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Influence of nonmedicated additives as alternatives to antibiotics on calf growth and health

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ABSTRACT

The objective was to determine whether a milk replacer with a blend of nonmedicated additives would have similar benefits to a milk replacer with added neomycin and oxytetracycline on calf health and growth. Thirty-six bull calves were purchased and fed 1 of 3 treatments through weaning. All treatments used a 20% CP, 20% fat milk replacer with either no additives (CON), a blend of nonmedicated additives (ADD; animal plasma, yeast cell wall extracts, inulin, ascorbic acid, and direct-fed microbials), or neomycin and oxytetracycline (MED; 362.87 g/t of neomycin; 181.44 g/t of oxytetracycline). Six calves from each treatment were slaughtered, and intestinal tissues were collected. Blood samples were obtained weekly and analyzed for glucose, BUN, creatinine, minerals, bicarbonate, albumin, proteins, and anion gap. Proc Mixed in SAS was used with repeated week statement to analyze blood results and repeated calf statement to analyze intestinal results. Hematocrit values and fecal scores were greater for control calves ($P < 0.05$). Blood results were not different except for sodium concentrations, which were greater for MED calves (139.5, 139.9, and 141.0 for CON, ADD, and MED, respectively; $P < 0.05$), and chloride concentrations, which were greater for MED (95.2, 95.1, and 97.2 for CON, ADD, and MED, respectively; $P < 0.05$). Villus lengths were significantly longer for ADD, and crypt depths were longer for MED ($P < 0.05$). Villus diameter was not different between treatments ($P > 0.15$). These results indicate that both nonmedicated and medicated additives may beneficially affect gastrointestinal morphology, reduce scouring, and improve growth characteristics of neonatal dairy calves compared with unsupplemented calves.

Key words: calf, milk replacer, antibiotics, additive, alternative

INTRODUCTION

Public pressure against antibiotic use in livestock and changing requirements for oxytetracycline and neomycin (US FDA, 2008) are necessitating milk replacer changes. The National Animal Health Monitoring Service reported 57.5% of farms used medicated milk replacers in 2007 (USDA, 2010). Of those farms, 49.5% used a combination of oxytetracycline and neomycin, almost double from the survey conducted by the National Animal Health Monitoring Service in 2002, where only 25.6% of farms using medicated milk replacer used this antibiotic combination. There are many alternatives to antibiotics, some of which include animal plasma, prebiotics, probiotics, ascorbic acid, and yeast cell components.

Animal plasma has been reported to be a good replacement for protein and to improve immune function (Morrill et al., 1995; Zhao et al., 2007). Prebiotics, such as mannan oligosaccharides (**MOS**) and fructooligosaccharides, affect the intestinal environment by increasing beneficial bacterial populations, such as bifidobacteria species (Buddington et al., 1996). Inulin, a type of fructooligosaccharide, has been added to diets of pets, dairy calves, poultry, piglets, and other animals, and results have generally been positive in reducing fecal odor and incidence of diarrhea and improving growth (Verdonk et al., 2005). Beta glucan, which is a component found in yeast cell walls, activates the immune system (Hoffman et al., 1993), and ascorbic acid, an antioxidant, also

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enhances the immune system (Del Rio et al., 1998) as well as protects structural integrity (Bendich, 1993). Direct-fed microbials (**DFM**) have been researched and are used in industry as a "natural" alternative to antibiotics, although results vary widely (Eastridge, 2006; Nocek and Kautz, 2006).

In addition to the need of finding antibiotic replacement, there is also a need to compare the addition of multiple nonmedicated supplements to milk replacers. There are many research trials comparing single nonmedicated supplements; however, when formulating dairy nutrition products, many companies are combining supplements because of potentially synergistic modes of action. Therefore, the objective of this study was to evaluate supplementation of milk replacer with nonmedicated additives (a combination of bovine plasma, MOS, β-glucan, vitamin C, DFM, and inulin) compared with antibiotics (a combination of oxytetracycline and neomycin) on calf growth and health.

