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GAIN

Green Aquaculture Intensification in Europe

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Deliverable D5.2
Report on online professional training courses

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RE	Restricted to a group specified by the consortium (including the Commission Services)	
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Executive summary

Two training courses were planned within the GAIN project to support implementation of the newest technologies developed and investigated from a sustainable circular economy perspective:

- "Capture and valorisation of aquaculture side-streams"
- "Novel aquafeeds"

Courses were organised by Salten Havbrukspark, Norway, and Sparos, Portugal. Target groups were industry, public administration, research and academia. Several GAIN topics were covered, including the newest technological developments achieved within the project:

- Eco-intensification of European aquaculture in general
- Valorisation of aquaculture side-streams and by-products
- European and Norwegian regulations regarding aquaculture side-streams
- Environmental aspects of aquaculture
- Purification of aquaculture wastewater and dewatering of sludge by the new S3 technology
- Drying technology for fish sludge
- Mortalities disposal by drying
- Technologies for processing of dissolved matter
- Fish sludge as bio-fertiliser
- Sustainable aquafeeds in general
- Sustainable ingredients
- Novel ingredients
- Alternative fish feed formulations
- Novel tools to assess feed performance
- Molecular Biomarkers
- Microbiome analysis
- Behaviour monitoring
- Simulation models

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1 Introduction

Within the GAIN project two training courses were planned to promote and enhance implementation of the newest sustainable technologies developed and investigated from a circular economy perspective. The course “Capture and valorisation of aquaculture side-streams” was organized by Salten Havbrukspark and Waister, Norway, and the course “Novel aquafeeds” by Sparos, Portugal. Target groups were decision–makers and professionals from industry, public administration and research, but also interested students. The “Novel aquafeeds” course was designed to cover the subject of *Novel ingredients*, *Alternative fish feed formulations* and *Novel tools to assess feed performance*.

Both courses were intentionally planned as onsite courses. However, in 2020/2021 governments in Europe implemented “COVID-19 measures” imposing unforeseeable travel restrictions, meeting restrictions, quarantine commands, etc. The feasibility of on-site courses therefore became unpredictable, and we consequently decided to offer online training courses instead. The online courses were termed “workshop” instead of “training courses”, since practical training was limited during the digital events.
Course organisation included pre- and post-activities: thematically and organisationally course design, selection and invitation of lecturers, design and distribution of promotional flyers and the evaluation of feedback from participants.

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2 Training course "Capture and valorisation of aquaculture side-streams"

The training course was held online at June 28th in 2021, directed from Bodø, Norway, by Salten Havbrukspark. The aim of the course was to support the development of knowledge on eco-intensification of the European aquaculture industry, with focus on value creation and sustainable use of by-products and side streams; specific target groups were decision makers and professionals from industry, public authorities and research.

50 % of the lecturers were members of the GAIN consortium, including

- Ca' Foscari University of Venice, Italy
- National Association of Manufacturers of Canned Fish and Shellfish (ANFACO-CECOPESCA), Spain
- Salten Havbrukspark AS, Norway
- The Spanish National Research Council (CSIC), Spain
- Waister AS, Norway

Lecturers not included in the GAIN consortium were from an international environmental non-governmental organization (ngo), the industry (i), public administration (a) and the public research sector (r), including:

- The Bellona Foundation, Norway (ngo)
- Circular Solutions, Chile (i)
- County Governor of Nordland, Norway (a)
- Norwegian Institute for Bioeconomy Research (NIBIO), Norway (r)
- University of Milan, Italy (r)

The course was limited to 40 attendees and had 31 registered participants. The participants were mainly from European countries with a majority from Norway (15), but one participant joined also from Chile (Figure 1). Affiliations of the participants were equally distributed between industry (15) and academy (15) and one participants came from administration/government (Figure 2).

