AQUA EXCEL 2020

AQUAculture infrastructures for EXCELlence in European fish research towards 2020 — AQUAEXCEL2020

D2.3b - Report on each of the brokerage events: #2

AquaTT, EATiP, NTNU

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 652831. This publication reflects only the view of the author, and the European Commission cannot be held responsible for any use which may be made of the information contained therein

Executive Summary

Objective: The AQUAEXCEL[2020] industry brokerage events are aimed to create a forum for the AQUAEXCEL[2020] research results, promoting engagement and exchange between researchers and potential beneficiaries, in particular industry stakeholders.

Rationale: Knowledge generated within the framework of the AQUAEXCEL[2020] project, both through the Transnational Access (TNA) programme, the Networking Activities (NA) and the Joint Research Activities (JRA), are communicated to the aquaculture industry community through the following parallel brokerage event activities: i) Innovative Output Catalogues (describing AQUAEXCEL[2020] knowledge OUTPUTs), ii) different types of presentations during the project industry brokerage events, and iii) AQUAEXCEL[2020] exhibition booths at the Aquaculture Europe events with dedicated information on the project actions and results. OUTPUTS generated within the project are also communicated to the aquaculture industry through other events such as EATiP meetings, Federation of Aquaculture Producer meetings, AquaNor and other major aquaculture events, and communication by partners, and IRAP members to their networks.

Knowledge OUTPUTS presented at the AQUAEXCEL[2020] industry brokerage events were selected by the project Industry and Research Advisory Panel (IRAP), identified as being high priority OUTPUTS for the aquaculture industry in Europe at present.

Main Results: The second AQUAEXCEL[2020] industry brokerage event “FROM RESEARCH INNOVATION TO INDUSTRY APPLICATION” was hosted as part of the EU-EATiP day during the Aquaculture Europe 2019 conference in Berlin (Germany) on 9 Oct 2019, 15:40-18:00.

The event was opened with a welcome by Courtney Hough (EATiP), followed by an introduction to the AQUAEXCEL[2020] project by Project Coordinator Dr Marc Vandeputte (INRA). The TNA programme was introduced to the participants, and the AQUAEXCEL3.0 project was announced, making attendees aware that further TNA opportunities will be available.

The core part of the brokerage event consisted of seven presentations on the selected knowledge OUTPUTS of high potential for transfer to the aquaculture industry. These OUTPUTS were a mix of OUTPUTS from the AQUAEXCEL[2020] project and from the AQUAEXCEL[2020] TNA programme. The topics of these knowledge OUTPUTS were: i) the effect of insect meal on the growth of sea bass, ii) defatted mealworm larvae meal as a feed for sea bass, iii) the effects of the addition of lactic acid bacteria to pike-perch feed, iv) a smart device for monitoring fish health and welfare, v) a functional model for fish growth, feed intake and waste production in aquaculture, vi) an early life management protocol for sea bream and vii) revelation of key molecules during amoebic gill disease (AGD) in Atlantic salmon. The presenters of the knowledge OUTPUTS were instructed in advance of their presentations to ensure focus for an industry audience.

After the OUTPUT presentations, an industry panel discussion followed, whereby industry experts had the opportunity to ask questions and further clarifications to the OUTPUT presenters. The panellists consisted of EATiP and National Mirror Platform representatives, as well as the CEO of MealFood Europe and Vice-President of IPIFF (International Platform of Insects for Food and Feed), since several OUTPUTs were insect-meal based.

Kahoot sessions (live appreciation through mobile phones) were carried out to gauge the audiences' interest in the OUTPUTS and how relevant they were to industry.

59 people from 18 different countries attended the event, roughly 22% from private companies, 61% from universities and research institutes, and 17% other (aquaculture cluster groups, government agencies, European Commission, etc).

Team members involved: Rebecca Doyle (AquaTT), Marieke Reuver (AquaTT), Catherine Pons (EATiP), Alexandra Neyts (EATiP), Courtney Hough (EATiP), Elin Kjørsvik (NTNU), Peadar O' Raifeartaigh (AquaTT), Olivia Daly (AquaTT), Anne Marie Williams (AquaTT), John Bostock (UoS).

Table of Contents

1 Introduction

The AQUAEXCEL2020 industry brokerage events are aimed to create a forum for engagement and exchange between researchers and potential beneficiaries of the research results, in particular industry stakeholders.

Knowledge generated within the framework of the AQUAEXCEL2020 project, both through the Transnational Access (TNA) programme, the Networking Activities (NA) and the Joint Research Activities (JRA), are communicated to the aquaculture industry community through the following parallel brokerage event activities: i) Innovative Output Catalogues (describing AQUAEXCEL2020 knowledge OUTPUTs), ii) different types of presentations during the project industry brokerage events, and iii) AQUAEXCEL2020exhibition booths at the Aquaculture Europe events with dedicated information on the project actions and results.

OUTPUTs generated within the project are also communicated to the aquaculture industry through other events such as EATiP meetings, Federation of Aquaculture Producer meetings, AquaNor and other major aquaculture events, communication by partners, and IRAP members to their networks.

Knowledge OUTPUTS presented at the AQUAEXCEL2020 industry brokerage events were selected by the project Industry and Research Advisory Panel (IRAP), as being high priority OUTPUTS for the aquaculture industry in Europe at present.

Innovative Output Catalogues are developed and disseminated for those high potential OUTPUTS. Researchers involved in the development of selected AQUAEXCEL2020 OUTPUTS are invited to present at the industry brokerage events.

The second AQUAEXCEL2020 industry brokerage event “FROM RESEARCH INNOVATION TO INDUSTRY APPLICATION” was hosted as part of the EU-EATiP day during the Aquaculture Europe 2019 conference in Berlin (Germany) on 9 Oct 2019, 15:40-18:00.

2 Before the Event

Preparation of the event

To ensure the AQUAEXCEL2020 industry brokerage event would be interesting for, and attract its core target audience, namely aquaculture industry stakeholders, the organisers carefully devised the programme focusing on its target audience.

The main aim of the event was to create a forum for engagement and exchange between researchers and potential industry beneficiaries of the research results generated from the AQUAEXCEL2020 project. AQUAEXCEL2020 produces many strong research results (OUTPUTS), of which numerous are expected to be relevant to the European aquaculture industry in particular. To facilitate successful transfer and exploitation of these OUTPUTS, the project has set up a procedure to collect and analyse all OUTPUTS and select those that could potentially be applied and have impact on the European aquaculture industry. In advance of the 2nd industry brokerage event, the project’s Industry & Research Advisory Panel (IRAP) met twice to discuss all OUTPUTS produced so far and select those OUTPUTS they identified as having potential high impact on industry. The IRAP made the final decision on which

OUTPUTS should be presented at the brokerage event, and also gave overall advice on event format that would facilitate transfer to industry.

It was advised and decided to keep the overall duration of the industry brokerage event short and efficient (half day), taking into account the limited time and resources of industry attendees. The event had to focus on short presentations of each of the selected OUTPUTS in a non-academic format. The organisers developed a PowerPoint template with clear instructions, to ensure the presenters tailored their presentation to an industry-focused audience. Presenters were instructed to prepare OUTPUT presentations using clear, concise language, understandable to a non-scientific audience and to make use of pictures, graphs, etc where possible. Information presented had to identify a clear industry need, the solution provided by the OUTPUT, the target market and economic impact, all key factors for industry stakeholders.

To keep attention focused, and to support monitoring the impact of the OUTPUTS as well as the event itself, it was decided to include interactive engagement as part of the programme, through means of Kahoot, an online poll tool. Another interactive element was inclusion of an industry panel discussion, giving industry experts the chance to ask OUTPUT owners for further clarifications. To facilitate further interaction and collaboration, it was decided to close with a drinks reception to offer the chance for OUTPUT owners and interested industry stakeholders to mingle in a relaxed atmosphere. The programme was planned to take all of the above into consideration.

Promotion of the event

The event was promoted in advance via promotional flyers, targeted emails and social media to interested stakeholders in the aquaculture research and industry communities.

A promotional flyer was developed which contained the scope of the event as well as the entire programme (see Annex 1 and Figure 1 below). This brokerage event flyer was distributed via aquaculture research and industry stakeholder email lists (e.g. through EATiP, FEAP, EAS, other aquaculture related EU-funded projects) and social media as well as internally to AQUAEXCEL2020 partners with the request to share widely within their networks.

The flyer was also distributed at Aquaculture Europe 2019 itself, in particular amongst the industry exhibition booths, and was displayed on the AquaTT and EATiP exhibition booths. The AquaTT exhibition booth also displayed a large A1 poster advertising the brokerage event.

AQUAculture Infrastructures for EXCELlence In European fish research towards 2020 – AQUAEXCEL2020

AQUAEXCEL2020 BROKERAGE EVENT 2019

FROM RESEARCH INNOVATION TO INDUSTRY APPLICATION

Are you working in the European aquaculture industry, and would you like to hear about the latest innovative research findings which can be applied to the aquaculture industry?

Would you like to contribute to the discussion on what industry expects from aquaculture research?

Curious to know how you can access top-class European aquaculture research infrastructures to carry out your applied research, fully funded by the European Commission?

Join us at the AQUAEXCEL2020 brokerage event to engage with aquaculture industry stakeholders and researchers!

Wednesday 9 October 2019, 15:40-18:00
at Aquaculture Europe 2019
Exhibition 2, ESTREL Congress Center, Berlin (Germany)

This event, organised by EATIP and AquaTT, will create a forum for engagement and exchange between researchers and potential industry beneficiaries of the research results generated from the AQUAEXCEL2020 project.

REGISTRATION

You are invited to register in advance by emailing secretariat@eatip.eu with your name and contact details, but participants are also welcome to join on the day. For more information visit www.aquaexcel2020.eu or say hello at the AquaTT (no. 33) or EATIP (no. 149) booths at Aquaculture Europe 2019.

