JOURNAL OF ANIMAL SCIENCE
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J Anim Sci 2009.87:1254-1260.
doi: 10.2527/jas.2008-0966 originally published online Dec 19, 2008;

Evaluation of corn grain with the genetically modified input trait DAS-59122-7 fed to growing-finishing pigs[1]

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ABSTRACT: A growth performance experiment was conducted to assess the feeding value of a double-stacked transgenic corn grain for growing-finishing pigs. The genetically modified corn grain contained event DAS-59122-7, which expresses the Cry34/35Ab1 binary insecticidal protein for the control of corn rootworm. This modified transgenic grain is resistant to western corn rootworm and is also tolerant to herbicides containing the active ingredient glufosinate-ammonium. The modified grain (59122), a nontransgenic near-isoline grain (control corn), and a commercial corn (Pioneer brand hybrid 35P12) were grown in a 2005 production trial in individually isolated plots that were located 201 m apart. A total of 108 pigs were allotted to corn-soybean meal diets containing 1 of the 3 grains as the sole source of corn. There were 3 pigs per pen and 12 replicate pens per treatment. Pigs were fed grower diets from 37 to 60 kg, early finisher diets from 60 to 90 kg, and late finisher diets from 90 to 127 kg. Within each phase, data for ADG, ADFI, and G:F were calculated. At the conclusion of the experiment, pigs were slaughtered and data for carcass quality were collected. Differences between 59122 and the control corn were evaluated, with statistical significance at $P < 0.05$. No differences in ADG, ADFI, or G:F between pigs fed the control corn and pigs fed the modified corn were observed during the grower, early finisher, or late finisher phases. For the entire experimental period, no difference between pigs fed the control and the 59122 corn were observed for final BW (128.9 vs. 127.1 kg), ADG (1.02 vs. 1.00 kg), ADFI (2.88 vs. 2.80 kg), or G:F (0.356 vs. 0.345 kg/kg). Likewise, no differences in dressing percentage (76.48 vs. 76.30%), LM area (49.8 vs. 50.4 cm^2), 10th-rib back fat (2.20 vs. 2.12 cm), and carcass lean content (52.9 vs. 53.4%) were observed between pigs fed the control and the 59122 corn grain. It was concluded that the nutritional value of the modified transgenic corn grain containing event DAS-59122-7 was similar to that of the nontransgenic near-isoline control.

Key words: corn, corn rootworm, DAS-59122-7, pig, transgenic corn

J. Anim. Sci. 2009. 87:1254–1260
doi:10.2527/jas.2008-0966

INTRODUCTION

The annual crop damage in the United States caused by the corn rootworms (*Diabrotica virgifera virgifera* LeConte and *Diabrotica barberi* Smith and Lawrence) is greater than the damage caused by all other insects (Metcalf, 1986). The negative effects of corn rootworm may, to some degree, be controlled by crop rotation and pesticide application, but substantial economic and biological benefits are associated with growing corn grains that are resistant to corn rootworm (Oehme and Pickrell, 2003). An example of a corn grain that is resistant to corn rootworm is 59122, which contains event DAS-59122-7. This corn grain is a transgenic grain produced by insertion of the *cry*34Ab1 and *cry*35Ab1 genes from *Bacillus thuringiensis* (***Bt***) Berliner strain PS149B1 and the phosphinothricin acetyltransferase (***pat***) gene from *Streptomyces viridochromogenes*. Expression of the Cry34Ab1 and Cry35Ab1 proteins confers in planta resistance to coleopteran pests, including corn rootworms (Herman et al., 2002). Expression of the PAT protein confers tolerance to herbicides containing the active ingredient glufosinate-ammonium (i.e., Liberty, Bayer AG, Leverkusen, Germany).

In previous studies, pig performance was not influenced by the presence of genes from *Bt* in corn (Weber and Richert, 2001; Hyun et al., 2005), and there

[1]Financial support from Pioneer Hi-Bred Int. Inc., Johnston, IA, is appreciated.

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Received February 17, 2008.

