J. Dairy Sci. 100:1–14
https://doi.org/10.3168/jds.2016-11221
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Growth performance of calves fed microbially enhanced soy protein in pelleted starters

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ABSTRACT

Our objective was to determine effects of feeding calves pelleted starters with microbially enhanced (fungi-treated) soy protein (MSP) in replacement of soybean meal (SBM) with different milk replacers (MR). Thirty-six Holstein calves (2 d old; 24 females, 12 males) in individual hutches were used in a 12-wk randomized complete block design study. Treatments were (1) MSP pellets with MR formulated for accelerated growth (28% crude protein, 18% fat; MSPA), (2) SBM pellets with MR formulated for accelerated growth (SBMA), and (3) MSP pellets with conventional MR (20% crude protein, 20% fat; MSPC). Pellets were similar except for 23% MSP or 23% SBM (dry matter basis). Pellets and water were fed ad libitum throughout the study. Feeding rates of MR on a dry matter basis were 0.37 kg twice daily during wk 1, 0.45 kg twice daily during wk 2 to 5, and 0.45 kg once daily during wk 6. Intakes were recorded daily. Body weights, frame size measurements, and jugular blood samples were collected 2 d every 2 wk at 3 h after the morning feeding. Fecal grab samples were collected 5 times per d for 3 d during wk 12 and then composited by calf for analysis of apparent total-tract digestibility of nutrients using acid detergent insoluble ash as an internal marker. Total and starter pellet dry matter intake were greatest for calves fed SBMA and least for MSPC. Calves had similar average daily gain among treatments, but there was a treatment by week interaction and during the last few weeks of the study calves on MSPC had less body weight compared with MSPA or SBMA. Gain-to-feed ratio was similar among treatments; however, there was a treatment by week interaction. Serum glucose was similar among treatments. Plasma urea nitrogen was greatest for calves fed MSPA and least for MSPC. Plasma concentrations of IGF-1 were greatest for calves fed SBMA. Plasma concentrations of triglycerides were greatest for calves fed MSPC. Plasma concentrations of β-hydroxybutyrate had a treatment by time interaction. Treatments had similar total-tract dry matter digestibility, but calves fed MSPC had greater crude protein digestibility than SBMA, with MSPA similar to both. Results demonstrated calves fed pelleted starters with MSP had maintained growth performance with less starter intake compared with SBM.
Key words: microbially enhanced soy protein, dairy calf, growth performance

INTRODUCTION

During the early growth phase of dairy calves, key immunological and digestive system developments are occurring which can affect long-term animal performance (Davis Rincker et al., 2011; Hill et al., 2013). To improve calf performance, high protein milk replacer (**MR**) and starter feeds have been developed and formulated for accelerated growth. In MR formulated for accelerated growth, most of the proteins are from milk-based sources, which often makes these feeding programs more expensive. However, milk proteins are still most commonly used as they have been shown to result in superior calf performance compared with plant-based proteins (Dawson et al., 1988).

Dry feed intake is also critical to development of an active, functioning rumen. Early consumption of dry feed increases butyrate in the rumen, which is responsible for development of functional ruminal epithelial tissue (Hill et al., 2006). Moreover, Hodgson (1971), Jenny et al. (1982), and Leaver and Yarrow (1972) showed that early dry feed consumption increased reticulorumen development, helped the calf to transition from liquid feed to dry feed, and reduced weaning stress.

A new proprietary processing technique has been developed by Prairie AquaTech (Brookings, SD) in which fungi are used to aerobically process soybean meal (**SBM**) to increase the protein content, improve digestibility, and decrease anti-nutritional compounds (Gib-

Received March 25, 2016.
Accepted September 26, 2016.
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bons and Brown, 2012). This microbially enhanced soy protein (**MSP**) has a much greater protein content and digestibility than SBM and has performed comparably to fish meal in aquaculture studies (Sindelar, 2014). It is also believed that fungal cell walls and β-glucans present in the MSP may give it prebiotic properties (Bruce et al., 2015). Because of its unique nutritional properties, MSP may be a beneficial feed for dairy calves with developing digestive systems.