WWW.AQUAEXCEL2020.EU
@AQUAEXCEL2020

AQUAEXCEL2020 BROKERAGE EVENT PROGRAMME

INTRODUCTION TO AQUAEXCEL2020	
15:40 - 15:45	**Welcome** Mr Courtney Hough (European Aquaculture Technology and Innovation Platform, EATiP)
15:45 - 15:55	**Introducing AQUAEXCEL2020 and its Relevance to the Aquaculture Industry** Dr Marc Vandeputte (Institut National de la Recherche Agronomique, INRA)
AQUAEXCEL2020: FROM RESEARCH INNOVATION TO INDUSTRY APPLICATION	
15:55 - 16:05	**Effect of Insect Meal on the Growth of European Sea Bass** Dr Stavros Chatzifotis (Hellenic Centre for Marine Research, HCMR)
16:05 - 16:15	**Defatted mealworm (*Tenebrio molitor*) larvae meal as a sustainable feed source for European sea bass** Ana Basto (Interdisciplinary Centre of Marine and Environmental Research of the University of Porto, CIIMAR)
16:15 - 16:25	**Lactic Acid Bacteria Improve Growth and Reduce Potentially Pathogenic Bacteria Levels in Pike-Perch** Dr Jovanka Lukic (University of Belgrade)
Interactive engagement through Kahoot	
16:35 - 16:40	**Video - AE-FishBIT: A Smart Device for Monitoring Fish Health and Welfare** Dr Jaume Pérez-Sánchez (Consejo Superior de Investigaciones Científicas, CSIC)
16:40 - 16:50	**AquaFishDEB: A Functional Model for Fish Growth, Feed Intake and Waste Production in Aquaculture** Orestis Stavrakidis-Zachou (Hellenic Centre for Marine Research (HCMR) / University of Crete)
16:50 - 17:00	**Early Life Management Protocol for Optimal Performance of Sea Bream** Dr Josep Calduch-Giner (Consejo Superior de Investigaciones Científicas, CSIC)
17:00 - 17:10	**Revelation of Key Molecules during Amoebic Gill Disease (AGD) in Atlantic Salmon** Dr Carla Piazzon (Consejo Superior de Investigaciones Científicas, CSIC)
Interactive engagement through Kahoot	
AQUAEXCEL2020 PERSPECTIVES FROM THE INDUSTRY	
17:20 - 17:50	**Industry Panel Discussion** Moderators: Mr Courtney Hough / Ms Catherine Pons (EATiP) Panelists: Fernando Torrent (Madrid Polytechnic University / EATiP) Arnault Chaperon (Caviar Pirinea / EATiP) Kjell Maroni (Norwegian Seafood Research Fund - FHF / EATiP) Hamish Rodger (Fish Vet Group / EATiP) Jesper Heldbo (Aquacircle / MiP Denmark) Damien Toner (BIM / MiP Ireland) Yolanda Molares (Acuiplus / MiP Spain) Adriana Casillas (MealFood Europe / IPIFF)
17:50 - 17:55	**Closing of the Event** Mr Courtney Hough (European Aquaculture Technology and Innovation Platform, EATiP)
Drink Reception - All welcome to mingle in a relaxed atmosphere!	

CONTACT US
Project Coordination: marc.vandeputte@inra.fr
Project Management: benedicte.ferreira@inra.fr
Brokerage Event Management: marieke@aquatt.ie
IRAP: secretariat@eatip.eu
Communication & Press: rebecca@aquatt.ie

WWW.AQUAEXCEL2020.EU
@AQUAEXCEL2020

This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement no. 652831. This output reflects the views only of the author(s), and the European Union cannot be held responsible for any use which may be made of the information contained therein.

Designed & developed by AquaTT

Fig 1: AQUAEXCEL2020 Brokerage Event 2019 promotional flyer

Fig 2: AQUAEXCEL2020 Brokerage Event 2019 promotional poster that was displayed at the AquaTT exhibition booth.

Fig 3: AQUAEXCEL2020 Brokerage Event 2019 promotional poster being displayed at the AquaTT exhibition booth.

Innovative Output Catalogues

AquaTT developed Innovative Output Catalogues for each knowledge OUTPUT that was presented at the brokerage event (see Annex 2). This involved collecting project catalogue templates from the knowledge OUTPUT owners. These templates have a number of sections to be completed, including information on the research carried out, who the results would have most impact for, etc. AquaTT then worked with the researchers to expand on the information they were given and develop it into an Innovative Output Catalogue that was concise and readable for the aquaculture industry. Innovative Output Catalogues are easy-to-read and attractive promotional leaflets to disseminate and facilitate knowledge transfer of high-potential OUTPUTS. The Catalogues focus on conveying information of relevance to industry end-users, highlighting aspects such as potential impact, underlying science, results, end-users and potential applications for each type of end-user, and status in terms of Technology Readiness Level, explaining what further activities are foreseen. The Innovative Output Catalogues were printed and made available for attendees of the brokerage event. They were also displayed at AquaTT's exhibition booth for exhibition visitors to take away after the brokerage event and they facilitated in-depth discussions with visitors to the booth.

3 The Brokerage Event

The industry brokerage event "FROM RESEARCH INNOVATION TO INDUSTRY APPLICATION" was hosted as part of the EU-EATiP day during the Aquaculture Europe 2019 conference in Berlin (Germany) on 9 Oct 2019, 15:40-18:00.

The brokerage event was opened with a welcome by EATiP (Courtney Hough), who explained the purpose of the event, highlighted the networking opportunities and introduced the panel members to the audience. This was followed by an introduction to the AQUAEXCEL[2020] project by its coordinator (Dr Marc Vandeputte, INRA). The TNA programme was introduced to the attendees, along with the announcement of the new and follow-up project AQUAEXCEL3.0, making attendees aware that further TNA opportunities will be available.

Fig 4: Courtney Hough (EATiP) opens the brokerage event and welcomes all attendees

Fig 5: Marc Vandeputte (INRA), AQUAEXCEL[2020] coordinator, announces AQUAEXCEL3.0

Dr. Stavros Chatzifotis (Hellenic Centre for Marine Research, HCMR) gave the first feed-focused presentation, speaking about his research results on the "Effect of Insect Meal on the Growth of European Sea Bass." Following Dr. Chatzifotis, PhD student Anna Basto (Interdisciplinary Centre of Marine and Environmental Research of the University of Porto, CIIMAR) spoke about "Defatted mealworm (*Tenebrio molitor*) larvae meal as a sustainable feed source for European sea bass." The final feed-themed presentation was provided by Dr Jovanka Lukic (University of Belgrade) who presented on her research results "Lactic Acid Bacteria Improve Growth and Reduce Potentially Pathogenic Bacteria Levels in Pike-Perch."

Fig 6: Stavros Chatzifotis (HCMR) presenting on the "Effect of Insect Meal on the Growth of European Sea Bass."

Fig 7: Ana Basto (CIIMAR) discusses the current status of her research on "Defatted mealworm (*Tenebrio molitor*) larvae meal as a sustainable feed source for European sea bass".

Fig 8: Jovanka Lukic (University of Belgrade) discusses the industry need of her OUTPUT resulting from her research on "Lactic Acid Bacteria Improve Growth and Reduce Potentially Pathogenic Bacteria Levels in Pike-Perch".

A Kahoot session followed these presentations (described in Section 4: Feedback Assessment).

Fig 9: The first Kahoot session presented on-screen, assessing industry needs, experiences and relevance of the presented OUTPUTs.

The second round of presentations began with Dr. Jaume Pérez-Sánchez (Consejo Superior de Investigaciones Científicas, CSIC), who presented AEFishBIT – an AQUAEXCEL[2020] project Joint Research Activity (JRA) OUTPUT. Dr. Jaume Pérez-Sánchez played a video explaining the purpose of AEFishBIT - a smart device for monitoring fish health and welfare. Following this, Orestis Stavrakidis-Zachou (Hellenic Centre for Marine Research (HCMR) / University of Crete) presented on another AQUAEXCEL[2020] JRA OUTPUT called AquaFishDEB, a functional model for fish growth, feed intake and waste production in aquaculture. Dr Josep Calduch-Giner (Consejo Superior de Investigaciones Científicas, CSIC) then presented an early life management protocol for optimal performance of sea bream that focused on hypoxia impacts. Dr Carla Piazzon (Consejo Superior de Investigaciones Científicas, CSIC) provided the final presentation of the event titled "Revelation of Key Molecules during Amoebic Gill Disease (AGD) in Atlantic Salmon." Another Kahoot session followed this round of presentations.

Fig 10: Dr. Jaume Perez-Sanchez (CSIC) shows the AEFishBIT video, a promotional tool to disseminate information on this smart device for monitoring fish health and welfare.

Fig 11: Orestis Stavrakidis-Zachou (Hellenic Centre for Marine Research (HCMR) / University of Crete) describes the AquaFishDEB model and which industry-relevant needs it can help to predict.

Fig 12: Dr. Josep Calduch-Giner (CSIC) presenting on the early life management protocol for optimal performance of sea bream

Fig 13: Carla Piazzon (CSIC) discusses the industry need for her OUTPUT around Revelation of Key Molecules during Amoebic Gill Disease (AGD) in Atlantic Salmon.

A second Kahoot session followed these presentation (described in the Section 4: Feedback Assessment).

Fig 14: The second Kahoot session gathered feedback on the final OUTPUT presentations, to provide insights into current issues and priorities for the aquaculture industry.

Following the presentations, perspectives from the aquaculture industry were sought through an interactive panel discussion. The organisers had invited EATiP / IRAP, as well as national Mirror Platforms representatives and the CEO of MealFood Europe and Vice-President of IPIFF (International Platform of Insects for Food and Feed), since several OUTPUTs were insect-meal based, to be part of the industry panel. Members of the public were also invited to ask questions and engage in the discussions around the presented OUTPUTS. Attendees were eager to find out more details of each of the research results, and further discussions were encouraged after the plenary session, by facilitating an informal networking event.

Questions / discussions:

Dr. Stavros Chatzifotis (Hellenic Centre for Marine Research, HCMR) – "Effect of Insect Meal on the Growth of European Sea Bass."

> It was remarked that freshwater fish feed on insects as their natural diet, while this is not the case for marine fish. Therefore, it was suggested that the best and most efficient strategy for use of insect meal is for freshwater fish, rather than marine fish.
>
> The importance of amino acids in the diet was discussed, along with the significance of costs. An industry suggestion was to use waste food from human consumption for insect feed, to speed up the process.

Anna Basto (Interdisciplinary Centre of Marine and Environmental Research of the University of Porto, CIIMAR) – "Defatted mealworm (*Tenebrio molitor*) larvae meal as a sustainable feed source for European sea bass."

> It was questioned whether there was any trend observed between residual and 100%, or only at 100% substitution. Ana responded saying that with up to 80% replacement they did not find a change in lipid content and hepatosomatic index and only total substitution (100%) led to some problems. She elaborated on the results, highlighting that she also analysed 12 genes related to lipid metabolism which also confirmed that up to 80% replacement is fine, but over that there seem to be problems. The industry experts suggested to also analyse histology, which was accepted as a future task.

Dr Jovanka Lukic (University of Belgrade) – "*Lactic Acid Bacteria Improve Growth and Reduce Potentially Pathogenic Bacteria Levels in Pike-Perch*."

Industry experts were eager to hear whether the OUTPUT contained information on any changes in the microbiota of the gut. Jovanka confirmed that level of pathogens was significantly reduced.

It was questioned whether there are plans to expand the same type of research to other fish species as well and it was confirmed that research is currently ongoing through another AQUAEXCEL[2020] TNA project, and that there is the expectation to move to other fish species at a later stage.

Dr. Jaume Pérez-Sánchez (Consejo Superior de Investigaciones Científicas, CSIC) – AEFishBIT, a smart device for monitoring fish health and welfare.

It was questioned whether the device is applicable for all fish size ranges or certain ranges only. At the moment the optimum size range is 100 – 200, with a minimum size of less than 50 and the aim is to make it applicable for even smaller sizes.

It was questioned what is expected to be gained more with the device than what could be measured by digital imaging? It was discussed that the device can be used complementary to digital imaging. In addition, you can then phenotype the different animals and combine it with the physiological responses, which would be a real novelty. It was also commented that it would be interesting to apply this for diseases, it is possible to predict so much just looking at behaviour. Another mentioned advantage is that with a device such as this, the number of animals that can be surveyed increases significantly.

