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Reduction of corn particle size in lactation diets improves sow and litter performance

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REDUCTION OF CORN PARTICLE SIZE IN LACTATION DIETS IMPROVES SOW AND LITTER PERFORMANCE

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Summary

One hundred primiparous sows were used to determine the effects of corn particle size in lactation diets on sow and litter performance. Sows were fed corn-soybean meal-based diet with the corn ground to 1,200, 900, 600, or 400 μm . Particle size of corn had no influence on sow weight or backfat loss, or piglet survivability. However, feed intake and digestibilities of DM, N, and GE were increased (6, 5, 7, and 7%, respectively) as particle size was reduced from 1,200 to 400 μm . The combination of increased feed intake and improved digestibilities resulted in increased intake of digestible nutrients. DE intake was increased 14% (13.72 to 15.60 Mcal/d) as corn particle size was reduced from 1,200 to 400 μm . Intakes of digestible DM and N were also increased (11 and 14%, respectively). The increased intake of digestible nutrients resulted in a 11% increase in litter weight gain. Reducing particle size increased severity of keratinization and lesions in the esophageal region of the stomach although all treatment averages were low to moderate, and the change was not associated with reduced sow performance. In conclusion, our data indicate that nutrient intake of sows and litter weight gains can be increased by grinding corn for lactation diets to particle sizes of 600 to 400 μm .

(Key Words: Process, Particle Size, Sow, Lactation, Stomach Ulcers.)

Introduction

A primary objective in sow nutrition is to maximize feed intake during lactation, thus improving litter performance and preventing excessive sow weight loss. In the 1991 KSU Swine Day Report (page 56), Healy et al. reported that reducing particle size of corn and sorghums from 900 to 500 μm improved efficiency of gain by 6% in nursery pigs and 5% in broiler chicks. Those improvements suggested greater energy value of diets as particle size was reduced well below a more typical fineness of 800 to 1,000 μm . However, little is known about optimum processing of ingredients for sow diets. Can grinding corn to a small particle size (i.e., $\leq 600 \mu\text{m}$) improve energy status of lactating sows? Would benefits in energy status be overshadowed by problems with palatability and(or) stomach lesions? An experiment was designed to determine the effects of particle size of corn on sow and litter performance, intake of digestible energy and protein, and changes in stomach morphology of primiparous sows.

Procedures

On d 110 of gestation, 100 primiparous sows were randomly assigned to a corn-soybean meal-based diet (Table 1) with the corn ground to one of four particle sizes. The greatest particle size (1,200 μm) was obtained with a roller mill, and the finer particle sizes (900, 600, and 400 μm) were obtained with a hammermill by grinding

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through 3/8, 1/8, and 3/64 in. screens, respectively. Sows were weighed and scanned ultrasonically for backfat thickness at farrowing and d 21 of lactation to determine weight and backfat loss. Litter size was standardized by d 2 of lactation, and pig weights were recorded at farrowing and weaning. The sows were allowed ad libitum access to feed and water, and feed intake was recorded weekly. On d 18, fecal samples were collected from each sow, and subsequently dried, ground, and analyzed for Cr, DM, N, and GE. At weaning, 35 sows were slaughtered and their stomachs were scored for severity of ulcers and keratinization. The remaining sows were moved to an environmentally controlled gestation facility for estrus detection and breeding. Thus, response criteria included changes in sow weight and backfat during lactation, nutrient intake and digestibility, litter performance, and rebreeding data. All data were analyzed with sow as the experimental unit, and polynomial regression was used to characterize linear or quadratic effects of particle size reduction.

Table 1. Composition of Basal Diet^a

Ingredient	% of diet
Corn	74.37
Soybean meal	21.04
Lysine-HCl	.05
Monocalcium phosphate	2.18
Limestone	1.11
Salt	.50
Vitamins and minerals ^b	.50
Chromic oxide ^c	.25
Total	100.00

^aThe basal diet was formulated to .85% lysine, .9% Ca, .8% P, and 1.5 Mcal DE/lb.

^bKSU vitamin, mineral, and Se mixes with added biotin (200 g/ton) and folic acid (1.5 g/ton).

^cUsed as an indigestible marker.

Results and Discussion

Physical characteristics of the corn and diets are given in Table 2. Actual particle sizes of the corn were very close to the targeted particle sizes for all treatments. Particle sizes of the diets were larger than those of corn, probably because of the large particle size of other ingredients such as soybean meal. Variation in particle size (Sgw) decreased as the corn was milled to smaller mean particle sizes. Although the effects of particle size uniformity are not fully understood, another study (p. 126) indicated that increased particle uniformity results in increased nutrient digestibility.

Sow and litter performance is given in Table 3. Postfarrowing sow weight, weaning sow weight, postfarrowing backfat thickness, and weaning backfat thickness were similar for all treatments. Thus, sow weight and backfat losses during lactation were not affected by particle size of corn in the diet ($P > .30$). Daily feed intake increased ($P < .05$) as corn particle size was decreased from 1,200 to 400 μm (9.23 and 9.76 lb/d, respectively). This indicated that no palatability problems were caused by finely ground corn.

