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FEEDING MEAT PRODUCTS TO POULTRY TODAY AND FUTURE ISSUES

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Summary

The production of animal products for both meat as well as the utilization of by-products derived from its production have relied heavily on the poultry industry. Poultry meat and to a lesser extent eggs have been a staple in the diets of mankind in most developing countries. Certainly the tremendous success of the broiler chicken in the U.S. has become a model for other species in our country as well as around the world. The improvements in nutrition and production efficiencies by the poultry industry are unparalleled by any other of the meat industries. In a country that has the lowest per capita income expenditure for food in the world, many of the examples explaining these efficiencies have a relationship to the growth and efficiencies exemplified by poultry. Nutrition, genetic improvements, the principles of integration and further processing are only a token of the leading example innovations. But in composite the average American family had generated sufficient income by February 7, 2004 to provide food for the entire year. There is no other country in the world that can make that claim.

Meat production and the need to strive for continuing efficiencies while focusing on food safety, consumer demands and the welfare of the participating animals is a subject that is important to every facet of the animal agriculture production chain. However as the demographics of agriculture have and continue to change the close familiarity of most consumers with the production practices become more distant. Therefore as a population of consumers, students, instructors, regulators, legislators, researchers, etc. there is less awareness as to the origin of our food. This is particularly evident with meat. It is important that the animal agriculture industries deliver the message and the facts that actually are responsible for the safe, nutritious, health conscious practices and the economics that are behind the scenes of each meal. The production of each animal for meat, milk, eggs and fibers are accompanied with portions that are determined as inedible. The reasons are of multiple origin. But the fact remains that animal production for meat results in the ancillary production of inedible by-products or co-products.

The market for U.S. meat and meat based products requires the production and annual slaughter of approximately 139 million head of livestock, as well as 36 billion pounds of poultry that includes approximately 8 billion chickens. Using basic approximates this volume generates by-product tissues that comprise the live weight of 50% of cattle, 42% of pigs, 37% of broilers and 57% of fish species. The annual result is approximately 54 billion pounds of inedible raw material. This material has most efficiently and safely been processed and utilized as rendered animal by-products. Rendering is a physical and chemical process that utilizes a time and temperature cooking process similar to sterilization functioning to inactivate bacteria, viruses, protozoa and parasitic microorganisms. The production of animal by-product ingredients that include protein, fat and mineral nutrients has been an asset in the chain for meat animal production. Changes in these practices must be accompanied by answers to the question of "What are you going to do with the other half of the animal"?

Introduction and Historical Perspective

There has been a long history worldwide of animal protein use in the poultry industry. Animal derived protein meals such as meat and bone meal (MBM), meat meal (MM), poultry meal (PM), hydrolyzed feather meal (HFM) and to a lesser extent blood meal (BM) and fish meal (FM) have all contributed as important feedstuff ingredients for poultry nutrition. Most recently these ingredients have contributed protein, minerals and energy as primary nutritional components, but historical literature frequently referenced the unidentified growth or health factors associated with their use when compared to similar diets containing only plant derived ingredients. The use of animal protein for poultry feed has been reported to occur as early as the 1880's. It was a practice that even preceded the establishment of a rendering industry and their commercial distribution as feed ingredients. Perhaps the first species to utilize animal protein was poultry as the byproducts from country slaughterhouses and on farm butchering were disposed of as an air dried tankage and utilized on the farm as "chicken scratch". But as the backyard enterprises began its phenomenal building of today's industrial giant, the poultry industry and rendered animal byproducts have experienced a unique and interdependent relationship. Today the poultry industry utilizes approximately 35 to 40% of all rendered animal by-products.

Though there are over 125 individual animal byproducts listed in the American Feed Control Officials (AAFCO) 2004 Ingredient Manual, the here-to-fore listed ingredients are the primary products resulting from the rendering process. All of these ingredients can contribute nutritionally and be utilized in poultry rations. The title assigned however, was that of meat meals, therefore this discussion will concentrate on meat and bone meal, meat meal and poultry meal.

