

Interview

PUFA without fishmeal or oil?

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Is the protein requirement for high-quality feed fish similar for tropical and temperate aquaculture?

It depends more or less on the feeding strategy. For naturally herbivorous fish, there will be differences in nutritional requirements compared with omnivorous and carnivorous fish. But if you compare the nutritional requirements of carnivorous fish in temperate and tropical climates, you will find more or less the same requirements for proteins and lipids.

For herbivorous species, protein requirements are generally lower than for carnivorous species. Although it depends on which species is being farmed, the protein requirement will be more or less 20 to 30 percent. For carnivorous species, the protein requirement is 40 percent or more.

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With fishmeal and fish oil supplies dwindling, what are some of the newer, viable sources of protein?

Fishmeal and fish oil are still popular, and are the most well researched protein and oil sources. But because of uncertain supply and rising production of aquaculture, we will have to make a switch in our thinking and include alternative protein sources.

We are focusing our research on the use of plant-based proteins and oils. We can now substitute fishmeal protein up to 60 or 75 percent by purified plant protein products. And for fish oil, we can substitute in freshwater fishes up to 100 percent, and for marine fishes up to 60 to 70 percent.

Which plant protein provides the best protein option, in terms of protein levels and prices? And how effective are current fishmeal and fish oil replacement products touted in the marketplace?

Soybean is most price competitive. It is quite cheap compared to other plant protein sources. It also has a high qualitative protein value and is highly digestible. This is the reason why production for soy products has increased over time, and why producers have selected and bred different strains of soybeans.

Other replacement products include legumes and oilseeds like peas, lupins, sunflower, rapeseed, cottonseed and cereals and the processing products. But amino acid profile, digestibility, mineral availability, anti-nutritional compounds, palatability and nutrient density limit their replacement efficiencies. If normal meals of those products are used, fishmeal can be replaced at maximum levels of 40 percent without negative impacts on growth parameters.

Furthermore, to ensure a dietary protein level of about 45 to 50 percent and a lipid level of about 20 percent, we'll need dietary ingredients with a minimum protein content of

about 65 percent. As normal plant meals are characterised by protein levels of 10-40 percent, we can only use protein-enriched products to achieve higher plant-protein inclusion rates. Those could be protein concentrates from soybeans or from peas and other plant-based ingredients like gluten, which are highly digestible and low in anti-nutritional factors.

But processing these is cost intensive and the supplementation of specific amino acids which may be limiting is still required. In the case of soybean, it's methionine and for wheat gluten, it's lysine, threonine as well as arginine. These will add to the cost of diet production.

Besides looking at alternatives from plant-protein sources, what are other focal areas for research on fishmeal and oil substitutes?

Current results from European and other international institutions have shown that we can substitute protein from fishmeal and oil sources at higher amounts. But what we do not know up to now is the effect of substitution on fish health. For this, we'll have to look deeper to investigate how the replacement of fish oil or fishmeal will affect fish health. This is currently a topic of specific interest.

Another important point is that, up to now, only fishmeal or fish oil has been substituted, and not both. And this is the next step of our investigation. So we will have to find a very vegetarian diet for the fish.

Has there been any initial stage of investigation showing the implications of substituting both fishmeal and oil? Or what might be some expected nutritional concerns, especially dietary lipid contents, that may arise from this?

We have seen that using normal plant-based meals could influence the digestive tract, gill epithelial or fish endocrinology. Therefore, research has focused on protein concentrates—purified forms of protein—which have reduced amounts of anti-nutritional factors, responsible for those health effects.

In the case of fish oil, replacing it with alternative oils yielded observable specific effects on hepatocytes and lipid metabolism. If we combine substitution of fishmeal and fish oil at the same time, there could be an overlap of effects. It's hard for me to give you a forecast on this but it could have a dramatic effect on fish health.

Asia produces some 90 percent of world aquaculture. China alone produces more than half of global aquatic output. What implications could limited fishmeal and oil supplies have on aquaculture in that part of the world?

Again, this is related to the feeding strategy of the species we want to cultivate. But if we want to sustain market-driven aquaculture, we will have to look for alternative protein sources.

In Asia, especially in China, the species produced are most often omnivorous or herbivorous, like the cyprinids. Those species could be reared with lower fishmeal content, and in the case of carp, produced in intensive systems where their diets normally contain about 5 to 10 percent fishmeal. For carnivorous species, you will need higher amounts of protein, especially proteins of higher quality.

It's more difficult to find a sustainable way of aquaculture development which is market driven and based on the production of carnivorous species. But there are such available methods. For example, the production of omnivorous or herbivorous fish could be integrated into classical agriculture farms where by-products of the farm can be used to lower inputs of feed and protein resources. Furthermore, especially in tropical climates, semi-intensive production types of those species, for example in ponds, could sustain the utilisation of external resources on a bigger scale.

The main nutritional benefit of fish for consumers is PUFA or polyunsaturated fatty acids, which fish derive from fishmeal and oil feed. What may be the effect of feeding plant-based proteins on PUFA levels in fish?

It is well known that the dietary fatty acid composition is reflected in the fish body lipids. Although many freshwater fish are able to convert feed-originated omega-3 fatty acids with 18 carbon atoms into longer chained polyunsaturated fatty acids, especially EPA and DHA, the amount of those PUFA is markedly reduced if fish are fed a diet containing high levels of plant oils.

LAST WORDS...

"Fish fed a finishing diet containing higher amounts of fish oil have a fatty acid profile comparable to fish fed fish oil diets over the whole production period."

For example, feeding rainbow trout 100 percent plant oil diets could reduce the amount of EPA and DHA in the fish body up to 50 percent, compared with those fish fed a fish oil diet.

But to increase the nutritional value, we can feed those fish a finishing diet containing higher amounts of fish oil. If this diet is fed over a period of a minimum three to four months

before slaughtering, the fatty acid profile is comparable to those fish fed fish oil diets over the whole production period.

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