Equalizing litters ensured no difference ($P > .30$) in number or weight of pigs at initiation of the experiment. Also, number of pigs weaned and survivability were similar ($P > .30$) among treatments. However, a numerical increase occurred in litter weight at weaning (from 103.4 to 110.5 lb) as particle size was reduced. Consequently, litter weight gain was increased by 11% as particle size was reduced ($P < .05$) from 1,200 to 400 μm . Increased litter weight gain can probably be attributed not only to increased ADFI for sows fed the 400 μm treatment, but also to increased digestibility of DM, N, and GE ($P < .001$). Digestible energy value of the diet with 400 μm corn was 7% greater than DE of the diet with 1,200 μm corn. As a result, intake of DE was increased 14% (from 13.72 to 15.60 Mcal/d) as corn particle

size was reduced from 1,200 to 400 μm ($P < .001$). Sows fed the 400 μm diet also had 14% greater intake of digestible N than sows fed the 1,200 μm diet. With increased digestibilities of nutrients comes decreased excretion of nutrients. DM excretion was reduced 22% by reducing corn particle size from 1,200 to the 400 μm . In addition, N excretion from sows fed the 400 μm treatment was 31% lower than N excretions from sows fed the 1,200 μm treatment.

Although numerical variability occurred in percentage of the sows returning to estrus and days to estrus, no significant differences or trends were observed in the data. However, reducing particle size from 1,200 to 400

μm increased the severity of stomach lesions and stomach keratinization. No negative effects on animal health or well-being were noted in this experiment, but gastric ulceration in swine seems to be influenced greatly by genetics and stressful environmental conditions. Thus, interactions with those factors may affect the extent to which particle size of lactation diets can be reduced.

In conclusion, our results indicate that intake of digestible nutrients is increased and excretion of DM and N as feces is reduced as particle size of lactation diets is reduced. Furthermore, litter performance was enhanced by grinding lactation diets to a particle size of 600 to 400 μm .

Table 2. Characteristics of Corn and Diets

Item	Particle size treatment, μm			
	1,200	900	600	400
<u>Grain characteristics</u>				
Hammermill screen size, in.	— ^a	3/8	1/8	3/64
Mean particle size, μm	1,268	885	597	408
Variation in particle size, Sgw	2.17	2.29	1.87	1.45
<u>Diet characteristics</u>				
Mean particle size, μm	1,298	925	619	476
Variation in particle size, Sgw	2.16	2.24	1.95	1.76

^aThe 1,200 μm treatment was milled through a roller mill.

Table 3. Effects of Corn Particle Size on Sow and Litter Performance^a

Item	Particle size, μm				CV
	1,200	900	600	400	
Sow wt postfarrowing, lb	383.8	385.9	380.2	386.6	7.0
Sow wt at weaning, lb	360.7	362.7	364.3	368.4	7.8
Lactation wt loss, lb	23.1	23.2	15.9	18.2	129.4
Fat depth postfarrowing, in.	1.14	1.23	1.20	1.15	13.8
Fat depth at weaning, in.	1.02	1.09	1.08	1.04	15.4
Lactation fat loss, in.	.12	.13	.12	.11	78.7
ADFI, lb ^b	9.23	9.35	9.69	9.76	10.7
<u>Apparent nutrient digestibility, %</u>					
DM ^d	84.17	85.08	86.39	88.31	2.2
N ^d	83.22	85.27	86.85	89.06	2.9
GE ^d	83.80	85.30	87.08	89.97	2.4
Dig DM intake, lb/d ^d	6.98	7.16	7.54	7.77	10.3
Dig N intake, lb/d ^d	.204	.212	.224	.232	10.0
DE intake, Mcal/d ^d	13.72	14.13	14.95	15.60	10.3
DM excretion, lb/d ^d	1.34	1.26	1.20	1.04	20.7
N excretion, lb/d ^d	.042	.037	.034	.029	26.1
<u>Litter performance</u>					
Initial litter size	9.7	10.1	10.1	10.1	14.6
Pigs weaned	9.1	9.0	9.5	8.9	11.8
Survivability, %	93.4	90.9	93.9	89.7	9.5
Initial litter wt, lb	26.5	26.5	27.0	25.4	15.8
Final litter wt, lb	103.4	107.3	111.4	110.5	15.6
Litter wt gain, lb ^b	76.9	80.8	84.3	85.1	17.3
Return to estrus, % ^e	84.5	87.6	64.9	89.7	47.5
Days to estrus ^b	5.8	5.0	5.2	5.8	63.1
Stomach keratinization ^{cef}	.2	1.1	.5	1.7	29.2
Stomach lesions ^{cef}	.3	.4	1.7	.9	29.3

^a100 primiparous sows (21 to 29 sows/trt).

^{b,c,d}Linear effect of particle size reduction ($P < .05$, $P < .01$, and $P < .001$, respectively).

^eQuadratic effect of particle size reduction ($P < .01$).

^fScored on a scale of 0 to 3 (0 = normal and 3 = severe).

^gPercentage of sows returning to estrus within 30 d of weaning.

^hDays for sows returning to estrus within 30 d of weaning.