Liquid Technologies – Innovations in Fragrance Industry

Daniel Strub

Liquid Technologies

The National Centre for Research and Development

WCTT
Wrocławskie Centrum Transferu Technologii

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Wrocław University of Science and Technology

Funded by the European Union

HR EXCELLENCE IN RESEARCH

unite!
University Network for Innovation, Technology and Engineering

Wrocław University of Science and Technology

A little bit of introductions – Daniel Strub

- PhD and habilitation in fragrance and organic chemistry
- Professor at Wrocław Tech
- Co-founder and CSO of Liquid Technologies
- Long-time advisor of the Polish Minister of Science – member of the panel of experts on infrastructure investments
- Expert of the European Commission's Research Executive Agency
- Expert of the National Centre for Research and Development
- Expert of an international business society – IFEAT.
- External experience – several long and short-term internships abroad in academia and industry – Haas School of Business at UC Berkeley, Leibniz Institute of Plant Genetics, University of Côte d'Azur, A. Fakhry & Co.

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A little bit of introductions

Liquid Technologies

- Small company, Wrocław based – 9 people
- R&D, production, and distribution of household, industrial, and specialty chemicals.

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Flavor and fragrance industry

- Relatively small market– ~ 40 billion EUR (2023)[1];
- Almost 80% in hands of 11 fragrance houses[2] (Givaudan – 18%[3]);
- Delivers commodities for various branches of industry (food, perfume, household chemistry, pharmaceutical)
- Relies on natural products (essential oils, absolutes, concretes) or synthetics (mostly made from fossil fuels)

[1] https://www.statista.com/statistics/475081/value-global-flavor-and-fragrance-market/

[2] https://www.leffingwell.com/top_10.htm

[3] https://www.statista.com/statistics/990255/flavors-and-fragrances-industry-global-market-share-by-manufacturer/

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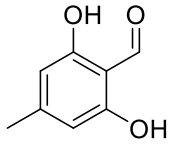
Issues for the fragrance industry

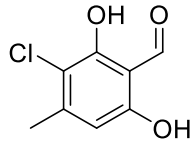
Strain for the environment:

- Large amount of pesticides used – plant derived products
- Extinction/near extinction of species – Musk Deer
- Cruelty – animal secretions (musk, castoreum, civet)

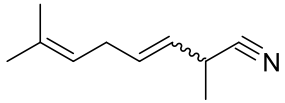
Prohibition of natural and synthetic ingredients – continuous change of legislation:

- Atranol and chloroatranol (treemoss and oakmoss absolutes)

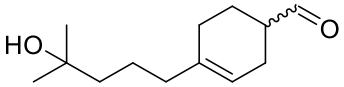




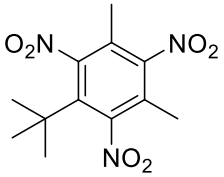
- Geranyl nitrile



- Lyral



- Nitro musks – Japan (all), EU (musk xylene); US (none)



Nikola, N., Hoferl, M., Buchbauer, G., Flavour Fragr. J. **2018**, *33*, 373-384

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R&D and implementation of new products into the market

HVACUniversal

HVACExternal
Alkali

The problem – scarcity of fragrances for extreme environments

Available fragrance agents:

- 100% can be used in perfumes (pH=7)
- 45% can be used in washing agents (pH=10)
- 5% can be used in dishwasher powders (pH=13)

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The idea

Synthesis of new aroma molecules from raw materials of a natural origin with application in perfumery, cosmetics and household chemistry (SYNFRA) – **LIDER Programme**

The National Centre for Research and Development

- New solutions for scenting alkaline household chemicals;
- Utilization of abundant natural raw materials, preferably byproducts of various industries;
- Combinatorial approach in the early phase of odorant discovery;
- Evaluation of oxime ethers as promising aroma molecules.

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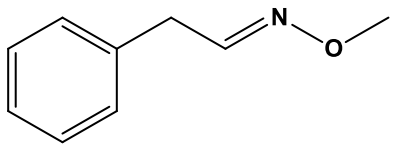
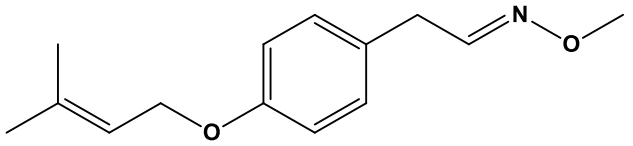
Evaluation of existing IPR surroundings

Natural fragrant oxime *O*-ethers:



Essential Oils:

- *Gardenia taitensis* (0.3-0.7%),
- *Citrus aurantium* (0.05-0.15%),
- *Spartium junceum* (0.05-0.15%),
- *Drypetes natalensis* (0.6%)



Fragrance profile similar to phenylacetaldehyde

Müller PM, Lamparsky D *Perfumes: Art, Science and Technology*. Springer Science+Business Media Dordrecht, **1995**.

