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Abstract

Two experiments were conducted to determine the influence of the tapping bar and sieve agitators (balls and brushes) on determining mean particle size and standard deviation of ground corn. Tapping bar had no influence (P>0.10) on mean and standard deviation; however the presence of balls and brushes on sieves decreased (P<0.002) mean particle size and increased (P<0.0001) standard deviation. These results suggest that balls and brushes should be used when determining mean particle size to assist particle flowability. More research should be conducted to determine the effects of the tapping bar and sieve agitators over a wider range of particle sizes.; Swine Day, Manhattan, KS, November 15, 2001

Keywords

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INFLUENCE OF DIFFERENT EQUIPMENT PROTOCOLS ON PARTICLE SIZE DETERMINATION OF GROUND CORN

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Summary

Two experiments were conducted to determine the influence of the tapping bar and sieve agitators (balls and brushes) on determining mean particle size and standard deviation of ground corn. Tapping bar had no influence (P>0.10) on mean and standard deviation; however the presence of balls and brushes on sieves decreased (P<0.002) mean particle size and increased (P<0.0001) standard deviation. These results suggest that balls and brushes should be used when determining mean particle size to assist particle flowability. More research should be conducted to determine the effects of the tapping bar and sieve agitators over a wider range of particle sizes.

(Key Words: Particle Size, Tapping Bar, Sieve Agitators.)

Introduction

Determining particle size of ground grains is an important part of the quality control program for feed mills and swine producers alike. For feed mills, coarse ground grain is associated with poor mixing characteristics, whereas grinding grain too fine results in greater energy consumption and lower production rates. For swine producers, poorer digestibilities and growth performance are associated with coarse ground grain and poorer feed flowability, increased dustiness, and the development of ulcers are problems associated with feeding grains that are ground too fine. Thus, proper determination of particle size of ground grains will have huge financial impacts for both feed mills and swine producers.

The approved method for determining particle size was outlined in the ASAE publication S319. Since its publication in 1968, different types of equipment to determine particle size have been created and modifications to the original protocol have occurred. The original publication suggests that sieve agitators be used to separate particles on smaller sieves; however, no one has evaluated the influence of these agitators (balls and brushes) on mean and standard deviation determination. The objective of these experiments was to measure the influence of different equipment protocols on the determination of particle size of ground corn.

Procedures

General. Ground corn was used to measure the influence of different equipment protocols on the determination of particle size. Twenty pounds of whole kernel corn was obtained from the Kansas State University Animal Science Feed Mill. The corn was ground to two different particle sizes. Each particle size was then sub-sampled into twenty 200-g aliquots that were passed through a riffle splitter to form two similar 100-g samples. Each of the 100-g samples was then randomly allotted to one of two treatments for Exp. 1 (balls and brushes vs. no balls and brushes) and Exp. 2 (tapping bar vs. no tapping bar). There were 10 replications of each particle size within each treatment for both experiments.

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[1]Food Animal Health and Management Center.

The basic standard operating procedures used at Kansas State University were followed for these experiments. Briefly, 100-g of sample was placed on the top of the sieve stack. The sieve stack contained 13 individual sieves with openings ranging from 3,350 to 53 microns (Table 1). The stack was then placed in the Ro-tap brand shaker machine (W. S. Tyler, Mentor, OH) and shaken for 10 minutes. The machine used at Kansas State University utilizes a tapping bar and shakes the samples at 1,725 rpm. One to 3 balls and/or brushes are placed on top of some sieves as illustrated in Figure 1. Weight of sample remaining on each sieve after the 10 minutes is then used to determine mean particle size and standard deviation.

Experiment 1. The influence of sieves with or without balls and brushes was evaluated. The approved 13-high sieve stack and general standard operating procedure were used. Sieves contained either no balls or brushes or 1 to 3 balls and/or brushes as indicated in Table 1. The tapping bar was used for both treatments.

Experiment 2. The influence of tapping bar was determined in Exp. 2 with samples allotted to either tapping or no tapping bar treatments. Standard operating procedures were used for the tapping bar treatment and the bar was removed for the no tapping bar treatment. Balls and brushes were included on the sieves as described for Exp. 1.

