FATS AND PROTEINS RESEARCH FOUNDATION, INC.

Director's Digest

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UTILIZATION OF FAT AND FIBER IN SOW DIETS

F.P.R.F. sponsored a three year study at the University of Kentucky on the utilization of fat in swine diets. The investigators were Schoenherr, Stahly and Cromwell and the first of several papers, that will eventually be published, appeared recently in the "Journal of Animal Science", entitled "The Effects Of Dietary Fat Or Fiber Addition On Yield And Composition Of Milk From Sows Housed In A Warm Or Hot Environment."

INTRODUCTION

During the past 10 years greater emphasis has been placed on selecting sow lines based on their level of prolificacy in contrast to their "meat" characteristics. Because the type as well as level of productivity of these prolific sow lines differ from their predecessors, their nutrient needs also are different.

The prolificacy of the sow is measured in her ability to (1) wean large litters of acceptable weight and (2) rebreed rapidly and consistently. The survival and weight gain of the sow's offspring are strongly influenced by the energy reserves of the pig at birth and the amount of colostrum and milk that it receives. These parameters are dependent on the amount and type of nutrients available from the diet and endogenous body reserves of the sow. In turn, the adequacy of the nutrient reserves in the sow's body influences the subsequent conception rate and lifetime productivity of the sow.

Swine producers are constantly interested in new ideas or methods of feeding the lactating sow. The feeding program for the lactating sow needs to be designed to bring out the genetic potential of the sow under various environmental conditions. The two nutrients often discussed are the fat and/or fiber levels in lactating sow diets.

Results of past research indicate that productivity of the lactating sow decreased as temperature increased above her thermal comfort zone ($7^{\circ}$to 25°C). In a hot environment, deep body temperature and respiration rate increase, feed intake decreased and milk production is reduced. The researchers suggest that the reduced feed intake apparently is an attempt by the sow to lower the thermal heat load resulting from digestion and metabolism of nutrients.

The amount of heat produced in the body from the digestion and metabolism of dietary fat is less than produced from starch and fiber. Therefore, on this basis, calories may be used more efficiently for milk production when obtained from fat than when derived from starch or fiber.

OBJECTIVES

This study was conducted to evaluate the effects of environmental temperature (20°C vs 32°C) and dietary energy source (fiber, starch, fat) on the lactational performance (milk yield and composition) of sows and to determine whether the responses of sows to a dietary energy source are altered by the animal's thermal environment.

RESULTS

The upper critical temperature for sows is estimated to be 25°C. In this study, the 32°C environment represented a hot thermal environment for the lactating sows as reflected by elevated respiration rates and rectal temperatures. As lactation progressed, the sows appeared to acclimate to their hot environment. Exposure to the hot (32°C) environment decreased voluntary feed intake and metabolizable energy intake of sows by 35%. The greater lactation weight loss of sows in a hot vs warm environment corresponds with the decreased energy intake of sows in the hot environment.

The influence of dietary energy source on feed and energy intake was altered by the thermal environment as evidenced by a diet times temperature interaction. Feed intake of sows fed the fibrous diet was not increased relative to those fed the basal at 20°C, but it was increased by 1.13 Kg/d at 32°C. Increasing the energy density of the diet resulted in a linear increase in the voluntary energy intake of the sows in the warm (20°C), but not in the hot (32°C) environment.

Milk yield increased quadratically over the duration of the lactation, however, the magnitude of the increase was dependent on the thermal environment, resulting in a time temperature interaction.

Milk energy yields during the 22 day lactation reflected the changes in milk yield and composition that occurred over time. In the hot environment, increasing energy density of the diet resulted in a linear increase in milk energy yield over the duration of the lactation. Milk fat content declined linearly over time in the 32°C, but not in the 20°C, environment. In this study, a tendency was observed for a greater milk fat percentage in a warm vs hot environment. Increasing the energy density of the diet resulted in a quadratic increase of milk fat content in both environments. Specifically, dietary fat additions increased milk fat compared with the basal and fiber diets. This response presumably reflects the sow's preferential incorporation of long chain fatty acids directly into milk fat.

