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Feeding rumen-protected amino acids during the transition period: Insights on the economics

For more than 20 years, the transition period—characterized as 3 weeks prior to calving to 3 weeks after calving—has been extensively researched. The transition period is a very challenging time period for dairy cows. During this time, dry matter intake (DMI) decreases, and the onset of lactation brings with it the demands of producing milk. Because it is almost impossible for a dairy cow to meet these demands, a negative energy and protein balance commonly occur. Due to this imbalance, mobilization of body tissue is required to meet the demands of the cow and milk production, which can then result in decreased performance and metabolic disorders. Notably, lysine and methionine are the two most limiting indispensable amino acids in typical dairy cow diets. This means that these amino acids must be consumed in the diet because the cow cannot produce these amino acids herself.

Within common protein sources, there are varying concentrations and digestibility of these amino acids. Soybean meal and canola meal contain greater amounts of lysine when compared to corn. Blood meal provides the largest amount of rumen bypass lysine and fishmeal provides the largest amount of rumen bypass methionine to the cow. However, heating of blood meal during the manufacturing process will decrease the digestibility of lysine. Researchers from Cornell University have reported that visual inspection of blood meal is not adequate for determining the digestibility of amino acids because differences in color do not correlate to digestibility. Additionally, researchers at the University of Illinois have noted that the amount of lysine available in soybean meal will vary greatly based on the extent of heating the soybean meal underwent during processing. Excessive heat exposure will decrease the digestibility of lysine; however, this is not a problem with soybean expellers because heat is not used in the extraction process. Lysine and methionine

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can be provided in a rumen-protected form to offset decreases in amino acid intake due to reduced DMI around the transition period and to ensure consistency of delivery. Using rumen-protected amino acids, producers can avoid feeding amino acids that are not required and thus cut down on excess nitrogen. The amount of rumen-protected amino acids required will vary based on the diet consumed by the cow.

By providing indispensable amino acids to cows during the transition period, mobilization of tissues can be decreased, potentially resulting in a more efficient and healthier cow. During the early postpartum period, a negative protein balance results in mobilization of muscle tissue to meet the demands of the mammary glands for milk protein synthesis. Quantification of muscle mobilization can assist in determining whether the requirements of the cow are being met by the amino acid profile provided through feed ingredients and rumen-protected amino acids. Several methods can be utilized to determine the amount of protein mobilization occurring, such as measurement of creatinine or 3-methyl histidine concentrations in the blood. Researchers at Purdue University have noted that ultrasound can also be used. Ultrasound of the longissimus dorsi muscle and the gluteus medius is a noninvasive technique with immediate results that can be utilized to determine muscle loss and would therefore be feasible for dairy farmers and nutritionists. This can help to determine if a herd is experiencing excessive protein mobilization after calving due to amino acid deficiencies and allow correction of this problem to improve milk production.

In previous studies conducted by our group, yields of milk and milk protein increased when rumen-protected methionine and lysine were consumed by cows during the transition period. However, the cows in these studies were fed rumen-protected amino acids throughout the entire transition period, which does not allow researchers to determine whether these amino acids were most beneficial prepartum, postpartum, or both. In addition to improving production responses, feeding rumen-protected amino acids has the potential to have a lesser impact on the environment. By enhancing the quality of the protein provided to cows through rumen-protected amino acids, producers can feed the correct amount of crude protein (less in most cases) needed to meet the cows' requirements.

To be more accurate in our calculation of protein provided to the cow, it is preferable to measure metabolizable protein rather than crude protein. Researchers from Pennsylvania State University noted that cows fed a diet deficient in metabolizable protein but supplemented with rumen-protected lysine, methionine, and histidine did not differ in performance when compared to cows fed a diet with adequate metabolizable protein but no additional rumen-protected amino acids.