Statistics. Both experiments were analyzed as a completely randomized design with sample as the experimental unit. Paired T-tests were used to compare means of the experimental treatments.

Results and Discussion

For Exp. 1, the presence of balls and brushes reduced ($P<0.002$; Table 2) mean particle size and increased standard deviation compared to samples analyzed without the balls and brushes. For Exp. 2, no differences ($P>0.10$; Table 3) were observed when the tapping bar was removed from the sieve stack for either mean particle size or standard deviation.

These results indicate that the tapping bar did not influence mean particle size or standard deviation of the ground corn samples used in our study (approximately 430 and 650 microns). However, the tapping bar may have an influence on samples that have a mean particle size outside of the range tested in this experiment. Also, mean particle size of samples that tend to be more adherent (higher moisture grains, high-oil varieties, complete diets, etc.) may be influenced by the presence of the tapping bar. More research should be conducted to determine the influence of the tapping bar on mean particle size of a wider range of feedstuffs. Sieve agitators, such as the balls and brushes, influenced both mean and standard deviation of the samples we analyzed. When the balls and brushes were used, mean particle size decreased and standard deviation increased suggesting that the sample was able to pass through the sieves more efficiently than when no balls or brushes were included. The purpose of the balls and brushes is to keep the sieve surface from becoming blocked by particles that can not pass through the openings. They will not break particles to smaller sizes or force particles through the sieve. Different configurations of balls and brushes would also be expected to influence the results, but were not tested in these experiments. Shaker machines that rotate at speeds other than 1,725 rpm are available, and would be expected to influence determination of mean particle size and standard deviation. Unfortunately, we were not able to evaluate the influence of rotation speed on mean particle size and standard deviation.

In conclusion, the tapping bar had no effect on mean particle size or standard deviation of samples tested in this experiment. Sieve agitators such as the balls and brushes used in these experiments should be used when determining mean particle size to assist particle flowability through the sieves. This experiment illustrates the importance of consistently using the correct procedure to determine mean particle size and standard deviation. More research should be conducted to determine the influence of sieve agitators and the tapping bar over a wider range of mean particle sizes and with a greater variety of feedstuffs.

Figure 1. Ro-tap Shaker Machine with Sieve Stack.

Figure 2. Ball and Brush Resting of a Sieve.

Table 1. Sieve Stack and Number of Balls and/or Brushes Included on Each Sieve

Sieve number, US	Opening, microns	Balls, number	Brushes, number
6	3,350	-	-
8	2,360	-	-
12	1,700	3	-
16	1,180	3	-
20	850	3	-
30	600	1	1
40	425	1	1
50	300	1	1
70	212	1	1
100	150	-	1
140	106	-	1
200	75	-	1
270	53	-	1
pan	37	-	-

Table 2. Influence of Balls and Brushes on Mean Particle Size and Standard Deviation of Ground Corn, Exp. 1[a]

Item	Balls and brushes	No balls and brushes	P<
Mean			
Grind 1	665 ± 9.6	755 ± 7.5	0.0001
Grind 2	458 ± 8.5	523 ± 12.4	0.002
Standard Deviation			
Grind 1	2.41 ± 0.012	2.00 ± 0.009	0.0001
Grind 2	2.13 ± 0.017	1.83 ± 0.019	0.0001

[a]Values are the means ± SE of 10 replications per treatment.

Table 3. Influence of Tapping Bar on Mean Particle Size and Standard Deviation of Ground Corn, Exp. 2[a]

Item	Tapping bar	No tapping bar	P<
Mean			
Grind 1	650 ± 2.9	640 ± 7.2	0.22
Grind 2	433 ± 4.7	440 ± 5.1	0.27
Standard Deviation			
Grind 1	2.44 ± .017	2.46 ± .008	0.18
Grind 2	2.24 ± .016	2.24 ± .019	0.95

[a]Values are the means ± SE of 10 replications per treatment.