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Influence of Particle Size of Enogen Feed High Amylase and Conventional Yellow Dent Corn on Lactating Sow Performance¹

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Abstract

A total of 107 sows (Line; 241 DNA; Columbus, NE) were used in a study to evaluate the effect of Enogen Feed corn and conventional yellow dent corn ground to different particle sizes in lactation diets on sow and litter performance. On d 107 of gestation, sows were blocked by body weight and parity and allotted to 1 of 4 dietary treatments. Dietary treatments consisted of 2 corn sources (Enogen Feed corn and conventional yellow dent) and 2 ground corn particle sizes (600 and 900 microns). A common diet was fed to sows from time of arrival into the farrowing house until they farrowed. Once the sows farrowed, they were fed treatment diets until weaning. Litters were cross fostered across treatments until 48 h post farrowing to equalize litter size. Litters were weighed at birth, d 2, 7, 14, and weaning (d 21). Sow average daily feed intake (ADFI) was measured each time the litters were weighed. There was a tendency for a source × particle size interaction for weight change from farrow to wean ($P = 0.065$) with the sows fed the 900-micron high amylase corn diets losing less weight compared to sows fed the other diets. From farrow to weaning, there was a corn source × particle size interaction ($P = 0.048$) for ADFI, with sows fed the conventional corn ground to 900 microns having the lowest ADFI, and sows fed the conventional corn ground to 600 microns having the greatest intake. Litter average daily gain (ADG) and total litter gain tended to be greater ($P < 0.10$) for sows fed diets with 600-micron ground corn compared to the 900-micron ground corn. This is the first study, to our knowledge, that demonstrates the impact of Enogen Feed corn on sow and litter performance. Additional research conducted in a larger scale, commercial facility with more sows is warranted. In summary, there were few differences in sow or litter characteristics among those fed high amylose or conventional yellow dent corn. Sows fed 600-micron ground corn tended to have greater litter ADG and weaning weights, but individual pig weights were not different among treatments.

¹ Appreciation is expressed to Syngenta Seeds, LLC (Downers Grove, IL) for their partial financial support of this trial.

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Introduction

Enogen Feed corn is a variety developed by Syngenta Seeds (Downers Grove, IL). Although its primary use has been for the ethanol industry, there is potential application in livestock diets. Research with beef cattle has found that feeding high amylase corn improves feed efficiency in finishing cattle. A recent experiment conducted with finishing pigs showed that pigs fed high amylase corn tended to have greater ADG than pigs fed conventional yellow dent corn; however, feed efficiency was not influenced.⁵

The greater amylase concentration in Enogen Feed corn is expected to increase starch digestibility compared with yellow dent corn. Grinding corn to fine particle sizes has also been demonstrated to increase starch digestibility, resulting in improved feed efficiency. For lactating sows, lowering particle size increases milk production and litter weaning weights.⁶ Therefore, the objective of this study was to evaluate the effects of feeding Enogen Feed corn and conventional yellow dent corn ground to different particle sizes on lactating sow performance.

Procedures

The Kansas State University Institutional Animal Care and Use Committee approved the protocol used in this experiment. The trial was conducted at the Kansas State University Swine Teaching and Research Center in Manhattan, KS. All diets were manufactured at the Kansas State University O.H. Kruse Feed Technology Innovation Center. Enogen Feed corn was sourced from Syngenta Seeds, LLC, Downers Grove, IL.

For the experiment, 107 sows (Line 241; DNA, Columbus, NE) were used across 4 batch farrowing groups, with approximately 28 sows per group from July 2019 to November 2019. Sows were moved into the farrowing house on d 107 of gestation and allotted by BW and parity to 1 of 4 dietary treatments (Table 1) in a randomized incomplete block design. Dietary treatments consisted of 2 different corn sources (Enogen Feed corn or conventional yellow dent) and 2 corn particle sizes (600 or 900 microns; Table 1).

From d 107 of gestation until farrowing (approximately d 115 to 116), sows were offered up to 6 lb/d of common lactation feed. Postpartum, sows were allowed *ad libitum* access to their respective treatment diets by an electronic feeding system (Gestal Solo Feeders Jyga Technologies, Quebec, Canada). Sow feed intake was recorded by weighing the amount of feed placed in the feeder and the amount remaining every 7 d until weaning. Sow body weight was measured 24 h after farrowing and at weaning. Cross fostering occurred within dietary treatment until 48 h postpartum to equalize litter size. Litters were weighed on d 2, 7, 14, and at weaning.