Recently, our group at the University of Illinois conducted a study to determine the effects of feeding cows a rumen-protected lysine (**RPL**; AjiPro-L Generation 3, Ajinomoto Heartland Inc., Chicago, IL) 4 weeks prior to calving (0.54% RPL of DMI), 4 weeks after calving (0.40% RPL of dietary DMI), or during the entire transition period. Cows consumed a common TMR diet with 14.2% crude protein prepartum and 16.8% crude protein postpartum, and RPL was topdressed in a carrier of dried molasses. Our treatments included cows that consumed RPL pre- and postpartum (PRE-L POST-L), prepartum but not postpartum (PRE-L POST-C), postpartum but not prepartum (PRE-C POST-L), or neither pre- nor postpartum (PRE-C POST-C). All cows also consumed a rumen-protected methionine (**RPM**; Smartamine M, Adisseo, Alpharetta, GA) prepartum (0.12% RPM of DMI) and postpartum (0.09% RPM of DMI). This would provide 98 g of metabolizable lysine and 35 g of methionine prepartum and 159 g of metabolizable lysine and 57 g of methionine postpartum per cow per day. However, this is number is projected based on AMTS calculations and would vary based on a cow's DMI.

Interestingly, although we hypothesized that consuming RPL during the entire transition period would increase lactation performance, cows that consumed RPL during the 4 weeks prior to calving had the greatest responses during the postpartum period. This included a tendency for greater DMI by 4.1 lb/day (Figure 1). Additionally, cows produced greater milk fat, protein, casein, and lactose yields, resulting in greater energy-corrected milk (ECM, Figure 2) by 16 lb/day. Although DMI did increase alongside ECM yield, there was no difference in efficiency between treatments, indicating that increased DMI did not result in a less efficient cow.

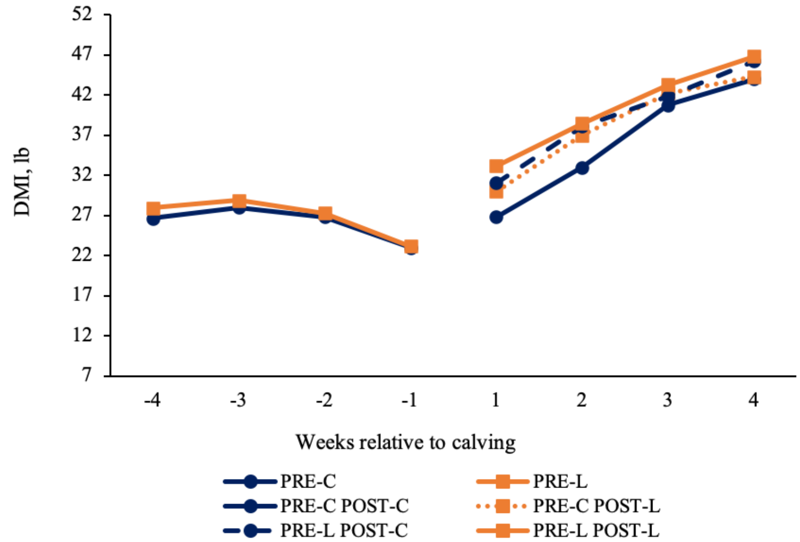

Figure 1 – Dry matter intake during the prepartum and postpartum period. Prepartum (-4 to -1 week) animals were fed a diet with RPL (PRE-L; 0.54% RPL of dietary dry matter intake) or without RPL (PRE-C). After calving, half of the cows from each prepartum treatment group were assigned to a diet with RPL (PRE-L POST-L; PRE-C POST-L; 0.40% RPL of dietary dry matter intake) or a diet without RPL (PRE-C POST-C; PRE-L POST-C) from week 1 to 4. Cows also consumed 0.12% rumen-protected methionine (RPM; Smartamine M, Adisseo) prepartum and 0.09% RPM postpartum of dietary dry matter intake. There was no difference between treatments prepartum. Postpartum, cows in PRE-L POST-L and PRE-L POST-C tended to have greater dry matter intake compared to those in PRE-C POST-L and PRE-C POST-C.

