Vegetable oil over fish oil - Researching Alternatives to Fish Oils in Aquaculture (RAFOA)

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In the RAFOA project, the four main European aquaculture species, Atlantic salmon, rainbow trout, sea bass and sea bream, were grown on diets containing variable amounts of vegetable oils (VO) but with sufficient essential fatty acids (EFA) provided by dietary fishmeal. The overall objectives were;

1. To replace as much as possible of the fish oil used in aquaculture feeds with vegetable oils, without compromising the health, welfare and growth performance of the fish.

2. To maintain health benefits, taste and other quality characteristics important to processor and consumer preferences.

3. To advance basic scientific knowledge of fish lipid nutrition.

This was achieved by conducting two large scale trials, for each species. In the first trials (RAFOA I), all species were grown from juveniles to market size on diets containing different ratios of FO to VO with the latter being either rapeseed (RO), linseed (LO) or olive oils (OO). In the second trials (RAFOA II), all species were grown from first feeding, or as close to first feeding as possible, on a high VO replacement diet which was agreed by the project partners after the RAFOA I trials were completed. Thus, the RAFOA II diets used a blend of VOs that would replicate the FO normally used for the commercial production of that species, in this case capelin oil for the salmonids and anchovy oil for the marine fish. The blend of oils was formulated to replicate the FO in terms of saturated, monounsaturated and polyunsaturated fatty acid concentrations and ratios except there would be none of the HUFA found in FO. The VO blend, composed of RO, LO and palm oil (PO), was used to replace between 60 and 100% of the added FO in the four species studied. In both trials I & II, following the feeding of various FO/VO ratios, all fish groups were grown for a period, of up to 24 weeks, on a FO finishing diet to follow restoration of n-3 HUFA and wash out of VO fatty acids.

Project partners at a recent meeting

Conclusions

RAFOA has established that, with judicious care, much if not all of the fish oil currently used in the production of salmon, rainbow trout, sea bream and sea bass can be replaced with a blend of vegetable oils without compromising the growth performance of any of the species. The substantial changes in the fatty acid compositions of the fillets resulting from the VO blend can be readily and largely reversed in all species with a "finishing diet" of fish oil. Thus, much of the FO used in current aquaculture is wasted in the sense that it can easily be replaced with more readily available and sustainable VO. This, as evidenced by the RAFOA findings, is logical since most of the oil used in fish diets is catabolised by the fish to provide growth for energy. A suitably blended VO diet can be catabolised and provide as much energy for growth as a fish oil diet, provided the EFA requirements of the fish are met. In the case of RAFOA the EFA requirements were provided by the lipid (oil) in the fish meal component of the diet. Thus, replacing both fish meal and fish oil simultaneously in fish feeds may be more challenging and difficult to achieve, though findings in RAFOA offer promising approaches to achieving this. Irrespective, there is no reason to continue the current excessive and wasteful use of increasingly limited and possibly non-sustainable FO in fish feeds. Blends from sustainable VO are perfectly acceptable alternatives for most but not necessarily all of the FO currently used in aquafeeds. Moreover, an important by-product of substantially replacing fish oil in aquafeeds with VO blends is that levels of persistent organic pollutants, including PCBs and dioxins emanating from FO are markedly reduced in the fish (as evidenced by related research carried out by RAFOA participants from resources outwith RAFOA). We are pleased to note that substantial replacement of FO with VO blends in aquafeeds is already being implemented by the feed industry and trust that RAFOA has played a significant part in achieving this desirable development. A caveat to this general conclusion is that RAFOA has shown that substituting FO with VO in salmon feeds increases the incidence of eye cataracts in salmon, but in none of the other species. In addition, some blood parameters suggest that fish grown on VO diets may be under somewhat increased stress. Therefore, in future studies with fish grown on diets with FO replaced with VO, particularly care should be given to monitoring the health and welfare of the fish. The RAFOA project has been extremely productive in terms of contributions to the scientific literature with over 40 peer-reviewed publications and over 60 conference presentations so far.

The author holding a prime salmon

The RAFOA project was a Fifth EU Framework Programme, as part of the DG Research initiative, Quality of Life and Management of Living Resources. The project started in January 2001 and completed in June 2005 was coordinated by Prof. John Sargent, until July 2002, and thereafter by Dr Gordon Bell with Dr Douglas Tocher as research director.
The other project partners included; The Nutreco Aquaculture Research Centre, Stavanger, Norway, the National Institute of Nutrition and Seafood Research, (NIFES), Bergen, Norway, the Institut National De La Recherche Agronomique (INRA), Unité de Nutrition des Poissons, Saint Pée Sur Nivelle, France, the Instituto Canario De Ciencias Marinas, (ICCM), Las Palmas, Spain, the Universidad De Cadiz, Puerto Real, Andalucia, Spain and the Laboratoire de Nutrition des Poissons, IFREMER, Plouzane, France.

More information on the RAFOA project can be found at www.rafoa.stir.ac.uk