THE UTILIZATION OF FATS AND ANIMAL BY-PRODUCTS IN POULTRY FEEDS: CURRENT PERSPECTIVES

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It is very useful to think of the chicken as an extremely complex bioconversion machine, employed for the purpose of concentrating and improving the quality of protein for human consumption. In this process, various sources of protein not usually consumed by humans serve as inputs, with the products being highly nutritious and aesthetically attractive poultry meat and eggs. While some components of poultry feed might be consumed to a limited extent by humans, this clearly does not apply to animal by-products. Thus, the contribution of the rendering industry must be viewed as an absolute benefit toward the nutrition of our societies. As with any feed ingredient, there are potential problems associated with the use of fats and animal by-products in poultry feeds and these must be considered in order to optimize the efficiency of their utilization. It is the object of this paper to review several current issues regarding the quality of fats and animal proteins, and consider their utilization in poultry feeding programs.

1. Public perception. It is extremely unfortunate that in some sectors of society the use of animal by-products in poultry feeds is viewed negatively. This view is not supported by scientific fact, but falls into the same category of misinformation that would include the erroneous belief that hormones are added to broiler feeds. In fact, in a well managed rendering operation, bacterial contamination is kept to low levels. While concern over contamination by animals infected with BSE is valid in regions affected, the occurrence is extremely rare outside the United Kingdom, where more than 99% of reported cases of "mad cow disease" have occurred. In a study conducted in England (1), chickens were orally challenged with a massive dose of BSE infected tissue at 4, 5, and 6 wks of age. Challenged chicks were monitored for more than 4 years, with no symptoms or infectivity in the birds tissues. It is extremely unfortunate that the public prefers to focus on animal materials as health threats, and is almost completely oblivious to those which may affect plant products, such as mycotoxin or pesticide residues.

2. Combination with Soybean Meal. In most poultry diets in the western hemisphere and throughout the world, soybean meal is the largest single source of protein. Most nutritionists, however, realize that improved performance almost always results by the incorporation of animal proteins into such feeds. Upon reflection, this should come as no surprise. While soy is an excellent source of protein, all are aware of problems associated with either under- or over- processing of the ingredient. In addition, soy contains a number of "problem carbohydrates." The oligosaccharides are virtually indigestible with or without enzyme supplementation. The negative effects of the ∃-mannans in soy are becoming widely recognized. Furthermore, use of animal proteins in a feed which is intended for the synthesis of animal proteins is of obvious benefit when considering amino acid balance. Finally, if we accept that some variation is inevitable in feed ingredients, then a combination of protein sources is less likely to be influenced by day-to-day variation.

Thus, as a combination of protein sources is desirable, in what diets and at what levels should animal by-products be used? While there is no definitive answer to this question, several perspectives are offered. Amino acid requirements are highest in starter feeds. On the one hand it can be argued that low levels of animal protein should be used in these feeds as their amino acid availability is usually less than that of soy. An opposing view is that high levels of soy (>34%) introduce a high concentration of indigestible carbohydrates and ∃-mannans into the feed, levels which can be reduced by the use of animal proteins. Some would argue that animal proteins are more likely to have bacterial contamination and should be excluded from starter diets. A response is that poor quality ingredients of any kind, be they improperly processed or heavily contaminated with salmonella or other pathogenic species, have no place in efficient poultry production. It is the responsibility of a quality control program to identify sources of high quality ingredients and eliminate those whose use presents an unacceptable risk. One animal protein which might be restricted in starter diets is poultry offal meal, in which all by-products of poultry processing (including feathers and mortality) are rendered together. Such an ingredient is usually very high in fat with lower amino acid digestibilities due to the presence of feathers. The higher energy/lower digestible protein composition of this ingredient strongly favors its use in finisher as opposed to starter diets.

3. Metabolizable Energy of Animal Proteins. Older tables of nutrient composition (2) severely underestimated the energy contribution of animal by-products. This seems to have been the result of artifacts in the experimental procedures employed. Use of 40% meat and bone meal for 2 week old chicks in an ME study (a common level of inclusion for ME studies) would supply about 4% calcium, which depresses efficiency of fat

absorption. Studies conducted at this laboratory (3) during the past decade, in which the effect of calcium was eliminated, found meat and bone meal from beef and pork processing to be approximately 2450 and 2800 kcal/kg, respectively (Table 1). These high values are quite reasonable from a simple consideration of the fat and protein components taken individually. The higher value for pork meal is reasonable considering the lower levels of calcium and phosphorus in this product. The ME of poultry by-product meals is heavily influenced by level of fat, and whether hatchery residues are rendered together with processing waste. However, a good quality poultry by-product meal can be expected to have at least 3000 kcal/kg of ME.