Accepted December 10, 2008.

were no negative effects on pig performance and carcass quality from the presence of genes that confer herbicide tolerance to corn (Stanisiewski et al., 2001; Hyun et al., 2004). However, to our knowledge, there is no information on the effects of feeding a transgenic corn grain with combined insect resistance and herbicide tolerance, such as 59122 to pigs, but 59122 was recently approved for use in animal feeding in the United States. Therefore, the objective of the current experiment was to test the hypothesis that pigs fed diets containing grain from 59122 corn would have performance and carcass composition that was not different from that of pigs fed a nontransgenic, near-isoline control corn hybrid or a commercial hybrid corn.

MATERIALS AND METHODS

The protocol for the experiment was reviewed and approved by the Institutional Animal Care and Use Committee at South Dakota State University.

Animals, Housing, and Experimental Design

A total of 108 growing pigs (initial BW: 37.05 ± 2.92 kg) originating from the matings of SP-1 boars to Line 13 females (Ausgene Int. Inc., Gridley, IL) were randomly allotted to 3 dietary treatments based on BW and sex in a complete randomized block design. There were 3 pigs per pen and 12 replicate pens per treatment (6 pens with gilts and 6 pens with barrows). Six of the replications were initiated on the same day, and the remaining 6 replications were initiated 13 d later to reduce variation among replications in initial BW. Pigs were housed in an environmentally controlled building with ambient temperature maintained between 18 and 22°C. Treatments were randomized within the building, and the experiment was conducted from February to May 2006. Pens (1.2 × 2.4 m) had fully slatted floors. A single-space feeder and a nipple drinker were installed in each pen.

Diets, Feeding, and Growth Performance Data Recording

A nontransgenic, near-isoline control corn, a commercial corn hybrid (Pioneer brand hybrid 35P12, Pioneer Hi-Bred Int. Inc., Johnston, IA), and a genetically modified corn (59122) containing event DAS-59122-7 were used in the experiment (Table 1). The commercial hybrid was included in the experiment only to establish the normal variation in the population of pigs that was used. Data for pigs fed diets containing the commercial hybrid were not intended to be included in the statistical analysis of the experiment unless significant differences between the genetically modified corn and the control corn were observed. All corn sources were grown in 2005 by Pioneer Hi-Bred International Inc. in field production plots located in Richland, Iowa. The 59122 corn plants received an application of glufosinate-ammonium herbicide (Liberty, Bayer AG) at the V4 and V7 growth stages (0.41 and 0.50 kg of active ingredient/ha, respectively); no application occurred beyond the V7 growth stage. Control and commercial check corn plots were not treated with Liberty. The control and commercial hybrid corn plots were located 201 m from the 59122 corn plot to minimize the possibility of cross-pollination. Fertilizer and insecticides were applied as needed and according to commercial corn production practices for the area. The 59122 corn plants demonstrated greater disease and insect resistance than control corn plants (6.5 vs. 5.5, respectively), based on a visual evaluation scale of 1 to 9, where 1 = poor resistance and 9 = best resistance. Grain yields were 6,777 kg/ha for the control corn plot and 7,999 kg/ha for the 59122 corn plot; the yield reduction observed with the control corn may have been due to the observed reduced insect resistance.

Pigs were fed their respective diets in a 3-phase program (i.e., from 37 to 60 kg, phase 1; from 60 to 90 kg, phase 2; and from 90 to 127 kg, phase 3). Within each phase, 3 experimental diets were formulated based on corn and soybean meal (Table 2). The only difference among the diets used within each phase was the origin of the corn. The corns were ground to a geometric mean particle size of 550 µm (American Society of Agricultural Engineers, 1993) before diet mixing. The control corn was ground first, followed by the commercial corn and the 59122 corn. Commercial corn was used to flush the system between each grinding. All diets were formulated based on nutrient requirements of growing-finishing swine (NRC, 1998). Diets for each phase were mixed approximately 10 d before the first use. Diets were packaged in 22.5-kg bags after mixing and fed in a meal form. Pigs were allowed ad libitum access to feed and water throughout the experiment.

