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Deliverable D7.8:

Practical summaries of main findings of the project

Authors:	Csaba Baár (CBHU), Kinga Varsányi (CBHU), Attila Berczeli (CBHU), Zsófia Kertész (CBHU)
WP/WP-leader:	WP7 / Zsófia Kertész (CBHU)
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Executive summary

Deliverable 7.8 provides practical summaries of the FutureEUAqua project results. For each output, a short and easy to understand description was developed to give an insight into the achievement and its relevance/importance to the target group. The descriptions are developed to respect the confidentiality level of the results.

The results are presented by Work Packages of FutureEUAqua to follow the work plan and logic of the project.

Introduction

The FutureEUAqua project aims to effectively promote the sustainable growth of climate-change resilient, environmentally-friendly organic and conventional aquaculture of major fish species and low trophic level organisms in Europe to meet future challenges concerning the growing consumer demand for high-quality, nutritious and responsibly produced food.

To this end, FutureEUAqua has promoted innovations in the whole value chain, including genetic resilience, ingredients and feeds, non-invasive monitoring technologies, innovative fish products and packaging methods, optimal production systems such as IMTA and RAS, taking into account socioeconomic considerations by the participation of a broad spectrum of stakeholders, and training.

Deliverable 7.8 aims to present the project's main outcomes, available at the time of the submission of the document. Short, practical summaries are provided to give an overview of the work conducted within the project.

The summaries are prepared to respect the level of confidentiality of the results. In each chapter, the name and contact information of the Work Package Leader is provided in case of further interest.

Results of FutureEUAqua

Work package 1: Sustainable breeding of important European aquaculture species

In Work Package 1, the FutureEUAqua project aimed to assess, validate, and demonstrate the ability of the current breeding programs, their breeding goals, and methodologies in four of the leading European aquacultures.

Work Package 1 Leader: Anne Helena Kettunen (Nofima); e-mail: Anne.Kettunen@Nofima.no.

Demonstration of climate resilience in Atlantic salmon, European sea bass and Gilthead Sea bream in semi-commercial and experimental conditions.

For commercial breeding programs, it is essential to know and document whether and to what extent the current commercial fish strains can maintain their production capacity in changing environments. More frequent, severe climate events in some areas are likely to result in rapid day-to-day temperature changes compared to the rearing conditions currently experienced in most aquaculture locations. Genotype/gene by-environment interactions were investigated for Atlantic salmon, European sea bass and Gilthead Sea bream to get an insight into the climate resilience of important European aquaculture species.

The results indicate that the fish material from these commercial breeding programmes selected for rapid growth will perform well across diverging production environments (salmon) and is resilient to rapid temperature changes experienced in the Mediterranean (sea bass and sea bream). Climate resilience optimises resource utilisation, improves production predictability, and increases the competitiveness of the aquaculture industry in these species.

Related deliverable: Deliverable 1.4: Demonstration of climate resilience status for Atlantic salmon, European seabass and Gilthead seabream (confidential report).

Identification of genetic parameters affecting survival against infectious pancreatic necrosis in rainbow trout.

Infectious diseases represent a significant threat to the sustainability of aquaculture production which not only causes high economic losses for the farmers due to mortalities and morbidity and impacting fish health and welfare. Infectious pancreatic necrosis (IPNV) is a highly contagious disease among the biggest challenges in rainbow trout production.

The survival against the disease has shown genetic variation, with some families surviving better than others. A consistent locus of rainbow trout was detected, explaining a large proportion of variation in survival against IPNV.

Related deliverable: Deliverable 1.5: Genetic parameters of disease resistance (seabass and rainbow trout) and genetic correlation to other traits recorded in Task 1.1 and 1.2 (seabass) (confidential report).

Work package 2: Sustainable and resilient feed and feeding strategies

In Work Package 2, FutureEUAqua aimed to verify breeding potential for nutrition and health physiology traits in fish that will enable future aquaculture and sustainability and resilience, with a focus on high fish performance, health and product quality.

