

# HEALTH AND IMMUNE OUTCOMES OF NOVEL OMEGA-3 OILS IN ATLANTIC SALMON

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## BACKGROUND

Omega-3 fatty acids are essential nutrients that play a crucial role in immune function and contribute to the normal functioning of the heart and development of the brain. Because the human body cannot synthesise omega-3 fatty acids, they must be obtained through diet, specifically fish and seafood. However, pressure on wild fisheries means that more than half of the fish consumed globally is now farmed.

Historically, high levels of omega-3 in farmed fish were maintained through the use of fishmeal and fish oil in aquafeeds. These ingredients are derived from wild marine fisheries that are already operating at or near sustainable limits, making them finite resources. The significant expansion of aquaculture over the past two decades has therefore relied on the increasing replacement of marine ingredients with more economical alternatives, primarily plant-based meals and vegetable oils. While effective from a production perspective, these alternatives lack the omega-3 fatty acids found in marine oils. As a result, the omega-3 content of farmed Atlantic salmon has reduced in recent years.

Omega-3 fatty acids are also essential for fish health. Reduced dietary levels have coincided with increased incidence and severity of inflammatory diseases in farmed fish. Inflammation underpins immune responses to parasitic, bacterial, and viral infections, meaning that low omega-3 diets have implications for fish health and welfare, as well as for the nutritional quality of farmed fish for human consumption. These challenges have driven industry-wide efforts to identify sustainable, non-marine sources of omega-3 fatty acids.

## AIMS

This project aimed to investigate the health impacts of entirely novel omega-3-rich oils when used as feed ingredients for farmed Atlantic salmon. In contrast to earlier studies that focused primarily on increasing omega-3 levels in fish flesh, this work sought to understand how new omega-3 sources influence fish health, immune function, and disease resistance.

## PROJECT OVERVIEW

The project evaluated a range of novel omega-3 oils derived from marine macroalgae and genetically modified oilseed crops, specifically *Camelina sativa*.

These oils supplied eicosapentaenoic acid (EPA), docosahexaenoic acid (DHA), or combinations of both. Their effects were compared with traditional fish oil, omega-3-rich krill oil, and omega-6-rich sunflower oil, which served as reference, positive, and negative controls, respectively. All feeds were manufactured to commercial standards, met known nutritional requirements for Atlantic salmon, and reflected current industry practice.

Atlantic salmon were fed these experimental diets during both freshwater and seawater life stages. Fish were then exposed to a series of pathogen and parasite challenges, including *Aeromonas salmonicida*, sea lice, and amoebic gill disease. The project focused on responses within key immune tissues, alongside whole-fish performance, examining how dietary oils influenced lipid metabolism, fatty acid composition, and immune-related biochemical pathways.

## RESULTS

The trials demonstrated that dietary treatment did not affect growth during the freshwater phase and that fish across all diets successfully completed smoltification. Differences emerged during the seawater phase, where reduced growth was observed in fish fed diets containing krill oil and southern hemisphere fish oil. Dietary oil source also influenced mineral levels and lipid composition within immune tissues.

Analysis showed that novel omega-3 oils altered not only fatty acid profiles but also lipid class balance, shifting the relative proportions of energy-storage and structural lipids in immune organs. Notably, fish fed diets containing microalgal oil and high-EPA Camelina oil showed improved outcomes in sea lice challenge trials, indicating enhanced protection against parasitic infestation.

Further investigation of lipid inflammatory mediators demonstrated that those derived from shorter-chain fatty acids were primarily driven by dietary input, while mediators derived from EPA and DHA were more responsive to environmental stress. Together, these findings provided new insight into how specific omega-3 sources shape immune and inflammatory responses in Atlantic salmon.

## IMPACT

The outcomes of this project have direct relevance for the aquafeed and salmon production industries, as well as for consumers, policymakers, and the wider public. By demonstrating that novel omega-3 oils can support fish health and disease resilience while reducing reliance on marine ingredients, the project provides a practical pathway towards more sustainable aquaculture.