Identification and comparison of volatile organic compound profiles produced by different types of microalgae cultures

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Introduction

Microalgae offer great potential for a variety of biotechnological processes, and are often a more climate-friendly option. Due to their high biodiversity (estimation of 800'000 different species), the variability of metabolites such as lipids, vitamins and active aroma compounds produced by microalgae is extremely high. [1] The use of selected microalgae for the production of feed supplements provides a natural, healthy and sustainable feed source for livestock, which could support additional protein inputs such as soy or even industrially produced nutrients or pharmaceuticals. The possibility for farmers to produce microalgae directly on the farm is a very attractive feeding method. [2]

Objectives

Select microalgae cultures suitable for animal feed, investigate the variability of metabolites and flavor, assess the quality (toxic, unhealthy) and process interfering substances.

Methods

Cultivation: Doucha's standard medium, 20-24.5°C, 2% CO_2, 115 rpm, light 136 µmol m^{-2} s^{-1} warm white constant, 10-14 days to an OD of 3-6.

Analysis: 1 mL sample, headspace Vacuum In-Tube Extraction (V-ITEX) for 5 min at 60 °C, GC-MS analysis

Results

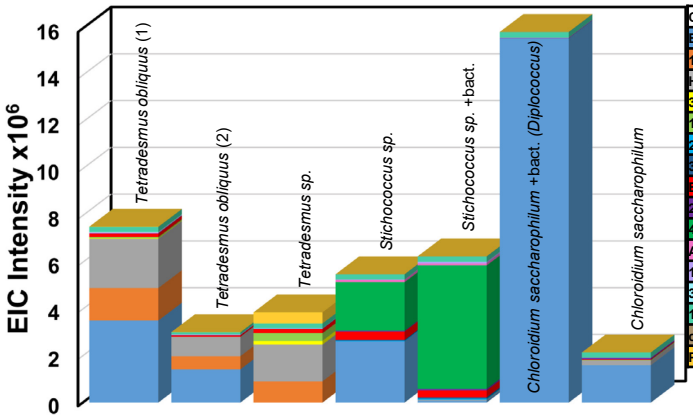


Fig. 1 *Composition of volatile compounds of the different algae cultures displayed as bar plots. Color description can be taken from Tab. 1.*

Tab. 1 *Odor thresholds and flavor description of the different volatiles.*

Compound	Odor threshold (ppb) [3]	Substantivity [4]
Ethyl Acetate	5-5000	ethereal fruity sweet weedy green grape rummy
1-Penten-3-ol	400	NA
Hexanal	4.5-5	fresh green fatty aldehydic grassy leafy fruity sweaty
3-Hexen-1-ol	NA	Green, grassy, melon rind-like with a pungent freshness
1-Hexanol	2500	pungent ethereal fusel oily fruity alcoholic sweet green
2-Penten-1-ol acetate	NA	NA
3-Methyl-2-buten-1-ol acetate	NA	sweet fresh banana fruity jasmin ripe heliotrope balsamic
Benzaldehyde	350-3500	sharp sweet bitter almond cherry
2-Ethyl-2-hexen-1-ol	NA	NA
4-Hexen-1-ol acetate	NA	NA
Acetic acid hexyl ester	2	fruity green apple banana sweet
1-Undecyne	NA	NA
3,4-Dimethylcyclohexanol	NA	NA
1,3-bis(1,1-dimethylethyl)-benzene	NA	NA
cis-9-Tetradecen-1-ol	NA	NA
Pentadecanal	1	NA

- Large variation in occurrence and abundance of volatiles in the different algae cultures
- Same cultures produce similar compounds but in different abundances
- Ethyl acetate, 4-Hexen-1-ol acetate and Hexanal are the compounds with the highest EIC intensities
- Pentadecanal and 1-Hexanol occurred predominantly in *Tetradesmus sp.*
- Bacterial contaminants affect volatile profile
- Most of the compounds detected provide a fresh, fruity and green flavor
- The heatmap shows clustering for algae cultures with high similarity of volatile profiles

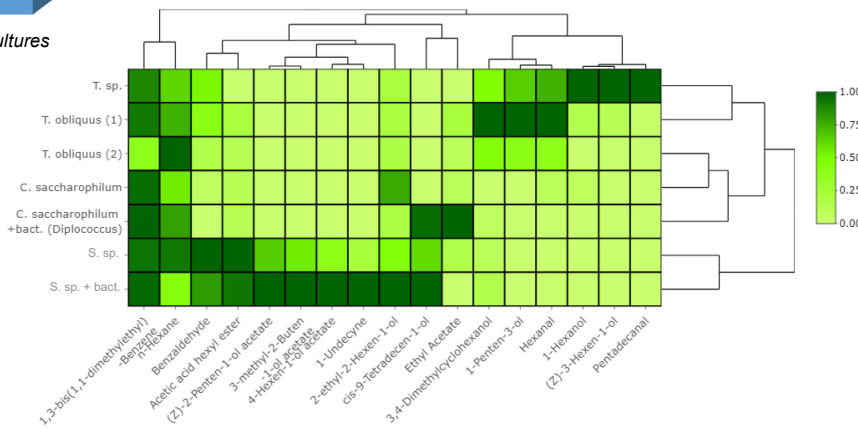
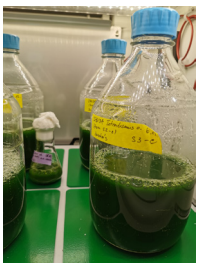


Fig. 2 *Heatmap of the volatiles found in the different algae cultures with normalized EIC intensities from zero (light green) to one (darkgreen).*

Conclusion

- Volatile profiles can be used as biomarkers that enable to distinguish similar and different algae cultures, their vitality and health and detect contaminations (bacterial or with other algae)
- The results could be used to create a volatile database for the different algae cultures
- Future experiments will investigate if the volatile profile is changing over the cultivation period (young to old)
- The analyses help to further develop the algae cultivation process
- Information on cultivation, flavor and taste is important for future experiments with algae as feed source for livestock or human nutrition



References

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[3]Odor & Flavor Detection Thresholds in Water (In Parts per Billion), Leffingwell & Associates [Available from: www.leffingwell.com/odorthre.htm.
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