Furthermore, feed formulations for smart, optimised and better performing conventional and organic aquaculture, focusing on the circular economy, were made and thus safeguarding aquaculture sustainability and product nutritional quality and safety.

Work Package 2 Leader: Elena Mente (Aristotle University of Thessaloniki) e-mail: ementе@vet.auth.gr

Novel feeds for conventional and organic sea bream and sea bass aquaculture

Feed ingredients should be sourced in a way that respects ecosystems and biodiversity and must ensure the health and welfare of the animals themselves. Instead of fish meal and fish oil, alternative ingredients should be used. The FutureEUAqua project tested the performance of farmed Atlantic salmon, Rainbow trout, European sea bass and Gilthead sea bream fed tailor-made diets.

The demonstration studies in both Mediterranean farmed fish species, gilthead sea bream and European sea bass, farmed Atlantic salmon and rainbow trout showed that innovative, unconventional, and organic, or potentially organic, feed ingredients have the potential to support good growth and FCR, enabling sustainable future European Aquaculture growth.

The tested novel ingredients were of lower trophic level and were used to replace fish meal fish oil and, in some cases also, soy protein concentrate in the diet. They included ingredients produced by unicellular organisms such as yeast meal and Schizochytrium limacinum, fermented soybean meal, krill products, insect meal and fish meal trimmings with or without bones. The feeds were nutritionally balanced with other ingredients commonly used in aquafeeds and with macro and micronutrients. Commercial feeds had confidential formulas. The performance of sea bass and salmon fed diets containing higher levels of FM and FO was superior to those fed conventional diets. In some species, fish in the FutureEUAqua treatments had higher mortality rates, not in all cases statistically significantly.

Regarding growth, it appears that sea bream performed marginally better than sea bass and salmon when fed the FutureEUAqua diets. For trout, there were no statistically significant differences in growth performance between fish fed conventional diets with inclusion of fermented soybean meal or normal soybean meal, likewise no difference in performance when testing organic diets with fish meal trimmings or fish meal fillet trimmings with lower P levels. A trend was observed for better growth performance by moderate inclusion of novel ingredients to future diets for sea bass and sea bream. A mixture of innovative ingredients used for aquafeeds that can be grown on by-products and waste of other agricultural industrial practices open new horizons for fishmeal replacement in fish feeds.

Related deliverables: Deliverable D2.3: Performance of large-scale demonstration test (confidential report).; Deliverable D2.4: Sustainable diets tailored to growth and health performance (confidential report).

Work package 3: Consumer and regulatory activities

In Work Package 3, FutureEUAqua aimed to develop and test communication strategies to increase consumer awareness, perception and acceptance of European aquaculture products and methods. WP3 assessed regulatory challenges related to access to new production sites in aquaculture production.

Work Package 3 Leader: Pirjo Honkanen (Nofima); e-mail: Pirjo.Honkanen@Nofima.no

Guidelines for communication strategies towards consumers

The FutureEUAqua guidelines for communication strategies highlight some aspects of the communication strategy where unique recommendations were elaborated to support the aquaculture sector in effective communications. Recommendations were developed regarding the target audience of the communication, the social media platform, and the content creation. The target audiences are industry and policy makers on national and EU levels, through which the campaign will reach consumers. The novelty of the guidelines is that they are built on scientific knowledge about consumers in the market as it results from a survey and an experiment conducted on 2500 respondents in Europe. They enable the development of refined communication material to the target population. The expected main benefit is improved consumer awareness, perception, and acceptance of different aquaculture production systems.

