

BEYOND PROTEIN AND FAT:

The underestimated uses of fishmeal and fish oil in swine and poultry diets

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Decades ago fishmeal and fish oil were the mainstay of pig and poultry production, but with the growth of aquaculture from the 1960s onwards these materials have been diverted largely towards feeding fish. With a very broad nutritional profile, their use as feed ingredients for pig and poultry does have large potential advantages, not least of which relate to farmed animal health and welfare. Their high quality is reflected in the market price, but least cost formulations may not always produce higher profit margins once the production benefits are taken into account.

Introduction

Animal protein sources have been known to provide performance advantages in feeds for the production of both swine and poultry since at least the 1880s, when the rendering industry became established with developments in infrastructure, logistics and technology (Denton, et al., 2005). Periods when animal protein sources have not been available, and where feeds were vegetable-based, such as during the Second World War, coincided with a dip in production efficiency (Ibid.), so their importance is clear, and more recent science continues to validate the position (e.g. Yun et al., 2005).

Fishmeal, as one of those animal protein sources, has a long history of use as an ingredient in pig and poultry feeds. Records of fishmeal and fish oil as ingredients in pig feed stretch back at least a century (Ashbrook, 1917), and have been known in poultry feeds for a similar length of time. Today, they are important strategic ingredients in feeds for both animals, where the nutritional benefits provided in weaning and other early life-stage diets are known to extend throughout the production cycle.

Background

Excellent nutritional benefits are provided by fishmeal through the relatively high protein content (62% to >70%, Sauvant et al., 2004) as well as the wide range of micronutrients including the amino acid profile, and the vitamin and mineral composition. A 5 percent or less inclusion (dry weight basis) is typical in terrestrial livestock feeds, and a review of the performance advantages including sows, weaning pigs and broilers is provided by Cho & Kim (2011) clearly illustrating some advantages in growth. Two IFFO-sponsored studies, one in 2009 (conducted by Prof. Haifeng at the Animal Husbandry and Veterinary Research Centre of the Beijing Academy of Agriculture and Forestry), and one in 2014 (conducted by Prof Ma at the China Agricultural University in Beijing) have shown how both fishmeal and fish oil can improve both the growth performance and health of weaned pigs. Whilst acknowledging the high cost of the material, this work shows that fishmeal and fish oil may also support achievements in improved bioeconomic efficiency of production. Even though fishmeal carries a high value and is a relatively expensive ingredient, therefore, the benefits from its incorporation may outstrip competitor ingredients through an influence on the economic production model to achieve improved profit margins.

Fishmeal is known to have a comparatively high digestibility, often supporting improved feed conversion ratios (FCRs) and faster growth in both young pigs and poultry. Improved digestibility and FCRs also have a bearing on environmental performance of the feed, where less unabsorbed nutrients results in the excretion of less faeces and lower levels of nitrogen and phosphorus (Fishmeal Information Network, 2000), and so their use can support ecologically responsible initiatives.

Fish oil is often present in the fishmeal, in the polyunsaturated form, often rich in the omega-3 fatty acids eicosapentaenoic acid (EPA), and docosahexaenoic acid (DHA), with the levels variable depending on the source species (Cho & Kim, 2011). At a level of 8-12 percent fat, fishmeal is a rich source of these materials (Windsor and Barlow, 1981). Overall, fishmeal is nutritionally dense, possessing a gross energy of 21.9 MJ/kg dry matter, and is an excellent source of digestible energy for the farmed animal, whether pig, poultry or fish. In contrast to many of the competitor ingredients, the nutritional benefits of fishmeal and fish oil are more than just the supply of protein and energy, with many of the micronutrients known to have positive impacts on health and welfare of farmed animals,

and potentially the quality of the end product. It is not just about crude protein supply when it comes to fishmeal as a feed ingredient.

Annual production of fishmeal and fish oil is relatively stable. IFFO provides estimates for global fishmeal and fish oil production on a per year basis, as well as figures for the market consumption of these ingredients. In a normal year, fishmeal production is estimated to be in the region of five million tonnes, and fish oil to be one million tonnes or slightly less. With the South American fisheries of Peru and Chile so important to global production, these figures are often affected and may show a decrease in years where there may be an El Niño event, such as experienced over 2015 and into 2016, but on the whole the production sits at roughly the 5:1 million tonnes ratio. For the year which we have the most recent complete figures, 2015, 4.75 million tonnes of fishmeal and 0.86 million tonnes of fish oil were produced (IFFO statistics).

The pattern of the market for fishmeal and fish oil has changed over time. For fishmeal, over a period of the last six decades, the market has moved from one where pig and poultry (chicken) production dominated to one where the aquaculture sector is the major proportion (Figure 1). Pig and poultry production, has, in the past, been reliant on fishmeal, and it is interesting to note that the destination has changed in the market alongside the growth of the aquaculture industry, with fishmeal and fish oil being essential ingredients in some fish species feeds.

Strategic ingredients

Once regarded as commodities, fishmeal and fish oil are now rightly positioned as strategic ingredients in the marketplace. Increasingly they have been used to meet the more demanding nutritional needs of the juvenile or maternal animal, or in customised diets for specialised products.

