PREDICTING LYSINE REQUIREMENTS USING PROTEIN AND LIPID ACCRETION CURVES FOR GROWING-FINISHING BARROWS[1]

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Summary

A total of 240 growing-finishing barrows (75 to 260 lb) were used to model accretion rates and the lysine:calorie ratio requirement based on lipid and protein content data obtained with a real-time ultrasound. Barrows were fed eight different diets consisting of four increasing lysine:calorie ratios and two levels of fat (0 and 6%). The modeled accretion rates effectively predicted the differences between treatments in agreement with the actual data. The modeled lysine:calorie ratio requirement accurately predicted the lysine:calorie ratios that maximized growth, evaluated by either the predicted or the actual data. Lipid and protein deposition rates were used to effectively model feed intake when pigs were fed close to their requirement.

(Key Words: Real-Time Ultrasound, Lipid Accretion, Protein Accretion, Lysine:Calorie Ratio, Fat, Lysine, Finishing Pigs.)

Introduction

The estimation of on-farm protein and lipid accretion curves is a valuable tool to calculate the lysine requirement for growing-finishing pigs reared under specific environments. The daily energy intake can be calculated from the daily protein and lipid accretion estimates with an allowance for the maintenance energy requirement. The lysine requirement in grams per day divided by the daily energy intake results in an estimate of a lysine:calorie ratio to use in diet formulation. Several studies have been conducted to predict the lysine requirement from protein accretion estimations. However, the lysine:calorie ratios predicted from serial ultrasound estimates have not been compared to those estimated from conventional lysine titration experiments. Therefore, the objectives of this study were to model the lysine: calorie ratio requirement using real-time ultrasound data for growing-finishing barrows reared under commercial settings and to compare those estimates to values determined on the same group of barrows using the more traditional lysine titration technique.

Procedures

A total of 240 barrows (PIC C22 × 337) with an initial weight of 75 lb was used in this experiment.

Treatments consisted of corn soybean meal-based diets (Table 1) arranged in a 2 x 4 factorial with two levels of fat (0 and 6% choice white grease) and four lysine:calorie ratios in each phase. More detailed descriptions of the diets, building characteristics, pen dimensions, and ventilation system are found in the paper discussing growth performance results of this study (p. 92).

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The 240 barrows used in the study were selected randomly from a total of 1,200 pigs that were housed in 48 pens at the rate of 25 pigs per pen. Five pigs/pen were selected, tagged, weighed, and scanned within 1 week of placement in the finishing barn and every 3 weeks after, until they were marketed at the end of the study.

The growth and real-time ultrasound data (backfat depth and loin eye area) were used to calculate daily body gain and lipid and protein accretion rates, based on the concepts developed by Dr. Allan Schinckel at Purdue University.

The daily lysine requirement in grams per day was calculated using the following formula:

$$\text{Total Lysine g/day} = \frac{M + \frac{P \times L}{E}}{D}$$

Where M is the lysine needed for maintenance (.036 × Wt, $kg^{.75}$); *P* is the daily body protein accretion; L is the lysine content of body protein (6.6%); E is the postabsorptive efficiency of lysine utilization (60%); and D is the true digestibility of lysine in the diet (88%).

Predicted daily feed intake was calculated by dividing the metabolizable energy requirement by the energy content of the diet. The metabolizable energy required to drive the observed protein and lipid accretion (with an allowance for the maintenance energy requirement) was calculated using the following formula:

Metabolizable energy requirement = (.255 × weight in $kg^{.60}$) + (8.84 × protein accretion) + (11.4 × lipid accretion)

The lysine:calorie ratio requirement was calculated by dividing the requirement of total lysine in grams/day by the requirement of metabolizable energy in Mcal/day.

Results and Discussion

The modeled ADG is presented in Figure 1. Average daily gain was predicted to be greater for the third and fourth lysine:calorie ratios (treatments C,G, and D,H) than for the first and second lysine:calorie ratios (treatments A,E and B,F). Adding fat to the diets resulted in improved predicted gains within each lysine:calorie ratio. These results agree with the modeled ADG and the growth performance data for barrows (p. 92). The ADG was increased by increasing the lysine:calorie ratio and by adding fat to the diets during phases 1 and 2 and for the overall trial.

Modeled protein accretion rate (Figure 2) was greater for treatments C,G and D,H (third and four lysine:calorie ratios) compared to the first and second lysine:calorie ratios (treatments A,E and B,F).