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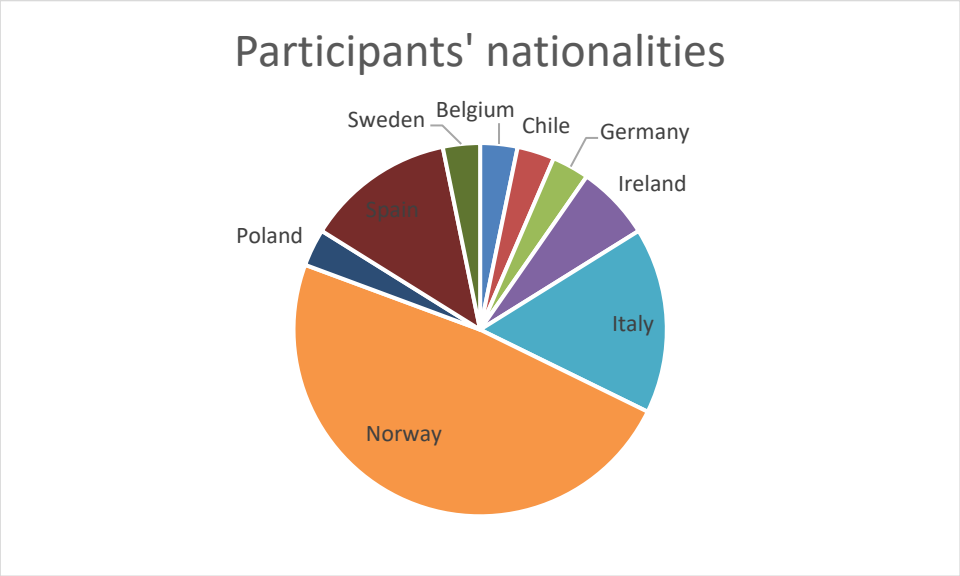

Figure 1: Course 1 - Participant's nationalities

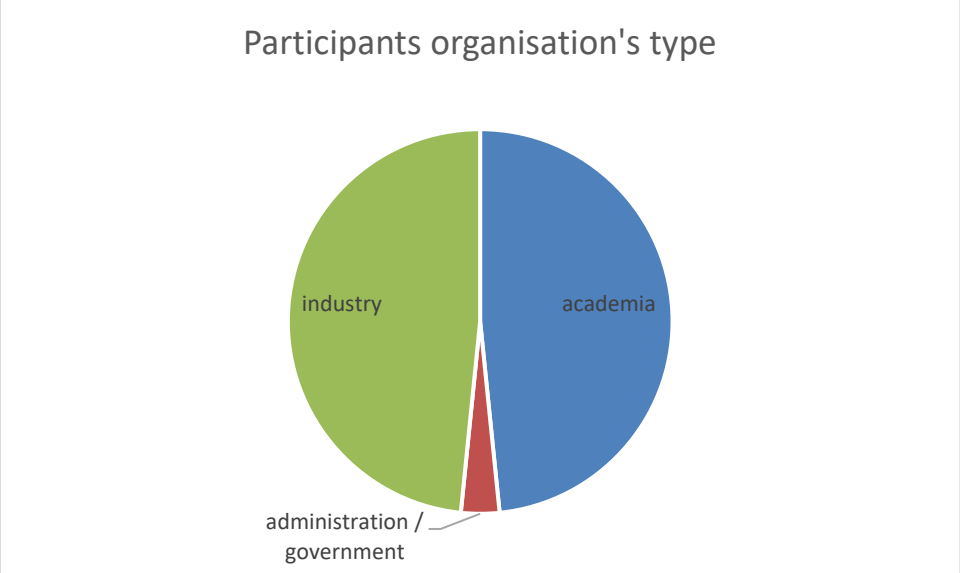

Figure 2: Course 1 - Participants organisation's type

2.1 Pre-course activities

Thematically course design will be presented below in the chapter "The training course", since it strongly overlaps with the course content.

The online training course was launched from Bodø, Norway, using the online meeting platform "Zoom". Organisationally and technical course design was performed by "Intune", a Norwegian company offering such services besides others. The course contained 10 lectures grouped into three models. Each lecture had a timeslot of 20 minutes, followed by 10 minutes of moderated discussion. An open-end discussion was organised at the end of the course.

As lecturers professionals from industry, academia, public administration and an

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environmental organisation were invited to present the relevant topics from different perspectives. Special care was taken to choose lecturers from key aquaculture areas in Europe, and, by covering 50% of the lectures, to highlight GAIN specific technologies and related background information.

The course was promoted by distributing two leaflets. Leaflet one contained a preliminary overview of the program, and was launched one month before the course. A second leaflet was launched one week before the course, containing a detailed program (Figure 3 and Figure 4). The leaflets were distributed by e-mails and sent to key organisations and professionals from the aquaculture sector, associated academia and respective public authorities. Additionally the course was launched on several websites (see e.g.https://gain2020.blog/).

