

SEAFOOD^{TOMORROW}



Nutritious, safe and sustainable seafood for consumers of tomorrow

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Deliverable D1.2

Fortified farmed carp, salmon, trout and seabream

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Dissemination Level	
PU Public	X
PP Restricted to other programme participants (including the Commission Services)	
RE Restricted to a group specified by the consortium (including the Commission Services)	
CO Confidential, only for members of the consortium (including the Commission Services)	

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1. Summary

Aquaculture feeds can be a relevant tool to biofortify farmed fish fillets in selected nutritional/health valuable compounds. However, data on the efficacy of nutrient biofortification strategies in farmed fish is still limited. In the framework of the SEAFOOD^{TOMORROW} project, several biofortification blends, comprising iodine-rich macroalgae, selenised-yeast and DHA-rich microalgae biomasses, were formulated and used to manufacture the experimental feeds to be tested at both pilot and farm-scale with rainbow trout, Atlantic salmon, common carp and gilthead seabream. Criteria associated to nutritional value, safety and legal compliance for use in animal feeds and economical (market availability and costs) were taken into account for the definition of the various fortification blends, which varied within species. In a first phase, 3 pilot-scale trials with the target fish species mentioned were undertaken and criteria related to the biofortification efficacy (e.g. target nutrient deposition in fillets, physiological and metabolic response of fish to the fortification strategies) were assessed. Overall, results from the various biofortification scenarios confirmed that aquafeed supplementation is a highly effective approach to significantly increase the fillets content in iodine, selenium and EPA+DHA. Based on these results, the specifications of the optimal fortification blends were defined, and its efficacy has been validated at large-scale trials with gilthead seabream, common carp, rainbow trout and Atlantic salmon, as a demonstration activity under industrial conditions.

2. Objective

The objective of this Deliverable is to validate, optimize and demonstrate novel natural feed specialties (functional blends of macroalgae, microalgae and selenised-yeasts) which were already used in aquafeeds at pilot-scale trials for Atlantic salmon, rainbow trout, common carp and gilthead seabream. They will result in novel biofortified products with enhanced levels of health-valuable nutrients such as iodine, selenium and sustainable n-3 LCPUFAs. Moreover, a goal of the farm-scale trials is to improve seafood quality.

3. Background

Seafood is one of the most important food commodities consumed in Europe as it is an important source of high-quality protein and is naturally rich in valuable nutrients for a healthy diet. It is therefore vital to develop new environmentally friendly and transparent seafood production and processing methods that will support European seafood security and quality in-line with market demands. Aquatic products (mainly fish, aquatic molluscs and crustaceans) play a key role in the food system, providing nearly 3 billion people with at least 15% of their animal protein intake. SEAFOOD^{TOMORROW} is developing, validating and demonstrating commercially viable and eco-innovative sustainable solutions to improve the socioeconomic and environmental sustainability of seafood production and processing sectors, while preserving seafood quality and safety, and promoting seafood consumption in a healthy diet. Supplying the European seafood industry with innovative, fully validated solutions (e.g. technical, social, economic and environmental) requires a transdisciplinary team, working with consumers or their representatives. Detailed and complex validation tools are being employed to ensure that solutions developed for European production and processing seafood industries represent increased value in the competitive global seafood markets and policy landscapes. These solutions will also enable the seafood industry to meet EU requirements, i.e. to be

environmentally sustainable, economically viable, and socially acceptable, providing long-term European food security given prevailing and future climate conditions. Project outputs will also help shape future EU policies through greater understanding of seafood industries and consumer needs. Over the last decades, fish nutrition research has devoted a continued effort and has made significant progress with respect to improving feeding efficiency and in replacing fishmeal and fish oil by alternative sources. However, this trend is altering the nutritional value of edible fish, conditioning the expected beneficial effects for consumers.

4. Experimental design

Three farm-scale-feeding trials were undertaken.

4.1. Fish trial - Common Carp

4.1.1. Experimental design

The farm-scale trial started on the 30th of May and finished on the 30th of September 2019. 1 fortified feed was tested against the control in 3 replicas (6 cages x 100 fish each) The trial started with a mean weight of about 250g for each fish. The volume of one cage was 3m³.



Figure 1. Experimental cages of carp farm-scale trial.

4.1.2. Feed (SPAROS)

Fish feed for a test was created by SPAROS.



Figure 2. SPAROS feed mill where all experimental fish feeds were produced.



