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Concentration and Extraction of Natural 4-Anisaldehyde, 3,4-Dimethoxybenzaldehyde and Benzaldehyde From Fermented Acid Whey

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Introduction & Motivation

Acid whey, a nutrient-rich by-product of the dairy industry, poses disposal challenges due to its sour taste and high calcium and lactate content. In this project, acid whey was fermented with lactic acid bacteria to produce natural aroma compounds such as 4-anisaldehyde (4-methoxybenzaldehyde), benzaldehyde, and vanillin (3,4-dimethoxybenzaldehyde). The aim of the project is to recover these compounds from the fermentation broth using solvent extraction (SE), preparative chromatography and finally, scale up the process.

Aroma compounds of interest

4-Anisaldehyde: COc1ccc(C=O)cc1
Benzaldehyde: c1ccccc1C=O
Vanillin: COc1ccc(C=O)cc1

Solvents used for Extraction

Parameter	Parafat-Rac	Diethyl Ether
Boiling point	68 °C	34.6 °C
Density	0.81 g/mL	0.71 g/mL
Flash point	18 °C	1 °C
Water solubility	0.01 g/100 mL	1.2 g/100 mL
Toxicity	LD50: 1.5 g/kg	LD50: 1.5 g/kg

Concentration of key aroma compounds

small scale

Initially, using a chromatography workstation, we compared two polyethylene glycol-based stationary phases, Diels HLB and Porafat Rac NP (Poremax, Milford, MA, USA) on a small scale (500 mL), originally developed for a solid phase extraction, and determined their separation performance. Advantages of these sorbents are:

- good chemical stability across a broad pH range
- compatibility with standard clean-in-place procedures

For the concentration of aroma compounds, an ethanol-water mixture (80% ethanol, v/v) was used due to its low toxicity, high solvent efficiency and suitability for food-grade applications.

large scale

Diels HLB performed better on smaller scale and was thus used for concentration of the key aroma compounds on larger scale (10 L of fermented acid whey).

Compound	Diels HLB	Porafat Rac
4-Anisaldehyde	95.9%	95.9%
Benzaldehyde	95.9%	95.9%
Vanillin	95.9%	95.9%

Conclusion

This study demonstrates an efficient and sustainable method for concentrating natural aroma compounds from fermented acid whey using two easily scalable extraction methods. By optimizing the extraction conditions, we achieved up to a 10-fold increase in the concentration of 4-anisaldehyde, benzaldehyde, and vanillin. The concentration of 4-anisaldehyde, benzaldehyde, and vanillin was significantly higher in the Diels HLB extract compared to the Porafat Rac extract. The results show that Diels HLB is a suitable sorbent for the concentration of these compounds. The study also highlights the potential of acid whey as a source of natural aroma compounds. The results of this study can be used to optimize the extraction process and to develop a sustainable method for producing natural aroma compounds from fermented acid whey.