J. Dairy Sci. 91:3128–3137
doi:10.3168/jds.2007-0950

Effects of Feeding Different Carbohydrate Sources and Amounts to Young Calves

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ABSTRACT

Corn, oats, molasses, and soyhulls are commonly used carbohydrate sources in calf starters. A total of 180 calves were used in 4 studies to compare the use of these ingredients in calf starters. Study 1 compared textured starters with different amounts of molasses or sucrose. The control starter contained 5% molasses (A). The test starters contained greater concentrations of dietary sugar than starter A as either 10% molasses (B) or 5% molasses plus 1.5% granular sucrose (C). Starters B and C were equal in dietary sugar. Study 2 evaluated textured starters containing 0 or 25% whole oats for calves up to approximately 12 wk old. Study 3 evaluated pelleted starters containing 0 or 62.75% soyhulls for calves up to approximately 8 wk old. Study 4 evaluated textured starters containing 0, 14, 28, and 42% soyhulls for calves between approximately 8 and 12 wk old. Calves were housed in individual pens in an unheated nursery with curtain sides through 8 wk and then in group pens of 6 calves/pen from 8 to 12 wk. Calves were bedded with straw. In study 1, calves fed the starters with extra molasses or sucrose had an average of 9% slower average daily gain (ADG) and greater average fecal scores from 42 to 56 d and 9% slower ADG from 0 to 56 d than calves fed the textured starter with low molasses. In study 2, ADG and feed efficiency (kg of feed/kg of gain) were 22 and 20% less, respectively, in calves fed the starter without oats from 0 to 28 d, but there were no differences thereafter. In study 3, calves fed starters with soyhulls had a 10% slower ADG and 8% lower efficiency of gain from 28 to 56 d than calves fed the starters without soyhulls. In study 4, ADG declined linearly as soyhulls increased in the starter. The change in ADG was 14% from 0 to 42% soyhulls. Replacing corn in a starter with molasses, sucrose, or soyhulls reduced postweaning ADG and increased the cost of ADG. Whole oats were an acceptable substitute for corn.

Key words: calf, carbohydrate, starter, digestible fiber

INTRODUCTION

Corn, oats, cane molasses, and soyhulls are commonly used carbohydrate sources in calf starters. In most of the United States, corn is the least expensive grain. Molasses is high in sugar (sucrose, a ruminally fermented carbohydrate; NRC, 2001), is perceived to be to a palatability enhancer, and is used to reduce the appearance of fine particles in calf starters. Oats are also a commonly used ingredient in calf starters because of their perceived palatability and bulkiness. Soyhulls are a low-cost ingredient much of the time, are digested well by functional ruminants, form hard pellets when pelleted, and are a good source of digestible fiber for the mature ruminant (NRC, 2001).

In the mature dairy cow, emphasis has been placed on maximizing rumen fermentation through feeding various carbohydrates, such as starch, sugar, and digestible fiber (Hall and Herejk, 2001; NRC, 2001). Similarly, for the calf, the NRC (2001) states "the starter should be relatively high in readily fermentable carbohydrates but adequate in digestible fiber to support the fermentation necessary for proper ruminal tissue growth (Brownlee, 1956; Flatt et al., 1958; Williams and Frost, 1992; Greenwood et al., 1997)."

Porter et al. (2007) demonstrated the need for coarse particles and a bulk ingredient in starters fed to calves housed in crates without bedding. Oats, if fed whole or coarsely processed, as is common in commercial starters in the United States, could add bulkiness or coarseness to a starter. Khan et al. (2007) recently reported than an equal amount of starch supplied by corn supports more ADG in calves than starch from oats, barley, or wheat. All of their starters were finely ground and fed with free-choice hay. These calves consumed 25 to 35% hay, which is counterproductive to rumen development and reduces ADG in calves (Warner et al., 1956; Stobo et al., 1966). Thus, their study did not test the value of oats as a bulky ingredient when no hay was fed to potentially optimize rumen development and calf ADG (Warner et al., 1956; Porter et al., 2007).

A high concentration of molasses (12 vs. 6%) has been shown to reduce ADG and increase the incidence of scouring in calves (Lesmeister and Heinrichs, 2005).

Received December 14, 2007.
Accepted April 15, 2008.
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Additionally, Huber et al. (1961) found the neonatal calf intestine to be void of sucrase. Despite the widespread use of molasses in starters, its use in calf starters is questionable.

Soyhulls are a good source of digestible fiber for the mature ruminant, and digestible fiber may be needed for proper ruminal tissue growth (NRC, 2001). Williams et al. (1987) observed similar ADG in calves fed barley or a citrus and beet pulp combination, but feed efficiency was greater when barley was fed.

