J. Dairy Sci. 101:1–13
https://doi.org/10.3168/jds.2017-13795

Effects of spray-dried plasma protein product on early-lactation dairy cows

C. Lee,* A. W. Tebbe,* J. M. Campbell,† and W. P. Weiss*[1]
*Department of Animal Sciences, Ohio Agricultural Research and Development Center, The Ohio State University, Wooster 44691
†APC Inc., Ankeny, IA 50021

ABSTRACT

Spray-dried plasma protein (SDP) compared with blood meal (BM) may contain various functional and active components that may benefit animal health. The objective of this experiment was to investigate the effects of feeding SDP or BM on production and blood profile in dairy cows during the transition and early-lactation periods. Seventy-two Holstein cows at 14 d before calving were used in a randomized block design. During the prepartum period, cows were fed a typical late-gestation diet containing BM (100 g/cow per day; 100BM, n = 24) or SDP (100 g/cow per day; 100SDP; n = 48). After calving, cows that were fed BM prepartum were fed a typical lactation diet formulated to provide 100 g/d of BM (100BM). Half the cows that were fed 100SDP prepartum were fed a lactation diet formulated to provide 100 g/d of SDP (100SDP; n = 24), and half were fed a diet formulated to provide 400 g/d of SDP (400SDP; n = 24) on a dry matter basis where SDP replaced BM (100SDP) or BM and soybean products (400SDP). All diets were balanced for crude protein concentration and metabolizable protein supply assuming BM and SDP were equal in rumen-degradable protein and rumen-undegradable protein. All data were analyzed using the MIXED procedure of SAS (SAS Institute Inc., Cary, NC) as a randomized block design where contrasts were made for 100BM versus 100SDP for prepartum variables and 100BM versus 100SDP and 100SDP versus 400SDP for postpartum variables. Prepartum supplementation of SDP had no effect on plasma fatty acids and β-hydroxybutyrate (2 d before calving). Plasma fatty acids (255 ± 29 μEq/mL) and β-hydroxybutyrate (675 ± 70 μmol/L) at 8 and 14 d of lactation were not affected by SDP in the diet. Feeding SDP at 100 g/d compared with 100BM increased or tended to increase milk fat, protein, and lactose contents for 16 wk after parturition. Providing SDP at 400 g/d in the diet increased milk yield (42 vs. 39 kg/d), energy-corrected milk (44 vs. 41 kg/d), energy-corrected milk per kilogram of dry matter intake, and yields of milk fat (1.60 vs. 1.48 kg/d), protein (1.21 vs. 1.16 kg/d), and lactose compared with 100SDP. Body weight losses tended to be lower for 100SDP compared with 100BM without a difference between 100SDP and 400SDP. Plasma histidine concentration (d 14 of lactation) was lower for SDP compared with 100BM. In addition, plasma 1-methyl-L-histidine tended to be lower as inclusion rate of SDP increased. In conclusion, SDP at 400 g/d increased milk and milk component yields without an increase in feed intake. Studies evaluating effects of functional and active compounds in SDP on gut microbiome, gut health, and immune functions may be needed to determine mode of action.
Key words: spray-dried plasma, transition, early lactation, dairy cow

INTRODUCTION

Dairy cows undergo negative energy and protein balance after parturition because of low DMI relative to milk production (Drackley, 1999; Bell et al., 2000). Therefore, additional nutrients [e.g., fatty acids (**FA**) and AA] from the body reservoir are mobilized to provide energy and AA to support milk production during early lactation. Negative energy balance is a risk factor for numerous health disorders, including ketosis, retained placenta, displaced abomasum, metritis, and mastitis (Drackley, 1999; Hailemariam et al., 2014). These disorders negatively affect animal welfare and can cause substantial economic losses to producers by increasing veterinary costs and reducing milk production and reproductive efficiency (Ametaj et al., 2012). Nutritional strategies that can improve energy and protein balance in early lactation, such as increasing DMI, metabolizable AA supplies, or health status (Drackley, 1999; Larsen et al., 2015), should result in improved animal welfare and greater profitability.

