J. Dairy Sci. 92:782–789
doi:10.3168/jds.2008-1242

Effects of corn processing, particle size, and diet form on performance of calves in bedded pens

H. G. Bateman II, T. M. Hill,[1] J. M. Aldrich, and R. L. Schlotterbeck
Akey, Nutrition and Research Center, PO Box 5002, Lewisburg, OH 45338

ABSTRACT

In a series of 5 trials, Holstein calves from zero to 12 wk old were housed in pens bedded with straw and fed diets to evaluate physical form of starters containing different processed corn on calf performance. Starters were formulated to have similar ingredient and nutrient compositions. Calves, initially less than 1 wk old, were housed in individual pens through 8 wk and weaned at 6 wk in trial 1 and at 4 wk in trials 2 and 3. In trials 4 and 5, calves initially 8 wk old were housed in group pens (6 calves/pen) from 8 to 12 wk. Trial 1 compared feeding calves a pelleted versus textured starter. Trial 2 compared feeding calves a textured starter versus feeding half meal starter with half textured starter. Trial 3 compared feeding calves textured starters containing whole, steam-flaked, or dry rolled corn. Trial 4 compared feeding calves textured starters containing steam-flaked versus dry rolled corn. Trial 5 compared feeding calves textured starters containing whole or dry rolled corn. Measurements included average daily gain (ADG), starter intake, feed efficiency, hip width change, body condition score change, fecal scores, and medical treatments. Physical form of starter feed did not affect any measurements in trials 1, 3, 4, and 5. In trial 2, calves fed starters manufactured with large amounts of fines had 11% less feed intake and 6% slower ADG than calves fed a textured starter. When starters contained similar ingredient and nutrient contents, manufacturing processes did not affect calf performance unless the diet contained a significant amount of fines, which reduced intake and ADG.
Key words: corn, processing, starter, calf

INTRODUCTION

Porter et al. (2007) reported greater ADG, starter intake, and earlier initiation of rumination in neonatal calves fed a coarse meal diet versus a fine particle diet that had been pelleted. Franklin et al. (2003) reported less starter intake and ADG in calves fed a pelleted versus textured starter, with the textured starter tending to support the most starter intake and ADG versus pelleted and meal starters. However, the ingredient and nutrient composition of their diets were not similar confounding the interpretation of results. Older papers with limited details of methods and diets (Lassiter et al., 1955; Gardner, 1967; Kertz et al., 1979) reported that starter intake and ADG was less when starters were fine meals versus pelleted fine meals or coarse particle grains as a mash or textured diet. Yet, finely ground corn is digested faster in the rumen and more completely over the total digestive tract than coarsely ground corn in dairy cattle (Remond et al., 2004) and in piglets (Healy et al., 1994). However, a minimal particle size is required because consumption of diets with too many fine particles can lead to rumen parakeratosis (Greenwood et al., 1997). Data reported by Porter et al. (2007) suggest that ruminal parakeratosis and bloat are minimized when 75% of the particles in a starter exceed 1,190 μm in diameter.

Many commercial starters today are textured and contain coarsely rolled or ground grains, whole grains, protein, mineral and vitamin supplement pellets, and molasses. At times, soft pellets break up during handling or while exiting the pellet mill and contain large amounts of fines. Some manufacturers add molasses to starters to cover up fines or aid in customer appeal. However, large amounts of molasses can result in soft pellets that break up with subsequent handling of the feed. Further, large amounts of molasses have been shown to reduce feed intake and ADG of calves (Lesmeister and Heinrichs, 2005; Hill et al., 2008b) such that processing to reduce one concern with the manufacture of calf starters may result in increases to another concern. Meal or mash feeds contain large amounts of fines because they are intentionally unscreened. All of these types of starters that contain large amounts of fines may lead to poor acceptability, low intake, and reduced ADG in calves versus starters made with low fines.

Lesmeister and Heinrichs (2004) reported no differences in ADG when feeding starters manufactured with different coarsely processed corn to calves bedded with shavings. Other research with highly processed and

Received April 7, 2008.
Accepted September 18, 2008.
[1]Corresponding author: mhill@akey.com

gelatinized corn and sorghum in pelleted diets have not yielded consistent responses compared with conventional dry processing (Abdelgadir and Morrill, 1995; Abdelgadir et al., 1996a,b).

