DRECA
DAIRY RESEARCH SUMMARY

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"Which are the key essential amino acids needed to maintain milk production in the dairy cow?"

Why is this important?

To optimize the biological and economic efficiency of the lactating dairy cow we need to match amino acid supply with requirement.

Dairy cows are only 25-35% efficient at converting dietary protein to milk protein. The best way to increase efficiency is to decrease the amount of protein fed but this must be done without detrimental effects on milk production. With a reduced margin of safety, imbalances in amino acid (AA; the building blocks of protein) supply will have a negative effect on milk protein output, so we must properly balance AA supply with demand. A large amount of research in dairy cows has focused on 3 AA (lysine, methionine and histidine); however, other essential AA, such as phenylalanine, threonine and tryptophan, also need to be supplied to sustain milk protein yield. These AA are usually taken up by the mammary gland in the same amount as that used for milk protein secretion, which then raises the question "will milk protein synthesis decrease if the supply of these AA is limited?"

Lorraine Doepel and Iroshan Hewage In the dairy barn

What did we do?

Five lactating Holstein cows were used in this study. The cows were fed a diet that supplied 100% of the cows' net energy requirements but only 70% of the metabolizable protein (MP) requirements. Each cow received each treatment for 10 days. The treatments, which were continuous abomasal infusions of AA, were:

1. control = water (CTL);
2. all AA to meet the requirements for MP (TAA);
3. all AA excluding threonine (No-Thr);
4. all AA excluding tryptophan (No-Trp);
5. all AA excluding phenylalanine (No-Phe).

Infusion set up for the amino acids

Milk samples were obtained on the last 3 days of each period and arterial and venous blood samples were obtained on the last day so that we could examine mammary metabolism of the AA.

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Alberta Agriculture and Rural Development, Alberta Milk, the University of Alberta, and the University of Calgary
A partnership in dairy research, extension and education activities
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What did we find?

Milk protein yield and milk urea nitrogen content were lower with the CTL treatment than with TAA, indicating that there was an AA deficiency with CTL. A limited supply of phenylalanine and threonine negatively affected milk and milk protein yield, with the milk protein effect being stronger with the phenylalanine limitation than with the threonine limitation. Deficiencies of threonine and tryptophan increased fat concentration whereas deficiencies of phenylalanine, threonine and tryptophan increased milk lactose concentration relative to TAA but yields were not affected.

Blood concentrations of phenylalanine, threonine, and tryptophan were lower with their respective treatments, but only phenylalanine uptake by the mammary gland was reduced with the imposed deficiency.

Blood urea-N was higher with No-Phe compared to TAA, suggesting that milk protein synthesis was limited by a deficiency of Phe and that excess AA supply was not used for milk protein secretion but converted to urea.

Concentrations of plasma metabolites related to energy metabolism were not affected by treatment.

Table 1. Effect of amino acid (AA) infusions on dry matter intake (DMI) and milk production and composition

	Treatment				
Item	**CTL**	**No-Phe**	**No-Thr**	**No-Trp**	**TAA**
DMI, kg/d	17.8	17.0	17.6	17.2	18.0
Milk yield, kg/d	29.9	30.1	30.4	32.8	33.4
Fat, g/d	1038	1077	1156	1246	1123
Crude protein, g/d	781	771	843	883	914
Lactose, g/d	1360	1381	1391	1506	1502
Milk Composition					
Fat, %	3.58	3.59	3.92	3.80	3.41
Crude protein, %	2.63	2.57	2.83	2.70	2.75
Lactose, %	4.55	4.60	4.59	4.60	4.50
MUN[2], mg/dL	8.81	13.54	14.63	14.24	14.12

[2]MUN = Milk Urea Nitrogen

What does this mean?

This study demonstrates that imbalances in AA supply negatively impact milk protein synthesis. As we learn more about balancing AA supply with requirement, we will be able to formulate diets with lower total protein content that are successful at maintaining milk and milk protein yield.

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Summary Points

- The proper balance of AA is necessary to maintain milk protein synthesis.
- Changes in AA supply affected milk lactose and fat content, indicating that energy and protein metabolism are closely inter-related.
- The results from this study, along with those from other studies, will be used to update our current feed formulation programs, allowing producers to feed their cows less protein while maintaining milk yield.

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