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Effects of sorghum genotype and processing method on production characteristics and growth performance of nursery pigs

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EFFECTS OF SORGHUM GENOTYPE AND PROCESSING METHOD ON PRODUCTION CHARACTERISTICS AND GROWTH PERFORMANCE OF NURSERY PIGS

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Summary

Three sorghum varieties that varied in starch composition were fed to Phase II and Phase III pigs to determine if feeding sorghum high in waxiness provided a benefit. In addition, each variety was fed as a meal, standard pellet, and an expanded pellet. As level of waxiness increased, pellet durability index increased numerically and the amount of fines produced decreased numerically. In addition, thermal processing of the diets increased the feeding value. Sorghum genotype had little effect on pig performance.

(Key Words: Sorghum, Waxy Sorghum, Expanded Pellet, Nursery Pigs.)

Introduction

Sorghum (*Sorghum bicolor*) is a grain that is grown extensively in the Great Plains of the United States. Traditionally, it has been looked upon as a replacement for corn in animal diets. However, it is viewed as having a feeding value of 95% when compared to corn. Breeders have been developing hybrids in an attempt to improve feeding value. Some of these hybrids have been bred to change the starch composition. Currently, KSU is evaluating two hybrids that vary in starch composition from a commercial hybrid, which has a starch composition of approximately 25% amylopectin and approximately 75% amylose. One hybrid, termed heterowaxy, has a starch composition of approximately 50% amylose and 50% amylopectin. The other hybrid, termed waxy, has a starch composition of more than 75% amylopectin. The question was whether the heterowaxy or waxy hybrid would outperform the normal hybrid when fed to nursery pigs and when processed using pelleting and expanding. Therefore, we designed an experiment to evaluate the two experimental sorghum varieties against a commercial sorghum hybrid.

Procedures

A total of 216 weanling pigs, averaging 15 days and 12 lb initial wt, was used in a 28-d growth assay. Pigs were blocked by weight and allotted randomly to treatment by sex and ancestry. We used four pens/treatment and six pigs/pen. Three sorghum hybrids were obtained from NC+ Hybrids, Colwich, KS. They included: 1) normal starch type, 2) heterowaxy starch type, and 3) waxy starch type. The processing methods included: 1) meal, 2) standard pellet, and 3) expanded pellet. Diets (Table 1) were formulated to 1.50% lysine for Phase II (d 7 to 21) and 1.30% lysine for Phase III (d 21 to 35). The pigs were fed a common pelleted Phase I diet from d 0 to 7 to adjust them to feed. Pigs were housed in 3.5 ft × 5 ft pens. Each pen had a self-feeder and nipple waterer to allow ad libitum consumption of feed and water. Feeders were adjusted daily to minimize feed wastage. Pigs and feeders were weighed at the end of each phase for the determination of average daily gain (ADG), average daily feed intake (ADFI), and feed-to-gain ratio (F/G).

Diets were manufactured at the KSU Feed Processing Center. An Amandus Kahl

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Table 1. Diet Composition

	Percent	
Item	Phase II[a]	Phase III[b]
Sorghum	77.53	83.51
Soybean meal	9.71	7.33
Soybean oil	3.00	3.00
Monocalcium phosphate	2.21	2.26
Spray dried animal plasma	2.00	-
Fishmeal	2.00	-
Lysine-HCl	1.04	1.13
Antibiotic[c]	1.00	1.00
Limestone	.48	.62
Salt	.30	.35
Vitamin premix	.25	.25
DL-Methionine	.20	.19
Trace mineral premix	.15	.15
L-Threonine	.14	.21
Total	100.00	100.00

[a]Diets for d 7 to 21 were formulated to 1.50% lysine, .85% Ca, and .75% P.
[b]Diets for d 21 to 35 were formulated to 1.30% lysine, .80% Ca, and .70% P.
[c]Supplied 150 g/ton apramycin. Diets for d 7 to 21 and 50 g/ton carbodox from d 21 to 35 supplied.

