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# Milling Characteristics of Corn and Yellow, Short-Season Field Peas Intended for Swine Diets

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## ABSTRACT

*The objectives of this study were to analyze particle size and amino acid concentrations in particles after milling corn and field peas. Twelve batches each of corn and peas were processed through a hammer mill (H; 3.175-mm screen) or roller mill (R) for a total of 4 treatments and 6 replications. Samples were poured onto sieves (1,000, 850, 710, 600, 425, and 300 μm) and shaken and tapped for 2 min. At the selected settings, mill type affected geometric mean diameter (P = 0.001) and geometric SD (P < 0.0001), and estimated parameters indicated that H generated particles with smaller diameters (corn-H = 600.7; peas-H = 637.5; corn-R = 759.3; peas-R = 736.2) but larger SD (corn-H = 1.75; peas-H = 1.75; corn-R = 1.64; peas-R = 1.56). Two samples per treatment were further ground to 0.5 mm, and an amino acid profile without Trp was determined. Amino acid data were analyzed as nested arrangements, with sieve opening size nested in mill type. There was no mill type effect for corn or peas, but there was a sieve opening size effect for 19 amino acids in corn and 17 in peas. Relatively high concentrations of most amino acids were found in large corn or small pea particles. Results indicated that corn and peas have similar milling characteristics with respect to particle size, but not with respect to the dispersion of amino acids among particle sizes. Losses of amino acids could occur if corn or peas are not properly ground.*

**Key words:** field pea, corn, mill, particle size, amino acid

## INTRODUCTION

Changes in feed ingredient prices typically lead to adjustments in the relative quantities of feed ingredients used in rations, or the substitution of less commonly used ingredients for more traditional ingredients. One such substitute is field peas. In a review, Anderson et al. (2007) described field peas as an energy- and protein-dense feedstuff with energy content comparable to that of corn. Typical CP content ranges from 23 to 25%. Blubaugh (2008) concluded that 20% yellow field peas in the middle to late nursery period can improve pig growth performance compared with traditional corn- and soybean meal-based diets. In growing-finishing swine diets, field peas may replace all the soybean meal without negative effects on pig performance, carcass composition, carcass quality, or pork palatability (Stein et al., 2006). Petersen and Spencer (2006) concluded that field peas could fully replace soybean meal in growing-finishing diets when diets satisfied nutrient requirements and pea particle size was appropriate.

Feed particle size and particle size distribution are affected by processing procedures, and both have been found to influence pig performance. With a hammer mill, there may be a wide distribution of particle sizes around the geometric mean, whereas with a roller mill, particles tend to be more uniform in size (Koch, 2002). Wondra et al. (1995) reported that greater uniformity in particle sizes of corn or processing with a roller mill improved nutrient digestibility and reduced undesirable changes in stomach morphology for pigs. Choct et al. (2004) analyzed processing (hammer mill vs. roller mill), particle size, and feeding method (liquid vs. dry) for wheat-based diets fed to weaner pigs. They observed that pigs fed hammer-milled diets consistently consumed more feed and grew faster. Thacker (2006) found that digestibility coefficients for DM, CP, and energy were greater for pigs fed ground (hammer-milled) oats vs. milled (roller-milled) oats, which the author attributed to the smaller particle size for ground oats.

When feed particle size is reduced, the surface area of the grain is increased, which allows greater

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exposure to enzymes in the digestive system (Goodband et al., 2002). Kim et al. (2002) concluded that the reduction of corn particle sizes in both simple and complex diets was beneficial to nursery pigs. Real digestibilities of amino acids in pigs were increased when particle size was reduced in wheat-sunflower meal diets (Lahaye et al., 2004) and soybean meal-based diets (Fastinger and Mahan, 2003). Lahaye et al. (2008) reported that coefficients of ileal digestibility for dietary energy, OM, and DM were improved when wheat particle size in a wheat-rapeseed meal diet was reduced from 1,000 to 500 µm. Brumm et al. (2008) observed a 3.2% difference in feed conversion when particle size in a corn- and soybean meal-based diet was changed by 250 µm. Solà-Oriol et al. (2007) found evidence that pig preferences for diets with rice, barley, sorghum, or oats were affected by particle size profile and feed texture, and Anguita et al. (2007) observed lower voluntary feed intake when pigs were fed diets with coarse ground corn.

