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COMPARISON OF PARTICLE SIZE ANALYSIS OF GROUND GRAIN WITH, OR WITHOUT, THE USE OF A FLOW AGENT

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Summary

The American Society of Biological and Agricultural Engineers' standard for particle size analysis indicates that the analysis can be conducted with or without the use of a flow agent. Because of this allowed variation in procedures, particle size analysis results can be variable and difficult to interpret, depending on whether the laboratory uses a flow agent or not. Therefore, a retrospective analysis was made of 603 samples of ground corn analyzed for particle size with, or without, 0.5 g of synthetic amorphous precipitated silica (Sipernat® 22-S) per 100 g of sample. Results of both analyses were compared with a Method of Agreement analysis. Results indicated that there was a bias between the two procedures for particle size analysis, but that the bias was consistent across the range of particle sizes evaluated (400 to 1000 µ). Particle size analysis conducted with a flow agent will result in a mean particle size that is approximately 80 µ smaller than the result from analysis without a flow agent. The same procedures were used in comparison of particle size standard deviation. Using a flow agent produced a greater particle size standard deviation value than without a flow agent. Unlike the bias for the particle size analysis, which was consistent for the wide range of samples evaluated, the standard deviation values showed a significant bias. As the standard deviation of the sample increased, the magnitude of difference between the two procedures also became greater. Results of this study indicate that there are differences in results between the two procedures; therefore, selection of one of the two procedures as the official standard is necessary. Also, it is important to know if a flow agent was, or was not, used in the analysis when interpreting results.

(Key Words: Flow Agent, Particle Size, Quality Control.)

Introduction

Particle size analyses of ground grain or complete diets are an important quality control procedure used in both commercial and on-farm feed mills. Reducing the particle size of the diet improves feed efficiency, and it has been calculated that every 100 µ increase in particle size above the recommended 700 µ will cost the producer $0.50 per pig in poorer feed efficiency. Therefore, achieving the proper particle size in swine diets has significant financial implications. The Kansas

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State University Swine Nutrition Laboratory analyzes approximately 800 samples per year for particle size. Numerous commercial laboratories also perform this test. But the American Society of Biological and Agricultural Engineers' standard for particle size analysis indicates that the analysis can be conducted with, or without, the use of a flow agent. Because of allowed variation in procedures, particle size analysis results can be variable and difficult to interpret, depending on whether the laboratory uses a flow agent or not. A flow agent added to the ground grain would help move particles through the screens and potentially result in a finer particle size and greater particle size standard deviation than results from samples analyzed without a flow agent. Therefore, the objective of this study was to compare the results of particle size analysis conducted either with, or without, the use of a flow agent.

Procedures

A retrospective analysis was made of 603 samples of ground corn analyzed for particle size at a commercial laboratory (Midwest Laboratories, Inc., Omaha, NE). The analysis was conducted using a Ro-Tap shaker with a stack of Tyler screens (Table 1). Rubber balls and/or carmichaels (brushes) also were used on top of the various screens. Samples of ground grain were put on the top sieve, and the sieves were shaken with the Ro-Tap for 10 minutes. The amount of material was then weighed, and the results were entered into a spreadsheet that calculated the mean particle size and its standard deviation. Next, a second sample (≈100 g) was mixed with 0.5 g of synthetic amorphous precipitated silica (Sipernat® 22-S) and the procedure was repeated. Results of both analyses were compared with a Method of Agreement analysis. In brief, this statistical procedure is used to compare results of two different analytical procedures.

Table 1. Tyler Sieve Numbers Used in Analysis

Sieve Openings, microns	Tyler Number (meshes/in)	No. of Balls and Brushes
3360	6	---
2380	8	---
1680	10	3 balls
1191	14	3 balls
841	20	1 ball & 1 brush
594	28	1 ball & 1 brush
420	35	1 ball & 1 brush
297	48	1 ball & 1 brush
212	65	1 ball & 1 brush
150	100	1 brush
103	150	1 brush
73	200	1 brush
53	270	1 brush
Pan	---	---