⁵ P. Ochonski, F. Wu, E. Arkfeld, J. M. Lattimer, J. M. DeRouchey, S. S. Dritz, R. D. Goodband, J. C. Woodworth, and M. D. Tokach. 2019. Evaluation of High Amylase Corn on Growth Performance and Carcass Characteristics of Finishing Pigs. *Kansas Agricultural Experiment Station Research Reports*: Vol. 5: Iss. 8.

⁶ K.J. Wonda, J.D. Hancock, G. A. Kennedy, R.H. Hines, K.C. Behnke. 1995. Reducing particle size of corn in lactation diets from 1,200 to 400 micrometers improves sow and litter performance. *J. Anim. Sci.* 73: 421-426.

Both Enogen Feed corn and conventional yellow dent ground corn were sampled at every feed manufacturing event for chemical analysis. The samples were pooled and sent for analysis of dry matter, starch, crude protein, crude fat, neutral detergent fiber, neutral detergent fiber, Ca, and P (Ward Laboratories, Inc., Kearney, NE). Particle size analysis was conducted on ground corn samples (100 g) with or without the inclusion of a flow agent. The sample was placed in a RoTap machine and shaken for 15 minutes.

Data were analyzed using the lmer function from the lme4 package in R⁷ (version 3.5.2 (2018-12-20)) where sow was the experimental unit, dietary treatment was a fixed effect, and sow group and block were the random effects. Statistical models were fitted using RStudio⁷. All results were considered significant at $P \leq 0.05$, and marginally significant at $0.05 \leq P \leq 0.10$.

Results and Discussion

There were no major differences in the chemical analysis of conventional yellow dent and high amylase corn (Table 2). Particle size spread was met, but the 900-micron ground corn, for both the conventional and high amylase corn, tended to be greater than the 900-micron target at approximately 975 microns (Table 3). As expected, particle size was greater when analyzed without a flow agent than when a flow agent was used.

From farrow to wean, there was a tendency for a source $\times$ particle size interaction ($P = 0.065$) for sow body weight change. Sows fed the 900-micron high amylase corn diets had decreased body weight loss, compared to sows fed other treatments, which were similar. For sow ADFI from farrowing to weaning, there was source $\times$ particle size interaction ($P = 0.048$) with the sows fed the 900-micron conventional yellow dent corn having lower feed intake than the sows being fed the 600-micron conventional yellow dent corn, whereas, sows fed the 900-micron high amylase corn had greater feed intake compared to the sows fed the 600-micron high amylase corn diets.

There was no evidence of treatment differences ($P > 0.10$) for litter size, pig weight, and litter weight on d 2 and at weaning. There was a tendency for a particle size main effect ($P < 0.10$) for litter ADG and total litter gain, with sows fed corn ground to 600 microns having increased litter ADG and total litter gain compared to sows fed corn ground to 900 microns.

In summary, there were few differences in sow or litter performance due to corn variety. Interestingly, feeding finely ground corn (600 microns) did not affect ADFI during lactation compared with sows fed coarsely ground (900 microns) corn. Furthermore, litter ADG and overall litter gain tended to be greater in sows fed 600-micron corn compared to sows fed diets with corn ground to 900-microns.

⁷ R Core Team. 2018. R: A Language and Environment for Statistical Computing. R Foundation for Statistical Computing, Vienna, Austria. <https://www.R-project.org/>.

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Table 1. Composition of experimental diets

Ingredient, %	
Corn (Enogen Feed or conventional yellow dent) ¹	66.10
Soybean meal, 46.5% crude protein	30.00
Calcium carbonate	1.20
Monocalcium phosphate, 21% P	1.15
Sodium chloride	0.50
L-Lysine-HCl	0.18
DL-Methionine	0.08
L-Threonine	0.12
Trace mineral premix	0.15
Vitamin premix	0.25
Sow add pack	0.25
Ronozyme HiPhos 2700 ²	0.04
Total	100.00
Standardized ileal digestible (SID) amino acids, %	
Lysine	1.05
Isoleucine:lysine	69
Leucine:lysine	144
Methionine:lysine	33
Methionine and cysteine:lysine	60
Threonine:lysine	70
Tryptophan:lysine	20.2
Valine:lysine	75
Histidine:lysine	45
Total lysine, %	1.19
Net energy, kcal/lb	1,091
SID lysine:net energy, g/Mcal	4.37
Crude protein, %	20.1
Calcium, %	0.90
Phosphorus, %	0.63
STTD P with phytase, ³ %	0.49
Analyzed Ca:analyzed P	1.42

¹Enogen feed corn replaced conventional yellow dent corn on a lb:lb basis in the diets.

