Corn Co-products; How Do They Affect the Behavior of Grow-Finish Swine?

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Summary and Implications

Byproducts of the ethanol industry have been receiving a great deal of attention as potential ingredients for the swine diet. As byproducts they have the potential to affect air emissions particularly in regards to ammonia emissions. However, limited research has been done regarding diets created with different basal ingredients and their acceptability by the pig and the overall behavior impact they have on the pig. Therefore, the objective of this experiment was to compare four different diets for the grow-finish pig in regards to its behavior and postures. Pigs were observed over their grow-finish phase of production, which was comprised of six different dietary formulation phases. Four treatments were compared: distillers dried grains plus solubles (DDGS), dehulled degermed corn (DDC), corn germ meal (CGM), and a traditional corn based diet (CORN). All diets were isocaloric and formulated to NRC recommendations (NRC, 1998). All pigs were recorded for 24 hours post dietary change (5 diet changes, total), and video was scored using a 15 minute scan sampling technique by two experienced observers. Pigs were observed for two behaviors (eating and drinking), two postures (active or inactive), or unknown (which was used when the posture or behavior of the pig could not be determined). Behaviors, postures and unknown for the grow-finisher pig throughout this trial were similar ($P > 0.05$) across the treatment groups. This is an important finding in so far as if new and different diets are implemented slowly, in this study specifically to aid in the reduction of ammonia and or sulfur outputs, then maintenance related behaviors will not be adversely affected in the grow-finish pig.

Introduction

Air emissions in regards to ammonia and hydrogen sulfide gases, continues to draw attention at both the state and federal levels. Therefore, practices to reduce the emission of ammonia from animal feeding operations are of great importance to producers as they consider how future regulations might impact their operations. Dietary manipulation to control nutrient excretions and air emission potential is of growing interest as a first step in cost effective emissions control. Ingredients of current interest are distillers dried grains plus solubles (DDGS), varying levels of sugar beet pulp, dehulled, degermed corn (DDC), corn germ meal (CGM), and fiber sources. However, when manipulating the dietary formulation to reduce unwanted emissions by the pig, consideration must be given to determine if the grow-finisher pig is "interested" in the diets being offered. Therefore, the objective of this experiment was to compare four different diets for the grow-finish pig in regards to its behavior and postures.

Materials and Methods

Housing and animals: This project was approved by the Iowa State University Institute for Animal Care and Use Committee, approval 11-05-6026-S. A total of 48 (PIC®) pigs weighing 18 ± 0.6 kg were allocated to eight rooms (2.13 m width by 3.96 m depth by 2.59 m height). Pigs weighed 124 ± 6.2 kg at the end of the trial. Lighting was maintained at 12:12 light: dark cycle. Pigs were checked twice daily at 0700 hours , one hour after lights were turned on and at 1500 hours for general health appearance, feed ,and water. Thermoregulation ranged from 18.3 to 26.7 ^{o}C as appropriate for pig size and growth stage (NPB, 2003). Within each room six pigs were housed in a pen (1.52 m width x 3.05 m length x 0.91 m height; Figure 1). This provided each pig with 0.77 m^2 of floor space. At the end of phase 4 one pig from each pen was removed for the remainder of the trial, therefore providing the remaining pigs with 0.93 m^2 / pig. This was done to keep with the general guidelines of pig / m^2 acceptable space allowance requirements. Fully slated diamond shaped Tenderfoot™ flooring was utilized. In each pen, pigs were provided with a Smidley® 2-hole feeder (0.55 m length x 0.97 m height x 0.44 m width x 0.18 m depth),and a hanging two nipple TroJan® water swing waterer, providing ad lib access. Water flow was tested to ensure compliance with the National Pork Board's water flow rate guidelines (NPB, 2008).

Figure 1. Photo of pen and room

Treatments: Four diets were compared; TRT 1 Corn Germ Meal (***CGM***), TRT 2 Distillers Dried Grains and Soluble (***DDGS***), TRT 3 Dehulled Degermed Corn (***DDC***), and TRT 4 Corn (***Corn*** [control]***)*** (Tables 1 to 2). Diets were formulated to provide a total of six dietary phases.