Individual pig BW were recorded at the beginning of the experiment and at the end of each of the 3 phases. Daily feed allotments were recorded as well, and feed that was left in the feeders was weighed back at the end of each phase. At the conclusion of the experiment, data for feed disappearance for each pen were summarized and the ADFI within each phase and treatment group was calculated. Data for pig BW gains were summarized as well, and ADG and the G:F ratio were calculated for each pen and subsequently summarized within each phase and treatment group.

Carcass Evaluation

Pigs were slaughtered on 2 different days in the same order as they were initiated on the experiment; all pigs were fed experimental diets for the same number of days. At the conclusion of the experiment, pigs were weighed and deprived of feed overnight. The following morning, pigs were transported approximately 3 km to the South Dakota State University Meat Science Laboratory, where they were weighed and slaughtered within 4 h after arrival. Within each processing day, the pro-

Table 1. Analyzed composition of the corn grains and soybean meal used in experimental diets (as-fed basis)

Item	Corn source[1]			Soybean meal
	Control	Commercial	59122	
Particle size, µm	549	508	519	—
GE, kcal/kg	3,958	3,891	3,929	4,112
DM, %	88.00	87.00	87.00	88.00
CP, %	8.80	8.60	8.30	47.40
Ether extract, %	3.60	3.60	3.30	1.60
Crude fiber, %	1.10	1.00	1.00	2.50
ADF, %	4.50	3.10	3.80	4.40
NDF, %	9.30	8.60	8.00	6.90
Total starch, %	64.02	62.95	63.61	ND[2]
Ash, %	1.10	0.90	1.20	7.10
Ca, %	0.02	0.02	0.02	0.50
P, %	0.27	0.26	0.28	0.67
Indispensable AA, %				
Arg	0.42	0.40	0.43	3.43
His	0.26	0.25	0.26	1.33
Ile	0.32	0.30	0.34	2.10
Leu	1.14	1.13	1.20	3.65
Lys	0.28	0.27	0.28	3.06
Met	0.22	0.21	0.21	0.72
Phe	0.44	0.44	0.46	2.28
Thr	0.31	0.31	0.32	1.85
Trp	0.07	0.07	0.07	0.67
Val	0.44	0.41	0.46	2.26

[1]A nontransgenic, near-isoline control corn, a commercial corn hybrid (Pioneer brand hybrid 35P12, Pioneer Hi-Bred Int. Inc., Johnston, IA), and a genetically modified corn (59122) containing event DAS-59122-7 were used in the experiment.

[2]ND = not determined.

cessing order was randomized among treatments. The average BW at slaughter was 127.08 ± 6.86 kg.

Pigs were stunned by electrocution, exsanguinated, and then scalded for 4 to 5 min. Hot carcass weights were recorded and carcass sides were placed in the chiller approximately 45 min after stunning. The left side of each carcass was ribbed between the 10th and 11th ribs 24 h postmortem, and the LM area, LM depth, and fat thickness were measured at the 10th rib by using standard procedures (National Pork Board, 2000). The carcass lean content for each pig was also calculated (National Pork Board, 2000). Subjective color and marbling scores were obtained after a 10-min bloom time according to the National Pork Producers Council Quality Standards (National Pork Producers Council, 1999).

Chemical Analysis

Samples of each source of corn and soybean meal (Table 1) and of each diet (Table 3) were analyzed for concentration of DM (procedure 930.15; AOAC, 2005), CP (procedure 990.03; AOAC, 2000), ash (procedure 4.1.10; AOAC, 2000), crude fat [procedure 920.39 (A); AOAC, 2000], crude fiber, ADF and NDF (procedure 973.18; AOAC, 2000), Ca (procedure 4.8.03; AOAC,

Table 2. Composition of experimental diets (as-fed basis)[1]

