# Valorisation of Seafood Canning Industry Residues for Biosurfactant Production

**Joana Dias de Almeida[1,2,3], Diogo Rodrigues[1,2], Frederico Castelo Ferreira[1,2,3], Nuno Torres Faria[1,2,3]**

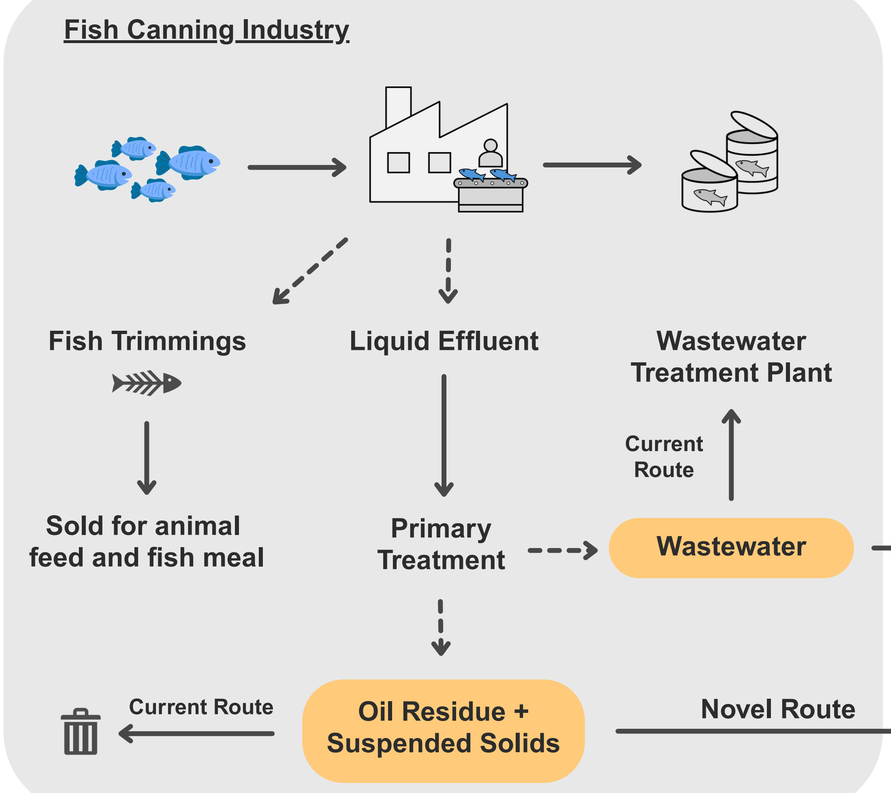
[1] Department of Bioengineering, iBB-Institute for Bioengineering and Biosciences, Instituto Superior Técnico, Universidade de Lisboa, Av. Rovisco Pais, 1049-001, Lisbon, Portugal

[2] Associate Laboratory i4HB - Institute for Health and Bioeconomy, Instituto Superior Técnico, Universidade de Lisboa, 1049-001, Lisbon, Portugal

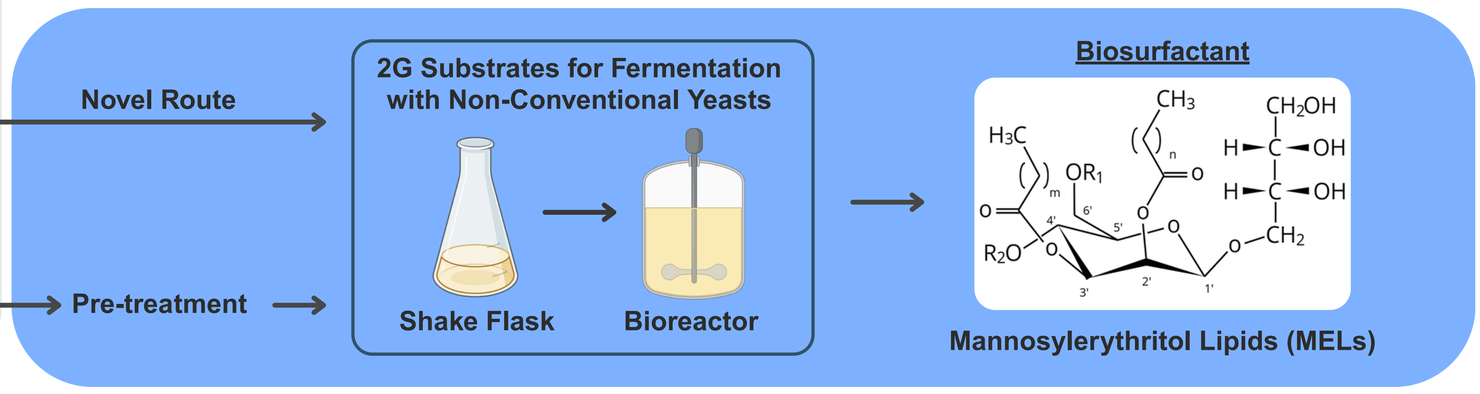
[3] Surfactinnov Lda, 4730-423, Ribeira do Neiva, Braga, Portugal

