Mean particle size: Evaluation of variation within industry processed grains and determination of the effect of laboratory grinding

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ABSTRACT

This study aims to determine how the mean particle size (MPS) of corn grain, soybean meal, and full fat soybean used for dairy cattle feed varies throughout industry samples and the extent laboratory grinding through 6-mm and 4-mm screens have on the MPS. Samples were collected from multiple feed mills in the Midwest, and were analyzed for original MPS and classified into fine, medium, or coarse samples. Medium corn grain samples were then ground through 6-mm and 4-mm screens and MPS was measured. Sample screens were classified as fine if they did not have a significant reduction in their MPS when ground through either screen. Medium classified samples saw a significant reduction in MPS when ground through a 4-mm screen only. Coarse classified samples saw the largest reduction in MPS by both 6-mm and 4-mm screens, reducing the original samples by over 50% from their original MPS. This study indicates that laboratory determination of digestibility may not reflect well the digestibility of the original feedstuff as classified as medium or coarse MPS of reduction through sample grinding in the laboratory prior to digestibility assays.

INTRODUCTION

In the diet of dairy cattle, corn is a vital component due to its energy content provided primarily by the starch it contains (2). Frodin et al. (2017) reported that diets that include adequate starch have an advantage in milk and fat-corrected milk yields over those insufficient in starch. A key factor that contributed to the digestibility of starch was particle size (1). Rimensberger et al. (2004) reported that corn with greater kernel processing had reduced MPS and increased the digestibility in both the rumen and the intestine. Reduced MPS also increased milk yield and content of protein in milk (4). Yu et al. (1999) reported that varying corn processing by feed mills, including coarse, fine-ground, steam-flaked, or steamexpanded, resulted in digestibility and milk production differences in dairy cows for these processed corn grains (5).

Various laboratory evaluations are used to determine the potential digestibility of feedstuffs for ruminal animals. Evaluation include in vitro or in vivo determinants of dry matter starch and neutral detergent fiber (NDF) digestibility. These evaluations usually require the grinding of samples in the laboratory to reduce sample screens with a small sample size (6.5-4.0 grams). NDF digestion measurements are usually performed using a 4-mm screen because determination of maximal extent of digestion potential is usually desired. Grains differ though in being ground through either a 4-mm or 4-mm screens in an effort to minimize the amount of particle differences between grains and the effect they have on the starch digestibility. However, the MPS of grains from feed mills, which are using processing methods, roller mills, hammer mills, varying screens, etc., may display differences in feed samples. This would tend to prevent the accuracy of digestibility measurements in comparison to animal digestion and performance.

MATERIALS & METHODS

Twelve different samples of 3 different types of feedstocks were used: corn grain, full fat soybean, or soybean meal. Samples were collected from various commercial feed mills throughout Wisconsin and Iowa and each sample was divided into three groups: original, 6-mm grind, and 4-mm grind. Each sample weighed approximately 110 g before measurements were performed. The 6-mm and 4-mm samples were ground through a Wiley Centrifugal Mill with corresponding screen size. Particle size of all samples, original, and ground, was determined using a Ro-Tap Shaker and 8 sieves. Each sample was dry sieved for 10 minutes, and then the sieve plates were weighed. The proportion of sample weight in each size was used to calculate MPS using a log normal distribution. Original MPS determined classification of feedstuffs as either fine, medium, or coarse. Fine was classified as having a MPS less than 900 μm, medium between 900-2000 μm, and coarse included samples that exceeded MPS of 2000 μm. Average, standard deviation, minimum, maximum, and maximum MPS was calculated for all samples. For each screen size, the MPS reduction and percent reduction from the original was calculated. A t-test was used to determine the significance of the 6-mm and 4-mm screens versus the original mean of that group.

RESULTS

Sample Distribution:
- Corn grain contained 5 samples in the fine group, 3 samples in the medium group, and 1 fine sample
- Soybean meal (SM) consisted of 2 medium samples
- Full fat soybean (FFS) consisted of 2 coarse samples

Table 1. Mean particle size (MPS) of corn grain, soybean meal, and full fat soybean meal with average production exhaustion, and standard deviation.

<table>
<thead>
<tr>
<th>Feed Classification</th>
<th>Fine</th>
<th>Medium</th>
<th>Original</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average mg</td>
<td>765.49</td>
<td>1219.91</td>
<td>985.54</td>
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<tr>
<td>Standard Deviation</td>
<td>177.07</td>
<td>77.57</td>
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<tr>
<td>Minimum mg</td>
<td>385.06</td>
<td>978.93</td>
<td>344.85</td>
</tr>
<tr>
<td>Maximum mg</td>
<td>1232.24</td>
<td>2022.63</td>
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</tr>
<tr>
<td>Sample n</td>
<td>3</td>
<td>3</td>
<td>1</td>
</tr>
</tbody>
</table>

Particle Size For Corn Grain

Figure 2. Change in particle size of corn grain sample after being ground through screens. Each type of feedstuff contained one coarse sample after being ground through a 4-mm screen.

DISCUSSION

Grinding fine corn grain samples from industry through a 6-mm screen does not cause significant reduction in MPS. Fine corn grain samples had a statistically significant reduction from the original when using a 4-mm screen (p < .05). Fine and medium corn grain samples were reduced by an average of 85.71 and 78.04%, respectively.

Medium soybean meal samples were reduced by an average of 207.22 μm. The coarse corn grain sample was reduced by 718.04 μm (84.65% of original). The coarse full fat soybean sample was reduced by 2699.64 μm (68.13% of original).

More research needs to be done into the effect of varying MPS on the in vitro or in vivo starch digestibility measurements to completely understand how significant the reduction of MPS during laboratory grinding.

REFERENCES