Director's Digest
FATS AND PROTEINS RESEARCH FOUNDATION, INC.

DR. GARY G. PEARL D.V.M.
Director Technical Services

16551 Old Colonial Road
Bloomington, Illinois 61704
Telephone: 309-829-7744 FAX: 309-829-5147
<www.fprf.org>

RENDERED ANIMAL BY-PRODUCTS:

A Necessity in Aquafeeds for the New Millennium

Dr. Albert Tacon – The Oceanic Institute

The Advocate Vol. 3(4)

Aquaculture currently consumes about 35% of the world fishmeal supply. The International Fishmeal and Oil Manufacturers Association expects aquaculture to consume 56% of the fishmeal supply by the year 2010.

The mechanism by which aquaculture gains an increasing share of the fishmeal supply is to outbid traditional users such as poultry and swine feed manufacturers. In other words, fishmeal prices are expected to rise as aquaculture continues to grow. This trend is the driving force behind research to reduce dependence on fishmeal.

Rendered Animal By-Products

Of all the different sources of animal protein and energy available for use within compound aquafeeds, the largest in terms of quantities available are rendered animal by-products, including animal protein meals and fats. The former includes meat and bone meal, meat meal, hydrolyzed feather meal, poultry by-product meal, blood meal, dried meat solubles, bone meal, animal plasma, and miscellaneous animal products (i.e. liver meal, lung meal, hide fleshings, animal digest). Fats include industrial tallows, edible beef tallow, lard, yellow grease, and feed-grade fats.

Availability and Cost

Renderers within the U.S. process over 20 million metric tons (mmt) of raw materials each year. In 1999 they produced over 8 mmt of by-products valued at almost $3 billion U.S. These figures included 3.31 mmt of inedible tallow and greases, 2.6 mmt of meat and bone meal, 1.12 mmt of other inedible products, .38 mmt of feather meal, 0.78 mmt of edible tallow, and .236 mmt of lard.

Although no precise statistical information exists concerning the global production and availability of the above animal by-product meals and energy sources, it is estimated that the total global production of rendered animal by-products is currently between 18 and 25

mmt, or about three times that of total global fishmeal and fish oil production (6 to 7 mmt). Table 1 shows recent reported ingredient trading values ($ U.S. per ton) for selected rendered animal by-products and other key feed ingredients.

Table 1. Reported ingredient trading values for selected rendered animal by-products and other key ingredients (Feedstuffs. January 1, 2001)

Ingredient	Trading Value ($U.S./Ton)
Meat and Bone Meal (Ruminant)	204-228
Meat and Bone Meal (Porcine)	237-253
Flash-Dried Blood Meal	390-450
Poultry By-Product Meal	270-315
Hydrolyzed Feather Meal	220-295
Menhaden Fishmeal	395-430
Anchovy Meal	N/A
Soybean Meal (High-Protein)	197-223
Cottonseed Meal	168-210
Canola Meal	146-162
Corn Gluten Meal	280-317
Prime Tallow	(Cents/Pound) 9.5-10
Yellow Grease	(Cents/Pound) 8.25-12
Choice White Grease	(Cents/Pound) 10-12.25
Poultry Grease	(Cents/Pound) 9.5

Despite their ready market availability and generally lower cost compared to fishmeal, rendered animal by-product meals have not generally found widespread use within aquafeeds. By-product meals generally are being used as lower-cost secondary sources of animal protein rather than as primary high-quality animal protein sources within aquafeeds. This has been largely due to their perceived variable composition (especially within products tested in the 1970s and "80s) and generally lower quality compared to fishmeal.

Processing and Nutritional Quality

The poorer nutritional values ascribed to these by-product meals have generally been related to specific essential amino acid imbalances (particularly for blood and feather meals), high ash content (meat and bone meals), reduced nutrient digestibility (inadequate processing/rendering techniques), variable nutrient content and quality (depending on the origin and composition of raw materials used), and possible microbial contamination (inadequate heat processing and poor storage).

However, it is generally accepted that the processing methods currently employed by the modern rendering industry have been greatly improved, with a consequent improvement in the nutritional quality and feed value of animal by-product meals (Bureau and Cho 1999; Shepherd 1998).

Improving Formulations

In addition to improving processing methods within the rendering industry, the increased use of animal by-product meals within aquafeeds can be facilitated through the

use of improved formulation techniques (by blending complementary protein sources to obtain the desired overall dietary nutrient profile), dietary supplementation with limiting free amino acids and minerals, dietary enzyme cocktails that improve nutrient availability and digestibility, and dietary feeding stimulants so as to improve palatability and consequent feed intake.

