Meat and Bone Meal for Swine

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Meat and bone meal is a product of the rendering industry and consists of meat, bone, blood, hoof, lean tissues, and fat. This by-product is a source of minerals and protein, but its value as a source of energy is less studied. Yet, meat and bone meal may contain up to 14 percent fat and 60 percent protein and thus can be a source of energy for monogastric animals. In order to better understand meat and bone meal as a source of energy and characterize the sources of variation in energy value, an experiment was designed to determine the metabolizable energy value for pigs.

One-hundred and ninety-eight pigs weighing 35 kilograms were used in a digestion trial to determine the metabolizable energy value of 21 meat and bone meal samples. The pigs were allocated to 22 dietary treatments that consisted of a corn-soybean meal reference diet and 21 test diets in which each of the 21 meat and bone meal samples replaced part of corn and soybean meal, keeping the ratio of corn and soybean meal the same in all the diets. This enabled the determination of the metabolizable energy value of meat and bone meal by the difference method, which was necessary because of the practical problem of feeding meat and bone meal as the sole feedstuff. The digestion trial included five days of adjustment during which the pigs were adjusted to the metabolism crates and the experimental diets. The adjustment period was followed by five days of feeding the experimental diet as well as total but separate collection of feces and urine.

The meat and bone meal samples were also analyzed for gross energy, crude protein, fat, calcium, phosphorus, and ash content. The feces were dried and ground prior to analysis. The urine collected was thawed, thoroughly mixed, and filtered twice through glass wool. About 800 milliliters of duplicate urine samples were measured into aluminum pans and weighed. Urine was dried at 55 degrees Celsius, weighed and stored in Whirl-Pak bags at -18 degrees Celsius. The dried urine samples were then analyzed for gross energy and nitrogen. Duplicate analyses were performed on all the diets, feces, feed leftovers, and urine samples. Metabolizable energy and nitrogen-corrected metabolizable energy was calculated for the meat and bone meal samples using the difference method.

Results and Discussion

Table 1 shows the range and averages of energy and gross energy and nutrient concentration of the 21 meat and bone meal samples used in the study. The gross energy content of the meat and bone meal samples ranged from 3,895 to 5,193 kilocalorie per kilogram (kcal/kg) dry matter, with an average of 4,601 kcal/kg dry matter. The average protein, fat, and ash content were 589, 113, and 239 grams (g) per kg, respectively. The dry matter content of the meat and bone meal samples ranged from 939 to 971 g/kg dry matter with an average of 957 g/kg. Analysis of the samples is an important step towards evaluating meat and bone meal as a source of energy because it can give indications about the quality of the sample.

The values for energy and chemical components of the meat and bone meal samples did not show any deviation from what has been reported previously. In addition, the ratio of calcium to phosphorus at 2:1 meets the definition of meat and bone meal created by the American Association of Feed Control Officials (AAFCO), which says meat and bone meal contains four percent or greater phosphorus. Meals containing less than four percent phosphorus are considered meat meals. So by AAFCO's definitions, the data set includes both meat meal and meat and bone meal.

Because the main contributors of energy in meat and bone meal are protein and fat, these would be important components to pay attention to in feed formulation. However, the quantity of ash in the meat and bone meal is just as important as it represents the totality of inorganic components of the samples. Excessive ash could be an indication of high percentage of bone in the sample that could increase the proportions of phosphorus and crude protein in the sample, but the protein from bone has a poor amino acid balance and can actually decrease metabolizable energy content of the sample.

Digestible energy, metabolizable energy, and nitrogen-

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corrected metabolizable energy were, on average, 3,402, 3,070, and 2,963 kcal/kg, respectively. These represent 73, 67, and 64 percent, respectively, of the gross energy content. The digestibility of the crude protein of the meat and bone meal samples was 82 percent on average. The values for digestible energy and metabolizable energy determined for the meat and bone meal samples used in the current study was higher than the values reported in the National Research Council's *Nutrient Requirements of Swine: 10th Revised Edition, 1998*. The values for metabolizable energy indicate that about two-thirds of the gross energy in meat and bone meal used in this study was utilized by the pigs.

The difference between the meat and bone meal samples having the lowest and highest metabolizable energy content was about 1,550 kcal/kg. The variation in energy availability from meat and bone meal no doubt is partially related to chemical composition. In fact, the results of our study indicate that differences in the chemical composition measured did not explain more than 50 percent of the variation in metabolizable energy content of meat and bone meal samples. The difference in gross energy content between the meat and bone meal having highest and lowest gross energy contents was approximately 1,300 kcal/kg, which represents about 84 percent of the difference in metabolizable energy content. This may be an indication that gross energy may not be a very strong indicator of how well the pigs utilize the energy in the feedstuff. Clearly, other sources of variation exist and these may be related to processing conditions or the components (different tissues put together during the rendering process) of the meat and bone meal samples. Whereas some of the variation may be captured in the chemical composition as pointed to earlier on, some other sources of the variations may be less apparent from the chemical components measured in this study.

There are strong indications from the data obtained in this study that meat and bone meal is a valuable source of energy for swine. As with most by-products, the variations in chemical compositions and materials put together in the sample will be a factor to consider in making recommendations about the energy value of the feedstuff.

Conclusion

Because of the cost of energy in feed formulation, an understanding of energy composition of a feedstuff is a necessity in the evaluation of the feedstuff. The digestion trial with the 21 meat and bone meal samples used in this study has provided valuable data that are robust and represent a wide variation in composition of meat and bone meal. The result of this study showed that meat and bone meal is, in addition to being a source of protein and minerals, a good energy source.

In addition, the current study highlighted the potential of using proximate compositions for predicting the apparent metabolizable energy and nitrogen-corrected apparent metabolizable energy of meat and bone meal for pigs. The study also helped to establish that in addition to the proximate compositions, factors that influence the utilization of these fractions, especially fat and protein, may have a substantial impact on energy utilization of meat and bone meal. We believe that although other factors may have influence on its energy utilization, the use of proximate fractions as well as the characteristics of these fractions should be sufficient for predicting the energy value of meat and bone meal for swine.

The values for metabolizable energy generated from this study form the basis for metabolizable energy values that will be used in the soon to be published National Swine Nutrition Guide coordinated by the U.S. Pork Center of Excellence. **R**

Table 1. Range and average gross energy (kcal/kg), crude protein, crude fat, phosphorus, calcium, and ash in the 21 meat and bone meal samples on a per kilogram dry matter basis.

	Dry Matter	Gross Energy	Protein	Fat	Phosphorus	Calcium	Ash
Minimum	939	3,895	491	92	23	37	142
Maximum	971	5,193	641	141	56	116	338
Average	957	4,601	589	113	38	77	239

Table 2. Range and average digestible energy, apparent metabolizable energy (AME), nitrogen-corrected apparent metabolizable energy (AMEn) contents in kcal/kg dry matter and crude protein digestibility for the 21 meat and bone meal samples.

	Digestible Energy	AME	AMEn	Crude Protein Digestibility, %
Minimum	2,669	2,320	2,212	73
Maximum	4,176	3,890	3,794	93
Average	3,402	3,070	2,963	82