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Short communication: Effects of increasing protein and energy in the milk replacer with or without direct-fed microbial supplementation on growth and performance of preweaned Holstein calves

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ABSTRACT

Forty-four Holstein calves were fed a direct-fed microbial (DFM) and 1 of 2 milk replacers to evaluate calf performance and growth. Treatments were (1) a control milk replacer [22:20; 22% crude protein (CP) and 20% fat], (2) an accelerated milk replacer (27:10; 27% CP and 10% fat), (3) the control milk replacer with added DFM (22:20+D), and (4) the accelerated milk replacer with added DFM (27:10+D). Dry matter intake, rectal temperatures, respiration scores and rates, and fecal scores were collected daily. Body weight, hip and withers height, heart girth, blood, and rumen fluid samples were collected weekly. Effects of treatment, sex, week, and their interactions were analyzed. Calves fed an accelerated milk replacer, regardless of DFM supplementation, consumed more CP and metabolizable energy in the milk replacer. No treatment differences were found for starter intake or intake of neutral detergent fiber or acid detergent fiber in the starter. Calves fed the accelerated milk replacer had greater preweaning and weaning body weight compared with calves fed the control milk replacer. Average daily gain was greater during the preweaning period for calves fed the accelerated milk replacer, but the same pattern did not hold true during the postweaning period. Feed efficiency did not differ among treatments. Hip height tended to be and withers height and heart girth were greater at weaning for calves fed the accelerated milk replacer compared with calves fed the control milk replacer. Fecal scores were greatest in calves fed DFM. Overall acetate, propionate, butyrate, and *n*-valerate concentrations were lower in calves fed the accelerated milk replacer, but DFM did not have an effect. Rumen pH was not different. Blood metabolites were unaffected by DFM supplementation, but calves fed the accelerated milk replacer had increased partial pressure of CO_2, bicarbonate, and total bicarbonate in the blood. Direct-fed microbial supplementation did not appear to benefit the calf in this trial

Key words: dairy calf, direct-fed microbial, milk replacer

Short Communication

Feeding an increased amount of CP in the milk replacer (**MR**) increased ADG ($P < 0.01$) in preweaned dairy calves by up to 0.65 kg/d (Lassiter et al., 1963; Nonnecke et al., 2003; Cowles et al., 2006). Multiple reports of improved feed:gain ratios ($P < 0.01$; Cowles et al., 2006), frame measurements ($P < 0.05$; Cowles et al., 2006; Raeth-Knight et al., 2009), and DMI of up to 211 g/d ($P < 0.01$; Cowles et al., 2006) were noted as a result of increased CP in MR. Nonnecke et al. (2003) saw as much as a 53% increase in mean BW at d 60 of age when calves were fed increased CP concentrations (30%) compared with the control (20%).

Previous research has also indicated beneficial growth results when ME intake is increased. Bartlett et al. (2006) found that BW, ADG, and feed efficiency improved when calves consumed ME at a rate of 4.41 versus 2.96 Mcal/d, regardless of protein intake. In that trial, Holstein bull calves were fed MR at varying CP concentrations (14, 18, 22, or 26%) and feeding rates (1.25 or 1.75% of BW) after the conclusion of a 2-wk adaptation period. After a 5-wk feeding period, calves consuming greater amounts of ME had increased BW by roughly 10 kg ($P < 0.01$) and those same calves had increased ADG during that same 5-wk feeding period (0.62 vs. 0.33 kg/d, respectively; $P < 0.01$). For both BW and ADG, linear increases were also found as CP consumption was increased. Feed efficiency was also improved for animals consuming greater ME ($P < 0.01$). Another trial found linear increases in ADG and feed efficiency when CP content of the MR was increased and ME intake remained similar (Blome et al., 2003).

By feeding an MR with increased CP and ME content, combined with a direct-fed microbial (**DFM**), availability and utilization of nutrients could be increased. This increase in available nutrients accompanied by an

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increase in DMI could lead to improved rumen development, improved ADG in the preweaning phase, and increased BW at weaning in dairy calves. Therefore, the objectives of this study were to evaluate the effects of increased CP in the MR with or without a DFM supplement on performance and growth of dairy calves.

