Effect of Ad libitum Feeding of Gilt Developer Diets Differing in Standard Ileal Digestive Lysine Concentrations on Growth Traits

A.S. Leaflet R3276

China Supakorn, Visiting Assistant Professor, ISU;
Clay Lents, Supervisory Research Physiologist, USDA, U.S. Meat Animal Research Center, Reproduction Research Unit, Clay Center;
Joseph D. Stock, Graduate Student, ISU;
Jeffrey L. Vallet, Supervisory Research Physiologist, USDA, U.S. Meat Animal Research Center, Reproduction Research Unit, Clay Center;
Terry J. Prince, Nutritionist , Prince Nutrition Service LLC;
Christine E. Phillips, Assistance Director of Production Research, Murphy Brown, LLC;
R. Dean Boyd, Technical Director for The Honor Company;
Ashley E. DeDecker, Assistant Director of Production Research, Murphy Brown, LLC;
Kenneth J. Stalder, Professor, ISU;

Summary and Implications

An experiment was conducted to determine the optimum dietary lysine concentration for optimum growth rate of replacement gilts during the growing-finishing period. A total of 2,960 gilts (Large White x Landrace), 42.3±7.0 kg average BW were allotted to randomized completely block design (RCBD). Three grower and finisher diets were formulated to contain low lysine (0.68 and 0.52% standard ileal digestible (SID) lysine), medium lysine (0.79 and 0.60% SID lysine), and high lysine (0.90 and 0.68 % SID lysine) at data recording day (142, 160 and 200 d of age). Covariate of body weight at 100 days was included in the models and it had significant influence on growth traits ($P<0.05$). Gilts fed the high lysine treatment had increased body weight (BW), flank-to-flank, backfat thickness, loin depth, fat-free-lean, and average daily gain (ADG) ($P<0.05$) when compared to gilts fed the medium and low lysine treatments. The results indicated that gilts require higher dietary lysine concentrations to maximize growth rate and high lysine diet may useful to impact growth traits when fed to developing gilt from 142 to 200 kg BW.

Introduction

Gilt development nutritional trials have a mixture of positive and negative impacts on sow longevity. Improving sow lifetime or productivity should be focused as a part of the replacement gilt management program by providing feeding regimes to achieve optimum body composition as the gilt enters to the breeding herd. Lysine, an essential amino acid, is the first limiting for typical swine diets based on cereal grains. The optimal dietary lysine concentration for optimal daily gain and/or feed efficiency during the replacement gilt growing-finishing period is important in term of gilt development and sow longevity or sow productive lifetime in order to improve producer economic efficiency and to achieve sufficient maternal productivity.

The objective of this study was to evaluate the optimum lysine levels during the growing-finishing period when fed ad libitum to developing gilts from 100 to 200 days of age under typical U.S. commercial farm condition.

Materials and Methods

Crossbred Large White x Landrace gilts (n=2,960) were used in this study. They originated from Murphy Brown LLC facilities in Milford, Utah. Gilts at 100 days were fed a grower diet containing similar metabolizable energy (ME) levels but differing in SID lysine levels. Three diets were chosen for this trial, including: (1) low lysine diet (0.68% Lys) (2) medium lysine diet (0.79% Lys), and (3) high lysine diet (0.90% Lys). Gilts were fed ad libitum, remained on grower diets for 6 weeks, and then were subsequently fed finisher diets differing in SID lysine (0.52, 0.60 and 0.68%, respectively). Gilts were provided ad libitum feed access to finisher diets treatments from 142 days of age until they were mated approximately 220 days of age and enter the breeding herd. The experimental grower and finisher diet (as-fed basis) composition (% dry matter; DM) is presented in Table 1.

Individual BW for each gilt was recorded using digital scale (Digi-Star SW4600EID Digital RFID, VID Recording scale; Digi-Star LLC, Fort Atkinson, WI). Backfat thickness (BF) and loin depth (LD) were measured at the 10^{th} rib using real-time ultrasound PIE Medical-Aquila apparatus with a 18 cm science probe (Pie Medical Equipment B.V., Maastricht, The Netherlands). Ultrasound images were captured by a trained technician using Sensoray 2225 and the digital images were stored and interpreted later using the Biosoft Toolbox II for swine (Biotronics Inc., Ames, IA). Additionally, a cloth tape applied to measure flank-to-flank values for data recording days (142, 160, and 200 days). Average daily gain (ADG) at data recording days was measured using a standard formula. Fat-free-lean meat content was calculated using the equation for live hogs using real time ultrasound measures: 0.379 x 2 [gender of pig; in case gilt =2] – [0.649 x 10^{th} rib of fat depth (mm)] + [0.841 x 10^{th} rib loin muscle area (cm^2)] + [0.132 x live BW (kg)] – 0.243. There were no significant difference for initial body measurements among dietary treatments from preliminary analysis.

