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Amino acid supplementation of calf milk replacers containing plasma protein

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ABSTRACT

We determined the effects of calf milk replacers containing 0, 5, or 10% bovine plasma protein (PP), either without or with the supplemental amino acids (AA) Ile and Thr, on growth and health of male Holstein calves (n = 104) for 56 d. Milk replacers were formulated to contain 22% crude protein (CP), 20% fat, and 2.0% Lys. Milk replacers (12.5% solids) were fed at a rate of 1.5% of body weight (BW) on a dry matter basis during wk 1 and 1.75% of BW beginning on d 8. Starter was introduced on d 36 so that effects of PP and AA balance in milk replacers could be isolated. Intake, respiratory scores, and fecal scores were measured daily. Body weight and stature were measured weekly and blood serum samples were obtained during wk 4. Treatments had no effects on intakes of dry matter, CP, or metabolizable energy. During wk 6 and 8, BW was less as PP inclusion increased without AA supplementation compared with the other treatments. In wk 7, calves fed the higher level of PP without AA had lower BW than calves fed either the lower level of PP without supplemented AA or the higher inclusion of PP with supplemented AA. Average daily gain and gain:feed were lowest for calves fed the higher inclusion of PP without supplemented AA; heart girth in wk 7 was smallest for those calves. During the first 21 d, occurrence of scours was greater in calves fed the control milk replacer than in calves fed milk replacers containing the higher inclusion of PP either without or with supplemental AA. Occurrence of scours was also greater for the lower inclusion of PP compared with the higher inclusion of PP when AA were supplemented. Throughout the 56-d experiment, the chance of antibiotic treatment was greater for calves fed the control milk replacer than for all other treatments except the higher inclusion of PP without supplemental AA. Additionally, chance of antibiotic treatment was greater for the higher inclusion of PP without supplemental AA than for other milk replacers with PP. Calves fed treatments with the higher inclusion of PP had fewer days of scours than the controls. All milk replacers with PP, except the milk replacer containing higher PP without supplemental AA, had fewer days of treatment with antibiotics compared to the all-milk control. Inclusion of PP provided similar performance and improved health as long as milk replacers were balanced for Ile and Thr.
Key words: calf, milk replacer, plasma protein, essential amino acids

INTRODUCTION

In the United States, over 85% of heifers are fed milk replacer (**MR**) for at least a portion of the preweaning period (NAHMS, 2011). Conventional (limit-fed) MR typically contain 20 to 22% CP and 20% fat (dry basis) and are traditionally formulated using milk protein sources (now principally whey proteins) because of their high digestibility and desirable AA profile for preweaned calves (Davis and Drackley, 1998). In MR formulation, however, protein ingredients are a major portion of the cost. With increasing demand from the human market, milk-derived proteins such as whey protein concentrate can become increasingly more expensive. Identification of non–milk protein sources that provide similar growth and health but at lower cost continues to be an important research objective.

Spray-dried plasma proteins (**PP**) are highly digestible and have a favorable EAA profile, with the exception of Met and Ile (Almeida et al., 2013). In addition, PP are processed to maintain the functional characteristics of proteins such as albumin and IgG. Plasma proteins have been evaluated in calf MR and have resulted in similar (Quigley and Bernard, 1996; Quigley and Wolfe, 2003) or improved (Morrill et al., 1995; Quigley et al., 2002) performance compared with all-milk protein MR. In those studies, PP replaced up to 25% of total CP from milk sources. In a study by Vasquez et al. (2017), the inclusion of PP was evaluated over a wide range of whey protein replacement in calf MR, and results indicated that replacing up to 33% of the total dietary CP with PP did not reduce performance.

Research in pigs has demonstrated that maximum PP inclusion is likely dependent on Ile content of the

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diet because Ile is the most limiting AA after Met (Torrallardona, 2010). Results from the study conducted by Vasquez et al. (2017) indicated that Thr might become limiting for growth in young calves as PP inclusion increases, even with Ile addition. Evaluation of AA supplementation with inclusion of PP may aid in the understanding and formulation of more cost-effective calf MR that perform similarly to conventional MR.