There has been a similar confusion in the scientific literature concerning the ME of fats, particularly those of animal origin. Studies conducted in the 1960's frequently used unreasonably high levels of fat in the test diets. A frequently cited reference (4) used 15% tallow and, not surprisingly, found a low ME. Another study found that the ME of tallow was significantly increased when mixed with vegetable oil (50:50) (5). No one seemed to realize that in practical diets, with 2 or 3% added fat, the same 50:50 blend occurs when we consider the highly unsaturated vegetable fats found in the grain component of the diet. Thus, as long as normal quality parameters are achieved, the author finds little justification for using low ME values for animal fats.

4. Amino Acid Availability. During the past decade, highly significant improvements have been made in the way in which animal by-product meals are processed. It has long been recognized that the use of very high temperatures reduces amino acid availability, particularly that of lysine. Once again, the selection of a supplier of animal proteins is of extreme importance. A visit to the facility, viewing the inputs used for the manufacture of meat and bone meal, for example, and assessing the relative cleanliness of the facility, may be of greater value than any specific laboratory test. While the availability of amino acids in animal proteins does not reach the 90% level commonly expected for soybean meal, high quality animal by-products can be manufactured with digestibilities over 80%.

5. The Problem of Pet Food. In some countries, the quality of animal by-products for poultry feeding has been compromised by the increasing use of these materials in pet foods. As manufacturers of pet foods are in a position to pay a much higher price for animal by-products, they can specify that only high quality inputs be used in manufacturing meals for their use. In the United States, this has occurred principally in the manufacture of poultry by-product meal, where two completely distinct meals are now manufactured: feed grade poultry meal and pet food

grade poultry meal. Unfortunately, if the highest quality by-products are used to make pet food grade meals, the quality of meals to be used by the poultry industry decreases (Table 2) (6). Increased variation is also inevitable.

6. Combining Products to Improve Consistency. As animal by-products are composed of ash, protein, and fat fractions, it is sometimes difficult to achieve a high degree of consistency from batch to batch. Consistency is, of course, vital if the poultry company is to justify paying a high price for any ingredient. In some areas, an interesting solution to this problem is to blend various animal by-products to achieve a specified level of nutrients. This is done in exactly the same way we formulate poultry feed. To illustrate, we may decide to produce a product with 60% protein, 8% calcium, 4% phosphorus, etc. This product is formulated using, as inputs, high and low protein meat and bone meal, poultry meal, blood meal, feather meal, possibly fish meal, etc. Obviously, the consistency of the nutrients in such a product can be much higher than in the individual ingredients. With the knowledge of customers, it is occasionally economically attractive to include low levels of plant proteins, such as cottonseed meal, which are not usually used as individual ingredients in poultry feeds.

7. Biogenic Amines. Ten years ago, several reports suggested that biogenic amines were a problem when using animal by-products. These reports, however, never appeared in the peer-reviewed scientific literature and now appear not to have been well justified. Concern over biogenic amines in animal products seems to have been initiated from the black vomit syndrome with certain fish meals. In recent years, the danger of biogenic amines in most animal products has been discounted.

8. Conclusion. Animal by-products and fats are excellent feed ingredients for poultry. As with any ingredient, quality control standards must be established and professional relationships maintained with suppliers. When high quality materials are available, there is almost no limit to how they can be successfully employed in poultry feeds. At the present time, in many countries the major impediment to such incorporation does not involve the quality of animal by-products, but public misconceptions regarding the wholesomeness of these materials.

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TABLE 1. Metabolizable energy of meat and bone meal
Previous Values (Scott et al., 1976)
45% Protein . . . . . 1760 kcal/kg
50% Protein . . . . . 1980 kcal/kg
Current Values (Dale, 1997)*
Beef meal (49% Protein) . . . . . 2450 kcal/kg
Pork meal (55% Protein) . . . . . 2800 kcal/kg
*Determined at low level of calcium

TABLE 2. Variations in the composition of poultry by-product meal		
	Feed Grade	Pet Food Grade
Protein (%)	58 (49-64)	66 (63-69)
Fat (%)	14 (11-25)	13 (11-15)
Ash (%)	17 (13-21)	15 (11-19)