Director's Digest
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USE OF RENDERED ANIMAL PROTEIN INGREDIENTS IN FISH FEEDS

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Feeds for salmonid and many other fish species (e.g. seabass, seabream, yellowtail, eel) generally contain high levels of fishmeal. It is widely agreed that fishmeal should be used more sparingly in these feeds to improve the economic sustainability of fish culture. The formulation of successful fish feeds which rely less on fishmeal requires accurate information on the nutritive value of more economical protein sources.

Rendered animal protein ingredients (blood meal, feather meal, meat and bone meal, poultry by-products meal) are protein sources that are, in general, economical. These products have been used in fish feeds for decades. However, their use has been greatly limited or even avoided in feeds for various reasons, such as poor digestibility, quality variability, and more recently, fear of disease transmission. Rendering companies have, over the past few decades, become increasingly concerned about the quality and safety of their products and have been adapting manufacturing practices accordingly. Many studies in recent years have shown the rendered animal protein ingredients to be useful ingredients for monogastric animals (poultry, swine) feed formulation. A relatively large number of studies on the nutritive value of rendered animal protein ingredients for fish have also been published in the scientific literature. Results and observations from research trials conducted at the University of Guelph over the past five years are summarized below.

Digestibility

Difference in digestibility is one of the primary reasons for variation in the nutritional value of feed ingredients- Measurement of digestible nutrient contents of ingredients provides, in general, a good indication of the availability of nutrients and energy, thus providing a rational basis upon which diets can be formulated to meet specific standards of available nutrient levels. Estimating digestible nutrient contents is especially critical for rendered animal protein ingredients since many of these ingredients have been shown to have lower digestibility than many other ingredients commonly used in fish feeds, for example herring meal, corn gluten meal, and soybean meal.

A relatively large number of studies have examined the digestibility of rendered animal protein ingredients. Estimates of apparent digestibility of protein among studies appear quite variable for most ingredients. This variation may be due to variation in the quality of the ingredients investigated but may also be due to the fact that different methods are used to estimate digestibility of feed ingredients in different studies. Some methods yield significantly different answers from others. Table I summarizes the results of a study examining the digestibility of a relatively large variety of rendered animal protein ingredients produced in North America. This study was conducted with rainbow tout reared at 15'C and the Guelph system was used to collect the faecal material.

High apparent digestibility coefficients (ADC) for protein and energy were observed for feather meals and poultry by-product meals fed to rainbow trout. These high values contrast with much lower values measured in trials conducted at the University of Guelph and elsewhere in the 1970's. These results suggest a significant improvement in the digestibility of feather meal and poultry by-products meal in the past two to three decades. This is probably the result of better manufacturing practices now employed in the production of these ingredients. Improved sorting of the raw material and the optimization of the cooking or hydrolysis and drying conditions are probably factors contributing to the high digestibility values now observed for feather meal and poultry by-products meal produced in North America.

The ADC for protein of the various meat and bone meals examined was relatively high. These values were in accordance with values obtained in previous studies at the University of Guelph. Digestibility of dry matter of meat and bone meal was relatively low since this type of ingredients contains high level of ash (25-30% ash, 4-5% phosphorus), which is only about 4050% digestible.

The ADC for protein of the blood meals appears to be highly dependent on the drying method used. Spray-dried blood products are very highly digestible while rotoplate-, steam-tube and ring-dried blood meals appear to have much lower ADC for protein and energy. The different drying techniques may impose different degrees of heat damage, a factor that has previously been shown to have a very significant effect on digestibility of blood meal for fish. The nutritive values of the different types of blood products available on the market appear unequal. Feed formulators should, therefore, seek information on the origin of the blood products purchased and adjust their feed formulae accordingly.

Table I only present dry matter, crude protein and gross energy digestibility. Reliable data on amino acid digestibility of most fish feed ingredients for fish are scarce. It appears reasonable in the interim to rely on digestibility of crude protein to predict the digestibility of individual amino acids of rendered animal protein ingredients and other protein sources and allow relatively conservative safety margins when formulating feeds.

Table 1. Manufacturing characteristics, crude protein (CP) content, and apparent digestibility coefficients (ADC) of dry matter (DM), CP, and gross energy (GE) of rendered animal protein ingredients from various origins.

Ingredients	Processing Conditions (as provided by manufacturers)	CP	ADC		
		as is %	DM %	CP %	GE %
Feather meal					
1	Steam hydrolysis, 30 min at 276 kPa, disc dryer	75	82	81	80
2	Steam hydrolysis, 5 min at 448 kPa, disk dryer	82	80	81	79
3	Steam hydrolysis, 40 min at 276 kPa, ring dryer	76	79	81	76
4	Steam hydrolysis, 40 min at 276 kPa, steam-tube dryer	75	84	87	80
Meat and bone meals					
1	125-135'C, 20-30 min, 17-34 kPa	57	61	83	68
2	same as above but air classification of final product to reduce ash content	55	72	87	73
3	133'C, 30-40 min, 54 kPa	50	72	88	82
4	128'C, 20-30 min, 17-34 kPa	48	66	87	76
5	132-138'C, 60 min	50	70	88	82
6	127-132'C, 25 min.	54	70	89	83
Poultry by-products meals					
1	138'C, 30 min	65	76	87	77
2	127-132'C, 30-40 min, 54 kPa	63	77	91	87
Blood meals					
1	Steam-coagulated blood, rotoplate dryer	83	82	82	82
2	Steam-coagulated blood, ring dryer	84	87	88	88
3	Whole blood, spray-dryer	83	92	96	92
4	Blood cells, spray-dryer	86	92	96	93
5	Blood plasma, spray-dryer	71	99	99	99
6	Steam-coagulated blood, steam-tube dryer	91	79	84	79
7	Whole blood, spray-dryer	82	94	97	94
8	Steam-coagulated blood, ring-dryer	86	87	85	86

Source: Bureau, D.P., A.M. Harris and C.Y. Cho (1999) Apparent digestibility of rendered animal protein ingredients for rainbow trout (*Oncorhynchus mykiss*). Aquaculture 180: 345-358.