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Opportunities for rendered animal proteins in aquaculture feeds

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Effective sources of lysine, histidine, arginine and sulphur amino acids

The essential amino acids and other nutrients in rendered animal proteins make them valuable as fishmeal replacements in aquafeeds. The quality of rendered products has much improved in recent years.

Aquaculture is a rapidly expanding industry worldwide, and the demand for high-protein ingredients as alternative sources for high-quality fishmeal will expand 200 to 300 percent if the optimistic projection for growth over the next 25 years comes true. Besides obvious economic incentives for replacing fishmeal, significant pressure to improve the environmental sustainability of aquaculture also has had an impact on feed formulation practices in recent years. Reducing fishmeal levels is seen as environmentally responsible by a large segment of the population.

Opportunities for rendered animal proteins

Alternative sources for diets for aquaculture species include byproducts produced by the inedible rendering industry, such as poultry meal, blood meal, meat and bone meal, hydrolyzed feathers, and many others. Rendered animal proteins are especially valuable in the context of fishmeal replacement.

Formulating feeds with low fishmeal content requires the use of combinations of economical ingredients, since many feedstuffs have significant limitations and cannot be used individually at very high levels in the diets of most fish species. Rendered proteins are, consequently, very valuable for the formulation of cost-effective, low-fishmeal aquaculture feeds.

In the past, the use of rendered animal byproducts has been limited by concerns about their poor digestibility and variable quality. A large number of studies have shown that the quality of these ingredients has considerably improved over the past two or three decades.

Today, rendered animal proteins often prove to be the most cost-effective feedstuffs when comparisons are done on a level playing field, for example, on a digestible protein basis (Table 1). The high nutrient density (high protein, high fat, low carbohydrate) of modern shrimp and fish feeds leaves very little room for economical ingredients with low

protein and digestible energy contents (cereal grains, field peas, canola meal, soybean meal, etc.). The high digestible protein and energy contents of most rendered animal protein ingredients makes them useful for the formulation of low-fishmeal fish feeds.

Essential acids, palatable nutrients

Numerous studies have shown that rendered animal protein ingredients are effective sources of essential amino acids such as lysine, histidine, arginine, and sulphur amino acids. As such, they complement very well plant protein ingredients like corn gluten meal and soybean meal, which are deficient in some essential amino acids.

Amino acids in blood meals are highly digestible and appear to be more efficiently utilized than synthetic amino acids by fish. This difference in lysine bioavailability between blood meal and synthetic lysine is significant enough to be of value for least-cost formulation. More work is required to better define the bioavailability of amino acids in rendered animal proteins.

In addition, animal proteins are generally more palatable to most aquatic species than plant protein ingredients. They are also good sources of several nutrients that are abundant in fishmeal: arachidonic acid, taurine, and hydroxyproline. Rendered products could also be cost-effective sources of cholesterol for fish and shrimp diets (Table 2).

Table 1. Protein content and costs of common ingredients used in aquafeed manufacturing.

	Crude Protein (%)	Digestibility of Protein (%)	Digestible Protein (%)	Raw Material Cost (U.S. $/mt)	Digestible Protein Cost (U.S. $/mt)
Fishmeal	65	89	58	1,020	1,763
Feather meal	80	75	60	300	500
Meat and bone meal	50	80	40	220	550
Poultry by-products meal	57	85	48	290	599
Soybean meal	48	89	43	260	609
Corn gluten meal	60	93	56	400	717

Cost source: www.hammersmithltd.blogspot.com, June 2007.

Table 2. Cholesterol content of animal protein ingredients obtained from rendering plants and fish feed manufacturers.

Cholesterol ingredient	(mg/100 g)
Fishmeal, menhaden	237
Fishmeal, herring	302
Blood meal, avian, disc-dried	407
Blood meal, mammalian, flash-dried	255
Blood meal, bovine, ring-dried	241
Feather meal, steam-hydrolyzed	90
Meat and bone meal, 43% crude protein	98
Meat and bone meal, 56% crude protein	100
Meat and bone meal, 56% crude protein	107
Poultry by-products meal, 65% crude protein	168

Table 3. Nucleotide content of selected rendered animal by-products.

Ingredient	Nucleotide Content (%)													
	CTP	UTP	UMP	URI	URA	ATP	AMP	A.D.	GUO	TMP	THY	GTP+CTO	CTD+GUA	TDP+ADP
Fish solubles	5,78	–	384,93	–	1,92	21,83	–	11,37	P	–	–	–		P
Fishmeal	0,49	–	4,72		0,9	2,16	–	1,53	P	–	–	–		P
Fishmeal	–	–	3,14	–	–	–	–	0,49	P	–	–	–	–	P
Blood meal, flash-dried	–	–	0,2	–	–	–	–	–	–	–	–	–	–	P
Blood meal, spray-dried	–	–	–	0,14	P	–	–	–	–	–	–	–	–	P
Feather meal	–	0,5	0,20	0,32	0,16	–	0,19	0,23	P	0,25	0,15	P	P	P
Meat and bone meal, 60% C.P.	–	–	2,27	0,11	0,04	–	0,8	0,40	P	–	–	–	–	P
Meat and bone meal, 45% C.P.	–	–	1,67	0,32	0,02	–	0,17	0,33	P	–	–	–	–	P

P = Nucleotide present in sample.

CTP = Cytidine triphosphate
UTP = Uridine triphosphate
UMP = Uridine monophosphate
URI = Uridine
URA = Uracil
ATP = Adenosine triphosphate
AMP = Adenosine monophosphate
A.D. = Adenosine
GUO = Guanosine
TMP = Thymidine monophosphate
THY = Thymidine
GTP+CTO = Guanine triphosphate + cytosine
CTD+GUA = Cytidine diphosphate + guanine
TDP+ADP = Thymidine diphosphate + adenine monophosphate

Peptides, nucleotides

Small peptides play numerous roles in the biology of aquatic species. Hydrolyzed, rendered proteins offer opportunities in the currently hot area of bioactive peptides. Numerous researchers have discovered that when certain proteins are hydrolyzed in just the right way, the products include one of these small peptides that have powerful physiological effects.

Recently, the research group of Chen, a member of the Animal Co-Products Research and Education Center funded by the Fats and Proteins Research Foundation, has attempted to produce bioactive peptides from rendered protein such as collagen. In the preliminary research, some bioactive peptides have been screened and identified using various chromatographic techniques and confirmed with in vitro antioxidant bioassays. The data suggest that one of these peptides could compete as a natural alternative to the popular synthetic antioxidants butylated hydroxyanisole (BHA) and butylated hydroxytoluene (BHT) used widely in the aquaculture feed manufacturing industry.

Another 2007 study by Gunther quantified the nucleotide content of several rendered animal protein ingredients (Table 3). The idea is to identify how rendered animal proteins can improve the nucleotide content of diets for first-feeding Atlantic salmon. Diets can then be used to enhance the growth and gut development of salmon larvae.

Increasing role

Perceived food safety issues, as well as import and export restrictions, are the major factors that limit the use of animal byproducts in aquaculture feeds today. Nonetheless, rendered animal proteins and fats are integral components of cost-effective aquaculture feeds in many countries. These ingredients will very likely play an increasing role as fishmeal levels in aquaculture feeds are further reduced.

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