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Addition of Fat to Diets of Lactating Sows. I. Effects on Sow and Pig Performance

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Sow energy intake during lactation is an important factor to consider when trying to maximize sow and pig performance. It has been shown that inadequate energy intake during lactation results in decreased litter weaning weight. Poor energy intake during lactation is also thought to result in a reduction in postweaning reproductive performance by extending the period from weaning to rebreeding. This reduction in postweaning performance is typically preceded by the excessive loss of weight and backfat during lactation.

One method that has been used to increase sow energy intake, and thus alleviate the problems described above is to add dietary fat. The addition of high concentrations of fat (e.g., 7.5 to 15% of the diet) has been shown to result in increased sow energy intake during lactation, and if consumed for approximately one week before farrowing, increased survival rates for pigs with light birthweights.

This article reports the effects of high fat diets on sow lactation performance, litter performance, and sow feed and energy intake. A subsequent article will discuss the effects of added dietary fat on energy intake, meal patterns, and blood hormones and metabolites. A specific objective of this research was to determine the effects of dietary fat on milk production and composition.

Procedures

Eighteen second parity crossbred sows[2] and 18 first parity sows (gilts) were used in two experiments. Sows and gilts received approximately 4 lb/d of a standard diet throughout gestation.

Sows and gilts were randomly allotted within room (six farrowing crates per room) to receive either a corn-soybean meal or a corn-soybean meal-10% tallow (fat) diet (Table 1). Diets were formulated to contain 1.01% lysine. Levels of other nutrients were included at 110% of the National Research Council requirements. Farrowing room temperature was maintained at 75°F, with continuous lighting. Sow and litter weights were recorded on a weekly basis from day 0 (within 24 h postfarrowing) to day 28. Feed intake was determined daily for 21 days. Litter size was standardized within 3 days after farrowing. Sow backfat thickness was measured at time of weighing using B-mode ultrasound. Milk production was estimated by weighing pigs before and after nursing for a period of 12 h using four sows on day 18 and four sows on day 19 of lactation. Immediately after estimation of milk production on day 18, milk samples were taken from all sows by manual expression from the gland. Milk samples were analyzed for their contents of dry matter, energy, protein, fat, and fatty acids. Data were analyzed as a randomized complete block experiment, with sows and gilts blocked by room and experiment.

Table 1. Composition of diets

Ingredient, %	Control	10% Tallow
Corn	66.15	55.00
Soybean meal (44% CP)	29.85	30.95
Limestone	.40	.30
Dicalcium phosphate	2.00	2.15
Salt	.50	.50
Vitamin premix	1.00	1.00
Trace mineral premix	.10	.10
Tallow	0	10.00
Formulated composition		
Protein, %	18.5	18.0
Metabolizable energy, Mcal/lb	1.46	1.67
Lysine, %	1.01	1.01
Calcium, %	.90	.90
Phosphorus, %	.75	.75

Results and Discussion

Analyzed values for the diets in each experiment were similar to predicted values (Tables 1 and 2). Values also exceeded the National Research Council requirements for all nutrients. Fatty acid compositions of experimental diets are provided in Table 3. Analyzed relative fatty acid percentages were greater for the 10% tallow diets with the exception that both linoleic and linolenic acid were higher in the control diets.

Feed intake was excellent (especially in the gilts) and there were no differences (P > .10) in feed intake due to diet for either sows or gilts. However, sows and gilts that consumed the high fat diet had slightly less feed intakes than the respective groups that consumed the control diet. No differences were detected for sow weight loss from farrowing to weaning in either experiment (Table 4). Sows that consumed the high fat diet gained .18 inches of

Table 2. Analyzed composition of diets

	Gilts		Sows	
Criteria	Control	10% Tallow	Control	10% Tallow
Dry matter, %	89.8	89.8	90.0	90.6
Protein, %	19.44	18.27	19.23	18.98
Lysine, %	1.01	.95	.93	.96
Gross energy, Mcal/lb	1.77	1.98	1.80	2.01
Fat, %	2.54	11.46	2.71	11.70
Calcium, %	.95	.89	.93	.90
Phosphorus, %	.76	.72	.77	.75

Table 3. Fatty acid composition of the diets[a]

	Gilts		Sows	
Fatty acid, %	Control	10% Tallow	Control	10% Tallow
Myristic (14:0)	0	.75	0	.71
Palmitic (16:0)	2.12	9.42	2.26	8.23
Palmitoleic (16:1)	0	.69	0	.69
Stearic (18:0)	.33	5.77	.36	4.61
Oleic (18:1)	2.60	11.19	2.68	10.88
Linoleic (18:2)	94.55	71.79	94.46	74.69
Linolenic (18:3)	.40	.21	.24	.18

[a] Data are presented as a percentage of the fat present in the sample.