Orestis Stavrakidis-Zachou (Hellenic Centre for Marine Research (HCMR) / University of Crete) - AquaFishDEB, a functional model for fish growth, feed intake and waste production in aquaculture.

One of the industry experts remarked that looking at it from a producer point of view, being a producer himself, they would definitely benefit from this type of tool (model) to prove to administration / government level for example what is actually the level of feed input and waste at farm level, as a justification to ask for new licenses in the future.

It was also asked how the AquaFishDEB model is different from other already existing models, particularly in relation to feed. It was explained that several other models were used to identify the rations in the feed, optimising existing models. Overall, the main difference is that the AquaFishDEB model has a more solid theory behind, and a more robust framework.

Dr Carla Piazzon (Consejo Superior de Investigaciones Científicas, CSIC) - *Revelation of Key Molecules during Amoebic Gill Disease (AGD) in Atlantic Salmon.*

It was questioned what the susceptibility after treatment was, in particular in relation to any immunity consequences. The presenter responded that this wasn't investigated yet and not known. Another attendee remarked that there is currently a study going on dealing with that question specifically. It was also asked whether the presenter sees the results as being applicable as potential early detection method for gill problems, and the response was that probably it would be possible indeed. The fish react very quickly to any respiration problem and regular tests should be able to reveal this.

59 people from 18 different countries attended the event, roughly 22% from private companies, 61% from universities and research institutes, and 17% other (aquaculture cluster groups, government agencies, European Commission, etc).

4 Feedback assessment

During the event, a real-time feedback survey was performed using two “KAHOOT” sessions. Participants were asked to log into an active online survey and answer some questions to get insight into aquaculture industry needs and wishes in general, questions related to the presented OUTPUTS, as well as a few feedback questions regarding the scope and format of the event to ensure the best possible knowledge transfer strategy and success.

Almost all participants found the format of the brokerage event and its presentations appropriate, and a large majority of the participants found the presentations highly relevant and interesting for industry. For the two KAHOOT surveys, 26-28 participants logged on, with 3-5 people not answering all questions. The majority of participants (70-74%) were from the public sector (including research/universities). The results from the two KAHOOT surveys are shown in Figures 15 and 16.

From the first session (Figure 15), 6 of 20 responded that they had tried insect meal in fish feed (1 with poorer fish growth), whereas most would need more proof before they would use it. When asked about the main challenge with using insect meal substitution for fish meal, a large majority thought this would be volume capacity and costly production. More than half (64%) of the respondents thought that plants/algal products and insects would be the most promising substitution alternatives for fish meal, and 20% answered that they did not know. Most respondents (80%) thought that increased use of probiotics in fish feed is promising for improved production results.

From the second Kahoot session (Figure 16), more than half of the respondents would be interested in a collaboration with the FishBIT creators, and 80 % answered that the AE-FishBIT was interesting to buy if it becomes available on the market. Most respondents (70%) would need more information before they would be interested in using the AquaFishDEB model. However, the topic is very relevant; almost all respondents were currently using (50%) or were planning to use (42%) models for growth and feeding in their systems (laboratory/farm). Nearly half of the 20 respondents could be interested in applying “early acute hypoxia” conditions (the “early life management protocol”) for their own young fish, although the other half did not know or thought it was too risky.

For the question about which issues would be the most important to solve 43% chose the option of “improved rearing technology for fish welfare”, before “alternative feed materials” and “new vaccines”.

Almost all respondents (96%) were interested in getting more information about the presented results, and most people answered that they would prefer to contact the speaker at a later time. However, during the social drinks reception, quite a few attendees contacted the speakers directly and showed their interest. Our conclusion was that a large majority found the OUTPUTS highly relevant and interesting for industry, and that the AQUAEXCEL2020 evaluation system is appropriate for the impact analysis. Such events could also be held more directly at industry related meetings in order to increase the number of industry stakeholders who are reached, as this brokerage event had a high number of research/academic attendees.

Further details of the KAHOOT survey results will be found in Deliverable D2.5 (Impact Analysis).

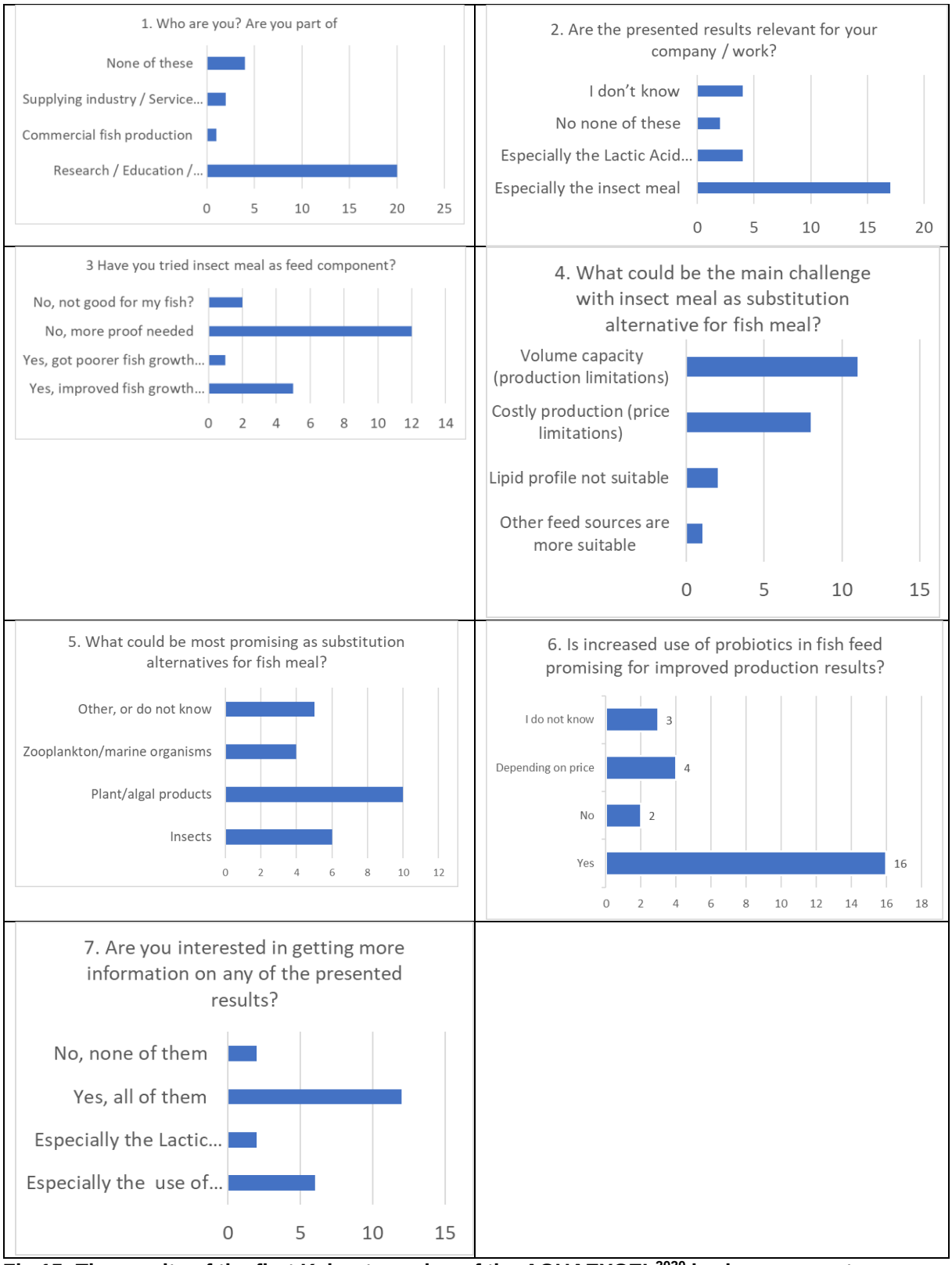


Fig 15: The results of the first Kahoot session of the AQUAEXCEL2020 brokerage event.

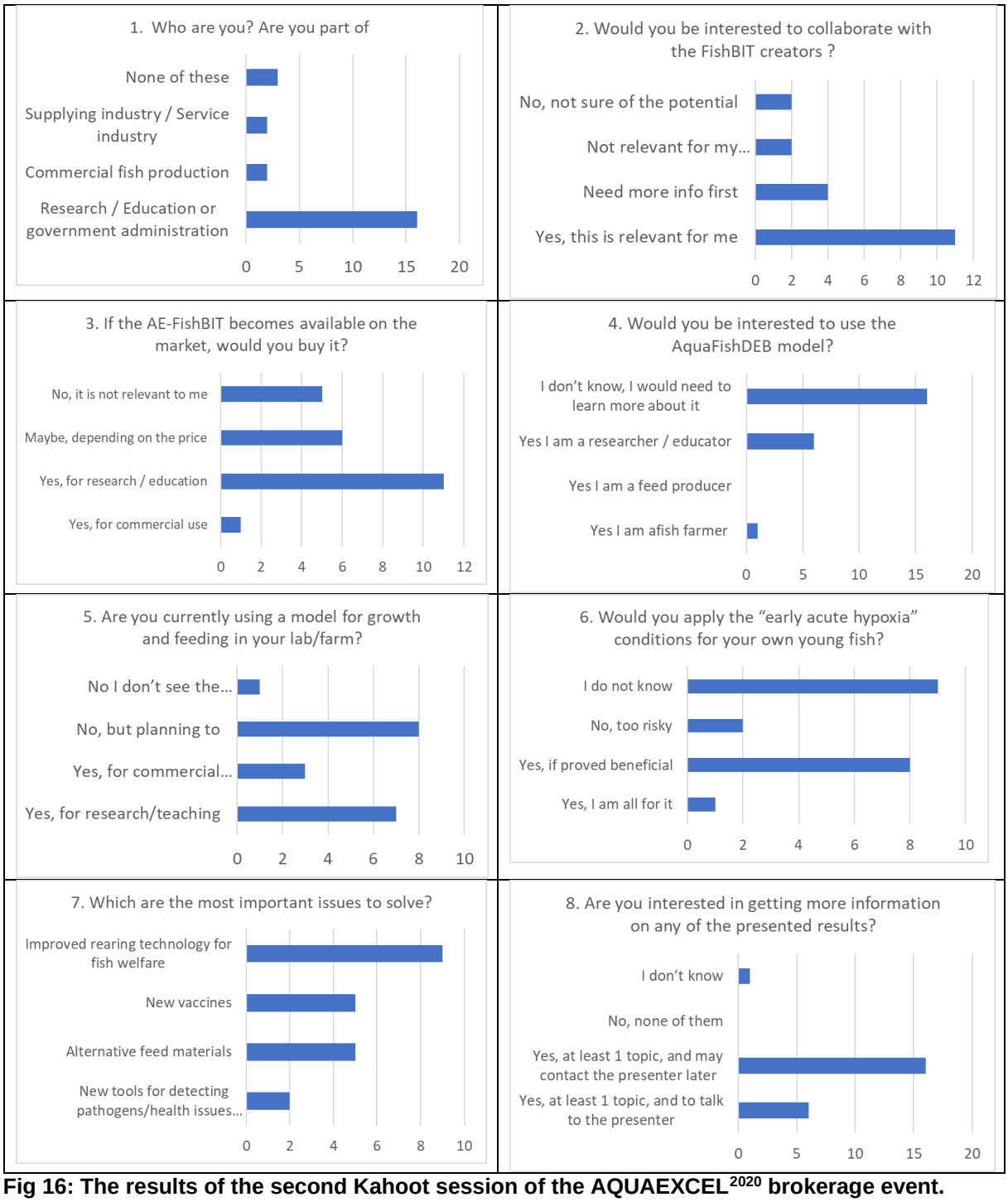


Fig 16: The results of the second Kahoot session of the AQUAEXCEL2020 brokerage event.

