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Scott Tilton
University of Nebraska - Lincoln

Austin Lewis
University of Nebraska - Lincoln, alewis2@unl.edu

Phillip S. Miller
University of Nebraska - Lincoln, pmiller1@unl.edu

Paul Ermer
University of Nebraska - Lincoln

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Scott L. Tilton
Austin J. Lewis
Phillip S. Miller
Paul M. Ermer[1]

Summary and Implications

The effect of dietary fat intake on the ability of the lactating sow to mobilize energy from adipose tissue fat was examined. Sows had ad libitum access to diets formulated to contained 1% lysine and either zero or 10% tallow. Data from two epinephrine challenges indicated sows fed tallow tended to have higher baseline concentrations of nonesterified fatty acids (NEFA) and lower stimulated release of NEFA in response to epinephrine than did control sows. Because baseline glycerol values did not differ between treatments, we interpreted this to suggest control sows tended to re-esterify (recycle) a greater portion of the fatty acids during unstimulated (no epinephrine treatment) conditions. This is in agreement with the finding that dietary fat did not affect hormone-sensitive lipase activity on day 21 of lactation.

Introduction

The addition of fat to the diet of the lactating sow typically results in a slight increase in energy intake. There is also an increase in the energy (fat) content of milk and an increase in energy intake by suckling pigs. During lactation, the rates of lipid synthesis and esterification in adipose tissue are increased, compared to rates during gestation. However, little is known about the in vivo and in vitro ability of the lactating sow to mobilize energy from adipose tissue and the affect of dietary fat on this ability.

The objectives of the following experiments were to measure changes in the mobilization of nonesterified fatty acids (NEFA), glycerol and glucose due to epinephrine stimulation. Hormone-sensitive lipase activity was also determined because this enzyme catalyzes the rate-limiting step in the release of energy from adipose tissue.

Procedures

Experiment 1. Seventeen first-parity crossbred sows were used to examine the effect of feeding a 10% tallow lactation diet on epinephrine-stimulated energy mobilization and hormone-sensitive lipase activity. Sows received approximately 4 pounds/day of a standard corn-soybean meal based gestation diet until farrowing. On day 110 of gestation, sows were moved to farrowing crates. Sows were randomly allotted within room to receive either a corn-soybean meal (n = 9) or a corn-soybean meal with 10% tallow (n = 8) diet (Table 1). Diets were formulated to contain 1% lysine and contained 110% of the NRC requirements for other nutrients. Farrowing room temperature was maintained at 70°F and there was continuous lighting. Pigs were cross-fostered within 48 hours after birth to standardize litter size. Sow and litter weights were recorded on a weekly basis. Sow feed disappearance was recorded daily.

On day 3 of lactation, sows were fitted with two jugular catheters. Catheters consisted of sterile medical-grade tubing inserted through an ear vein.

Sows received an epinephrine challenge on day 6 and 20 of lactation. Epinephrine acts to stimulate the processes of fatty acid breakdown from triacylglycerol in adipose tissue. Dosage of epinephrine used was .73 mg /lb of body weight. This dosage was chosen because a linear response up to this dosage was reported in the 1996 Nebraska Swine Report. Blood samples were collected 15 and 5 minutes before epinephrine administration and zero, 2, 4, 6, 8, 10, 15, 20, 25, 30, 45, 60 and 120 minutes after administration of epinephrine.

Plasma was separated and analyzed for glucose, NEFA and glycerol. Baseline, peak height adjusted peak height, and area under the curve were calculated for each sow. Peak height consisted of the average of the 8, 10 and 15 minute samples, whereas adjusted peak height was corrected for differences in baseline concentrations of the metabolite (i.e., peak concentration - baseline concentration). Baseline concentration was the average of the two samples collected before epinephrine administration. Response area was calculated from zero to 45 minutes after epinephrine infusion, by averaging the values obtained from consecutive time points and multiplying the average by the time elapsed between the two data points. Data were then summed over the 45-minute period.

Adipose tissue samples were collected at weaning (d 21) from anesthe-

Table 1. Composition lactation of diets

Ingredient, %	Control	Tallow
Corn	67.9	56.80
Soybean meal, 46.5% CP	28.00	29.00
Tallow	0.00	10.00
Dicalcium phosphate	2.10	2.30
Limestone	.40	.30
Salt	.50	.50
Vitamin premix	1.00	1.00
Trace mineral premix	.10	.10
Formulated composition:		
Metabolizable energy, Mcal/lb	1.42	1.63
Protein, %	19.00	18.50
Lysine, %	1.00	1.00
Calcium, %	.90	.90
Phosphorus, %	.75	.75
Analyzed composition:		
Protein, %	19.17	18.68
Dry matter, %	91.46	91.83
Ether extract, %	3.00	11.35
Calcium, %	1.09	1.07
Phosphorus, %	.89	.89

Table 2. Effects of an epinephrine challenge during d 6 and 20 of lactation on plasma metabolite concentrations in sows fed either a corn-soybean meal diet or a similar diet with 10% tallow (Experiment 1)

