View metadata, citation and similar papers at core.ac.uk

brought to you by CORE

provided by Kansas State University

Kansas Agricultural Experiment Station Research Reports

Volume 0
Issue 10 *Swine Day (1968-2014)*

Article 720

1998

Effects of expander conditioning of corn- and sorghum-based diets on pellet quality and performance in finishing pigs and lactating sows

S L. Johnston

Robert H. Hines

G A. Kennedy

See next page for additional authors

Follow this and additional works at: https://newprairiepress.org/kaesrr

Part of the Other Animal Sciences Commons

Recommended Citation

Johnston, S L.; Hines, Robert H.; Kennedy, G A.; Maloney, C A.; Traylor, S L.; Sorrell, S P.; Hancock, Joe D.; and Behnke, Keith C. (1998) "Effects of expander conditioning of corn- and sorghum-based diets on pellet quality and performance in finishing pigs and lactating sows," *Kansas Agricultural Experiment Station Research Reports*: Vol. 0: Iss. 10. https://doi.org/10.4148/2378-5977.6560

This report is brought to you for free and open access by New Prairie Press. It has been accepted for inclusion in Kansas Agricultural Experiment Station Research Reports by an authorized administrator of New Prairie Press. Copyright 1998 Kansas State University Agricultural Experiment Station and Cooperative Extension Service. Contents of this publication may be freely reproduced for educational purposes. All other rights reserved. Brand names appearing in this publication are for product identification purposes only. No endorsement is intended, nor is criticism implied of similar products not mentioned. K-State Research and Extension is an equal opportunity provider and employer.

Effects of expander conditioning of corn- and sorghum-based diets on pellet quality and performance in finishing pigs and lactating sows

Abstract

Pellet durability index was similar for sorghum- vs com-based diets but was greater for expander-conditioned pellets than standard-conditioned pellets. For finishing pigs, ADG, F/G, and carcass measurenlents were similar for pigs fed sorghum vs com. Efficiency of gain was 6% better for pigs fed pelleted diets compared to those given meal diets but was sinlilar for pigs fed the conventional- and expander-conditioned diets. For sows, the com- and sorghumbased diets supported similar litter performance. Our data indicate that sorghum is an excellent feedstuff: comparable to corn, in diets for finishing pigs and sows.; Swine Day, Manhattan, KS, November 19, 1998

Keywords

Swine day, 1998; Kansas Agricultural Experiment Station contribution; no. 99-120-S; Report of progress (Kansas State University. Agricultural Experiment Station and Cooperative Extension Service); 819; Swine; Sorghum; Expander; Pellets; Sows; Finishing pigs

Creative Commons License

This work is licensed under a Creative Commons Attribution 4.0 License.

Authors

S L. Johnston, Robert H. Hines, G A. Kennedy, C A. Maloney, S L. Traylor, S P. Sorrell, Joe D. Hancock, and Keith C. Behnke

This research report is available in Kansas Agricultural Experiment Station Research Reports: https://newprairiepress.org/kaesrr/vol0/iss10/720

EFFECTS OF EXPANDER CONDITIONING OF CORN- AND SORGHUM-BASED DIETS ON PELLET QUALITY AND PERFORMANCE IN FINISHING PIGS AND LACTATING SOWS [1]

S. L. Johnston, J. D. Hancock, R. H. Hines, K. C. Behnke [2], G. A. Kennedy [3], C. A. Maloney, S. L. Traylor [2], and S. P. Sorrell

Summary

Pellet durability index was similar for sorghum- vs corn-based diets but was greater for expander-conditioned pellets than standard-conditioned pellets. For finishing pigs, ADG, F/G, and carcass measurements were similar for pigs fed sorghum vs corn. Efficiency of gain was 6% better for pigs fed pelleted diets compared to those given meal diets but was similar for pigs fed the conventional- and expander-conditioned diets. For sows, the corn- and sorghum-based diets supported similar litter performance. Our data indicate that sorghum is an excellent feedstuff, comparable to corn, in diets for finishing pigs and sows.

(Key Words: Sorghum, Expander, Pellets, Sows, Finishing Pigs.)

Introduction

Sorghum grain is a major crop in Kansas. Experiments suggest that relative feeding value for sorghum is at least 95 to 97% that of corn. However, the price of sorghum grain is generally 10% less than that of corn, making sorghum an economical alternative to corn for use in swine diets.