Ingredient, %	37 to 60 kg, phase 1			60 to 90 kg, phase 2			90 to 127 kg, phase 3		
	Control	Commercial	59122	Control	Commercial	59122	Control	Commercial	59122
Corn	68.96	69.35	69.14	75.62	75.26	75.47	82.23	81.99	81.9
Corn oil	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Soybean meal	27.37	27.01	27.20	20.96	21.26	21.06	14.43	14.64	14.75
Limestone	0.89	0.88	0.88	0.80	0.85	0.84	0.73	0.75	0.74
Dicalcium phosphate	0.88	0.87	0.88	0.72	0.74	0.73	0.71	0.72	0.71
Salt	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40
Vitamin-mineral premix[2]	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50

[1]A nontransgenic, near-isoline control corn, a commercial corn hybrid (Pioneer brand hybrid 35P12, Pioneer Hi-Bred Int. Inc., Johnston, IA), and a genetically modified corn (59122) containing event DAS-59122-7 were used in the experiment.

[2]The vitamin-mineral premix provided the following quantities of vitamins and minerals per kilogram of complete diet: vitamin A, 3,432 IU; vitamin D_3, 990 IU; vitamin E, 44 IU; vitamin K_3, 2.2 mg; riboflavin, 2.8 mg; vitamin B_{12}, 0.016 mg; D-pantothenic acid, 11 mg as calcium pantothenate; niacin, 18 mg; choline, 220 mg; Cu, 8 mg; Fe, 176 mg; I, 0.35 mg; Mn, 42 mg; Se, 0.30 mg; and Zn, 83 mg.

Table 3. Analyzed composition of experimental diets (as-fed basis)[1]

	37 to 60 kg, phase 1			60 to 90 kg, phase 2			90 to 127 kg, phase 3		
Item	Control	Commercial	59122	Control	Commercial	59122	Control	Commercial	59122
GE, kcal/kg	3,972	3,942	3,962	4,002	3,984	3,983	4,015	3,942	3,963
DM, %	89.04	88.05	88.80	88.80	87.30	87.70	88.00	86.60	87.10
CP, %	17.32	18.23	18.67	16.90	17.30	16.70	13.80	13.70	13.90
Ether extract, %	4.55	4.22	3.49	3.90	4.20	3.90	4.20	4.20	4.30
Crude fiber, %	1.40	1.90	2.20	1.40	1.40	1.40	1.50	1.40	1.30
ADF, %	4.70	6.20	4.80	2.20	2.30	2.10	2.50	1.80	3.00
NDF, %	8.30	7.80	8.70	8.50	7.70	7.60	7.50	7.70	7.30
Ash, %	4.39	4.30	4.55	4.40	4.80	4.00	2.70	3.50	3.70
Ca, %	0.74	0.77	0.76	0.67	0.64	0.66	0.57	0.66	0.61
P, %	0.55	0.55	0.59	0.46	0.47	0.49	0.44	0.44	0.48
Indispensable AA, %									
Arg	1.04	1.14	1.19	1.03	1.03	1.04	0.84	0.80	0.86
His	0.45	0.49	0.51	0.44	0.44	0.45	0.38	0.37	0.39
Ile	0.67	0.79	0.83	0.69	0.73	0.69	0.56	0.55	0.60
Leu	1.58	1.70	1.79	1.63	1.65	1.64	1.48	1.43	1.54
Lys	0.87	0.97	1.03	0.84	0.83	0.85	0.66	0.63	0.68
Met	0.27	0.29	0.33	0.28	0.28	0.28	0.28	0.24	0.25
Phe	0.83	0.91	0.95	0.84	0.85	0.84	0.71	0.69	0.73
Thr	0.62	0.65	0.68	0.62	0.60	0.63	0.52	0.50	0.53
Trp	0.19	0.20	0.21	0.16	0.17	0.17	0.16	0.14	0.14
Val	0.7	0.90	0.95	0.80	0.84	0.79	0.67	0.66	0.72

[1]A nontransgenic, near-isoline control corn, a commercial corn hybrid (Pioneer brand hybrid 35P12, Pioneer Hi-Bred Int. Inc., Johnston, IA), and a genetically modified corn (59122) containing event DAS-59122-7 were used in the experiment.

