Evaluating Deodorization Distillates for Enzymatic Fatty Amine Synthesis

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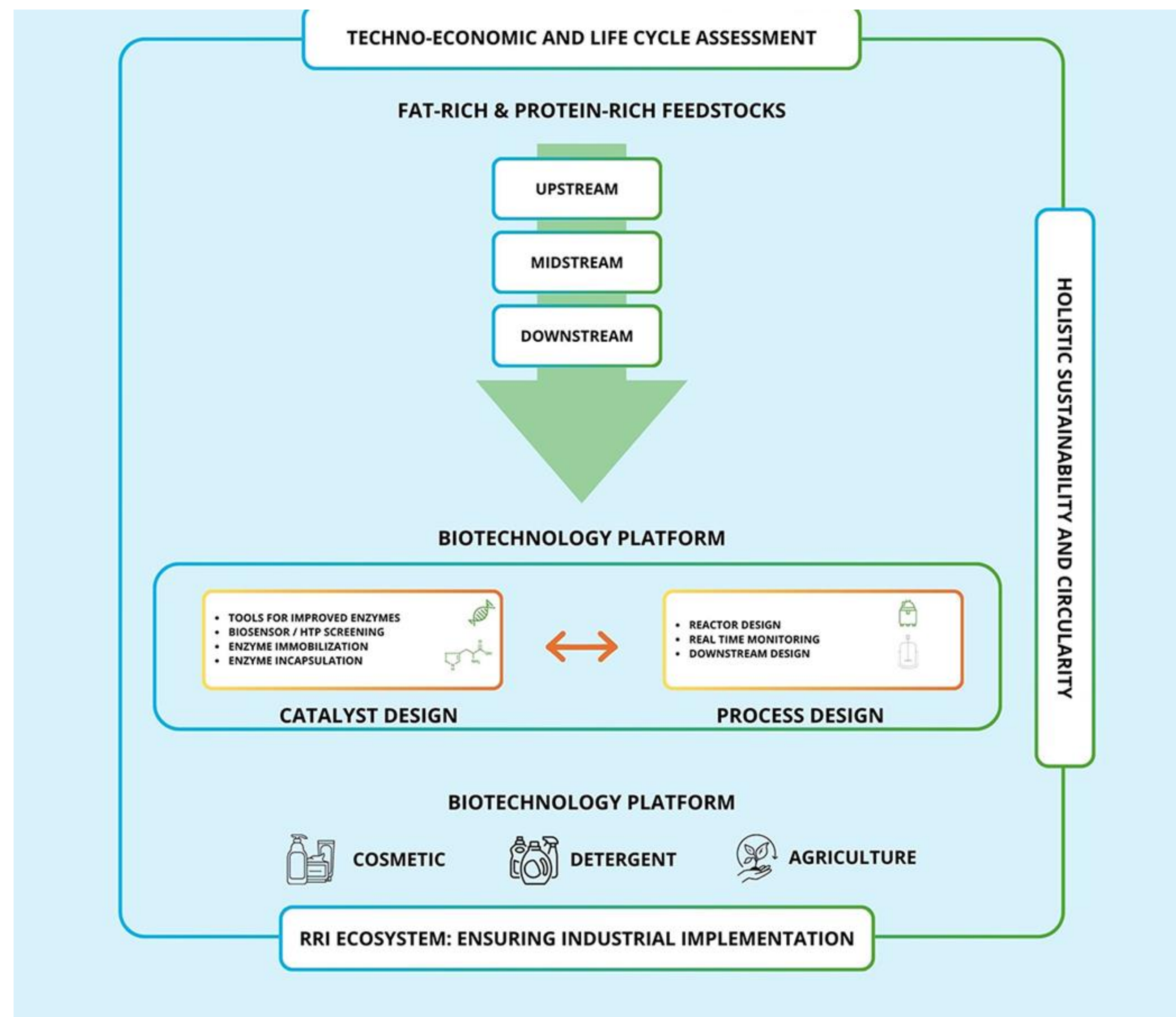
The FLEXIZYME project proposes a novel chemo-enzymatic platform for converting fat- and protein-rich residues into fatty amines, key compounds in cosmetics, detergents, and agrochemicals. Fatty amines are traditionally synthesized through energy-intensive chemical processes. Enzymatic alternatives offer a greener route, but require substrates of high purity and compatibility.