Nutrient digestibility of grain sorghum has been reported to respond more to particle size reduction than corn. However, little research has compared the two energy sources after thermal processing. Therefore, two experiments were designed to compare corn and sorghum as mash, standard-conditioned pellets, and expanded-conditioned pellets in diets for finishing pigs and lactating sows.

Procedures

A total of 72 (avg initial wt of 128 lb) crossbred barrows (PIC line 326 boars × C15 sows) was blocked by weight, sorted by ancestry, and allotted to pens in an environmentally controlled building. There were two pigs per pen and six pens per treatment. Treatments were: corn-based 1) meal, 2) standard-conditioned pellets, 3) expander-conditioned pellets; and sorghum-based 4) meal, 5) standard-conditioned pellets, and 6) expander-conditioned pellets. In the sorghum- based diets, sorghum replaced corn on a w:w basis (Table 1). The diets were formulated to .9% lysine, .65% Ca, and .55% P. To make up for any loss of potency, vitamins were added to the expanded diets at 1.25 times the amount of the basal diet.

The grain portion of the diets was ground using a hammermill equipped with a screen having 1/8 in. openings. The geometric mean particle sizes (d_{gw}) were 572 µm for the corn and 528 µm for the sorghum. The standard pellet diets were preconditioned at 175 °F using a California Pellet Mill® conditioner with a retention time of 10 sec. The expanded diets were preconditioned to a temperature of 175°F and expanded (Aman -

[1]We thank the Kansas Department of Agriculture and the Kansas Sorghum Commission for funding this project.

[2]Department of Grain Science and Industry.

[3]Department of Diagnostic Medicine/Pathobiology.

dus-Kahl) using a cone pressure of 200 psi. Both, standard- and expander-conditioned diets were pelletized in a California Pellet Mill® 1000 series "Master HD" model pellet mill. The die was 1.5 in. thick and had 3/16 in.-diameter holes. Electrical energy consumption was measured on the main drive motor for the expander and pellet mill using an amp-volt meter. Pellet durability index (PDI) was measured on the cooled pellets using standard procedures. Briefly, 500 g of cooled pellets were placed in a rotating metal box for 10 min. This procedure also was conducted with five ½ in. hexagonal nuts added to the pellets prior to tumbling.

Table 1. Compositions of Basal Diets for Finishing[a]

Ingredient, %	Corn	Sorghum
Corn	79.87	---
Sorghum	---	79.87
Soybean meal		
(46.5% CP)	15.74	15.74
Soy oil	1.00	1.00
Lysine-HCL	.29	.31
Threonine	.05	.12
DL-methionine	.05	.14
Tryptophan	.01	---
Monocalcium phosphate	1.07	1.07
Limestone	1.03	1.03
Salt	.30	.30
Vitamin premix[b]	.15	.15
Trace mineral premix	.10	.10
Corn starch	.21	.04
Antibiotic[c]	.13	.13
Total	100.00	100.00

[a]Diets were formulated to .9% lys, .65% Ca, and .55% P.
[b]Expanded diets were fortified (at the expense of corn starch) to 1.25 times the vitamins of the basal diet.
[c]Provided 50 mg of tylosin per lb of diet.

The 5-ft × 5-ft pens were equipped with a one-hole self-feeder and nipple waterer to allow ad libitum consumption of food and water. The pigs and feeders were weighed at initiation, d 32, and conclusion of the growth assay to allow calculation of ADG, ADFI, and F/G. Chromic oxide was added to the feed as an indigestible marker, and apparent digestibilities of DM and N were determined. The pigs were slaughtered on d 50 (average final BW of 243 lb). Hot carcass weights were taken to allow calculation of dressing percentage. Last rib fat depth was measured at the midline on both sides of the split carcass and averaged. Stomachs were collected and scored for keratinization: 0=normal; 1=mild keratinization; 2=moderate keratinization; and 3=severe keratinization; and for ulceration: 0=normal; 1=mild ulceration; 2=moderate ulceration; and 3=severe ulceration.

Growth data were analyzed using the GLM procedure of SAS. Contrasts were: 1) corn vs sorghum; 2) meal vs pellets; 3) standard-conditioned pellets vs expander-conditioned pellets; 4) corn vs sorghum × meal vs pellets; and 5) corn vs sorghum × standard-conditioned pellets vs expanded-conditioned pellets. Stomach morphology changes were analyzed using the Cochran-Mantel-Haenszel procedure of SAS.