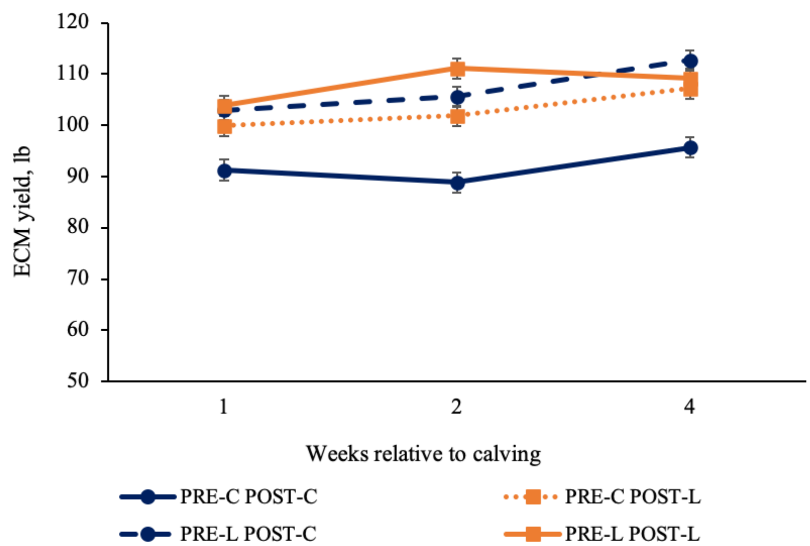

Figure 2 – Energy-corrected milk yield during the postpartum period. Prepartum (-4 to -1 week) animals were fed a diet with RPL (PRE-L; 0.54% RPL of dietary dry matter intake) or without RPL (PRE-C). After calving, half of the cows from each prepartum treatment group were assigned to a diet with RPL (PRE-L POST-L; PRE-C POST-L; 0.40% RPL of dietary dry matter intake) or a diet without RPL (PRE-C POST-C; PRE-L POST-C) from week 1 to 4. Cows also consumed 0.12% rumen-protected methionine (RPM; Smartamine M, Adisseo) prepartum and 0.09 % RPM postpartum of dietary dry matter intake. Cows in PRE-L POST-L and PRE-L POST-C had greater energy-corrected milk yield compared to those in PRE-C POST-L and PRE-C POST-C.

It is likely that because lysine is a group II amino acid (meaning it will bypass the liver and be taken up in excess by the mammary gland), increasing lysine allowed for improved mammary gland regeneration and growth prepartum, which subsequently primed the mammary gland for enhanced component yield postpartum.

One common question is whether the aforementioned benefits come with an offsetting cost, which would limit the usage of this strategy. Due to enhanced ECM yield, cows consuming RPL and RPM prior to calving were the most economically efficient. The income from milk yield over feed cost during the entire transition period (IOFC total) was greatest for cows that consumed RPL and RPM prior to calving (Table 1). Based on our results, cows would only need to consume RPL prepartum in order to achieve the same benefits postpartum. Additionally, the income derived from these cows would be $2.53 more than that from cows that did not consume RPL pre- or postpartum. However, it is important to highlight that cows receiving any treatment with rumen-protected AA had greater IOFC than cows not receiving RPL (control). Variation in protein and fat price can also affect the IOFC. Figure 3 illustrates that variations in the price of milk fat increase IOFC more than variations in milk protein price, as indicated by a greater slope of the line (the equation for fat is $y = 3.88x + 6.67$, and the equation for protein is $y = 2.78x + 0.54$).

