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Production and nitrogen utilization in lactating dairy cows fed ground field peas with or without ruminally protected lysine and methionine

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ABSTRACT

Previous research has shown that cows fed ≥24% of the diet dry matter (DM) as field peas decreased milk yield as well as concentration and yield of milk protein, possibly due to reduced DM intake and limited supply of Lys and Met. Twelve multiparous and 4 primiparous lactating Holstein cows were randomly assigned to 1 of 4 diets in a replicated 4 × 4 Latin square design. The diets contained (DM basis) 34.8% corn silage, 15.2% grass-legume silage, 5.9% roasted soybean, 2.4% mineral-vitamin premix, 2.0% alfalfa pellets, and either (1) 36% ground corn, 2.4% soybean meal, and 1.3% urea (UR), (2) 29.7% ground corn, 9.8% soybean meal, 0.13% ruminally protected (RP) Lys, and 0.07% RP-Met (CSBAA), (3) 25% ground field peas, 12.3% ground corn, and 2.4% soybean meal (FP), or (4) FP supplemented with 0.15% RP-Lys and 0.05% RP-Met (FPAA). Our objective was to test the effects of FP versus UR, FPAA versus CSBAA, and FPAA versus FP on milk yield and composition, N utilization, nutrient digestibility, ruminal fermentation profile, and plasma concentration of AA. Milk yield did not differ across diets. Compared with cows fed UR, those fed FP had greater DM intake, concentration and yield of milk true protein, apparent total-tract digestibility of fiber, urinary excretion of purine derivatives, and concentrations of total volatile fatty acids in the rumen and Lys in plasma, and less milk urea N and ruminal NH_3-N. The concentration of milk urea N, as well as the concentration and yield of milk fat increased in cows fed FPAA versus CSBAA. Moreover, cows fed FPAA had greater ruminal concentration of total volatile fatty acids, increased proportions of acetate and isobutyrate, and decreased proportions of propionate and valerate than those fed CSBAA. The plasma concentrations of His, Leu, and Phe decreased, whereas plasma Met increased and plasma Lys tended to increase in cows fed FPAA versus CSBAA. Concentration of milk true protein, but not yield, was increased in cows fed FPAA versus FP. However, cows fed FPAA showed decreased concentrations of His and Leu in plasma compared with those fed FP. Overall, compared with the CSBAA diet, feeding FPAA did not negatively affect milk yield and milk protein synthesis. Furthermore, RP-Lys and RP-Met supplementation of the FP diet did not improve milk yield or milk protein synthesis, but decreased urinary urea N excretion.
Key words: dairy cow, ground field pea, milk yield, ruminally protected amino acid

INTRODUCTION

Field peas (or dry peas, split peas; *Pisum sativum*), a pulse crop commonly grown in the northern plains of the United States and Canadian provinces, are primarily used as human food, but also as livestock feed when food quality standards are not met (Gilbery et al., 2007). Field peas are one of the few feedstuffs that combine relatively high concentrations of CP and starch (Gilbery et al., 2007), making them a unique substitute for typical dairy protein and energy sources such as soybean meal, corn, and barley. Field peas may also be an alternative to soybean meal in organically certified dairies due to the increased risk for soybean meal to be genetically modified (Froidmont and Bartiaux-Thill, 2004). However, most of the RDP in field peas consists of soluble protein (**SP**), which may decrease milk yield and N utilization in lactating dairy cows, particularly at high levels (≥24% of diet DM) of inclusion. Soluble protein is defined herein as true protein soluble in borate-phosphate buffer, but precipitable with tungstic acid (Licitra et al., 1996). Degradable protein or RDP is defined as dietary nitrogenous sources degraded by the ruminal microbiota. According to the NRC (2001), ruminally degraded feed CP provides a mixture of

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peptides, free AA, and NH_3 for microbial growth and synthesis of microbial protein.

Albrecht (2012) reported a quadratic decrease in DMI, as well as linear reductions in milk yield and concentration and yield of milk true protein in dairy cows fed incremental amounts of cracked field peas (0, 12, 24, or 36% of the diet DM) at expense of ground corn and soybean meal. These negative responses were more severe at high levels of supplementation (i.e., 24 and 36% of the diet DM), thereby suggesting that depressed DMI and deficiency in the supply of MP-Lys or MP-Met or both could be involved. However, we are not aware of any study to date that has tested the effects of ruminally protected (**RP**)-Lys and RP-Met supplementation to diets containing ground field peas (**GFP**) on milk yield and N utilization in dairy cows. It is also unknown how milk yield and milk protein synthesis are affected by feeding GFP compared with a NPN source such as urea.

