognition threshold
1-sensitivity threshold

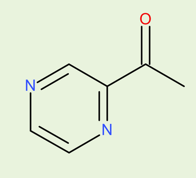
Fig. 1 GC-FID/ODP

Methodology

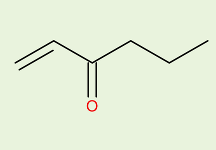
- Analysis of **oVOCs** using a **GC-FID/ODP** (olfactory detection port), and GC-MS as a supporting tool, e.g. to ensure the purity of the reference substances
- Ten known odorants regarding **different structure types** and with relevance for **food and consumer goods** were selected for the training of the panel [2]. The panel consisted of **10 persons** (2 male, 8 female, aged from 23 to 61).



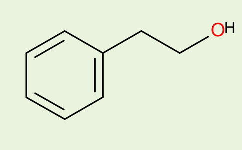
δ-Decalactone,Dec fruity, coconut



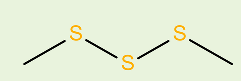
2-Acetylpyrazine,Ace roasty, popcorn



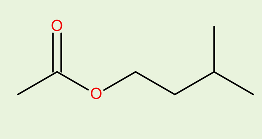
Hexen-3-one,Hex burnt plastic



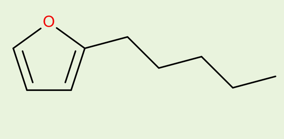
Phenylacetic acid,Phe honey, soapy



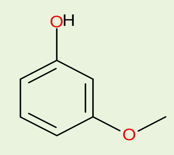
Dimethyl trisulfide, Dim sulphurous, onion



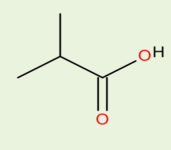
Isoamyl acetate,Iso fruity, banana



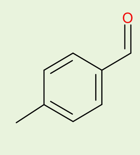
2-Pentylfuran,Pen fruity, mushroom



2-Methoxyphenol,Oxy smoky



Isobutyric acid,But cheesy, sweaty



4-Methylbenzaldehyde, Met marzipan

- Prior to GC-O measurement each panelist had to pass a short ranking test consisting of 3 different concentrations of 2-methyl naphthalin.
- **Various methods** are used to evaluate the GC-O intensity data:
  - A – **Reproducibility** by triple determination with the same dilution level
  - B – **Variance of the sensitivity of the panelists** to the different substances (determination of individual recognition thresholds)
  - C – detection frequency (**DF**) of a substance by the panelists

