Kansas Agricultural Experiment Station Research Reports

Volume 5
Issue 8 *Swine Day*

Article 36

2019

Effects of Conditioning Temperature on Pellet Quality of Nursery Pig Diets

G. E. Nichols
Kansas State University, gage500@k-state.edu

C. R. Stark
Kansas State University, Manhattan, crstark@ksu.edu

A. M. Ogles
Kansas State University, amogles@k-state.edu

See next page for additional authors

Recommended Citation

Nichols, G. E.; Stark, C. R.; Ogles, A. M.; Dunmire, K. M.; and Paulk, C. B. (2019) "Effects of Conditioning Temperature on Pellet Quality of Nursery Pig Diets," *Kansas Agricultural Experiment Station Research Reports*: Vol. 5: Iss. 8. https://doi.org/10.4148/2378-5977.7866

Effects of Conditioning Temperature on Pellet Quality of Nursery Pig Diets

Abstract

The objective of this experiment was to determine the effect of conditioning temperature on pellet durability index (PDI) and pellet hardness. A phase 1 swine nursery diet was formulated to contain 25% spray-dried whey. The diet was manufactured and pelleted at the Kansas State University O.H. Kruse Feed Technology and Innovation Center, Manhattan, KS. The treatments consisted of three different conditioning temperatures: 130, 145, and 160°F. Diets were steam conditioned (10 in width × 55 in length Wenger twin staff pre-conditioner, Model 150) for approximately 30 sec on a 1-ton 30-horsepower pellet mill (1012-2 HD Master Model, California Pellet Mill) with a 3/16 in × 1 1/4 in pellet die (L:D 6.7). Treatments were pelleted at 3 separate time points to provide 3 replicates per treatment. Samples were collected directly after discharging from the pellet mill and cooled in an experimental counterflow cooler. Samples were analyzed for PDI using the Holmen NHP 100 (TekPro Ltd, Norfolk, UK) in duplicate for each replicate. Pellet hardness was determined by evaluating the peak amount of force applied before the first signs of fracture. Pellets were crushed perpendicular to their longitudinal axis using a texture analyzer. A total of 30 pellets of similar length were selected at random from each replication to be tested and the force needed to crush each pellet was averaged within replication. Although conditioning temperature was increased in a linear fashion, a quadratic increase ($P < 0.002$) in hot pellet temperature was observed. Increasing conditioning temperature resulted in increased (linear, $P < 0.045$) PDI and pellet hardness. There was a tendency for a low correlation ($P < 0.076$, $r = 0.618$, $r^2 = 0.382$) between pellet hardness and PDI. Overall, increasing the conditioning temperature increased both pellet hardness and pellet durability; however, these two responses were not strongly correlated. Future research and more data need to be generated to determine the relationship between PDI and pellet hardness at varying levels of pellet quality to determine what factors influence this relationship.

Keywords

Pellet Quality, Pellet Hardness, Conditioning Temperature

Authors

G. E. Nichols, C. R. Stark, A. M. Ogles, K. M. Dunmire, and C. B. Paulk

Effects of Conditioning Temperature on Pellet Quality of Nursery Pig Diets

Gage E. Nichols,[1] Charles R. Stark,[1] Aundria M. Ogles,[1] Kara M. Dunmire,[1] and Chad B. Paulk[1]

Summary

The objective of this experiment was to determine the effect of conditioning temperature on pellet durability index (PDI) and pellet hardness. A phase 1 swine nursery diet was formulated to contain 25% spray-dried whey. The diet was manufactured and pelleted at the Kansas State University O.H. Kruse Feed Technology and Innovation Center, Manhattan, KS. The treatments consisted of three different conditioning temperatures: 130, 145, and 160°F. Diets were steam conditioned (10 in width × 55 in length Wenger twin staff pre-conditioner, Model 150) for approximately 30 sec on a 1-ton 30-horsepower pellet mill (1012-2 HD Master Model, California Pellet Mill) with a 3/16 in × 1 1/4 in pellet die (L:D 6.7). Treatments were pelleted at 3 separate time points to provide 3 replicates per treatment. Samples were collected directly after discharging from the pellet mill and cooled in an experimental counterflow cooler. Samples were analyzed for PDI using the Holmen NHP 100 (TekPro Ltd, Norfolk, UK) in duplicate for each replicate. Pellet hardness was determined by evaluating the peak amount of force applied before the first signs of fracture. Pellets were crushed perpendicular to their longitudinal axis using a texture analyzer. A total of 30 pellets of similar length were selected at random from each replication to be tested and the force needed to crush each pellet was averaged within replication. Although conditioning temperature was increased in a linear fashion, a quadratic increase ($P < 0.002$) in hot pellet temperature was observed. Increasing conditioning temperature resulted in increased (linear, $P < 0.045$) PDI and pellet hardness. There was a tendency for a low correlation ($P < 0.076$, $r = 0.618$, $r^2 = 0.382$) between pellet hardness and PDI. Overall, increasing the conditioning temperature increased both pellet hardness and pellet durability; however, these two responses were not strongly correlated. Future research and more data need to be generated to determine the relationship between PDI and pellet hardness at varying levels of pellet quality to determine what factors influence this relationship.

