EFFECTS OF SOURCE OF SUPPLEMENTAL PROTEIN ON NITROGEN PASSAGE TO THE SMALL INTESTINE

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TAKE HOME MESSAGES

- Large variation exists in the effects of rumen undegradable protein (RUP) on passage of nitrogen (N) fractions and amino acids to the small intestine of dairy cows.

- A portion of this variation is caused by the source of crude protein (CP) in the control diet, proportion and source of RUP in experimental diet, effect of RUP on ruminal outflow of microbial protein, degradability of the RUP source, and the amino acid content of RUP outflow from rumen.

INTRODUCTION

Increases in milk production, and concerns about environmental pollution, have challenged dairy producers and nutritionists to establish the minimum amount of CP required by dairy cows for achieving optimal, but not necessarily maximal, milk production. To accomplish this goal it is essential that sources of supplemental CP be identified that will maximize efficiency of nutrient use and minimize environmental pollution and economic costs. The objectives were to review and summarize the effects of the amount and source of dietary CP supplements on the supply of N fractions passing to the small intestine.

MATERIALS AND METHODS

A N flow data set of 57 research trials provided a maximum of 224 treatment comparisons. Dry matter intake ranged from 23.8 to 59.0 lb/d and dietary CP ranged from 11.3 to 23.1%. Only treatment comparisons that were isonitrogenous were included in the data set. The data set contained a wide range of values for passage of total N, nonammonia N (NAN), microbial N, nonammonia nonmicrobial N (NANMN), lysine (Lys), and methionine (Met).

To summarize and evaluate these data a meta-analytic technique was used. In the figures, symbols represent the mean percentage change either positive or negative, the bars represent the 95% confidence interval, and the number in parenthesis is the number of treatment comparisons. If the 95% confidence interval bar does not overlap 0, then the mean percentage change is different from 0. If the 95% confidence interval bars for the RUP supplements do not overlap, then they are different from each other.
RESULTS

Data from the meta-analysis indicated that feeding the supplemental RUP sources increased passage of NAN to the small intestine. The source of CP in the control diet to which the supplemental RUP in the experimental diet was compared had a significant effect on the magnitude of the response obtained from the RUP. Because soybean meal (SBM) was the most frequently used CP supplement in the control diets and because SBM is widely used for feeding dairy cows, N flow data were compared for RUP treatments and SBM control diets.

Including different proportions of CP in the experimental diets from supplemental RUP sources increased the escape of NANMN from the rumen compared with SBM control diets (Figure 1). The overall effect was a 26% increase in ruminal outflow of NANMN. The supplemental RUP increased the escape of NANMN from the rumen at all percentages of inclusion in the experimental diet. The smallest mean magnitude of response was at the less than 25% concentration of RUP in the experimental diet, which is the concentration that most closely represents practical feeding recommendations of RUP supplements.

The mean response for each source of supplemental RUP showed that treated soy products, corn byproducts, a mixture of animal, marine, and (or) plant proteins (RUP mix), and blood meal increased the amount of NANMN delivered to the small intestine compared with SBM control diets (Figure 2). Other protected plant proteins and fish meal also increased passage of NANMN to the small intestine, but the response was not significant. The magnitude of the mean increase in passage of NANMN to the small intestine caused by the different sources of supplemental RUP ranged from about 12 to 52% and the average for all sources of RUP was more than 20%. Even though this is a wide range in response, differences among sources of supplemental RUP were not significantly different.

There was a 7% depression in the overall response to RUP supplements on passage of microbial N to the small intestine (Figure 3). Blood meal, fish meal, and RUP mix depressed ruminal outflow of microbial N by 10 to 14%. There was also a mean decrease of 6 to 8% in ruminal outflow of microbial N caused by corn byproducts and other protected plant sources and a mean increase of 2% for treated soy products; but, these differences were not significant compared with the SBM control diets. Therefore, feeding the supplemental sources of RUP increased the intestinal supply of NANMN (i.e. feed plus endogenous protein) but decreased the intestinal supply of microbial N compared with SBM.

The overall mean for ruminal outflow of NAN was increased about 6% when experimental diets that contained RUP were compared with SBM control diets (Figure 4). Compared with SBM control diets, experimental diets that contained treated soy products, corn byproducts, and RUP mix increased outflow of NAN. Other protected plant proteins and fish meal did not increase ruminal outflow of NAN. Blood meal increased ruminal outflow of NAN by about 5% compared with SBM, but this increase was not significant. Overlapping of the 95% confidence interval bars indicates that the ruminal outflow of NAN was not different among sources of supplemental RUP.
Across all comparisons, the ruminal outflow of essential amino acids (EAA) was improved by 9% when RUP supplements were compared with SBM (Figure 5). All RUP supplements caused a positive response; but only the response to blood meal, RUP mix, and corn byproducts was significant ranging from 12 to 16%. Therefore, these data suggest that the benefit of the greater ruminal outflow of NANMN elicited by most RUP supplements was greater than their detrimental effects on ruminal outflow of microbial N.

Corn byproducts and fish meal were the most effective sources of RUP for enhancing the delivery of Met to the small intestine (Figure 6). Although not significant, the mean response was greater for corn byproducts than fish meal probably because corn byproducts supplied a larger percentage of the dietary protein. In contrast, the least effective sources of RUP for improving the intestinal supply of Met were blood meal and treated soy products. One of the most distinctive differences among these RUP supplements is their Met content, which is greater for corn and fish proteins than for blood and soy proteins. Therefore, the amount and source of RUP and the Met content of the RUP affects the ruminal outflow of Met.

The largest positive mean increase for the ruminal outflow of Lys was obtained with blood meal (Figure 7), which has one of the highest concentrations of Lys among these RUP supplements. In contrast, the largest mean decrease was for corn byproducts that contain a low concentration of Lys. Responses to fish meal, RUP mix, and treated soy proteins were intermediate between blood meal and corn byproducts. As was observed for Met, the amount and source of RUP in the diet and the Lys content of the RUP supplement affects the ruminal outflow of Lys.
Figure 2. Effect of source of RUP supplement in experimental diets compared with SBM control diets on NANMN flow from the rumen of lactating dairy cows. Means of published comparisons (n) ± 95% confidence intervals are shown.

Figure 3. Effect of source of RUP supplement in experimental diets compared with SBM control diets on microbial N flow from the rumen of lactating dairy cows. Means of published comparisons (n) ± 95% confidence intervals are shown.

Figure 4. Effect of source of RUP supplement in experimental diets compared with SBM control diets on NAN flow from the rumen of lactating dairy cows. Means of published comparisons (n) ± 95% confidence intervals are shown.
Figure 5. Effect of source of RUP supplement in experimental diets compared with SBM control diets on essential amino acid flow from the rumen of lactating dairy cows. Means of published comparisons (n) ± 95% confidence intervals are shown.

Figure 6. Effect of source of RUP supplement in experimental diets compared with SBM control diets on methionine flow from the rumen of lactating dairy cows. Means of published comparisons (n) ± 95% confidence intervals are shown.

Figure 7. Effect of source of RUP supplement in experimental diets compared with SBM control diets on lysine flow from the rumen of lactating dairy cows. Means of published comparisons (n) ± 95% confidence intervals are shown.