Research on feeding calves fermented SBM has demonstrated improved immune responses in some cases (Kwon et al., 2011), whereas other trials have shown no improvement (Wolfswinkel, 2009). Lesmeister et al. (2004) reported that supplementing feeds with yeast increased feed component digestibility by increasing microbial activity in the rumen, leading to increased butyrate production. Although MSP has some similarities to fermented SBM, it is produced by an aerobic incubation with a nonyeast fungus, instead of a bacterial or yeast-based fermentation process. Two important compositional differences are that MSP has greater protein content and fewer anti-nutritional factors (antigens, stachyose, raffinose, and trypsin inhibitor) compared with fermented SBM (Gibbons and Brown, 2012).

Our hypothesis was that the improved quantity and quality of protein in MSP, compared with SBM, would allow the former to be used in the starter pellet with conventional MR (20% CP:20% fat), and achieve similar or improved calf growth performance compared with SBM used with MR formulated for accelerated growth (28% CP:18% fat). We also hypothesized that feeding MSP in pellets with MR formulated for accelerated growth may have additive benefits. The objectives of this research were to conduct a feeding study to determine the effects of MSP in dairy calf starter pellets on growth performance, which was evaluated based on feed intake, BW, body frame size, blood metabolic profile, fecal consistency scores, and apparent total-tract nutrient digestion. As part of this, we also wanted to determine if the increased calf starter pellet CP from the MSP benefited the calves.

MATERIALS AND METHODS

Experiment Design

The research was conducted under protocols approved by the South Dakota State University Institutional Animal Care and Use Committee. Thirty-six newborn Holstein calves (24 females and 12 males) were used in a 12-wk feeding experiment. All calves were housed in individual hutches at the South Dakota State University Dairy Research and Training Facility (Brookings, SD). Length, width, and height of individual calf hutches were 223, 98, and 133 cm, respectively (Calf-Tec, Hampel Animal Care, Germantown, WI). Wheat straw was used as bedding material. The experiment was conducted from September 2014 to May 2015. Calves were added to the study as they were born. Prior to starting the study all calves received 2 feedings of colostrum at rate of 1.9 L per feeding. Calf serum blood protein concentrations were tested by refractometer 24 h after birth, to ensure adequate transfer of immunoglobulins had occurred. Overall mean serum concentration of proteins were 5.4 ± 0.13 g/dL. Calves were assigned to 1 of 3 treatments in a randomized block design experiment. Calves were blocked by sex and birthdate. The 3 treatments were (1) MSP pellets with MR formulated for accelerated growth (**MSPA**), (2) SBM pellets with MR formulated for accelerated growth (**SBMA**), and (3) MSP pellets with conventional MR (**MSPC**). The 2 starter pellets were similar composition except for 23% SBM or 23% MSP on DM basis. Ingredient compositions of the pellets are shown in Table 1.

Management of Calves

Milk bottles were used to feed MR throughout the preweaning period. During the first 2 wk, calves received MR medicated with 10 mg of neomycin sulfate and 10 mg of oxytetracycline mix. Nonmedicated MR were fed from wk 2 to weaning at 6 wk. During wk 1, calves were fed twice daily 0.37 kg of MR in 2.83 L of water. During wk 2 to 5, calves received 0.45 kg of MR in 2.83 L of water and 0.45 kg of MR once

Table 1. Ingredient composition for calf starter pellets containing soybean meal (SBM) or containing microbially enhanced soy protein (MSP) fed to calves

	Pellet[1]	
Ingredient, % of DM	SBM	MSP
Corn, ground	35.0	35.0
Microbially enhanced soy protein[2]	—	23.0
Soybean meal	23.0	—
Wheat middling	35.0	35.0
Molasses, sugar cane	5.0	5.0
Mineral mix[3]	1.7	1.7
Salt	0.3	0.3

[1]Pellets were custom made by Pipestone Grain Company, Pipestone, MN.

[2]Prairie AquaTech, Brookings, SD.

[3]48.2% dicalcium phosphate; 13.7% salt; 28.37% limestone; 3% selenium (0.06%); 5% ruminant trace mineral mix (2.59% calcium; 10.64% magnesium oxide; 1,802 mg/kg of cobalt carbonate; 25,022 mg/kg of copper sulfate; 340 mg/kg of iodine; 100,715 mg/kg of iron sulfate; 49,906 mg/kg of manganese sulfate; 49,900 mg/kg of zinc sulfate; 1.0% mineral oil; rice hulls as carrier); 1.2% liquid molasses; 0.44% vitamin A; 0.13% vitamin D, 66 IU/kg; and 0.017% vitamin E, 275,000 IU/kg.

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