Related deliverable: Deliverable 3.3: Suggestion Communication strategies (public report)

The use of Eco-labels communicating sustainability to consumers

FutureEUAqua analysed the effects of currently used eco-labels on consumer awareness and decision-making related to aquaculture products. Simulated choice decisions were used, monitored by eye-tracking, to analyse the role of label viewing and attention on consumer choice of aquaculture products. Online choice experiment on consumers from different countries has further validated laboratory experiments. Overall, the results of the two studies suggest that eco-labels are relevant cues for communicating the sustainability of aquaculture products. However, "umbrella" eco-labels, like the organic Euro-leaf and the new GGN sustainable farming, may be more effective than single-category eco-labels.

Related deliverable: Deliverable 3.2: Report on lessons from marketing approach of existing Eco-labels (public report)

Policy recommendation: Availability of production sites for aquaculture in Europe

Aquaculture regulations in five European countries (France, Germany, Greece, Italy, and Norway) were analysed, focusing on area access and area planning/marine spatial planning. The output from the analysis is a description of the status in each country and a discussion of the achievement of policy goals, identification of bottlenecks and good practices, which can form the basis for new and improved practices in EU member states and other countries. The analysis of challenges and conflicts related to the availability of production sites for different aquaculture productions, and subsequent suggestions for revision to remedy these, can contribute to the continued development of aquaculture production in Europe.

Related deliverable: Deliverable 3.4: Report on regulatory framework of aquaculture (public report)

Work package 4: Sustainable and resilient production systems

In Work Package 4, FutureEUAqua investigated the innovations on sustainability and resilience in two different production types, IMTA and RAS, within the frame of nutrient flows and treatment, and water quality, emphasising production, economic profitability and environmental impact.

Work Package 4 Leader: Wout Abbink (WUR); e-mail: wout.abbink@wur.nl

Data for Life Cycle assessment

Life Cycle Assessment requires data collection on environmental impacts in the entire value chain. The datasets prepared in FutureEUAqua can be used in future research and innovation actions. The method and format of these data sets are not new; its main benefit is that they reduce the efforts needed for data collection.

Related deliverable: Deliverable 4.9: Final version of the environmental and economic model

A simulation model to evaluate the economic effect of production, feed ingredients, by-products, different breeds, production system and packaging

A calculation tool was developed that enables users to assess the economic profitability of aquaculture across the full value chain or parts of the value chain. The tool can help future aquaculture farmers assess innovation's economic feasibility in the value chain. Compared to similar tools, its novelty lies in its coverage of the full value chain. The model can be used in future research.

Related deliverable: Deliverable 4.9: Final version of the environmental and economic model (confidential report).

Innovative water quality descriptors

In most RAS, a series of physical-chemical water quality parameters are traditionally measured continuously, daily, or weekly; the frequency depends on the expected variation and the immediate importance of the parameter. Generally, these measurements are connected to monitoring and alarm systems that immediately inform the operator about existing levels and activate an alarm (and a response) if beyond the given set limits.

New and innovative water quality evaluation methods/water quality descriptors (particle size distribution and bacterial activity) complemented by traditional water quality parameters (organic matter) and nitrogenous compounds (particulate and dissolved) were established to create a complete view of the water quality.

Related deliverable: Deliverable 4.5: Water quality descriptors (confidential report).

Sustainable production in IMTA

In recent years, seaweed aquaculture in northern Europe has been growing. Historically, seaweed production in this region was dominated by a collection of wild plants; cultivation was relatively rare. Nevertheless, seaweed was considered an excellent component of sustainable aquaculture for many years because of the plant's capacity to extract dissolved nutrients and sequester carbon from aquatic environments.

Several EU projects investigated the production, environmental, and economic performance of integrated multitrophic aquaculture (IMTA), a production system that cultures two or more different trophic level species in the same farm.

A report was developed to shed light on ways of combining salmon and seaweed culture that is environmentally sustainable, financially profitable and attractive to growers. It draws on approximately 15 years of research on IMTA that includes numerous European and Canadian studies, many of which have involved the authors. Past studies focusing on salmon-seaweed co-culture in a single farm unit found that salmon farmers were generally wary of undertaking IMTA and preferred to specialise in one highly profitable crop. The reasons for this reluctance are discussed in the report and lead to exploring integration at a larger spatial scope, such as a bay or fjord.

