Expression of recombinant antibodies in microalgae: from proof of concept to potential treatment for the aquaculture sector.

Supervisory team:
Lead supervisors: Dr Adam Monier (University of Exeter), Dr Susan Kimmance (Plymouth Marine Laboratory; PML)
Prof Mike J. Allen (University of Exeter), Dr Félix Cicéron (Plymouth Marine Laboratory; PML), Dr Rob Ellis (University of Exeter)

Collaborators: Prof Jung Tae Sung (College of Veterinary Medicine, Gyeongsang National University, South Korea), Dr Kim Thompson (Moredun Research Institute, Scotland)

Host institution: University of Exeter (Streatham/St Luke's), Plymouth Marine Laboratory; PML
Submit applications for this project to the University of Exeter

Project description:

Shrimp is one of the most valuable seafood products, representing a market of £20 billion per year. Around 55 % of the global shrimp production comes from farming, which generates valuable incomes in many countries. However, emerging infectious disease threaten this industry; pathogens such as the bacterium Vibrio parahaemolyticus cause hepatopancreatic necrosis disease (AHPND) by developing in the digestive tract of farmed shrimps and secreting toxins. Currently, solutions to control the spread of infection in aquacultures are limited to water disinfection using antibiotics or ozone, or providing antibacterial plant extracts, immunostimulants, and probiotics food supplements to the crustaceans - mainly bacteria and microalgae. None of those techniques is both sustainable and very efficient. So far, the most conclusive solution to limit V. parahaemolyticus infections consists of inducing a passive immunisation of shrimp by adding anti-Vibrio antibodies to their food. These tests are currently still at the research stage. In one study, antibodies were generated by infecting a fish with the vibrio's toxin. Following infections, the gene sequences encoding the antibodies were isolated and transformed into Human Embryonic Kidney (HEK) cell platforms. Antibodies were then produced by those HEK cells cultured in bioreactors, purified, and added to the shrimp food pellets. This approach is not economically viable when scaled up. However, this antibody could be produced and delivered directly within a microalga. This would be an ideal alternative since microalgae have two major advantages: they require inexpensive growth conditions, and several species can be used to produce recombinant proteins.

This project consists in producing fish antibodies in microalgae and show how microalgal synthetic biology can lead to new treatment solutions for the aquaculture sector. Various genetic sequences of a previously characterised anti-Vibrio antibody will be cloned into DNA constructs for transformation in microalgae. Several new signal peptides will be identified using bioinformatic methods in order to address the antibody localisation within specific cellular compartments. The antibody's affinity towards its target will be measured from microalgal crude extracts and after purification, to compare with the HEK cells' version. Once the most suitable clones are identified, similar analysis will be reproduced after scaling up the cultures and freeze-drying the cells. Upon completion of this PhD, the applicant can expect to have created a new cell platform that can be used for shrimp treatment trials. They will also have developed various molecular tools and methods that will be shared with the microalgae research community.