

Seafood sustainability: Novel aquafeeds for biofortified rainbow trout



SUMMARY

Rainbow trout (*Oncorhynchus mykiss*) is one of the most farmed aquaculture species in Europe. The use of novel fish feeds with natural functional ingredients, such as the macroalgae *Saccharina latissima*, has attracted much attention in recent times, due to a public health drive to improve diets by increasing essential nutrients in products. In most EU Member States, dietary iodine intake is a health concern, with many consumers not reaching their daily recommended intake. Fish can be an effective vehicle for iodine provision. This research examined the effects of dietary inclusion of the iodine-rich macroalgae *S. latissima* on rainbow trout metabolism and fillet nutritional value for human consumption. The results show that the dietary inclusion of *S. latissima* at 1% to 2% is feasible, but a 4% inclusion significantly reduces the trout's final body weight.



RESULTS

This Knowledge Output concerns the effects of biofortified fish diets with the iodine-rich macroalgae sugar kelp (*S. latissima*) on rainbow trout (*O. mykiss*). The impact of diets including increasing amounts (1, 2 and 4%) of *S. latissima* were:

- Apparent absorption coefficients in trout fed on fortified feed with 1–4% dry weight kelp were 67–61% arsenic; 32–40% cadmium; <5% iron; 80–83% iodine; 66–58% selenium. Iodine concentrations in feed up to ~4% kelp was proportional to iodine accumulation in trout fillets.
- Dietary inclusion of kelp impacted lipid metabolism, with a downregulation of fatty acid synthase, accompanied by a general decrease of fatty acids in fillet.
- Feed iodine concentrations (up to 2% kelp) did not negatively affect growth performance, but significantly increased the protein efficiency ratio after eight weeks of feeding. A significant downregulation of an oxidative stress marker, *gpx1b2*, was observed in fish fed with 2% *S. latissima*, which might suggest the need for less endogenous antioxidants.
- Trout fed on 4% kelp meal were affected in terms of lower growth and final body weight and lower hepatosomatic index, and histomorphological changes in the intestine. There were no significant differences in mRNA transcription of genes involved in growth or iodine metabolism.
- All fillets had low toxic element concentrations.

Supplementation of diets with 1 or 2% *S. latissima* can be achieved without detrimental effects on the trout's final weight. Lipid-lowering effects of the supplemented diets does not compromise the concentration of omega-3 fatty acids (eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA)). Consuming a 160 g fillet (2% kelp) contributes to ~60% of recommended daily iodine intake for adults.



IMPACTS

Availability of fortified farmed fish may enable consumers to overcome nutritional deficiencies, which could contribute to an improved health profile of the European population. Reducing the need for fish meal and oils, this knowledge also contributes towards improving ecological and social sustainability of fish feeds. It has the potential to reduce the environmental impact of fish farming and improve consumer perception of the industry.

Contributes to the UN Sustainable Development Goal 12: Responsible consumption and production.



KNOWLEDGE NEED

Fish is a rich source of important nutrients including trace minerals such as iodine and selenium, and omega-3 fatty acids (EPA, DHA). Biofortification of fish through nutritional enhancement composition of their feed is a potential strategy to ensure better intake of these essential elements in human diets, and to overcome nutritional deficiencies. To establish farmed fish as a future successful functional food, there is a need to know the effect of enriching fish feeds on the final fish product, in terms of nutritional value, safety and legal compliance.

END-USERS & APPLICATIONS

- ➔ **Trout feed producers:** can use this knowledge to develop and produce novel feed formulas for rainbow trout (and potentially other related species e.g. Atlantic Salmon), using sustainable ingredients and reducing the environmental impact of aquaculture while lowering costs
- ➔ **Trout farmers and producers:** can use the novel feed formulation to improve the quality and nutritional value of their fish, while at the same time maintaining production levels and promoting aquaculture as a sustainable and environmentally friendly sector
- ➔ **Scientific community:** aquaculture researchers and those working in the area of seafood sustainability can use the validated datasets and new knowledge to support further Research and Development on the effects of sustainable fish feeds on fish production and welfare

DISSEMINATION AND EXPLOITATION

Scientific publications:

- Ferreira M *et al.* (2020). Diets supplemented with *Saccharina latissima* influence the expression of genes related to lipid metabolism and oxidative stress modulating rainbow trout (*Oncorhynchus mykiss*) fillet composition. *Food and Chemical Toxicology*, 139, 111332. DOI: 10.1016/j.fct.2020.111332.
- Open access version: zenodo.org/record/4081428#.YFCOFJ37TIV
- Granby K *et al.* (2020). Growth performance, bioavailability of toxic and essential elements and nutrients, and biofortification of iodine of rainbow trout (*Oncorhynchus mykiss*) fed blends with sugar kelp (*Saccharina latissima*). *Food and Chemical Toxicology*, 139, 111387. DOI: 10.1016/j.fct.2020.111387.
- Open access version: orbit.dtu.dk/en/publications/growth-performance-bioavailability-of-toxic-and-essential-element

Exploitation activities for policy makers:

- Managers, regulators and policy makers will be reached through the final **SEAFOOD^{TOMORROW}** event, EC info session, and a dedicated EU policy event.

Exploitation activities for seafood industry:

- Horizon Results Platform: seafoodtomorrow.eu/horizon-results-platform
- DTU, ZUT and IPMA, have reached fish farmers in Denmark, Poland and Portugal and shared this knowledge through pilot trials of the feeds.

Dissemination activities for society / all users:

- Project newsletter and news articles
- Promotion on Twitter and LinkedIn



INNOVATION STATUS

Technology Readiness Level 7 – system prototype demonstration in operational environment

Patents and IPR: Not applicable. Knowledge generated in the project has been widely disseminated and is open to industrial use.



FUTURE RESEARCH

Further demonstration studies are needed to determine the long-term effects of the iodine biofortification strategy at an industrial scale. A Norwegian trial performed first on trout and then salmon has shown promising results. Additional collaborative testing should be performed with feed producers, trout and other fish farmers, and the retail sector. Biofortified trout have been positively evaluated by consumer panels in various EU countries. To complete and qualify the system, the benefits of iodine biofortified fish must be showcased to the retail sector in terms of human nutrition and market feasibility.

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