Ammonia is the main N source for microbial protein synthesis (Nolan, 1975; Aharoni et al., 1991) and is essential for the growth of several species of ruminal bacteria (Allison, 1970; Bryant, 1973). On the other hand, a large number of studies have established that preformed AA, as free AA, peptides, or SP, increased microbial growth, fiber digestion, or both (Cotta and Russell, 1982; Chikunya et al., 1996; Griswold et al., 1996; Atasoglu et al., 1999; Carro and Miller, 1999). Thus, feeding GFP versus urea may increase microbial protein synthesis as GFP-SP releases free AA, peptides, and NH_3 following degradation in the rumen, whereas urea only yields NH_3 for microbial growth. Moreover, Reynal et al. (2007) reported that, on average, 10% of the total AA flow to the omasum consisted of soluble AA from feed origin (i.e., free AA, peptide AA, and SP AA). Of this 10%, which represented 74 g/d of omasal flow of dietary total soluble AA, only 8 g/d came from the SP AA pool, suggesting extensive ruminal degradation of SP or low concentration of SP in the diets.

Our hypotheses were (1) cows fed 25% of the diet DM as GFP would improve milk yield and N utilization due to increased DMI, nutrient digestibility, and microbial protein synthesis [estimated as urinary excretion of purine derivatives (**PD**)] compared with cows fed urea; (2) milk yield and milk protein synthesis would be similar in cows fed diets containing ground corn plus soybean meal or GFP (25% of the diet DM) with both rations formulated to yield a 3:1 MP-Lys to MP-Met ratio (7.2% Lys and 2.4% Met in MP; NRC, 2001) via RP-Lys and RP-Met supplementation; and (3) milk protein synthesis would increase in cows fed a diet that consisted of GFP formulated to yield a 3:1 MP-Lys to MP-Met ratio via RP-AA supplementation compared with GFP without RP-AA supplementation. We decided to feed 25% GFP because greater amounts have been shown to decrease DMI, milk yield, and N utilization, as well as ruminal and total-tract digestibility of fiber (Khorasani et al., 2001; Albrecht, 2012). The objective of our study was to test the effects of the experimental diets on milk yield and composition, N utilization, nutrient digestibility, ruminal fermentation profile, and plasma concentration of AA through the following pairwise comparisons: (1) GFP versus urea (i.e., **FP** vs. **UR**); (2) GFP versus ground corn plus soybean meal, both diets supplemented with RP-Lys and RP-Met (i.e., **FPAA** vs. **CSBAA**); and (3) FPAA versus FP.

MATERIALS AND METHODS

The experiment was conducted at the University of New Hampshire Fairchild Dairy Teaching and Research Center (43°14′N, 70°95′W; Durham, NH) from June 29 to September 14, 2014. Care and handling of the animals were approved in accordance to the University of New Hampshire Institutional Animal Care and Use Committee guidelines (IACUC protocol no. 140402).

Animals, Experimental Design, and Diets

Twelve multiparous Holstein cows (4 ruminally cannulated) averaging (mean ± SD) 97 ± 36 DIM and 684 ± 61 kg of BW and 4 primiparous Holstein cows averaging 101 ± 23 DIM and 619 ± 35 kg of BW at the beginning of the study were used. Cows were randomly assigned to treatment sequences in a replicated 4 × 4 Latin square design. Distribution of animals to squares was done to balance for differences in DIM, milk yield, and parity. Cows were housed in a tiestall barn with free access to water throughout the experiment. Each experimental period lasted 21 d, with 14 d for diet adaptation and 7 d for data and sample collection. Diets were fed as TMR and were prepared twice daily, at 0630 and 1630 h, using a Super Data Ranger mixer (American Calan Inc., Northwood, NH). Feed was placed in individual wooden feed tubs (90 × 90 × 90 cm) with 30% of the daily TMR allocation offered at 0700 h and the remaining 70% at 1700 h to account for uneven intervals between feeding times (i.e., 10 h between 0700 and 1700 h and 14 h between 1700 and 0700 h). The amount of TMR offered to the animals was recorded using the Super Data Ranger scale (American Calan Inc.). Refusals were collected daily before the afternoon feeding and weighed as done for the TMR. Feed offered was adjusted daily to yield approximately 5% refusals per animal.