Rendered Meat Products

Meat and Bone Meal (MBM – Meat Meal (MM)

Meat and bone meal (MBM) is probably the most commonly used protein ingredient in poultry rations. It also comprises the largest quantity of available rendered feed ingredients. MBM has been used as a protein supplement in feed longer than any other protein supplement with the possible exception of skim milk. MBM by ingredient definition must contain a minimum of 4% phosphorus with a calcium level not to exceed 2.2 times the actual phosphorus level. Ingredients of lower phosphorus content must be labeled as meat meal (MM). AAFCO defines both ingredients as the rendered products from mammalian tissues including bone but exclusive of blood, hair, hoof, horn, hide trimmings, manure, and stomach and rumen contents except in such amounts as may occur unavoidably in good processing practices. Thus the raw material and processing is defined as to the tissue content but more importantly also limits those raw materials that cannot be included. A very antiquated AAFCO specification is that of a maximum of 12% pepsin indigestible residue and not more than 9% crude protein as pepsin indigestible. A common procedure for evaluating animal protein meals, even today, is pepsin digestibility especially for the export market. This is a standardized procedure recognized by the AOAC International (official method 971-09). However, different pepsin concentrations ranging from 0.2% to 0.002% are used by different laboratories and as an in vitro assay predictor of protein quality the assay is generally considered as inadequate and poorly correlated to in vivo analyses. A study conducted by Parsons 1996 to compare assay procedures is summarized in Table #1.

Table #1
In Vitro Assays as Predictors of Meat and Bone Meal Quality for Chicks.[a]

Assay Procedure	Coefficient Correlation for Predicting Lysine Digestibility
Pepsin Digestibility	
.2% pepsin	0.25
.02% pepsin	0.70
.002% pepsin	0.60

[a] Parson, 1996

Both MBM and MM ingredients have protein levels that exceed 50%. Even though a standard protein is not required, products must be labeled with a guaranteed protein as well as minimum phosphorus, minimum and maximum calcium and minimum crude fat. Raw materials will affect the nutrient content of animal meals. Increasing the proportion of bone will increase ash and generally lower protein content. Thus protein content of both MBM and MM will vary depending on source and species of derived raw material.

With recent concerns over bovine spongiform encephalopathy (BSE) and the current Food and Drug Administration (FDA) prohibitions, codified in 1997 that prohibits certain ruminant derived tissues in animal feeds or ingredients to be fed to ruminants, species labels for animal by-product ingredients are now commonplace. Thus porcine meat and bone meal and ruminant meat and bone meal are common traded ingredients. If the meat meal product contains any ruminant tissue excepting blood, tallow or gelatin it must be labeled "Do Not Feed to Cattle or Other Ruminants". The species distinction though specifically used to provide added assurance that no ruminant sourced material will be used in ruminant diets, the labeled species distinction assists in nutrient characterization. Meals made from swine and poultry by-products tend to contain more protein and less ash than those derived from beef by-products. The market has likewise placed a premium on non-restricted use protein products such as those of porcine origin and other non-restricted material. Scott et. al. 2000 evaluated thirteen commercial porcine MBM products from both independent renderers and commercial packing plants. The products yielded concentrations of crude protein that ranged from 53.5 to 65.5%. Levels are generally higher in crude protein for porcine derived MBM when compared to other raw material sourced product due primarily to an associative lower ash content.

Databases for most co-products are difficult to interpret. Though it is important to reference standard compositional tables for nutrient contributions of ingredients, databases for rendered animal products in particular are often dated and do not reflect changes in modern rendering processes and raw material controls. The reputation of the supplier and the values/specifications provided by the supplier may provide nutrient profiles more indicative of their specific products than that provided in database profiles. The following Table 2 is illustrative of the historical improvement for representative amino acid digestibility coefficients.

Table 2
Digestibility Coefficients of Selected Amino Acids in MBM as Reported in Literature since 1984

Amino Acid	1984[1]	1989[2]	1990[3]	1995[4]	1997[5]	2000[6]
Lysine, %	65	70	78	92	71	87.5 – 92
Threonine, %	62	64	72	89	-	80.2 – 88.9
Tryptophan, %	-	54	65	-	70	86.4
Methionine, %	82	-	86	91	-	87.4 – 92
Cystine, %	-	-	-	71	-	76.4

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 MBM in poultry using the precision fed cockerel balance assay. (5) Bellaver, Easter, Parsons. (1997) Determined at the ileum of pigs. (6) FPRF reports. (2000) Upper range values for meat and bone meal as determined via ileal, intestinal, and cockeral assays (Cromwell, Parsons, Klopfenstein projects).

