EFFECTS OF CORN PARTICLE SIZE ON FEEDLOT STEER PERFORMANCE AND CARCASS CHARACTERISTICS

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Story in Brief

The effects of corn particle size on feedlot performance and carcass characteristics were investigated. Angus crossbred steers (725 lb., n=33), housed in 18 different pens, were given ad libitum access to an 86% concentrate, 14% cottonseed hull diet for 145 d. Only the particle size of the corn grain differed. All corn (86.0 % DM) was rolled through stacked rolls with roller mill clearances set to produce different grain particle sizes. Coarsely rolled particles had a geometric mean diameter of 2,598 $\pm$ 1.71 microns (µ); this is slightly finer than most commercially processed rolled corn. Medium and fine particle sizes were 1,545 $\pm$ 1.86 and 756 $\pm$ 1.86 µ, respectively. Particle size did not alter feed intake by steers, but ADG and feed efficiency tended to respond quadratically with the medium particle size being best (3.43 lb. and 5.9). Marbling score was highest (91.0 % choice) for the medium particle size. However, no treatment responses in backfat thickness, KHP or yield grade were detected. Diet DM digestibilities were similar, although starch digestibility (97.5, 96.2 and 95.4 % for fine , medium and coarse) was higher with the fine particles. To optimize feed efficiency, corn should be rolled to a geometric mean diameter of 1628 µ whereas maximum gain would be obtained at 1744 µ. During the first half of the study, coarsely rolled corn tended to produce the highest ADG. However, ADG tended to be highest with fine rolled grain during the last half of the feeding period. In this study, a particle size, much finer than fed commercially, optimized performance, feed efficiency and marbling. However, the optimum particle size and distribution may be altered by chewing efficiency (and thereby on animal age and breed) and source and level of dietary roughage.

(Key Words: Digestibility, Corn, Intake.)

Introduction

Corn processing and particle size influence digestion and cattle performance (Adeeb et al., 1971). Finely ground grains are more extensively digested in the rumen than coarser grains. However, with coarsely ground grain, flow of starch to the small intestine may increase, leading to increased energetic efficiency (Owens et al., 1986). Optimum particle size for maximum

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cattle performance has not been well addressed in the literature. Differences in roughage level and source as well as processing methods and cattle types has complicated this task. The purpose of this trial was to examine the impact of particle size on the performance of growing steers.

Materials and Methods

Animals. Thirty-three predominately black, Angus, Salers and Hereford crossbred steers were obtained in the fall of 1993. These yearlings had grazed native range in Osage County, OK during the preceding summer. On December 2, 1993 (d 0) the steers were weighed, dehorned (if necessary), vaccinated with an 8-way clostridial killed bacterin and implanted with Synovex-S®. Following weighing, animals were stratified by weight and assigned to one of three treatments. All cattle were worked to full feed by d 14. Eighteen pens were used (fifteen pens housing two calves each; three pens housing one calf each). Steers were reimplanted on d 88 with Synovex-S®.

Diets. Feed (Table 1) was available for ad libitum consumption. Rations differed only in the degree of corn processing before ration mixing. Corn was rolled with a stack roller system provided by Automatic Feed Mfg. Co., Pender, NE. Corn samples were sieved to determine particle size (Ensor et al., 1970). Geometric mean particle size for the three treatments are shown in Table 2. Animals were fed once daily. Orts were weighed and discarded weekly. The diet contained 14% cottonseed hulls. This relatively high roughage level was intended to prevent acidosis and depressed feed intakes from fine grinding. This would allow us to look at the effects of the particle size without having complications of different intakes. Diet energy was calculated using ADG and DMI in the NRC (1984) energy equation for large frame steer calves.

Data Collection. The average of the two weights taken on d 0 and d 1 was used as a starting weight. Interim weights were measured on d 28, 61, 88, 116 and 144 of the trial. Fecal grab samples were obtained at each weighing. Feces were analyzed for starch, protein and purine content. Cottonseed-hull based pellets containing chromic oxide were fed from d 132 to d 142 to provide 10 g chromic oxide per d to each animal. Fecal grab samples from each steer were taken at 7:00 AM and 4:00 PM on d 139, 140 and 141. Samples were composited across time and analyzed for chromium concentration and starch content. Total tract, starch and protein digestibilities were calculated. All animals were slaughtered at Dodge City, KS on d 145. Carcass data were collected following a 48 hr chill.

Results and Discussion

Cattle Performance. The effects of particle size on cattle performance are summarized in Table 2. No significant differences were detected in performance from d 0 to d 61, but a linear and quadratic trend was noted for ADG and feed efficiency from d 62 to d 144. Over the entire feeding period, linear and quadratic trends were seen in ADG and feed efficiency; the cattle fed the medium particle size appeared to be superior. These same trends were found when the ME and NEg for the ration was calculated using the DMI and weight gains of the steers. These values are slightly higher that those calculated from the NRC (1984) values shown in Table 2. From these data we can conclude that the medium treatment produced slightly superior efficiency and ADG than the fine or coarse particle corn.

Table 3 summarizes results of regressing performance against particle size. The estimated particle size required for maximum intake were substantially larger than that required for maximum gain or efficiency during all feeding periods. Maximum gain occurred at a larger particle size than optimum efficiency. The particle size calculated to maximize intake, gain and efficiency for the first half of the feeding period was larger than for the second half of the feeding period. This may be due to reduced chewing as animals became older. For the total feeding period, maximum intake was estimated to occur with a corn particle size of 2,276µ. Gain was predicted to be maximized at 1,744µ, and efficiency was optimal at 1,628µ. Calculated ME and NEg peaked at a geometric mean diameter of 1,655µ and 1,641µ, respectively. These results indicate that a larger particle size may be optimal early in the feeding period whereas a reduced size may optimize energy utilization later.

Carcass Characteristics. Table 2 summarizes the carcass characteristics. Only marbling score varied among treatments. Cattle fed the medium particle size had a significantly higher marbling score. The additional energy these animals extracted from the diet or more optimum site of digestion may be responsible for the increased marbling with no increase in backfat or KHP.

Digestibility. Diet digestibility and fecal nutrient content data are summarized in Table 4. Fine and medium particles tended to produce higher total tract digestibility than coarse. Cattle fed fine particles had higher starch digestibility than coarse (P=.02) and tended to be higher than medium (P=.13). Despite the increased starch digestibility, depressed performance with fine particles may indicate that site of digestion may be important in maximizing efficiency. The fine rolled corn is likely digested to a greater extent in the rumen than medium or coarse. Medium rolled corn may have been digested to a greater extent in the small intestine than fine. If small intestinal digestion is more efficient, it may lead to improved performance if the proper balance between ruminal and

intestinal digestion can be achieved. Fecal starch was higher for medium and coarse when compared with fine. Purine concentration in feces differed among treatments. In contrast, protein content of the feces was higher for fine and medium compared with coarse, which may reflect increased proliferation of rumen bacteria due to increased grain digestion in the rumen.

Although cattle fed the finely rolled corn exhibited inferior performance to the medium particle, digestibility data suggest increased digestion for the finer corn. These cattle may have been experiencing sub-clinical acidosis or the balance of digestion between the rumen and small intestine may have been optimized by the medium rolled corn.

Conclusions. Application of results may be limited to dry corn fed with 14% cottonseed hulls to large framed yearlings. However, these results illustrate the importance of particle size. Because feed intakes among the treatments were identical, the performance difference likely is attributable to particle size.

Literature Cited

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