Randomized completely block design (RCBD) was applied in this trial. Growth traits as dependent variables

were evaluated for normality by using the Shapiro-Wilk test and examining the normal plot. Data were analyzed using mixed model equation methods (PROC MIXED; SAS version 9.4). Models for analysis included the fixed effects of lysine dietary treatments (high, medium, and low lysine), and data recording day (142, 160, and 200 days) as a block effect. Body weight at beginning of study (at 100 days of age) was used as a linear covariate in the models. The interaction of pen x barn was included as a random effect for all the traits analyzed. Fixed and random effects were evaluated for differences at P-value of 0.05. Means of significant fixed effects were separated using the PDIFF option of SAS version 9.4.

Results and Discussion

Least square means (±SE) for growth and body composition traits are presented in Table 2. Dietary lysine treatments were a significant source of variation for growth traits at various data recording days (P<0.05). Gilts fed the high lysine dietary treatment had increased BW, flank-to-flank, BF, LD, fat-free lean meat, and ADG when compared to gilts fed the medium and low lysine treatments. Data recording days (142, 160, and 200 days) effect was significantly different for growth and body composition traits (P<0.05). Growth and body composition traits at 200 days were significantly greater when compared to other data recording days (P<0.05). Linear regression coefficients of BW at 100 days were 0.52±0.04 kg for BW, 0.44±0.01 cm for flank-to-flank, 0.17±0.07 mm for BF, 0.04±0.001 cm for LD, 0.45±0.01 kg for fat-free-lean, and 0.008±0.0004 kg/day for ADG, respectively. The effect of BW as a covariate in the model was positive and significant for all growth traits (P<0.05). This indicates that gilts with a larger BW at 100 days of age were heavier throughout the study.

Dietary lysine treatments were associated with gilt growth traits in the present study. Results from the present study were similar to previous work that reported developing gilt growth and composition differences when fed different level of dietary essential amino acids especially lysine. Improvement of muscle growth in monogastric animals with dietary lysine supply is not limiting due to greater protein synthesis rather than decreased protein degradation. Therefore, excess dietary lysine could be necessary for developing novel nutritional strategies to enhance the muscle and skeleton growth and development of meat animals.

Table 1. Diet formulation (as-fed basis)

	Grower diets (day 100 to 141)			Finisher diets (day 142 to 200)		
Item (%)	LL	ML	HL	LL	ML	HL
Corn (15%AF)	47.88	58.50	73.00	49.10	66.13	80.26
Soy bean meal (47.5%CP)	14.40	14.40	17.10	7.50	7.50	10.30
Corn germ	16.00	8.00	0.00	20.00	7.50	0.00
Wheat middlings	18.00	15.00	5.00	18.00	15.00	5.00
Dicalcium phosphate (21%P)	1.15	1.27	1.56	0.98	1.10	1.38
Choice white grease	1.00	1.00	1.00	2.90	1.00	1.00
Limestone ground	0.98	0.92	0.76	0.93	0.90	0.77
L-Lys (50%)	0.00	0.33	0.60	0.00	0.29	0.45
NaCl	0.40	0.40	0.40	0.40	0.40	0.40
Trace mineral premix[1]	0.10	0.10	0.10	0.10	0.10	0.10
L-Threonine	0.00	0.04	0.14	0.00	0.04	0.14
Alimet MHA Liq (Methionine)	0.00	0.00	0.11	0.00	0.00	0.03
Vitamin premix[2]	0.05	0.05	0.05	0.05	0.05	0.05
L-tryptophan	0.00	0.00	0.03	0.00	0.00	0.02
L-Threonine	0.00	0.04	0.00	0.00	0.02	0.09
Biotin (200 mg/l)	0.03	0.03	0.03	0.03	0.03	0.03
Chemical determined values, %						
CP	17.28	15.92	14.95	13.07	13.07	12.14
Lys	0.71	0.81	0.96	0.61	0.61	0.72
Met	0.27	0.25	0.33	0.21	0.21	0.23
Met+Cys	0.50	0.48	0.57	0.41	0.41	0.44
Thr	0.58	0.57	0.66	0.45	0.45	0.51
Trp	0.16	0.15	0.17	0.11	0.11	0.13
Calculated values, %						
SID[3] Lys,	0.68	0.79	0.90	0.52	0.60	0.68
SID Lys:ME, g/Mcal	3,135	3,188	3,276	3,208	3,192	3,278

