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# Epinephrine and Energy Mobilization by Lactating Sows

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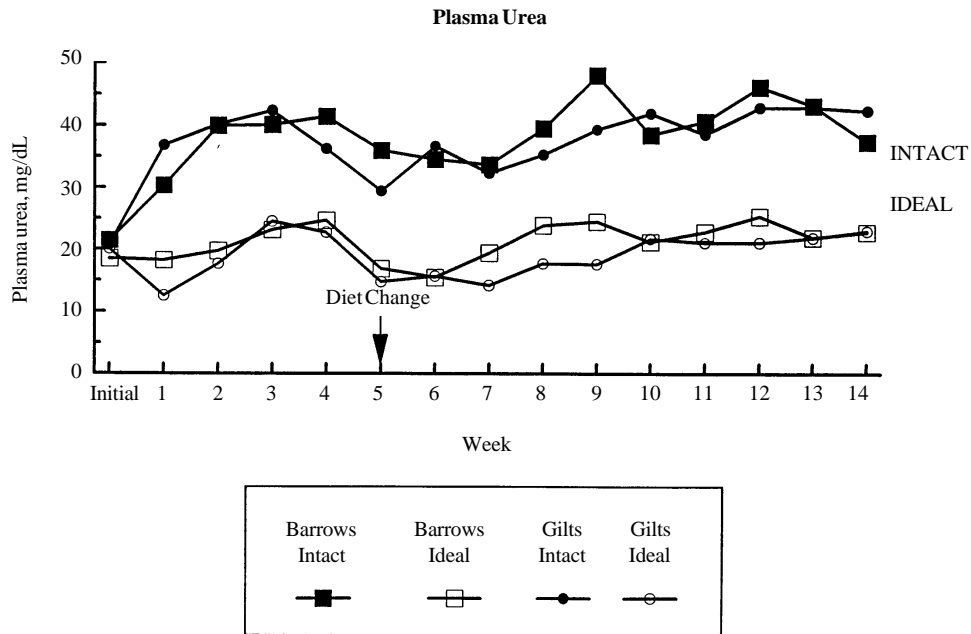


Figure 1. The response of plasma urea in barrows and gilts consuming corn-soybean (INTACT) or corn-soybean meal-amino acid supplemented (IDEAL) diets during a 14-week growing-finishing period.

actions ( $P < .1$ ) observed for carcass and shoulder weight were due to the low values observed for the barrows receiving the IDEAL diet. For barrows, carcass weight was eight percent lower in the IDEAL vs INTACT diets. Diet did not affect any of the other carcass characteristics evaluated. Although growth rate was reduced in barrows vs gilts consuming the IDEAL diet (see Table 3), there was a numerical decrease in the carcass lean percentage of the barrows (barrows, 45.8%; gilts 46.4%).

### Conclusions

Growth performance was not affected in gilts receiving IDEAL vs INTACT diets during the growing-finishing period. Although attempts were made to pair-feed barrow to gilts, the decreased feed efficiency of the barrows consuming the IDEAL diets resulted in reduced ADFI and ADG compared to gilts. However, we recognize that the pair-feeding regimen may have accentuated differences in growth

performance between barrows and gilts consuming the IDEAL diets. Plasma urea concentration during the growing-finishing period was reduced in pigs consuming the IDEAL diet. There did not seem to be differences in plasma urea concentration between barrows and gilts receiving either diet.

<sup>1</sup>Phillip S. Miller is an Assistant Professor, Austin J. Lewis is a Professor, Cynthia K. Wolverton is a Research Technologist, and Christopher A. Borland is an Undergraduate Student.

## Epinephrine and Energy Mobilization by Lactating Sows

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### Summary and Implications

Research was conducted to determine the optimal dosage of epinephrine (adrenalin) for use as an *in vitro* diagnostic tool to measure

changes in the mobilization of energy from body tissues. Doses of epinephrine were .1, .2, .4, .8, 1.2, and 1.6  $\mu\text{g}/\text{kg}$  of body weight. Blood samples were collected from 15 minutes before epinephrine infusion through 120 minutes post infusion. Samples were analyzed for nonesterified fatty acid (NEFA) and glucose content. Linear increases in NEFA and glucose were found for increasing dosages of epinephrine, along with a quadratic

effect for some of the NEFA data because of a hypersensitive response to epinephrine at the lowest two levels. These data, although not establishing an optimal dosage of epinephrine, have shown that the lactating sow is capable of responding to increasing concentrations of epinephrine by increasing energy mobilization from body tissues and that the dosages of epinephrine used were insufficient



to induce maximal energy mobilization from peripheral tissues.