Behavioral measures: Behavior and postures of the grow finish pigs were collected on the first day of each dietary phase change (Figure 3 & 4). Video was collected for 24 hours following the diet change. One 12 V color CCTV camera (Model WV-CP484, Panasonic® Matsushita Co Ltd., Japan) was positioned in the corner, opposite of the feeder in the room 2.29 m above the floor. Recordings were made for a 24 hour period using a digital video recorder (RECO-204, Darim Vision®, USA) in black and white mode at 5 frames per second. For night vision, an infrared unit (Tracksys LTD, UK) was placed near the camera illuminating the room. The infrared units were secured to the wall using a camera mounting bracket. A monitor (Trinitron® SSM-14L Color Video Monitor, Sony, Japan) was used to view the DVR output to ensure picture clarity and camera positioning prior to each behavioral recording. The acquisition of two behaviors, two postures, and one unknown category were obtained by two experienced observers using 15 min scan sampling each time the diets changed (n = 6). Observational data were recorded using Observer software (The Observer, Ver. 5.0.25 Noldus Information Technology, Wageningen, The Netherlands). Two behaviors were determined: ***Eating*** was defined as any contact / head over / in feed trough involving voluntary oral ingestion of concentrates. ***Drinking*** was defined as a pig being in contact with the water nipple. Two postures were collected: ***Active*** included standing which was defined as assuming or maintaining an upright position on extended legs. ***Inactive*** included sitting (defined as most of the finisher pigs body weight and the posterior of their body truck in contact and supported by the ground) and lying (both lateral and sternal defined as side contacting the ground or underside contacting the ground). ***Unknown*** was scored when the posture or behavior of the pig could not be determined. Picture clarity can be seen in Figure 2.

Figure 2. View of chambers used for scoring grow-finish pigs behaviors and postures

Statistical Analysis: Analyses were performed using the PROC Mixed procedure in SAS (SAS Inst., Inc., Cary, NC) software for parametric data. The experimental unit was the chamber (containing six grow-finisher pigs phase one through four and five grow-finisher pigs for phase five and six). A repeated measures experimental design was implemented. Four treatments were compared (CGM, DDGS, DDC and Corn). Behavioral and posture data was tabulated out on a percentage-bases for each hour. This data was used to obtain the means. The percentages were arcsine square root transformed to achieve a normalized distribution. The statistical model included treatment, time and treatment by time interaction. The error term was treatment and day nested within pen. Only treatment will be reported here.

Results and Discussion

Behavioral Measures; There were no ($P > 0.05$) treatment (Table 3) effects for any behaviors, postures, or for the unknown category collected over the trial. On average the grow-finish pigs spent 7.17 % of their time budget engaged in eating related activates, 0.88 % drinking, and active and inactive were 4.42 and 87.24 % respectively. Behavior and postures for the grow-finisher pig throughout this trial were similar across the treatment groups. This is an important finding in so far as if new and different diets are implemented to aid in the reduction of ammonia and or sulfur outputs then maintenance related behaviors will not be adversely affected.

Acknowledgements

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Table 1. Composition of dietary treatments during starter and grower swine feeding phases. [a]

Item	*Starter phase 1*				*Grower phase 1*				*Grower phase 2*			
	C[b]	DDGs	DDC	CGM	C	DDGs	DDC	CGM	C	DDGs	DDC	CGM
Ingredient, % (as-fed basis)												
Corn	55.50	51.00		52.71	69.50	60.85		61.14	74.74	62.00		66.00
DDGs		5.00				10.00				15.00		
DDC			53.50				67.17				72.40	
CGM				5.00				10.00				15.00
Soybean meal	33.80	33.41	35.79	33.56	26.17	25.00	28.50	24.65	21.20	19.19	23.55	15.15
Whey, dried	5.00	5.00	5.00	3.00								
Vegetable oil	1.60	1.60	1.60	1.60	0.30	0.30	0.30	0.20	0.30	0.30	0.30	
Dicalcium phosphate	1.59	1.40	1.60	1.58	1.38	1.04	1.42	1.34	1.10	0.59	1.13	1.05
Limestone	0.80	0.88	0.80	0.84	0.89	1.05	0.85	0.91	0.90	1.16	0.86	0.95
Salt	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35
Vitamin mix	0.30	0.30	0.30	0.30	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Trace mineral mix	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
L-Lysine/HCl					0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.20
Celite[c]	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Analyzed composition (dry matter basis)												
Crude protein, %	22.51	23.91	21.33	23.48	19.77	21.14	19.46	21.03	16.98	19.25	17.90	17.46
Lysine, %	1.35	1.38	1.36	1.41	1.21	1.27	1.14	1.26	1.08	1.13	0.94	1.07
Sulfur, %	0.16	0.18	0.16	0.16	0.14	0.19	0.16	0.16	0.13	0.19	0.14	0.14

