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Evaluation of serum protein-based arrival formula and serum protein supplement (Gammulin) on growth, morbidity, and mortality of stressed (transport and cold) male dairy calves

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ABSTRACT

Previous studies with calves and other species have provided evidence that blood serum-derived proteins and fructooligosaccharides (FOS) may benefit intestinal health. We assessed the effects of supplementing products containing serum proteins as a component of arrival fluid support or serum proteins plus FOS (in addition to additional solids, minerals, and vitamins) in an early life dietary supplement on performance, morbidity, and mortality of stressed (transport, cold) male calves. Male Holstein calves (n = 93) <1 wk old were stratified by arrival body weight (BW) and plasma protein concentration, and then randomly assigned to 1 of 4 treatment groups in a 2 × 2 factorial arrangement of one-time administration of fluid support [either control electrolyte solution (E) or the serum protein-containing arrival formula (AF)] and 14 d of either no supplementation (NG) or supplementation with Gammulin (G; APC Inc., Ankeny, IA), which contains serum proteins and FOS in addition to other solids, minerals, and vitamins. Upon arrival at the research facility, calves were orally administered either AF or E. At the next feeding, half of the calves from each fluid support treatment received either milk replacer (20% crude protein, 20% fat) or the same milk replacer supplemented with G (50 g/d during the first 14 d). Starter and water were freely available. Feed offered and refused was recorded daily. Calf health was assessed by daily assignment of fecal and respiratory scores. Stature measures and BW were determined weekly. Blood samples were obtained at d 0 (before treatments), 2, 7, 14, and 28. Calves were weaned at d 42 and remained in the experiment until d 56. After 2 wk of treatments, calves previously fed AF had greater body length (66.6 vs. 66.0 cm), intakes of dry matter (38.7 vs. 23.5 g/d) and crude protein (9.2 vs. 5.6 g/d) from starter, and cortisol concentration in blood (17.0 vs. 13.9 ng/mL) than calves fed E. Supplementation with G resulted in greater BW gain during the first 2 wk, increased intakes of dry matter and CP, and decreased respiratory scores. For the 8-wk experiment, G supplementation resulted in lower mean fecal score (1.6 vs. 1.8) and fewer antibiotic treatments per calf (1.5 vs. 2.5) than NG. Survival was greater in G than in NG calves (98 vs. 84%). Despite the marked reduction in morbidity and mortality, blood indicators of acute-phase response, urea N, and total protein were not affected by AF or G in transported cold-stressed male calves.
Key words: calf, serum protein, acute phase response

INTRODUCTION

The most challenging period for young calves is from birth through weaning; during this time calves experience remarkable physiological, metabolic, and environmental changes (Davis and Drackley, 1998). Despite advances in calf nutrition and health, morbidity and mortality are greater during this time than at any other point of the animal's life (Quigley et al., 2005; NAHMS, 2010). The main causes of mortality during the preweaned period are diarrhea and respiratory problems, with most of the deaths occurring during the first 2 to 3 wk of life (NAHMS, 2010). For the dairy enterprise, decreasing morbidity and mortality is important because of the economic losses associated with treating illnesses, decreased calf performance, and death. Factors associated with morbidity and poor performance during the preweaned period are inadequate feeding, poor management, and the presence of stressors such as cold weather and transport (Wells et al., 1996; Svensson et al., 2006b; Vasseur et al., 2010).

Success in calf rearing is a function of excellent nutrition and management practices that start as soon as the calf is born. Adequate colostrum intake and provision of a dry, comfortable, and clean environment to minimize exposure to pathogens are the first steps

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to provide better adaptation of the newborn calf to its new environment (Quigley et al., 1995; Godden, 2008). Colostrum-deprived calves exposed to unfavorable conditions (e.g., high pathogen loads, environmental stressors) after birth exhibit greater risk for morbidity and mortality (Quigley et al., 2005; Godden, 2008; Gulliksen et al., 2009). Subsequent nutrition is crucially important to provide all nutrients for proper growth and health; however, adequate nutrition is not enough to ensure proper survival, growth, and health in circumstances where the young calf is immunologically disadvantaged, facing unfavorable environmental conditions, or subjected to other stressors. Transport (Johnston and Buckland, 1976; Odore et al., 2004) and cold weather represent stressors for the young calf, affecting its immune system (Odore et al., 2004; Fike and Spire, 2006) and increasing the susceptibility to enteric and respiratory problems (Fike and Spire, 2006; Svensson et al., 2006a), which are the principal causes of high morbidity and mortality during the preweaned period (NAHMS, 2010).