2000), and P (procedure 968.08D; AOAC, 2000). Amino acids were analyzed on a Beckman 6300 Amino Acid Analyzer (Beckman Instruments Corp., Palo Alto, CA), using ninhydrin for postcolumn derivatization and norleucine as the internal standard. Before analysis, samples were hydrolyzed with 6 *N* HCL for 24 h at 110°C (procedure 982.30; AOAC, 2005). Methionine and Cys were determined as Met sulfone and cysteic acid after cold performic acid oxidation overnight before hydrolysis (procedure 982.30; AOAC, 2005). Tryptophan was determined after NaOH hydrolysis for 22 h at 110°C (procedure 982.30; AOAC, 2005). Gross energy was analyzed in all samples using bomb calorimetry (Model 1271, Parr Instruments, Moline, IL). Whole corn samples were analyzed for total starch content by near-infrared transmittance analysis (method A-20; Corn Refiners Association, 1980).

The absence or presence of the Cry34Ab1 and Cry35Ab1 proteins in the nontransgenic and transgenic grains was confirmed using ELISA methods specific for each protein (Pioneer Hi-Bred Int. Inc.). The CV for the assays were 13.7 and 2.9% for Cry34Ab1 and Cry35Ab1, respectively. Each source of corn and the soybean meal was also analyzed for mycotoxins using ELISA (Midwest Seeds, Brookings, SD).

Statistical Analysis

Data were analyzed as described by Jacobs et al. (2008), with use of the false discovery rate as described by Benjamini and Hochberg (1995). The false discovery rate was used to minimize the chance of falsely declaring a difference for a measured trait as significant when the difference may have occurred only by chance based on the number of measured traits. Data were analyzed using a mixed model ANOVA (PROC MIXED, SAS Institute Inc., Cary, NC). Corn, sex, and the corn × sex interaction were fixed effects in the analysis of performance and carcass data. Start date and the start date × corn interaction were random effects for performance data, and start date, the start date × corn interaction, and pen nested within start date and corn were random effects for carcass data. Estimate statements were used to compare endpoints for pigs fed diets containing the control corn vs. those fed diets containing the 59122 corn. The pen was the experimental unit for performance data and the pig was the experimental unit for carcass data. The false discovery rate adjusted *P*-value was reviewed when significant differences ($P < 0.05$) generated from the estimate comparison statement were observed for a trait. Data from pigs fed diets containing the commercial corn were used to estimate experimental variability, with least squares mean values generated for reference purposes only. Comparisons between the commercial corn and 59122 treatments were generated only in the event of observed significant differences between the control and 59122 corn treatments after application of the false discovery rate.

RESULTS

Results of the chemical analyses did not reveal the presence of mycotoxins in any of the grains that were used. The Cry34Ab1 and the Cry35Ab1 proteins were present in the 59122 corn in quantities of 310 and 9.6 ng/mg, respectively, but no traces of these proteins

Table 4. Performance of pigs fed experimental diets[1,2,3]

Item	Corn source[4] Control	Commercial	59122	SEM	*P*-value	Adjusted *P*-value[5]
Initial BW, kg	37.0	37.0	37.0	1.8	0.99	0.99
Final BW, kg	128.9	125.2	127.1	1.9	0.57	0.85
ADG, kg	1.02	0.98	1.00	0.03	0.47	0.85
ADFI, kg	2.88	2.83	2.80	0.08	0.41	0.85
G:F, kg/kg	0.356	0.347	0.345	0.009	0.47	0.85

[1]There were 12 pens of 3 pigs per treatment.

[2]Interactions between type of grain and sex were analyzed but were not significant for any of the measured traits.

[3]SEM and *P*-values are for the comparison of the control and the 59122 corn.

[4]A nontransgenic, near-isoline control corn, a commercial corn hybrid (Pioneer brand hybrid 35P12, Pioneer Hi-Bred Int. Inc., Johnston, IA), and a genetically modified corn (59122) containing event DAS-59122-7 were used in the experiment.