Feed particle size may also directly affect the time needed to adequately mix feed, the segregation of ingredients during handling, feed flow ability, and air quality. If there is variability in particle size among ingredients, inadequate mixing (CV >12%) can reduce nursery pig performance (Groesbeck et al., 2007). Harner et al. (1996) noted that particles in a complete feed might segregate during handling if there are substantial differences among ingredient particle sizes. Feed flow ability is influenced by particle size and particle size SD, and differences in flow ability appear to be influenced more strongly by variation in particle size than by the shapes of particles (Groesbeck et al., 2006). Costa et al. (2007) reported that roller-milled corn has a positive effect on feed digestibility because of smaller particle sizes, but smaller particle sizes may reduce air quality in pig production units.

The purpose of the present research was to supplement existing information about processing field peas, particularly with respect to hammer milling vs. roller milling, and to provide new information about the effects of milling on amino acid concentrations in field pea and corn particles. Specific objectives were to 1) compare the particle size and particle size distribution between corn and field peas after processing with a hammer mill or a roller mill, and 2) analyze amino acid concentrations in corn and field pea particles of various sizes after processing with a hammer mill or a roller mill.

## MATERIALS AND METHODS

### *Milling*

Twelve batches of corn (*Zea mays*) and 12 batches of yellow, short-season field peas (*Pisum sativum* L.), initial weight 2.27 kg, were processed through a 6 × 6 Allis Chalmers (Chicago, IL) hammer mill or a Bar #10 roller mill (Bar NA Inc., Seymour, IL) for a total of 4 treatments with 6 replications. Corn and field peas were processed in the hammer mill using a 3.175-mm screen with a consistent feed rate of approximately 1.14 kg/min. With the roller mill, corn and field peas were milled once, and then the settings were changed and the materials were milled a second time. Corn was fed through the roller mill with consistent feed rates of approximately 1.14 kg/min on the first pass and approximately 0.57 kg/min on the second pass. Field peas were fed through the roller mill with consistent feed rates of approximately 2.27 kg/min on the first pass and approximately 1.51 kg/min on the second pass. For both corn and field peas, the first pass occurred with the rollers

**Table 1. Distribution of corn and field pea particles from a hammer mill or a roller mill**

| Sieveopening, µm | Corn | | | | Field peas | | | |
|---|---|---|---|---|---|---|---|---|
| | Hammer[1] | | Roller[2] | | Hammer[1] | | Roller[3] | |
| | Wt, g | % | Wt, g | % | Wt, g | % | Wt, g | % |
| 1,000 | 60.42 | 30.4 | 107.94 | 54.0 | 68.07 | 34.1 | 75.74 | 37.9 |
| 850 | 17.48 | 8.8 | 16.53 | 8.3 | 21.19 | 10.6 | 27.46 | 13.8 |
| 710 | 19.39 | 9.8 | 14.68 | 7.3 | 20.91 | 10.5 | 27.16 | 13.6 |
| 600 | 13.35 | 6.7 | 10.17 | 5.1 | 14.97 | 7.5 | 17.23 | 8.6 |
| 425 | 34.96 | 17.6 | 21.14 | 10.6 | 29.60 | 14.8 | 27.06 | 13.6 |
| 300 | 23.35 | 11.7 | 11.02 | 5.5 | 15.15 | 7.6 | 10.37 | 5.2 |
| Pan | 29.88 | 15.0 | 18.50 | 9.3 | 29.69 | 14.9 | 14.59 | 7.3 |

[1]Feed rate of approximately 1.14 kg/min with a 3.175-mm screen.

[2]Feed rate of approximately 1.14 kg/min with rollers set at 3.50 mm on the first pass, and feed rate of approximately 0.57 kg/min with rollers set at 0.50 mm on the second pass.

[3]Feed rate of approximately 2.27 kg/min with rollers set at 3.50 mm on the first pass, and feed rate of approximately 1.51 kg/min with rollers set at 0.50 mm on the second pass.