Dietary supplements or additives that would improve nutrition and diminish the negative effects of poor management and unfavorable conditions would be useful for calf managers. Previous research with calves (Arthington et al., 2000b; Quigley et al., 2002) suggested that serum protein products improve health and decrease morbidity and mortality (Quigley and Wolfe, 2003) while maintaining or increasing growth. In addition, studies in humans and other species have shown that fructooligosaccharides (**FOS**) stimulate growth of beneficial bacteria in the gastrointestinal tract, inhibit colonization by pathogens, and improve mineral absorption (Howard et al., 1995; Sabater-Molina et al., 2009; Grand et al., 2013). Based on these data, our prediction was that products containing serum proteins or serum proteins plus FOS, in addition to milk products (dried whey and dried whey protein concentrate), minerals, and vitamins, would improve performance, morbidity, and mortality of dairy calves subjected to the stressors of winter cold weather and transport, especially during their first 2 to 3 wk of life. Therefore, the aim of the present study was to evaluate the effects of an arrival fluid support product containing serum proteins or an early life dietary supplement containing serum proteins and FOS among other ingredients on performance, morbidity, and mortality of stressed male calves.

MATERIALS AND METHODS

Calf Management and Experimental Design

All procedures were approved by the University of Illinois Institutional Animal Care and Use Committee. Ninety-three male Holstein calves <1 wk old were purchased from dairy farms in western New York by a buyer in 3 blocks of 30 to 32 calves each and transported to the University of Illinois Nutrition Field Laboratory. Calves were transported in a livestock trailer and subjected to a ~14-h trip. The first group was acquired in February 2009 (32 calves), the second group in November 2009 (31 calves), and the third in January 2010 (30 calves).

Each group of calves was examined by the veterinary staff upon arrival. The evaluation included heart and lung auscultation, hydration status, alertness, mobility, navel status, and body temperature. After receiving an ear tag in the left ear calves were subjected to a standard arrival and postarrival processing scheme. A blood sample was obtained by jugular venipuncture and plasma protein was determined by refractometry. Calf BW was measured.

Calves were stratified by arrival BW and plasma protein concentration, blocked, and assigned randomly within blocks to 1 of 4 treatments. Treatments were in a 2 × 2 factorial arrangement of type of arrival fluid support (**AFS**) and early-life dietary supplementation (**SUP**). The AFS factor comprised one-time administrations of either control electrolyte solution (**E**) or arrival formula (**AF**). The SUP factor consisted of either no supplement (**NG**) or 14 d of supplementation with a commercial product (Gammulin; APC Inc., Ankeny, IA) containing serum proteins and FOS (**G**). The resulting individual treatments, therefore, were **EN** (n = 25), **AFN** (n = 24), **EG** (n = 22), and **AFG** (n = 22).

Calves were housed in individual hutches (Calf-tel, Hampel Corp., Germanton, WI) bedded deeply with straw over crushed rock covered with landscape cloth. Straw was added to each hutch daily as needed. All calves were castrated by the veterinary staff via surgical removal of the testicles using local anesthesia 1 wk after arrival. Calves remained in hutches from arrival until the end of the experiment at d 56 when they were sold.

Feeds and Feeding Program

The AF (APC Inc.) fluid support supplement was administrated via nipple feeder or esophageal feeder upon arrival, and was prepared by mixing for each calf 250 g of AF in 2 L of warm (45°C) water. The ingredient composition of AF included spray-dried bovine serum in addition to milk products (dried whey and dried whey protein concentrate), minerals, electrolytes, and vitamins. Administration of AF was compared with administration of a commercial electrolyte solution (Land O'Lakes electrolyte system; Land O'Lakes Animal Milk Products Co., Arden Hills, MN), which was prepared