Capture and valorisation of aquaculture side-streams

An **online workshop** supporting the development of knowledge on eco-intensification of the European aquaculture industry, with focus on value creation and sustainable use of by-products and side streams; we aim to present and discuss new knowledge and possibilities for the industry, authorities and research.

Date: 28.06.2021

Participation is free of charge. The workshop is limited to a maximum of 40 participants.

Registration: send an e-mail including your name and organisation to christian@havbrukspark.no - you will receive a link and instructions by e-mail to join the workshop. **Deadline:** 21.06.2021

Program

0845: Registration, welcome: Berit Laastad, Christian Bruckner, Salten Havbrukspark AS, Norway

0915 – 1130: Part 1: Background, regulations, and technologies

- **Opening lecture: Eco-intensification of European aquaculture.**
  Roberto Pastres, Ca' Foscari University of Venice, Italy
- **Overview of the valorisation of aquaculture side-streams and by-products.**
  Carmen Gonzalez Sotelo, Marine Research Institute, Spanish National Research Council (CSIC), Spain
- **European and Norwegian regulations regarding aquaculture side-streams.**
  Katrin Reiss, County Governor of Nordland, Norway
- **We have no waste to waste – aquaculture is a nutrient sink.**
  Mari Vold Bjordal, The Bellona Foundation, Norway

1130 - 1400: Part 2: Solutions for capture of aquaculture side-streams

- **Capturing particles from aquaculture wastewater and dewatering of sludge by the new S3 technology.**
  Lars Svenningsson, Salten Havbrukspark AS, Norway
- **Converting fish sludge into a dried product with novel drying technology.**
  Maite Navarro, Circular Solutions, Chile
- **Eco-efficient mortalities disposal by drying.**
  Hallstein Baarset, Waister AS, Norway
- **Technologies for processing of dissolved matter.**
  Martiña Ferreira Novio, Leticia Regueiro, National Association of Manufacturers of Canned Fish and Shellfish (ANFACO-CECOPESCA), Spain

1415 – 1515: Part 3: Valorisation and application of aquaculture side-streams in a circular economy perspective

- **Applicability of fish sludge as bio-fertiliser.**
  Joshua Cabell, Norwegian Institute for Bioeconomy Research (NIBIO), Norway
- **Opportunities and limitations for use of mortalities as feed product.**
  Marta Castrica, University of Milan, Italy
- **Closure of the workshop**

Figure 3: First leaflet launching the online trainings course "Capture and valorisation of aquaculture side-streams" one month before course start.

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Capture and valorisation of aquaculture side-streams

An online workshop supporting the development of knowledge on eco-intensification of the European aquaculture industry, with focus on value creation and sustainable use of by-products and side streams; we aim to present and discuss new knowledge and possibilities for the industry, authorities and research.

Date: 28.06.2021; time schedule in Central European Summer Time

Program

0845: Registration, welcome: Berit Laastad, Christian Bruckner, Salten Havbrukspark AS, Norway

Part 1: Background, regulations, and technologies

0915: Opening lecture: Eco-intensification of European aquaculture.
Roberto Pastres, Ca' Foscari University of Venice, Italy

0945: Overview of the valorisation of aquaculture side-streams and by-products.
Carmen Gonzalez Sotelo, Marine Research Institute, Spanish National Research Council (CSIC), Spain

1015: Break

1030: European and Norwegian regulations regarding aquaculture side-streams.
Katrin Reiss, County Governor of Nordland, Norway

1100: We have no waste to waste – aquaculture is a nutrient sink.
Mari Vold Bjordal, The Bellona Foundation, Norway

Part 2: Solutions for capture of aquaculture side-streams

1130: Capturing particles from aquaculture wastewater and dewatering of sludge by the new S3 technology.
Lars Svenningsson, Salten Havbrukspark AS, Norway

1200: Converting fish sludge into a dried product with novel drying technology.
Maite Navarro, Circular Solutions, Chile

1230: break

1315: Eco-efficient mortalities disposal by drying.
Hallstein Baarset, Waister AS, Norway

1345: Technologies for processing of dissolved matter.
Martiña Ferreira Novio, Leticia Regueiro, National Association of Manufacturers of Canned Fish and Shellfish (ANFACO-CECOPESCA), Spain

Part 3: Valorisation and application of aquaculture side-streams in a circular economy perspective

1415: Applicability of fish sludge as bio-fertiliser.
Joshua Cabell, Norwegian Institute for Bioeconomy Research (NIBIO), Norway

1445: Opportunities and limitations for use of mortalities as feed product.
Marta Castrica, University of Milan, Italy

1515: Open discussion, closure of the workshop

Figure 4: Second leaflet launching the online trainings course "Capture and valorisation of aquaculture side-streams" one week before course start.