Results

A comparison was made between samples analyzed for particle size with a flow agent (X axis; Figure 1) and without a flow agent (Y axis; Figure 1). The straight line running diagonally through the middle of the chart is included because, if both methods were in perfect agreement, all values should be on this line. In addition, if the values are consistently distributed on either side of the perfect agreement line, this would indicate that one of the procedures is biased or consistently different than the other. In Figure 1, all the samples are above the line, indicating that there is a bias and that using a flow agent will result in a particle size value smaller than will result from using no flow agent. The next procedure was to see if this bias was consistent across the different particle sizes (Figure 2). On the X axis is the average of the two procedures (mean particle sizes of the analysis with and without flow agent). On the Y axis is the actual difference between the two results (particle size with flow agent minus particle size without flow agent). The slope of this line (0.027) trended not to be different than zero ($P = 0.13$), indicating a similar bias across the range of particle sizes tested, but the intercept (-80 µ) was highly significant ($P<0.001$). This indicates that, across the range of particle sizes tested, the analysis with a flow agent will consistently be 80 µ less than the analysis without a flow agent. For example, if the same sample is split and sent to two labs, one lab is using a flow agent and the other lab is not, and the value from the lab using the flow agent is 620 µ, the expected value from the lab not using flow agent is 700 µ.

The same comparison of the particle size standard deviation with, or without, a flow agent was conducted (Figure 3). This compared results of the standard deviation between samples of corn analyzed with a flow agent (X axis) and without a flow agent (Y axis). Using a flow agent will produce a greater standard deviation value than not using a flow agent. The diagonal through the center of the chart would represent a perfect comparison between the two procedures. The Method of Analysis procedure then compared the average of the two procedures (Figure 4; X axis = mean of the particle size standard deviations, with and without flow agent) with the actual difference between the two results (Y axis = standard deviation with flow agent minus standard deviation without flow agent). Unlike the bias for the particle size analysis, which was very consistent for the wide range of samples evaluated, the standard deviation values showed a significant bias. There was strong evidence ($P<0.05$) that the slope of this line (0.4596) was different than zero, indicating that the magnitude of difference between the two procedures increased as the standard deviation of the sample increased.

Discussion

Particle size analysis is an economically important quality control component of a feeding program. In addition, particle size standard deviation is an indicator of the flow ability of the diet. Because the American Society of Biological and Agricultural Engineers' standard for particle size analysis is not specific for the use of a flow agent, this can lead to variation in how results are interpreted. The results for mean particle size analysis between the two methods seem to have good agreement. Although there is an 80-µ difference, this bias could be adjusted for when comparing or reporting results. Because research studies evaluating the effects of particle size on pig performance are conducted on grain or feed samples analyzed without a flow agent, reporting results obtained with a flow agent is confusing, unless those results are adjusted (by adding 80 microns).

For particle size standard deviation, the little data that has been collected evaluating its effects on feed flow ability has been collected by measuring standard deviation without a flow agent. For this parameter, there is no opportunity to standardize the results of one procedure to those of the other. Therefore, if specifying an acceptable particle size standard deviation, the method of analysis (with or without flow agent) must also be specified.

In conclusion, one might argue whether the use of a flow agent may or may not provide a "better" evaluation of a sample's particle size or particle size standard deviation than not using a flow agent. The use of a flow agent facilitates the movement of particles through the screens, resulting in a finer particle size and greater standard deviation of the sample, compared with not using a flow agent. To the best of our knowledge, all existing data reporting the effects of particle size and its standard deviation on growth performance and diet flow ability have been conducted without the use of a flow agent. Thus, use of a flow agent in analysis would require some type of conversion when interpreting or comparing results. Because there are differences in results between the two procedures, official standard methods of feed grain particle size analysis need clarification. Also, when evaluating particle size analysis results across laboratories, it is important in interpretation of results to know if a flow agent has been used in the analysis.