Results

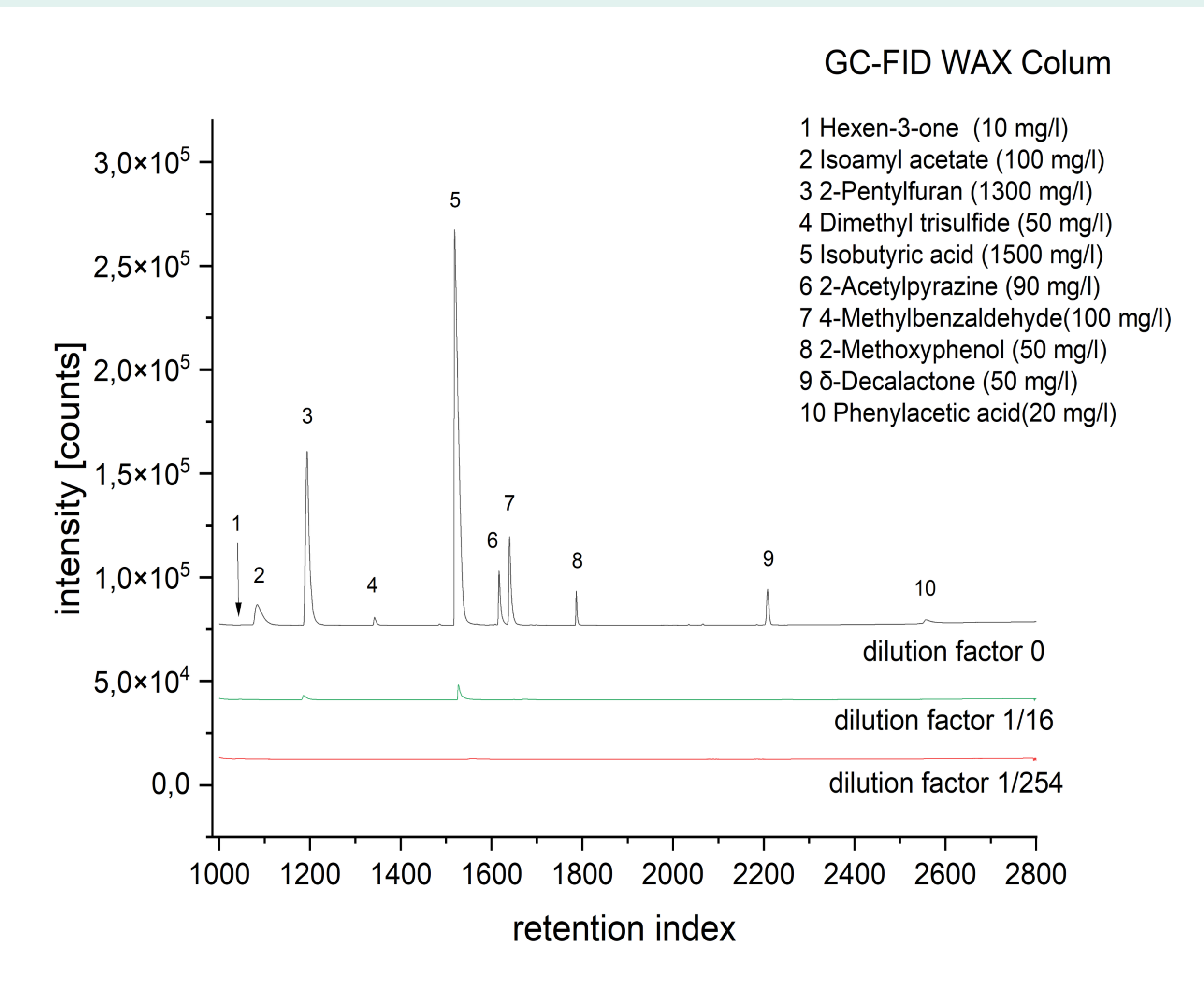


Fig. 2 Chromatogram trainings mixture
from dilution 1:16 most substances are not detectable by FID anymore

