



Review article

Investigation of sources of variation in the effect of prepartum protein supplementation on early lactation performance of dairy cows



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ABSTRACT

The objective of this study was to evaluate the effects of prepartum protein supplementation on subsequent milk yield, milk composition, feed intake and tissue mobilisation by using regression analysis. The data were compiled from 15 peer-reviewed articles that included 47 treatments. Crude protein content of prepartum diets ranged from 97 to 206 g/kg DM. For the evaluation of potential interaction between prepartum protein supplementation and basal diet, diets were categorised as grass silage-based, maize silage–soya bean meal (SBM) and other diets (alfalfa/grass hay/straw). A significant interaction ($P < 0.05$) between dietary protein content and type of diet was found in milk protein yield and postpartum dry matter intake. This suggests that the impact of prepartum protein feeding on subsequent lactation performance may depend on the composition of basal diet. Milk protein yield and postpartum dry matter intake responses to prepartum SBM supplementation in maize silage-based diets were negative. Higher impact was observed when the proportion of hay or straw was high in the prepartum diet. In grass silage-based diets, the production responses were intermediate and more variable than in the other groups. No relationship was found between prepartum protein supplementation and postpartum tissue mobilisation. In conclusion, excessive prepartal SBM supplementation in maize silage-based diets may decrease milk protein yield and dry matter intake during early lactation. Positive responses to increased prepartal protein supply can be achieved in hay or straw based diets.

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1. Introduction

During early lactation dairy cows mobilise amino acids in support of lactation. Breakdown of muscle protein is a major source, but skin, uterine involution and myometrial protein degradation may contribute to the mobilisation of amino acids as well (Blum et al., 1985; Bell et al., 2000). Van Saun et al. (1993) and Moorby et al. (1996) hypothesised that mobilisable protein reserves could be increased by supplemental protein feeding during dry period, and subsequently support milk production. These two studies reported that prepartum supplementation with rumen undegradable protein (RUP) positively affected milk protein content or protein yield. In contrast, Greenfield et al. (2000) and Hartwell et al. (2000) reported that excessive RUP supplementation during the prepartum period had a negative carry-over effect on the subsequent lactation performance.

It seems plausible to attribute the observed differences in lactation responses at least partly to differences in dietary composition during prepartum period. In the study by Moorby et al. (1996) grass silage was supplemented with maize gluten meal and in the study by Van Saun et al. (1993) grass and legume silage-based diet with blood meal, whereas in the studies by Greenfield et al. (2000) and Hartwell et al. (2000), maize silage-based diets were supplemented with soya bean meal (SBM). Feeds of maize origin have low lysine content, and SBM has a low methionine content compared to several other plant proteins. Methionine and lysine are often the first-limiting amino acids for growth and milk production in maize based diets (NRC, 2001), whereas histidine was reported to be the first-limiting amino acid in a grass silage-based diet without feeds of maize origin (Vanhatalo et al., 1999). Further, there is evidence that the effect of methionine and lysine supplementation on performance of early lactation cows fed maize-based diet is more pronounced, if amino acid supplementation begins before rather than after calving (Socha et al., 2005). Therefore, it is possible that based on the differences in amino acid composition of the basal diet, there is an interaction between prepartum protein supplementation and basal diet, e.g. responses observed with grass silage-based diet may differ from those observed with maize silage-based diet.

The aim of this study was to combine information from previous studies using meta-analysis. Meta-analysis is a statistical method, which can be used to uncover the consistencies in a set of seemingly inconsistent findings. Potentially confounding factors can be included in the

statistical model as covariates, to explain some of the heterogeneity. Since there are large differences between studies (different experimental designs, different status of animals etc.), study effects can and must be considered random in mixed models, to further explain heterogeneity (St-Pierre, 2001).

This is the first study that evaluates the impact of prepartum protein supplementation on early lactation milk production by combining data from published studies through meta-analysis. The underlying hypothesis is that the effect of prepartum protein supplementation on subsequent lactation performance is high, when the protein content of the basal diet is low, and the composition of the basal diet affects the observed response. In addition to meta-analysis of lactation performance, the effects of prepartum protein supply on protein reserves and their changes in the dairy cow will be briefly reviewed.

2. Material and methods

2.1. Inclusion criteria

Fifteen publications were included in this study, containing altogether 47 feeding treatments. To be included in the meta-analysis, studies needed to meet all the following criteria: (1) be a peer-reviewed publication; (2) the objectives of experiments must have been to investigate the effects of changing the supply of protein to dairy cows during the dry period on postpartum milk production, feed intake and body condition; (3) prepartum protein supply and subsequent early-lactation milk production were reported; (4) individually recorded feed intakes were reported; (5) the study was designed to allow equal energy intake in control and supplemented groups. Summary of the studies is presented in Supplementary Information (Table S1).

2.2. Description of the dataset

Of the 15 publications, only multiparous cows (second lactation or higher) were used in 11, only primiparous were used in the study by Van Saun et al. (1993), and both primiparous and multiparous cows were used in the studies by Tesfa et al. (1999, 2001) and VandeHaar et al. (1999). Tesfa et al. (2001) reported results for primiparous and multiparous cows separately, and a summary of the results for each parity group in that study is shown in separate rows in Supplementary Information (Table S1).

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