Our objective in this experiment was to determine the effects of calf MR containing 0, 18, or 36% of total replaceable milk protein as bovine PP, either without or with supplemental Ile and Thr, on calf growth and health.

MATERIALS AND METHODS

Calves, Arrival, and Processing

All procedures were conducted under protocols approved by the University of Illinois Institutional Animal Care and Use Committee (protocol 13138). The study was conducted from October 2013 to February 2014. A total of 105 male Holstein calves, less than 1 wk old, were selected at a local farm in east-central Illinois. Three groups of calves were brought to the research site at different times throughout the course of the study due to calf availability and space limitations at the research facility. The groups included 40 calves in the first group, 20 calves in the second group, and 45 calves in the third group. At the time of selection, blood samples were taken from the jugular vein into 10-mL evacuated serum separation tubes (Becton Dickinson, Rutherford, NJ). Blood was centrifuged at 1,300 × *g* for 15 min, and a refractometer was used to determine total protein concentration in the serum for all potential calves. Calves were selected based on total protein in serum and visual health assessment. After selection, calves were transported to the research site. All calves selected were given 2 mL of BO-SE (Merck Animal Health, Kenilworth, NJ), 1 mL of vitamins A and D (Sparhawk Laboratories Inc., Lenexa, KS), and 2 mL of Inforce (Pfizer, New York, NY). If a calf was chosen for the trial and had a total protein of <5.5 g/dL, it was also given 50 mL of Bovisera (Colorado Serum Co., Denver, CO) and 20 mL of clostridial C and D antitoxin (Boehringer Ingelheim, Ridgefield, CT). Initial measurements of BW, body length, heart girth, withers height, hip height, and hip width were obtained after arrival at the research facility. In each group of calves, all treatments were equally represented within blocks, and once all calves were enrolled, each treatment group had 21 calves.

Housing

Calves were housed in south-facing individual hutches (Calf-tel, Hampel Corp., Germantown, WI) placed approximately 1.5 m apart. Hutches were placed on a base of crushed rock, which was covered by landscape cloth and a layer of straw. Straw was checked daily and more added as needed. Temperature and humidity were recorded using data from the local weather station.

Experimental Diets

Calves were blocked on the day of arrival (d 0) by BW and serum total protein concentration and then randomly assigned within block to 1 of 5 MR treatments that contained increasing amounts of PP (NutraPro B, APC Inc., Ankeny, IA) without or with supplemental Ile and Thr. All treatments resembled a commercial formula containing 22% CP and 20% fat and were formulated to contain 2.0% Lys (Table 1).

The treatments were control, an all-milk protein MR with Met added to achieve a Met:Lys ratio of 0.31 (**M**); 5% addition of PP (18% of CP) with Met added to equal the ratio in treatment M (**5P**); 5% PP addition as in treatment 5P but with Ile and Thr added to equal the amounts in treatment M (**5PA**); 10% addition of PP (36% of CP) with Met added to equal the ratio in treatment M (**10P**); and 10% PP addition as in treatment 10P but with Ile and Thr added to equal amounts in treatment M (**10PA**). Milk replacers were manufactured by Milk Specialties Global Animal Nutrition (Eden Prairie, MN).

Feeding and Management

Calves were fed twice daily at 0500 and 1630 h. All MR were reconstituted to 12.5% solids. For the first 2 d after arrival MR were fed at a rate of 1.25% (DM basis) of arrival BW. For the remainder of the first week (d 3–7) calves were fed MR at a rate of 1.5% of arrival BW. Beginning on d 8 MR was fed at a rate of 1.75% of BW, adjusted weekly. Milk replacer intake was recorded daily. During wk 8 (d 50–56) calves were fed MR only one time per day, and after d 56 MR was no longer fed. Water was offered for ad libitum consumption, and intake was recorded daily. Calf starter (AMPLI-CALF Starter 22, Purina Animal Nutrition LLC, Gray Summit, MO) was fed beginning in wk 6 (d 36) for ad libitum intake and intake was measured daily. No starter was offered during the first 5 wk so that potential differences in MR protein source and AA balance could be detected with greater sensitivity.