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Evaluation of alternative models of digestible lysine requirements from 3 models applied to 2 genetic populations of pigs with different body compositions

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ABSTRACT

The objectives of this study were 1) to compare 3 models that predict daily lysine requirements and 2) to evaluate whether the relative differences in predicted lysine requirements for each model are similar for barrows and gilts within each of 2 genetic populations of pigs, high-lean and low-lean gain. Two models, Schinckel et al., 2003b (SCH-03) and NRC, 1998 (NRC-98), use constant estimates of the efficiency in which lysine is used for protein deposition. The NRC, 2012 (NRC-12), model uses efficiency values that decrease with increased BW. In addition, the NRC-12 model estimates greater digestible lysine is required for maintenance than the other 2 models. The 3 models predicted that high-lean-gain pigs had greater (25.5 to 27.3%) overall predicted lysine:NE ratios than did low-lean-gain pigs. The greatest differences between the models in their predicted total lysine requirements were after 75 kg of BW. At 75 kg of BW, the NRC-12 model predicted digestible lysine requirements of 15.64 g/d for all 4 genetic groups versus 14.67 and 13.40 g/d for the NRC-98 and SCH-03 models. The differences increased at 100 kg (17.17 vs. 15.43 and 14.11 g/d) and 125 kg of BW (18.69 vs. 16.16 and 14.78 g/d). The NRC-12 model predicted 6.5 and 16.7% greater total SID lysine was required from 25 to 125 kg of BW than the NRC-98 and SCH-03 models, respectively. The 3 models predicted similar differences in lysine requirements for the 4 groups of pigs. The NRC-12 model predicted greater daily lysine requirements than the previous models after 75 kg of BW.

Key words: pig, lysine requirement, growth model

INTRODUCTION

Swine growth models can be used to predict the nutrient requirements, feed costs, and economic returns of specific genetic populations of pigs (Moughan et al., 1995; de Lange et al., 2001, Schinckel et al., 2008b). Pigs with greater carcass muscle growth rates have greater daily essential-amino-acid requirements (Schinckel, 1994; NRC, 1998; Van Heugten, 2009). Selection for increased carcass lean percentage and carcass lean tissue feed efficiency has resulted in increased essential-amino-acid requirements relative to energy intake and diets with greater cost per kilogram (Schinckel, 1994; Schinckel et al., 2008b).

Pig growth models provide estimates of daily digestible lysine requirements (g/d) and estimates of dietary lysine concentrations relative to their energy content (lysine, g/Mcal of NE). The new *Nutrient Requirements of Swine* (NRC, 2012) has an updated model of daily lysine requirements for growing pigs based on research in past data and new data conducted in the past decade.

The objectives of this study were 1) to compare the predictions of 3 mod-

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els that predict daily lysine requirements (NRC, 1998; Schinckel et al., 2003b; NRC, 2012) and 2) to evaluate whether the relative differences in predicted lysine requirements for each model are similar for barrows and gilts of 2 genetic populations of pigs with substantially different compositional growth rates.

MATERIALS AND METHODS

Experimental Data

The pig compositional growth data for this experiment were collected and analyzed at The Ohio State University (Wiseman et al., 2007a,b). In that study, 2 genetic populations of pigs with different herd histories of lean tissue growth were used to estimate chemical compositional growth from 25 to 125 kg of BW (Wiseman et al., 2007a,b; Schinckel et al., 2008c). The experiment was conducted as a 2 (genetic population) × 2 (sex) × 5 (BW) factorial arrangement of treatments in 2 groups of pigs (n = 120 pigs total) in a completely randomized design. Various body tissues and organs were collected on individual pigs at intervals of 25 kg of BW from 25 to 125 kg, whereupon chemical composition of the major components was determined. Fitting the chemical composition data to functions of age and BW and prediction of daily chemical composition curves were presented previously (Schinckel et al., 2008c). The high-lean-gain (**HLG**) pigs, in comparison with the low-lean-gain (**LLG**) pigs, had 1) 32.8% lesser predicted daily rates of lipid deposition (205 vs. 305 g/d), with differences between the 2 genetic lines increasing from 23 to 37% from 25 to 125 kg of BW, 2) 12.3% greater (118.9 vs. 106.0 g/d) daily rates of protein deposition, and 3) 18.8% greater (423 vs. 356 g/d) predicted daily water accretion rates. Barrows overall had 21.3% greater lipid deposition (279 vs. 230 g/d) and 54 g/d greater ADG than did gilts. The HLG pigs had less carcass backfat depth at 100 (1.98 vs. 2.93 cm) and 125 kg (2.34 vs. 3.14 cm) of BW than the LLG pigs (Wiseman et al., 2007a). Gilts had less carcass backfat depth than did barrows at 100 kg (2.08 vs. 2.83) and 125 kg (2.51 vs. 2.97 cm) of BW. At 125 kg of BW, the difference in predicted fat-free lean percentages between the 2 genetic populations (51.06 vs. 46.06%) was 2-fold greater than the difference between the barrows and gilts (47.31 vs. 49.82%).