[a]Starter phase 1: duration = 14 d, average initial BW = 18 kg; Grower phase 1: duration = 21 d, average initial BW = 27 kg; Grower phase 2: duration = 21 d, average initial BW = 41 kg.
[b]C – corn control diet; DDGs – dried distillers grain with solubles diet; DDC – dehulled, degermed corn diet; CGM – corn germ meal diet.
[c]Celite – indigestible marker (World Minerals Corp; Lompoc, CA).
[d]ME - metabolizable energy.

Table 2. Composition of dietary treatments during swine finisher feeding phases. [a]

Item	*Finisher phase 1*				*Finisher phase 2*				*Finisher phase 3*			
	C[b]	DDGs	DDC	CGM	C	DDGs	DDC	CGM	C	DDGs	DDC	CGM
Ingredient, % (as-fed basis)of complete diet												
Corn	79.15	59.50		65.98	82.19	60.07		60.90	86.20	58.65		60.91
DDGs		20.00				25.00				30.00		
DDC			76.64				79.70				83.66	
CGM				20.00				25.00				30.00
Soybean meal	17.00	17.17	19.50	10.37	13.40	12.00	15.88	10.80	9.76	8.50	12.30	6.00
Whey, dried												
Vegetable oil	0.30	0.20	0.30		1.00		1.00		0.80		0.80	
Dicalcium phosphate	0.90	0.22	0.95	0.85	0.76		0.79	0.65	0.59		0.62	0.43
Limestone	0.90	1.25	0.86	0.97	0.90	1.28	0.88	1.00	0.90	1.20	0.87	1.01
Salt	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35
Vitamin/trace	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Trace mineral mix	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
L-Lysine/HCl	0.10		0.10	0.18	0.10		0.10		0.10		0.10	
Celite[c]	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Analyzed composition (dry matter basis)												
Crude protein, %	16.20	19.62	15.88	16.24	14.65	18.29	14.29	16.46	11.90	18.35	12.93	15.32
Lysine, %	0.89	1.02	0.84	0.93	0.81	0.88	0.73	0.83	0.70	0.77	0.66	0.68
Sulfur, %	0.12	0.20	0.12	0.13	0.11	0.11	0.11	0.15	0.10	0.21	0.11	0.13

[a]Finisher phase 1: duration = 21 d, average initial bodyweight = 58 kg; Finisher phase 2: duration = 21 d, average initial bodyweight = 78 kg; Finisher phase 3: duration = 14 d, average initial bodyweight = 101 kg.
[b]C – corn control diet; DDGs – dried distillers grain with solubles diet; DDC – dehulled, degermed corn diet; CGM – corn germ meal diet.
[c]Celite – indigestible marker (World Minerals Corp; Lompoc, CA).
[d]ME - metabolizable energy.

Table 3. Least squares means, standard errors and *P*-values for treatments on behaviors and postures for grow-finishing pigs observed over six 24 h time periods using a 15 min scanning from June to October, 2006.

	Treatments				
	CGM	**DDGS**	**DDC**	**CORN**	***P-values***
Behavior, %					
Eating	7.39 ± 0.46	7.26 ± 0.46	6.44 ± 0.46	7.57 ± 0.46	0.38
Drinking	0.93 ± 0.17	0.95 ± 0.17	0.75 ± 0.17	0.89 ± 0.17	0.87
Postures, %					
Active	4.05 ± 0.74	4.30 ± 0.74	4.96 ± 0.74	4.36 ± 0.74	0.74
Inactive	86.98 ± 0.10	87.38 ± 0.10	87.70 ± 0.10	86.91 ± 0.10	0.98
Unknown	0.65 ± 0.03	0.14 ± 0.03	0.15 ± 0.03	0.27 ± 0.03	0.40