Their high value in animal feeds extends beyond the immediate contribution to the growth performance of the animal, with some of the micronutrients in particular known to support good physiological function.

The bioavailability of the essential amino acids is high, and fishmeal is particularly rich in lysine and methionine. A broad range of minerals is also provided by fishmeal including

calcium, phosphorus, magnesium, potassium, selenium, as well as vitamins such as B1, B2, B6 and B12 as noted by the FAO, and Windsor and Barlow (1981).

This is a comparatively wide and rich nutritional spectrum for a feed ingredient, supporting growth and optimal physiological function at the most sensitive stages of the life cycle.

Fishmeal – more than just protein and fat

The original reason for using fishmeal in feeds for pig and poultry was based on the ability of fishmeal to provide high levels of protein, with a good amino acid profile, in a highly digestible format for the animal. Cho & Kim (2011) compare fishmeal with other animal feed ingredients such as rendered meat meal, poultry byproduct meal, blood meal and soybean meal, illustrating that it is the balanced amino acid profile of the fishmeal (and especially being rich in methionine and lysine) that provides fishmeal with nutritional advantages. Those authors also point out the role that lysine has in farmed animal immune-competence. Fishmeal provides a very favourable nutrient profile for terrestrial animal feed, and it does not suffer from some of the drawbacks often seen with vegetable-based meals, such as anti-nutritional factors.

It is not merely the contribution that fishmeal provides in relation to the macronutrients, however, as this high performance ingredient is rich in a number of other vitamins and minerals. Again, it is important to look at these factors in comparison to other feed ingredients. One aspect is that least cost formulations based on crude protein may require the addition of synthetically produced amino acids to meet the precise nutritional requirement of the farmed animal (Beski, Swick, & Iji, 2015). This situation is particularly relevant to lysine, but also to some of the other amino acids such as methionine and tryptophan.

Appetence and palatability of the feed are also important factors in the nutrition of young animals and getting them onto the feed quickly can be one of the most important aspects of husbandry. This has been highlighted as of great importance in weaning pigs by Dong & Pluske (2007) where the weaning period imposes nutritional, psychological and environmental stresses on piglets. Those authors reviewed the literature highlighting several studies where the inclusion of fishmeal in the feeds indicated improvements in feed

intake and growth. Fishmeal has also been shown to have advantages in palatability (and hence feed consumption) with broiler chicks (Karimi, 2006). Like fishmeal, fish oil also carries wider benefits than the calorific or energetic contribution to the diet.

Omega-3 fatty acids and health benefits

There is a broad body of literature on the benefits to humans of consuming omega-3 fatty acids, and the evidence base continues to grow. IFFO's partner organisation GOED (the Global Organisation for EPA and DHA Omega-3) reports that in the region of 30,000 scientific papers or more have been published to date with 80 percent indicating positive benefits of the consumption of EPA and DHA (in Nichols, et al., 2016). There is therefore a considerable weight of evidence in support of the benefits of fish oil relating to EPA and DHA, and especially to its anti-inflammatory properties.

Those benefits to humans are wide-ranging and include positive effects on cardiovascular health, immune function, neural development and mental health, and may well be based on a requirement that stems from our evolutionary past and relates to the large brain size in *Homo sapiens* relative to other primates and land animals (Bradbury, 2011).

In an attempt to improve consumption rates of EPA and DHA in the population, there has been some research on the use of fish oil in feeds to achieve an enhancement of omega-3 content in both pig (Leskanich, et al., 1997) and poultry (Rymer and Givens, 2005) meat. Studies have also looked at the influence of omega-3 fatty acids in the maternal diet on suckling pigs (Fritsche, et al., 1993).

Although there are very real drivers to improve the consumption of omega-3 fatty acids in the human population, there are also important farmed animal health and production reasons to use these ingredients in feed. Similar to humans, omega-3 fatty acids have been shown to provide direct benefits to pigs and poultry. Key amongst those benefits relates to immune system functionality (Murray et al., 1991; Murray, et al., 1993; Wang, et al., 2002), and at a time when the use of antibiotics in animal production systems is widely criticised due to the possible impact on human medicine and regarded as "one of the biggest threats facing mankind" (O'Neill, 2015), there is a need to optimise the farmed animal's resilience as far as possible and reduce the reliance on chemotherapeutants.

There may also be benefits in how the farmed animal copes with stress (Carroll, 2004), which also relates to immune-competence and the ability of the farmed organism to deal with pathogens. Those benefits have the potential to reduce stress, reduce disease and improve survival rates in farmed populations, and so have great value in these farming systems.

Overall, the benefits of the use of fishmeal and fish oil in terrestrial animal feeds extend well beyond the obvious contribution of crude protein, fat and dietary energy supply. From that perspective, their value is greater than the majority of other ingredients in their potential contribution as functional ingredients to the growth and health of the farmed animal.

References

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<http://www.goedomega3.com/>

Full references available on request from
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Figure 1: The changing market for fishmeal 1960-2014 (IFFO data)

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