5 After the Event

All Innovative Output Catalogues from the OUTPUTS presented at the brokerage event are available online on the project's website: www.aquaexcel2020.eu. This will contribute to the promotion of both the TNA and AQUAEXCEL2020 research results on a wider level.

All knowledge OUTPUT presenters will be requested to complete a feedback survey, which included the identification of additional end-users following the brokerage event, the

description of follow-up discussions and interested stakeholders and possible future collaborations.

The survey will be repeated after the final AQUAEXCEL2020 brokerage event to monitor knowledge exploitation and transfer success.

6 Conclusion

The second AQUAEXCEL2020 industry brokerage event was successfully held on 9 October 2019, during the Aquaculture Europe 2019 conference in Berlin (Germany). The event was integrated as part of the EU-EATiP day since it was considered to be an effective and relevant forum for engagement and exchange between researchers and potential beneficiaries of the AQUAEXCEL2020 research results, namely aquaculture industry stakeholders.

Knowledge generated within the framework of the AQUAEXCEL2020 project was communicated to the aquaculture industry community through means of presentations on selected Knowledge OUTPUTS. In addition, Innovative Project Catalogues (describing the AQUAEXCEL2020 knowledge OUTPUTs) were handed out and there were AquaTT and EATiP exhibition booths at the Aquaculture Europe 2019 event with dedicated information on the project actions and results.

Knowledge OUTPUTS presented at the second AQUAEXCEL2020 industry brokerage event in Berlin were selected by the project Industry and Research Advisory Panel (IRAP), as being high priority OUTPUTS for the aquaculture industry in Europe at present.

7 Glossary

AQUAEXCEL[2020]: AQUAculture Infrastructures for EXCELlence in European Fish Research towards 2020

CIIMAR: Interdisciplinary Centre of Marine and Environmental Research of the University of Porto

CSIC: Consejo Superior de Investigaciones Cientificas

EATiP: European Aquaculture Technology and Innovation Platform

FEAP: Federation of European Aquaculture Producers

HCMR: Hellenic Centre for Marine Research

INRA: Institut National de la Recharche Agronomique

IRAP: Industry Research Advisory Panel

JRA: Joint Research Activity

8 Document information

EU Project N°	652831	Acronym	AQUAEXCEL2020
Full Title	AQUAculture Infrastructures for EXCELlence in European Fish Research towards 2020		
Project website	https://aquaexcel2020.eu/		

Deliverable	N°	D2.3	Title	Report on each of the brokerage events
Work Package	N°	2	Title	NA2 – Fostering Innovation from RIs

Date of delivery	Contractual	09/2019 (Month 48)	Actual	10/2019 (Month 49)
Dissemination level	X	PU Public, fully open, e.g. web		
		CO Confidential, restricted under conditions set out in Model Grant Agreement		
		CI Classified, information as referred to in Commission Decision 2001/844/EC.		

Authors (Partner)	AquaTT, EATiP, NTNU			
Responsible Author	Name	Rebecca Doyle (AquaTT), Marieke Reuver (AquaTT) Courtney Hough Catherine Pons (EATiP) Alexandra Neyts Elin Kjørsvik (NTNU)	Email	rebecca@aquatt.ie; marieke@aquatt.ie; Courtney@eatip.eu; Catherine@eatip.eu; alexandra@eatip.eu elin.kjorsvik@ntnu.no

Version log			
Issue Date	Revision N°	Author	Change
dd/mm/yyyy			Ex: first version/first review by WP leader etc/ version

Annex 1 – Brokerage Event Flyer

AQUA EXCEL 2020

AQUAculture infrastructures for EXCELlence in European fish research towards 2020 – AQUAEXCEL2020

AQUAEXCEL2020 BROKERAGE EVENT 2019

FROM RESEARCH INNOVATION TO INDUSTRY APPLICATION

Are you working in the European aquaculture industry, and would you like to hear about the latest innovative research findings which can be applied to the aquaculture industry?

Would you like to contribute to the discussion on what industry expects from aquaculture research?

Curious to know how you can access top-class European aquaculture research infrastructures to carry out your applied research, fully funded by the European Commission?

Join us at the AQUAEXCEL2020 brokerage event to engage with aquaculture industry stakeholders and researchers!

Wednesday 9 October 2019, 15:40-18:00
at Aquaculture Europe 2019
Exhibition 2, ESTREL Congress Center, Berlin (Germany)

This event, organised by EATiP and AquaTT, will create a forum for engagement and exchange between researchers and potential industry beneficiaries of the research results generated from the AQUAEXCEL2020 project.

REGISTRATION

You are invited to register in advance by emailing secretariat@eatip.eu with your name and contact details, but participants are also welcome to join on the day. For more information visit www.aquaexcel2020.eu or say hello at the AquaTT (no. 33) or EATiP (no. 149) booths at Aquaculture Europe 2019.

AQUATT

WWW.AQUAEXCEL2020.EU
@AQUAEXCEL2020

AQUAEXCEL2020 BROKERAGE EVENT PROGRAMME

INTRODUCTION TO AQUAEXCEL2020	
15:40 - 15:45	**Welcome** Mr Courtney Hough (European Aquaculture Technology and Innovation Platform, EATIP)
15:45 - 15:55	**Introducing AQUAEXCEL2020 and its Relevance to the Aquaculture Industry** Dr Marc Vandeputte (Institut National de la Recherche Agronomique, INRA)
AQUAEXCEL2020: FROM RESEARCH INNOVATION TO INDUSTRY APPLICATION	
15:55 - 16:05	**Effect of Insect Meal on the Growth of European Sea Bass** Dr Stavros Chatzifotis (Hellenic Centre for Marine Research, HCMR)
16:05 - 16:15	**Defatted mealworm (*Tenebrio molitor*) larvae meal as a sustainable feed source for European sea bass** Ana Basto (Interdisciplinary Centre of Marine and Environmental Research of the University of Porto, CIIMAR)
16:15 - 16:25	**Lactic Acid Bacteria Improve Growth and Reduce Potentially Pathogenic Bacteria Levels in Pike-Perch** Dr Jovanka Lukic (University of Belgrade)
Interactive engagement through Kahoot	
16:35 - 16:40	**Video - AE-FishBIT: A Smart Device for Monitoring Fish Health and Welfare** Dr Jaume Pérez-Sánchez (Consejo Superior de Investigaciones Científicas, CSIC)
16:40 - 16:50	**AquaFishDEB: A Functional Model for Fish Growth, Feed Intake and Waste Production in Aquaculture** Orestis Stavrakidis-Zachou (Hellenic Centre for Marine Research (HCMR) / University of Crete)
16:50 - 17:00	**Early Life Management Protocol for Optimal Performance of Sea Bream** Dr Josep Calduch-Giner (Consejo Superior de Investigaciones Científicas, CSIC)
17:00 - 17:10	**Revelation of Key Molecules during Amoebic Gill Disease (AGD) in Atlantic Salmon** Dr Carla Piazzon (Consejo Superior de Investigaciones Científicas, CSIC)
Interactive engagement through Kahoot	
AQUAEXCEL2020 PERSPECTIVES FROM THE INDUSTRY	
17:20 - 17:50	**Industry Panel Discussion** Moderators: Mr Courtney Hough / Ms Catherine Pons (EATIP) Panelists: Fernando Torrent (Madrid Polytechnic University / EATIP) Arnault Chaperon (Caviar Pirinea / EATIP) Kjell Maroni (Norwegian Seafood Research Fund - FHF / EATIP) Hamish Rodger (Fish Vet Group / EATIP) Jesper Heldbo (Aquacircle / MIP Denmark) Damien Toner (BIM / MIP Ireland) Yolanda Molares (Aculplus / MIP Spain) Adriana Casillas (MealFood Europe / IPIFF)
17:50 - 17:55	**Closing of the Event** Mr Courtney Hough (European Aquaculture Technology and Innovation Platform, EATIP)
Drink Reception – All welcome to mingle in a relaxed atmosphere!	

CONTACT US

Project Coordination: marc.vandeputte@inra.fr
Project Management: benedicte.ferreira@inra.fr
Brokerage Event Management: marieke@aquatt.ie
IRAP: secretariat@eatip.eu
Communication & Press: rebecca@aquatt.ie

WWW.AQUAEXCEL2020.EU
@AQUAEXCEL2020

This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement no. 652831. This output reflects the views only of the author(s), and the European Union cannot be held responsible for any use which may be made of the information contained therein.

Designed & developed by AquaTT

Annex 2 – Project Catalogues (8)

NUTRIENT AND ENERGY DIGESTIBILITY OF INSECT MEAL IN SEA BASS

AQUA EXCEL 2020

SUMMARY

This study evaluated and compared the nutrient and energy digestibility of sea bass diets in which 30% of fish meal was replaced by proteins from the insects *Tenebrio molitor*, *Hermetia illucens*, *Musca domestica*, *Zophobas morio* or *Alphitobius diaperinus*. The results indicate that the inclusion of *Musca domestica* and *Tenebrio molitor* had no adverse effects on the digestibility of the diets, and that fish meal can be successfully substituted by those insects in the diets of European sea bass at 30% replacement level. This study will be of particular interest to aquafeed producers who wish to use insects as an alternative food source.

KNOWLEDGE NEED

Fish farmers rely on sustainable feed that can make fish strong and healthy. The aquaculture industry is looking for alternative feed sources because the supply of key ingredients of fish feed found in fish meal and fish oil is limited. However, completely replacing these feed sources in a fish's diet can lead to adverse effects on its health, including decreased digestion efficiency and increased susceptibility to diseases and stress. Alternative fish feed sources with high biological value and low competitiveness with human food are needed, and their safe substitution levels must be established.

POTENTIAL IMPACT

- Substituting sea bass (and other species') diets with insect meal reduces the need for fish meal and oil, which are costly, volatile, and unsustainable sources, potentially leading to a more sustainable and competitive aquaculture sector.
- The establishment of insect meal as a suitable feed substitution for sea bass opens the door for further research into its applicability for other aquaculture species.
- The findings could contribute towards improving ecological and social sustainability of fish feeds, especially if applied to multiple species.