2.2 The training course

The course was grouped in three modules:

- Part 1: Background, regulations, and technologies
- Part 2: Solutions for capture of aquaculture side-streams
- Part 3: Valorisation and application of aquaculture side-streams in a circular economy perspective

Part 1 contained general background information on aquaculture side streams. Ca' Foscari University of Venice and The Spanish National Research Council (CSIC) provided an overview of aquaculture side-streams and by-products and their valorisation, and elaborated the possibilities of eco-intensification of European aquaculture. The County Governor of Nordland presented and discussed European and Norwegian regulations regarding aquaculture side-streams, while The Bellona Foundation provided background information on environmental challenges and possibilities within a circular economy perspective.

In part 2 we focussed on technologies investigated and developed within GAIN.
Salten Havbrukspark presented the S3 filter dryer technology, combining capturing of particles from aquaculture wastewater and dewatering of sludge.
Circular Solutions and Waister introduced drying systems from Waister to convert fish sludge and mortalities into a dried product.

The National Association of Manufacturers of Canned Fish and Shellfish on the other hand focussed on dissolved matter in aquaculture waste and presented technologies with a promising potential to capture and valorise these side streams.

In part 3 we focussed on the valorisation of aquaculture side streams. The Norwegian Institute for Bioeconomy Research discussed the applicability of fish sludge as bio-fertiliser, whereas the University of Milan presented opportunities and limitations for use of mortalities as feed product.

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2.3 Feedback survey

We asked the participants to evaluate the course via a questionnaire. Global aspects of the course as well as the specific modules could be rated by a score ranging from 0 to 5.
Global general aspects of the course received an evaluation of 4.7, part 1, background, regulations, and technologies received 4.6, part 2, solutions for capture of aquaculture side-streams received 4.6 and part 3, valorisation and application of aquaculture side-streams in a circular economy received 4.5. The adequacy, how the different modules were presented, could be also evaluated. Part 1 and 2 were regarded as adequate by all participants, whereas part 3 was adequate for 80 % of the participants. Detailed results are summarised in table 1 below.

Table 1: summarized results from the feedback survey of the online trainings course "Capture and valorisation of aquaculture side-streams". Part 1: background, regulations, and technologies; part 2: solutions for capture of aquaculture side-streams; part 3: Valorisation and application of aquaculture side-streams in a circular economy;

global aspects of the course	**score from 0 to 5**		
Programme of the workshop	4,8		
Lecturers of the workshop	5		
Round table discussion	4,2		
Live streaming system performance	4,8		
Quality of virtual arrangement	4,6		
Level of new information/learning quality	5		
Level of the workshop	4,4		
Documentation provided	4		
Quality of organization	4,6		
Advantage taken from the workshop	5		
Global score of the workshop	4,8		
Adequacy of modules	**module 1**	**module 2**	**module 3**
	% of participants		
Time devoted to modules			
Too much	0	0	0
Adequate	100	100	60
Not enough	0	0	40
Level of explanation			
Too high	0	0	0
Adequate	100	100	100
Too low	0	0	0
Specific aspects of the modules	**score from 0 to 5**		
Interest of the topics dealt with	4,8	4,8	4,8
Quality with which topics were explained	4,3	4,5	4,6
Applicability of topics dealt with to your personal work	4,8	4,8	4,4
Quality of information provided	4,8	4,5	4,6
Amount of information provided	4,7	4,7	4,4
Interaction of lecturers with participants	4,5	4,5	4,2

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3 Training course "Novel aquafeeds"

The training course was held online on September 21st and 22nd 2021, on the Zoom platform, and "branded" as "Workshop", as it was thought to better attract the industry in this way. The aim of the course was to present and discuss novel developments of knowledge on novel fish feeds that support eco-intensification of the European aquaculture industry, providing training to professionals on this topic, including aspects of value creation and sustainable use of by-products and side streams from aquaculture, fisheries and agro-industries.
"
Target groups were professionals in the aquafeed value chain (e.g., junior and senior staff involved in R&D, formulation and technical support) and research institutions (e.g., lecturers, researchers, PhD students, post-docs) across the European Union, associated countries and other countries.