## Introduction

The epinephrine (adrenalin) challenge has been successfully used in cattle to examine changes in the ability to mobilize energy from body stores. This is due to the classical “fight or flight” response that animals exhibit when frightened. Epinephrine is the principal hormone involved with this type of response, and it is responsible for large amounts of energy being mobilized to respond to perceived threats. However, to date, the epinephrine challenge has seen limited use in swine, and the optimal dosage has not been determined for use with the lactating sow.

The objective of this experiment was to determine the optimal dosage of epinephrine needed to examine the ability of the lactating sow to mobilize energy from body stores. This was done with the goal of subsequently using the epinephrine challenge to detect diet-induced differences in the ability of the lactating sow to mobilize energy during lactation.

## Procedures

Six first parity crossbred sows were used to determine the optimal dosage of epinephrine. Sows received approximately 4 lb/d of a standard diet through d 110 of gestation. On d 110, sows were moved to farrowing crates. Sows were fed 4 lb/d of a 1% lysine corn-soybean meal diet (Table 1) until farrowing and had *ad libitum* access to the same diet after parturition. Nutrient concentrations in this diet exceeded National Research Council requirements. Farrowing room temperature was maintained at 70°F, and there was continuous lighting. Sow and litter weights were recorded on a weekly basis from d 0 (within 24 hours postfarrowing) to d 23 (weaning). Feed intake was determined on a daily basis for 23 days.

Sows were fitted with two jugular catheters on d 110 of gestation. Catheters consisted of medical grade tub-

**Table 1. Composition of diet**

Ingredient	Percent
Corn	67.90
Soybean meal (46.5% CP)	28.00
Limestone	.40
Dicalcium phosphate	2.10
Salt	.50
Vitamin premix	1.00
Trace mineral premix	.10
Formulated composition	
Protein, %	18.50
Metabolizable energy, Mcal/lb	1.46
Lysine, %	1.00
Calcium, %	.90
Phosphorus, %	.75
Analyzed composition	
Dry matter, %	89.29
Protein, %	18.95
Fat, %	2.81
Ash, %	5.46
Calcium, %	.93
Phosphorus, %	.76

**Table 2. Sow and litter performance**

Criteria	Low	Mean <sup>a</sup>	High
Sow feed intake, lb/d			
d 0 to 23	4.81	9.63	12.79
Sow weight loss (-) or gain (+), lb			
d 0 to 23	-54.78	-24.02	+5.06
Litter size at birth	9	10.67	12
Litter size at d 23	6	8.17	10
Litter weight at birth, lb	28.75	33.43	41.05
Litter weight gain, lb			
d 0 to 23	29.83	82.47	132.92

<sup>a</sup>Average performance of six sows and litters.

ing inserted into the sow through an ear vein.

The experimental design was a

replicated 6 x 6 Latin square. Sows were randomly assigned to receive each of six doses of epinephrine on d 3 to 8 and on d 17 to 22 of lactation. Dosages of epinephrine used were .1, .2, .4, .8, 1.2, or 1.6 µg/kg body weight. Blood samples were collected from these animals starting at 9:45 a.m., with epinephrine infusion occurring at 10:00 a.m. Collection times were -15, -5, 0 (immediately prior to infusion), 2, 4, 6, 8, 10, 15, 20, 25, 30, 45, 60, and 120 minutes after epinephrine infusion.

Plasma was analyzed for glucose and nonesterified fatty acids (NEFA). Peak height, adjusted peak height, and area under the curve were then calculated daily for each sow. Peak height consisted of the average of the 8, 10, and 15 minute samples, while the adjusted peak height was corrected for differences in baseline concentration of the metabolite (i.e., peak concentration - baseline concentration). Baseline concentration was determined by averaging the values obtained before epinephrine infusion. Response area was calculated from 0 to 45 minutes after epinephrine infusion. This was done by averaging values obtained from consecutive time points, and multiplying the average by the time elapsed between data points. These values were then summed over the 45-minute period.

## Results and Discussion

(Continued on next page)

**Table 3. Plasma metabolite concentrations**

Criteria	Epinephrine dosage, µg/kg						P <sub>≤</sub>	
	.1	.2	.4	.8	1.2	1.6	L <sup>a</sup>	Q <sup>a</sup>
NEFA <sup>b</sup>								
Baseline, µEq/L	213.0	128.5	114.4	144.3	106.9	180.9	NS <sup>c</sup>	NS
Peak, µEq/L	248.4	157.5	137.7	185.8	188.1	295.5	.11	.05
Adjusted peak, µEq/L	36.6	28.9	23.3	41.4	81.1	114.5	.01	NS
Response area, µEq L <sup>-1</sup> •min <sup>-1</sup>	1,458.7	856.2	697.5	1,112.5	1,844.4	2,628.1	.01	.06
Glucose								
Baseline, mg/dL	84.1	82.7	85.6	85.0	89.7	77.5	NS	NS
Peak, mg/dL	84.8	91.6	87.5	97.5	108.9	103.5	.01	NS
Adjusted peak, mg/dL <sup>d</sup>	0.0	8.3	0.3	11.7	23.0	27.7	.01	NS
Response area, mg dL <sup>-1</sup> •min <sup>-1</sup>	274.9	365.0	317.2	417.0	569.1	860.2	.01	NS

<sup>a</sup>L = linear, Q = quadratic.

