COMPLETED PROJECT CASE STUDY

EARLY DETECTION, HEALTHIER SALMON: ADVANCING BIOMARKER DIAGNOSTICS FOR SUSTAINABLE SCOTTISH AQUACULTURE

PARTNERS

University of the West of Scotland | University of Aberdeen, Bakkafrost Scotland | Vertebrate Antibodies Ltd | Fleet Bioprocessing | University of Waterloo | With collaboration from Environment Canada

PROJECT LEADS

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BACKGROUND

Salmon aquaculture plays a critical role in Scotland's rural economy and global seafood industry. Scottish salmon is the UK's largest food export, with exports reaching a record £844 million in 2024, surpassing the previous high of £618 million set in 2019. The sector directly supports over 2,500 jobs across Scotland, many in remote coastal communities where employment alternatives are limited, with thousands more employed by the associated supply chain.

Central to the sustainability and growth of this high-value sector is the health and welfare of farmed salmon. Disease outbreaks pose significant threats to productivity, fish welfare, and export quality, making early diagnosis and effective monitoring essential.

Recent investigations have identified a range of promising biomarkers, with immunoglobulin M (IgM) and cardiac troponins emerging as key indicators of fish health. Improved diagnostic tools based on such biomarkers could play a crucial role in enhancing disease management, safeguarding animal welfare, and securing the long-term resilience of Scotland's salmon farming sector.

Led by the University of the West of Scotland (UWS), this project aimed to develop innovative tools for detecting and monitoring salmon health through biomarker-based diagnostics. Project collaborators included the University of Aberdeen, Bakkafrost Scotland, Vertebrate Antibodies Ltd (VAL), and Fleet Bioprocessing Ltd.

AIMS

The project aimed to develop rapid, cost-effective, and high-throughput immunoturbidimetric assays for detecting biomarkers associated with bacterial and viral diseases in Atlantic salmon.

Specific objectives included:

- Optimising antibody-based assays for specificity, sensitivity, and reproducibility;
- Transitioning ELISAs to turbidimetric formats suitable for automation;
- Validating assays using serum from health-challenged and experimentally infected salmon.

OVERVIEW

Initial investigations focused on IgM and troponins as primary biomarkers of salmon health. These were validated through enzyme-linked immunosorbent assay (ELISA), revealing significant differences between diseased and healthy fish. This confirmed their potential for diagnosing key conditions affecting farmed salmon, such as pancreas disease, gill disease, cardiomyopathy syndrome and bacterial infections.

Although access restrictions to the Roche automated analyser posed significant challenges, the project adapted by exploring alternative diagnostic formats. These included nanogold-based plate assays, lateral flow immunoassays (LFIA), and a multiplex bead-based immunoassay developed in collaboration with Environment Canada and the University of Waterloo.

The project also explored oxidative stress as an indicator of disease. A nitric oxide (NO) assay, based on Griess reagent chemistry, was trialled to distinguish between acute and chronic infections.

RESULTS

Key outcomes of the project include the development of immunoassay designs for four immune markers, assay optimisation to demonstrate acceptable performance and reproducibility, and validation of methods across different automated platforms using serum from health-challenged and experimentally infected salmon.

The nanogold assay demonstrated rapid, visual, and quantitative detection of IgM in under two hours, with high sensitivity and specificity. This approach was extended to a lateral flow format, using biotinylated IgM antibodies, which showed promise as a low-cost, field-deployable solution.

Although the lateral flow format had lower sensitivity, performance can be improved by quantifying the intensity of test bands, increasing its potential for practical field use. The plate-based method, while laboratory-based, remains more quantitative and specific, offering robust accuracy for biomarker detection. Meanwhile, a multiplex Bio-Plex MAGPIX immunoassay is in development to simultaneously detect IgM, interleukin-1 beta, and IgT for broader health monitoring.

Troponin was successfully validated as a biomarker for salmon health using the Roche Cobas analyser, representing a valuable tool for routine aquaculture health monitoring. The team is also finalising validation of haptoglobin as an additional diagnostic marker.

Although still being optimised, the nitric oxide assay provided valuable insights into immune response and disease progression. The ongoing development of the Luminex-based multiplex immunoassay, in partnership with the University of Waterloo, will enable simultaneous detection of multiple immune biomarkers, streamlining diagnostics and providing comprehensive health profiles.

Despite delays in reagent acquisition and restricted lab access, the team successfully pivoted to alternative methods. Collaborations facilitated the continued development of diagnostic tools aligned with the project's goals.

IMPACT

This project has strengthened existing collaborations with the University of Aberdeen and Bakkafrost Scotland while establishing new partnerships with Vertebrate Antibodies Ltd, Fleet Bioprocessing Ltd, Environment Canada, and the University of Waterloo. These partnerships are expected to drive long-term innovation in aquaculture diagnostics.

By validating and developing biomarker-based diagnostic tools, particularly multiplex assays and troponin-based tests, UWS and its partners have positioned themselves at the forefront of fish health innovation. The focus on IgM and troponins provides aquaculture stakeholders with new tools for detecting bacterial and viral infections more effectively.

These advancements support the sustainability of the seafood industry by enabling early disease detection, improving fish welfare, and reducing environmental impacts. The introduction of flexible, sensitive, and scalable diagnostic solutions marks a significant step forward in salmon health monitoring and disease management in Scottish aquaculture.

For information on the further development, commercialisation and international availability of these diagnostic advancements, please visit the WellFish Tech website.