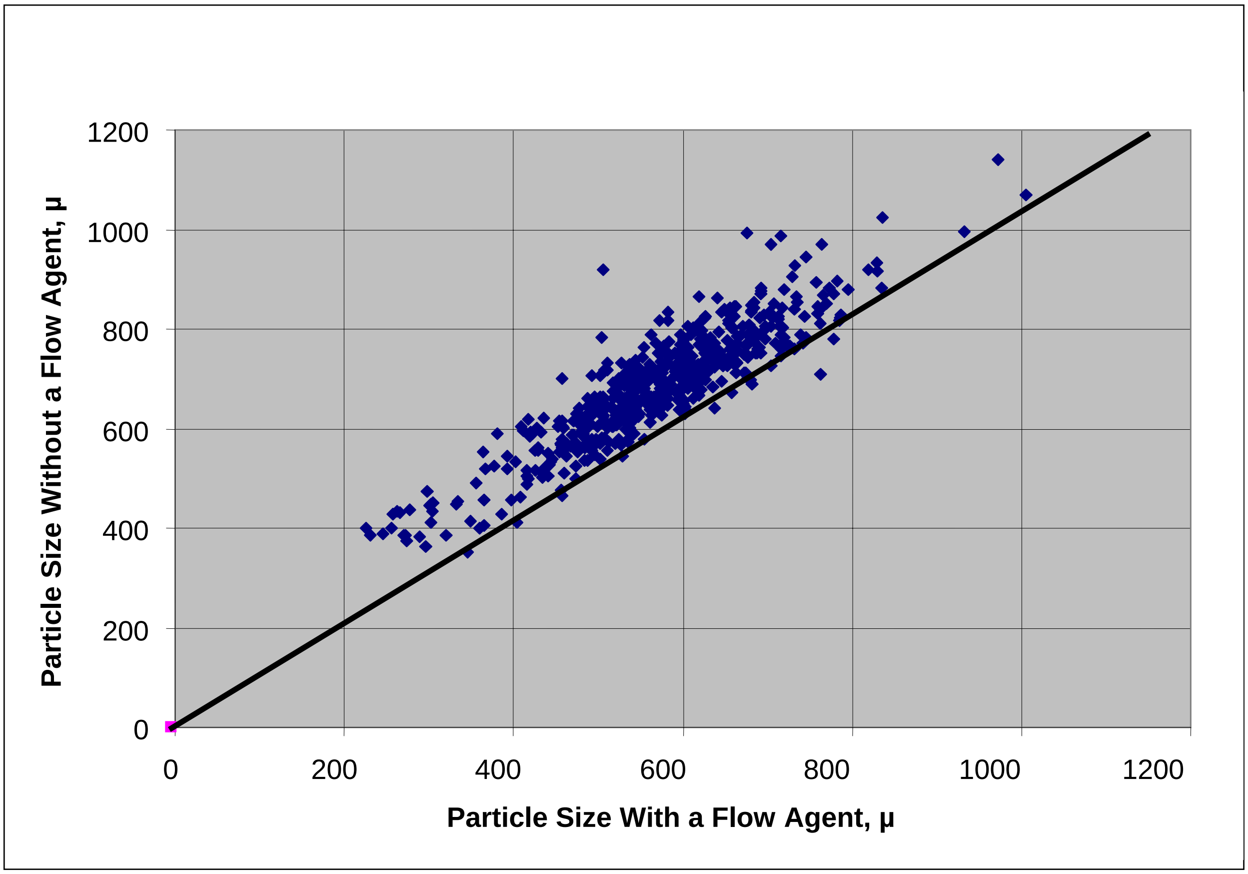

Figure 1. Comparison Between Analysis of Corn Particle Size With, and Without, a Flow Agent.