Related deliverable: Deliverable 4.11: Salmon-seaweed co-culture: Beyond farm-level integrated multitrophic aquaculture (IMTA) (public report).

Work package 5: Internet of Things for healthy fish and environment

In Work Package 5, FutureEUAqua aimed to monitor the impact of housing environments, and innovative diets on fish health and welfare during large-scale demonstration activities carried out in other Work Packages using a wireless communication system to integrate Key Performance Indicators (KPIs).

Work Package 5 Leader: Giuseppe Lembo (COISPA) e-mail: lembo@fondazionecoispa.org

Biomass estimation sensing system and novel machine learning techniques

Biomass estimation sensing system and novel machine learning developed is based on stereo vision and provide a way to accurately measure fish growth dimensions in their cages in a non-invasive manner and without the need to access the off-shore installation physically.

Related deliverable: Deliverable 5.3: Biomass estimation sensing system and novel machine learning techniques (public report).

Wireless Sensor Network to enhance fish welfare and environmental sustainability

The developed real-time wireless communication system and sensor network include a cloud platform communicating wirelessly underwater. The novelty of this system is based on the capability of the wireless communication system to monitor simultaneously, in real-time, both environmental conditions and fish activity in the aquaculture facility. The collected data can provide real-time, accurate fine-scale measurements of environmental conditions, fish health, welfare, and habitat use. This may help farmers/producers to take early responses, increasing the likelihood of response success, reducing potential welfare issues and improving production.

Related deliverable: Deliverable 5.2: Calibration of physiological sensors technologies (public report).

Work package 6: Quality and safety of aquaculture products

In Work Package 6, FutureEUAqua aimed to develop innovative, high-quality, minimally processed fish products and related packaging conditions to valorise aquaculture raw materials. FutureEUAqua investigated several novel seafood processing methods, packaging and quality control that contribute to a more efficient and sustainable European aquaculture industry.

Work Package 6 Leader: Francesco Capozzi (UNIBO); e-mail: francesco.capozzi@unibo.it

Fish Texture Evaluation Tool (FTET)

Fish Texture Evaluation Tool is a novel device for testing and evaluating fish products' texture and, thereby, freshness (among other aspects). It's automatic, non-destructive testing of fish samples performed without manual user intervention. Results are delivered rapidly and dependably without destroying the tested fish samples. The current application is based on monitoring a feature (texture) that changes even in the early post-mortem stages and therefore has an enhanced ability to distinguish fish within the frames of high-quality shelf life.

Related deliverable: Deliverable 6.8: Development of operational principles and associated technology of the non-destructive fish texture evaluation prototype, demonstration of best practices on texture evaluation by industrial testing and validation (confidential report).

Further Work Package 6 results

Seafood and seafood products are highly perishable due to their chemical composition (abundant moisture and poly-unsaturated fatty acids). They are regarded as highly sensitive to thermal processing technologies, as they may promote, if not correctly optimised, heat-induced changes to flavour and texture, consequent to oxidation and drip loss. These products are often subjected to various processing methods to extend their shelf-life by maintaining quality and minimising the loss of nutritional quality.

- Protocols for optimising cold plasma treatment of fish products were developed to maximise the sanitation effect with a minimal detrimental effect on quality. The results were used for the setup of shelf-life studies of the fish products and allowed to develop of a prototype of an uncooked seabream product, characterised by preserved nutritional value and increased stability compared to the untreated one
- Protocols for optimising an innovative cryo-smoking technology were developed to obtain ready-to-eat slightly smoked salmon, with reduced interruption of the cold chain of fillets to produce high-quality smoked salmon.
- FutureEUAqua proved that a component of shrimp shell used as an edible coating increased the shelf-life of fishballs made from trout rest raw material.
- FutureEUAqua has tested a promising packaging method combining super-chilling with modified atmosphere or vacuum skin. The tested method produced the same salmon fillet quality as the conventional but with a considerably extended shelf-life using less plastic material.