A survey of meat and bone meal and meat meal commercial sources for various nutrients are presented in Table 3.

Table 3
Mean Protein, Fat, Calcium. Phosphorus and Amino Acid Contents of Meat and Bone Meal and Meat Meal[ab] as prepared by Knabe (1996).

	Meat and bone meal[b]			Meat meal[c]		
Nutrient, %	n	Mean	SD	n	Mean	SD
Crude protein	255	51.4	2.64	171	54.0	2.93
Crude fat	78	10.70	1.61	35	10.72	1.55
Calcium	255	9.99	1.01	171	7.69	1.16
Phosphorus	255	4.98	.38	171	3.88	.41
Arginine	61	3.60	.35	22	3.34	.57
Histidine	62	.92	.19	22	.95	.28
Isoleucine	62	1.40	.25	22	1.58	.21
Leucine	62	3.10	.47	22	3.32	.49
Lysine	64	2.64	.36	22	2.85	.47
Methionine	39	.70	.14	7	.79	.18
Cystine	7	.46	.23	7	.45	.26
Phenylalanine	62	1.67	.22	20	1.98	.58
Threonine	64	1.65	.23	22	1.74	.33
Tryptophan	29	.26	.05	2	.29	.05
Valine	62	2.11	.34	22	2.44	.43

[a]As-fed basis from commercial sources.
[b]Rendered Feeds in Swine Feeding, Dr. D.A. Knabe, Texas A & M University, FPRF Directors Digest #273.
[c]Protein, fat, calcium and phosphorus contents for meals having less than 4.4% phosphorus. The mean protein content of meals analyzed for amino acids was 54.9±2.1.

Poultry By-Product Meal

Poultry by-product, also referenced by the industry as poultry meal (PM) consists of ground rendered clean parts of the carcass of slaughter poultry such as necks, feet, undeveloped eggs and intestines, exclusive of feathers, except in such amounts as might occur unavoidably in good processing practices. The label shall include guarantees for minimum Phosphorus (P) and minimum and maximum calcium (C). The calcium level, as with MBM and MM, shall not exceed the actual level of phosphorus by more than 2.2 times.

Poultry meal is also an ingredient resulting in constant improvements. It is an ingredient that commands competition from the companion animal food industry. The nutritional demands from this industry as well as an emerging aquaculture industry have led to the development of low ash poultry meal via special processing. This ingredient is commonly traded as pet food grade poultry meal. Though the standard references credit poultry meal as containing 60% protein, the low ash products are generally in the range of 62-65% protein. PM is an excellent protein source for poultry and generally demonstrates improved digestibility of its amino acids when compared to those found in MBM and similar to those reported for soybean meal or fish meal. Its current demand for use in other species and the internal "buy back" usage by poultry integrators often lowers its competitive position relative to other ingredients for use in poultry rations.

Current Usage in Poultry Rations

Animal protein meals are a useful constituent of poultry rations. Each of these products has been used successfully at various levels in rations for poultry of all types with primary and higher levels used in broiler and turkey diets. Plant protein fluctuations have created increased usage of animal by-products by the poultry industry this past year. Though economics certainly were responsible in part for the increase, there has been renewed interest in the use of animal products to improve performance. The undigested oligosaccharide portion of soybean meal has been associated with an increase incidence of footpad lesions and other growth depression effects (Firman 2004). Protein source alterations in diets has been a consequence of responding to current economics and striving to improve performance. Meat and bone meal found itself in more poultry diets in 2004 than in several of the past preceding years. In monitoring several commercial broiler and turkey diets this past year, MBM was utilized in well over 90% when offered in best-cost formulation models. Containing substantial protein, fat, phosphorus, and calcium, its absence from a formula requires considerably more inclusion rates of soybean meal, limestone, fat and phosphorus sources to replace them. This property provides for the latitude to increase energy density via fat when needed or the alternative for increased grain usage.