For the sow experiment, 168 animals (PIC line C15 with 1 to 4 parities) were used in a 21-d lactation experiment. At d 110 of gestation, the sows were washed and moved into an environmentally controlled farrowing facility. Treatment began on d 110 to acclimate the sows to the feed prior to farrowing. Diets were corn- and sorghum-based (Table 2) and formulated to 1.0% lysine, .9% Ca, and .8% P. Treatments and feed processing were the same as for the finishing experiment, except the pellet mill die had an opening of 5/16 in.

The sows were scanned ultrasonically for backfat and weighed at farrowing and weaning. Litters size was equalized by d 2 of lactation. Piglet weights were recorded at farrowing and weaning.

The sows had ad libitum access to water and were fed four times daily to ensure ad libitum access to feed while minimizing feed wastage. The feed had .2% chromic oxide added, and grab samples of feces were collected on d 18 from each sow. Feed and feces were analyzed for DM, N, GE, and Cr, and apparent digestibilities were calculated. At weaning, sows were moved to an environmentally controlled breeding barn and serviced.

Table 2. Compositions of Basal Diets for Lactation[a]

Ingredient, %	Corn	Sorghum
Corn	64.54	—
Sorghum	—	64.54
Soybean meal (46.5% CP)	27.01	27.01
Corn gluten meal (60% CP)	2.50	2.50
Soy oil	1.00	1.00
Monocalcium phosphate	2.06	2.06
Limestone	1.14	1.14
Salt	.50	.50
Vitamin premix[b]	.25	.25
Sow premix[b]	.25	.25
Trace mineral premix	.15	.15
Lysine-HCL	—	.02
Corn starch	.30	.28
Antibiotic[c]	.10	.10
Chromic oxide[d]	.20	.20
Total	100.00	100.00

[a]Diets were formulated to 1.0% lys, .9% Ca, and .8% P.

[b]Expanded diets were fortified (at the expense of corn starch) to 125% of the vitamins of the basal diet.

[c]Supplied 50 mg chlortetracycline per lb of diet.

[d]Indigestible marker.

The data were analyzed using the GLM procedures of SAS with the same contrasts as used for the finishing experiment. Sow was the experimental unit.

Results and Discussion

The PDIs (Table 3) were 77.6% (average of standard and modified procedures) for the standard corn pellets and 78.0% for the standard sorghum pellets. The expanded corn pellets had a PDI of 96.6%, whereas the PDI for the expanded sorghum pellets was 91.3%.

These data suggest that the conditions used with standard steam processing were effective for both corn- and sorghum-based diets. However, with expander processing, the PDIs were greater for corn-based diets than for the sorghum-based diets. Thus, either PDIs in sorghum-based diets simply will not respond as much to expander processing, or the expander conditions were optimized for the corn-based but not the sorghum-based diets. No differences (P>.15) in ADG, ADFI, F/G, or digestibility of DM occurred among pigs fed the corn and sorghum diets (Table 4). However, DE and digestibilities of N were greater in corn- vs sorghum-based diets (P<.001). Pelleting improved F/G by 6% (P<.04) and DE and apparent digestibilities of DM, N, and GE (P<.001). Expander conditioning increased (P<.003) apparent digestibilities of DM and GE but did not improve ADG or F/G compared to standard steam conditioning (P>.12). Treatment had no effect on dressing percentage (P>.12) or last rib fat depth (P>.15).

Pigs fed grain sorghum had greater keratinization (P<.04) but no greater severity of ulcers (P>.5) compared to pigs fed corn (Table 5). Pelleting the diets increased both keratinization and ulceration (P<.002), but no difference occurred between the standard pellets and the expander pellets (P>.4).

For the sow experiment, PDIs (Table 6) were 60.8% (average of standard and modified procedures) for the standard corn pellets and 66.0% for the standard sorghum pellets. The expanded corn pellets had a PDI of 90.2%, whereas the PDI for the expanded sorghum pellets was 86.3%. Thus, with the finishing diet used in Exp. 1, the corn-based diet responded more to expander processing than the sorghum-based diet.

Weight loss (Table 7) was not different (P>.15) for sows fed the corn- and sorghum-based diets. Also, no differences in the number of pigs weaned, survivability of the pigs, digestibility of DM, or digestibility of GE occurred for sows fed the corn- vs sorghum-based diets (P>.15). However, it is noteworthy that final litter weights for sows fed the sorghum-based diet in meal form were numerically 3% lower than those of the sows fed the corn-based meal treatment. This difference disappeared with pelleting.