Figure 3. Experimental and Control feeds developed by SPAROS.

4.1.3. Sampling



Figure 4. Sampling of carp on site.

4.1.4. Farming (experimental) condition



Figure 5. Sampling site of carp farm-scale trial.

4.1.5. Results

Table 1. Carp farm-scale trial data.

Test Diets	Control	SFT CARP
# fish/ cage	100	100
Replicates	3	3
Duration (days)	117	117
Initial weight, g	250 g	250 g
Final weight, g	1295 g	1359 g

Table 2. Basic information about farm-scale trial.

Trial status update	Ongoing/Completed
Any mortality or signs of distress with SFT feed?	No
Any differences on zootechnical performance?	No
Will the fish be ready for task 4.1 Auction?	Yes
Which partners are involved in analytics?	IPMA/CIIMAR, ICETA, CISC
Estimated date for shipping samples to analytics	11-18 November 2019

Table 3. Results of carp trial.

Variant	Initial individual weight [g]	Final individual weight [g]	Total growth [%]	FCR	SGR [%/day]
Control	270	1394	415.82	1.48	1.40
	252	1274	405.54	1.56	1.39
	228	1218	434.08	1.54	1.43
Means for Control	250	1295	418.48	1.52	1.41
SFT Carp	254	1402	452.00	1.43	1.46
	249	1334	435.62	1.45	1.43
	248	1343	441.35	1.50	1.44
Means for SFT Carp	250	1359	442.99	1.46	1.45

The results of carp farm-scale trial show that the use of SFT feed did not adversely affect the growth rate of carp measured by the TC and SGR indicators, nor did it worsen the FCR feed utilization rate. Although, better absolute results for the experimental variant were found for all the above indicators, the obtained differences are not statistically significant. This means that fortified feed does not adversely affect the breeding results and the issue of chemical analysis is to confirm the impact of the feed on the chemical composition of carp meat.

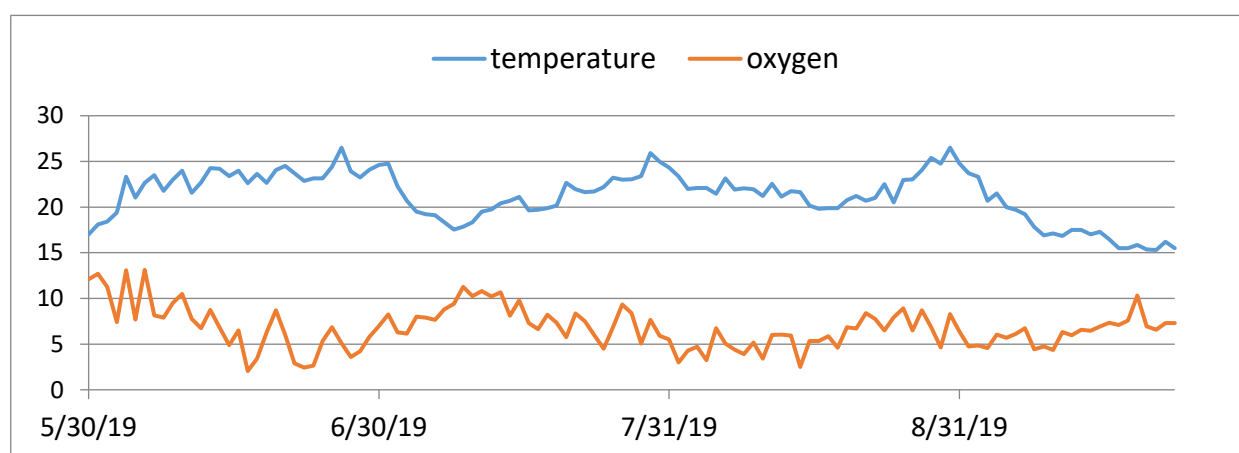


Figure 6. Average temperature and oxygen content in water during farm-scale trial.

The thermal conditions during the experiment were typical for the summer period in northern Poland. Compared to previous years, the water temperature was similar to that recorded in the last decade, but higher than recorded in the years of functioning of the State Fisheries Farm, i.e. until the end of the 20th century. In contrast, compared to southern Poland, the thermal conditions were worse - fewer days were recorded with temperatures above 20° C. Nevertheless, commercial fish was obtained by using industrial feed (both control and experimental). The oxygen content in the water during the experiment did not drop below the level that would limit the carp growth rate, and thus the oxygen conditions in the pond were favourable for fish growth.

