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The Effect of Pellet Mill Production Rate and Knife Distance on Pellet Quality

C. E. Evans
Kansas State University, caitlinevans@k-state.edu

R. J. Beeman
Kansas State University, rbeeman25@k-state.edu

M. Saensukjaroenphon
Kansas State University, Manhattan Kansas, maruts@ksu.edu

See next page for additional authors

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The Effect of Pellet Mill Production Rate and Knife Distance on Pellet Quality

Abstract

Longer pellet lengths may lead to decreased pellet breakage, resulting in increased pellet durability index (PDI). Thus, the objective of this experiment was to determine the effects of production rate and knife distance on pellet length and subsequent pellet quality. Treatments were arranged in a 2 × 3 factorial with two production rates (16 and 33 lb/min) and three knife distances (0.25, 0.50, and 0.75 in). All diets were conditioned at 185°F and pelleted using a CPM pellet mill (Model 1012-2 HD, California Pellet Mill Co., Crawfordsville, IN) equipped with a 0.19 in × 1.25 in die. The production rate (PR) and knife distance (KD) were randomized to minimize the effects of pelleting and sampling order. There were 3 replicates per treatment. Samples were analyzed for pellet length, percentage fines, and PDI using the standard and modified tumble box method (STD and MOD, respectively) and Holmen NHP100 (TekPro Ltd, Norfolk, UK) with a 60-sec run time. Data were analyzed using the GLIMMIX procedure of SAS (v. 9.4, SAS Inst. Inc., Cary, NC). There was no evidence for an interaction between PR and KD for all analyzed variables ($P >$ 0.24). The 16 lb/min PR yielded a longer pellet ($P \leq 0.05$) compared to the 33 lb/min PR. The PR had no effect on percentage fines ($P > 0.10$); however, decreasing the PR tended to increase PDI regardless of analytical method ($P \leq 0.10$). Increasing KD resulted in longer ($P < 0.01$) pellets and decreased ($P < 0.01$) percentage fines. Reducing KD to 0.25 in reduced PDI compared to 0.50 in and 0.75 in treatments, which yielded similar PDI. In conclusion, pellet quality can be improved by increasing the pellet length from 0.19 to 0.34 in (KD 0.25 and 0.75 in, respectively).

Keywords

pellet quality, pellet length, knife distance, production rate

Authors

C. E. Evans, R. J. Beeman, M. Saensukjaroenphon, C. B. Paulk, and C. R. Stark

The Effect of Pellet Mill Production Rate and Knife Distance on Pellet Quality

Caitlin E. Evans,[1] Reid J. Beeman, Marut Saensukjaroenphon, Chad B. Paulk, and Charles R. Stark

Summary

Longer pellet lengths may lead to decreased pellet breakage, resulting in increased pellet durability index (PDI). Thus, the objective of this experiment was to determine the effects of production rate and knife distance on pellet length and subsequent pellet quality. Treatments were arranged in a 2 × 3 factorial with two production rates (16 and 33 lb/min) and three knife distances (0.25, 0.50, and 0.75 in). All diets were conditioned at 185°F and pelleted using a CPM pellet mill (Model 1012-2 HD, California Pellet Mill Co., Crawfordsville, IN) equipped with a 0.19 in × 1.25 in die. The production rate (PR) and knife distance (KD) were randomized to minimize the effects of pelleting and sampling order. There were 3 replicates per treatment. Samples were analyzed for pellet length, percentage fines, and PDI using the standard and modified tumble box method (STD and MOD, respectively) and Holmen NHP100 (TekPro Ltd, Norfolk, UK) with a 60-sec run time. Data were analyzed using the GLIMMIX procedure of SAS (v. 9.4, SAS Inst. Inc., Cary, NC). There was no evidence for an interaction between PR and KD for all analyzed variables ($P > 0.24$). The 16 lb/min PR yielded a longer pellet ($P \leq 0.05$) compared to the 33 lb/min PR. The PR had no effect on percentage fines ($P > 0.10$); however, decreasing the PR tended to increase PDI regardless of analytical method ($P \leq 0.10$). Increasing KD resulted in longer ($P < 0.01$) pellets and decreased ($P < 0.01$) percentage fines. Reducing KD to 0.25 in reduced PDI compared to 0.50 in and 0.75 in treatments, which yielded similar PDI. In conclusion, pellet quality can be improved by increasing the pellet length from 0.19 to 0.34 in (KD 0.25 and 0.75 in, respectively).

Introduction

Pellet quality is generally defined as the ability of the pellet to withstand mechanical handling without excessive breakage and fines generation. Pellet durability index (PDI) is one of the most common parameters used to measure pellet quality and indicates the percentage of intact pellets remaining after undergoing mechanical handling during manufacturing and delivery. Extensive research has been conducted on the factors affecting pellet quality with much of the emphasis being placed on diet formulation, particle size, die specification, and cooling. Much of this research, however, fails to consider the length of the pellets. This may lead to incorrect assumptions, as longer

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

pellet lengths have been previously shown to increase PDI.[2] Additionally, it is thought that moving the knife closer to the die to yield shorter pellets may increase the fines to pellet ratio. However, to our knowledge, there are little data to substantiate these claims. Thus, the objective of this experiment was to determine the effects of production rate and knife distance on pellet quality.