EATiP – Strategic Research and Innovation Agenda (SRIA) Thematic Area 4 - Sustainable Feed Production: Goal 1, Goal 2 and Goal 3; Thematic Area 2 - Technology & Systems: Goal 1. To see the full list and descriptions of the thematic areas and goals, please visit: **eatip.eu/?page_id=46**

AQUAEXCEL2020 PROJECT CATALOGUE

WWW.AQUAEXCEL2020.EU
@AQUAEXCEL2020

UNDERLYING SCIENCE

This experiment evaluated and compared the nutrient and energy digestibility of diets in which 30% of fish meal was replaced by proteins from the insects *Tenebrio molitor*, *Hermetia illucens*, *Musca domestica*, *Zophobas morio* or *Alphitobius diaperinus*. 18 groups of 15 fish were placed into 18 indoor 250L cylindroconical tanks equipped with a settling column. Diets were designed to be isoproteic (containing comparable amounts of protein) and isoenergetic (containing comparable amounts of energy) and to meet the nutrient requirements of sea bass. The apparent digestibility coefficients (ADCx), which provide estimates of nutrient availability in feedstuffs, were determined using 1% celite® as an inert marker. The nutrients examined were dry matter, organic matter, crude protein, crude fat, acid detergent fibre and energy.

RESULTS

- The diets containing *Musca domestica* and *Tenebrio molitor* showed overall digestibility similar to each other and to the one of standard fish meal (without insect replacement).
- Despite the poor digestibility of the *Zophobas morio* diet in terms of dry matter, organic matter and energy, the protein and fat digestibility were similar to standard fish meal.
- Acid Detergent Fiber (ADC_{ADF}), the fraction of the diet containing chitin from the insects but also lignin from plant ingredients, was significantly higher in *Zophobas morio* and *Alphitobius diaperinus* diets. Some studies have shown that chitin can interfere with fat digestibility, however in the present study no differences were found in ADC_{EF}.
- Overall, the results indicate that the inclusion of *Musca domestica* and *Tenebrio molitor* meal had no adverse effects on the digestibility of the diets and that fish meal can be successfully substituted by those insects in the diets of European sea bass at a level of 30% replacement.

END-USERS & POTENTIAL APPLICATIONS

END-USER 1: Sea bass fish feed producers
APPLICATION: Developing and producing novel feed formulations based on alternative, safe and sustainable feed sources (like insect meal) with high biological value and low competitiveness with human nutrition.

END-USER 2: Sea bass farmers
APPLICATION: Feeding of aquaculture fish stocks with more sustainable (and potentially cheaper) fish feeds while keeping good production levels, leading to higher profits and reduced impact on the environment.

END-USER 3: Aquaculture marketing and lobby groups
APPLICATION: Supporting a sustainable, dynamic image of the aquaculture sector, working towards improving global food security while decreasing environmental impact.

END-USER 4: Aquaculture researchers
APPLICATION: Furthering knowledge relating to fish meal replacement and its effect on nutrient digestibility in sea bass and other fish species.

STATUS

Technology Readiness Level (TRL) 4 – the knowledge has been validated in a laboratory environment.

Further research is needed to:

- Establish the precise optimal *Musca domestica* and *Tenebrio molitor* substitution rate in sea bass diets.
- Investigate further effects of the *Musca* and *Tenebrio* diet substitution on other crucial elements such as digestive organs and their tissues, and microbiota composition.
- Understand changes in susceptibility to stressors under different diet compositions.
- Explore suitability for other species and/or life stages.
- Examine potential effects on the fish product, e.g. on texture, odour and taste.
- Perform feeding trials on a commercial scale (i.e. validated and demonstrated in an industrially relevant environment).

AT A GLANCE

TITLE: Nutrient and Energy Digestibility of Insect Meal in Sea Bass
KNOWLEDGE TYPE: Exploitable scientific result
WHERE TO FIND IT: Contact the output owner (details below)
STATUS: In progress
TNA FACILITY USED: Hellenic Centre for Marine Research (HCMR), Greece
CONTACT DETAILS: Stavros Chatzifotis, HCMR, Greece, stavros@hcmr.gr
PATENTS OR OTHER IPR EXPLOITATIONS: No

Designed and developed by AquaIT

AQUAEXCEL2020 PROJECT CATALOGUE
WWW.AQUAEXCEL2020.EU
@AQUAEXCEL2020

EFFECT OF INSECT MEAL ON THE GROWTH OF EUROPEAN SEA BASS

SUMMARY

This research investigated the effect of fish meal substitution with three different insect meals on European sea bass (*Dicentrarchus labrax*) growth. Results show that 30% substitution of fish meal with either *Hermetia illucens* or *Musca domestica* larvae meal had no negative effects on growth performance and somatic indices. The results also reinforce previous observations that the dietary inclusion of *Tenebrio molitor* should be no more than 25%. This study will be of particular interest to sea bass farmers who wish to use insect-based meals as an alternative food source for their stock.

KNOWLEDGE NEED

Fish farmers rely on sustainable feed that can make fish strong and healthy. The aquaculture industry is looking for alternative feed sources because the supply of key ingredients of fish feed found in fish meal and fish oil is limited. However, completely replacing these with a different feed source in the fish's diet can lead to adverse effects on the fish, for example decreased digestion efficiency leading to lower growth rates. Alternative fish feed sources with high biological value and low competitiveness with human food are needed, and their safe substitution levels must be established.

POTENTIAL IMPACT

- Partly substituting sea bass diets with insect meal reduces the need for fish meal and oil, which are costly, volatile and unsustainable sources. This could lead to a more sustainable and competitive aquaculture sector.
- The establishment of the optimum level of fish meal substitution with insect meal opens the door for further research into its applicability for other aquaculture species.
- The findings contribute towards improving ecological and social sustainability of fish feeds, especially if applied to multiple species.

EATiP - Strategic Research and Innovation Agenda (SRIA): Thematic Area 4 - Sustainable Feed Production, Goal 1 and Goal 2; Thematic Area 2 – Technology and Systems, Goal 1. To see the full list and descriptions of the thematic areas and goals, please visit: **eatip.eu/?page_id=46**

AQUAEXCEL2020 PROJECT CATALOGUE

WWW.AQUAEXCEL2020.EU
@AQUAEXCEL2020

UNDERLYING SCIENCE

360 fish were randomly divided into 12 indoor 500 litre tanks. The fish were fed with formulated diets in which 30% of fish meal was replaced by insect proteins (*Tenebrio molitor*, *Hermetia illucens*, or *Musca domestica*). A control group was fed fish meal with no insect substitutions. Calculations were performed to obtain the specific growth rate, feed conversion ratio, viscerosomatic index, hepatosomatic index, mesenteric fat index (ratio of visceral to subcutaneous fat), relative gut length and the condition factor of the fish.

RESULTS

- Results show that 30% substitution of fish meal with either *Hermetia illucens* or *Musca domestica* larvae meal had no negative effects on growth performance and somatic indices of European sea bass.
- The fish fed with the *Tenebrio molitor* substitution diet at a level of 30% had a significantly higher feed conversion ratio, indicating poorer utilisation of food. These results reinforce previous observations that the dietary inclusion of *Tenebrio molitor* should be no more than 25%.
- The fish groups fed fish meal and *Hermetia illucens* had significantly higher condition factors than the groups fed on *Musca domestica* and *Tenebrio molitor*, which could indicate a better general condition.
- Fish from the *Hermetia illucens* group had higher mesenteric fat indices and viscerosomatic indices than the fish meal group.

END-USERS & POTENTIAL APPLICATIONS

END-USER 1: Sea bass fish feed producers
APPLICATION: Developing and producing novel feed formulations based on alternative, safe and sustainable feed sources (insect meal) with high biological value and low competitiveness with human nutrition.

END-USER 2: Sea bass farmers
APPLICATION: Feeding of aquaculture fish stocks with more sustainable (and potentially cheaper) fish feeds while maintaining good production levels, leading to higher profits and reduced environmental impact.

END-USER 3: Aquaculture marketing and lobby groups
APPLICATION: Supporting a sustainable, dynamic image of the aquaculture sector, working towards improving global food security while decreasing environmental impact.

END-USER 4: Aquaculture research community
APPLICATION: Furthering knowledge relating to fish meal replacement and its effect on many aspects, such as growth, health, and taste of the final product, in sea bass and other fish species. This will support development of the aquaculture sector and contribute to increased levels of Technology Readiness, and aid progression towards commercialisation.

STATUS

Technology Readiness Level (TRL) 4 – the knowledge has been validated in a laboratory environment.

Further research is needed to:

- Establish the precise optimal *Hermetia illucens* and *Musca domestica* substitution rate in sea bass diets.
- Investigate further effects of the *Hermetia illucens* and *Musca domestica* diet substitutions on other crucial elements such as microbiota composition.
- Understand changes in susceptibility to stressors under different diet compositions.
- Explore suitability for other species and/or life stages.
- Examine potential effects on the fish product, e.g. on texture, odour and taste.
- Perform feeding trials on a commercial scale (i.e. validated and demonstrated in an industrially relevant environment).

AT A GLANCE

TITLE: Effects of Insect Meal on the Growth of European Sea Bass
KNOWLEDGE TYPE: Exploitable scientific result
WHERE TO FIND IT: To be published. Contact details below.
STATUS: To be published
TNA FACILITY USED: Hellenic Centre for Marine Research (HCMR), Greece
CONTACT DETAILS: Stavros Chatzifotis, Hellenic Centre for Marine Research (HCMR), Greece, stavros@hcmr.gr
PATENTS OR OTHER IPR EXPLOITATIONS: No

AQUAEXCEL2020 PROJECT CATALOGUE
WWW.AQUAEXCEL2020.EU
@AQUAEXCEL2020

DEFATTED MEALWORM (*TENEBRIO MOLITOR*) LARVAE MEAL AS A SUSTAINABLE FEED SOURCE FOR EUROPEAN SEA BASS

AQUA EXCEL 2020

SUMMARY

This research investigated the effect of fish meal replacement by defatted mealworm (*Tenebrio molitor*) larvae meal in European sea bass (*Dicentrarchus labrax*) aquafeeds and showed that it is possible to replace up to 80% of fish meal by insect meal without impairing growth performance, digestibility and flesh quality. These results will be of particular interest to sea bass farmers who wish to use insect-based meals as an alternative food source for their stock.

KNOWLEDGE NEED

The European sea bass (*Dicentrarchus labrax*) is one of the most important fish species in European and Mediterranean aquaculture. A major challenge to efficient production of European sea bass and other species is the high cost of aquafeeds. Additionally, the supply of key nutrients found in fish meal and fish oil is limited. However, completely replacing these ingredients with a different feed source in the fish's diet can lead to adverse effects, for example decreased digestion efficiency and increased susceptibility to diseases and stress. Alternative fish feed sources with high biological value and low competitiveness with human food are needed, and their optimum substitution levels must be established.

POTENTIAL IMPACT

- Substituting European sea bass diets with insect meal reduces the need for fish meal and oil, which are costly, volatile and unsustainable sources. This could lead to a more sustainable aquaculture sector.
- The establishment of the optimum level of fish meal substitution with insect meal for sea bass opens the door for further research into its applicability for other aquaculture species.
- The findings contribute towards improving ecological and social sustainability of fish feeds, especially if applied to multiple species.

EATiP - Strategic Research and Innovation Agenda (SRIA) Thematic Area 4 – Sustainable Feed Production; Goal 1 and Goal 2.
To see the full list and descriptions of the thematic areas and goals, please visit: **eatip.eu/?page_id=46**

AQUAEXCEL2020 PROJECT CATALOGUE

WWW.AQUAEXCEL2020.EU
@AQUAEXCEL2020

UNDERLYING SCIENCE

A feeding experiment was carried out to evaluate the effect of four different experimental diets with increasing replacement levels of fish meal by defatted *Tenebrio molitor* larvae meal: 0% (control diet), 40 (TM40), 80 (TM80) and 100% (TM100) of replacement. The effect of these dietary treatments were assessed through the analysis of growth performance, digestibility, nutrient utilisation, intestinal morphology, muscle total lipid content and fatty acid profile, muscle instrumental texture and colour, plasma metabolites and humoral immune parameters and expression of genes related to growth and lipid metabolism.