Shrimp Feeding Trials

Feeding trials recently completed at OI with juvenile shrimp (Litopeaneus vannamei) reared within experimental outdoor, biosecure zero-exchange culture systems have shown that high-quality fishmeal (72.3% crude protein, 10.86% lipid) could be totally replaced with either meat and bone meal (55.61% crude protein, 10.61% lipid) or poultry by-product meal (69.15% crude protein, 15.67% lipid) with little or no significant loss in growth performance, food conversion efficiency, or survival (Table 2). These trials were conducted using pelleted rations formulated to contain approximately 35% crude protein and 9% lipid, with no added dietary vitamins or trace element premix. Clearly, the road is open to make significant cost savings.

Table 2

Parameter	Trial 1	Trial 2	Trial 3
Fishmeal Inclusion Level (%)	22.0	-	-
Meat and Bone Meal (%)	-	31.0	-
Poultry By-Product Meal (%)	-	-	23.0
Initial Body Weight (g, Week 0):	1.85	1.88	1.88
Final Body Weight (g, Week 8)	13.40	12.28	12.39
Average Weekly Growth (g per Week)	1.44	1/30	1.31
Shrimp FCR	1.68	1.76	1.78
Survival (%)	94.3	95.0	95.0

Conclusion

A recent feeding trial at the Oceanic Institute demonstrated that high-quality fishmeal could be completely replaced with wither meat and bone meal or poultry by-product meal with little or no loss in performance. The increased use of adequately processed terrestrial animal by-product meals within compound aquafeeds is a means of safely recycling animal by-products from terrestrial, warm-blooded farm animals food chain, cold-blooded aquatic animals – farmed fish and shrimp.

This has the advantage of converting non-food grade products with potentially negative environmental effects (i.e., disposal through dumping or incineration) into high-quality, nutritious, and safe foods. Moreover, the dietary replacement of fishmeal and other marine resources within aquafeeds will reduce the cost and improve the profitability of aquaculture ventures.

References

Bureau, D.F. and C.Y. Cho. 1999. Nutritive value of rendered animal protein ingredients for fish: outline of recent research – http://www.uoguelph.co/fishnutrition/.

Shepherd, T. 1998. Rendered products in aquaculture feeds. *International Aquafeed*, 4: 13-16.

USE OF RENDERED ANIMAL PROTEIN INGREDIENTS IN FISH FEEDS

Gary G. Pearl*
Fats and Proteins Research Foundation, Inc.
R. R. #2 Box 298, Bloomington, IL 61704
E-Mail gpearl@fprf.org

To sustain the expected and necessary growth in global aquaculture production in all species economic and reliable feed ingredients is a most influencing factor. Marine animal protein sources have been a most common ingredient in most aquaculture diets. Rendered animal protein ingredients and their complimenting role in providing for more economical and balanced diets for all marine species are becoming increasingly important. It is imperative that new technologies and formulation practices be developed to reduce the feed cost resources needed to produce seafood and shellfish. The combination of multiple animal protein sources that include both marine and terrestrial sources can provide resourceful, economic sources.

Meat and bone meal, meat meal, poultry byproduct meal, poultry meal, blood meal, feather meal and fish meal all have varying but contributing nutrients for the respective species. As with all other classes of protein ingredients not only protein digestibilities vary among the sources and fish species but also amino acid availabilities of a protein source show intravariation. Thus both protein digestibility and individual amino acid availabilities of a protein source for individual fish species need to be determined to formulate efficient and economical fish foods. Though these important criteria are not available in complete detail, a relatively large number of studies on the nutritive value of rendered animal protein ingredients for fish has been published in the scientific literature. Numerous studies in a variety of species is known to be in progress now. Rendering companies have, over the past few decades, become increasingly concerned about the quality and safety of their products and have been adapting new technology and manufacturing practices accordingly. The improvements in nutrient digestibility have been confined as illustrated in the following table:

Digestibility Coefficients of Selected Amino Acids in Meat and Bone Meal as Reported in Literature Since 1984.

Amino Acid	1984 [1]	1989 [2]	1990 [3]	1995 [4]	2000 [5]
Lysine, %	65	70	78	92	87.5 – 92
Threonine, %	62	64	72	89	80.2 – 88.9
Tryptophan, %	-	54	65	-	86.4
Methionine, %	82	-	86	91	87.4 – 92
Cystine, %	-	-	-	71	76.4

[1]Jorgensen et. al. 1984. Determined at the ileum of pigs. [2]Knabe et. al. 1989. Determined at the ileum of pigs. [3]Batterham et. al. 1990. Determined at the ileum of pigs. [4]Parsons. 1995. High quality meat and bone meal in poultry using the precision fed cockerel balance assay. [5]FPRF Reports. 2000. Upper range values for MBM as determined via Ileal, intestinal & cockeral assays. (Cromwell, Parsons, Klopfenstein projects)

Reliable data on amino acid digestibility on most fish feed ingredients for fish are scarce, but becoming more available. It appears reasonable in the interim to rely on digestibility of crude protein to predict the digestibilities of individual rendered animal protein ingredients and other protein sources and allow relatively conservative safety margins when formulating feeds.