Introduction

Pelleting has been shown to improve weanling pig performance and reduced feed wastage. Poor pellet quality, however, can reduce feed efficiency in nursery pigs. Therefore, it is important to track pellet quality by testing PDI to ensure whole pellets reach the pigs after mechanical stress on pellets during transportation. The current standard

[1] Department of Grain Science and Industry, College of Agriculture, Kansas State University.

used to evaluate feed pellet quality is the pellet durability index (PDI) method. The PDI is a calculation of the percent of whole pellets that are left after the use of a machine to physically damage pellets. There are currently two common methods of testing pellet durability, the first is the use of a Holmen forced air pellet durability tester and the other is the use of a mechanical tumble box.

As feed manufacturers strive to maximize pellet quality, there is a concern that the overall hardness of pellets could influence pig performance. It is hypothesized that feed intake may be reduced in nursery pigs once a certain degree of pellet hardness is achieved, but currently there are no data to support this hypothesis. Before feeding trials can be conducted, data need to be collected to identify which factors affect pellet hardness as it compares to PDI. Therefore, the objective of this experiment was to determine the effect of conditioning temperature of an early phase nursery diet on pellet hardness, and the relationship between the two.

Procedures

A phase 1 nursery pig diet was manufactured at the Kansas State University O.H. Kruse Feed Technology and Innovation Center, Manhattan, KS. The diet was based on corn, soybean meal, and dried whey (Table 1). Prior to pelleting, diets were steam conditioned at three temperatures, 130, 145, and 160°F, to achieve three separate treatments. Diets were steam conditioned (Wenger twin staff pre-conditioner, Model 150) for 30 sec and subsequently pelleted using a 30-horsepower pellet mill (1012-2 HD Master Model, California Pellet Mill) equipped with a 3/16 in × 1 1/4 in pellet die (L:D 6.7). The pellet mill feeder rate was set to achieve approximately 1 ton per hour. There were three separate pelleting runs, within each of the three treatments to provide three replications per treatment. During each processing run, pellet samples were collected throughout the run and immediately placed in an experimental counter-flow cooler for 15 minutes. Conditioning temperature, hot pellet temperatures, and production rates were collected during each pelleting run. All production rates were measured to be similar at 33 lb/min.

Two samples from each replication were analyzed for PDI using the Holmen NHP 100 (TekPro Ltd, Norfolk, UK) for 60 sec. For analysis of PDI, cooled pellet samples were collected, and the fines were sifted off by using a U.S. #5 screen to remove all fines, and 100-g samples were collected and weighed for analysis. The 100-g sample was placed into the hopper of the Holmen NHP 100 and the desired run time selected (60 sec). Once completed, the hopper was emptied, the samples were sifted again over a U.S. #5 screen, and the remaining pellets were weighted for calculation of PDI.

Pellet hardness was measured using a Model TA-XT2 Texture Analyzer (Stable Micro Systems, Surrey, UK). The force required to crush a pellet was determined by evaluating the peak amount of force applied before the signs of first fracture. Thirty pellets of similar length were analyzed from each of the replications for a total of 270 samples. Pellets were crushed perpendicular to their longitudinal axis.[2]

---

[2] Fahrenholz, A.C. 2012 Evaluating Factors Affecting Pellet Durability and Energy Consumption in a Pilot Feed Mill and Comparing Methods for Evaluating Pellet Durability. Ph.D. Dissertation. Kansas State University, Manhattan, KS.

Data were analyzed using the GLIMMIX procedure of SAS version 9.4 (SAS Institute, Inc., Cary, NC) with pelleting run as the experiment unit. Means were evaluated using linear and quadratic CONTRAST statements for equality space treatments. Results were considered significant at $P \leq 0.05$.

Results and Discussion

Early phase nursery pig diets are pelleted at lower temperatures compared to traditional corn-soybean meal diets. This is due to the increased concentrations of whey in early nursery diets. Added whey in the diet leads to increased moisture absorption from the steam and can cause the pellet mill rolls to slip and potentially plug at higher temperatures. In this experiment, diets were pelleted with a conditioning temperature up to 160°F and hot pellet temperature (HPT) up to 166°F without roll slippage or plugging. Increasing the conditioning temperature from 130 to 160°F resulted in a quadratic increase (quadratic, $P < 0.002$) in hot pellet temperature (Table 2). Therefore, as conditioning temperature increased from 130 to 160°F, HPT increased from 155 to 166°F, respectively. Increasing conditioning temperature increased (linear, $P < 0.045$) PDI and pellet hardness. There was a tendency for a minor correlation ($P < 0.076$, $r = 0.618$, $r^2 = 0.382$) between pellet hardness and PDI (Figure 1). Replicates with PDI ranging from 90 to 93% had corresponding pellet hardness ranging from 30.9 to 37.6 lb.