The course had 336 registered participants from 40 different countries: India (40), Portugal (30), Egypt (22), Italy (20), Spain (19), Brazil (12), Norway (11), France (10), United States of America (9), United Kingdom (9), Indonesia (7), Netherlands (6), Germany (5), Turkey (5), Chile (4), Philippines (4), Belgium (3), Greece (3), Malaysia (3), Thailand (3), China (2), Denmark (2), Ireland (2), Morocco (2), Singapore (2), besides others.

33 % of the lecturers were members of the GAIN consortium, including

- Ca' Foscari University of Venice, Italy
- SPAROS Lda, Portugal
- University of Stirling, united Kingdom
- Agencia Estatal Consejo Superior de Investigaciones Científicas, Spain

Lecturers not included in the GAIN consortium were from public research institutions, universities and industry.

3.1 Pre-course activities

The online training course was launched from Olhão, Portugal, using the online meeting platform "Zoom". Organisationally and technical course design was performed by SPAROS. The course contained 16 lectures given by a single or two lecturers (grouped into four sessions). Each lecture had a timeslot of 15 minutes. At the end of each session, 20 minutes were used for a round-table discussion.

As lecturers professionals from industry, academia, public administration and from industry were invited to present the relevant topics from different perspectives.

The course was promoted by social media in two leaflets: the first one with information regarding the course (3 months prior the course) and the second one with a full programme (2 weeks prior the course). Leaflet one contained a preliminary overview of the program. A second leaflet contained a detailed program (Figure 5). The leaflets were distributed by e-mail and Linkedin. Additionally, the course was launched on several websites (see e.g.

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https://gain2020.blog/; https://www.sparos.pt/gain-workshop-novel-aquafeeds/).

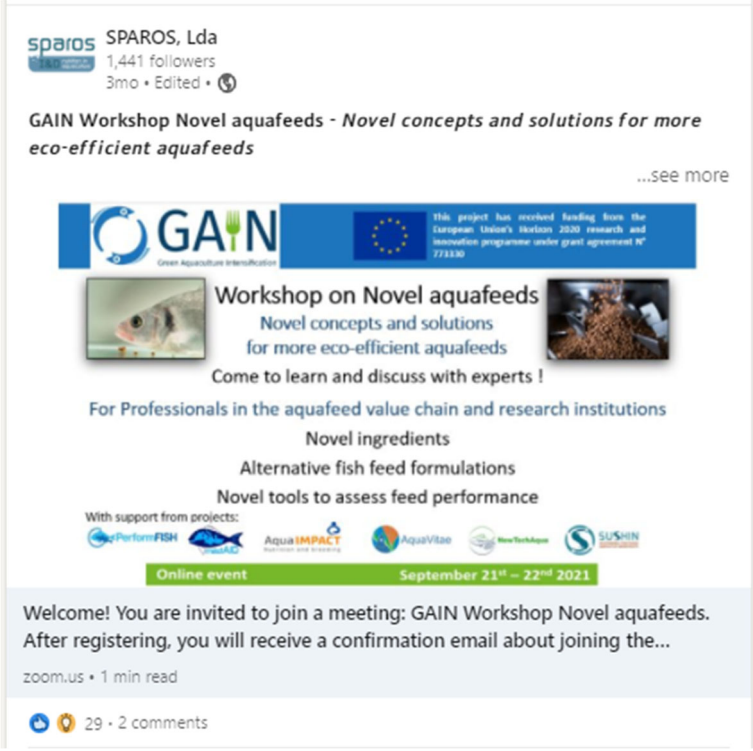

Figure 5: First leaflet launching the online training course "Novel Aquafeeds" three months before course starts.