Modeled lipid accretion rate (Figure 3) was greater for treatments G and H (third and fourth lysine:calorie ratios with added fat) followed by the rest of the treatments except for treatment B (second lysine:calorie ratio with no added fat), which presented the lowest modeled lipid accretion. Treatments E and F were expected to have higher fat accretion than treatments A and B. This held true except that treatments A and E has similar predicted fat accretion. However, in both experiments, treatments C,G and D,H (third and fourth lysine:calorie ratios) deposited more protein in relation to fat than treatments A,E and B,F (first and second lysine: calorie ratios). These results are supported by the carcass composition analysis presented in the growth performance paper (p. 92). Percent lean and fat-free lean index were increased and backfat was decreased with increasing lysine:calorie ratios.

Adding fat to the diets did not appear to have a great influence on protein accretion (Figure 2). However, a tendency for greater lipid accretion (Figure 3) can be detected, particularly in treatments F, G, and H (second, third, and fourth lysine:calorie ratios with added fat) Again, this agrees with the carcass composition results.

Until approximately 160 lb, predicted ADFI (Figure 4) was similar for all treatments, with a slight intake advantage for treatments with no added fat. This agrees with the measured performance in this study. After 160 lb, predicted ADFI decreased for treatments A, B, E, and F compared to the other treatments. These treatments were furthest below the pigs requirements. In contrast, the growth performance data did not show decreases in feed intake for these treatments. This indicates (based on the field data) that feed intake was driven mainly by the energy content of the diet and weight of the pig, rather than by the lysine content of the diet or by the lipid and protein accretion rates. The formulas to calculate feed intake based on lipid and protein deposition appear to be more accurate when pigs are fed close to their requirement.

The modeled lysine requirement in g/day (Figure 5) followed protein accretion. As expected, the greatest lysine requirement was predicted for treatments C,G and D,H (third and four lysine:calorie ratios).

Treatments with greater protein accretion (C,G and D,H,) and thus, with a greater requirement for total lysine, also demonstrated an increased lysine:calorie ratio requirement (Figure 6) when compared to treatments A,E and B,F. These results agree with the lysine:calorie ratios fed during the growth performance experiment (p. 92), where treatments C,G and D,H corresponded to the highest lysine:calorie ratio regimens fed. Also, these data agree with the responses observed with gilts.

In order to compare the predicted lysine:calorie ratio requirement vs. the actual ratio fed (p. 92), treatment D was selected (Figure 7). During phases 1 and 2 (75 to 175 lb), the modeled lysine:calorie ratio requirement was higher at the beginning of the phase but similar at the end of phase. During phases 3 and 4 (175 to 260 lb), the modeled lysine:calorie ratio requirement accurately predicted the actual lysine:calorie ratio requirement observed. The reason for the difference between the predicted and the actual lysine:calorie ratio requirement during phases 1 and 2 was due to the fact that treatment D had a greater predicted lysine:calorie ratio requirement during these first phases compared to the same lysine:calorie ratio regimen but with added fat. This is surprising, because we would expect the modeled prediction requirement for the same lysine: calorie ratio to be similar. On the other hand, the actual lysine:calorie ratio requirement used for this comparison was based on the greatest numerical response observed in the growth performance data, which was for the third lysine:calorie ratio in phase 1 and between the third and fourth lysine:calorie ratios in the rest of the phases. However, statistically, a significant linear response was observed in the growth performance data. This means that we could have chosen the fourth lysine:calorie ratio regimen as the actual requirement observed, which would have agreed more with the predicted requirement.

In conclusion, this study demonstrated that real-time ultrasound can be used to accurately predict growth and lysine:calorie ratio requirement of growing–finishing pigs reared in specific environments. Also, it can be used to model feed intake based on lipid and protein depositions. However, the formulas to calculate feed intake appear to be more accurate when pigs are fed close to their requirement, which implies that when lysine requirements derived using ultrasound measurements are in excess of the dietary levels fed, the requirement may actually be higher than the modeled estimate.

Table 1. Dietary Treatments

		Lysine:Calorie Ratio (g lysine/Mcal ME)							
		0% Fat				6% Fat			
Item		A	B	C	D	E	F	G	H
Phase 1	(75-130 lb)	2.41	2.71	3.01	3.31	2.41	2.71	3.01	3.31
Phase 2	(130-175 lb)	1.75	2.00	2.25	2.50	1.75	2.00	2.25	2.50
Phase 3	(175-220 lb)	1.38	1.58	1.78	1.98	1.38	1.58	1.78	1.98
Phase 4	(220-260 lb)	1.02	1.22	1.42	1.62	1.02	1.22	1.42	1.62