3.16OE 15.2 annular gap expander (100 hp) was used to process the expanded diets. After expanding, the diets were pelleted using a CPM Master Model HD pellet mill (30 hp). The standard pellet diets were manufactured using the same pellet mill. The pellet mill was equipped with a 3/16 in. × 1 1/4 in. die for both processes. Diets were conditioned to 170°F prior to expanding and/or pelleting. Cone pressure and production rate were held constant. Data were collected to allow for the determination of production rate, total and specific energy consumption, percent fines, and pellet durability index. Specific energy is the difference between full load and empty load current.

Results and Discussion

The amount of total and specific energy required to process the standard pellets increased as waxiness increased (Table 2). This response was expected, because waxy sorghums have a high percentage of branched starch chains, which require more energy to process. However, high shear conditioning (expanded pellets) decreased the amount of specific energy needed to process the diets as waxiness increased. This suggests that waxy sorghums respond more favorably to severe thermal processing than to standard pelleting. Fines returned is a good general indicator of pellet quality. As waxiness increased, fines produced decreased. This held true for both standard pelleting and high shear conditioning. Pellet durability index (PDI) is an even better indicator of pellet quality. As waxiness increased, so did pellet quality. In addition, each sorghum genotype increased in PDI as processing method became more severe. Overall, as waxiness increased, we saw increases in pellet quality and a trend for a decrease in the amount of specific energy required to process the diet.

Overall, no negative effect on growth performance of Phase II pigs occurred as waxiness increased. In fact, as waxiness increased, ADFI increased numerically. However, as thermal processing was applied to the diet, ADFI decreased ($P<.001$). This is consistent with the results published by Traylor et al. (1996 KSU Swine Day Report of Progress), who found that thermal processing generally will decrease ADFI. No real differences in ADG occurred as waxiness increased or thermal processing became more severe. However, we observed a tendency for a linear decrease in F/G as both waxiness and thermal processing increased ($P<.10$). Pelleting the diet improved F/G in the normal genotype ($P<.05$), and as waxiness increased, high shear conditioning had a tendency to improve F/G ($P<.10$).

For Phase III pigs, we saw a quadratic effect for ADFI ($P<.02$) as waxiness increased. In addition, ADFI decreased as severity of thermal processing increased (meal vs. standard pellet, P<.001), (standard pellet vs. expanded pellet, P<.02). When ADG was evaluated, we saw a quadratic trend as waxiness increased (P<.06). In addition, ADG increased (P<.02) as severity of thermal processing increased. A linear improvement occurred in F/G as waxiness and severity of thermal processing increased (genotype × standard pellet vs. expanded pellet, P<.001).

Although animal performance was not increased dramatically by increasing waxiness of the sorghum, we demonstrated that thermal processing will improve both the processing characteristics and feeding value of waxy sorghum varieties, thereby making them a possibility for feeding of livestock. However, the decision to plant these varieties should be based not only on the data presented here, but also on production yields in the field.