<sup>b</sup>NEFA = nonesterified fatty acid.

<sup>c</sup>NS = not significant, P > .10.

<sup>d</sup>Adjusted peak is the peak concentration adjusted for baseline concentration of zero (i.e., peak - baseline).



There was a limited number of sows in this study, and sow and litter performance was quite variable (Table 2). These data are included primarily to aid in interpretation of the metabolite responses.

No differences were observed in baseline concentrations of NEFA or glucose among dosages of epinephrine (Table 3). This was expected because epinephrine is metabolized rapidly, therefore the previous dosage should not affect baseline concentrations on the next day.

Peak NEFA concentration in plasma exhibited a quadratic response ( $P < .05$ ) to epinephrine dosage, with a decline from the .1  $\mu\text{g}/\text{kg}$  dosage to the .4  $\mu\text{g}/\text{kg}$  dosage, followed by increases in NEFA concentration to the 1.6  $\mu\text{g}/\text{kg}$  dosage. When adjusted for

baseline, peak height increased linearly ( $P < .01$ ), suggesting that variation in baseline concentration (although not significant) was contributing to the quadratic effect observed with the unadjusted peak concentrations. Response area for NEFA increased linearly ( $P < .01$ ) with some tendency ( $P < .06$ ) for a quadratic response to increasing doses of epinephrine, following a pattern similar to that observed for peak height.

Peak glucose concentration increased linearly with increasing dosage of epinephrine ( $P < .01$ ). This was also observed for the adjusted peak concentration ( $P < .01$ ) and the glucose response area ( $P < .01$ ). These data show that the sow responds to increasing dosages of epinephrine by increasing glucose release into plasma from glycogen stores and from increased

gluconeogenesis.

### Conclusions

The lactating sow is able to increase energy mobilization from body tissues in response to administration of increasing dosages of epinephrine. The optimal dosage of epinephrine was not established. This experiment has shown that the optimal dosage is higher than the dosage used previously in sows or the optimal dosage for the dairy cow (.4  $\mu\text{g}/\text{kg}$ ).

<sup>1</sup>Scott L. Tilton and Paul M. Ermer are graduate students, Austin J. Lewis is a Professor, Phillip S. Miller is an Assistant Professor, and Cynthia K. Wolverton is a Research Technologist, Department of Animal Science.

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# The Effects of Tallow Addition to the Diets of Lactating Sows on Hormone and Metabolite Concentrations

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*was observed for sows consuming either diet. These results show the addition of tallow to lactation diets does not affect the concentrations of glucose, NEFA, insulin or glucagon in the fed state.*

The objective of the following experiment was to measure changes in feed and energy intake and meal patterns associated with the addition of tallow to lactation diets. In addition, nonfasting (fed) concentrations of hormones and metabolites were measured.

### Summary and Implications

*The metabolic responses of sows fed a corn-soybean meal or a corn-soybean meal-10% tallow diet were measured. The addition of tallow to lactating sows diets had no effect on feed or energy intake. In addition, there were no effects on the concentrations of glucose, nonesterified fatty acids (NEFA), insulin, or glucagon. No differences in either the time spent consuming feed or the number of meals consumed were observed. Finally, no linear association between eating time and area under the curve for insulin*

### Introduction

In previous research (Nebraska Swine Report, 1995) we have reported several behavioral and physiological responses to the addition of tallow to lactating sow diets. Although there were no differences in feed or energy intake, the addition of tallow resulted in increased rate of feed consumption and decreased the percentage of time spent consuming feed. Fasting concentrations of glucose were increased and nonesterified fatty acids (NEFA) and glucagon were decreased in sows fed the tallow diet.

### Methods

Eight first-litter crossbred gilts were used. Gilts were randomly and equally allotted within room (two rooms) to receive either a corn-soybean meal (C-SBM) or a corn-soybean meal-10% tallow diet (Tallow, Table 1). Dietary treatments were initiated after parturition. Sow weight postpartum averaged 389 lb. Farrowing room temperature averaged 72° F and continuous lighting was provided. Sow and litter weights were obtained after parturition and on d 21 of lactation. Feed intake was