MATERIALS AND METHODS

Animals, Housing, and Diet

This trial was approved by the University of Wisconsin–River Falls Institutional Animal Care and Use Committee. The trial used a total of 36 bull calves in 3 repetitions of 12 calves each. Bull calves born within 3 d of each other were purchased from a local dairy and housed at the University of Wisconsin, River Falls (**UWRF**), laboratory farm. Within 6 h of birth, all calves received 4 L of pasteurized colostrum that was tested with a refractometer and fed if it was measured at 18°Brix or higher followed by feedings of waste milk until they were transported to the UWRF laboratory farm. Upon arrival, calves were unloaded in groups of 3, and treatments were randomly assigned within each group. All calves were fed 2 L of an oral rehydration solution (Electrolytes Plus, Milk Products LLC, Chilton, WI). Calves were housed outside in individual plastic hutches (1.8 m × 1.37 m) bedded with straw. After 3 d, a shovelful of straw (approximately 3,700 cm^3) was taken from each hutch and mixed together on a tarp, and hutches were rebedded with the mixed straw as an attempt to ensure all calves were exposed to similar microbial organisms. Milk replacer (Milk Products LLC) was fed twice daily at a feeding rate of 283.5 g (as fed) of milk replacer powder in 2 L of warm water; ad libitum fresh water was also offered daily. Calves were fed treatments until 28 d and then once daily from d 29 to 35. At 21 d, calves were moved from individual outside hutches to individual indoor pens in a ventilated barn where they began receiving calf starter (18% CP; Stockman's Brand, Wilson, WI); intake was recorded daily. Samples of calf starter were taken from every feed bag, mixed, subsampled, and submitted for nutrient analysis (Dairyland Laboratories Inc., Stratford, WI). Any calves that developed a scour score of 3 or higher for more than 2 d were treated with extra afternoon feedings of an oral rehydration solution for 3 d (Electrolytes Plus, Milk Products, LLC).

Nutrient composition of milk replacer used as a base for treatments is shown in Table 1. Treatments included a control (**CON**) group, which received an all-milk protein milk replacer (20% protein, 20% fat) with no additives; a medicated (**MED**) group, which received the CON milk replacer with added neomycin (362.87 g/t) and oxytetracycline (181.44 g/t); and an enhanced nonmedicated (**ADD**) group, which received the CON milk replacer with a blend of nonmedicated additives. Milk protein sources were dried whey, reduced-lactose whey, and whey protein concentrate, and fat was supplemented as whey-encapsulated edible-grade lard. Single ingredient additives in the ADD milk replacer included the following: MOS (Bio-Mos, Alltech Inc., Nicholasville, KY) included at a rate to provide 4 g per calf per day as fed and spray-dried animal plasma (Nutrapro, APC Inc., Ankeny, IA) at a feeding rate to provide 28.4 g/d per calf as fed. Also added was a pack of combined ingredients (Biomatrix International, Princeton, MN) including inulin, β-glucan, vitamin C, and DFM at a feeding rate of 8.5 g/d per calf as fed. At this feeding rate, DFM inclusion resulted in a total bacteria feeding rate of 35.7 billion cfu/d per calf. All treatment milk replacers were assessed for finished product color and mixing characteristics, and conformed to company internal quality standards (Milk Products LLC).

Calves were weighed 12 h after arrival at the UWRF laboratory farm. Hip height, withers height, and heart girth were also measured. Measurements were recorded weekly approximately 4 h after the morning feeding. A jugular blood sample was obtained 24 h after arrival to the laboratory farm. Blood samples (7 mL) were drawn into evacuated blood tubes (Vacutainers, BD, Franklin Lakes, NJ) containing sodium fluoride and potassium oxalate for glucose determinations and a clot enhancer for creatinine analyses. Blood from heparinized samples was drawn into capillary tubes to determine hematocrit percentage using a reader, and serum was used to measure serum protein via refractometer; the remaining blood was centrifuged for 15 min at 3,600 × *g* at room temperature. Plasma and serum were stored at −20°C until further analysis. Samples were submitted to a commercial laboratory (Marshfield Labs, Marshfield, WI) for an animal blood profile, which included analyses of BUN, glucose, creatinine, serum proteins, sodium, chloride, potassium, calcium, phosphorus, albumin, and anion gap. Health scores were conducted daily on each calf to evaluate scores of scours (scale of 1 to 5, 1 being solid and 5 being very watery), respiration, and general appearance through wk 3 until calves were moved to indoor pens (Heinrichs et al., 2003b).

Intestinal Analyses

Calves were monitored daily for scour scores, and 48 h after the