4.2. Fish trial - Atlantic Salmon

4.2.1. Experimental design

The farm scale trial of Atlantic Salmon started on August 26th and was terminated on October 22nd due to sea lice infection. The trial consisted of 4 cages of 4 x 4m. Each cage had 200 fish with an average global weight of 2,4kg. All fishes were weighted and measured in the cage. Two cages were fed control feed with Aller Aqua commercial feed and two cages were fed fortified feed containing 3% seaweed.



Figure 7. Control feed from Aller Aqua for experimental trial.



Figure 8. Location of trial in Vadheim (Western Norway).

4.2.2. Feed



Figure 9. Experimental feed delivered from SPAROS.



Figure 10. The fish were hand-fed to satiation.

Fish were measured and weighed before the beginning of the trial.

4.2.4. Farming (experimental) condition

Experimental cages were incorporated in Aller Aqua commercial and experimental farm, at Floteneset. The fish were hand fed to satiation. The fish were checked for sea lice every week and environmental conditions monitored in a daily basis.



Figure 11. Floteneset, the site for experimental site for salmon and rainbow trout in western Norway.



Figure 12. Experimental trial for fish feed fortified with seaweed.



Figure 13. There were no difference in appetite of fish fed experimental feed with seaweed.

At October 14th the fish were checked for sea lice and exceeded the allowed number of sea lice per fish for treatment. Treatment resulted in poor appetite and a decision was made to terminate the experiment between the Coordinator, WP leader and partners involved.



Figure 14. Salmon infected with sea lice.

4.3. Fish trial – Rainbow trout

Aller Aqua started a trial comparing fortified feed with test feed in their cage farm. The trial started on September 6th and was completed on November 14th. Before harvesting, fish were taken out and anaesthetised before being measured and weighed, with exception of fish to be used for feeding trials, in order to avoid retention time before use.



Figure 15. Rainbow trout used in experiment as it had less problems with sea lice.



Figure 16. Salmon Fish being checked for sea lice.

4.3.1. Results

Both the trial fish and the control had good appetite. There was no reduction in appetite after introducing the feed fortified with seaweed to the fish. The results showed that the fish fed with seaweed had grown 33 %, whereas the control fish grew 28 %. The fish has been sent to all the partners for consumer auctions in T4.1 and analysis in T3.2.

Tabel 4. Initial and final data (weight and length) for trout, by treatments.

	Fortified with seaweed		Control group	
	Weight	Length	Weight	Length
06.sep	2,90	54,00	3,10	54,50
14.nov	4,38	59,58	4,32	58,92
growth	1,48	5,58	1,22	4,42
% growth	33,0 %		28,2 %	



Figure 17. Rainbow trout farm-scale trial final sampling.

4.4. Fish trial - Gilthead seabream

4.4.1. Experimental design

The farm-scale trial started on the 27th of August and will finish in the end of November. Approximately, 1500 fishes (3 nets x 500 fishes each) are being fed by the fortified feed and 500 fishes by the normal (control) feed. The trial started with a mean weight of about 440g for each fish.

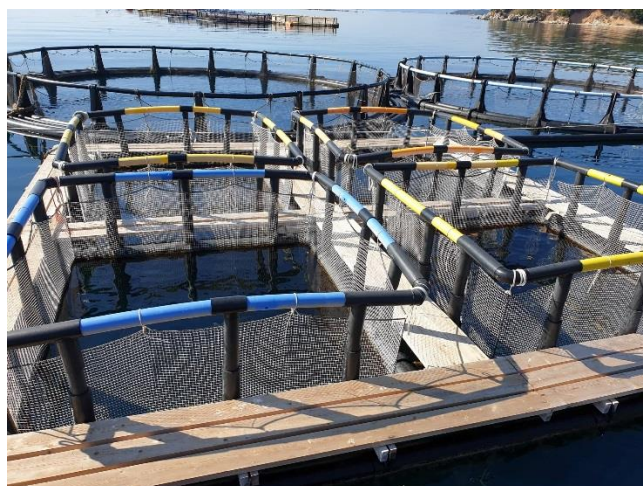
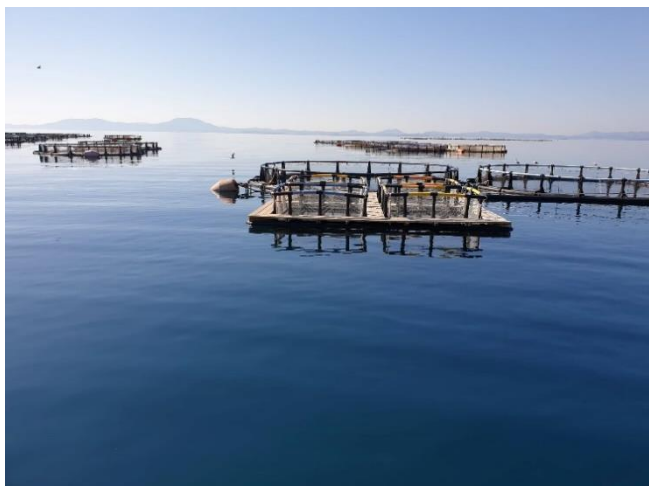