Pelleting improved apparent digestibilities of DM, N, and GE (P<.001), and digestibilities of N and GE in the sorghum-based diets increased more with pelleting than digestibilities in the corn-based diet (corn vs sorghum × mash vs pellets interaction, P<.04). Expanding prior to pelleting improved (P<.05) DE and digestibility of GE of the diet and tended (P<.08) to improve apparent digestibility of N. Finally, the percentage of sows that returned to estrus and the length of time to return were similar for all treatments (P>.2).

In conclusion, few differences occurred in performance data among finishing pigs and sows fed corn versus sorghum. This is probably because of advances in grain sorghum hybrids and response of grain sorghum to advanced feed processing (e.g., grinding to less than 600 μm). Pelleting improved F/G in the finishing experiment by 6% for both sorghum- and corn-based diets. Thus sorghum, when properly processed, can be used to decrease diet costs, while maintaining a high level of animal performance.

Table 3. Effects of Standard and Expander Conditionings on Corn- and Sorghum-Based Finishing Diets

	Corn		Sorghum	
Item	Standard pellets	Expanded pellets	Standard pellets	Expanded pellets
Pellet production rate, lb/h	3,108	2,504	3,186	2,518
Electrical energy consumption, kWh/t				
Pellet mill				
Gross	8.6	8.7	9.1	10.4
Specific	3.3	2.1	3.8	3.8
Expander				
Gross	---	32.1	---	27.2
Specific	---	12.6	---	7.6
Pellet durability index, %				
Standard[a]	83.0	96.6	83.7	93.4
Modified[b]	72.2	96.2	72.3	89.2
Starch damage, %[c]	35.1	50.0	32.8	46.8

[a]Am. Soc. Agric. Engin. method (1987).
[b]Am. Soc. Agric. Engin. method (1987) with the addition of five (½ in.) hexagonal nuts prior to tumbling.
[c]Mash values were 29.8 for corn- and 24.2 for sorghum-based diets and estimates of total starch damage resulting from gelatinization and shear.

Table 4. Effects of Corn- and Sorghum-Based Diets Fed in Three Forms on Performance of Finishing Pigs[a]

	Corn			Sorghum				Contrasts[b]				
Item	Meal	Standard pellets	Expanded pellets	Meal	Standard pellets	Expanded pellets	SE	1	2	3	4	5
Overall (d 0 to 50)												
ADG, lb	2.31	2.39	2.37	2.45	2.30	2.44	.07	---[c]	---	---	.15	---
ADFI, lb	6.87	6.96	6.47	7.31	6.55	6.74	.16	---	.005	---	.08	.04
F/G	2.97	2.91	2.73	2.98	2.85	2.76	.08	---	.04	.12	---	---
Apparent nutrient digestibility, %												
DM	90.5	91.4	92.4	90.8	91.8	92.9	.3	---	.001	.003	---	---
N	86.9	89.0	90.1	84.3	86.7	87.8	.8	.001	.001	---	---	---
GE	90.5	92.2	93.3	90.5	92.3	93.4	.3	---	.001	.003	---	---
DE of the diet, kcal/lb	1,672	1,705	1,724	1,647	1,678	1,698	6	.001	.001	.003	---	---
Dressing percentage	73.5	73.7	73.0	72.5	73.4	72.6	.5	---	---	.12	---	---
LRFD, in	1.14	1.15	1.12	1.16	1.11	1.15	.05	---	---	---	---	---

[a]A total of 71pigs (avg initial wt of 128 lb) with two pigs/pen and six pens/treatment.

[b]Contrasts were: 1) corn vs sorghum; 2) meal vs pellets; 3) standard pellets vs expanded pellets; 4) corn vs sorghum × mash vs pellets; and 5) corn vs sorghum × standard pellets vs expanded pellets.

[c]Dashes indicate P>.15.

