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PERFORMANCE OF YOUNG PIGS FED SORGHUM GRAIN DAMAGED BY LESSER GRAIN BORER OR FUNGAL INVASION

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Summary

Nutritional quality and physical conditions were used to evaluate grain sorghum damaged by either the lesser grain borer Rhyzopertha dominica (F.) or by nontoxin-producing fungi. Experimental treatments were: 1) control (14.0% moisture), 2) lesser grain borer (LGB) (14% moisture with initial infestation of 4.5 adults/lb of grain) and 3) fungal (Fungal) (15.5% moisture). Control grain was used to formulate a 17% crude protein diet. The remaining dietary treatments were formulated by replacing the control grain with the two damaged grains on a weight basis. Forty-five female Yorkshire and 12 crossbred male pigs, with an average initial weight of 22 lb were used in growth (35 days) and metabolism studies, respectively. Results indicated similar average daily gains and digestibilities for the two types of damaged grain when compared with the control. Pigs fed the diet containing the insect-damaged grain showed an 18% poorer feed conversion rate and a 21% higher average daily feed consumption during the 14 to 35-day interval. Throughout the feeding study, the diet containing the fungal-damaged grain sorghum resulted in feed conversion and average daily feed consumption similar to pigs fed the control diet.

Introduction

Nutritional quality of sorghum grain damaged during storage by either insects or fungal invasion has not been well documented. The advent of combine harvesting has resulted in grain sometimes going into storage at higher than acceptable moisture levels, increasing the the possibility of losses due to molds and/or insects. It has been reported that moisture contents between 14 and 17% in combination with relative humidities of 70 to 80% are required for growth of non-toxin producing fungi. Insects, on the other hand, will infest grains at moisture levels below 14%. In this study, the physical characteristics and chemical composition of grain sorghum infested with either lesser grain borer, Rhyzopertha dominica (F), or nontoxin-producing fungi were investigated. Swine growth and metabolism trials were used to determine the nutritional value of damaged grain sorghum.

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Procedures

General. Freshly harvested grain sorghum from a single source was mixed and subdivided into three lots. Each lot was assigned randomly to one of three experimental treatments. The control treatment was grain sorghum with an initial moisture content of 14.0% (Control). The lesser grain borer treatment (LGB) had an initial moisture content of 14.0% and was infested at a rate of 4.5 adults/lb grain. The grain sorghum for the nontoxin-producing fungal treatment (Fungal) was conditioned to 15.0% moisture. No inoculation was necessary as adequate spores were present in the grain mass. The ecological succession under the above condition is from Aspergillus glaucus to Aspergillus candidus.

The three grain sorghum lots were stored in 55 gallon cylindrical drums, the lids of which each had a central 3.0 in hole covered with 80 mesh wire to prevent cross contamination yet allow air movement. Drums were stored for 120 days at approximately 77° F. After the storage period, the grain was sampled using a grain probe to to determine the physical conditions and chemical composition. Physical conditions measured for the LGB-damaged and control grains were whole seed moisture (ASAE, 1978), test weight and fine material (USDA, 1970), percent kernels with emergence holes (by visual examination), and number of adult insects per 100 g of grain (sieving and counting). For the fungal treatment, the physical conditions measured were whole seed moisture, test weight, germination percentage, percent invaded kernels, and dominant storage organism present. Percentage of invaded kernels and dominant storage organism was determined by incubating 50 surface-disinfected seeds on malt agar supplemented with 4% NaCl and 200 ppm Tergital NPX and identifying viable fungi. Official methods were used to determine the moisture, crude protein, crude fat, crude fiber, nitrogen free extract, and ash content.

Control grain was used to formulate a fortified soybean meal-sorghum grain diet (17% crude protein). Control grain then was replaced in the formula, on a weight for weight basis, with the two damaged grains (table 1).

Growth Trial. Forty-five female Yorkshire pigs with average initial weight of 22 lb were allotted randomly to nine pens (three pens per treatment, five pigs per pen) by weight and litter. Pigs were housed in an environmentally controlled building on woven wire floors. Feed and water were offered ad libitum. Average daily gain (ADG), feed conversion (F/G) and average daily feed consumption (ADFC) were determined at 14 and 35 days.

Results

General. Changes in the physical conditions of LGB-infested grain sorghum after 120 days of storage are shown in table 2. Whole seed moisture content of LGB-damaged grain was slightly higher than that of the control (14.5% vs 14.0%). Damaged grain showed a decrease in test weight from 54.3 lb/bu to 50.6 lb/bu and an increase in fine material (5% vs 0.3%). Percentage of insect-damaged kernels and the number of adult insects per 100 g of grain were 0% and 10% for the control and 25% and 35% for the insect-infested grain, respectively.

Physical condition of fungal-invaded grain is given in table 3. This treatment showed a final whole seed moisture of 16.5% and test weight of 51.5 lb/bu. Percentage germination of the fungal-damaged grain was substantially lower than that of the control (10% vs 98%). Percentage of kernels invaded by storage fungi was 0% for the control and 80% for the fungal-damaged grain. The dominate storage organism present in this treatment was A. candidus.