Blood by-products originate from the meat processing industry and can be a good source of nutrients (especially AA) when fed to livestock (Almeida et al., 2013). Blood meal (**BM**) and spray-dried plasma

Received September 6, 2017.
Accepted February 23, 2018.
[1]Corresponding author: weiss.6@osu.edu

(**SDP**) are both blood byproducts, but the blood components (whole blood vs. plasma) and production processes (e.g., drying procedure) are different. Blood meal has been widely used as a valuable protein source (high RUP) for dairy cows, whereas SDP has not been evaluated as a feed ingredient especially for transition and early-lactation cows. Spray-dried plasma contains various functional and active components such as immune-related proteins, growth factors, and biologically active peptides (Campbell et al., 2008; Pérez-Bosque et al., 2016). Although direct comparisons between SDP and BM are limited, feeding SDP may provide more of those components to cows compared with BM, potentially improving health status of transition and early-lactating cows. For example, AA ileal digestibility in pigs was greater for SDP compared with BM (Almeida et al., 2013). When SDP replaced other protein sources (e.g., soybean products, dried skim milk, meat meal) in diets of pigs, calves, poultry, mice, and fish (van Dijk et al., 2001; Gisbert et al., 2015; Song et al., 2015; Beski et al., 2016), feed intake, BW gains, and immune function were improved. Improved dietary protein utilization with reduced AA catabolism in the gut has been observed in pigs fed a diet containing SDP (Jiang et al., 2000).

Because the functional proteins and nonfunctional proteins in SDP can benefit nutrient supplies and health of dairy cows, our hypothesis was that feeding SDP compared with BM to dairy cows during the transition and early-lactation periods would increase production and improve the quality of colostrum. In addition, we hypothesized that the effects of SDP would be dose-related.

MATERIALS AND METHODS

All procedures in this project that involved animals were approved by The Ohio State University Institutional Animal Care and Use Committee.

Diets and Experimental Design

A total of 72 prepartum cows (21 primiparous and 51 multiparous) were used. Cows were blocked into groups of 3 based on parity and expected calving date (17 blocks of multiparous and 7 blocks of primiparous). The experiment consisted of 2 phases: a prepartum phase and postpartum phase. During the prepartum phase, cows were moved to individual box stalls 14 d before anticipated calving and received 1 of 2 treatment diets. Both diets were essentially the same (Table 1) except that one diet contained ring-dried BM (Akey Inc., Lewisburg, OH) and the other contained SDP (APC Inc., Ankeny, IA) and a treated soybean meal. One cow in each block was randomly assigned to BM and 2 cows were assigned to SDP treatment. Cows were fed a fixed amount of silage and concentrate (containing either BM or SDP) once daily with essentially complete consumption by all cows so that cows consumed 100 g of either BM (**100BM**) or SDP (**100SDP**). Grass hay was provided to allow ad libitum intake by all cows (intake was measured). Cows remained in box stalls for 2 d after calving and then were moved to tiestalls. The first morning after calving, all cows were switched to early-lactation diets (Tables 2 and 3). Cows that were fed 100BM prepartum were switched to a diet that contained BM (100BM). One cow in each block that was fed SDP prepartum was fed a diet formulated to provide 100 g/d of SDP (100SDP); the other cow in the block was fed a diet formulated to provide 400 g/d of SDP (**400SDP**). Essentially, the only difference between the 100BM and 100SDP diet was that SDP replaced BM. For the 400SDP diet, SDP replaced both BM and soy products. A study demonstrated a positive effect of feeding 400 g/d (Bach et al., 2017); however, because of potential cost, the 100 g/d treatment was included because it likely would be more economically feasible for field application. During the prepartum period, 400SDP was not included as a treatment because diets could not be made isonitrogenous without significant modification of the diet and the necessary inclusion rate (approximately 4% of diet DM) could have restricted intake. All diets were formulated to be isonitrogenous and to provide the same amount of MP. During the first 25 DIM, cows received diets formulated with an assumed DMI of 17 kg/d. Target RDP, RUP, and MP (NRC, 2001) were 10.5, 6.5, and 11.5% of diet DM, respectively (protein fractions of SDP were assumed to be equal to BM). Starting on 26 DIM, cows were fed diets that were formulated with an assumed DMI of 27.5 kg/d with target RDP, RUP, and MP of 10.0, 6.0, and 11%, respectively (Table 3). This was done to maintain target intakes of BM or SDP (i.e., 100, 100, or 400 g/d) throughout the experimental period. Dietary concentrations of BM, SDP, and alfalfa hay were reduced and whole cottonseed concentration was increased after 25 DIM. To keep diets as similar as possible, one base concentrate was fed to all cows and separate concentrate mixes for each treatment were blended at the time of TMR preparation (14.7 and 9.0% of diet DM for fresh and early-lactation diets, respectively). All cows remained on the early-lactation diets until 120 DIM (16 wk). All diets (close-up, fresh, and early lactation) were formulated to provide nutrients meeting the requirements for cows according to NRC (2001). During the lactation phase, diets were mixed every morning (0300 h) and provided to individual cows ad libitum (5% orts) as a TMR with free access to