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Evaluation of Pellet Binders on Pellet Durability Index of a High-Fat Swine Diet

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Summary

The objective of this study was to evaluate the addition of different pellet binders on pellet quality of a grower swine diet by measuring pellet durability index (PDI). Dietary treatments consisted of a corn-soybean meal-based control diet with 20% dried distillers grains with solubles and 4% choice white grease, the control diet with 0.6% lignosulfonate (AMERI-BOND 2X; LignoTech USA Inc.; Rothschild, WI), or the control diet with increasing levels of a pasta by-product (2.5, 5.0, or 10.0%; International Ingredients, St. Louis, MO). Pellet binders were added to the control diet in the place of corn to create dietary treatments. Each treatment was pelleted in 333 lb batches at 3 separate periods to provide 3 replications per treatment. Pelleting run was considered the experimental unit and time of processing served as the blocking factor. Order of pelleting dietary treatments was randomized within each time period. Corn was ground to approximately 600 μm . Diets were pelleted via steam conditioning (10- × 55-in. Wenger twin staff conditioner, Model 150) and using a 30-horsepower pellet mill (1012-2 HD Master Model, California Pellet Mill) with a 5/32- × 1-in. pellet die. During each processing run, pellet samples were collected throughout the run and immediately placed in an experimental counter-flow cooler for 10 minutes. After cooling, samples were analyzed for pellet durability index using the Holmen NHP 100 (TekPro Ltd, Norfolk, UK) for 30 seconds. There was no evidence ($P > 0.172$) of difference for the effect of treatment on conditioner temperature, hot pellet temperature, or production rate. The average conditioner temperature, hot pellet temperature, and production rate were 185.9°F, 188.2°F, and 1,364 lb/h, respectively. The diet containing lignosulfate improved ($P < 0.001$) PDI compared to the control diet. Increasing pasta by-product from 2.5 to 10% increased the PDI ($P < 0.01$) compared with the control diet. Diets containing 2.5% pasta by-product had lower PDI compared to those with lignosulfonate, diets with 5% pasta by-product and lignosulfonate had similar PDI, and diets containing 10% pasta by-product had increased PDI compared to the lignosulfonate treatment. In conclusion, adding pellet binders to the high fat finisher diets improved PDI by 7.4 to 10.7%. Adding 5% pasta by-product improved PDI similar to that of lignosulfonate and adding 10% pasta by-product further improved PDI compared to lignosulfonate.

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Introduction

Swine diets are pelleted to improve bulk density, transportation characteristics of feeds, reduce ingredient segregation during handling, decrease dust levels, reduce feed intake, increase weight gain, and improve feed utilization.³ However, in order to maintain this advantage pellets must be of high quality. Previous research indicated that nursery pigs fed diets with poor quality pellets reduced feed efficiency to levels similar to those of the mash control diet.⁴ Many factors affect pellet quality, including ingredient particle size, formulation, and processing variables, such as conditioning temperature and duration, screw configuration and speed, and mash moisture. Pellet binders can be added to the diet to reduce the amount of pellet fines generated during handling after extrusion through the pellet diet. Current commercially available binders can be classified in the following categories: 1) lignin-based binders; 2) hemi-cellulose binders; 3) mineral binders/clays; and 4) specialty binders (gums, starches, formulated products, etc.). A variety of pellet binders have been tested, with a limited number being widely used within the swine industry. One of the more common pellet binders used in animal feeds is lignosulfonate (AMERI-BOND 2X; LignoTech USA Inc., Rothschild, WI). In addition, new by-products from the food industry are becoming available for use as pellet binders. Therefore, the objective of this study was to determine the effects of lignosulfonate and 3 different concentrations of a pasta by-product on pellet quality by measuring pellet durability index.

Procedures

The experiment was conducted at the Kansas State University O.H. Kruse Feed Technology Innovation Center in Manhattan, KS. Dietary treatments consisted of a corn-soybean meal-based control with 20% dried distillers grains with solubles and 4% choice white grease, the control diet with 0.6% lignosulfonate (AMERI-BOND 2X; LignoTech USA Inc., Rothschild, WI), or the control diet with increasing levels of a pasta by-product (2.5, 5.0, or 10.0%; International Ingredients Corporation, St. Louis, MO). Pellet binders were added to the control diet in the place of corn to create dietary treatments. Each treatment was pelleted in 333-lb batches at 3 separate periods to provide 3 replications per a treatment. Therefore, a 1,000-lb batch of each diet was mixed in a 1-ton mixer (Hayes & Stolz, Fort Worth, TX) and divided into 3 replicates. Pelleting run was considered the experimental unit and time of processing served as the blocking factor. Order of pelleting dietary treatments was randomized within each time period. Corn was ground to approximately 600 μm . Diets were pelleted via steam conditioning (10- \times 55-in. Wenger twin shaft pre-conditioner, Model 150) and using a 30-horsepower pellet mill (1012-2 HD Master Model, California Pellet Mill) with a 5/32- \times 1-in. pellet die. During each processing run, pellet samples were collected throughout the run and immediately placed in an experimental counter-flow cooler for 10 minutes. After cooling, samples were analyzed for PDI using the Holmen NHP 100 for 30 seconds. For analysis of PDI, cooled pellet samples were collected and the fines were sifted off by using the No. 6 sieve stack. Sifted pellets were then split using a riffle divider and 100-g sample was collected and weighed for analysis. The 100-g

³Vanschoubroek, F., L. Coucke, R. Van Spaendonck. 1971. The quantitative effect of pelleting feed on the performance of piglets and fattening pigs. *Nutr. Abstracts and Rev.* 41:1-9.