Firman et. al. (2004) recently reported a literature review summary of completed research in a series of Feedstuff articles referencing the area of protein, amino acids, phosphorus availability and metabolizable energy for MBM when used in poultry diets. On the basis of the nutrient merits of meat meals, there are no nutritional or scientific reasons not to consider them as feed ingredients for poultry rations. Current formulation systems in which animal proteins are offered pull near the maximum established levels of meat and bone meal to provide protein, animal acid energy and mineral nutrients for poultry. However the continued use of animal byproduct ingredients will undoubtedly be influenced more by factors other than their established nutrient contributions.

The Future Issues

The future of animal byproduct ingredients will be determined more by perception, regulatory actions, international trade manipulations, opportunistic marketing practices and either by the support or non-support of the animal industries sector. As we review the historical usage of animal byproducts they have primarily been utilized as feed ingredients. Animal byproducts have been the traditional general term used to describe the products. However the terms byproducts and coproducts are often used interchangeably. The need to debate which term is most appropriate or descriptive is not extremely important except to draw attention to one important fact. By-product is defined as a secondary product obtained during the manufacture of a principal commodity. Co-product possesses the meaning of being produced together or jointly. Such is the fact for the synergism of animal production and processing with the generation of by-products or co-products. The production of meat, milk and eggs for human consumption is accompanied with approximately 50% of total live weight of inedible byproducts or coproducts. It is not possible to have the edible portions without producing the inedible. In the US this accounts to approximately 54 billion pounds annually. As meat animal numbers increase and accompanied with an increase in the inedible portion tissue generation as more and more kitchen and table ready processing procedures are developed the annual volume of raw material increases. The feed industry is still the primary utilization of the feed ingredients produced from this tissue source. But the difference between today and tomorrow stands to be determined by a number of both internal and external factors. Factors that will be influenced both by scientific data but also be many other less defined influencers. But the basic question to answer is "what will the animal industries do with the 54 billion annual pounds of ancillary production resulting from the livestock and poultry for providing meat, milk and eggs"? Current alternatives to rendering exist such as burial, burning, incineration, landfilling, composting or pryolysis. But when compared all are very unacceptable either due to human and animal health, environmental, ecological or economic consequences. Perhaps there are future options but in today's environment the production and processing realities are a dependence between the utilization of the produced byproducts and sustainable animal production.

It becomes very difficult to assess the future status for a very unsettled topic related to animal by-products and rendering. As this topic is being prepared the agencies of the Food and Drug Administration (FDA), United States Department of Agriculture (USDA) – Food Safety and Inspection Service (FSIS) – Animal and Plant Health Inspection Service (APHIS), Environmental Protection Agency (EPA) and many state and local counterpart departments all have mitigation initiatives, regulations, and policies in various stages of development and implementation. Thus the content of this document is not intended to serve as a state of the art for regulatory or compliance guidelines. However the inferences of possible new regulatory standards and the abundance of precaution/precautionary principle philosophy brings serious doubt as to the future of animal by-products and rendering implications without some change.

Bovine Spongiform Encephalopathy: BSE

Without doubt an impelling force has been the bovine spongiform encephalopathy (BSE) issue. A disease that has brought uncertainties about its pathogenesis, and complex challenges to the scientific community but sensationalism for the media and confusion among the consuming public. Nearly 99% of all cases have occurred in the United Kingdom. However some twenty-one countries have experienced the disease. Within the past two years there have been two cases confirmed in North America. The current BSE surveillance regime in both the United States and Canada is on target. The US has completed over 160,000 examinations and will complete an anticipated 268,500 by mid 2005 on high-risk segments of the cattle population. These numbers are based on a 99% detection confidence for a 1 in 10 million BSE incidence. The feed ingredient and rendering industries are to be commended for their compliance to the restricted use protein regulation. FDA and third-party compliance records continue to validate a compliance that exceeds 99%. Risk assessment studies to include the Harvard Study (Cohen 2001) have concluded that the US is highly unlikely to experience a significant incidence of BSE as a result of the preventative measures taken and enforced since 1986.