The objectives of these studies were to evaluate replacing corn with oats, replacing corn with molasses or molasses and sugar, and replacing corn with soyhulls in calf starters. Four studies were conducted to compare the use of these ingredients in starters fed to calves less than 3 mo old and managed in pens bedded with straw. Our hypothesis was that adding molasses, oats, or soyhulls would reduce ADG of the calves.

MATERIALS AND METHODS

Study 1 used 48 Holstein bull calves (40.2 ± 1.2 kg; 12/treatment) <1 wk of age from multiple dairy farms. Study 1 evaluated the concentration of cane molasses and sucrose in starters (Table 1). The control starter contained 5% molasses (A). The test starters contained greater concentrations of dietary sugar than starter A as either 10% molasses (B) or 5% molasses plus 1.5% granular sucrose (C). Starters B and C were equal in dietary sugar. All starters were formulated to have similar CP, ADF, and mineral concentrations except for starter B, which was higher in K. Starters and fresh water were fed ad libitum throughout the 56-d study. All calves were fed a 20% milk CP, 20% fat milk replacer (**MR**; Akey White Gold, Akey, Lewisburg, OH) at 0.454 kg/d reconstituted to 3.8 L (0.12 kg/L), halved into a.m. and p.m. feedings for 39 d, followed by 0.227 kg/d for d 40 to 42 (a.m. feeding only). Calves were received 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. Study 1 was conducted from June through September. The average temperature was 21°C and ranged from 5 to 31°C based on hourly measurements.

Study 2 used 48 Holstein bull calves (40.6 ± 1.1 kg; 24/treatment) 3 to 4 d old from one dairy farm. Study 2 compared textured starters containing A) 25% whole oats or B) 0% whole oats (replaced with 23% rolled corn and 2% soybean meal, with minerals balanced between starters) for the 84-d study (Table 2). All calves were fed a 20% milk CP, 20% fat MR (Akey White Gold, Akey) at 0.454 kg/d reconstituted to 3.8 L (0.12 kg/L), halved into a.m. and p.m. feedings for 25 d, followed by 0.227 kg/d for d 26 to 28 (a.m. feeding only). Calves were maintained in individual pens from d 0 to 56 and then grouped into 4 replicate pens of 6 calves from d 56 to 84. Calves were maintained on the same starter for all 84 d. Five percent chopped grass hay was blended with the starters before feeding to the calves from d 56 to 84 in the group pens. Starters and water were fed ad libitum. They were received midday after a 3-h transit and were fed MR at the normal p.m. feeding after arrival. Study 2 was conducted from August through November. The average temperature was 14°C and ranged from –6 to 33°C based on hourly measurements.

Study 3 used 48 Holstein bull calves (41.4 ± 0.8 kg; 24/treatment) that were <1 wk of age from multiple dairy farms. Study 3 compared completely pelleted starters containing A) 0% or B) 62.75% soyhulls (replacing mostly corn and soybean meal with minerals balanced between starters) for the 56-d study (Table 3). All calves were fed a 20% milk CP, 20% fat MR (Akey White Gold, Akey) at 0.454 kg/d reconstituted to 3.8 L (0.12 g/L), halved into a.m. and p.m. feedings for 25 d, followed by 0.227 kg/d for d 26 to 28 (a.m. feeding only). Calves were maintained in individual pens for d 0 to 56. Starters and water were fed ad libitum. 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 the following a.m. feeding. Study 3 was conducted from April through June. The average temperature was 17°C and ranged from –1 to 30°C based on hourly measurements.

Study 4 used 48 Holstein bull calves (73.1 ± 3.1 kg; 12/treatment) that were 8 to 9 wk old. Study 4 compared textured starters containing A) 0%, B) 14%, C) 28%, or D) 42% soyhulls for the 28-d study. Soyhulls replaced mostly corn and soybean meal with minerals balanced between starters. The starters were textured and consisted of 75% supplement pellets, 20% whole oats, and 5% molasses. Calves were maintained in 4 replicate pens of 6 calves. Five percent chopped grass hay was blended with the starters before feeding. Starters and water were fed ad libitum. They originated from multiple dairies at less than 1 wk of age. Before 9 wk of age, the calves were managed like the calves in study 3. Study 4 was conducted from February through March. The average temperature was 7°C and ranged from –10 to 26°C based on hourly measurements.

In studies 1, 2, and 3, the day after arrival at approximately 1200 h the calves were weighed, blood was sampled from the jugular vein, and serum protein was measured by using a refractometer. Calves were randomly assigned to treatment. Calves were weighed again weekly at approximately 1200 h through d 56 (and d 84 in study 2). In study 4, calves were blocked by previous