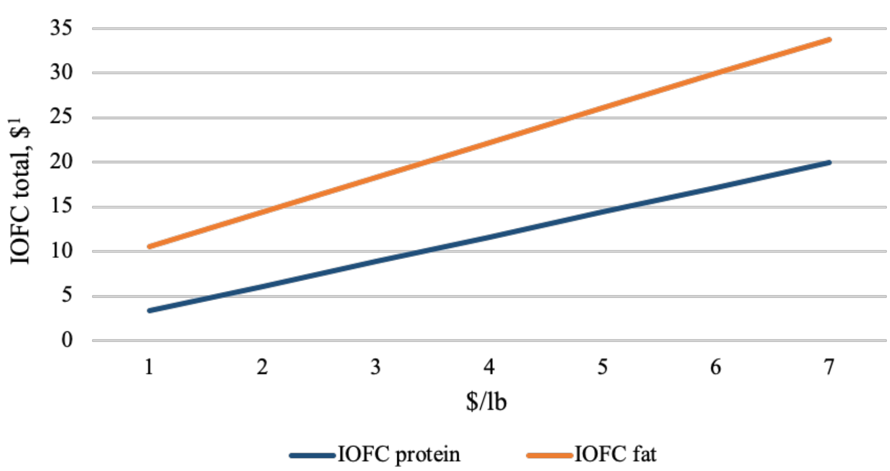

Figure 3 – Income from milk yield over feed cost (IOFC) for varying protein or fat prices for cows in PRE-L POST-C. Cows in PRE-L POST-C consumed 0.54% rumen-protected lysine (RPL; AjiPro-L, Ajinomoto) of dietary dry matter intake prepartum and no RPL postpartum. Cows also consumed 0.12% rumen-protected methionine (RPM; Smartamine M, Adisseo) prepartum and 0.09% RPM of dietary dry matter intake postpartum.

[1]Income over feed cost total (milk income – feed cost prepartum – feed cost postpartum) only for cows in PRE-L POST-C.

Variations in the price for milk fat in the industry, however, are much smaller than variations in the price for milk protein.

Table 1 – Economics

Treatments[1]	$/lb DM TMR prepartum[2]	$/lb DM TMR postpartum[2]	Feeding cost prepartum[3]	Feeding cost Postpartum[4]	Milk income[5]	IOFC total[6]	IOFC wet[7]
PRE-C POST-C	0.1006	0.0946	2.62	3.40	28.78	22.76	25.38
PRE-C POST-L	0.1006	0.1422	2.62	5.45	31.53	23.46	26.07
PRE-L POST-C	0.1359	0.0946	3.62	3.71	32.62	25.29	28.91
PRE-L POST-L	0.1359	0.1422	3.62	5.77	32.94	23.55	27.17

[1]Dietary treatments included at top dress with rumen-protected lysine (RPL; AjiPro-L, Ajinomoto) prepartum and postpartum (PRE-L POST-L), with RPL prepartum and without RPL postpartum (PRE-L POST-C), without RPL prepartum and with RPL postpartum (PRE-C POST-L), and without RPL prepartum and postpartum (PRE-C POST-C).
[2]Cows consumed 1.01 g of RPL and 0.22 g of rumen-protected methionine (RPM; Smartamine M, Adisseo) per lb of TMR (DM basis) prepartum and 0.84 g of RPL and 0.19 g of RPM per lb of TMR (DM basis) postpartum
[3]Feeding cost prepartum calculated as $/lb DM prepartum × DMI prepartum in the study.
[4]Feeding cost prepartum calculated as $/lb DM postpartum × DMI postpartum in the study.
[5]Milk price calculated using a milk price of $13.34/cwt, protein price of $5.63/lb, and fat price of $1.96/lb (provided by USDA: Announcement of Advanced Pricing and Pricing Factors for August 2020 https://www.ams.usda.gov/mnreports/dymadvancedprices.pdf) and protein and fat yields corresponding to each treatment. Milk income = (average milk yield × milk price/100) + (protein yield × protein price) + (fat yield × fat price) for each treatment.
[6]Income over feed cost total (milk income – feed cost prepartum – feed cost postpartum).
[7]Income over feed cost wet (milk income – feed cost postpartum).

In conclusion, it is likely that by providing cows adequate amounts of RPL and RPM before and after calving, we were able to balance amino acids and allow for a smoother transition into early lactation. In addition to production and lactation responses, additional research in our lab has indicated that RPL and RPM significantly improve the immune function, liver function, and reproductive and uterine health of cows after calving. However, these benefits are not included in our economic analysis, and thus the real benefits of PRE-L POST-L may be understated. More research on feeding rumen-protected amino acids prepartum, postpartum, or both is needed for a more robust economic analysis. Though not measured in our study, it is also probable that cows that consume RPL and RPM would have decreased nitrogen output because less crude protein is needed in the diet when rumen-protected amino acids are included in an adequate quantity. It seems that providing a sufficient amount of RPL and RPM is essential for a productive cow and results in an economically efficient system.

—Laura Fehlberg and Dr. Phil Cardoso