Studies in domestic chickens indicate that they are resistant to both parental and oral challenge. The Veterinary Laboratories Agency, Webridge, U.K., under the direction of Dr. Danny Mathews (Mathews, 2001), conducted oral challenge studies using BSE-infected brain stems fed to chickens. The oral challenge consisted of 5 g of infected tissue given by esophageal tube into the crop of broiler chickens at four, five and six weeks of age. For perspective, it is believed that 10 mg of infective brain tissue can initiate bovine infection. The challenged chickens were taken to a 57-month endpoint with no symptoms or infectivity in the birds' tissues. Studies were also conducted by Mathews incorporating intracranial and intraperitoneal inoculations of infected bovine brain stem material into young male chickens. The parental challenge consisted of 50µml intracranial and 1 ml intraperitoneal doses. Chickens were again taken to a 57-month endpoint. Chickens that showed any "motor disturbance" following inoculation were sacrificed and tissues sub-passaged back to chickens, observing any sub-clinical form of disease. Sub-passage in mice was also attempted. These studies were completed with confirmed negative findings. The oral, intracranial and intraperitoneal inoculations provided extreme challenge not perceived to represent natural exposure. The research was conducted using raw nervous system tissue when, in actuality, food or feed ingredients are heat processed. Research has shown that heat does not destroy the infective agent but does lower its infectivity by a number of log reduction factors. The fact is that poultry have been determined to be extremely refractory to any of the transmissible spongiform encephalopathies via inoculation challenges. Additionally the lack of any reported cases in any avian species provides strong scientific evidence as a rebuttal for BSE to be a reason for the exclusion of animal protein derived ingredients from poultry diets.

Anti-Animal/Vegetarian/Organic Initiatives

Issues other than BSE will continue to impact the future of the utilization of animal byproduct ingredients as well as many other facets of poultry production, processing and consumer acceptance. Poultry has been the model for animal protein production growth and efficiencies. However recent challenges have queried the methods of housing, the euthanasia procedures and numerous other management and production practices. It must be recognized that numerous consumer group segments have beliefs and perceptions that differ from many of the current practices that make up our management, feeding and production systems. "Natural" and organic are becoming more stronger and more frequently used marketing tools. There is a growing segment of the worlds' population that possesses rightist beliefs that precludes the use of animal or their products from food or fiber use. The supporters of all vegetarian diets for both animals and humans continues to increase. Various segments of the human nutrition and medical professions and even the plant protein segments of the agriculture industry are highly promotive of diets that replace animal proteins with plant protein sources. Certainly the marketing programs that promote "No Animal Protein", "No Animal Byproducts Used" are negative connotations that all of the animal industries must address. Rendered animal byproducts ingredients are an important facet of the issue to be addressed but in reality becomes an issue that all of animal agriculture must address.

There are reported experiences and limited data on the use of all vegetarian feed for poultry. Many of the demand for the vegan diets are from sources to export especially into the European market, however all vegan producted poultry products both meat and eggs are available in the domestic market. Similarly organic produced products are becoming increasing evident as considerations in the marketplace. Federal regulations are in place for guidance in product labeling, but somewhat obscure in defining the requirements and even more remote in compliance. The belief that animal byproducts should not be fed to organically raised animal is contrary to its true definition.

All vegan diets have been fed with marginal success. Most economic evaluations report an expected increase in formula costs of from $6 to $12 per ton and a resultant decrease in feed utilization. A frequent associative observation has been an increase in water intake a resulting wet litter condition that precipitates footpad lesions and other feet and leg problems. The increase in total ration oligosaccharide content as well as other toxins have been incriminated. Additionally pellet quality compromises and a reduction in feed production efficiencies have been noted. Thus the universal removal of animal byproducts from poultry diets raises the need for further research in formulation techniques and an assessment of over all economics in maintaining the poultry products competitive advantage in the animal food marketplace.

The past and the present document the significant contributions that rendered animal products have provided to the poultry industry as well as animal agriculture. Their future remains in question and are highly complex factors. Several are subject to be influenced by science, however many decisions will be derived entirely independent from scientific and technical documentation.

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