Estimation of Daily Lysine and Energy Requirements

The daily digestible lysine requirements were estimated by 3 models. The first (**SCH-03**) has been used previously by Schinckel et al. (2003b, 2008b, 2009b). In this model, the standardized ileal digestible (**SID**) lysine intake required (g/d) = [LM + (PD × lysine concentration)/EFF], where **LM** is the grams of digestible lysine needed for maintenance, **PD** is the daily empty body protein deposition (g/d), lysine concentration (g of lysine/g of PD) is assumed to be 0.068, and **EFF**, the efficiency with which digestible lysine is used for PD, is assumed to be 0.625 (Schinckel, 1999; Schinckel et al., 2003b). It should be noted that LM includes that needed for endogenous gastrointestinal track losses, integument losses, and body protein turnover (NRC, 2012). The EFF value is similar to the 0.630 value estimated by Moughan (1989) needed to achieve the maximal protein deposition. The grams of digestible lysine required for maintenance were predicted as 0.036 × (BW, kg)$^{0.75}$ (Fuller et al., 1989). This equation requires 10.88 g of digestible (SID) lysine per 100 g of PD.

The second model (**NRC-98**) evaluated was that of NRC (1998) in which SID lysine intake required (g/d) = [LM + (PD × lysine concentration)/EFF], where LM is 0.036 × (BW)$^{0.75}$, and 12 g of digestible lysine is required for each 100 g of PD. With a lysine concentration of 0.071, the calculated EFF for the NRC-98 model is 0.592.

The third model (**NRC-12**) is from NRC (2012). The LM includes separate equations for basal endogenous gastrointestinal tract (**GIT**) losses and integument losses. The postabsorptive inefficiency of using SID lysine for these maintenance functions was assumed to account for the amino-acid losses associated with basal body protein turnover, the third major metabolic process associated with amino-acid maintenance requirements (Moughan, 1999, 2003; NRC, 2012). The basal endogenous GIT losses are predicted as a function of DM feed intake. Based on a research review of 57 studies, basal endogenous GIT lysine losses were estimated at 0.417 g per kilogram of feed DM intake (NRC, 2012). The equation is as follows: basal endogenous GIT lysine losses (g/d) = feed intake (g/d) × (0.417/1,000) × 0.88 × 1.1. The 0.88 accounts for the DM content of the feed, and the 1.1 accounts for the 10% of GIT losses, which occur in the large intestine relative to those recovered at the ileum (NRC, 2012). The integument losses are predicted as follows: integument losses (g/d) = 0.0045 × (BW, kg)$^{0.75}$. Then total SID lysine required for maintenance (LM) was estimated as SID lysine (g/d) = GIT losses, g/d + integument losses, g/d/{0.75 + [0.0002 × (maximum PD − 147.7)]}, where maximum PD is an estimate of the maximal protein deposition (g/d) of the pig. This adjustment was based on a N balance trial that found that the daily rate and fraction of true ileal digestible lysine intake oxidized decreased with increasing maximal PD (Moehn et al., 2004; NRC, 2012).

In the NRC-12 model, the SID lysine requirements for PD are predicted as follows: SID lysine, g/d = lysine retained in the PD/[0.75 + 0.002 × (maximum PD − 147.7)] × (1 + 0.0547 + 0.002215 BW, kg). The lysine concentration of the PD was assumed to be 7.1%. The EFF of lysine use is 0.75 + 0.002 × (maximum PD − 147.7)/(1 + 0.0547 + 0.002215BW, kg). The EFF of lysine use decreased with BW and increased as the maximal PD of the pig increased. For pigs with maximum PD rates of 147.7 g/d, the EFF values are 0.675, 0.672, 0.614, 0.588, and 0.563 at 25, 50, 75,