3.2 The training course

The course was grouped in four modules:

- Part 1: Introduction – what are sustainable aquafeeds?
- Part 2: Novel ingredients: strengths and weaknesses, yeast and bacterial proteins, PAPs from agroindustry, by-products, by-products from aquaculture, micro and macro-algae, mineral and vitamin sources, challenges for a sustainable supply
- Part 3: Alternative fish feed formulations: Results for the industry, results from research projects (GAIN, PerformFISH, AquaIMPACT, MEDAID and SUSHIN)"
- Part 4: Novel tools to assess feed performance: where are we and how to progress, molecular biomarkers, microbiome analysis, simulation models

3.2.1 Day 1

Part 1 contained the welcome and introduction from Roberto Pastres, GAIN scientific coordinator, and a first lecture on sustainable & eco-efficient ingredients and aquafeeds.
Part 2 focused on the strengths and weaknesses regarding novel ingredients and contained 6 lectures.

3.2.2 Day 2

Part 3 focused on the alternative fish feed formulations, more specifically related to the results

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from other research projects having fish nutrition as a main topic, and contained 5 lectures. Part 4 discussed novel tools to assess feed and contained 4 lectures.

3.2.3 Full course program (speaker / institution)

Day 1 (21. September)

- Part 1: Introduction – what are sustainable aquafeeds?
  - Welcome (Roberto Pastres, UNIVE)
  - Sustainable & eco-efficient ingredients and aquafeeds (Jorge Dias,SPAROS)
- Part 2: Novel ingredients - *Strengths and Weaknesses*
  - Yeast and bacterial proteins (Fabio Brambilla, Naturalleva; Sachi Kaushik)
  - PAPs from agroindustry by-products (Tiago Aires, Sorgal; Luisa Valente, Univ. Porto/CIIMAR)
  - By-products from aquaculture (Vasilis Karalazos, BIOMAR; Brett Glencross, IFFO)
  - Micro and macro-algae (Andrea di Biase, Veronesi; Ana Teresa Gonçalves, GreenColab)
  - Mineral and Vitamin sources (Phelly Vasilaki, IRIDA; Antony Prabhu, IMR)
  - Challenges for a sustainable supply (Richard Newton, Univ. Stirling)
  - Round-table Discussion (Speakers and participants)

Day 2 (22. September)

- Part 3: Alternative fish feed formulations - *Results for the industry*
  - Results from GAIN project (Luis Conceição, SPAROS; Jaume Pérez, CSIC)
  - Results from PerformFISH project (Marisol Izquierdo, ULPGC)
  - Results from AquaIMPACT project (Daniel Montero, ULPGC)
  - Results from MEDAID project (Alicia Estevez, IRTA)
  - Results from SUSHIN project (Gloriana Cardinaletti, Univ. Udine)
  - Round-table Discussion (Speakers and participants)

- Part 4: Novel tools to assess feed performance - *Where are we and how to progress*
  - Molecular Biomarkers (Ana Teresa Gonçalves, GreenColab; Jorge Fernandes, Nord Univ.)
  - Microbiome analysis (Carla Piazzon, CSIC)
  - Behaviour monitoring integrated with other tools (Jaume Pérez, CSIC)
  - Simulation models (Ana Nobre, SPAROS; Edouard Royer, UNIVE)
  - Round-table Discussion (Speakers and participants)

3.3 Feedback survey

We asked the participants to evaluate some questions in regards aquafeed sustainability and also in relation to information on where they work, time in the area and more specifically how

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they see the future of sustainable ingredients in aquaculture.
The survey was carried out through polling during the course in two stages (one per day of the course). Detailed results are summarised in table 2 and 3 below.

Table 2: Summarized results from the feedback survey of the online trainings course "Novel Aquafeeds". Part 1;