RESULTS

- The voluntary feed intake decreased in fish fed TM100, but these fish had the best FCR resulting in similar final body weight among treatments.
- Up to 80% replacement did not impair protein digestibility and the morphologic integrity of the intestine was maintained.
- Whole body lipid content and the hepatosomatic index increased in fish fed TM100, but flesh total lipid content, colour and texture remained similar among dietary treatments.
- Total replacement of fish meal did not alter the ACH50 and lysozyme activity but increased plasma peroxidase activity.
- The eicosapentaenoic (EPA) and docosahexaenoic (DHA) acids remained unaffected in fish fed diets up to 80% replacement level.
- The hepatic expression of lipogenic enzymes (*elovl5, scd1b, fads2*) and key enzymes of bile acid biosynthesis (*cyp7a1*) was consistently down-regulated by defatted TM.
- Changes in the expression profile of myogenic factors evidence different compensatory mechanisms to preserve high muscle protein accretion with the inclusion of TM.

END-USERS & POTENTIAL APPLICATIONS

END-USER 1: European sea bass fish feed producers
APPLICATION: Developing and producing novel feed formulations for European sea bass (and potentially other species) based on alternative, safe and sustainable feed sources (insect meal) with high biological value and low competitiveness with human nutrition.

END-USER 2: European sea bass fish farmers
APPLICATION: Feeding of aquaculture fish stocks with more sustainable (and potentially cheaper) fish feeds while keeping good production levels, leading to higher profits and reduced environmental impact.

END-USER 3: Aquaculture marketing and lobby groups
APPLICATION: Supporting a sustainable, dynamic image of the aquaculture sector, working towards improving global food security while decreasing environmental impact.

END-USER 4: Aquaculture research community
APPLICATION: Furthering knowledge relating to fish meal replacement and its effect on many aspects (such as growth, digestibility, flesh quality, etc.), in European sea bass and other species. This will support development of the aquaculture sector and contribute to increased levels of Technology Readiness, and progression towards commercialisation.

STATUS

Technology Readiness Level (TRL) 4 – the knowledge has been validated in a laboratory environment.

Further research is needed to:

- Investigate further effects of the *Tenebrio* diet substitution on immune status, microbiota composition and acceptability by consumers.
- Explore suitability for other species.
- Perform feeding trials on a commercial scale (i.e. validated and demonstrated in an industrially relevant environment).

AT A GLANCE

TITLE: Defatted mealworm (*Tenebrio molitor*) larvae meal as a sustainable feed source for European sea bass

KNOWLEDGE TYPE: Peer-reviewed scientific publication

WHERE TO FIND IT: Not currently publicly available

STATUS: Expected to publish in 2020

TNA FACILITY USED: Institute of Aquaculture Torre de la Sal (IATS-EXP, CSIC), Castellón, Spain

CONTACT DETAILS: Ana Basto, Aquaculture and Seafood Safety Group, CIIMAR, Portugal; ana.basto@ciimar.up.pt

PATENTS OR OTHER IPR EXPLOITATIONS: No

AQUAEXCEL2020 PROJECT CATALOGUE

WWW.AQUAEXCEL2020.EU
@AQUAEXCEL2020

LACTIC ACID BACTERIA IMPROVE GROWTH AND REDUCE POTENTIALLY PATHOGENIC BACTERIA LEVEL IN JUVENILE PIKE-PERCH

Larval pike-perch cultivated in fish rearing facility in National Agricultural Research and Innovation Centre (NARIC) © Ulrik Lykke Iversen

SUMMARY

This research evaluated the effects of lactic acid bacteria (LAB), applied through different types of feed, on the health of larval pike-perch (*Sander lucioperca*). The results showed that administration of LAB through live feed (*Artemia nauplii*) improved fish growth and reduced skeletal deformities. Supplementation of LAB through commercial dry feed also reduced skeletal deformities and significantly reduced the number of potentially pathogenic bacteria. Both treatment types improved protein utilisation. These findings will be of particular interest to pike-perch feed producers and farmers.

KNOWLEDGE NEED

Pike-perch is a relatively new fish species for cultivation, and is considered to have high potential for inland aquaculture diversification in Europe. This is a result of increased demand due to the decline of wild catches, and also due to the pike-perch flesh quality (neutral taste and fillets without bones). Major bottlenecks for further expansion of the pike-perch culture industry in Europe include low larval survival, high incidence of deformities, and high sensitivity to stressors such as pathogenic bacteria. Overcoming these challenges is crucial for the successful expansion of pike-perch aquaculture production.

Preliminary screenings for evaluation of the effects of probiotics in Artemia culture at a laboratory scale. © Ivanka Lukic

POTENTIAL IMPACT

- The administration of LAB through feed improves the growth, health and survival of pike-perch juveniles which could lead to an increase in production yield and an improvement in fish welfare.
- The potential for LAB to minimise fish pathogenic bacteria growth could minimise the ecological consequences of fish farming related to the spread of pathogens to the environment.
- The observations are promising in terms of usage of probiotics for more environmentally friendly production of pike-perch in Recirculating Aquaculture Systems (RAS).
- The findings could contribute to a better overall understanding of LAB action in RAS.

EATiP - Strategic Research and Innovation Agenda (SRIA) Thematic Area 7 – Aquatic Animal Health and Welfare; Goal 3. Thematic Area 4 – Sustainable Feed Production; Goal 2. To see the full list and descriptions of the thematic areas and goals, please visit: **eatip.eu/?page_id=46**

AQUAEXCEL2020 PROJECT CATALOGUE

WWW.AQUAEXCEL2020.EU
@AQUAEXCEL2020

UNDERLYING SCIENCE

This study aimed to test the effects of lactobacilli applied to juvenile cultured pike-perch, either through commercial dry feed or through live feed. The effects examined were on fish growth, microbiota balance, and skeletal development. On the twelfth day post-hatching (DPH), the fish were divided into groups to receive different combinations of feed and LAB, including a control group which received the same feed minus the LAB. After 14 days of treatment, fish were assessed for digestive enzyme activity and microbiota composition. Skeletal deformities, individual total lengths and individual body weights were also recorded at the end of the treatments.

RESULTS

- Administering LAB through live feed had beneficial effects on larval growth, skeletal development and protein digestibility (trypsin to chymotrypsin activity ratio (T/C)).
- Application of LAB-processed dry feed was also associated with better skeletal development, and significantly reduced numbers of potentially pathogenic bacteria (*Aeromonas* and *Mycobacterium*).
- Both treatment types improved protein utilisation, as evidenced by digestive protease activities.

END-USERS & POTENTIAL APPLICATIONS

END-USER 1: Pike-perch farmers
APPLICATION: Using optimal feed combinations for improved growth and health of larval pike-perch and reduction of pathogen burden.

END-USER 2: Pike-perch feed and nutrition manufacturers
APPLICATION: Developing novel feed combinations that will improve growth and health of larval pike-perch and reduce pathogen burden.

END-USER 3: Pike-perch breeders
APPLICATION: Support in the breeding of larval pike-perch during the weaning process, by reducing the costs and time associated with *Artemia* feeding through early transition of pike-perch to an inert diet. Additionally, supporting eco-friendly pike-perch rearing through antipathogenic potential of probiotics.

END-USER 4: Nutrition and microbiology research community
APPLICATION: Greater understanding of important nutritional demands of pike-perch larvae for growth and proper bone development. Additionally, it provides the opportunity for further research with other fish species, and also for further examination of proteolytic properties of lactobacilli using animal proteins as a substrate.

STATUS

Technology Readiness Level (TRL) 3 - Proof of concept has been demonstrated in experimental conditions

- The research is currently being exploited by the scientific community through a scientific publication (see 'AT A GLANCE' below).
- Further technical optimisation through additional testing in larger cohorts is required for industry exploitation.
- A follow-on project is currently in progress which builds on the results of this research. This project should support technological improvement of probiotic supplementation to larval pike-perch during weaning.

AT A GLANCE

TITLE: Lactic Acid Bacteria Improve Growth and Reduce Potentially Pathogenic Bacteria Level in Juvenile Pike-Perch

KNOWLEDGE TYPE: Scientific publication

WHERE TO FIND IT: Ljubobratovic et al. 2017. Supplementation of lactobacilli improves growth, regulates microbiota composition and suppresses skeletal anomalies in juvenile pike-perch (*Sander lucioperca*) reared in recirculating aquaculture system (RAS): A pilot study. Research in Veterinary Science 115, 451 – 462. DOI: 10.1016/j.rvsc.2017.07.018

STATUS: Published

TNA FACILITY USED: National Agricultural Research and Innovation Centre (NAIK), Indoor System for Fish Disease Challenge (SDC), Hungary

CONTACT DETAILS: Jovanka Lukic, Institute of Molecular Genetics and Genetic Engineering (IMGGE), University of Belgrade, Serbia; lukicjovanka@imgge.bg.ac.rs

PATENTS OR OTHER IPR EXPLOITATIONS: No

Designed and developed by AquaIT

AQUAEXCEL2020 PROJECT CATALOGUE

WWW.AQUAEXCEL2020.EU
@AQUAEXCEL2020

AE-FISHBIT: A SMART DEVICE FOR MONITORING FISH HEALTH AND WELFARE

SUMMARY

Researchers have designed a miniaturised tool called AE-FishBIT, to monitor individual farmed fish in a non-invasive manner. The device's simultaneous measurement of physical activity and respiratory frequency sets it apart from similar devices in the market. AE-FishBIT will be of interest to aquaculture farmers and other end users who can use it to monitor fish behaviour for selective breeding and for fine-tuned adjustment of environmental conditions.

KNOWLEDGE NEED

The assessment of overall production, health, welfare and stress is a major challenge for more efficient and ethical fish production. With the recent advent of MicroElectroMechanical System (MEMS) technology, biosensors are increasingly being used to non-invasively measure a wide range of variables. However, challenges with the technology so far include interference between transmitted signals which limits the use of a large number of sensors, and in the aquatic environment the use of low radiofrequency transmission is limited. AE-FishBIT overcomes current technological challenges with its small size, low power, and its capacity to measure physical activity and metabolic activity simultaneously.

POTENTIAL IMPACT

- Individual and non-invasive assessment of feeding behaviour, fish health and welfare status allowing farmers to select robust fish and make correct adjustments in the culture conditions, which ultimately contribute to improved productivity in the aquaculture sector.
- Better monitoring leads to more strict and reliable welfare standards, and a better perception of quality controls in aquaculture production, which could lead to improved consumer perception of aquaculture products.