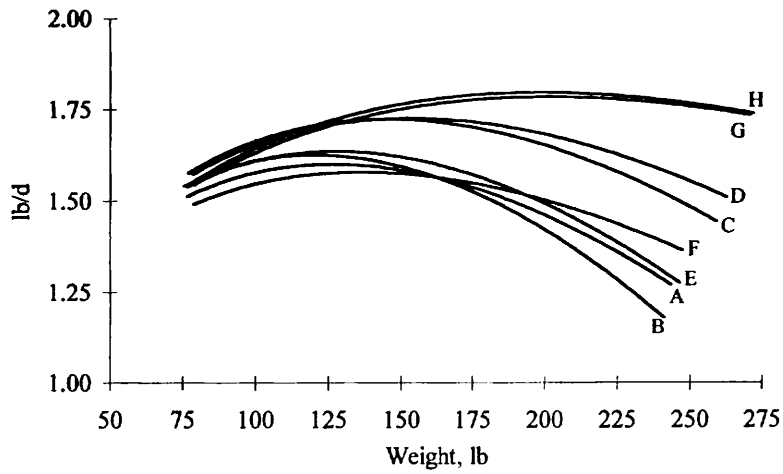

Figure 1. Modeled Daily Growth for Barrows Fed Diets with Increasing Lysine:Calorie Ratios and Two Dietary Fat Levels.

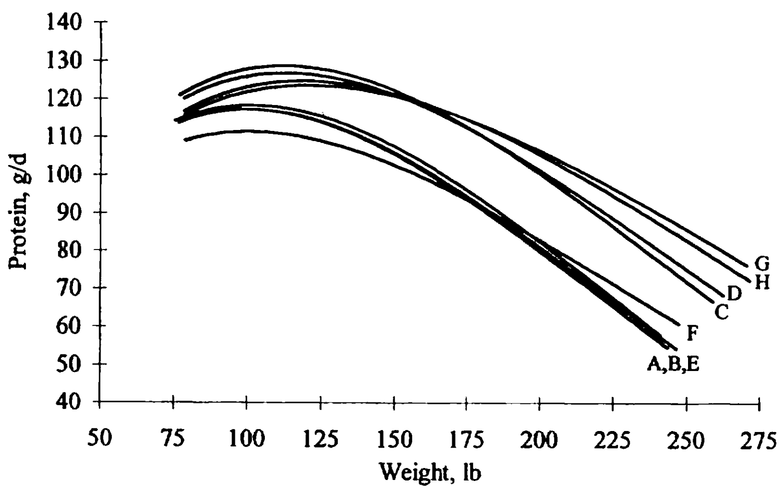

Figure 2. Modeled Daily Protein Accretion for Barrows Fed Diets with Increasing Lysine:Calorie Ratios and Two Dietary Fat Levels.

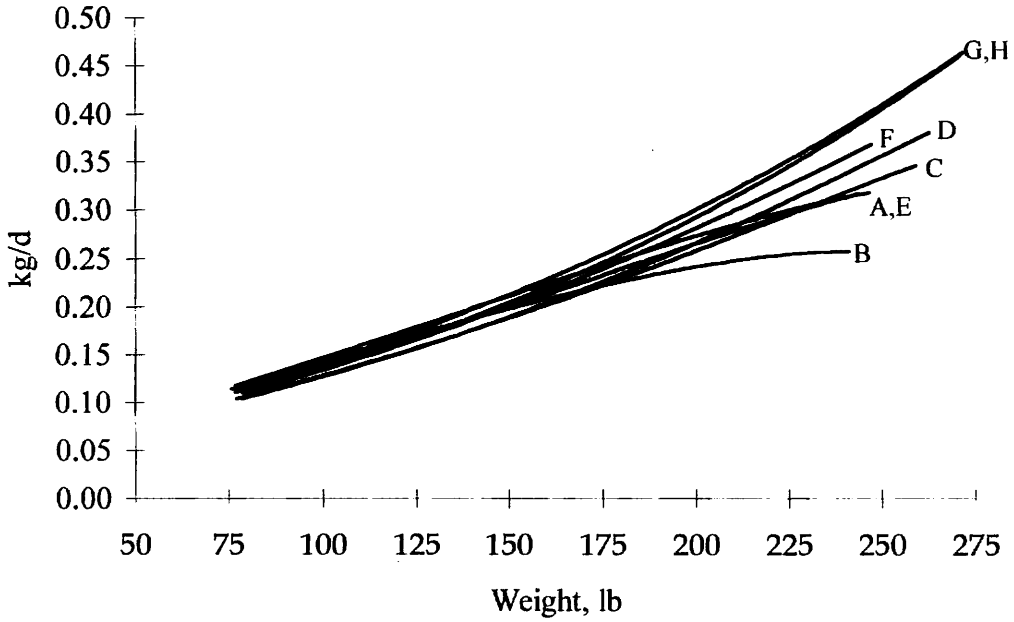

Figure 3. Modeled Daily Lipid Accretion for Barrows Fed Diets with Increasing Lysine: Calorie Ratios and Two Dietary Fat Levels.