## Motivation and Background

**Fish Canning Industry**




- In 2023, **canned seafood sales in Europe exceeded 1.1 million tonnes**.
- The fish canning industry generates large volumes of effluents rich in **organic matter, salts, suspended solids, nitrogen, and oils**, offering significant potential for resource recovery. However, current research mainly focuses on wastewater treatment, with limited attention to valorisation.
- **Mannosylerythritol lipids (MELs)** are non-ionic biosurfactants with low ecotoxicity, high biodegradability, and applications in cosmetics, personal care, and cleaning products, making them promising alternatives to traditional fossil-based surfactants.
- This work aims to explore the potential incorporation of **side-streams from the fish canning industry as second-generation (2G) substrates** in the fermentation process for the production of MELs.




## Materials and Methods

**Oil Residue + Suspended Solids** —Centrifugation→ **Crude Oil Effluent (cOE)** —Degumming→ **Degummed Oil Effluent (dOE)**

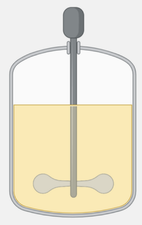
**Culture Medium:** D-glucose (40 g/L), yeast extract (1 g/L), $NaNO_3$ (3 g/L), $KH_2PO_4$ (0.3 g/L) and $MgSO_4$ (0.3 g/L).

**Shake Flask Experiments:**

**Condition 1:** 20 g/L Vegetable Oil + Fresh Water.
**Condition 2:** 20 g/L cOE + Fresh Water.
**Condition 3:** 20 g/L Vegetable Oil + Wastewaters W1 or W2 (collected after operation) or W3 (after equipment cleaning).
**Condition 4:** 20 g/L cOE + Wastewaters W1 or W2.

**Operational Conditions:** 27 °C and 200 rpm for 10 days.

*Moesziomyces antarcticus*



**Scale-Up in a 2 L Bioreactor:**

**Condition 1:** cOE + Fresh Water ⟶ No MELs production
**Condition 2:** dOE (three 20 g/L feeds on days 0, 3 and 6) + Wastewater W1.

**Operational Conditions:** temperature of 27 °C, agitation between 400–600 rpm, aeration between 0.5–1 vvm and DO at 15% for 9 days.

## Results and Discussion

**Table 1:** Shake flask studies using two hydrophobic carbon sources (vegetable oil and oil effluent) and four aqueous phases (fresh water and three wastewaters) in a cultivation of *M. antarcticus*.

| Condition | Final MELs titre (g/L) | MELs Purity (%) | Productivity ($g_{MEL}$/L.day) |
|---|---|---|---|
| Vegetable Oil + Fresh Water | 17.9 ± 3.6 | 90 ± 3 | 1.8 ± 0.4 |
| cOE + Fresh Water | 14.7 ± 0.2 | 92 ± 1 | 1.5 ± 0.0 |
| Vegetable Oil + W1 | 9.8 ± 1.0 | 76 ± 2 | 1.0 ± 0.1 |
| Vegetable Oil + W2 | 9.2 ± 2.7 | 76 ± 6 | 0.9 ± 0.3 |
| Vegetable Oil + W3 | 0.0 ± 0.0 | 0 ± 0 | 0.0 ± 0.0 |
| cOE + W1 | 10.4 ± 0.2 | 77 ± 1 | 1.0 ± 0.0 |
| cOE + W2 | 12.3 ± 0.8 | 80 ± 1 | 1.2 ± 0.1 |

- **Cannery oil effluent** are a promising alternative to vegetable oils for MELs production.
- **Wastewaters W1 and W2** supported yeast growth and MELs production, and can replace water in the fermentation process.
- **Wastewater W3** inhibited yeast growth and MELs production, likely due to the accumulation of residual cleaning agents.
- Combining **cOE with W1 or W2** resulted in MELs productivities of 1.0 or 1.2 g/L/day, respectively, comparable to the control (1.8 g/L/day).

