Swine NRC revisions

The 11th revised edition of "Nutrient Requirements of Swine" was released in July and represents a significant revision from the 10th edition.

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THE 10th revised edition of the National Research Council's (NRC) "Nutrient Requirements of Swine" was published by the National Academy Press in 1998.

A decade later, it became clear that a revision of the so-called "NRC for swine" was needed, and discussions with the National Academies about revising the document were initiated. A project proposal was written in February 2009, and the National Academies committed to the revision, provided that funding to cover the costs of the revision could be identified.

Subsequently, prospective funding agencies were contacted, and in May 2009, the funding needed for the revision was secured.

Following the successful funding of the revision, the National Academies approved the project, and during the summer and fall of 2009, a committee of 10 swine nutritionists was assembled. The committee was approved in November 2009, and the National Academies provided the statement of task to the committee as a guideline for the revision.

The statement of task included a charge to update nutrient and energy requirements for all categories of pigs, to update the feed composition database and the computer model, to provide information about new feed ingredients from the corn and soybean industries, to review effects of feed additives routinely used in diets fed to pigs, to describe effects of feed processing, to discuss strategies for improved nutrient retention rates and reduced nutrient excretion rates and to describe areas where future research is needed.

The first meeting of the committee took place in January 2010. Committee members agreed on an outline for the work, and each committee member was assigned specific aspects of the revision. The work was conducted during the following 18 months, and the last chapters were completed in July 2011.

All chapters were then assigned to external reviewers who provided feedback, comments and questions for each chapter. The committee revised the document and responded to reviewer comments in November 2011, and the final document was approved in December 2011 and sent to the National Academy Press for printing.

The 11th revised edition of "Nutrient Requirements of Swine" was released in July 2012 and represents the combined results of the committee's efforts. Whereas the 10th revised edition contained 11 chapters, 188 pages and 79 feed ingredients, the 11th revised edition was expanded to 17 chapters, 400 pages and 122 feed ingredients.

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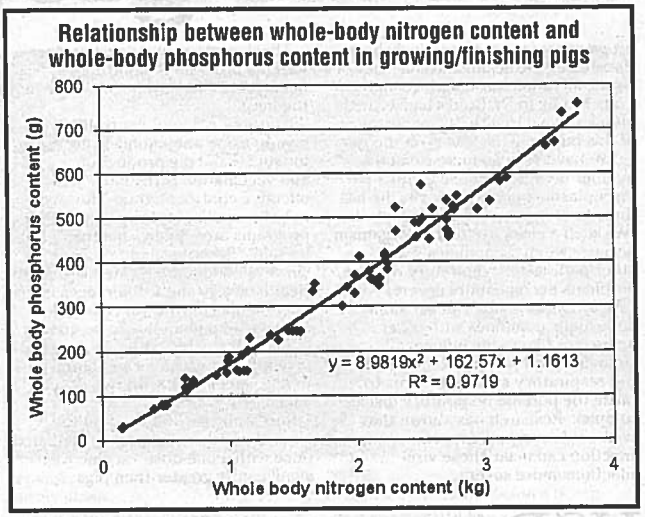

Energy

Chapter 1 includes information about general energy metabolism and calculation of values for digestible energy (DE) or metabolizable energy (ME).

Equations to calculate net energy (NE) values are also provided, and it was concluded that the following equation, which is based on DE and total nutrient concentrations of feed ingredients, is most practical for calculating NE of feed ingredients: NE = (0.70 x DE) + (1.61 x ether extract) + (0.48 x starch) - (0.91 x crude protein) - (0.87 x ADF), where NE and DE are expressed in kilocalories per kilogram and ether extract, starch, crude protein and acid detergent fiber (ADF) are expressed as grams per kilogram.

The equation, which was adapted from Noblet et al. (1994), was also used to calculate NE of feed ingredients that are included in the feed composition tables.

Factors influencing energy utilization in pigs are discussed, with the conclusion that energy metabolism is influenced by the physiological state of the animal, ambient temperature and physical activity. Factors affecting the maintenance requirement for energy are discussed in detail, and it was proposed that ME for maintenance (MEm) can be predicted in growing/finishing pigs based on bodyweight (BW) using the following equation: ME_m (growing/finishing pigs) = 197 kcal/kg $BW^{0.60}$.

This equation was adapted from Birkett and de Lange (2001) and reflects a suggestion that MEm in growing/finishing pigs is better predicted from $BW^{0.60}$ than from $BW^{0.75}$, which was used in the 1998 NRC. It was, however, concluded that $BW^{0.75}$ should be used to predict MEm requirements for gestating and lactating sows, and the following equations were, therefore, proposed for sows: MEm (gestating sows) = 100 kcal/kg $BW^{0.75}$, and MEm (lactating sows) = 110 kcal/kg $BW^{0.75}$.

A new feature of the 11th revision of the swine NRC is that the effects of immunization against gonadotropin-releasing hormone and the use of ractopamine in diets fed to finishing pigs are integrated into the document, and the implications on energy metabolism of using these technologies are discussed in Chapter 1.

Amino acids

Chapter 2 describes amino acids that are present in feed ingredients and animal proteins, and a division into essential, non-essential and conditionally essential amino acids is proposed.

The theoretical basis for determining amino acid requirements for pigs is explained, and numerous studies that determined amino acid requirements for different categories of pigs are referenced in this chapter.

Theoretical needs for amino acids for maintenance and for protein deposition are described, and the need for amino acids in the different amino acid pools in the body are discussed. As an example, for gestating sows, specific amino acid needs for six different pools are considered, and the combined requirements for these pools are considered the requirement for amino acids for gestating sows.