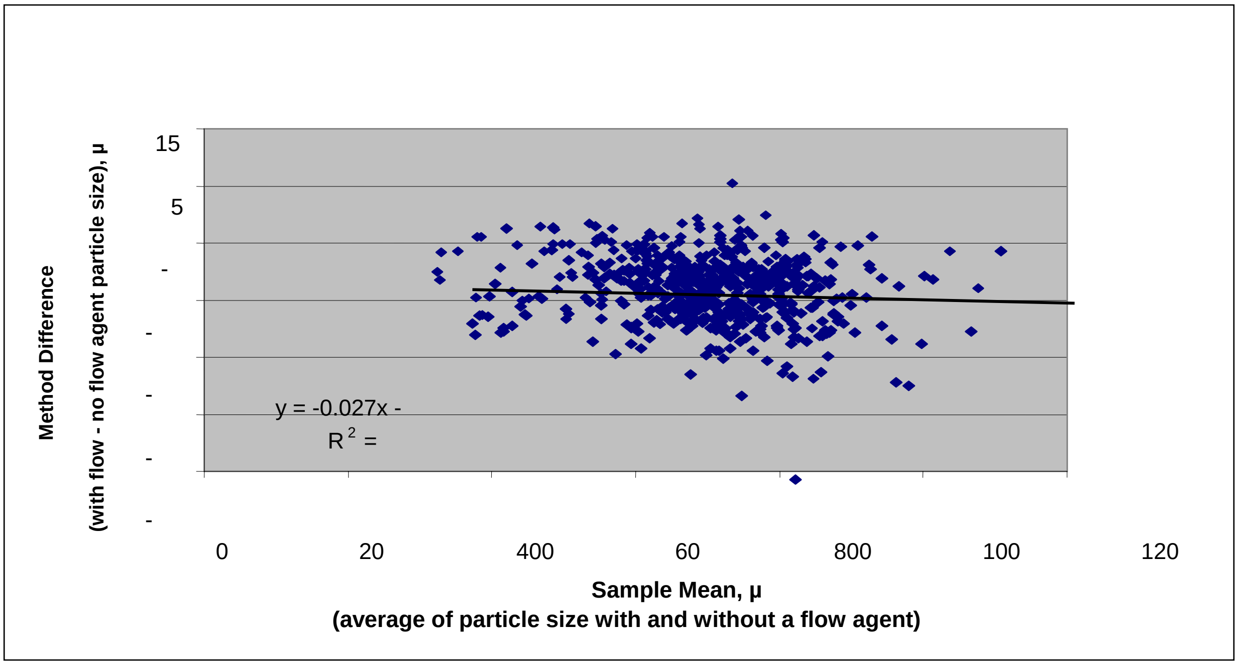

Figure 2. Method of Agreement Between Particle Size Analysis With, and Without, a Flow Agent.