The chemical composition of the three grain sorghum treatments is shown in table 4. The crude protein expressed on a dry matter basis was slightly higher in both the LGB- and fungal-damaged grain (9.8% control, 10.5% LGB, and 10.0% fungal). Crude fat was unchanged in the LGB treatment but was substantially less in the fungal treatment (2.9% control, 2.8% LGB, and 1.8% fungal). Crude fiber increased in both the LGB (2.6%) and fungal (2.7%) treatements when compared with the control (2.3%). Nitrogen-free extract remained relatively constant (83.7% control vs 83.3% fungal) in the fungal treatment, while decreasing to 82.2% in the LGB treatment. Ash content was not altered by either treatment.

Growth and Digestion Trials. Swine performance results are given in table 5. During the first 14 days of the trial no differences were found in average daily gain (ADG), feed conversion (F/G), or average daily feed consumption (ADFC). During days 14 to 35 no differences were noted in ADG. However, a poorer ($P<.05$) F/G ratio was found for the pigs consuming the LGB-damaged grain. Results over the entire trial indicated no difference in ADG. However, the F/G ratio and ADFC were higher ($P<.05$) for the pigs consuming the LGB treatment when compared to the control diet.

Results of the swine digestion trial are reported in table 6. No differences were found in digestibility of dry matter, protein or energy. Nitrogen balance was similar for all diets.

Table 1. Composition of Experimental Swine Diets

Ingredient	Percentage
Sorghum grain[a]	74.85
Soybean meal, dehulled, solv. extracted (47.0%)	22.00
Limestone mn 38.0% Ca	1.15
Dicalcium/Phosphate mn 18.5% P, 15.5% Ca	.75
Salt	.25
Premix	1.00
Total	100.00

[a]Control sorghum grain was replaced (wt/wt) with ground sorghum damaged by the lesser grain borer (treatment 2) and ground sorghum grain fungal damaged (treatment 3).

Table 2. Physical Condition of Lesser Grain Borer Infested Grain Sorghum After 120 Days of Storage

Item	Control	Damaged
Moisture	14.0%	14.5%
Test weight (lbs/bu)	54.3	50.6
Fine material	0.3%	5.0%
Infested kernels	0.0%	25.0%
Adults/100 g of whole seeds	10[a]	35

[a]Contamination occurred during last 20 days of storage.

Table 3. Physical Condition of Fungal-Invaded Grain Sorghum After 120 Days of Storage

Item	Control	Damaged
Moisture (whole seed)	14.0%	16.5%
Test weight (lbs/bu)	54.3	51.5
Germination	98.0%	10.0%
Invaded kernels	0.0%	80.0%
Dominant storage organism	None	*A. candidus*

Table 4. Chemical Composition of Grain Sorghum After 120 Days of Storage

Item	Control	Lesser Grain Borer	Fungal
		%	
Moisture	10.0	12.7	16.2
Crude protein[a]	9.8	10.5	10.0
Crude fat[a]	2.9	2.8	1.8
Crude fiber[a]	2.3	2.6	2.7
Nitrogen-free extract[a]	83.3	82.2	83.7
Ash[a]	1.7	1.9	1.8

[a]Dry matter basis.

Table 5. Performance of Growing Swine as Influenced by Grain Sorghum Infested With Lesser Grain Borer or NonToxin-Producing Fungi

Item	Treatment		
	Control	Lesser Grain Borer	Fungal
Number of pigs	15	15	15
Avg. initial wt., lb	21.12	22.0	22.80
Average daily gain		lb/day	
Days 0-14	.62[a]	.59[a]	.64[a]
Days 14-35	1.17[a]	1.18[a]	1.08[a]
Days 0-35	.97[a]	.97[a]	.92[a]
Feed conversion		F/G	
Days 0-14	2.13[a]	2.04[a]	2.05[a]
Days 14-35	1.83[a]	2.16[b]	1.86[a]
Days 0-35	1.90[a]	2.13[b]	1.93[a]
Average daily feed consumption		lb/day	
Days 0-14	1.32[a]	1.21[a]	1.30[a]
Days 14-35	2.13[a]	2.57[b]	2.00[a]
Days 0-35	1.85[a]	2.07[b]	1.78[a]

[a]Means in the same row with same superscript are not significantly different ($P<0.05$).

Table 6. Nutrient Apparent Digestibility Coefficients, Nitrogen Balance and Digestible Energy of Diets Containing Grain Sorghum Infested With Lesser Grain Borer or NonToxin-Producing Fungi

	Treatment		
Nutrient[a]	Control	Lesser Grain Borer	Fungal
Dry matter %	84.7	83.1	83.1
Crude protein %	75.5	73.0	74.0
Crude fiber %	61.5	57.2	58.8
Crude Fat %	71.1	67.2	70.2
Nitrogen-free extract %	92.0	90.8	90.9
Energy %	83.9	82.4	82.5
Digestible energy, K cal/lb	1637	1620	1632
Nitrogen balance, g/day	+8.4	+7.3	+7.4

[a]Dry matter basis.