Efficiencies of utilization of dietary amino acids for maintenance and protein synthesis in growing/finishing pigs are also presented, and it was concluded that the efficiency of utilization (above maintenance) of standardized ileal digestible lysine for protein deposition decreases from 0.682% in pigs at 20 kg of bodyweight to 0.568 in pigs at 120 kg of bodyweight.

Aspects of calculating amino acid requirements for all categories of pigs are also explained. For growing/finishing pigs, requirements are separated for gilts, barrows and intact males. Effects on amino acid requirements of using ractopamine and immunization against gonadotropin-releasing hormone are also discussed.

Lipids

Chapter 3 describes theoretical aspects of lipid metabolism, synthesis and deposition of lipids and requirements for specific fatty acids. Advantages of dietary lipids are explained, and analytical procedures used to analyze feed ingredients for lipid concentrations and fatty acids are outlined as well.

Quality measures for dietary fatty acids are also presented, and analytical procedures to estimate oxidative stability in fat are discussed, although it is acknowledged that no single procedure can be used to estimate lipid oxidation. Essential and bioactive fatty acids are also discussed, and it was concluded that dietary n-3 fatty acids may have positive effects on the immune response of pigs. Although oxidized lipids may have negative effects on the intestinal barrier function, it was acknowledged that evidence for such effects in pigs have been non-conclusive at this point.

Digestibility of lipids in feed ingredients is explained, and calculation of DE from the chemical composition of fats is proposed. Effects on pig performance of adding fat to diets for growing/finishing pigs and sows are presented, and consequences for pork fat quality of adding fat to the diets of finishing pigs are discussed. The theoretical correlation between dietary iodine value product and pork fat quality is explained as well.

Carbohydrates

Chapter 4 describes the different carbohydrates that may be included in feed ingredients, and classification of carbohydrates into monosaccharides, disaccharides, oligosaccharides and polysaccharides is explained in detail. Analysis of the different categories of carbohydrates

explained: Part 1

is also discussed.

The digestibility and potential fermentability of each category of carbohydrates is explained, and the possible energetic contribution of carbohydrates to diets fed to pigs is discussed. Non-energetic aspects of certain carbohydrates (oligosaccharides and fiber components) are mentioned as well.

Water

Chapter 5 describes the importance of water in swine nutrition. Pigs contain between 48% and 82% water, depending on size, and water is needed for most biochemical reactions in the body.

Water turnover in pigs is, therefore, described, with the conclusion that the requirement for water is between 80 mL and 120 mL/kg of bodyweight in growing/finishing pigs and non-lactating sows. However, many factors influence pigs' intake of water. Among these are level of feed intake, dietary ingredients, ambient temperature and humidity and the health status of the animal. Actual water usage is, therefore, typically much greater than the theoretical requirement, so it is recommended that water be freely available to pigs.

Specific considerations should be given to lactating sows because of their high water requirement for milk synthesis. Lactating sows may drink up to 40 liters of water per day, and sow feed intake may be improved if sows are allowed to mix feed and water prior to consumption. The quality of water is also discussed, and guidelines for water quality are presented.

Minerals

The minerals that are used in diets fed to swine are described in Chapter 6. The function and the expected bioavailability of both macro and micro minerals are mentioned, and calculation of the electrolyte balance in diets from concentrations of macro minerals is explained. Signs of deficiencies of minerals are also discussed, and where excesses of minerals may be detrimental to pig growth performance, tolerable levels of the minerals are explained.

One of the changes from the 1998 NRC to the 2012 NRC is that values for the relative bioavailability of phosphorus are no longer used. Instead, values for the standardized total tract digestibility (STTD) of phosphorus are used as the basis for estimating phosphorus requirements of pigs, and the STTD of phosphorus in all feed ingredients is also provided in the feed composition tables.

Based on published data, it was also concluded that phosphorus requirements of growing/finishing pigs may be calculated from nitrogen retention because a straight line relationship between the body content of nitrogen and phosphorus has been observed (Figure).

It was also concluded that the phosphorus required to maximize bodyweight gain and feed efficiency is only 85% of the phosphorus needed to maximize bone mineralization. However, in calculating the requirements for phosphorus, it was assumed that the efficiency of utilizing STTD phosphorus for phosphorus retention is only 77%, although many experiments have shown that the efficiency of utilizing STTD phosphorus is close to 100%. Thus, there is a considerable safety margin in the data for the calculated phosphorus requirements. Future research is needed to determine if these safety margins are needed.

Vitamins

Chapter 7 is the vitamin chapter. Both fat-soluble and water-soluble vitamins and their biological functions are briefly described, and differences in expected bioavailability among different forms of vitamins are mentioned.

Specifically for vitamin E, differences between synthetic and natural vitamin E are discussed, as are differences among the many forms of synthetic vitamin E.

The impact of vitamin D on mineral utilization is also discussed, and new knowledge about pigs' need for vitamin D is described. Specifically for sows, the requirement for vitamin D was greatly increased because results of recent research indicate that sow and litter performance is improved if greater levels of vitamin D are included in the diets. Toxicity symptoms of excess provisions of vitamin A or vitamin D are also described, whereas it was concluded that the toxicity of excess levels of the water-soluble vitamins has not been reported.

One of the challenges in estimating vitamin requirements is that vitamin activity often is reduced as feed ingredients are stored, and many different factors may influence the activity of vitamins. It is, therefore, common practice to ignore the vitamins that may be provided by the feed ingredients in the diet, and the entire need for vitamins is usually supplied from a vitamin premix. However, the activity of vitamins in vitamin premixes may also decline over time, so attention to activity of vitamins in diets fed to swine is, therefore, required.

References

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