EATiP – Strategic Research and Innovation Agenda (SRIA) Thematic Area 2 – Technology and Systems; Goal 4, Thematic Area 7 – Aquatic Animal Health and Welfare; Goal 4. To see the full list and descriptions of the thematic areas and goals, please visit: **eatip.eu/?page_id=46**

AQUAEXCEL2020 PROJECT CATALOGUE

WWW.AQUAEXCEL2020.EU
@AQUAEXCEL2020

UNDERLYING SCIENCE

Weighing less than one gram, AE-FishBIT is a tiny programmable and reconfigurable tri-axial accelerometer for on-board processing of recorded data. The prototype is externally attached to the fish operculum to monitor physical activity by mapping accelerations in x- and y-axes, while operculum beats (z-axis) serve as a measurement of respiratory frequency. The device has been tested and validated in gilthead sea bream and European sea bass.

RESULTS

- AE-FishBIT can register jerk accelerations and operculum beats (two in one) as a direct measure of physical activity and respiratory frequency.
- Testing in swim test chambers allows a close correlation between O_2 consumption and calculated respiratory frequency in exercised fish.
- The device allows for the discrimination of fish with different proactive/reactive stress responses when facing different aquaculture stressors, including diet composition, oxygen levels and tank size.
- Using the device, it was also found that age, photoperiod, feeding time or enteric parasitic infections alter basal metabolism and diurnal/nocturnal activity of farmed fish.
- Visual observations regarding tissue damage, feeding behaviour and circulating levels of stress markers did not suggest a negative impact from device tagging.

END-USERS & POTENTIAL APPLICATIONS

END-USER 1: Aquaculture farmers
APPLICATION: Managing health and welfare by monitoring a number of "sentinel" fish, allowing farmers to make necessary adjustments in culture conditions with less trial-and-error than traditional methods.

END-USER 2: Aquaculture breeders
APPLICATION: Tool for selective breeding by monitoring changes in feeding behaviour and metabolic activity to identify fish with a more efficient energy use.

END-USER 3: Fish processors and wholesalers
APPLICATION: Good quality certification of aquaculture products through the monitoring of the welfare status of the fish, increasing its appeal to customers and potentially increased profitability.

END-USER 4: Aquaculture researchers
APPLICATION: Measuring reactions to variables such as a change in nutrition, rearing density or other environmental conditions by monitoring physical activity and respiratory frequency of fish in controlled experiments.

STATUS

Technology Readiness Level (TRL) 4 – the knowledge has been validated in a laboratory environment.

- To the best of the researchers' knowledge there is currently no other tagging device that provides a simultaneous measurement of both physical activity and respiratory frequency in a non-invasive manner.
- Additional tests of the device are planned in other farmed fish (Atlantic salmon, trout, sole, turbot), correlating adjustments at cellular-tissue level with the monitored AE-FishBIT parameters.
- Further developments to the AE-FishBIT device are envisaged to increase the autonomy of the system, make it more compact and easier to attach.

AT A GLANCE

TITLE: AE-FishBIT: A Smart Device for Monitoring Fish Health and Welfare
KNOWLEDGE TYPE: Prototype and Scientific Publication
WHERE TO FIND IT: vimeo.com/325943543; Martos-Sitcha et al. 2019. Ultra-Low Power Sensor Devices for Monitoring Physical Activity and Respiratory Frequency in Farmed Fish. Front Physiol 10, 667. DOI: 10.3389/fphys.2019.00667
STATUS: Published
TNA FACILITY USED: Consejo Superior de Investigaciones Científicas (IATS-CSIC), Spain; Universidad de las Palmas de Gran Canaria (ULPGC), Spain
CONTACT DETAILS: Jaume Pérez-Sánchez, CSIC, Spain; jaime.perez.sanchez@csic.es
PATENTS OR OTHER IPR EXPLOITATIONS: A patent for the device has been being registered (P201830305) with the goal of licensing it at international level before the end of the AQUAEXCEL2020 project.

Designed and developed by AquaIT

AQUAEXCEL2020 PROJECT CATALOGUE
WWW.AQUAEXCEL2020.EU
@AQUAEXCEL2020

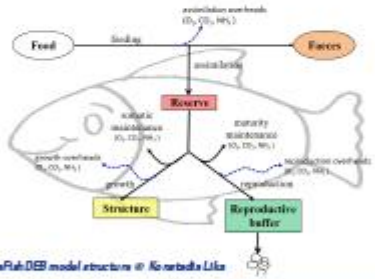
AquaFishDEB: A FUNCTIONAL MODEL FOR FISH GROWTH, FEED INTAKE AND WASTE PRODUCTION IN AQUACULTURE

SUMMARY

AquaFishDEB is a numerical model that captures the effects of feed quality, feeding schedule and water characteristics on individual growth, feed consumption, waste production (faecal and non-faecal nitrogen loss, faecal dry matter, CO_2) as well as oxygen consumption in three aquaculture species (Atlantic salmon, gilthead sea bream and rainbow trout). The model is one of the main components of the AQUAEXCEL2020 virtual laboratory for designing experiments in aquaculture research facilities. AquaFishDEB will be of interest to various end users in the aquaculture sector, including researchers, teachers, trainers and farmers.

KNOWLEDGE NEED

The impact of different management conditions on the growth and performance of species in aquaculture must be understood to ensure the highest standards in welfare and to optimise productivity. Experiments with fish typically involve extensive use of laboratory facilities and run for long periods of time. Both from an ethical perspective (3Rs) and from a cost perspective, there is a need to use alternatives such as models and tools for design and planning of experiments.



AquaFishDEB model structure © Konstadia Lika

POTENTIAL IMPACT

- Use of the AquaFishDEB model will help to optimise the use of experimental resources and improve experimental design, thereby greatly minimising the costs associated with traditional scientific experiments.
- The AquaFishDEB model will help to improve aquaculture management by predicting the results of feed quality, feeding schedule and water characteristics.
- The AquaFishDEB model will support researchers and teachers in designing experimental environmental conditions that optimise feed intake and growth, optimise the use of experimental resources, and improve experimental design.

EATiP – Strategic Research and Innovation Agenda (SRIA) Thematic Area 2 – Technology & Systems; Goal 2, Thematic Area 1 – Product, Quality, Consumer Safety and Health; Goal 3, Thematic Area 6 – Knowledge Management; Goal 2.
To see the full list and descriptions of the thematic areas and goals, please visit: **eatip.eu/?page_id=46**

AQUAEXCEL2020 PROJECT CATALOGUE

WWW.AQUAEXCEL2020.EU
@AQUAEXCEL2020

UNDERLYING SCIENCE

The model is based on the Dynamic Energy Budget (DEB) theory, a powerful theoretical framework for modelling the metabolic dynamics of an individual organism throughout its life cycle making explicit use of energy and mass balances. For each species, the modelling procedure had two steps. The first step involved the parameterisation of the individual DEB model. The second step incorporated the obtained DEB parameters into the AquaFishDEB model that simulates the dynamics for a group of fish exposed to specified conditions. For gilthead sea bream and Atlantic salmon, parameters were estimated using data obtained from literature and from partners of the AQUAEXCEL2020 project. For rainbow trout, the parameter values were retrieved from the AmP database: **bio.vu.nl/thb/deb/deblab/add_my_pet**.

RESULTS

The result of this research is a functional model for growth, feed intake and waste production in farmed Atlantic salmon, gilthead sea bream and rainbow trout. Based on physiological rules for the assimilation and utilisation of energy and elemental matter, AquaFishDEB allows for the modelling of the processes of feeding, digestion, maintenance, maturation and growth for farmed fish. The model output includes growth (specific growth rate, weight-at-time) and feeding characteristics (e.g. feed conversion ratio, feed intake), as well as waste production (e.g. faecal and non-faecal nitrogenous loss) and gaseous exchange (O_2 consumption and CO_2 production).

END-USERS & POTENTIAL APPLICATIONS

- **END-USER 1: Aquaculture fish farmers**
  APPLICATION: To design and plan optimal fish husbandry conditions, thereby increasing productivity and hence profitability, and improving fish welfare.
- **END-USER 2: Aquaculture feed producers**
  APPLICATION: To get better insight into feed conversion ratios and feed intake in different life stages of fish or in different species, implementing this knowledge by improving their feed formulations.
- **END-USER 3: Aquaculture researchers and educators**
  APPLICATION: To get a better insight into growth dynamics under various experimental conditions and use the model as a tool to teach the design and planning of fish experiments, optimising the use of experimental resources and increasing fish welfare.

STATUS

Technology Readiness Level (TRL) level 4 – The prototype has been tested and shown that it can be integrated as a component with other modelling components.

- The sensitivity of the model is currently being evaluated.
- The model is currently being validated with independent data for salmon, trout and gilthead sea bream. Once the validation stage has been finalised the model has the potential to be used as an operational tool.

AT A GLANCE

TITLE: AquaFishDEB: A Functional Model for Fish Growth, Feed Intake and Waste Production in Aquaculture
KNOWLEDGE TYPE: Software / modelling tool
WHERE TO FIND IT: Not yet publicly available
STATUS: Currently validating the prototype model
TNA FACILITY USED: Hellenic Centre for Marine Research (HCMR), Greece ; University of Crete, Greece
CONTACT DETAILS: Dina Lika, Hellenic Centre for Marine Research, Greece, lika@uoc.gr
PATENTS OR OTHER IPR EXPLOITATIONS: No

Designed and developed by AquaIT

AQUAEXCEL2020 PROJECT CATALOGUE
WWW.AQUAEXCEL2020.EU
@AQUAEXCEL2020

EARLY LIFE MANAGEMENT PROTOCOL FOR OPTIMAL PERFORMANCE OF SEA BREAM

SUMMARY

This OUTPUT is an early life management protocol of O_2 (oxygen) concentration levels in the aquatic environment of gilthead sea bream (*Sparus aurata*). The protocol is an improved management tool that will help to rear more robust sea bream. This fish species was shown to exhibit a high metabolic plasticity to cope with changes in O_2 concentrations. Moreover, gilthead sea bream demonstrated higher larval survival and improved metabolic performance later in life after exposure to low O_2 concentrations during a specific window of development (60-80 days post-hatching). This protocol will assist fish farmers and researchers to improve their fish management and research results during the production cycle.

KNOWLEDGE NEED

How fish are managed during early life stages affects their health and performance in later years. Therefore, good early life management of environmental factors, including O_2 concentration, is highly important to fully exploit productive traits of farmed fish. A progressive decline in O_2 concentration causes hypoxia, a condition in which fish are deprived of adequate O_2 supply at tissue level. To ensure that the physiological function of fish is not compromised, and to guarantee their welfare, changes in O_2 concentrations should be considered and well-regulated in aquaculture systems, exploiting also the potential benefits of hypoxia pre-conditioning at specific stages of the life cycle.

POTENTIAL IMPACT

- Applying this protocol will result in more robust and healthier sea bream at later stages in life, resulting in increased profits for sea bream farmers.
- Using a protocol to produce robust and healthy fish will result in higher quality and more efficient scientific experiments, leading to improved animal welfare and aquaculture profitability.
- Developing a protocol for O_2 supply during early life management can bring a uniform approach to managing fish across the aquaculture industry which would benefit both quality and welfare standards. Development of similar protocols for other fish species should be studied.

