

## Sustainable aquafeeds – a review (FEAP Annual report 2015)

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It is well-known that the fish feed industry is putting a lot of effort in its search for alternatives for fish meal and fish oil as ingredients in their formulations for fish feed due to the limited availability and, hence, sustainable use of these protein sources.

In the following review, we will look to the big EU project 'Arraina' – that is studying the long term effects of different replacement sources. The upcoming trend of using insects as a new and valuable protein source will be presented as well as the use of algae and transgenic plants as possible alternatives.

**ARRAINA** [www.arraina.eu](http://www.arraina.eu)



The overall objectives of ARRAINA are to develop sustainable alternative aquaculture feeds tailored to the nutritional requirements of European farmed fish species, throughout their respective life cycles, with reduced levels of fish meal and fish oil; to assess the long term physiological consequences by applying targeted predictive tools applicable to multiple species and to provide flexibility in the use of various ingredients in the formulation of feeds which are cost-effective, environmentally-friendly and that ensure production of seafood of high nutritional value and quality (Kaushik, 2014).

European research has already shown that it is possible to reduce fish meal (FM) and fish oil (FO) levels, individually or in combination, in fish feeds. However, several questions remain to be addressed such as whether results obtained e.g. with juvenile fish up to marketable size can be extended to the whole life cycle; whether such dietary interventions can have effects during specific physiological stages such as very early life stages or with broodstock; whether the supply of nutrients, based on available data on nutrient requirements, are valid for all stages of fish fed diets low in FM and FO; whether fish can be tailored to accept such low level marine diets. The ARRAINA project addresses these questions using the top five farmed fish in Europe: Atlantic salmon, rainbow trout, common carp, European seabass and gilthead seabream.

A series of studies deals with evaluating and fine tuning data on micronutrient requirements of fish fed low fish meal low fish oil (low FM/FO) feeds.

Long term studies with fish fed low FM/FO feeds during the different life cycles show the effects on growth, reproductive performance, survival and disease resistance for the different species.

Other work addresses the development of novel nutrient vectors. New research is being made on the application and validation of the concept of “nutritional programming”, early in life or through broodstock nutrition, so as to modify the metabolic potential and, possibly, the acquisition of a changed physiological phenotype.

Investigation into the consequences of feeding fish larvae on different types of microdiets, having different physical properties, is being made - in terms of feed intake, feeding rhythms and digestive function. Additional work looks at the transfer of undesirable contaminants from feed to fish, specifically for Atlantic salmon and sea bream and the possible interactions between contaminants and dietary vitamin A.

## INSECTS TO FEED FISH



Meals and oils made from Insect sources could make an important contribution to the sustainable development of the aquaculture industry. A FAO report, entitled 'Edible insects: Future prospects for food and feed security' (2013), examines the potential of using insects as a source of protein and other nutrients in diets for poultry and farmed fish. <http://www.fao.org/docrep/018/i3253e/i3253e00.htm>

On a species-specific basis, NIFES studies have shown insect meal to be a good source of protein for farmed salmon. Insects and insect larvae are an important component of the natural diet of salmon, and insect meal is therefore one of the most natural things we can add to fish feed.

Nifes has also shown that Insect meal contains all the amino acids that salmon need, containing not only protein but also fatty acids that are beneficial to general animal health. Experiments have shown that insect protein can replace up to 100 per cent of the fish protein in the salmon diet, without compromising either the growth of the fish or the taste of their flesh.

Insects can transform carbohydrates, for example, from food waste, into nutrients that fish need, and in a form that they can utilize. Today in Europe, we throw out about 20 per cent of all our food. This could instead become a sustainable resource for insect production. On a global scale, insect meal based on organic waste could provide three times as much protein as the entire volume of soya produced today.

To further explore these possibilities, the **AquaFly** project has been launched, receiving nearly €1.5 million from the Research Council of Norway. Led by Nifes, AquaFly will look at the use of insects as safe and healthy ingredients of future fish feeds, using environmental, social and economic perspectives.

More info <http://nifes.no/en/counting-insects-future-fish-feeds>

These opportunities are receiving increasing investment attention and the recently formed 'International Platform of Insects for Food and Feed' provides new impetus to this approach – see [www.ipiff.org](http://www.ipiff.org)

## ALGAE

Fish oil is currently the most common and major source of omega3 fatty acids EPA and DHA, largely responsible for the health benefits of eating fish.

There are 2 types of algae: autotrophic or phototrophic algae which grow using light and CO<sub>2</sub>. Heterotrophic algae are single-celled algae that grow using oxygen and a source of carbon (such as plant by-products). Biomass from heterotrophic algae can be produced in a stable manner, in sterile conditions and in large quantities. Current technology allows heterotrophic algae to be produced far more efficiently than phototrophic algae, which make them a more suitable and economical alternative.

Some of these algal meals, containing DHA up to 3 times more than fish oil, are already commercially produced and tested for their effects on fish health, performance and nutrition (salmon and other fish sp.). Nofima fed the alga-based feed – concentrations up to 15% - to small salmon weighing. All fish had more than tripled their weight after 3 months, irrespective of the feed they had received.

The amount of the long-chained marine  $\omega$ -3 fatty acids in the fillets was higher in salmon receiving the algae meal than it was in salmon that had been given fish oil as their only source of these fatty acids. The use of algae meal was looked at for suitability to ensure a high technical fillet quality of the salmon. The high content of short-chain saturated fatty acids as well makes algae meal suitable as a technical stabiliser in fish feed.

It can be concluded that such algae meals are an excellent source of omega-3 for small salmon, and that it can replace fish oil, based on current levels in feed. However, these are still small-scale tests and upscaling and optimization of algae production technologies are still needed to prove if this source can be an economic and viable alternative for future use.

## **TRANSGENIC PLANTS**

Another new but, still very experimental, approach is to obtain terrestrial plants that produce omega 3 fatty acids using genetic engineering techniques.

A British collaborative research effort, by University of Stirling and Rothamsted Research, has developed genetically modified (GM) plants that can produce up to 20% of eicosapentaenoic acid (EPA).

In the current work, five microalgal and fungal genes have been used to engineer Camelina plants (*Camelina sativa*) so as to generate a renewable, terrestrial, sustainable source of omega-3 oils. The extracted oils from plants, grown under glass, were used as a replacement for marine fish oil in feeds for Atlantic salmon. The study results have shown that growth performance, feed efficiency, fish health and nutritional quality for the human consumer were unaffected when dietary fish oil was substituted with oil from these plants.

Obviously, this activity is still far from commercial exploitation. There are some scientific refinements needed for the oils before a 'final' oil product can be taken through to commercial production. The regulatory and approval processes required are necessary and will make this a long process before successful commercial application can be envisaged.

Read the full article <http://www.nature.com/srep/2015/150129/srep08104/full/srep08104.html>