FEED AND NUTRITION IN ORGANIC AQUACULTURE

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Organic production is a system of farm management and food production that combines best environmental practices, a high level of biodiversity, the preservation of natural resources, the application of high animal welfare standards and a production method in line with the preference of certain consumers for products produced using natural substances and processes (Mente et al., 2019). Organic aquaculture reflects a specific production approach driven by the growing public interest in sustainable utilization of resources (Mente et al., 2011, 2012, 2019). When applying the principles of organic aquaculture production the following factors need to be addressed: production system design that assures ecosystem balance, biodiversity stewardship, and avoidance of environmental pollution; animal welfare and feeding requirements that respect the health of the organism, product quality, and the expectations of feeding requirements along the lines of similar organic systems; and certain challenges related to breeding (Lembo and Mente, 2019).

Organic fish feed is currently produced according to the EU regulations 834/2007, 889/2008 and 710/2009, 1358/2014, 673/2016, 848/2018. However, due to the limited options in available certified organic ingredients rich in essential nutrients needed to cover the dietary needs of farmed fish, it is challenging for the feed industry to achieve organic feeds of equal quality compared to the conventional ones. Thus, the farmers may experience reduced fish and feed performance leading to disproportionally higher costs in organic farming practices, both due to lower production volumes and to higher feed conversion ratios. Prolonged production cycles increase also the risk of losses due to diseases. Hence, replacing fishmeal and fish oil in high performing diets for organic fish farming is not straightforward. Another challenge related to organic aquaculture is maintaining in practice zero levels any undesirable compounds along the food chain, from ingredient to fork, as consumers often demand from organic products. Chemical antioxidants currently used in conventional aquaculture, in order to safeguard in particular marine ingredient quality, though some on the way out (such as ethoxyquin and its dimers), pesticides etc., find their way in the fish production line, and even if present in small amounts in the fillet, this may represent a risk for scandals and food scares (IFFO, 2015). However, the use of natural antioxidants is of great interest for organic aquaculture.

To safeguard biodiversity and sustainable exploitation of natural resources, the use of capture fisheries-based fish meal and fish oil needs to be limited in both organic and conventional fish feeds (Tacon and Metian, 2015; Lembo and Mente, 2019). However, fish performance, health status and final product quality (Kousoulaki et al., 2016) may be jeopardized when substituting dietary fishmeal by alternative ingredients of lower nutritional value. Thus, new fish aquafeeds and feeding strategies and the exploitation of the genetic potential of farmed fish by selective breeding in using and transforming more efficiently the dietary components to the necessary essential nutrients provides great potential and may allow safer larger steps in the progress of achieving sustainable and resilient fish farming practices

Moreover, though fish cannot synthesize several essential nutrients required for their metabolism and growth, and depend on the feed for their supply, certain animal groups can use nutrient-deficient diets, as they bear symbiotic microorganisms that can provide these compounds (Douglas, 2010). Thus, also aquatic animal's gut microbiota can in theory play critical role in obtaining sustainability in fish farming (Mente et al. 2016; Antonopoulou et al., 2019). Fish would obtain maximal benefits when the microbial supply of essential nutrients is scaled to its demand. Undersupply would limit fish growth while oversupply could be harmful due to allocation of resources to neutralise toxicity caused by non-required compounds. The extent to which the microbial function varies with fish demand and which are the underlying mechanisms are largely unknown.

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In terms of sustainable feed formulations, recent advances prove, among other low trophic level organisms the concept of the nutritional (Kousoulaki et al., 2017) and technical (Samuelsen et al., 2018) feasibility of substituting fish oil by heterotrophically produced microalgae in salmon feeds. Such organisms may be grown on byproducts and waste of other agricultural industrial practices. Nevertheless, achieving the desirable circular economy, which demands recycling of organic and inorganic nutrients, we unavoidably press the current set regulatory limits for undesirable compounds in raw materials and seafood products with potential risks for animal health, welfare, production performance and product safety for the consumers. Mapping occurrence and continuous monitoring and documentation on uptake and accumulation of contaminants on farmed animals in relation to the current levels in feed ingredients and diets is necessary to update and render regulations relevant.

The FutureEUAqua project through workpackage 2 will demonstrate sustainable and resilient nutritional solutions for highest possible fish performances, using common or specially selected fish population, in terms of growth, health, welfare and end product quality, progressing the current state of the art, already endorsed in laboratory or industrial relevant environments to operational environments. FutureEUAqua will design, produce and test commercially relevant, safe, of low ecological footprint, species specific nutritionally adequate or currently inadequate (for non-selected families) innovative feeds for organic aquaculture using feeding protocols, that match the natural feeding behaviour of farmed fish. Both already existing and new candidate ingredients will be documented. Pilot (tanks and cages) and large scale (tanks/cages) fish performance results will be validated via innovative nutrient retention biomarkers (gut microbiome evaluated by 16S rRNA NGS), welfare indicators (e.g. mucosal mapping), quality indicators (nutritional value, taste and texture) and bioenergetics modelling. The ongoing positive growth trend of the aquaculture industry is expected to continue, reflecting the rising demand for healthy human food products. Hence, since 2000 there has been an increasing demand for seafood that has been farmed according to certified organic standards, notably in European countries. It follows, therefore, that like the terrestrial organic livestock production sector, the onus is on the aquatic nutritionist to formulate an organic feed close to the feed that each fish and shrimp species are consuming in their natural environment

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