On an energetic basis, fat calories are estimated to be utilized less efficiently for maintenance functions than are starch calories. However, fat calories consumed in excess of the maintenance requirements are retained more efficiently in body tissues than those of starch in growing pigs. In our study, direct incorporation of dietary fat into milk fat would minimize the need to utilize the end products of carbohydrate digestion (glucose and acetate) for milk fat synthesis, thus sparing them for the synthesis of nonfat milk components (protein, lactose). In this instance, the amount of heat resulting from the metabolism of nutrients for synthesis of milk likely would be reduced. This would lower the burden of heat to dissipate and could result in a greater voluntary intake of ME and a higher level of milk production in heat-stressed sows, as was observed in this study.

The influence of the dietary energy source fed to the dam on average daily litter gain reflected differences in daily milk energy yield. In the hot environment, daily litter weight gain increased quadratically as dietary energy concentration increased in the initial 14 to 16 days of lactation. In the warm environment, daily litter gain was initially increased by fat and fiber additions to the sow's diet, but during the middle and late stages of lactation, gains were not enhanced.

Pigs nursing the fat-supplemented dams in the hot environment required more energy per unit of gain during the latter stages of the lactation than those nursing sows fed the high fiber or high starch diets. This response likely reflects the direct incorporation of milk fat into body fat of pigs nursing sows consuming high fat diets. By day 14 to 16 of lactation, pigs nursing sows fed high fat diets had gained more weight than those nursing sows fed starch or fiber diets. The increased body weight would increase the maintenance requirements of the pigs nursing sows fed added fat.

THE RESEARCHERS CONCLUDED THAT THESE RESULTS INDICATE THAT THE EFFECTS OF THERMAL HEAT STRESS ON SOW MILK ENERGY YIELD AND LITTER WEIGHT GAIN ARE AGGRAVATED BY DIETARY FIBER ADDITION AND MINIMIZED BY DIETARY FAT ADDITION.

HOW WILL THIS STUDY ASSIST YOU IN SELLING ANIMAL FAT TO FEED MANUFACTURERS AND SWINE PRODUCERS?

1. Most feed nutritionists will have seen this paper, but sometimes a small mill owner may miss the paper and the digest in feedstuffs. Talk to your small and medium size feed mills about high fat sow diets.

2. I would suggest making copies of the following three Tables and show them to your customers. This data reinforces our work since 1971 at several universities that demonstrated advantages of fat addition to late gestating and lactating sow diets.

3. To those of you who sell direct to swine producers, make sure the producer has the opportunity to analyze the pertinent results of this paper - newsletter, personal contact or nutrition bulletin.

4. The researchers used a 10.65% added fat in the high energy treatment. This is twice as high as the 5% we currently recommend. Similar results have been obtained at the 5% added level in previous trials and we continue to believe the most cost effective level is 4 1/2 - 5% added fat with the total fat level of diet being approximately 8%.

5. The object of this trial was not to study baby pig survivability but please observe Table 5. In the warm environment there was a 2.8 and 2.7% improvement in the weaned litter size versus initial litter size for the fat added diet when compared to the fiber and starch diets, respectively.

TABLE 1. COMPOSITION OF EXPERIMENTAL DIETS (%)

Item	Energy source		
	Fiber	Starch	Fat
Ground yellow corn	36.00	75.28	58.76
Dehulled soybean meal	12.13	20.10	25.19
Wheat bran[a]	48.49		
Choice white grease			10.65
Dicalcium phosphate	.35	2.70	3.39
Ground limestone	1.96	.77	.69
Iodized salt	.60	.63	.73
Trace mineral premix[b]	.06	.06	.07
Vitamin premix[c]	.11	.13	.14
Se mix[d]	.06	.06	.07
Choline mix[e]	.11	.13	.14
Neo-terramycin mix[f]	.11	.13	.14
Santoquin[g]	.02	.03	.03
Calculated composition, (as-fed basis)			
ME, kcal/kg	2,932	3,157	3,607
CP, %	16.7	16.1	17.1
NDF, %	22.0	9.2	8.2
Fat, %	3.3	2.8	13.0
Lysine, %	.75	.81	.93
Ca, %	.93	1.00	1.14
P, %	.75	.81	.93

[a]Wheat bran was ground through a 3.2-mm screen.