[5]*P*-value adjusted using the false discovery rate.

were detected in the other 2 corn hybrids or in soybean meal (the lower limit of quantification of both proteins was 0.81 ng/mg of grain). The concentrations of energy and nutrients differed only minimally among the 3 corn hybrids (Table 1) and were close to expected values (NRC, 1998). Likewise, all diets contained the expected concentrations of energy and nutrients (Table 3).

Pigs remained healthy throughout the experiment (Table 4). No mortality occurred and no pigs were removed from their treatment group during the experiment; all pigs that were assigned to the experiment were slaughtered and included in the final analysis of data. There were no interactions for any growth performance traits between sex and trait, and only the combined data for the 2 sexes (barrows and gilts) are presented. There were no differences in ADG, ADFI, or G:F between pigs fed the control corn and pigs fed the 59122 corn for the grower, early finisher, or late finisher phases (data not shown). Likewise, for the entire growing-finishing period, there was no difference in ADG (1,021 vs. 1,001 g), ADFI (2,877 vs. 2,800 g), or G:F (0.356 vs. 0.359 kg/kg) between pigs fed diets containing the control and the 59122 corn hybrids. Likewise, no difference was observed between pigs fed the 2 corn hybrids in final BW (128.9 vs. 127.1 kg), and no interactions were observed between type of corn and pig sex.

There were no differences between pigs fed the control corn and the 59122 corn in HCW (95.7 vs. 94.1 kg) or dressing percentage (76.48 vs. 76.30%; Table 5). Likewise, the 10th-rib backfat, 10th-rib LM area, and 10th-rib LM depth were not different between pigs fed the control corn and the 59122 corn (2.20 vs. 2.12 cm, 49.8 vs. 50.4 cm^2, and 6.75 vs. 6.68 cm, respectively). The objective color score (2.34) and marbling (1.70) for pigs fed the control corn were not different from the values measured in pigs fed the 59122 corn (2.40 and 1.88, respectively). Likewise, lean meat percentage was not different between pigs fed diets containing the 2 corn hybrids (52.9 vs. 53.4% for pigs fed diets containing control corn and 59122 corn, respectively).

An interaction ($P < 0.05$) between type of corn and pig sex was observed for LM depth. Barrows had deeper LM than gilts when fed the control corn (6.84 vs. 6.65 cm), but gilts had deeper LM than barrows when fed the 59122 grain (6.85 vs. 6.46 cm). However, for all other carcass traits, no interactions between type of grain and pig sex were observed.

DISCUSSION

The worldwide production of genetically modified crops is rapidly increasing, and in 2005, more than 90 million ha were planted, with soybeans and corn being the most dominant crops (James, 2005). Crops that contain input traits such as herbicide tolerance or insect resistance are the most widely grown genetically modified crops (James, 2005). These crops belong to the first generation of biotechnology crops, and they are not expected to differ in gross composition from their unmodified isogenic counterparts (Faust, 2002; Flachowsky et al., 2005a). First-generation biotechnology crops are evaluated based on the principle of substantial equivalence, which is most often assessed by compositional analysis of nutrients (Aumaitre et al., 2002; Endo and Boutrif, 2002; Faust, 2002), but studies with dairy cattle (Ipharraguerre et al., 2002), beef cattle (Erickson et al., 2003), sheep (Bohme et al., 2001), broilers (Tony et al., 2003; McNaughton et al., 2007), quail (Flachowsky et al., 2005b), and pigs (Cromwell et al., 2002; Hyun et al., 2004, 2005) have also been completed. Fragments of recombinant DNA have never been identified in milk or in liver, spleen, or muscle tissues from animals fed genetically modified crops (Aumaitre, 2004; Alexander et al., 2007; Flachowsky et al., 2007).

