



Joining forces for a sustainable European aquaculture sector of the future

AQUAEXCEL²⁰²⁰ is a €9.7 million European Union-funded Horizon 2020 research infrastructure project aimed at supporting the sustainable growth of the aquaculture sector in Europe. It comprises a large group of leading European aquaculture research facilities that work towards bringing aquaculture research in Europe to a new level by 2020. It will do so by integration of the European aquaculture community, and providing it with crucial tools, facilities, and novel services to conduct advanced fish research.

Aquaculture currently provides about half of the fish for human consumption worldwide. The demand for fish is rising, but fisheries are not expected to grow due to fully or over-exploited fish stocks. Aquaculture production seeks to meet this increasing demand for fish, but while the aquaculture sector is growing in the rest of the world, it has stagnated in Europe in recent years. The European aquaculture industry has ambitions to grow sustainably with continuing efficient and environmentally responsible production of high-value fish products. This will be possible if it ensures excellent scientific research and translates results into innovation and industrial growth.



Nofima Centre for Recirculation in Aquaculture, Norway ©Nofima

European researchers need effective and convenient access to the best aquaculture research infrastructures to conduct research for the advancement of knowledge and technology in the aquaculture sector. AQUAEXCEL²⁰²⁰ aims to bring together, integrate, and open up diverse key national and regional aquaculture research infrastructures in Europe to all European researchers, from both academia and industry, ensuring their optimal use and joint development. These research infrastructures are made available through the AQUAEXCEL²⁰²⁰ Transnational Access (TNA) program. Building on the success of its predecessor AQUAEXCEL (2011-2015), the AQUAEXCEL²⁰²⁰ project unites a group of major aquaculture experimental facilities that have the capacity to undertake experimental trials on a selection of commercially important aquaculture fish species and system types.

Almost half of the project's budget will go into the provision of this transnational access to aquaculture research facilities and harmonised services for both academic users as well as private sector users, especially SMEs. Academic and industry researchers will then be able to perform their research projects with “free



Nofima Cleaner fish experimental unit, Norway ©Terje Aamodt and Nofima

of charge” access to 39 top EU aquaculture research infrastructures that are not available in their country of origin. Over 100 researchers have previously used this opportunity to extend their investigations including on different systems, species, and facility and water types, as part of AQUAEXCEL and AQUAEXCEL²⁰²⁰.

One of the current key areas of interest for the aquaculture industry is sustainable aquaculture feed, and fish farmers are always looking for sustainable feed that can make fish strong and healthy. A recently published study led by the Agencia Estatal Consejo Superior de Investigaciones Científicas (CSIC) in Spain concludes that marine feed ingredients in aquaculture can potentially be replaced by plant ingredients without detrimental effects, when appropriate feed additives are added.

This research was made possible through combining long-term research efforts in AQUAEXCEL and ARRAINA (an EU-funded project with focus on sustainable nutrition in aquaculture) with short-term studies through the Transnational Access (TNA) program in AQUAEXCEL and AQUAEXCEL²⁰²⁰. ARRAINA investigated fish diets with a high replacement of marine ingredients by plant raw materials as alternatives to the traditional fishmeal as aquaculture feed. The conjunction with the two TNA projects allowed this study’s integrative approach investigating the impact of the ARRAINA diets on the fish’s intestinal health and integrity.

The team of researchers of the Fish Nutrigenomics and



ICRA facilities, Spain ©Fernando de la Gándara and IEO

Pathology Groups of the Institute of Aquaculture Torre de la Sal (IATS-CSIC; project partner in AQUAEXCEL²⁰²⁰), in collaboration with scientific (Centro de Ciências do Mar - project partner in AQUAEXCEL²⁰²⁰, and Norwegian University of Life Sciences), and industrial (BIOMAR, and NOREL) partners, found that butyrate supplementation helps to preserve intestinal function in gilthead sea bream that are fed plant-based diets.

Plant-based fish food is seen as more sustainable than those containing marine products, such as fishmeal. Research shows that some farmed fish species can survive without any or with a very limited supply (< 7%) of marine feed ingredients but they can



- ✓ Higher survival and growth
- ✓ Prevention of malformations
- ✓ Reduce leaching of water soluble nutrients
- ✓ Increase lipid retention
- ✓ Better essential lipid composition of the fish



- ✓ Strongly antibacterial against gram-positive and gram-negative bacteria
- ✓ Stabilization of the intestinal microflora
- ✓ Strengthening of the animal intestinal barrier
- ✓ Easily digestible
- ✓ Improvement of growth and feed conversion



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Facilities at CSIC, Spain ©Jaume Pérez-Sánchez (IATS-CSIC)



Fish eggs ©INRA PEIMA

then suffer from decreased efficiency to digest food and increased susceptibility to diseases and stress. Sodium butyrate is one of the most promising feed additives to be used in aquaculture to prevent these adverse effects. It is a salt of short-chain fatty acid produced by bacterial fermentation of undigested carbohydrates.

