Effects of amount of colostrum replacer, amount of milk replacer, and housing cleanliness on health, growth, and intake of Holstein calves to 8 weeks of age

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ABSTRACT

Newborn Holstein bull calves (n = 96) were assigned randomly at birth to receive 150 g (C150) or 450 g (C450) of IgG in the first 24 h of life from a lacteal-based colostrum replacer in 2 trials. Mass of product fed was 500 and 1,500 g, respectively. Replacer was reconstituted with warm water and administered by esophageal feeder at approximately 1, 6, and 12 h of age. Thereafter, calves were fed 2 L of whole milk twice daily at approximately 0700 and 1700 h until transported to the experimental facility at 2 to 3 d of age. Calves fed C450 had greater serum total protein and IgG concentrations at 2 to 3 d of age. Failure of passive transfer of immunity (serum IgG <10 g/L) was detected in 100 and 11% of calves fed C150 and C450, respectively. Calves (n = 48) in trial 1 were assigned randomly within colostrum group to receive 0.68 kg/d of milk replacer (MR) for 42 d, and then 0.34 kg/d for 7 d (moderate MR, MMR) or 1 kg/d of MR for 5 d, 1.36 kg/d for 37 d, and 0.68 kg/d for 7 d (high MR, HMR). Starter and water were available for ad libitum consumption. Calves fed HMR had greater average daily gain, higher average fecal scores, more days with abnormal fecal scores, and more medical days than calves fed MMR. Calves fed HMR also had lower starter intake and tended to have lower gain-to-feed ratio than calves fed MMR. Calves fed C450 and MMR began eating calf starter earlier and ate more starter than other groups from 3 wk. In trial 2, calves (n = 48) were assigned randomly within colostrum group to housing in nursery pens bedded with clean, dry straw (clean bedding) or soiled straw used in previous studies (dirty bedding). Milk replacer was fed at 0.68 kg/d for 39 d, and then 0.34 kg/d for 3 d along with free-choice texturized starter and water. Calves fed C450 had fewer days with abnormal fecal scores and days with medical treatments compared with calves fed C150. Calves housed in dirty bedding tended to grow more slowly and have lower gain-to-feed ratio than calves housed with clean bedding. Temporal changes in serum IgG and total protein varied by treatment. Serum IgG in calves fed C150 varied little from 0 to 4 wk and increased thereafter, whereas IgG in calves fed C450 declined to 4 wk (estimated half-life = 23.9 d) and increased thereafter. Differences in serum IgG concentrations caused by feeding different amounts of colostrum replacer did not markedly affect growth or intake when calves were fed different amounts of milk replacer or when they were housed with clean or dirty bedding.

Key words: calves, colostrum, disease, growth

INTRODUCTION

Health of young dairy calves has an important effect on preweaning performance and, possibly, on production later in life (Weaver et al., 2000; Heinrichs and Heinrichs, 2011; Soberon et al., 2012). Early consumption of an adequate amount of high-quality colostrum is important for acquisition of passive immunity, which, in turn, may influence predisposition to disease (Donovan et al., 1998; Weaver et al., 2000; Stilwell and Carvalho, 2011).

When colostrum is of inadequate quantity or quality to feed the newborn calf, colostrum supplement or replacer products may be used. Such products vary in IgG source (plasma, colostrum), nutrient composition, and the ability of the calf to absorb IgG from the product (Quigley et al., 2002; Foster et al., 2006; Swan et al., 2007).

Some studies have reported that calves fed colostrum products may be more or less predisposed to infectious diseases such as diarrhea during the critical first weeks of life (Jones et al., 2004; Swan et al., 2007). Also, the environment in which the animal is raised may influence predisposition to disease (Frank and Kaneene, 1993; Gulliksen et al., 2009; Cobb et al., 2014) or animal performance (Hill et al., 2011). Important interactions...
may exist between passive immunity, nutrition, and environment. For example, calves with different passive immune status may utilize nutrients differently when fed varying amounts of liquid preweaning (Hill et al., 2006; Quigley et al., 2006). Also, even though it has been shown that the level of liquid fed before weaning has a positive effect on preweaning growth (e.g., Khan et al., 2011), potential interactions of feeding level and immune status are not clear. Alternatively, calves may be more predisposed to disease when housed in environments with greater immunological challenge. Therefore, our hypothesis was that passive immunity as a result of variable colostrum replacer ingestion and either nutrient supply by different liquid feeding or pen cleanliness would not affect measurements of growth, feed efficiency, or health of calves to 56 d of age.

**MATERIALS AND METHODS**

**Colostrum Feeding**

Newborn Holstein bull calves (n = 96) were used in 2 studies of 48 calves. Trial 1 was conducted between September 18 and November 13, 2013, and trial 2 was conducted between November 21, 2013 and January 22, 2014.

All calvings were observed. Within 1 h of birth, each calf was moved from the maternity pen to a clean plastic hutched with straw. Heat lamps were used during cold weather. Each calf was identified with an ear tag and then assigned randomly to treatment. Calves were fed 2 L of whole milk twice daily in individual nipple bottles until transported approximately 3.5 h on a truck to the experimental facility at 2 to 3 d of age.