Figure 18. Experimental nets of seabream farm-scale trial.

4.4.2. Feed (SPAROS)



Figure 19. Alternative fortified feed created by SPAROS.

4.4.3. Sampling



Figure 20. Images of seabream farm-scale trial sampling point.

4.4.4. Farming (experimental) condition

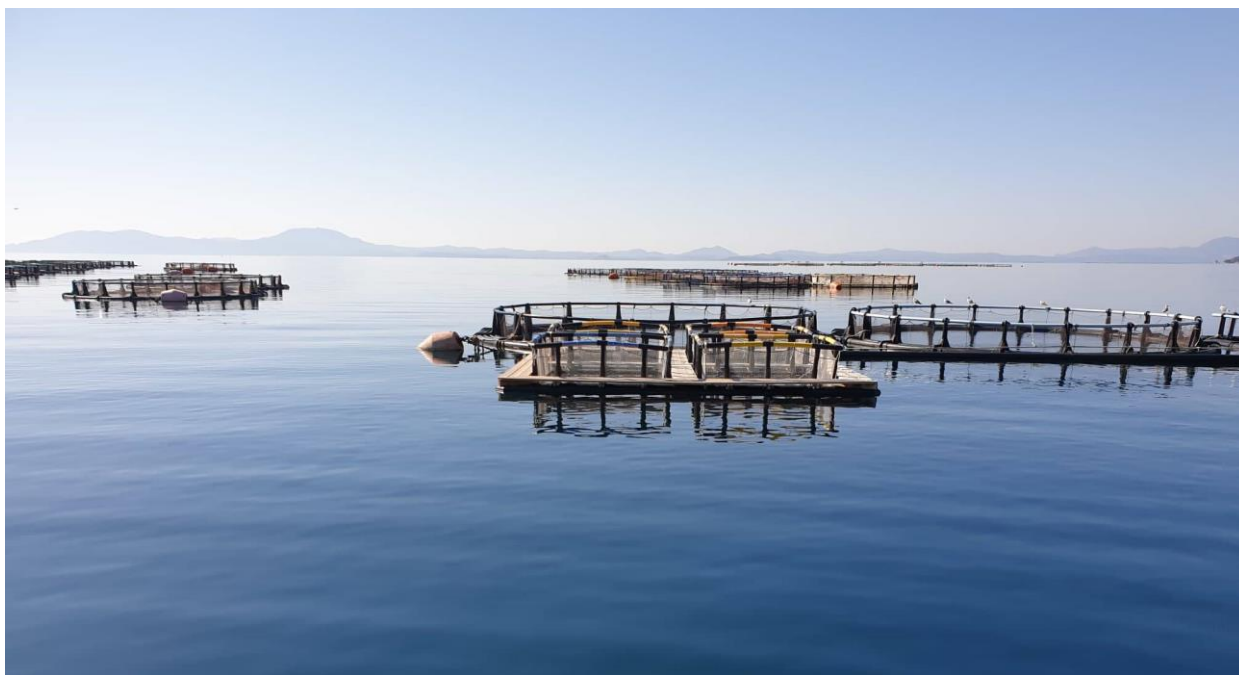


Figure 21. Sampling site of seabream farm-scale trial.

5. Conclusions

For carp, the alternative feed does not adversely affect the breeding results, since indicators such as weight, FCR, SGR and total growth rate are not statistically significant.

Analysis for seabream and trout are currently ongoing and results are expected in December 2019/January 2020.