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Effect of milk replacer program on calf performance and digestion of nutrients with age of the dairy calf

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ABSTRACT

Calves fed large amounts of milk replacer (MR) gain more body weight preweaning than calves fed less-aggressive programs; however, postweaning growth may be reduced. Limited research suggests that less than optimal digestion of the postweaned diet due to large amounts of MR with reduced dry feed intake preweaning may contribute to growth impairment postweaning. Current research was conducted to compare growth and postweaning digestion in 3-d-old male Holstein calves fed various MR programs. The MR programs were a conventional [CON; 0.44 kg of dry matter (DM) 21% crude protein (CP), 21% fat powder fed for 42 d], moderate (MOD; 0.66 kg of DM 27% CP, 17% fat powder fed for 42 d), and aggressive program (AGG; up to 0.87 kg of DM 27% CP, 17% fat powder fed for 49 d). All calves were fed a 20% CP textured starter and water ad libitum for 56 d. The trial used 96 calves (initially 41 ± 1.9 kg of body weight) received 5 wk apart in 2 groups of 48 calves. During d 51 to 56, fecal samples were collected from 5 calves per treatment randomly selected from calves in the first group. Selected nutrients and acid-insoluble ash (used as an internal flow marker) were analyzed in the starter and feces to estimate digestibility. Data were analyzed as a randomized complete block design with starting time of each group of calves as a block. Repeated measure analysis was performed on overall (0 to 56 d) data. Means were separated with a protected least significant difference test. Pen was the experimental unit. Calves fed CON had the least average daily gain [CON = 0.35, MOD = 0.51, and AGG = 0.55 kg/d; standard error of the mean (SEM) = 0.018], feed efficiency (CON = 0.35, MOD = 0.49, and AGG = 0.48 gain/feed, SEM = 0.016), and change in hip width (CON = 3.3, MOD = 4.1, and AGG = 4.1 cm, SEM = 0.20) compared with calves fed other programs. Calves fed AGG had the greatest change in BCS and least starter intake compared with calves fed the other programs. Digestibility of organic matter was 79, 78, and 68% and neutral detergent fiber was 54, 51, and 26% for calves fed programs CON, MOD, and AGG, respectively, and were least for calves fed AGG. These results indicate that postweaning digestion is lower than optimal and contributes to lower postweaning growth in calves fed aggressive compared with conventional or moderate MR programs.
Key words: calf, milk replacer, digestion

INTRODUCTION

Many have reported that as more milk or milk replacer (**MR**) is fed preweaning, preweaning ADG increases (Jasper and Weary, 2002; Cowles et al., 2006; Hill et al., 2006a,b, 2007). The amount of increased ADG is a function of nutrients provided. However, when the amount of milk or MR fed is more than approximately 0.7 kg of DM, postweaning ADG may be compromised compared with calves fed conventional amounts of milk (Bar-Peled et al., 1997; Jasper and Weary, 2002), nonacidified MR (Cowles et al., 2006; Hill et al., 2006a,b, 2007), or acidified ad libitum MR (Nocek and Braund, 1986; Hepola et al., 2008; Hill et al., 2013). Additionally, preweaning MR intake did not influence DMI after 56 d (Hill et al. 2007, 2010, 2013; Osorio et al., 2012).

Starter intake and fermentation of starch in the rumen develops the rumen (NRC, 2001). Publications from different laboratories, each using over 900 calves, report that the ADG of the dairy calf between birth and 2 mo of age was positively related to starter intake (Heinrichs and Heinrichs, 2011; Bateman et al., 2012). The meta-analysis of Bateman et al. (2012) was very dynamic across many feeding rates, compositions of MR programs, and a broad range of ambient temperatures. Additionally, Heinrichs and Heinrichs (2011) reported that starter intake in the first 2 mo was significantly associated with more milk, fat, and protein production in the first lactation as well as in lifetime production. Together, these data point to the importance of starter

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intake in driving rumen development, calf growth, and possible future milk production.

Two laboratories have measured digestibility at approximately 1 wk after weaning in calves fed low or high amounts of MR and both reported 6 to 13% lower OM digestibility in calves fed the high level of MR (over 0.7 kg of DM daily) versus lower levels of MR (less than 0.7 kg of DM daily; Terre et al., 2007a,b; Hill et al., 2010). Reduced digestibility in calves fed high levels of MR was likely associated with less development of the rumen (Terre et al., 2007a,b; Suarez-Mena et al., 2011). Digestibility of NDF reported by Terre et al. (2007a,b) was 40% less in calves fed the high (~0.9 kg of DM) versus low (~0.45 kg of DM) level of MR. Feeding large amounts of MR could continue to impair fiber digestion as the calf transitions to higher-fiber diets as they age. More information is needed to understand the effect of MR rates on postweaning digestion. For that reason, we evaluated 3 MR programs involving 3 feeding rates on calf performance and postweaning digestion of several nutrients, including NDF and ADF.

