Food impact study on selected breath VOCs using portable mass spectrometry

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INTRODUCTION

Due to its non-invasive nature, breath analysis is getting more engaged in nutritional research. Considering complexity of the food metabolism, an extensive research among different population groups is required.

For wide screening accomplishment, it is necessary to establish novel, portable and affordable solutions to complement conventional diagnostic techniques.

To provide accurate diagnostics and diet recommendations, an individual approach is required.

MATERIALS AND METHODS

SAMPLE COLLECTION

Exhaled breath samples were collected 1L Tedlar bags from 27 participants in 2 categories:
- people with Diabetes mellitus type II – DM: 6 participants
- people with cardiovascular diseases – CVD: 21 participants

Participants were recruited in period May – October 2022 in Germany and Belgium, with ethical approvals and informed consents.

Each participant provided two exhaled breath samples:
- before the meal – BM
- 120 min after the meal – AM

Standardized meal		Energy (kcal)	CHO (g)	Protein (g)	Fat (g)
White bread	2 slices (+- 80g)	194	39,2	10,25	0,88
Low-fat yoghurt	125g	45	5,6	5,4	0,1
Jam	25g	64	15,5	0	0
Coffee	1 cup	0	0	0	0
Orange juice	20 cl	84	18,2	1,4	1
Butter	12,5 g	93	0,1	0,1	10
Total		480	78,6	17,15	11,98

Table 1. Nutritional content of meal provided

INSTRUMENTATION

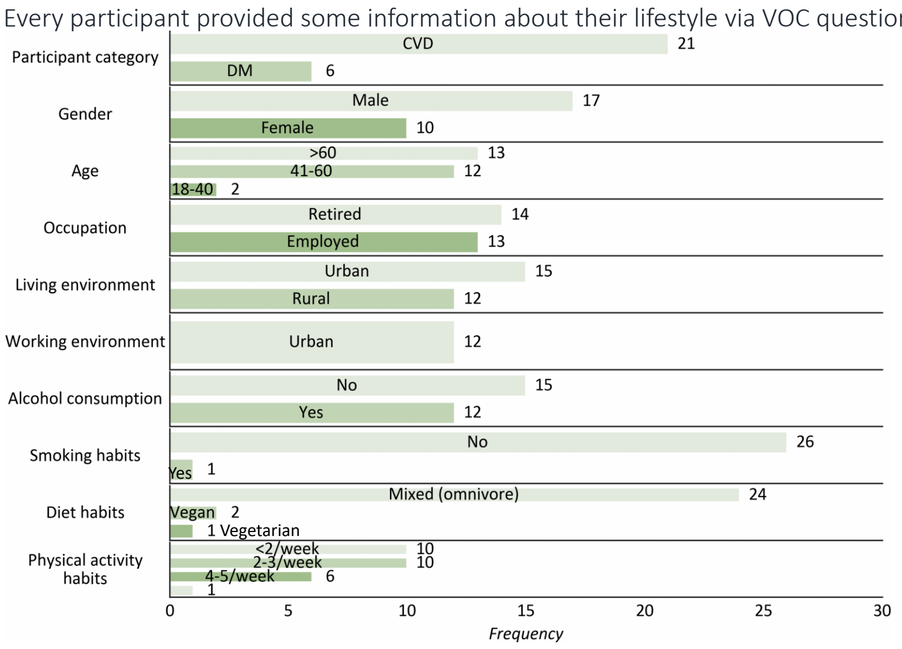
Inlet: PDMS sheet membrane 0.127mm thickness
Ion source: Electron impact (EI)
Mass analyzer: Single quadrupole (QMS 200)
Mass scan range (m/z): 0-300
System dimensions (LxHxW): 616x220x433mm
Weight: 23Kg
Power consumption: <200 W

Figure 1. Portable mass spectrometer

Concentration levels for breath acetone, ethanol, isoprene and n-pentane were determined in samples before the meal (BM) and after the meal (AM).