During the months of August through December 2012, 44 Holstein calves (9 males and 35 females; birth weight = 34.19 ± 4.9 kg) from Mississippi State University (Mississippi State) were randomly assigned at birth to 1 of 4 treatments in a 2 × 2 factorial arrangement of treatments: a control MR [**22:20** (22% protein:20% fat); Land O'Lakes Inc., St. Paul, MN], an accelerated MR with increased CP and decreased fat concentrations [**27:10** (27% protein:10% fat); Land O'Lakes Inc.], 22:20 with the addition of a DFM (**22:20+D**; Calf RD; TechMix Inc., Stewart, MN), or 27:10 with the addition of the DFM (**27:10+D**). Upon birth, calves were esophageally tube fed 1.8 L of colostrum, as is protocol at the Mississippi State University Bearden Research Dairy. Calves were fed milk twice daily at 0600 and 1800 h, housed in hutches (212 × 117 × 122 cm usable calf space), and bedded with straw. After 35 d calves were fed once daily and weaned at 42 d. Calves remained in hutches until 56 d. Calves were fed using buckets. Milk replacer was fed at 15% solids content, mixed, and fed based on the manufacturer's recommendations. Calves fed 22:20 were given 567 g of MR/d, which was reduced to 283 g/d during wk 5, whereas calves fed 27:10 were fed 816 g of powder/d during the first 2 wk and 1,134 g/d during wk 3 and 4, which was reduced to 567 g/d during wk 5. Direct-fed microbial supplementation was given at 2 g per feeding (4 g/head per day) and mixed into the MR, as suggested by the manufacturer. Calves were offered starter (18% CP and 2% fat; Purina Mills LLC, St. Louis, MO) from d 1 of the trial and offered water free choice. Starter was given at a rate of 2.3 kg/head per day until orts decreased to less than 0.45 kg/head per day and was then increased to 4.6 kg/head per day.

Body weight, withers height, hip height, and heart girth were measured weekly on Thursdays at 1400 h. The same 3 graduate assistants took rectal temperatures, respiration rates and scores, and fecal scores daily. Respiratory scores were defined as 1 = normal, 2 = runny nose, 3 = heavy breathing, 4 = moist cough, and 5 = dry cough. Fecal scores were defined as 1 = normal and solid; 2 = slightly loose; 3 = slightly discolored, obvious scours; and 4 = discolored, extreme scours (Larson et al., 1977). Feed samples were taken weekly and compiled by month. Orts (feed refusals) were weighed daily and sampled weekly. Feed and orts samples were subjected to proximate analysis, including DM, NDF, and ADF, according to Goering and Van Soest (1970). Crude protein content was determined using the Kjeldahl N method (AOAC, 1990). Fat content was determined by ether extraction: 2 g of sample were placed in alundum crucibles and placed in a Goldfisch ether extraction apparatus (model 35001; ExpotechUSA Inc., Houston, TX) with 40 mL of ether. Samples were boiled in ether for 4 h, dried at 100°C for at least 24 h, and weighed. Metabolizable energy was calculated using the calf diet ME equation from NRC (2001) as follows:

$$\text{Milk ME} = \text{milk ME} + (\text{DM fed} \times \text{cMEng}),$$

where cMEng was the concentration of ME in the milk, calculated as

$$\text{ME (Mcal/kg of DM)} = [0.057 \times \text{CP (\%)} + 0.092 \times \text{fat (\%)} + 0.0395 \times \text{lactose (\%)}] \times 0.9312.$$

Rumen fluid samples were collected at wk 4, 6, and 8 during weekly growth measurements via esophageal tubing. A tube was inserted into the mouth of the calf and fed down the esophagus. A 60-mL syringe was used to draw rumen fluid from the rumen. Rumen pH was recorded with a pH meter (pH 6+ portable meter kit; Oakton Instruments, Vernon Hills, IL) and rumen fluid was mixed with 1 mL of phosphoric acid and stored at −20°C. Upon thawing, rumen fluid was strained through cheesecloth and centrifuged at 3,000 × g for 30 min at 22°C. Rumen fluid was strained again to remove all impurities. Four milliliters of rumen fluid was mixed with 1 mL of metaphosphoric acid solution containing 2-ethyl butyric acid [25% (wt/vol) metaphosphoric acid containing 2 g of 2-ethyl butyric acid/L] and analyzed for VFA by gas-liquid chromatography using a Shimadzu GC 2010 (Shimadzu Corp., Kyoto, Japan) equipped with a 15-m EC 1000 column (Alltech Associates Inc., Deerfield, IL). The procedures for reagent preparation and the temperature gradient for the VFA analysis were the same as conducted by Grigsby et al. (1992) and Bateman et al. (2002).

Blood was collected from all calves at 18 h after birth and weekly thereafter before weekly growth measurements (1400 h). Blood was collected via jugular venipuncture using 10-mL evacuated tubes. Only initial blood samples at birth were used to determine IgG concentrations (Bova-S; VMRD Inc., Pullman, WA) before the onset of the trial. Heparin-coated tubes were brought to the laboratory at the dairy for analysis of blood gas and electrolytes using the Idexx Vet Stat blood gas and electrolyte analyzer (Idexx Laboratories Inc., Westbrook, ME). Blood was drawn into microcentrifuge tubes from the heparinized tube and centrifuged