LL=low lysine, ML=Medium lysine, and HL=High lysine, AF=As-fed, CP=Crude protein, P=Phosphorus, [1] Premix provided the following mineral per kilogram: 19 mg MN, 77 mg Zn, 77 mg Fe, 12 mg Cu, 171 mg Se, 400 mg I and 114 mg Cr. [2] Premix provided the following vitamins per kilogram: 20,566,783 IU vitamin A, 2,932,099 IU vitamin D_3, 117,504 IU vitamin E, 73 mg vitamin B_{12}, 589 mg biotin, 9,700 mg menadione, 14,698 mg ribofravin, 58,790 mg d-pantothenic acid, 88,183 mg niacin, and 4,409 mg folic acid. [3] SID = standard ileal digestible; calculated using SID coefficients for the various ingredients obtained from the NRC (2012).

Table 2. Least square means±standard error (SE) for body weight (BW), flank-to-flank, backfat thickness (BF), loin depth (LD), fat-free-lean meat, and average daily gain (ADG) of dietary treatments by data recording day

	Dietary treatment[2]		
Traits[1]	LL	ML	HL
BW, kg			
142 d	67.6±0.31[a]	70.4±0.31[b]	73.2±0.31[c]
160 d	81.7±0.31[a]	85.3±0.32[b]	89.7±0.32[c]
200 d	115.5±0.32[a]	120.8±0.33[b]	127.7±0.32[c]
Flank-to-flank, cm			
142 d	67.9±0.13[a]	68.6±0.13[b]	69.6±0.13[c]
160 d	73.3±0.13[a]	74.4±0.13[b]	75.7±0.13[c]
200 d	84.1±0.13[a]	85.5±0.13[b]	87.3±0.13[c]
BF, mm			
142 d	8.2±0.10[a]	8.6±0.10[b]	9.0±0.10[c]
160 d	10.1±0.10[a]	10.5±0.10[b]	11.1±0.10[c]
200 d	15.2±0.11[a]	15.7±0.11[b]	16.6±0.11[c]
LD, cm			
142 d	3.5±0.02[a]	3.7±0.02[b]	3.9±0.02[c]
160 d	3.8±0.02[a]	4.1±0.02[b]	4.4±0.02[c]
200 d	4.7±0.02[a]	5.1±0.02[b]	5.5±0.02[c]
Fat-free-lean meat, kg			
142 d	33.4±0.19[a]	35.6±0.20[b]	37.4±0.20[c]
160 d	36.9±0.20[a]	39.8±0.20[b]	42.2±0.20[c]
200 d	45.0±0.20[a]	48.8±0.21[b]	52.0±0.20[c]
ADG (kg/day)			
142 d	0.61±0.008[a]	0.68±0.008[b]	0.75 ±0.008[c]
160 d	0.79±0.008[a]	0.82±0.008[b]	0.90 ±0.008[c]
200 d	0.82±0.008[a]	0.86±0.008[b]	0.91 ±0.008[c]

[1] Body weight was measured by digital weighing scale, flank-to-flank was measured over the top of the back to opposite flank, BF and LD was measured at 10th rib by real time ultrasound, fat-free-lean meat was calculated from 0.379 x 2 [gender of pig; in case gilt =2] – [0.649 x 10th rib of fat depth (mm)] + [0.841 x 10th rib loin muscle area (cm^2)] + [0.132 x live BW (kg)] – 0.243, and ADG using a standard formula.

[2] Finisher diet of LL (low lysine, 0.52% SID lysine), finisher diet of ML (medium lysine, 0.60% SID lysine), and finisher diet of HL (high lysine, 0.68% SID lysine), * Results for continuous variables presented as the regression coefficient and their associate standard error at P<0.05, and [a-c] within rows, significant difference between dietary lysine treatments (P<0.05).