VOC QUESTIONNAIRE DATA

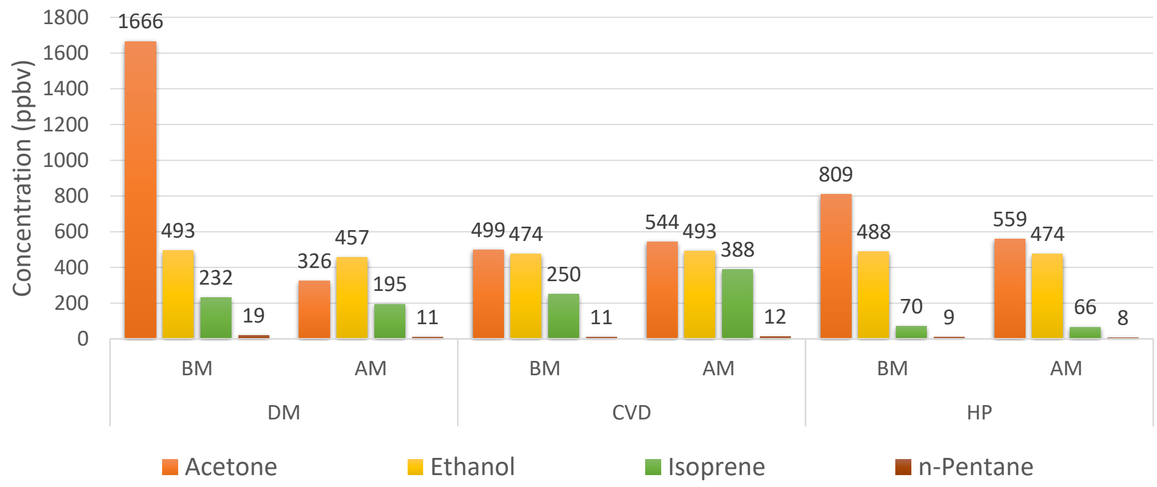
Every participant provided some information about their lifestyle via VOC questionnaire.



Bar graph 1. Summary of data collected via questionnaire

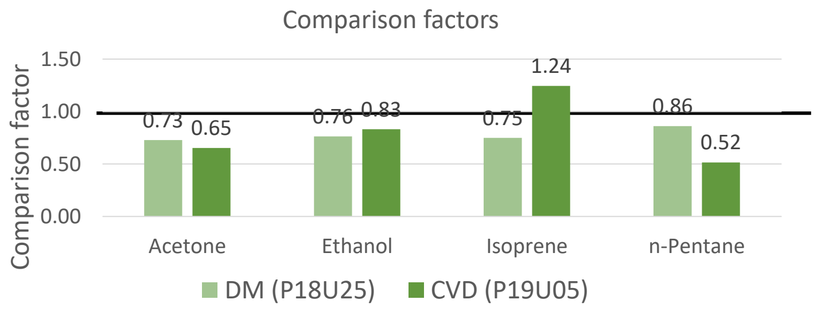
RESULTS

VOC QUANTIFICATION



*Bar graph 2. Mean ppb concentration levels obtained for acetone, isoprene, ethanol and n-pentane for participants from 3 user groups: people with diabetes type II (DM), people with cardiovascular disease (CVD) and *healthy people (HP)*
**previously reported data in Jakšić et al. https://doi.org/10.1007/s00216-022-04168-3*

FOOD IMPACT ON BREATH VOCs



Bar graph 3. Comparison factor – calculated ratio between acetone, ethanol, isoprene and n-pentane levels determined in sample 120 min after the meal (AM) and levels in sample before the meal (BM) for participants with DM and CVD

	Food impact %	
	DM	**CVD**
Acetone	67	85
Ethanol	50	70
Isoprene	50	80
n-Pentane	67	60

Table 2. Percentage of significantly altered VOC levels upon meal consumption. An increase or decrease in exhaled breath VOC level greater than 10% was considered as a significant change.

LIFESTYLE IMPACT ON BREATH VOCs

Quantified exhaled breath VOCs levels and data collected via questionnaire were used for food impact assessment.

One way-ANOVA on ranks test	p-value			
Categorical parameter	Acetone	Ethanol	Isoprene	n-Pentane
Participant group	0.448	0.641	**0.001**	1.000
Age	0.281	0.474	**0.046**	0.597
Gender	0.841	0.920	0.802	0.960
Living environment	0.770	0.626	**0.010**	**0.045**
Alcohol consumption	0.495	0.306	0.188	0.608
Physical activity	0.808	0.252	0.604	0.583

Table 3. Summary of One-way ANOVA on ranks statistical tests results for several categorical parameters against comparison factors obtained experimentally. Bolded p-values imply statistically significant difference between breath VOCs changes for distinct categories since p-value is below the treshold (α=0.05). The tested hypothesis assumed that there are no differences between categories.

CONCLUSIONS

- VOC sensor has been successfully used for selected breath VOCs concentration levels determination.
- Significant change in selected breath VOCs levels upon meal consumption was observed in about 67% participants with diabetes type II for acetone and n- pentane, and 50% for ethanol, and isoprene.
- Significant change in selected breath VOCs levels upon meal consumption was observed in about 85% participants with cardiovascular disease for acetone, 70% for ethanol, 80% for isoprene and 60% for n-pentane.
- Upon meal consumption significant statistical differences were observed for:
  - isoprene level between two examined participants groups and people of different age categories
  - isoprene and n- pentane levels between people who are living in urban and rural environments.
- Future work will expand VOCs number and involve more participants in order to get more reliable conclusions and to contribute to the breath research field.

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