	Treatment[a]		Collection time		P <	
Criteria	Control	Tallow	d 6	d 20	Trt	Period
Nonesterified fatty acids						
Baseline,μEq/L	135.8	261.7	232.2	165.4	N.S.[b]	N.S.
Peak,μEq/L	208.2	274.3	275.0	207.5	N.S.	N.S.
Adjusted Peak,μEq/L	72.3	12.6	42.8	42.2	N.S.	N.S.
Response area,μEq*L^{-} *min^{-1}	3738	1760	3370	2128	N.S.	N.S.
Glycerol						
Baseline,μmol/L	66.1	70.7	79.9	56.9	N.S.	N.S.
Peak,μmol/L	101.0	95.7	108.4	88.3	N.S.	N.S.
Adjusted peak,μmol/L	34.9	25.0	28.5	31.4	N.S.	N.S.
Response area,μmol*L^{-} *min^{-1}	1067.0	943.2	1069.3	940.9	N.S.	N.S.
Glucose						
Baseline, mg/dL	89.5	86.5	82.3	93.6	N.S.	.05
Peak, mg/dL	98.27	95.44	90.8	103.0	N.S.	N.S.
Adjusted peak, mg/dL	8.64	9.25	8.52	9.37	N.S.	N.S.
Response area, mg*dL^{-} *min^{-1}	362.8	250.9	246.9	366.8	N.S.	N.S.
NEFA:glycerol ratio						
Baseline	1.70	4.24	2.92	3.02	.09	N.S.
Peak	1.61	2.63	2.29	1.96	.06	N.S.

[a]Litter weight gain and sow weight loss were used as covariates in this analysis. The number of sows fed control and tallow diets was 9 and 8, respectively.
[b]Not significant, P > .10.

Table 3. Effect of diet on hormone-sensitive lipase (HSL) activity in sows on d 21 of lactation[a]

Criteria	Control	Tallow	P <
Experiment 1			
No. of sows	9	8	
nmol FFA[b] released, nmol/mL	334.50	315.98	N.S.[c]
nmol FFA released/mg protein	125.17	128.56	N.S.
nmol FFA released/g of tissue	669.00	631.95	N.S.
HSL, IU/g of tissue	11.15	10.53	N.S.
Experiment 2			
No. of sows	15	15	
nmol FFA released/mL	316.8	322.4	N.S.
nmol FFA released/mg protein	106.8	108.8	N.S.
nmol FFA released/g of tissue	633.6	644.7	N.S.
HSL, IU/g of tissue	10.56	10.75	N.S.

[a]Litter weight gain and sow weight loss were used as covariates in this analysis.
[b]FFA = free fatty acid.
[c]Not significant, P > .10.

tized sows. Samples were flash-frozen using liquid nitrogen and stored until analyzed for hormone-sensitive lipase activity. Hormone-sensitive lipase is the enzyme in adipose tissue assumed to be the rate-limiting step in fatty acid breakdown from triacylglycerol (lipolysis). Diets were analyzed for dry matter, protein, fat, calcium and phosphorus.

Experiment 2. Thirty sows were used to determine further the effect of dietary fat during lactation on hormone-sensitive lipase activity. Sows were managed as reported in the previous experiment. Biopsies were taken at weaning (d 21) and treated as in Experiment 1.

Results and Discussion

Formulated and analyzed nutrient levels for diets are presented in Table 1. In general, formulated and analyzed values agreed; however, calcium and phosphorus percentages analyzed between .1 and .2% greater than formulated values.

Sows fed tallow tended to have higher baseline concentrations of NEFA (Table 2). This led to decreases in the adjusted peak concentration of NEFA and the NEFA response (to epinephrine) area in sows fed tallow . However, these differences were not statistically significant. Because the NEFA:glycerol ratio in control sows was lower (P<.10) both at baseline and peak concentrations, we believe control sows may be re-esterifying more NEFA during stimulated and nonstimulated conditions. In addition, control sows seemed to be more sensitive to epinephrine than were tallow sows (higher adjusted NEFA peak and NEFA response area). Because there were no differences due to treatment in either glycerol and glucose parameters, it would suggest rate of lipolysis and glucose utilization were not affected by dietary treatment. The lack of differences in hormone-sensitive lipase activity from either Experiment 1 or 2 (Table 3) further supports the conclusion that no difference exists for the rate of lipolysis in sow adipose tissue due to the addition of fat to the lactation diet.

Plasma glucose concentration was greater (P < .05) on day 20 than day 6 of lactation. This glucose response is likely due to the increase in feed intake as lactation progressed (observed in the previous report). Although not significant, peak height and response areas for these metabolites follow similar trends, with NEFA and glycerol values decreasing and glucose values increasing as lactation progresses.

Conclusions

The lactating sow is able to increase energy mobilization from adipose in response to epinephrine. It seems likely adipose tissues (fat) in lactating sows consuming diets with a high concentration of tallow are less responsive to signals (epinephrine) stimulating lipolysis. In addition, fatty acids seem to be re-esterified (recycled) to a lesser extent after lipolysis in sows consuming tallow.

[1]Scott L. Tilton and Paul M. Ermer are graduate students, Austin J. Lewis is a Professor and Phillip S. Miller is an Associate Professor, Department of Animal Science.