MATERIALS AND METHODS

Holstein bull calves (initially 41 ± 1.9 kg of BW, 2 to 4 d of age) from a single dairy farm were received at midday after a 3.5-h transit. Calves arrived at the research nursery in 2 groups of 48 head, 35 d apart. Calves in each group (block) were randomly assigned to the treatments. The day after arrival, at approximately noon, the calves were weighed (d 0, initial BW). At this time, blood was sampled intravenously, serum was separated by centrifugation at 3,000 × *g* at 20°C for 15 min (VWR, Batavia, IL), and serum protein concentration was estimated using an optical refractometer (ATAGO U.S.A. Inc., Bellevue, WA).

Three MR programs were compared using 32 male Holstein bull calves per program. The conventional (**CON**) program was 0.44 kg of DM of a 21% CP, 21% fat MR powder (Provimi, Brookville, OH) fed daily for 39 d, divided into 2 equal morning and evening meals. From d 40 to 42, calves were fed 0.22 kg of DM in one morning meal. The moderate (**MOD**) program was 0.66 kg of DM of a 27% CP, 17% fat MR powder (Provimi) fed daily for 39 d, divided into 2 equal morning and evening meals. From d 40 to 42, calves were fed 0.33 kg of DM in one morning meal. The aggressive (**AGG**) program was 0.66 kg of DM for 5 d and 0.87 kg of DM for 37 d (to d 42) divided into 2 equal morning and evening meals. From d 43 to 49, the MR was fed at 0.43 kg of DM/d in one morning meal. The CON and MOD MR were reconstituted to 13% solids and the AGG MR was reconstituted to 15% solids with warm water (45°C) and fed at 0600 and 1600 h via buckets with nipples. In each program, all calves consumed all of the MR offered. Calves were fed a 20% CP textured starter (Provimi) and water ad libitum for the 56-d trial.

Calves were housed in a curtain-sided, naturally ventilated nursery with no added heat in 1.2- × 2.4-m individual pens bedded with straw for 56 d. All animals were cared for as described in the *Guide for the Care and Use of Agricultural Animals in Agricultural Research and Teaching* (FASS, 2010). The trial was conducted July through October. The average temperature in the nursery was 21°C with a range from 5 to 35°C. The average relative humidity was 77% with a range from 32 to 98%.

Calves were weighed initially and every 7 d. Hip widths of the calves were measured with a caliper and BCS was estimated initially and every 14 d. Calf BCS was based on a 1 to 5 system using 0.25-unit increments, with 1 being emaciated and 5 being obese (Wildman et al., 1982). Scores were based on changes around the vertical and transverse processes of the spine as palpated by an experienced technician. Starter intake offered and refused was measured daily. Feces were scored daily in the first 56 d (1 to 5 scale; 1 = firm, normal, 2 = less firm, normal, 3 = thick, batter-like, 4 = thin, batter-like, 5 = watery; modified from Kertz and Chester-Jones, 2004).

During d 51 to 56, when calves were weaned from MR, fecal samples were collected from 5 calves randomly selected per treatment in the first group of calves received. Calves were rectally palpated by hand to obtain a fecal sample. Fecal samples were systematically collected such that a total of 12 fecal samples were collected from the 5 calves per treatment over 6 d to represent every 2 h in a 24-h period. The starter was sampled daily over 5 d and pooled. Pooled fecal samples by calf were subsampled and analyzed for acid-insoluble ash relative to concentration in the pooled starter feed and feed intake over the 5-d period to estimate digestibility and fecal output.

Composites of feed and fecal samples were dried, ground, stored frozen, and subsequently were analyzed (AOAC International, 2000) for DM (oven method 930.15), CP (Kjeldahl method 988.05), fat (alkaline treatment with Roese-Gottlieb method 932.06 for MR; diethyl ether extraction method 2003.05 for starters and hay), fatty acids (feed only by GC; method 963.22), starch (α-amylase method; Hall, 2009), and sugar (Dubois et al., 1956). The starter and feces were analyzed for NDF with ash by the procedure of Van Soest et al. (1991) without sodium sulfite or α-amylase, and ADF with ash (Robertson and Van Soest, 1981).