Related deliverables: Deliverable 6.3: Prototype of an innovative uncooked seabream processed product with high nutritional value and desired sensorial characteristics (public report); Deliverable 6.4: Prototype of an innovative cold- smoked salmon product with high nutritional value and desired sensorial characteristics (public report); Deliverable 6.5: Prototype of an innovative ready-to-cook product containing flesh mince obtained by advanced recovery system; Deliverable 6.10: Determination of the optimum MAP conditions and type of packaging for shelf-life maximisation of seafood products

Work package 7: Training, capacity building and support to policy

In Work Package 7, FutureEUAqua developed tools to build capacity among key actors and support them in implementing innovations and good practices.

Work Package 7 Leader: Zsófia Kertész (Campden BRI Hungary); e-mail: z.kertesz@campdenkht.com

Inventory of successful cases

The inventory collects good practices from the aquaculture sector from all over the world. The descriptors are grouped into eight chapters (production system design; feeding practice; breeding practice; water quality; IT solutions; information for users; product and packaging performance; others) following the work plan of FutureEUAqua. The collection can help SMEs to extend their knowledge, competencies, and management skills. Users can find information on the specific need and problem addressed, the technical description of the innovation, the description of the novelty, the necessary prerequisites, and a source of more detailed information. The information used is publicly available.

Related deliverable: Deliverable 7.3: Inventory of successful cases (public report).

Best practice guide for aquaculture producers and processors

This guide provides a practical and comprehensive overview of the main innovations and results of the FutureEUAqua project. Its main benefit is to enhance the capacity of actors within the aquaculture sector, to identify their problems and needs and to resolve them by applying the innovations of FutureEUAqua. They can find in the guide tips and recommendations that are easy to understand and adapt to their system, research etc. Its novelty is that it covers very different aspects of the aquaculture sector, from breeding practices to fish product production and novel packaging solutions.

Related deliverable: Deliverable 7.4: Online handbook with best practice guidelines (public report).

Training Course and Educational Material

"Sustainable, resilient and climate-friendly Blue Growth of EU Aquaculture and Beyond" was the title of the FutureEUAqua online course, which was hosted by CIHEAM Bari's eLearning platform, aiming to turn/transform results and outputs into practical knowledge to implement the innovative solution identified and developed in the framework of the Horizon 2020 "FutureEUAqua" project.

The course was mainly addressed to aquaculture stakeholders, innovation brokers, SMEs and policy makers, involved in deploying innovations in aquaculture, with a focus on sustainable agriculture, feed ingredients and feeding strategies, organic aquaculture, production systems, safety and quality, monitoring technologies, consumer awareness and the European regulatory framework for aquaculture.

The online training had three modules:

- Module I: Innovative feeds and feeding strategies for improving welfare & performance of fish in sustainable and organic aquaculture
- Module II: Consumer perception and preferences regarding aquaculture

- Module III: Regulatory framework for aquaculture in the EU, with special focus on organic aquaculture

The training materials are publicly available on the FutureEUAqua website: https://futureeuaqua.eu/index.php/training-material/.

Related deliverable: Deliverable 7.5: Online courses (public report).

Conclusion

The FutureEUAqua project has the ambitious aim of supporting the EU aquaculture value chain with innovations to build more sustainable businesses, reflecting innovative efficiency, that reduces the environmental footprint of the activity and provides demonstrable health and nutritional benefits for the consumer.

The Deliverable 7.8 aims to present the main outcomes of the project. Short and easy to understand descriptions were developed for each result to give an insight into the achievement and its relevance to the target group.

The results were grouped by work packages. All work packages provided results, except the dissemination, coordination, and management work packages (WP8, WP9 and WP10) since these work packages aim to support the successful communication and execution of the project rather than generating new or improved knowledge.