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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 µg/kg of body weight. Blood samples were collected from 15 minutes before epinephrine infusion through 120 minutes post infusion. Samples were analyzed for nonesteri-fied 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 concent rations 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 tubing 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.

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[a]	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

[a]Average performance of six sows and litters.

Results and Discussion

(Continued on next page)

Table 3. Plasma metabolite concentrations

	Epinephrine dosage, μg/kg						P≤	
Criteria	.1	.2	.4	.8	1.2	1.6	L[a]	Q[a]
NEFA[b]								
Baseline, μEq/L	213.0	128.5	114.4	144.3	106.9	180.9	NS[c]	NS
Peak, μEq/L	248.4	157.5	137.7	185.8	188.1	295.5	.11	.05
Adjusted peak, μEq/L[d]	36.6	28.9	23.3	41.4	81.1	114.5	.01	NS
Response area, μEq L^{-1}•min^{-1}	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[d]	0.0	8.3	0.3	11.7	23.0	27.7	.01	NS
Response area, mg dL^{-1}•min^{-1}	274.9	365.0	317.2	417.0	569.1	860.2	.01	NS

[a]L = linear, Q = quadratic.
[b]NEFA = nonesterified fatty acid.
[c]NS = not significant, P > .10.
[d]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 µg/kg dosage to the .4 µg/kg dosage, followed by increases in NEFA concentration to the 1.6 µg/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 µg/kg).

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