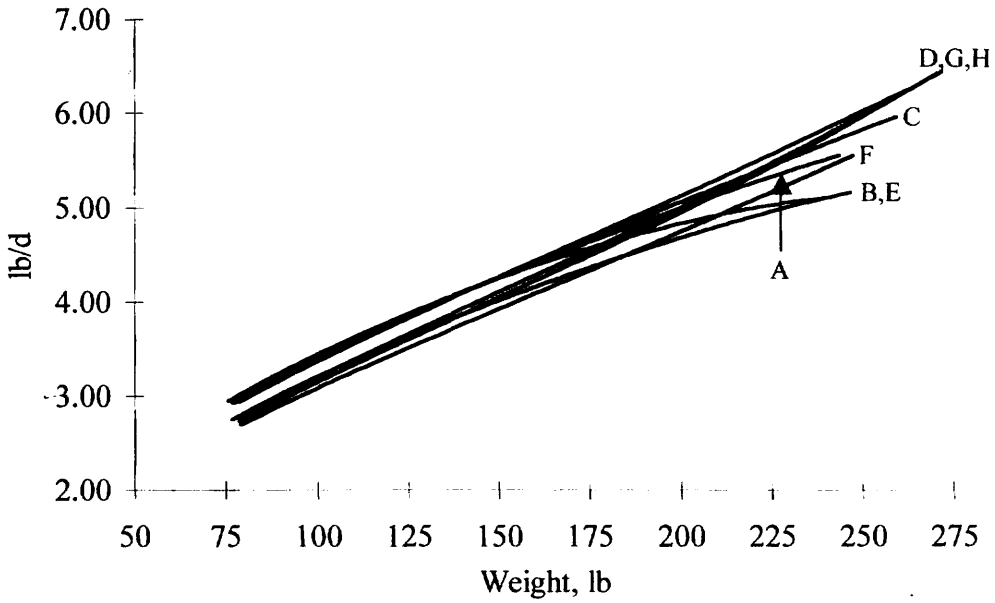

Figure 4. Modeled Daily Feed Intake for Barrows Fed Diets with Increasing Lysine: Calorie Ratios and Two Dietary Fat Levels.

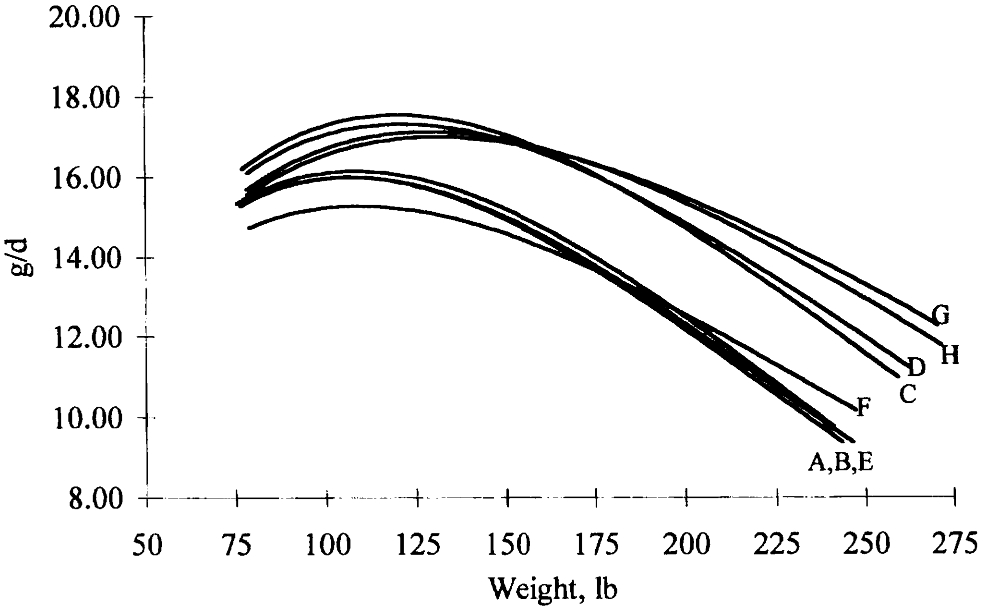

Figure 5. Predicted Daily Total Lysine Requirement for Barrows Fed Diets with Increasing Lysine:Calorie Ratios and Two Dietary Fat Levels.