EATiP - Strategic Research and Innovation Agenda (SRIA) Thematic Area 2 – Technology & Systems; Goal 3, Thematic Area 6 – Knowledge Management; Goal 1, Thematic Area 7 – Aquatic Animal Health and Welfare; Goal 3. To see the full list and descriptions of the thematic areas and goals, please visit: **eatip.eu/?page_id=46**

AQUAEXCEL2020 PROJECT CATALOGUE

WWW.AQUAEXCEL2020.EU
@AQUAEXCEL2020

UNDERLYING SCIENCE

Acute and mild hypoxia was induced in sea bream juveniles to assess the resilience of this farmed fish to acute and chronic hypoxia exposure at different rearing densities. The impact of hypoxia pre-conditioning was assessed at the level of blood, tissue and whole organism by means of swimming tests and haematological, hormonal, and wide and targeted transcriptional analysis. Additional hypoxia challenges were conducted during early life stages to test the hypothesis that reduced O_2 levels at specific stages of development can assist fish farmers to improve fish management later in life through the involvement of epigenetic mechanisms.

RESULTS

- Blood physiological hallmarks demonstrate the enhancement of O_2-carrying capacity in addition to a reduced but more efficient aerobic energy production in juvenile fish exposed to acute hypoxia.
- Transcriptional analyses disclose the different contributions of liver, heart, muscle and blood to mild hypoxia and crowding stress responses in sea bream.
- Hypoxia pre-conditioning during juvenile stages allows improved swimming and metabolic performance at reduced O_2 concentration levels.
- Metabolic effects of hypoxia pre-conditioning during early life stages (60-80 days post-hatching) are more persistent than the effects resulting from hypoxia pre-conditioning during later life.
- The early life O_2 management protocol improves survival rates as well as growth and swimming performance of hypoxia-challenged fish later in life.

END-USERS & POTENTIAL APPLICATIONS

END-USER 1: Marine biologists, aquaculture and biotechnology scientists
APPLICATION: Applying the protocol to better track growth potentiality and size heterogeneity of sea bream.

END-USER 2: Farmers of gilthead sea bream
APPLICATION: The protocol is an improved management tool that will help to rear more robust sea bream, thereby supporting individual fish welfare and profitability of the sea bream aquaculture industry.

STATUS

Technology Readiness Level (TRL) 4- the knowledge has been validated in a laboratory environment.

Further research is needed to:

- Check and refine the tested protocol for different sea bream strains and culture conditions.
- Determine how long metabolic priming lasts over the course of the production cycle, assisting farmers to produce robust, healthy and high quality fish.

AT A GLANCE

TITLE: Early Life Management Protocol for Optimal Performance of Sea Bream

KNOWLEDGE TYPE: Guidelines/standards

WHERE TO FIND IT: Martos-Sitcha et al. (2017). Gene expression profiling of whole blood cells supports a more efficient mitochondrial respiration in hypoxia-challenged gilthead sea bream (*Sparus aurata*). Frontiers in Zoology 14, 34. DOI 10.1186/s12983-017-0220-2; Martos-Sitcha et al. (2019). Tissue-Specific Orchestration of Gilthead Sea Bream Resilience to Hypoxia and High Stocking Density. Front Physiol 10, 840. DOI 10.3389/fphys.2019.00840

STATUS: Additional articles will be published in 2020

FACILITY USED: Consejo Superior de Investigaciones Cientificas (IATS-CSIC), Spain

CONTACT DETAILS: Jaume Pérez-Sánchez, CSIC, Spain; jaime.perez.sanchez@csic.es; Josep Calduch-Giner, CSIC, Spain; j.calduch@csic.es

PATENTS OR OTHER IPR EXPLOITATIONS: No

Designed and developed by AquaIT

AQUAEXCEL2020 PROJECT CATALOGUE

WWW.AQUAEXCEL2020.EU
@AQUAEXCEL2020

REVELATION OF KEY MOLECULES DURING AMOEBIC GILL DISEASE (AGD) IN ATLANTIC SALMON

SUMMARY

This study investigated the expression of genes involved in Amoebic Gill Disease (AGD) pathogenesis in Atlantic Salmon (*Salmo salar*) during an experimental and a natural infection, including a post-freshwater treatment to eliminate the parasite. The results emphasise the importance of the studied genes in fish respiratory organs, and during AGD progression. This study also shows that freshwater treatment not only eliminates the parasite but also helps to restore gill homeostasis.

KNOWLEDGE NEED

Gill diseases, including AGD, are one of the main health challenges for the marine Atlantic salmon industry worldwide. Its impact has increased drastically in recent years due to the expansion of its geographic distribution and host range. Freshwater or hydrogen peroxide baths are the only available treatments, with no existing preventive measures. Epithelial proliferation and increased mucus secretion are common hallmarks of AGD, leading to respiratory distress in affected fish, followed by mortalities if left untreated. So far, the molecular mechanisms underlying these pathological changes are poorly understood. Characterisation of the proliferative host response in terms of expression dynamics of targeted genes is vital to improve our understanding of gill health and contribute to combating AGD.

POTENTIAL IMPACT

- The results can contribute to a more timely and accurate detection of AGD pathogen presence, key for aquaculture farmers to prevent stock losses, improve fish welfare and increase profitability.
- The findings are an important starting point for future characterisation of poorly-known fish mucins. Further research on Muc5 sequences, and their differential expression in different gill conditions of Atlantic salmon and other fish species, could improve our understanding of gill health.
- This research could provide a basis for development of tools for diagnostics and vaccines of AGD. Comparative pathology with other respiratory disorders can provide valuable insights into pathogenic mechanisms and potential therapeutic targets.

EATiP - Strategic Research and Innovation Agenda (SRIA) Thematic Area 7- Aquatic Animal Health and Welfare; Goal 1 and Goal 3. To see the full list and descriptions of the thematic areas and goals, please visit: **eatip.eu/?page_id=46**

AQUAEXCEL2020 PROJECT CATALOGUE

WWW.AQUAEXCEL2020.EU
@AQUAEXCEL2020

UNDERLYING SCIENCE

The hallmark signs of AGD are hyperplasia of the lamellar epithelium and increased production of gill mucus. This study investigated the expression of genes involved in mucus secretion, cell cycle regulation, immunity and oxidative stress in gills using a targeted 21-gene PCR array. Gill samples were obtained from experimental and natural *Neoparamoeba perurans* infections, and sampling points included progressive infection stages and post-freshwater treatment.

RESULTS

- The results indicate a key role of Muc5-type mucins and Th2 cytokines (interleukin 4/13) in respiratory organs of fish, as in mammals. This shows the potential of these as biomarkers for AGD. Indeed, Muc5-type mucins are the principal components of airway mucus in humans, and over-expression is a hallmark of various airway diseases.
- The expression profile of the selected genes provided a strong measure on the advancement of the disease; there was an increased response upon disease severity.
- The results also demonstrate that treatment of the disease with freshwater is not only effective against the parasite (amoeba) but also supports the partial restoration of the host immune, mucosal, structural and antioxidant status, i.e. re-establishing gill homeostasis under field conditions.
- The predictive model constructed, based on the expression values of the selected genes from the experimental infection, was able to accurately predict the disease severity of the field samples, indicating the reliability of the experimental infection model as a tool to study this disease under controlled conditions.

END-USERS & POTENTIAL APPLICATIONS

END-USER 1: Researchers in animal welfare, host-pathogen interactions and comparative immunology
APPLICATION: The results highlight the importance of several molecules and pathways on the progression of AGD. They enhance the information available on this disease and fish immune response and could be extrapolated to other fish species and related pathologies.

END-USER 2: Pharmaceutical industry
APPLICATION: The potential of Muc5-type mucins and interleukin 4/13 as biomarkers for AGD could support the development of tools for diagnostics, vaccines and/or disease treatment for AGD in salmon and other fish species.

END-USER 3: Aquaculture veterinarians
APPLICATION: The potential of Muc5-type mucins and interleukin 4/13 as biomarkers for AGD will support early detection and good management of AGD in salmon stocks.

END-USER 4: Aquaculture farmers
APPLICATION: The results will eventually help farmers with early detection and management of AGD in salmon (and potentially other fish species).

STATUS

Technology Readiness Level (TRL) 1 – basic principles observed. This is the first study exploring expression of gill mucins in Atlantic salmon during an infectious process.

- Further research on Muc5 sequences and their differential expression in different gill conditions of Atlantic salmon and other fish species is needed to improve our understanding of gill health.
- In the future, this study could form the basis for further research around diagnosing and vaccinating against AGD.

AT A GLANCE

TITLE: Revelation of Key Molecules during Amoebic Gill Disease (AGD) in Atlantic Salmon
KNOWLEDGE TYPE: Scientific publication
WHERE TO FIND IT: Marcos-López *et al.* 2018. Gene expression analysis of Atlantic salmon gills reveals mucin 5 and interleukin 4/13 as key molecules during amoebic gill disease. Scientific Reports 8, 13689. DOI: 10.1038/s41598-018-32019-8
STATUS: Published
TNA FACILITY USED: Consejo Superior de Investigaciones Científicas (IATS-ANA, CSIC), Spain
CONTACT DETAILS: Carla Piazzon, CSIC, Spain, carla.piazzon@csic.es
Mar Marcos Lopez, FishVet Group, Ireland, mar.marcos-lopez@fishvetgroup.com
PATENTS OR OTHER IPR EXPLOITATIONS: No

Designed and developed by AquaIT

AQUAEXCEL2020 PROJECT CATALOGUE
WWW.AQUAEXCEL2020.EU
@AQUAEXCEL2020

Annex 3 – OUTPUT Presentation PowerPoint slides (7)

OUTPUT presentation #1:

OUTPUT presentation #2:

OUTPUT presentation #3:

OUTPUT presentation #4:

OUTPUT presentation #5:

OUTPUT presentation #6:

OUTPUT presentation #7:

Annex 4: Check list

Deliverable Check list (to be checked by the "Deliverable leader")

	Check list		Comments
BEFORE	I have checked the due date and have planned completion in due time		*Please inform Management Team of any foreseen delays*
	The title corresponds to the title in the DOW		*If not please inform the Management Team with justification*
	The dissemination level corresponds to that indicated in the DOW		
	The contributors (authors) correspond to those indicated in the DOW		
	The Table of Contents has been validated with the Activity Leader		*Please validate the Table of Content with your Activity Leader before drafting the deliverable*
	I am using the AQUAEXCEL2020 deliverable template (title page, styles etc)		*Available in "Useful Documents" on the collaborative workspace*
The draft is ready			
AFTER	I have written a good summary at the beginning of the Deliverable		*A 1-2 pages maximum summary is mandatory (not formal but informative on the content of the Deliverable)*
	The deliverable has been reviewed by all contributors (authors)		*Make sure all contributors have reviewed and approved the final version of the deliverable. You should leave sufficient time for this validation.*
	I have done a spell check and had the English verified		
	I have sent the final version to the WP Leader, to the 2nd Reviewer and to the Project coordinator (cc to the project manager) for approval		*Send the final draft to your WP Leader, the 2nd Reviewer and the coordinator with cc to the project manager on the 1st day of the due month and leave 2 weeks for feedback. Inform the reviewers of the changes (if any) you have made to address their comments. Once validated by the 2 reviewers and the coordinator, send the final version to the Project Manager who will then submit it to the EC.*