

USING FISH OIL WASTE TO PRODUCE BIO-BASED SURFACTANTS

PARTNERS

University of St Andrews | Eco Clean Team Ltd | Industrial Biotechnology Innovation Centre (IBioIC) | Sustainable Aquaculture Innovation Centre (SAIC)

PROJECT LEADS

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BACKGROUND

The aquaculture sector in Scotland is expanding, with plans to double its contribution to the economy by 2030. As a result of this growth, there are increasing opportunities to use new or growing waste streams for useful outputs, driving targets for circular economy and increased sustainability.

Eco Clean Team's vision is to replace the conventional surfactants produced by synthetic or petrochemical feedstocks from oil, gas and chemical processing with surfactants produced from fish oil waste. The valorisation of waste sources is part of the UK and Scottish governments' strategies to relaunch the economy after the Covid-19 pandemic, and this project was developed with the aim to support and promote circular economy solutions. The vision is to create new opportunities for business growth by reducing waste, thereby also reducing the environmental impact of production and consumption in Scotland.

By using fish waste to produce sustainable alternatives, Eco Clean Team's objective aligns directly with IBioIC's biotechnology strategy, as well as SAIC's (the Sustainable Aquaculture Innovation Centre) priority innovation area to unlock additional capacity in Scotland's aquaculture sector.

AIMS

This four-month feasibility study aimed to provide Eco Clean Team with a thorough assessment of the market and value chain, enabling a full understanding of the commercial viability of the proposal. Alongside this, the University of St Andrews aimed to define two different catalytic routes for high-value, bio-based surfactant production from fish oil waste.

In order to achieve these aims, the project was divided in four work packages (WP):

- WP1: Identify conditions to produce appropriate long-chain fatty acids
- WP2: Design of eco-friendly synthesis of bio-based surfactant
- WP3: Bio-based surfactant synthesis at the real condition and bio-based surfactant characterisation
- WP4: Market analysis and determination of strategy for market penetration

LABORATORY STUDIES

WORK DONE

WP1: The fish oil waste must be converted to esters using an eco-friendly process, while reducing the amount of catalyst impurities in the final product. To achieve this result, laboratory tests of the synthesis of a catalyst were completed.

WP2: The project tested different routes for the production of bio-based surfactants, using fish oil waste.

WP3: Preliminary tests on physical chemistry properties were investigated at the end of the reaction to verify that the bio-based surfactant was formed.

OUTCOMES

WP1: Means by which to produce the sought-after long-chain fatty acids were explored, along with their efficiency and the best route to the final product selected for further testing. Efficiency was measured in regard to both time and conversion rates.

WP2: This work identified and designed two main synthetic routes for production of bio-based surfactants using fish oil as a precursor. One used a catalyst developed as a by-product from the construction industry to produce Ethoxylated bio-based surfactants. The other used an enzymatic process to produce sugar-derived ester surfactants.

WP3: The foam at the liquid surface indicated that surfactants had successfully been formed.

The academic partners were able to develop an economic and environmentally sustainable process to produce bio-based surfactants from fish oil. Several of these were produced and will be explored further.

MARKET ANALYSIS

WORK DONE

WP4: As part of this feasibility study, Eco Clean Team was expected to secure the expertise required to complete a full and detailed market assessment. Specifically, an application was submitted for Zero Waste Circular Economy Business Support, which was successful.

OUTCOMES

The award was spent on engaging Mabbett to support Eco Clean Team in completing a market analysis, achieving the following information:

- A detailed analysis of the global surfactant/bio-surfactant market
- The route-to-market options and commercialisation strategy
- Defined marketing strategy, split between national and international consideration (target markets, positioning etc)
- A benchmark of the industrial process cost for the production of bio-based surfactant

- Feedstock sourcing strategy

The team also visited fish producers and potential clients to gain additional insights into opportunities for supply and demand.

IMPACT

Using the new process designed by the University of St Andrews has several benefits, such as producing a cleaner product, a safer and faster reaction, and easy scale-up. The project has enabled an achievement of TRL 3, which is a critical stage in Eco Clean Team's product development cycle, while also providing a proven use for the University's technology.

The market potential is significant, with demand for bio-based surfactants by application typically grouped as:

- Detergents
- Industrial and institutional (I&I) cleaning
- Food processing
- Others (e.g., agricultural chemicals, oil and gas chemicals, pharmaceuticals)

Based on Mabbett's market study, industrial and institutional cleaners are a positive target market considering the market share, expected growth in this area, supporting regulatory and policy frameworks, guiding standards (such as CEN/TS 17035:2017 Surface Active Agents), and receptiveness to the use of animal by-products. The global market for industrial cleaners has an estimated market value of \$49.2 billion in 2019 and is growing at ~10% per year.

The feasibility of the process has now been proven and the research team has since been successful in securing a six-figure sum, through the IBioIC Innovation Fund, to continue its product and company development journey. This will ensure that the novel method is replicable, straightforward to implement, and allows the products to be manufactured in high volumes. This follow-up project has the potential to produce economic benefits for Scotland. In the short term, the work will provide new commercial opportunities and sustain business for partners across the value chain. In the medium term, it will grow a biotechnology company headquartered in Scotland, with significant economic and global scale-up potential.

Eco Clean Team's aim is to create employment in Scotland, providing apprenticeship opportunities and jobs across the fields of marketing, manufacturing, business development, research and innovation, and logistics. The valorisation of waste from aquaculture also provides the potential for Scotland's improved commercial competitiveness, productivity, and ability to scale a product globally.

NEWS ARTICLES

[Fish oil waste source for the production of bio-based surfactants – IBioIC](#)

[Eco Clean Team has been awarded a six-figure sum to develop detergents from salmon waste – salmonbusiness.com](#)

[Fish oils used to create eco-friendly detergents, ousting petrochemicals – E&T Magazine \(theiet.org\)](#)

[Scots innovators clean up with detergents made from salmon farm waste – The Scotsman](#)

[Fish Oils Used to Create Key Component for Eco-Friendly Detergent – fishfocus.co.uk](#)

[Salmon by-product used to make greener cleaners – FishFarmingExpert.com](#)

[Fish oils could soon feature in eco-friendly detergent – The Fish Site](#)