[b]Contained: 17.5% Fe, 15.0% Zn, 6.0% Mn, 1.75% Cu, .20% I.

[c]Supplied per kg of mix: vitamin A, 6,630,000 IU; vitamin D_3, 884,000 ICU; vitamin E, 22,100 IU; vitamin K as menadione 4.42 g; riboflavin, 8.84 g; pantothenic acid, 22.10 g; niacin, 44.2 g; vitamin B_{12}, 22.1 mg.

[d]Contained 200 mg Se per kg mix.

[e]Contained 500 g choline chloride per kg mix.

[f]Contained 110 mg of neomycin and 110 mg terramycin per kg mix.

[g]Contained 670 g of ethoxyquin per kg mix.

TABLE 4. EFFECT OF DIETARY ENERGY SOURCE AND ENVIRONMENTAL TEMPERATURE ON MILK YIELD AND MILK COMPOSITION OF LACTATING SOWS (MAIN EFFECTS)[a]

Criterion	Environmental temp., °C	Energy source			CV[b]
		Fiber	Starch	Fat	
Milk yield, kg/d					
	20°C	8.43	8.34	8.03	16.0
	32°C	7.33	7.47	7.62	
Milk energy yield, Mcal/d[cd]					
	20°C	8.54	7.96	9.16	17.5
	32°C	7.05	7.73	8.58	
Milk fat, %[ef]					
	20°C	5.57	4.98	6.90	22.5
	32°C	5.18	5.75	6.80	
Milk protein, %					
	20°C	4.8	5.1	4.9	16.1
	32°C	4.9	4.8	5.1	

[a]Represents the mean value of 10 sows per treatment group over a 22-d lactation.

[b]Coefficient of variation (100 $s/\bar{X}$).

[c]Temperature effect ($P < .12$).

[d]Linear effect of energy concentration at 32°C ($P < .08$).

[e]Temperature effect ($P < .15$).

[f]Linear effect of energy concentration at 32°C ($P < .05$).

TABLE 5. EFFECT OF DIETARY ENERGY SOURCE AND ENVIRONMENTAL TEMPERATURE ON GROWTH OF THE LITTER (MAIN EFFECTS)[a]

Criterion	Environmental temp., °C	Energy source			CV[b]
		Fiber	Starch	Fat	
Litter size					
Initial					
	20°C	10.0	10.0	9.7	9.6
	32°C	9.9	9.5	9.8	
Weaned					
	20°C	9.0	9.1	9.1	11.4
	32°C	9.2	9.0	9.3	
Average pig wt, kg					
Initial					
	20°C	1.31	1.32	1.39	7.2
	32°C	1.32	1.35	1.40	
Weaned[c]					
	20°C	5.85	5.40	5.99	22.5
	32°C	4.67	4.85	5.31	
Avg litter gain, kg/d[d]					
	20°C	1.97	1.88	1.98	16.8
	32°C	1.57	1.64	1.79	
Milk intake/litter gain, g/g[d]					
	20°C	4.53	4.56	4.23	38.6
	32°C	4.84	4.77	5.07	
Milk energy intake/litter gain, kcal/g[e]					
	20°C	4.63	4.87	5.07	87.6
	32°C	4.93	4.96	5.64	

[a]Represents the mean value of 20 sows per treatment group over a 22-d lactation.

[b]Coefficient of variation (100 $s/\bar{x}$).

[c]Temperature × energy concentration ($P < .05$).

[d]Temperature effect ($P < .05$).

[e]Energy concentration effect ($P < .11$).