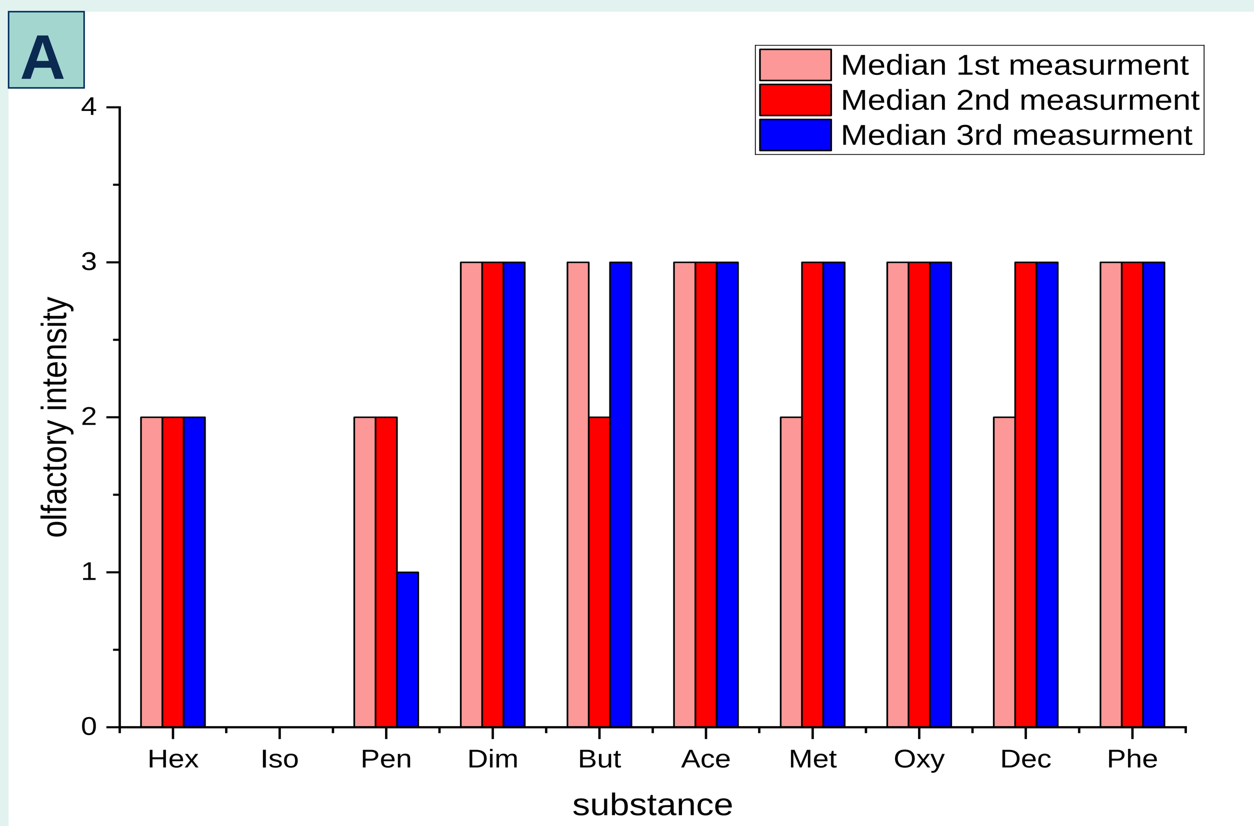


Fig.3 Reproducibilty of the panel

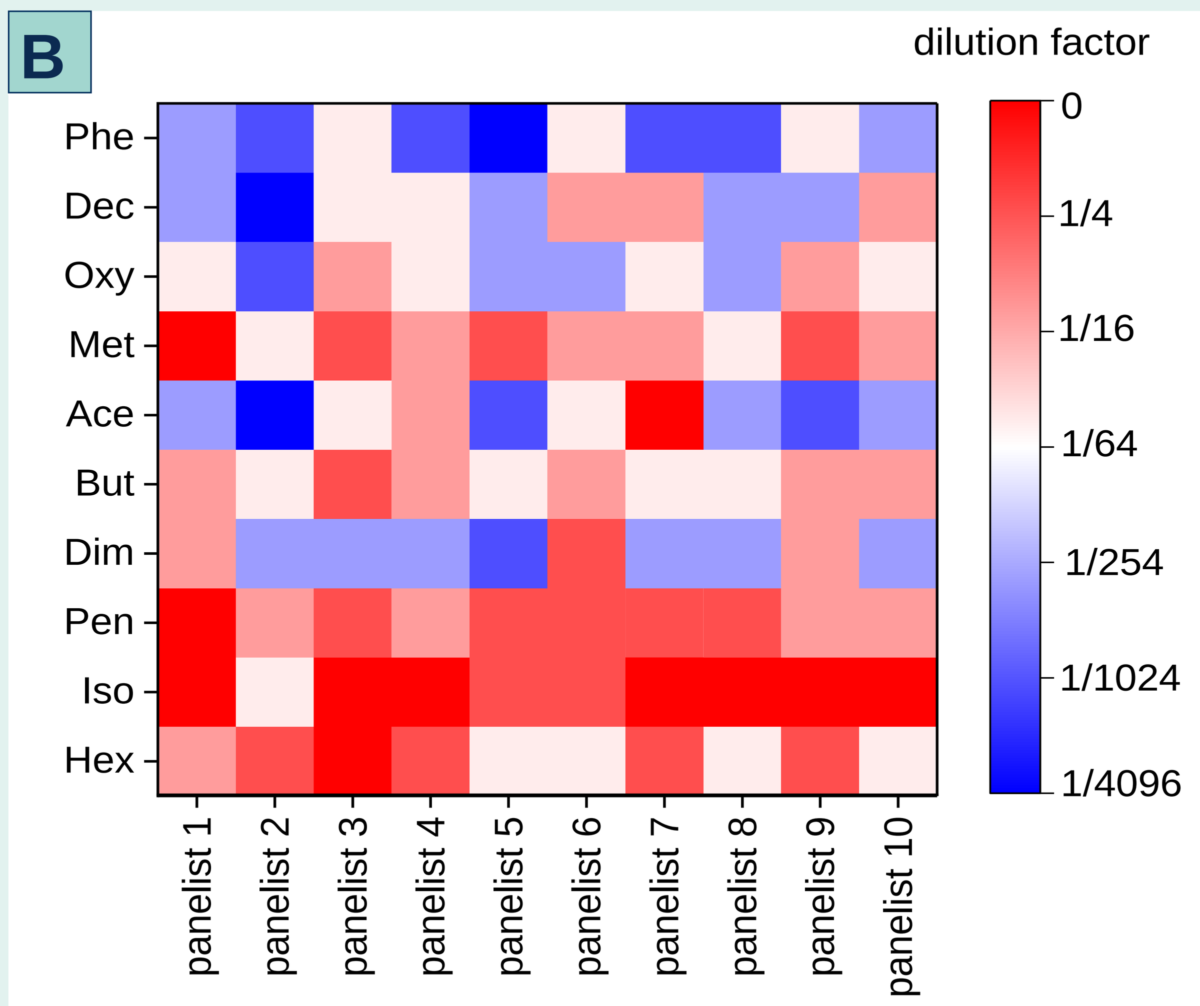


Fig.4 Heatmap trainings mixture

Variance of sensitivity of the panelists

- Panelist 7 had a high recognition threshold for 2-acetylpyrazine compared to other panellists.
- Panellist 2 is for most odorants more sensitive than the panel median

Reproducibility of the panel

- To evaluate the **panel reproducibility,** the first dilution was evaluated three times
- the panel median shows sufficient consistency

C

Detection frequency of a substance

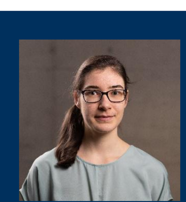
- The detection frequency (DF) is the absolute number of panelists that detected and recognized an odour at a distinct retention index
- The DF is often used to describe the relevance of an odour in a sample extract.
- For 2-acetylpyrazine the recognition threshold of the panellists is between 0,088 mg/l and 1.4 mg/l (Tab. 1) .
- Due to the differences in the sensitivity of single panelists GC-O evaluations should not be performed by a single person, but at least by 3 panellists

Tab. 1: Absolute and relative DF of 2-acetylpyrazine

Concentration of 2-Acetylpyrazine [mg/l]	Intensity	Relative frequency [%]	Intensity *relative frequency
90	3	100	3
22,5	3	90	2,7
5,6	3	90	2,7
1,4	3	80	2,4
0,35	2	70	1,4
0,088	0	20	0
0,022	0	10	0
0,006	0	0	0

References:
[1] Vene et al. (2013) A Method for GC-Olfactometry Panel Training, Springer Volume 6, page 179-189
[2] Hoffman et al. (2014) Natures Chemical Signatures in Human Olfaction: A Foodborne Perspective for Future Biotechnology, Wiley_VCH,126, 2–24

Mareike Reindanz



Lina Müller

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