Table 4. Summary of sow and pig performance and milk composition

	Gilts		Sows	
Criteria	Control	10% Tallow	Control	10% Tallow
Feed intake, lb/d	13.40	12.10	13.98	13.25
Energy intake, Mcal ME/d[a]	19.569	20.110	20.405	22.015
Lysine intake, g/d[a]	61.41	52.16	58.96	57.70
Sow weight change, lb				
d 0 to 21	-2.57	-6.65	-8.38	.37
d 0 to 28	-1.82	-11.01	-11.13	-5.82
Sow backfat change, in.				
d 0 to 21	-.12	-.08	-.08[b]	.18[c]
d 0 to 28	-.09	-.13	-.07	.06
Litter size at birth[d]	11.33	11.22	10.33	10.44
Litter size at d 21	9.63	9.25	9.56	9.78
Litter weight gain, lb[e]				
d 0 to 21	91.21	91.58	103.40	103.40
d 0 to 28	119.93	122.03	146.03	148.66
Milk yield, lb/d[e]	17.04	14.54	23.19	25.56
Milk composition				
Percent solids, %	19.36[b]	21.14[c]	19.58[b]	21.17[c]
Percent protein, %	5.32	5.16	5.30	5.10
Percent fat, %	7.66[b]	10.02[c]	7.77[b]	9.11[c]
Percent ash, %	.776	.818	.805	.837
Percent Ca, %[g]	.867	--	.805[b]	.952[c]
Percent P, %[g]	.733	.682	.705	.672
GE, kcal/lb	534.7[b]	622.4[c]	545.4[b]	617.3[c]

[a] Calculated value, not statistically analyzed.
[b,c] Within parity, treatments with unlike superscripts differ, $P < .05$.
[d] Number of pigs after crossfostering.
[e] Number of pigs nursed was used as a covariate in this analysis.
[f] Milk yield was determined on four animals per parity*treatment classification, using the weigh-suckle-weigh technique.
[g] Expressed as a percentage of solids.

Table 5. Fatty acid composition of milk[a]

	Gilts		Sows	
Fatty acid, %	Control	10% Tallow	Control	10% Tallow
Capric (10:0)	.22[b]	.01[c]	.13[b]	.01[c]
Lauric (12:0)	.20	.17	.21	.20
Myristic (14:0)	2.84[d]	2.57[e]	2.70[d]	2.39[e]
(14:1)	.26	.20	.22	.20
Palmitic (16:0)	18.25[b]	16.48[c]	17.63[b]	14.77[c]
Palmitoleic (16:1)	7.83[b]	4.91[c]	7.07[b]	4.77[c]
Stearic (18:0)	1.78[b]	2.61[c]	1.70[b]	2.08[c]
Oleic (18:1)	12.71[b]	18.45[c]	12.15[b]	16.48[c]
Linoleic (18:2)	55.47	54.32	57.94	58.92
Linolenic (18:3)	.46[b]	.27[c]	.22	.18

[a] Data are presented as a percentage of the fat present in the sample and do not reflect differences in percentage of the milk that is fat. Values in parentheses are chain length:saturated carbons.
[b,c] Treatments with unlike superscripts within parity differ $P < .05$.
[d,e] Treatments with unlike superscripts within parity differ $P \leq .10$.

backfat, whereas control sows lost .08 inches during the first 21 days of lactation ($P < .05$). However, no differences in backfat loss were detected on day 28 for sows or on day 21 or day 28 for gilts.

There were no differences ($P > .10$) in litter size at birth or weaning (Table 4). In addition, there were no differences ($P > .10$) in litter weight gain.

Milk yield determined on days 18 and 19 ranged from 14 to 26 lb per day (Table 4). Although not compared statistically, sows produced 6 to 10 lb per day more milk than gilts. The percentage of solids and fat in milk samples was greater ($P < .01$) in samples collected from sows and gilts that consumed the high fat diets, resulting in higher gross energy values for milk from sows fed high fat diets. There were also changes in the fatty acid composition of the milk due to diet (Table 5). There were reductions ($P < .05$) in the percentage of short-chain (C10 to C14) saturated fatty acids in the milk of sows that consumed the 10% tallow diet, with the exception of lauric acid (C12:0). The percentage of palmitic acid (C16:0) was less in the milk of sows that consumed high fat diets.

Conclusions

Lactating sows that consume diets high in fat tend to have a slight reduction in feed intake. This reduction in feed intake is observed even though energy intake increases during lactation, provided that sows are in a thermoneutral environment. This increase in energy intake results in an increase in milk fat percentage. When considered with the milk production estimates, this results in an increase in the amount of fat secreted in milk. Although there was an increase in the energy density of the diet that the pigs received, there were no differences in pig growth performance due to dietary treatment.

Sow weight loss during lactation was not affected by treatment, suggesting that sows in these studies consumed adequate amounts of energy to meet the demands of lactation (Table 4). This is

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also supported by the small amount of backfat lost during lactation, or in the case of the second parity sows fed the 10% tallow diet, an increase in backfat thickness during lactation.

Milk fatty acid composition was altered (Table 5). The increase in oleic (C18:1) and linoleic (C18:2) acid in the milk is a direct response to increased dietary intake of these fatty acids. However, the amount of palmitic acid (C16:0) in the milk decreased even though dietary palmitic acid content increased. In addition, there is a reduction in the percentages of short-chain fatty acids in the milk of sows fed the high tallow diet. This is also indicative of a reduction in fatty acid synthesis in the mammary glands of sows that consumed the high tallow diet. Therefore, more milk fat was derived from dietary origin in gilts or sows fed the 10% tallow diets. The ability to manipulate milk fatty acid content nutritionally is not surprising because the pig is thought to utilize fat proportionally to what is consumed. In addition, it has been shown that dietary fatty acid content has a significant effect on milk composition.

In summary, the addition of 10% tallow to lactation diets resulted in an alteration of milk fat and fatty acid profiles, without significantly altering sow and pig performance during the lactation period. The increase in milk energy observed in sows and gilts consuming the tallow diets has important research applications for investigating the effects of energy intake on litter performance and sow weight loss during lactation.

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[2]Two sows were removed from the experiment on d 19 due to a technical error. Data from these animals appear only in the initial litter information, and milk yield and composition data.