Procedures

A corn-soybean meal-based grower diet (Table 1) was manufactured in accordance with CGMPs (Current Good Manufacturing Practices) at Kansas State University O.H. Kruse Feed Technology Innovation Center in Manhattan, KS. Treatments were arranged in a 2 × 3 factorial with two production rates (16 and 33 lb/min) and three knife distances from the die (0.25, 0.50, and 0.75 in). It was previously determined that 33 lb/min was the maximum throughput for the diet with the second production rate chosen as approximately half of the maximum production rate. Diets were conditioned at 185°F and pelleted using a CPM pellet mill (Model 1012-2 HD, California Pellet Mill Co., Crawfordsville, IN) equipped with a 0.19 in × 1.25 in die with a L:D ratio of 6.6. The production rate (PR) and knife distance (KD) were randomized to minimize the effects of pelleting and sampling order. There were 3 replicates per treatment.

Samples were collected during each run and cooled using ambient air in a counter-flow cooler for 12 min. Samples were stored in tri-layer paper feed sacks for 24 h prior to analysis. To determine pellet length, 100 pellets were randomly selected from each replicate and measured using digital scientific calipers. Length measurements were then averaged across the replicate. The percentage of fines was determined by sifting a subsample, using a U.S. No. 5 sieve (0.16 in) to separate fines and pellets. Fines were then weighed and expressed as a percentage of the original sample weight. Pellet durability index was determined using the ASAE Standard S269.5 tumble box and modified tumble box methods (STD and MOD, respectively) and Holmen NHP100 (TekPro Ltd, Norfolk, UK). Pellets were sifted using a U.S. No. 5 sieve pre- and post-analysis for all PDI methods. For the tumble box methods, 500 g of sifted pellets were agitated for 500 revolutions, with the modified method including the addition of three 0.75-in hex-nuts to the analysis chamber. The NHP method utilized 100 g of sifted pellets and a 60-sec run time with the use of a filter. The PDI was calculated as the weight of recovered pellets after sifting divided by the initial sample weight and then multiplied by 100 to yield a percent.

Data were analyzed using the GLIMMIX procedure in SAS (v. 9.4, SAS Inst. Inc., Cary, NC). Means were separated using least squares means with results considered significant if $P \leq 0.05$ and a trend if $0.05 < P \leq 0.10$.

Results and Discussion

There was no interaction between PR and KD for all analyzed variables ($P > 0.24$; Table 2). The 16 lb/min PR yielded a longer pellet ($P = 0.01$) compared to the 33 lb/min PR. This potentially resulted because the pellets produced at a faster produc-

[2] S.E. Cutlip, J.M. Hott, N.P. Buchanan, A.L. Rack, J.D. Latshaw, and J.S. Moritz. 2008. The effect of steam conditioning practices on pellet quality and growing broiler nutritional value. J. of Appl. Poult. Res. 17:249-261.

tion rate reached their maximum column length quicker than those produced at the slower production rate, and pellets broke off sooner at a shorter length. Reducing PR tended to improve PDIs (STD, $P = 0.06$; MOD, $P = 0.09$; NHP, $P = 0.07$). Increasing KD from 0.25 to 0.75 inch resulted in longer pellets ($P < 0.01$) and decreased percentage fines ($P < 0.01$). Because fines are defined as any material falling through the designated screen size for that pellet diameter, fines can contain small, broken pellets as well as fine particles. In this study, a U.S. No. 5 sieve measuring 0.16 in was used to separate pellets and fines, which means that as KD and pellet length decreased, the likelihood of shorter pellets passing through the sieve opening increased. This is especially true at 0.25 in KD with an average pellet length of 0.19 in, which is only a difference of 0.03 in from the sifting screen size. The 0.25 in KD had decreased PDI compared to the similar PDI when KD was 0.5 in and 0.75 in. Ultimately, a majority of the improvement in pellet quality was observed when increasing the pellet length from 0.19 to 0.34 in (KD 0.25 and 0.75 in, respectively).

In conclusion, it is important to consider pellet length when designing pellet quality studies or when conducting feeding trials where pellet quality may be a factor. Moreover, decreasing production rate could improve pellet quality.

Table 1. Diet composition (as-is)

Ingredient, %	
Corn	69.22
Soybean meal, 48%	26.48
Choice white grease	1.50
Monocalcium phosphate, 21% P	0.55
Limestone	1.13
Salt	0.35
L-Lysine-HCl	0.31
DL-Methionine	0.07
L-Threonine	0.09
Trace mineral premix	0.15
Vitamin premix	0.15
Total	100.00
Calculated analysis	
Total lysine, %	1.20
Metabolizable energy, kcal/lb	1,526
Crude protein, %	18.70
Calcium, %	0.60
Available phosphorus, %	0.31

Table 2. Main effects of production rate (PR) and knife distance (KD) on pellet length and pellet quality

Main Effect:	PR, lb/min			KD, in				Probability, *P* <		
Item	16	33	SEM	0.25	0.50	0.75	SEM	PR	KD	PR × KD
Pellet length, in[1]	0.34[a]	0.31[b]	0.01	0.19[c]	0.34[b]	0.45[a]	0.01	0.013	<0.001	0.239
Fines, %	26.71	28.88	2.62	65.85[a]	11.33[b]	6.20[c]	4.65	0.539	<0.001	0.269
Pellet durability index, %										
Standard tumble	64.31	59.18	1.74	39.82[b]	70.37[a]	75.05[a]	2.31	0.056	<0.001	0.362
Modified tumble[2]	39.69	34.24	2.16	19.63[b]	42.82[a]	48.45[a]	2.75	0.087	0.001	0.528
NHP[3]	49.92	37.85	4.93	13.83[b]	55.25[a]	62.58[a]	6.26	0.074	0.002	0.810

[1]A total of 100 pellets per replicate were randomly selected and their lengths measured to determine the pellet length.
[2]Standard tumble method with the addition of three 0.75 in hex-nuts per chamber.
[3]Holmen NHP100 with 60-sec run time.