Table 5. Effects of Corn- and Sorghum-Based Diets Fed in Three Forms on Stomach Lesions in Finishing Pigs

	Corn			Sorghum				Contrasts[a]				
Item	Meal	Standard pellets	Expanded pellets	Meal	Standard pellets	Expanded pellets	SE	1	2	3	4	5
Stomach keratinization												
Total observations	12	11	12	12	11	12						
Normal	7	4	1	5	0	2						
Mild	4	4	7	6	2	5						
Moderate	1	2	4	1	8	4						
Severe	0	1	0	0	1	1						
Mean score	.5	1.0	1.3	.7	1.9	1.3	.3	.04	.001	---[b]	---	.08
Stomach ulcerations												
Total observation	12	12	12	12	11	12						
Normal	12	8	6	12	7	8						
Mild	0	0	5	0	2	1						
Moderate	0	0	1	0	2	2						
Severe	0	4	0	0	0	1						
Mean score	0	1.0	.6	0	.6	.7	.3	---	.002	---	---	---

[a]Contrasts were: 1) corn vs sorghum; 2) meal vs pellets; 3) standard pellets vs expanded pellets; 4) corn vs sorghum × mash vs pellets; and 5) corn vs sorghum × standard pellets vs expanded pellets.

[b]Dashes indicate P>.15.

Table 6. Effects of Standard and Expander Conditioning on Corn- and Sorghum-Based Lactation Diets

	Corn		Sorghum	
Item	Standard pellets	Expanded pellets	Standard pellets	Expanded Pellets
Pellet production rate, lb/h	4,098	2,427	2,363	2,549
Electrical energy consumption, kWh/t				
Pellet mill				
Gross	6.5	8.3	6.9	8.7
Specific	2.7	2.0	3.0	2.7
Expander				
Gross	---	29.0	---	28.0
Specific	---	8.4	---	8.3
Pellet durability index, %				
Standard[a]	65.7	91.4	71.7	90.4
Modified[b]	55.8	89.0	60.2	88.8
Starch damage, %[c]	35.4	45.8	34.0	47.5

[a]Am. Soc. Agric. Engin. method (1987).
[b]Am. Sco. Agric. Engin. method (1987) with the addition of five (1/2 in.) hexagonal nuts prior to tumbling.
[c]Mash values were 25.5 for the corn- and 27.1 for sorghum-based diets and the values are estimates of total starch damage resulting from gelatinization and shear.

Table 7. Effects of Corn and Sorghum-Based Lactation Diets Fed in Three Forms on Sow and Litter Performance[a]

	Corn			Sorghum				Contrasts[b]				
Item	Meal	Standard pellet	Expanded pellet	Meal	Standard pellet	Expanded pellet	SE	1	2	3	4	5
Sow BW at farrowing, lb	435.4	427.0	433.0	438.3	425.5	437.6	13.9	----	----	----	----	----
Sow body weight change, lb	5.8	16.5	3.5	9.4	11.0	16.3	6.6	----	.13	----	----	.005
ADFI, lb	13.0	13.4	13.2	13.3	13.5	14.0	.1	.08	----	----	----	----
Litter performance												
Initial pigs/litter	11.4	11.6	11.5	11.6	11.5	11.6	.4	----	----	----	----	----
Pigs weaned/litter	10.6	10.5	10.5	10.5	10.6	10.6	.4	----	----	----	----	----
Survivability, %	93.0	90.5	91.3	90.5	92.2	91.4	.1	----	----	----	----	----
Litter weight, lb												
Initial weight	37.0	37.9	37.9	37.5	37.7	38.4	2.2	----	----	----	----	----
Weaning	134.0	128.1	135.1	131.9	135.4	138.3	7.9	----	----	----	----	----
Weight gain	97.0	90.2	97.2	94.4	97.7	99.9	7.3	----	----	----	----	----
Return to estrus, %[c]	76.9	82.8	76.9	87.1	85.7	71.4	16.0	----	----	----	----	----
Days to estrus[d]	5.0	5.1	4.5	4.5	5.3	4.9	.1	----	----	----	----	----
Apparent nutrient digestibility, %												
DM	85.5	87.1	87.7	85.4	87.0	87.2	.4	----	.001	----	----	----
N	89.1	89.2	91.0	84.9	87.7	88.1	.8	.001	.001	.08	.04	----
GE	88.3	88.9	90.6	86.5	89.6	90.1	.5	----	.001	.05	.008	.13
DE of the diet, kcal/lb	1,568	1,574	1,608	1,524	1,583	1,587	9	.004	.001	.05	.008	.13

[a]One hundred sixty-eight sows with 1 to 4 parities.

[b]Contrasts were: 1) corn vs sorghum; 2) meal vs pellets; 3) standard pellets vs expanded pellets; 4) corn vs sorghum × mash vs pellets; and 5) corn vs sorghum × standard pellets vs expanded pellets.

[c]Percentage of sows returning to estrus within 30 d of weaning.

[d]For sows returning to estrus within 30 d of weaning.