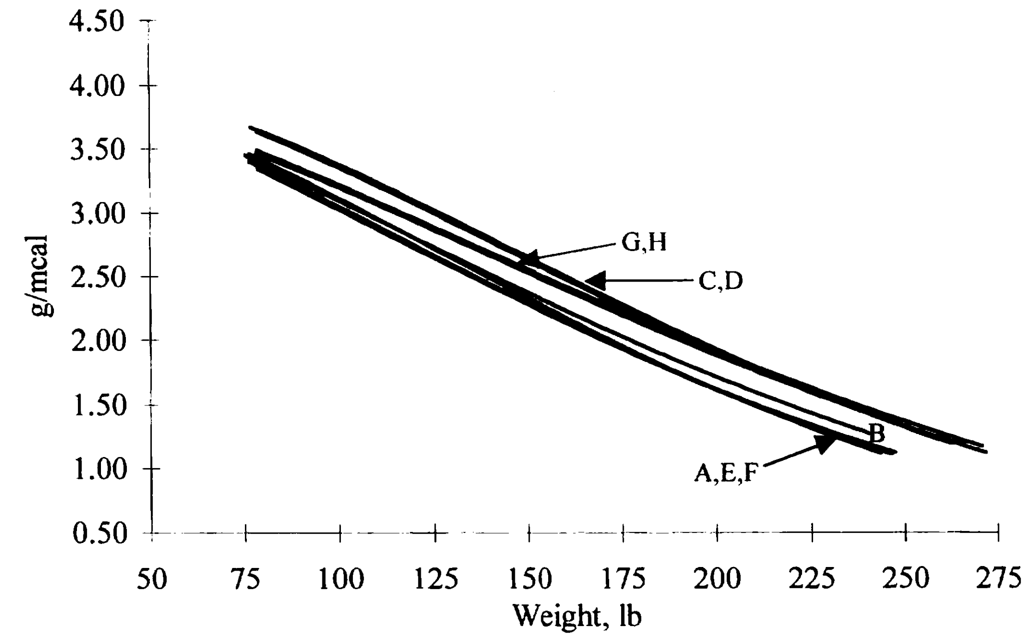

Figure 6. Predicted Lysine:Calorie Ratio Requirement for Barrows Fed Diets with Increasing Lysine:Calorie Ratios and Two Dietary Fat Levels.

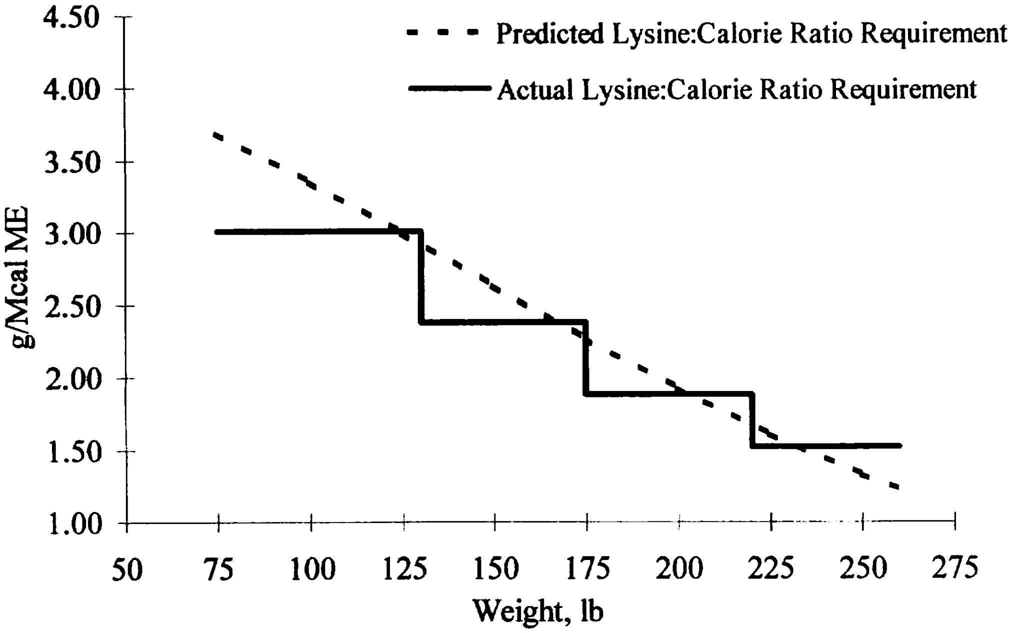

Figure 7. Comparison between Predicted and Actual Lysine:Calorie Ratio Requirements for Growing-Finishing Barrows.