Scaled Up

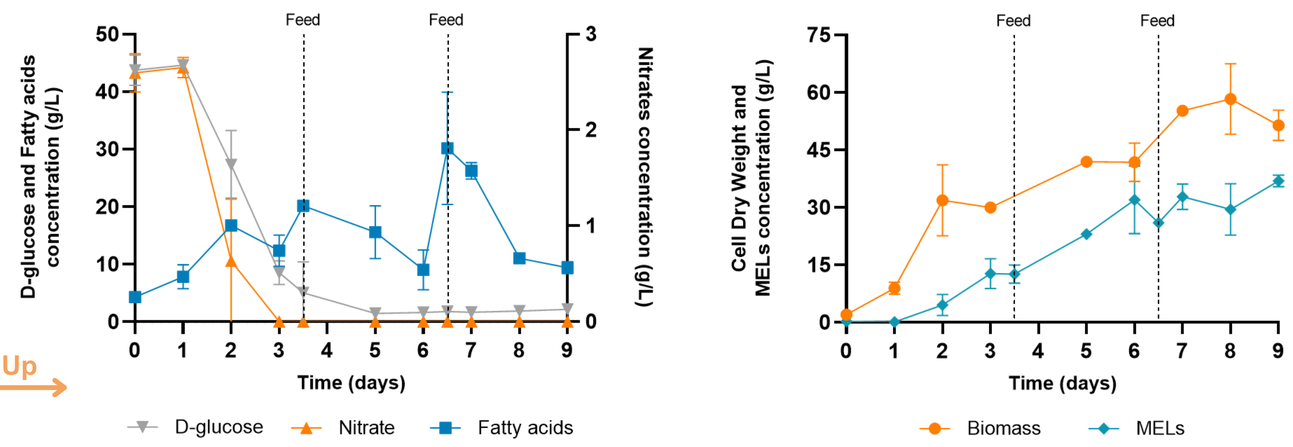



**Figure 1:** Bioreactor experiment using Wastewater W1 as a substitute for purified water and three feeds of Degummed Oil Effluent (20 g/L) on days 0, 3, and 6 to replace vegetable oil.

**Table 2:** Results of bioreactor studies testing the substitution of fresh water with Cannery Wastewater 1 and vegetable oils with Degummed Oil Effluent (dOE).

| Condition | Final MELs titre (g/L) | MELs Purity (%) | Productivity ($g_{MEL}$/L.day) |
|---|---|---|---|
| Vegetable Oil + Fresh Water | 43.9 ± 1.0 | 78 ± 1 | 3.4 ± 0.3 |
| dOE + Wastewater W1 | 37.0 ± 1.1 | 80 ± 1 | 4.1 ± 0.1 |

## Conclusions

- Cannery effluents can be used as a **carbon source and as a substitute for water** in the fermentation medium for the production of MELs.
- The **scale-up** of the process in the bioreactor demonstrated promising results for the implementation of effluents in the process, enabling the production of MELs with purity and productivity (**80% and 4.1 g/L/day**) superior to the experimental control (78% and 3.4 g/L/day).
- NMR and GC analysis revealed a conserved MELs structure across the different conditions.

## Acknowledgments

This work was promoted by Surfactinnov, supported through the Innov ID 2024 Call, from Portugal Ventures, assisted by IST; and FCT through the PhD grant (2024.01989.BDANA).
The authors acknowledge Bluebio Alliance, Portugal, for the networking, industrial contacts and project support, as well as the institutional funding through iBB-Institute for Bioengineering and Biosciences (UIDB/04565/ 2020 and UIDP/04565/2020), i4HB—Associate Laboratory Institute for Health and Bioeconomy (LA/P/0140/2020).
This work received support from the European Commission through the SURFs UP project (ID No. 101157586), under the Horizon Europe programme (HORIZON-JU-CBE-2023-IA-05). Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or REA. Neither the European Union nor the granting authority can be held responsible for them.