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Calf Note #238 – Amino acids for young calves, Part 1

Introduction

In the next few Calf Notes, I will review the current status of amino acid nutrition in young calves during the first 4 months of life, and point out some of the pitfalls and challenges we face in our

Amino acid nutrition for young calves is among the most complex of topics in animal nutrition. Calves begin their lives as monogastrics, and use amino acids from the milk or milk replacer they consume. However, at some point later in life, their digestion has completely changed to that of a ruminant animal and, thus, they utilize a combination of undegraded dietary and microbial protein as sources of amino acids for maintenance and growth needs.

If calves were only monogastrics or only ruminants, the calculation of amino acid supply would be more straightforward and we could utilize existing models – for pigs (monogastric) or cows (ruminant) to estimate amino acid flow. However, the transition from monogastric digestion to ruminant fermentation and digestion during the first 8 to 12 weeks of age makes prediction of amino acid flow extremely challenging. To date, we have no functional models of amino acid supply during this critical period in life.

A big step

The 2021 NASEM Nutrient Requirements of Dairy Cattle predicted nutrient requirements for young calves. They included a significant new approach to predicting metabolizable protein (MP) supply in young calves to 4 months of age. This approach to predicting MP supply can logically be extended to amino acid supply, though there are no published studies (to my knowledge) that support the modeling approach taken by the Committee. Let's take a look at the new approach to predicting MP supply.

During the "transition phase", the digestive system of the calf changes in response to changing substrate. As the calf begins to eat dry feed, bacteria in the rumen begin fermenting non-fiber carbohydrate to produce volatile fatty acids (especially butyrate and propionate) that induce metabolic changes in the rumen and other tissues in the animal. Also, bacterial fermentation of carbohydrate and degradable proteins increases the more bacterial biomass leaving the rumen and reaching the small intestine as a source of amino acids for the calf. Essentially, the calf is becoming a ruminant, and the ratio of microbial protein to total protein reaching the intestine increases. Initially, there is little microbial contribution to the total amino acid nutrition, as the calf receives most of its amino acids from milk.

The 2021 NASEM published a meta-analysis of the change in contribution of microbial protein to total protein reaching the intestine with increasing calf starter intake (Figure 1). We can see that early in life, before the calf consumes any calf starter, the total contribution of microbial protein reaching the intestine is very low, but increases as the calf eats more calf starter, which drives rumen development. By the time the calf consumes 1.3 kg of calf starter, the contribution of microbial nitrogen to total nitrogen reaching the intestine reaches a maximum at about 60%. That is, 60% of the nitrogen reaching the intestine is microbial in origin and this doesn't change thereafter. Thus, the maximum point (i.e., 1.3 kg/d of calf starter intake) indicates when our calves are functioning as mature ruminants. While the rumen may still be small, it appears to be functioning "normally" and changing the nature of the protein reaching the intestine.

Why is this important? Well, the amino acid profile of milk proteins, undegraded dietary proteins, and microbial proteins differ and these changing dynamics will affect the amount of each amino acid reaching the intestine.

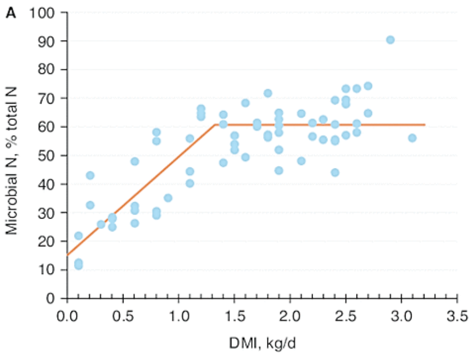

Figure 1. Change in microbial N flow to the intestine as a % of total N. Source; 2021 NASEM Nutrient Requirements of Dairy Cattle.

Let's look at a hypothetical example. We'll feed a calf 800 g/d of calf milk replacer from birth to weaning at 64 days. The CMR contains 24% protein (air-dry basis) and 8% of the protein is Lysine. We'll also feed a calf starter to 60 days containing 20% CP and 4% of that protein is Lysine. From day 61, we'll offer a grower feed containing 18% CP (4% of CP as Lysine) and clover hay with 16% CP (5% of CP = Lysine).

If we use the equation of Quigley et al. (2021) to predict dry feed intake and the graph in Figure 1 to partition microbial protein (which contains 9.3% of protein as Lys) and assume that N flow = N intake (an assumption made by NASEM), we can estimate the flow of Lysine from each source. The table shows the changing source of Lysine as the calf consumes increasing amounts of dry feed.

The estimated flow of Lysine to the calf increases from 13 g/d at 7 d of age to 35 g/d by 63 d of age then doesn't change to 70 d of age due to weaning. The contribution of microbial crude protein (MCP) and rumen undegraded protein (RUP) increases with increasing age and intake of dry feed.

The implication of these changing dynamics in MP and amino acid supply are important and we'll address how these changes affect our predictions of growth. We'll also look at research that supplemented amino acids in CMR and starters.

Table 1. Predicted flow of Lysine from calf milk replacer (CMR), microbial crude protein (MCP) and rumen undegraded protein (RUP) in calves from 7 to 70 d of age.

	Lysine flow, g/d				
Age, d	CMR	MCP	RUP	Total	CMR, %
7	13.1	0.1	0.2	13.3	98
14	13.5	0.2	0.5	14.2	95
21	13.9	0.5	1.0	15.3	91
28	14.2	1.1	1.8	17.1	83
35	14.2	2.3	3.1	20.1	71
42	14.2	4.3	4.7	23.2	61
49	14.2	7.1	6.3	27.6	51
56	14.2	10.5	7.9	32.7	43
63	14.2	11.7	8.7	34.6	41
70	0.0	19.7	14.8	34.5	0

Written by Dr. Jim Quigley (23 December 2022)

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