⁴Nemechek, J. E., M. D. Tokach, S. S. Dritz, E. D. Fruge, E. L. Hansen, R. D. Goodband, J. M. DeRouchey, J. C. Woodworth. 2015. Effects of diet form and feeder adjustment on growth performance of nursery and finishing pigs. *J. Anim. Sci.* 93:4172-4180.

sample was placed into the hopper of the Holmen 100 and the desired run time selected (30 seconds). Once completed, the sample was removed from the hopper and weighed. PDI was calculated by dividing this final sample weight by the 100-g initial sample weight.

Results and Discussion

There was no evidence ($P > 0.172$) of difference for the effect of treatment on conditioner temperature, hot pellet temperature, or production rate. The average conditioner temperature, hot pellet temperature, and production rate were 185.9°F, 188.2°F, and 1,364 lb/h, respectively. There was an overall effect ($P < 0.001$) of dietary treatment on PDI. Diets containing pellet binders had improved ($P < 0.05$) PDI compared to the control diets. Increasing the concentration of pasta by-product from 2.5 to 10% increased ($P < 0.05$) the PDI. Diets containing 2.5% pasta by-product had decreased ($P < 0.05$) PDI compared to those with lignosulfonate, diets with 5% pasta by-product and lignosulfonate had similar PDI, and diets containing 10% pasta by-product having increased ($P < 0.05$) PDI compared to the lignosulfonate treatment.

Diet composition of ingredients influences approximately 23 to 40% of pellet quality. Pellet binders are ingredients that are added to diets in small concentrations but can have a large impact on the pelleting process and subsequent pellet quality. Lignosulfonates are a common binder currently used in the feed industry. When lignosulfonate comes in contact with the moisture from steam in the conditioning process it becomes sticky and helps bind ingredients together. In this study, adding 0.6% lignosulfonate to the diet increased the PDI by 10.7% compared to the control diet. In addition to pellet binders, by-product ingredients can influence pellet quality. These ingredients are composed of varying concentrations of starch, protein, sugar, non-starch-polysaccharides, fat, fiber, inorganic matter, and water. All of these constituents can influence the pelleting process and subsequent pellet quality. Pasta by-product is an alternative ingredient that is not commonly used in the swine industry. Pasta by-product is largely comprised of wheat flour, which serves as a pellet binder and also provides essential nutrients for the pig. When added to the diet at increasing concentrations (2.5, 5, and 10%) it improved PDI by 7.4, 11.6, and 14.4%. Diets with 5% pasta by-product had similar PDI compared to those containing 0.6% lignosulfonate and diets with 10% pasta by-product further improved PDI by 3.7%.

Table 1. Diet composition (as-fed basis)¹

Ingredient, %	Finisher diet
Corn	67.69
Soybean meal, 46.5% crude protein	5.80
Distillers dried grains with solubles	20.00
Choice white grease	4.00
Monocalcium phosphate, 21% P	0.85
Calcium carbonate	0.75
Sodium chloride	0.35
L-Lysine-HCl	0.35
L-Threonine	0.04
L-Tryptophan	0.03
Trace mineral premix	0.08
Vitamin premix	0.08
Total	100
Calculated analysis	
Total lysine, %	0.66
Metabolizable energy, kcal/lb	1,593
Crude protein, %	14.2
Calcium, %	0.51
STTD P, ² %	0.31

¹Pellet binders were added in the place of corn to create dietary treatments.

²STTD P = standardized total tract digestible phosphorus.

Table 2. Evaluation of pellet binders on pellet durability index (PDI) of a high-fat finisher swine diet¹

Item	Control	Lignosulfonate	Pasta by-product, %			SEM	Probability, <i>P</i> <
			2.5	5	10		Treatment
Conditioner temperature, °F	186.0	185.7	185.9	185.8	186.0	0.19	0.760
Hot pellet temperature, °F	188.0	187.8	188.5	188.7	188.2	0.57	0.583
Production rate, lb/h	1,363	1,370	1,375	1,354	1,359	6.9	0.172
Pellet durability index, ² %	49.8 ^a	60.5 ^c	57.2 ^b	61.4 ^{cd}	64.2 ^d	3.8	0.001

¹Diets were steam pelleted (10 in. width × 55 in. length Wegner twin staff pre-conditioner, Model 150) at on a 1-ton 30-horsepower pellet mill (1012-2 HD Master Model, California Pellet Mill) with a 5/32- × 1-in. pellet die over 3 days of replication.

²A 100-g sample was placed into the hopper of the Holmen 100 and processed for 30 seconds. The sample was then removed from the hopper and weighed. Pellet durability index was calculated by dividing the final sample weight by the 100-g initial sample weight.

^{a,b,c,d}Means within a row with different superscripts differ (*P* < 0.05).