In conclusion, increasing the conditioning temperature increased both pellet hardness and pellet durability, however, these two responses were not strongly correlated. Future research and more data need to be generated to determine the relationship between PDI and pellet hardness at varying levels of pellet quality, and what factors influence this relationship.

Table 1. Diet composition (as-is)

Ingredient	%
Corn	42.05
Soybean meal, 46.5% crude protein	17.42
Spray-dried whey	25.00
Fish meal	4.50
HP 300[1]	5.00
Choice white grease	3.00
Limestone	0.40
Monocalcium P, 21% P	0.50
Sodium chloride	0.30
L-Lysine-HCl	0.41
DL-Methionine	0.21
L-Threonine	0.18
L-Tryptophan	0.04
L-Valine	0.13
Trace mineral premix	0.15
Vitamin premix	0.25
Choline chloride 60%	0.05
Phytase[2]	0.03
Zinc oxide	0.39
Total	100.00
Calculated analysis	
Standardized ileal digestible (SID) amino acids, %	
Lysine	1.40
Isoleucine:lysine	57
Leucine:lysine	110
Methionine:lysine	37
Methionine and cysteine:lysine	56
Threonine:lysine	63
Tryptophan:lysine	19.3
Valine:lysine	70
Histidine:lysine	32
Total lysine, %	1.54
Metabolizable energy, kcal/lb	1579
SID Lys:net energy, g/Mcal	5.32
Crude protein, %	21.1
Calcium, %	0.74

[1]Hamlet Protein, Finlay, OH.
[2]DSM Ronozyme HiPhos 2700, Parsippany, NJ.

Table 2. Effect of conditioning temperature on hot pellet temperatures, PDI, and pellet hardness[1]

	Conditioning temperature, °F				Probability, <	
	130	145	160	SEM	Linear	Quadratic
Hot pellet temperature, °F	154.8	161.7	166.0	0.14	0.001	0.002
Pellet durability index,[2] %	86.8	88.6	91.5	1.32	0.045	0.773
Pellet hardness,[3] lb	29.7	32.2	35.1	1.00	0.019	0.862

[1]Diets were steam conditioned (10 in width × 55 in length Wenger twin staff pre-conditioner, Model 150) for approximately 30 sec at 3 conditioning temperatures (170, 180, and 190°F) on a 1-ton 30-horsepower pellet mill (1012-2 HD Master Model, California Pellet Mill) with a 3/16 in × 1 1/4 in pellet die (L:D 6.7). Treatments were pelleted at 3 separate time points to provide 3 replicates per treatment.
[2]The pellet durability index (PDI) was tested using the Holmen NHP 100 (TekPro Ltd, Norfolk, UK) for 60 sec.
[3]Pellet hardness was tested using a Model TA-XT2 Texture Analyzer (Stable Micro Systems, Surrey, United Kingdom) to determine the force at first fracture.

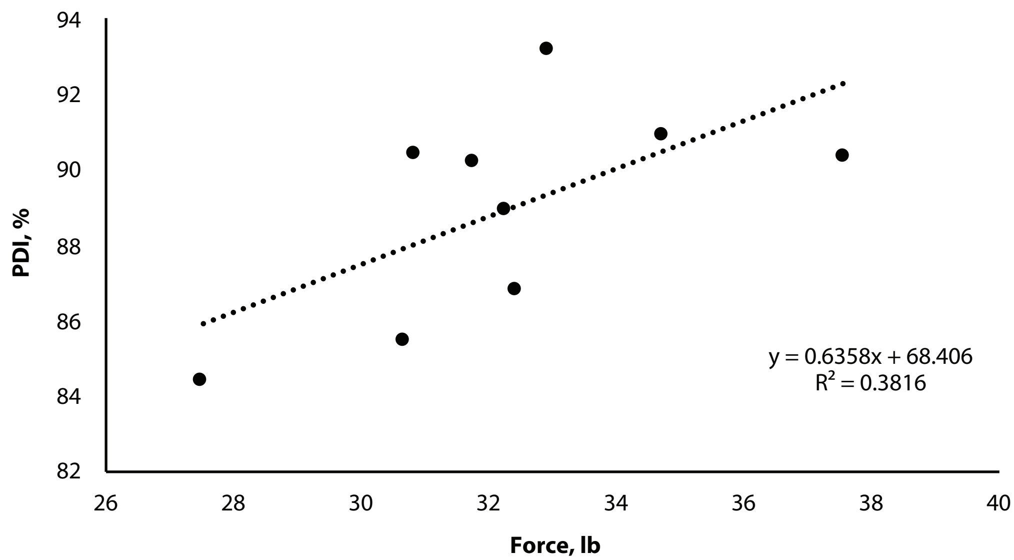

Figure 1. The relationship of pellet hardness (Force) and pellet durability index (PDI).