In experiments with swine, it has been demonstrated that the nutrient composition and the digestibility of energy and crude nutrients are not affected by the presence of a gene from *Bt* (***Bt*-corn**) in the grain (Gaines et al., 2001; Reuter et al., 2002b). It also was reported that the inclusion of insect-protected corn containing a

Table 5. Carcass characteristics of pigs fed experimental diets[1,2,3]

Item	Corn source[4]			SEM	P-value	Adjusted P-value[5]
	Control	Commercial	59122			
HCW, kg	95.7	92.8	94.1	1.4	0.50	0.77
Dressing, %	76.48	76.45	76.30	0.41	0.65	0.77
LM area, cm^2	49.8	50.6	50.4	2.2	0.77	0.77
LM depth, cm	6.75	6.80	6.68	0.11	0.68	0.77
10th-rib fat, cm	2.20	2.14	2.12	0.12	0.65	0.77
Lean meat, %	52.9	53.4	53.4	1.0	0.58	0.71
Marbling	1.70	1.79	1.88	0.12	0.27	0.77
Color score	2.34	2.35	2.40	0.009	0.70	0.77

[1]There were 12 pens of 3 pigs per treatment.

[2]Interactions between type of grain and sex were analyzed but were not significant except for LM depth, where gilts fed the 59122 grain had greater LM depth ($P < 0.05$) than gilts fed the control grain, but barrows fed the control corn had greater LM depth than barrows fed the 59122 corn.

[3]SEM and P-values are for the comparison of the control and the 59122 corn.

[4]A nontransgenic, near-isoline control corn, a commercial corn hybrid (Pioneer brand hybrid 35P12, Pioneer Hi-Bred Int. Inc., Johnston, IA), and a genetically modified corn (59122) containing event DAS-59122-7 were used in the experiment.

[5]P-value adjusted using the false discovery rate.

gene from *Bt* in diets fed to growing-finishing pigs did not affect performance (Weber and Richert, 2001; Reuter et al., 2002a) or carcass composition (Custodio et al., 2004; Hyun et al., 2005). Improved performance of weanling pigs fed *Bt*-corn rather than commercial corn has been reported (Piva et al., 2001), but the *Bt*-corn used in this experiment contained fewer mycotoxins than the commercial counterpart, which may explain the difference in performance.

Corn grains containing events that confer in planta herbicide tolerance were also used in several previous studies, and it was demonstrated that these grains had a feeding value that was not different from the feeding value of the nontransgenic parent line when fed to pigs (Stanisiewski et al., 2001; Hyun et al., 2004). Thus, there is substantial evidence that both insect-protected and herbicide-tolerant hybrids of corn have a feeding value that is not different from the commercial parent lines (Aumaitre, 2004; Flachowsky et al., 2005a). Results of the current experiment showed that growth performance and carcass quality were not different for pigs fed the transgenic corn grain containing event DAS-59122-7 and pigs fed the near-isogenic control corn. To our knowledge, this is the first time that the performance of pigs fed a corn grain with combined insect-resistance and herbicide tolerance genes has been reported. However, the present results agree with recently reported data showing that the inclusion of grain containing event DAS-59122-7 did not affect the performance or carcass yield of broiler chickens (McNaughton et al., 2007) or the performance and egg quality of laying hens (Jacobs et al., 2008). The current data also demonstrated that the presence of the *cry*34Ab1 and *cry*35Ab1 genes from *Bt* Berliner strain PS149B1 and the *pat* gene from *Strep. viridochromogenes* in the grain did not affect pig performance. Thus, it appears that this transgenic corn, 59122, has a feeding value to pigs, broiler chickens, and laying hens that is similar to its nontransgenic parent lines.

In conclusion, results from the current experiment document that the presence of the *cry*34Ab1 and *cry*35Ab1 genes from *Bt* Berliner strain PS149B1 and the *pat* gene from *Strep. viridochromogenes* in corn grain does not affect growth performance or carcass composition of pigs. Therefore, such grains have a feeding value that is not different from commercial corn hybrids. The decision on whether or not to use such grains in diets fed to growing pigs should therefore be based on agronomic and economic considerations, because there were no growth performance or carcass differences when these grains were fed to swine.

LITERATURE CITED

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