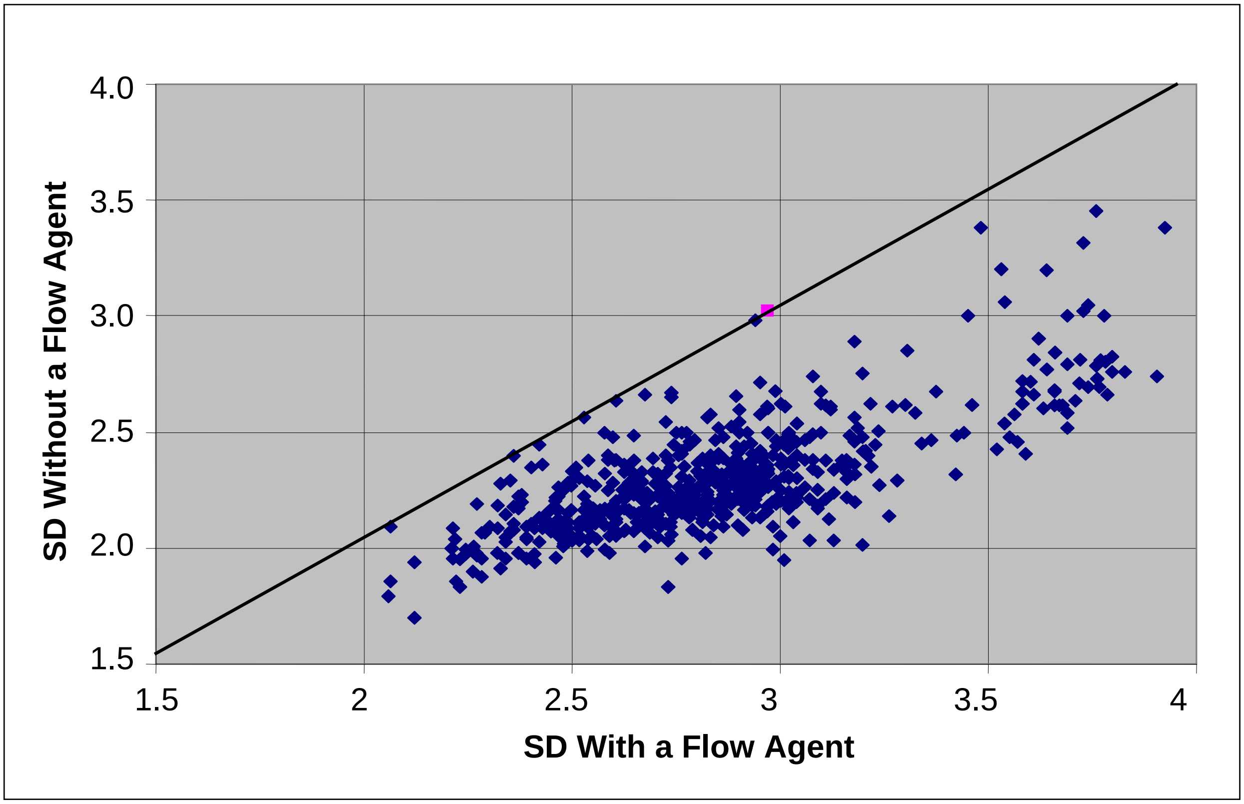

Figure 3. Comparison Between Corn Particle Size Standard Deviation (SD) With, and Without, a Flow Agent.

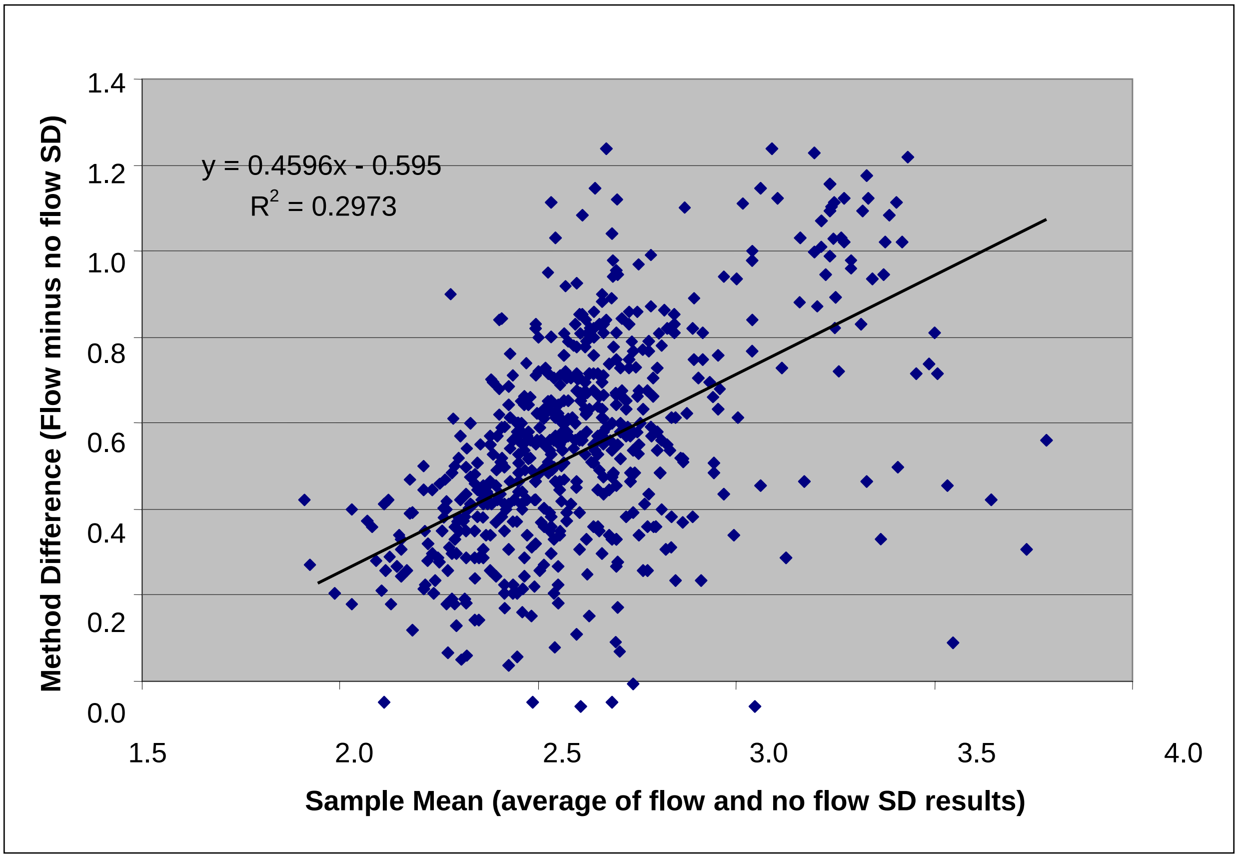

Figure 4. Method of Agreement Between Standard Deviation (SD) With, and Without, a Flow Agent.

INDEX OF KEY WORDS

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