²HiPhos 2700 (DSM Nutritional Products, Parsippany, NJ).

³Standardized total tract digestible phosphorus.

Table 2. Chemical analysis of corn varieties, (as-fed basis)¹

Item, %	Conventional yellow dent corn	Enogen Feed corn ²
Dry matter	87.8	87.9
Starch	59.2	61.0
Crude protein	7.9	7.5
Crude fat	4.2	4.3
Acid detergent fiber	1.7	1.7
Neutral detergent fiber	6.9	6.8
Calcium	0.10	0.09
Phosphorus	0.23	0.21

¹Ground corn samples were collected at time of feed manufacturing and pooled for analysis (Ward Laboratories, Inc., Kearney, NE). Each value represents the mean of six analyses per corn source.

²High amylase corn (Enogen Feed, Syngenta Seeds, LLC, Downers Grove, IL).

Table 3. Particle size analysis of ground corn samples^{1,2}

Item	Conventional yellow dent		Enogen Feed corn ³	
	With flow agent ⁴	Without flow agent	With flow agent	Without flow agent
Particle size, μ ⁵				
600	602	732	618	728
900	974	1,116	975	1,126

¹Ground corn samples were collected the day of feed manufacturing.

²Ground corn samples were split down using a riffle splitter to obtain 100-g samples. Flow agent (0.5 g) was added to one of the 100-g samples and the sample was placed into the sieve stack and processed on the RoTap machine for 15 minutes. After the 15 minutes, the sieves were each individually weighed to determine the quantity of sample left on each sieve. Similar procedures were run on the other 100-g sample without the flow agent. Samples were run in duplicates for each individual sample for both with and without flow agent.

³High amylase corn (Enogen Feed, Syngenta Seeds, LLC, Downers Grove, IL).

⁴Powdered synthetic amorphous silicon dioxide.

⁵Kansas State University particle size analysis template was used to calculate the particle size of each sample.

Table 4. Effect of corn source × particle size on lactating sow performance¹

Item	Micron:	Conventional yellow dent		Enogen Feed corn ²		SEM	Probability, <i>P</i> <		
		600	900	600	900		Corn source × particle size	Particle size	Corn source
Number of sows, n		28	27	25	27				
Parity		1.89	1.93	1.92	1.93	---	---	---	---
Lactation length, d		18.7	18.7	18.7	18.8	0.24	0.672	0.937	0.634
Sow body weight, lb									
Entry		555.2	554.8	543.6	552.8	---	---	---	---
After farrowing		516.2	519.8	519.8	515.8	11.98	0.560	0.969	0.971
Weaning (d 21)		484.6	484.1	484.5	491.9	10.90	0.532	0.589	0.558
Change (farrow to wean)		-31.5	-35.5	-34.4	-23.5	4.79	0.065	0.395	0.261
Sow ADFI, lb ³									
Farrow to wean		10.95	9.60	10.35	10.89	0.46	0.048	0.390	0.460
Litter count, n									
d 2		13.1	13.0	13.0	13.3	0.28	0.447	0.807	0.773
Weaning (d 18)		12.5	12.3	12.7	12.6	0.28	0.913	0.504	0.407
Pig weight, lb									
d 2		3.35	3.39	3.38	3.31	0.10	0.576	0.881	0.822
Weaning (d 21)		11.61	11.18	11.73	11.36	0.35	0.930	0.228	0.647
Litter weight, lb									
d 2		46.0	46.9	45.4	46.5	1.22	0.908	0.397	0.681
Weaning (d 21)		144.8	138.6	148.8	143.2	4.75	0.747	0.173	0.301
Litter ADG, lb		6.13	5.64	6.41	5.95	0.25	0.937	0.061	0.238
Total litter gain, lb		98.8	91.6	103.1	96.6	4.26	0.749	0.069	0.185

¹A total of 107 sows (Line 241; DNA, Columbus, NE) were enrolled in a 21-d trial. There were 26 ± 2 sows per treatment across 4 batch farrow groups.

²High amylase corn (Enogen, Syngenta Seeds, LLC, Downers Grove, IL).

³The experimental diets were fed to sows from farrowing to weaning.

ADG = average daily gain. ADFI = average daily feed intake.