Effective enzymatic synthesis demands substrates with high free fatty acid (FFA) content. This study explores the potential of Short Path Distillation applied to byproducts of vegetable oil refining in order to obtain sustainable feedstocks for enzymatic fatty amine production. The aim was to evaluate the yield and composition of the distillate and non-volatile fractions, focusing on glyceridic compounds and free fatty acids.



EXPERIMENTAL PART

Three different by-products were tested: Two deodorization distillates, from coconut oil and palm oil physically refined and High-Oleic Sunflower Acid Oil from soapstocks.

A Short Path Distiller KDL5 (UIC GmbH, Germany) was employed (Figure 1). The heating system of the evaporator was a jacket circulated with heated oil. The vacuum system included a diffusion pump and a vamp pump. The conditions applied were: Temperature, 200°C; Feed Flow, 2.5 g/min; and Pressure, 0.02 mbar.

The glyceridic compositions of the initial samples and obtained fractions were analyzed by HPSEC-ID by the IUPAC Standard Method 2.508: Determination of Polymerized Triglycerides in Oils and Fats by High Performance Liquid Chromatography.

Short-Path Distiller KDL-5 (UIC)
- Evaporator area, 4.8×10^{-2} m^2
- Condenser area, 6.5×10^{-2} m^2

RESULTS

The results revealed substantial differences in distillate yield and composition depending on the feedstock. Coconut Deod produced up to 80.9% distillate, characterized by a high concentration of free fatty acids (FFA, up to 89.4%) and moderate levels of glyceridic compounds. Palm Deod yielded less (52–57%), but its distillates contained over 90% FFA and very low levels of di- and triglycerides. Notably, monoglycerides were relatively abundant due to their lower volatility. The HO Sunflower by-product showed the lowest distillate yield (~43%), yet its distillates also had high FFA content (~90%) and a glyceridic fraction dominated by monoglycerides.

These findings underscore that a universal distillation protocol is suboptimal. Instead, feedstock-specific optimization is essential to: i) maximize recovery of target compounds, ii) minimize thermal degradation, and iii) enhance energy efficiency and product quality.

	Yield (%)	Polymers (%)	Tri-Gly (%)	Di-Gly (%)	Mono-Gly (%)	Free Fatty Ac (%)
Coconut Deod						
Batch A	100	0.5	8.4	31.5	3.8	55.8
Non-volatile	32.9	0.6	23.4	61.7	2.1	12.2
Distillate	67.1	n.d.	0.3	14.8	3.9	80.9
Batch B	100	0	1.3	18.9	3.5	76.4
Non-volatile	19.1	n.d.	2.1	68.6	3.1	26.2
Distillate	80.9	n.d.	1.2	7.0	2.3	89.4
Palm Deod						
Batch A	100	0.2	7.9	5.2	6.2	80.5
Non-volatile	47.8	1	15.9	10.7	6.7	65.7
Distillate	52.2	0.2	0.2	0.8	5.9	92.7
Batch B	**100**	**0.2**	**5.3**	**4**	**6.4**	**84.1**
Non-volatile	42.6	n.d.	13.4	8.9	5.6	72.1
Distillate	57.4	n.d.	n.d.	2.3	7.5	90.1
HO Sunflower Acid oil						
Batch	100	0.8	45	9.2	4.1	40.9
Non-volatile	56.1	2.3	79.1	14.4	0.5	3.6
Distillate	43.9	n.d.	0.7	1.8	6.8	90.7

CONCLUSION

Feedstock composition has a strong impact on distillation behaviour, and process parameters should be individually optimized for each raw material to enhance efficiency and product quality.

The fatty acid profile (FA) must be compatible with the specificity of enzymes like lipases and transaminases. Ongoing studies are exploring whether specific FAs, particularly chain length and degree of unsaturation, affect the catalytic efficiency of the amine-converting enzymes (CARs).

FLEXIZYME -CONSTRUCTION OF A FLEXIBLE AND ADAPTABLE ENZYMATIC BIOTECHNOLOGICAL PLATFORM FOR SUSTAINABLE INDUSTRIAL PRODUCTION OF BIO-BASED FATTY AMINES FROM SIDE STREAM MATERIALS

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