1. Do we need more sustainable & eco-efficient ingredients and aquafeeds compared to what is used today:	
a. Strongly agree	58%
b. Agree	38%
c. Neutral	4%
d. Disagree	0%
e. Strongly disagree	0%
2. Which of the following ingredients so you think can contribute to more sustainable & eco-efficient ingredients and aquafeeds:	
a. Yeast proteins	47%
b. bacterial biomass proteins	32%
c. PAPs from agroindustry by-products (land animals)	14%
d. By-products from aquaculture	3%
e. Microalgae (autotrophic)	1%
f. Microalgae (fermentation)	0%
g. Macroalgae	3%
h. Others	0%
3. Which of the following ingredients so you think can be used cost-effectively in aquafeeds in the near future (2-4 years):	
a. Yeast proteins	3%
b. bacterial biomass proteins	10%
c. PAPs from agroindustry by-products (land animals)	7%
d. By-products from aquaculture	21%
e. Microalgae (autotrophic)	7%
f. Microalgae (fermentation)	17%
g. Macroalgae	24%
h. Others	10%
4. Which of the following ingredients so you think can be used cost-effectively in aquafeeds in the mid-term future (5-10 years):	
a. Yeast proteins	4%
b. bacterial biomass proteins	6%
c. PAPs from agroindustry by-products (land animals)	8%
d. By-products from aquaculture	20%
e. Microalgae (autotrophic)	20%
f. Microalgae (fermentation)	18%
g. Macroalgae	6%
h. Others	18%

Table 3: summarized results from the feedback survey of the online trainings course "Novel Aquafeeds". Part 2; Second

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Day Survey

1. I work:	
a. At the aquaculture industry	13%
b. At other animal industry	0%
c. At an industry other than animal	13%
d. At a University / Research Institute	50%
e. I´m a student	19%
f. I´m not employed	
2. How many years in the industry/academia you have?	
a. Less than 3 years	6%
b. Between 3 and 5 years	19%
c. Between 5 and 10 years	25%
d. Above 10 years	50%
3. How would you rate the presentations and discussions in this workshop?	
a. Excellent	63.5%
b. Good	31.3%
c. Adequate	6.3%
d. not very good	0%
e. poor	0%
4. Was this course helpful in further developing my knowledge of novel feed for aquaculture?	
a. Strongly agree	43.8%
b. Agree	56.3%
c. Neutral	0%
d. Disagree	0%
e. Strongly disagree	0%
5. I received new and relevant information during this workshop.	
a. Strongly agree	37.5%
b. Agree	62.5%
c. Neutral	0%
d. Disagree	0%
e. Strongly disagree	0%
6. Do you believe that novel aquafeeds will be largely used in the near future?	
a. Strongly agree in up to 5 years	68.8%
b. Strongly agree in up to 10 years	12.5%
c. Agree in up to 5 years	12.5%
d. Agree in up to 10 years	6.3%
e. Neutral	0%
f. Disagree	0%
g. Strongly disagree	0%
7. Do you believe these novel ingredients will be cost effective in the next few years?	
a. Strongly agree in up to 5 years	25%
b. Strongly agree in up to 10 years	18.8%
c. Agree in up to 5 years	43.8%
d. Agree in up to 10 years	6.3%
e. Neutral	6.3%

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f.	Disagree	0%
g.	Strongly disagree	0%

4 Conclusions

Within the training course "Capture and valorisation of aquaculture side-streams" we aimed to provide knowledge on value creation and sustainable use of by-products and side streams from aquaculture, and to discuss the possibilities for an eco-intensification of the European aquaculture industry with decision makers and professionals from industry, public authorities and research.

We received a variety of comments and suggestions to improve course quality. Thematically there was a clear request to more explore the valorisation of side products. Further some participants aimed for more workshop characteristics including more and longer discussions. Also more documentation should be provided.

The course was generally well received by the participants. Especially the quality and novelty of the provided information were appreciated. As an example for positive feedback Kari Thyholt, coordinator of the NCE Aquatech Cluster, wrote: "*Thank you for sharing a lot of very interesting results. It has been a very good workshop. Kind regards, Kari Thyholt, NCE Aquatech Cluster*".

Within the training course "Novel Aquafeeds" we aimed to provide an in-depth perception on the state-of-the art and on future challenges in formulation and production of novel, sustainable and cost-effective fish feeds. We focussed specifically on the interaction of current formulation trends (plant-rich, alternative feedstuffs, functional additives) and feed processing constraints, resulting in improved fish performance; more specific topics were identification of trends in novel formulation by the Industry; identification of synergies among projects & researchers; improved dialogue between researchers and industry on improvement of aquafeeds eco-efficiency;

The course was very well received by the participants as 94.8 % considered it excellent or good. 100 % of the attendees considered it helpful (strongly agree or agree) to further develop their knowledge in relation to the topic novel aquafeeds. 75 % of the attendees had 5 years or more experience as professionals.

The majority of the attendees (68.8%) believed that novel aquafeeds will be largely used in up to 5 years.

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