Although important information is present in the literature relative to the physical characteristics of a calf starter, the industry could benefit from a more systemic approach of research on this topic to confirm what specific form or forms of starters are best for calf performance. The objectives of these 5 trials were to evaluate form (coarse textured, completely pelleted, finely rolled meal with limited coarse particles) of starters containing corn and common coarse processing of corn (whole, dry rolled, steam flaked) for calves under 3 mo of age managed in pens bedded with straw. One hypothesis was that calves fed coarse, textured starters would have greater intake and ADG than calves fed pelleted starters or starters with a large amount of fine particles. Another hypothesis was intake and ADG of calves would not be affected by processing of the corn (whole, dry rolled, steam flaked).

MATERIALS AND METHODS

All calves used in this study were cared for using acceptable practices as described in the Guide for the Care and Use of Agricultural Animals in Agricultural Research and Teaching (FASS, 1999).

Trial 1 compared feeding calves a textured (**TX**) starter with coarsely rolled corn versus a completely pelleted (**P**) starter with finely rolled corn (Table 1) from the same corn source. Complete starters were wet sieved (Shaver et al., 1988) using a vibratory sieve shaker (Fritsch, Oberstein, Germany) and geometric mean particle sizes were determined (ASAE, 1983). The textured starter had a geometric mean particle size of 2,103 μm with 82% of the particles >1,180 μm. The pelleted starter had a geometric mean particle size of 735 μm with 2% of the particles >1,180 μm. Both starters were formulated to have similar nutrient concentrations; however, ingredient composition differed slightly. Starters and fresh water were fed ad libitum. All calves were fed a 20% milk CP, 20% fat milk replacer (**MR**; Akey White Gold, Akey, Lewisburg, OH) at 0.454 kg/d, halved into a.m. and p.m. feedings for 39 d, followed by 0.227 kg/d on d 40 to 42 (a.m. feeding only). This trial used 48 Holstein bull calves (24/treatment) <1 wk of age from multiple dairy farms. Calves were received at approximately 1600 h after a 10-h transit and immediately fed 0.227 kg of a nutrient and electrolyte product (Critical Care; Akey) reconstituted to 2 L with warm water. Their first MR was fed at the following a.m. feeding. Calves were then weighed, blood was sampled from the jugular vein, serum protein measured using an optical refractometer (Atago USA Inc., Bellevue, WA), and calves were randomly assigned to treatment. The trial lasted 56 d and was conducted during the months of June through September. The average ambient temperature inside the calf housing during the trial was 21°C and ranged from 5 to 31°C based on hourly measurements.

Trial 2 compared feeding calves TX with coarsely rolled corn and whole oats to feeding half finely rolled meal starter with half coarse textured starter (**MT**; Table 1). Starter MT was manufactured by mixing equal weights of starter TX with starter TX that had been purposely ground. Starter TX had a geometric mean particle size of 2,029 μm with 81% of the particles >1,180 μm. Starter MT had a geometric mean particle size of 813 μm with 4% of the particles >1,180 μm. Starters were formulated to have the same ingredient and nutrient concentrations. All calves were fed a 26% milk CP, 17% fat MR (Akey Pinnacle, Akey) at 0.681 kg/d, halved into a.m. and p.m. feedings for 25 d, followed by 0.340 kg/d on d 26 to 28 (a.m. feeding only). Holstein bull calves (48) that were 2 to 4 d old from a single dairy were received midday after a 3-h transit. Calves were fed MR at the p.m. feeding. The day after arrival, calves were weighed, blood was sampled from the jugular vein, serum protein measured using an optical refractometer (Atago USA Inc.), and calves were randomly assigned to treatments. Trial 2 lasted 56 d and was conducted from November through January. The average ambient temperature in the calf housing facility was 4°C and ranged from −10 to 24°C based on hourly measurements.

Trial 3 compared feeding Holstein bull calves coarse textured starters containing whole (**TW**), steam-flaked (**TS**), or dry rolled (**TR**) corn (Table 2) from the same corn source. Starters had geometric mean particle sizes ranging from 2,153 to 2,942 μm and 80 to 86% of the particles were >1,180 μm. Starters were formulated to have identical ingredients and nutrient concentrations. All calves were fed 0.681 kg/d of a 26% milk CP, 17% fat MR (Akey Pinnacle, Akey) halved into a.m. and p.m. feedings for 25 d, followed by 0.340 kg/d in d 26 to 28 (a.m. feeding only). Three- to 4-d-old Holstein bull calves (48; 16 calves per treatment) from a single dairy were received midday after a 3-h transit. Calves were fed MR at the p.m. feeding. The day after arrival, calves were weighed, blood was sampled from the jugular vein, and serum protein measured using an optical refractometer (Atago USA Inc.). Calves were then randomly assigned to starter treatments. The trial lasted 56 d and was conducted from May through June. The average ambient temperature inside the calf housing during the trial was 18°C and ranged from 3 to 32°C based on hourly measurements.