Ataloxime; *Atalantia ceylanica*

Bacher M, Brader G, Hofer O, Greger H, *Phytochemistry* **1999**, *50*, 991

Synthetic fragrant oxime *O*-ethers

International Flavors & Fragrances Inc.:

• Narula APS, Mahesh R, Pawlak M, Brooks CDW (**2005**) Oxime methyl ethers. US Patent 6924263 B2

• Narula APS, Mahesh R, Pawlak M, Merritt PM, Brooks CDW (**2006**) Oxime methyl ethers. US Patent 7015189 B2

Givaudan Roure International:

• Kaiser R, Naegeli P, Nussbaumer C (**2002**) Oxime ethers and perfume and flavouring compositions containing them. European Patent P0672746 B1

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Evaluation of existing IPR surroundings

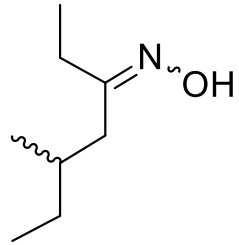
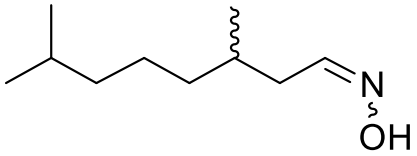
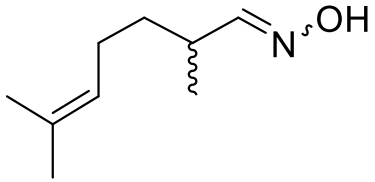


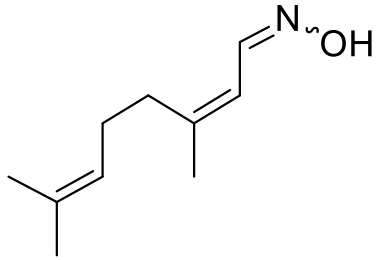
Fig leaves



Earthy, green, rosy

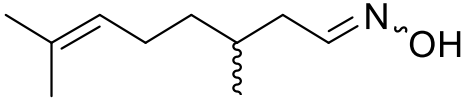


Gardenia flowers

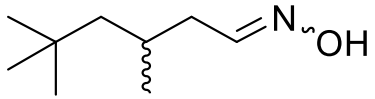


Musty, seaweed-like

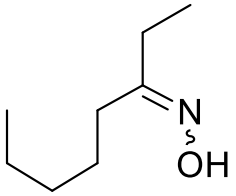
M. Zviely, M. Li Ketoximes. *Perfumer & Flavorist* **2013,** *38*, 36-39.



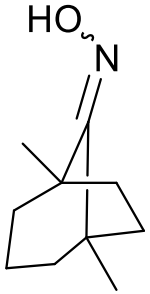
Leafy, green, rosy-citrusy



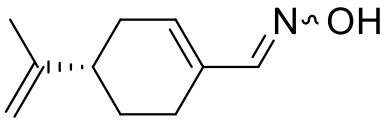
Green, vetiver, woody with herbal top notes



Intensive, green, resembling the scent of crushed twigs and moss



Intensive, fresh, fruity, herbal, typical scent of the round leaf buchu oil (*Agathosma betulina*)



sweetener, about 2000 times more sweet than sucrose

http://www.thegoodscentscompany.com/data/rw1004001.html

Ketoximes

Black currant odorants are desirable olfactory agents for perfume compositions.

Michael Zviely, CIC; and Ming Li, The Key Laboratory of Food Colloids and Biotechnology, Ministry of Education, Department of Applied Chemistry, School of Chemical & Material Engineering, Jiang Nan University, China

A.D. Kinghorn, C.M. Compadre Chapter 12: Alternative Sweeteners, 3rd ed., red. Lyn O'Brien-Nabors, CRC Press, **2001**

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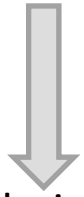
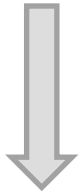
Our combinatorial approach

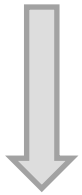
190 compounds in 19 small combinatorial libraries – miligram scale



Initial sensory analysis GC-O – 20 hits



Synthesis and purification of suspected targets in multimiligram scale



Sensory analysis of 20 compounds by 3-5 panelists

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Conclusions

- We were able to minimize resources needed in the phase of new odorant discovery: chemicals – more than 20 times less used; human resources – more than 20 times less; and time – whole process was more than 10 times shorter.