Table 2. Production Characteristics for Phase II and Phase III Diets

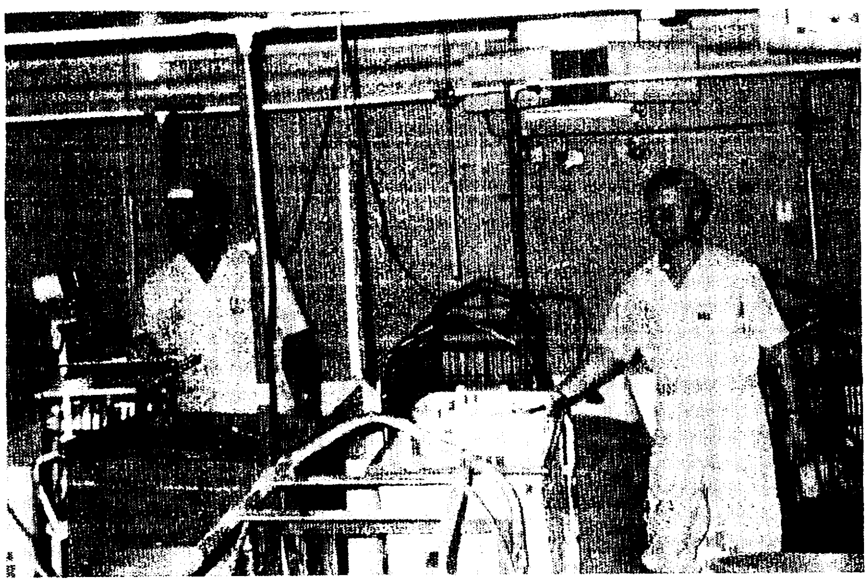
	Normal		Heterowaxy		Waxy	
Item	Pellet	Expanded Pellet	Pellet	Expanded Pellet	Pellet	Expanded Pellet
Phase II						
Production rate, lbs/hr	2,711	1,945	2,683	2,617	2,522	1,823
Pellet mill energy consumption, kWh/t						
Total	8.44	10.91	8.86	8.18	9.37	10.74
Specific[a]	3.03	3.49	3.38	2.66	3.53	2.85
Expander energy consumption, kWh/t						
Total	-	32.85	-	23.17	-	31.70
Specific[a]	-	7.85	-	4.63	-	5.17
Pellet durability index, %						
Standard[b]	80.8	94.7	84.9	95.2	90.3	97.2
Modified[c]	67.0	92.3	74.4	92.9	84.6	96.6
Fines, %	11.7	5.1	8.9	3.9	6.7	4.4
Phase III						
Production rate, lbs/hr	3,132	2,021	3,265	2,035	3,089	1,934
Pellet mill energy consumption, kWh/t						
Total	8.23	9.83	8.53	10.01	8.99	9.89
Specific	3.62	2.64	4.09	2.85	4.28	2.33
Expander energy consumption, kWh/t						
Total	-	31.52	-	32.18	-	30.05
Specific	-	7.83	-	8.56	-	5.15
Pellet durability index, %						
Standard	73.3	94.9	79.9	96.1	87.8	97.2
Modified	58.1	92.7	67.7	93.7	83.9	96.7
Fines, %	11.7	6.4	10.0	4.7	6.9	4.2

[a]Expressed as the difference between full load and empty load current.
[b]Am. Society of Ag. Eng. S269.3.
[c]Am. Society of Ag. Eng. S269.3 with the addition of five ½ in. hexagonal nuts.

Table 3. Growth Performance of Pigs Fed Three Sorghum Genotypes

	Normal			Heterowaxy			Waxy		
Item	Meal	Pellet	Expanded Pellet	Meal	Pellet	Expanded Pellet	Meal	Pellet	Expanded Pellet
Phase II									
ADG, lb	.66	.72	.64	.68	.63	.64	.70	.68	.67
ADFI, lb[ab]	1.18	1.09	.98	1.19	1.12	.99	1.16	1.16	1.03
F/G[cde]	1.78	1.52	1.54	1.75	1.78	1.56	1.64	1.69	1.54
Phase III									
ADG, lb[fh]	.73	.75	.79	.73	.67	.74	.78	.70	.77
ADFI, lb[afg]	1.28	1.16	.93	1.10	1.01	.84	1.33	1.12	.97
F/G[ij]	1.52	1.52	1.16	1.49	1.49	1.12	1.64	1.59	1.23

[a]Meal × standard pellet ($P<.001$).
[b]Standard pellet × expanded pellet ($P<.001$).
[c]Meal × standard pellet ($P<.05$).
[d]Sorghum genotype × meal vs. standard pellet (linear, $P<.10$).
[e]Standard pellet × expanded pellet ($P<.10$).
[f]Standard pellet × expanded pellet ($P<.02$).
[g]Normal × heterowaxy vs. waxy (quadratic, $P<.02$).
[h]Normal × heterowaxy vs. waxy (quadratic, $P<.06$).
[i]Meal × standard pellet ($P<.01$).
[j]Genotype × standard pellet vs. expanded pellet ($P<.001$).



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