**Trial 1.** On arrival, calves were assigned randomly within colostrum group to receive a milk replacer (MR; 26% CP, 17% fat, as-fed basis; Table 1) containing whey, whey protein concentrate, dry fat, vitamins, and minerals at the following rates: 0.68 kg/d to 42 d and then 0.34 kg/d for 7 d (moderate, MMR) or 1.0 kg/d of MR for 5 d, 1.36 kg/d for 37 d, and then 0.68 kg/d for 7 d (high, HMR). Milk replacer was reconstituted to 13 and 15% solids, respectively, for MMR and HMR treatments and fed at 0600 and 1530 h in nipple buckets. A texturized starter (18% CP, 3.0 Mcal of ME/kg as fed) and water were available at all times. Starter refusals were measured daily and new starter was offered at 1100 h. Average temperature in the nursery was 5°C (−9 to 22°C) and average relative humidity was 70% (29 to 100%).

**Trial 2.** Pens were bedded with deep straw according to normal management for the farm, but straw was either clean and unused (clean bedding, CB; n = 24) or soiled (dirty bedding, DB; n = 24). Soiled straw bedding was collected during a previous trial and stored in an open-sided, unheated shed. No effort was made to standardize or quantify the degree of contamination in soiled bedding; however, soiled bedding selected for use as bedding in this trial was visibly wet, contained fecal material from calves in the previous study, or both. On arrival, calves were assigned randomly within colostrum group to receive a milk replacer (Table 1) containing whey, whey protein concentrate, dry fat, vitamins, and minerals at the following rates: 0.68 kg/d to 42 d and then 0.34 kg/d for 7 d (moderate, MMR) or 1.0 kg/d of MR for 5 d, 1.36 kg/d for 37 d, and then 0.68 kg/d for 7 d (high, HMR). Milk replacer was reconstituted to 13 and 15% solids, respectively, for MMR and HMR treatments and fed at 0600 and 1530 h in nipple buckets. A texturized starter (18% CP, 3.0 Mcal of ME/kg as fed) and water were available at all times. The average temperature in the nursery was −3°C with a range from −24 to 21°C. The average relative humidity was 74% with a range from 38 to 100%.

**General Management**

Calves were cared for under acceptable practices as described in the Guide for the Care and Use of Agricultural Animals in Research and Teaching (FASS, 2010). Upon arrival at the experimental facility, calves were unloaded, placed into individual pens, and assigned randomly within colostrum group to treatment. Calves were fed 2 L of electrolytes at the p.m. feeding. At 1100 h on the day after arrival, calves were weighed (initial BW), blood was sampled from the jugular vein, serum was harvested, and serum total protein (TP)

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<th>MR</th>
<th>Starter</th>
<th>CR</th>
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*Trial 1 and 2. All calvings were observed. Within 1 h of birth, each calf was moved from the maternity pen to a clean plastic hutched with straw. Heat lamps were used during cold weather. Each calf was identified with an ear tag and then assigned randomly to treatment. Calves were fed 2 L of whole milk twice daily in individual nipple bottles until transported approximately 3.5 h on a truck to the experimental facility at 2 to 3 d of age.

**Trial 1.** On arrival, calves were assigned randomly within colostrum group to receive a milk replacer (CR; 30% IgG; Table 1) containing whey, whey protein concentrate, dry fat, vitamins, and minerals at the following rates: 0.68 kg/d to 42 d and then 0.34 kg/d for 7 d (moderate, MMR) or 1.0 kg/d of MR for 5 d, 1.36 kg/d for 37 d, and then 0.68 kg/d for 7 d (high, HMR). Milk replacer was reconstituted to 13 and 15% solids, respectively, for MMR and HMR treatments and fed at 0600 and 1530 h in nipple buckets. A texturized starter (18% CP, 3.0 Mcal of ME/kg as fed) and water were available at all times. Starter refusals were measured daily and new starter was offered at 1100 h. Average temperature in the nursery was 5°C (−9 to 22°C) and average relative humidity was 70% (29 to 100%).

**Trial 2.** Pens were bedded with deep straw according to normal management for the farm, but straw was either clean and unused (clean bedding, CB; n = 24) or soiled (dirty bedding, DB; n = 24). Soiled straw bedding was collected during a previous trial and stored in an open-sided, unheated shed. No effort was made to standardize or quantify the degree of contamination in soiled bedding; however, soiled bedding selected for use as bedding in this trial was visibly wet, contained fecal material from calves in the previous study, or both. On arrival, calves were assigned randomly within colostrum group to receive a milk replacer (Table 1) containing whey, whey protein concentrate, dry fat, vitamins, and minerals at the following rates: 0.68 kg/d to 42 d and then 0.34 kg/d for 7 d (moderate, MMR) or 1.0 kg/d of MR for 5 d, 1.36 kg/d for 37 d, and then 0.68 kg/d for 7 d (high, HMR). Milk replacer was reconstituted to 13 and 15% solids, respectively, for MMR and HMR treatments and fed at 0600 and 1530 h in nipple buckets. A texturized starter (18% CP, 3.0 Mcal of ME/kg as fed) and water were available at all times. The average temperature in the nursery was −3°C with a range from −24 to 21°C. The average relative humidity was 74% with a range from 38 to 100%.

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