- 20 promising leads for possible application in alkaline functional products were discovered;

- The combinatorial strategy has important drawbacks: reactivity, substantivity, limited range of reactions.

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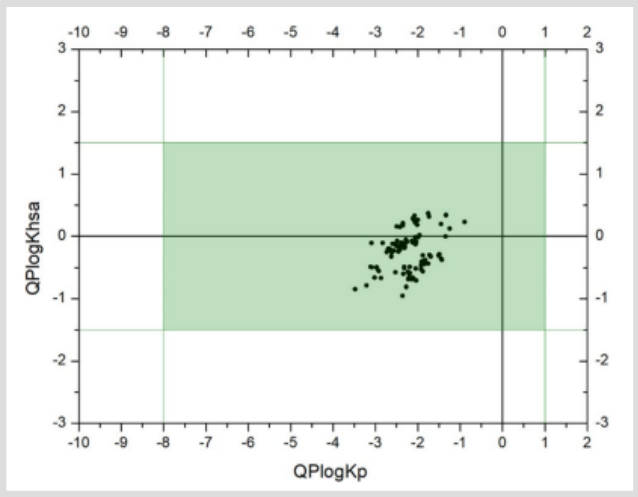
Applied Research



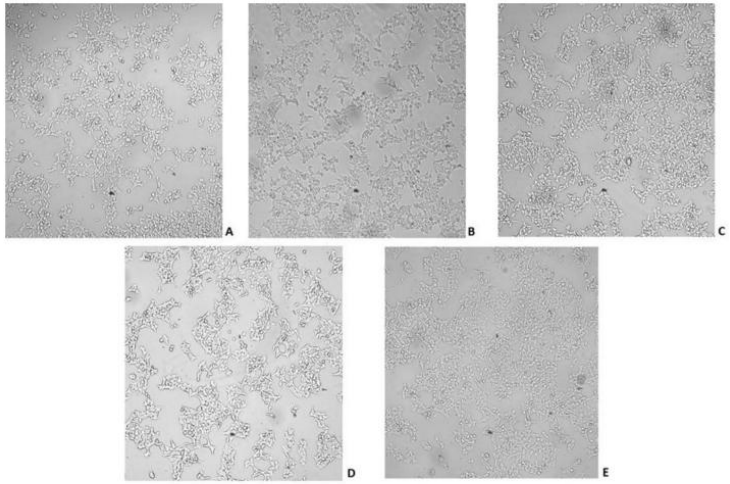
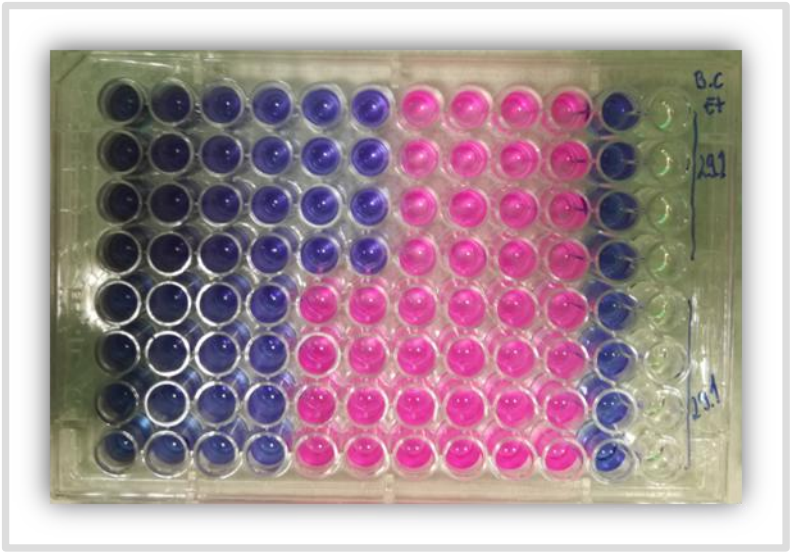
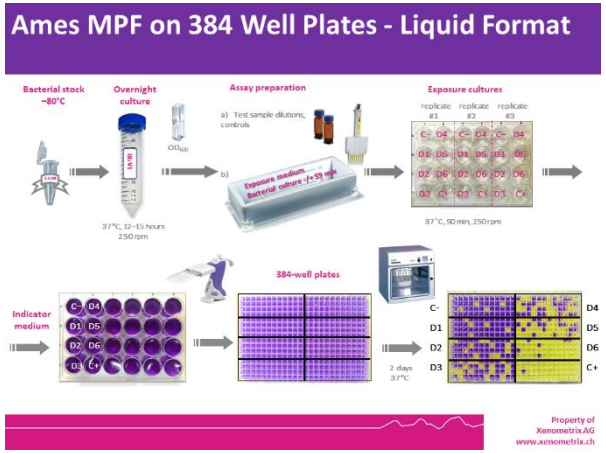