Two Transnational Access (TNA) studies were conducted to define the most effective butyrate dose for gilthead sea bream based on growth performance and measures of intestinal function, architecture and permeability. Fish given the butyrate supplement showed fewer intestinal problems normally associated with a plant-based diet. This finding was supported by several different approaches carried out by the research team.

The authors investigated 80 intestinal genetic markers and could show changes in the expression of genes involved in antioxidant defence, epithelial permeability and mucus production when fish were fed with plant-based diets alone. Most of these were returned to normal when sodium butyrate was added to the diet. The research was published in the scientific journal PLOS ONE, (<http://dx.doi.org/10.1371/journal.pone.0166564>).

The team's next steps will be to investigate if the benefits of the butyrate supplement can also be found in the protein and bacteria composition found in the digestive system. It will be a big challenge to understand how these functional features are modified by genetic and epigenetic factors and an important step towards establishing gilthead sea bream as a powerful model for the development of sustainable and healthy fish feeds.

Other expected outcomes from the AQUAEXCEL²⁰²⁰ project are, for example, standardised protocols for fish experiments,

allowing high quality experimental designs and repeatability, including trait definitions, experimental conditions and procedures. The project is also developing innovative biosensors for monitoring the physiological status of fish in a minimal invasive manner. "FishBIT" is a new way to monitor fish health, welfare and nutritional condition via biosensors (to watch the video, visit www.aquaexcel2020.eu/media-centre/media). The project also plans to assemble catalogues of fish lines that are available for transnational access, with reference phenotypic and genomic information. Definition of common standards and data interoperability across research infrastructures will foster collaborative activities, including with two infrastructures of the European Strategy Forum on Research Infrastructures (ESFRI).

An integrated portal providing one-stop information about, and access to all aquaculture facilities in Europe is available through the project's website at www.aquaexcel2020.eu and will be continuously updated. Aquaculture facilities who would like to be included in this unique aquaculture research infrastructure directory, in the form of an interactive map, should visit the project website and register. The interactive map is a powerful tool to identify aquaculture facilities, genetic and human resources and to promote mutual collaboration.

AQUAEXCEL²⁰²⁰ is eager to contribute to educating a new generation of aquaculture researchers and industry stakeholders to use their new knowledge, skills and tools to advance an innovative, sustainable aquaculture sector. Nine unique state-of-the-art training courses, three of them held as distance learning courses, are being offered between April 2016 and September



NAIK Pond-in-pond system, Hungary ©NAIK HAKI



Sole breeders at AquaCOV facilities at IEO, Spain ©IEO



In the lab at INRA PEIMA, France ©INRA PEIMA



Sampling at ULPGC, Spain ©ULPGC

2020, and are open for anyone interested. Registration and course fee for participants are covered by the AQUAEXCEL²⁰²⁰ project.

Knowledge management plays a pivotal role in successful innovation. Therefore, AQUAEXCEL²⁰²⁰ has set up an innovative knowledge management protocol to ensure that all new knowledge will be transferred to relevant end users, facilitating the integration of new discoveries to the advancement of the European aquaculture sector. Researchers within the project and users of the transnational access (TNA) program are requested to describe their research results, together with their applications and anticipated impact. After consultation with aquaculture industry experts, the knowledge generated through the AQUAEXCEL²⁰²⁰ project and its TNA programme will be transferred to relevant industry stakeholders.

We cannot predict which innovations will come out of AQUAEXCEL²⁰²⁰ and its TNA programme, but we look forward to finding out. By establishing a facility within the project that aims at maximizing the possibilities for new knowledge to be translated into innovation, the possibilities for success are substantially increased. This brings us one step closer to our goal of supporting the sustainable growth of the aquaculture sector in Europe.

The AQUAEXCEL²⁰²⁰ consortium comprises 22 partners based in 12 European countries, who are considered leaders in their respective domains of expertise, offering access to 39 top-level aquaculture facilities in Europe.

The project will run for five years from 2015 to 2020, with a total budget of €9.7 million funded by the European Union. The project is coordinated by the Institut National de la Recherche Agronomique (INRA) in France.

Dr Marc Vandeputte, AQUAEXCEL²⁰²⁰ project coordinator, is a researcher in fish genetics and coordinates aquaculture research at INRA. Ranked the number one agricultural institute in Europe and number two in the world, INRA carries out mission-oriented research for high-quality and healthy foods, competitive and sustainable agriculture and a preserved and valorised environment. In aquaculture, INRA has internationally recognized teams in fish physiology, nutrition, genetics and pathology.

AquaTT is the project dissemination partner.
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