Figure 1. Images of HEK293T cell lines from a Nikon Eclipse TS2R microscope. (**A**) Control well. With added tested agents: (**B**) Propiophenone oxime, (**C**) β-ionone oxime, (**D**) (+)-carvone oxime, and E. norcamphor oxime. On comparison of the images, it can be stated that the tested compounds do not affect the morphology or viability of the cell line.





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Effects – entrepreneurial

- **Patented and implemented new fragrance substances (LiquaniTe);**
- **License and revenues from the use of inventions for the University;**
- **Greater recognition for both the University and the company.**
- **The NCBR pointed project *SYNFRA* as a model case study and a potential benchmark for future applicants.**

HVAC External Alcali

Čištění vnějších klimatizačních jednotek

Silný alkalický čisticí prostředek vhodný k odstraňování gastronomických tuků a mastnoty ze strojů nebo jiných zařízení vystavených olejovým skvrnám.

HVAC Universal

Čištění klimatizačních jednotek

Koncentrát pro čištění vnitřních a venkovních systémů HVAC. Odstraňuje nečistoty, prach, usazeniny kondenzátorů, odstraňuje prach, tabák a organické usazeniny výparníků. Odstraňuje nepříjemné pachy, tuky.

VTP CENTRUM

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Effects - scientific

- **5 publications in reputable scientific journals;**

[1] Balcerzak L., Gibka J., Sikora M., Kula J., **STRUB D.J**. Minor constituents of essential oils and aromatic extracts. Oximes derived from natural flavor and fragrance raw materials – sensory evaluation, spectral and gas chromatographic characteristics. *Food Chemistry,* **2019**, 301, 125283. doi: 10.1016/j.foodchem.2019.125283 **(IF 6.3; Q1)**

[2] Surowiak A., Sowała M., Talm, M., Groborz K., Balcerzak L., Lochyński S., **STRUB, D.J**. Cytotoxicity, early safety screening, and antimicrobial potential of minor oxime constituents of essential oils and aromatic extracts. *Scientific Reports,* **2022**, 12, 5319. doi: 10.1038/s41598-022-09210-z **(IF 4.6; Q1)**

[3] Balcerzak L., Surowiak A., Adamowicz A., Kaleta M., Pieńkosz-Żagań A**., STRUB, D.J**. Evaluation of small combinatorial libraries of nitrogenous low-molecular-weight compounds for new fragrance development. *Journal of Industrial and Engineering Chemistry,* **2022**, 115, 339-344. doi: 10.1016/j.jiec.2022.08.017 **(IF 6.1; Q1)**

[4] Balcerzak L., Surowiak A., Groborz K, Stróżak S., Piekarska K., **STRUB D.J.** Comparative Evaluation of Mutagenic, Genotoxic, Cytotoxic, and Antimicrobial Effects of Flavour and Fragrance Aldehydes, Ketones, Oximes, and Oxime Ethers. *Toxicology*, **2023**, 490, 153510. doi: 10.1016/j.tox.2023.153510 **(IF 4.5; Q2)**

[5] Balcerzak, L., Trusz, A., Piekarska, K., **STRUB D.J.** Aquatic Toxicity Comparison Between Selected Flavour and Fragrance Aldehydes, Ketones, Oximes, and Oxime Ethers, *Ecohydrology & Hydrobiology*, **2025**, 100659. https://doi.org/10.1016/j.ecohyd.2025.100659 **(IF 2.2; Q1)**

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Bartosz Urbanek, PhD

Arkadiusz Szydełko, PhD

Thank you for the attention

Whatsapp contact

We are open to:

- **academic and industrial research partnerships**,
- joint R&D projects and grant consortia,
- applications in detergents, HVAC, I&I cleaning, and niche perfumery,

Liquid Tech website

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