METHIONINE SUPPLY AND REQUIREMENT IN GROWING CALVES

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METHIONINE SUPPLY AND REQUIREMENT IN GROWING CALVES

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Little quantitative information is available on the amino acid requirements of ruminating animals (Lewis and Mitchell, 1976) and the only data for the calf is that given by Williams and Smith (1974) and for the older steer by Fenderson and Bergen (1975). Microbial degradation of amino acids in the rumen precludes the use of dietary amino acid supplements when constructing dose-response relationships so that such supplements must be given post-ruminally. Short term growth responses to amino acid supplementation are difficult to determine and alternative physiological response parameters have been used in such studies (Lewis and Mitchell, 1976).

In the experiment described here, a methionine limiting condition was obtained by giving growing calves a diet which supplied mainly microbial protein to the duodenum and by infusing intra-duodenally additional amino acids excluding methionine and cyst(e)ine. Graded levels of methionine were infused intra-duodenally, responses in plasma free methionine concentration were measured and a break-point in the dose-response relationship was established. Methionirte requirement was estimated as the sum of methionine given by intra-duodenal infusion at this break-point plus methionine uptake from the small intestine on the basal diet.

Materials and Methods

1. *Animals*

Three Friesian bull calves were fitted with simple cannulae in the proximal duodenum and in the terminal ileum when approximately 6 weeks old. The calves were weaned over the next few days and experiments began when the animals were approximately 18 weeks old and weighed 90-120 kg.

2. *Basal diet*

The experimental ration which contained (g/kg) rolled barley (636), molassed sugar-beet pulp (300), tallow (20), urea (15), mineral + vitamin premixes (29) was offered at 2 hourly intervals by a mechanical feeder and supplied 57 g dry matter and 1.55 g nitrogen/kg metabolic body weight ($W^{0.75}$) daily. In addition, each animal received 10 g/d chromic oxide as a digesta flow marker. Water was available *ad libitum.*

3. *Experimental procedures*

Throughout the experiment, the calves were restrained in metabolism cages under continuous lighting.

3.1. Estimation of metabolisable energy intake.

Faeces were collected from each calf over

5d. Digestible organic matter (DOM) was determined by reference to the chromic oxide marker and metabolisable energy (ME) calculated assuming that DOM contained 19 MJ digestible energy (DE)/kg and that ME was DE × 0.82.

3.2. Measurement of digesta flow rates

Aliquots of duodenal and of ileal digesta were collected twice daily over three consecutive days from each calf. Microbial protein in duodenal digesta was identified by the ^{35}S-incorporation procedure outlined by Mathers and Miller (1977) except that the sodium [^{35}S] sulphate was supplied orally. Nitrogen (N) in digesta samples was determined by a microkjeldahl procedure, ammonia by autoanalyser, chromic oxide by conversion to dichromate, and methionine and cyst(e)ine by ion exchange chromatography following performic acid oxidation and acid hydrolysis. Flow rates of nutrients through the intestine were estimated by reference to the chromic oxide marker.

3.3. Estimation of methionine requirement

When digesta collections had been completed, each animal was infused intra-duodenally with a mixture of amino acids which supplied 275 mg N/$W^{0.75}$/d and was based on the composition of fish meal but contained neither methionine nor cyst(e)ine. This supplementary N together with the microbial contribution was calculated to be adequate for a growth rate of 0.5 kg/d. The infusate was supplemented with graded levels of methionine from 0-200 mg/$W^{0.75}$/d. Each infusion period lasted 3 d. On the final day of each period, blood samples were withdrawn over a 6 hour period from the heart via a catheter inserted into a jugular vein. Plasma was analysed for free methionine by ion exchange chromatography.

Results

1. *Nutrients supplied by basal diet*

The organic matter digestibility coefficient was 0.85, the estimated ME of the diet 12.6 MJ/kg dry matter and the estimated intake of ME was 0.72 MJ/$W^{0.75}$/d.

Details of the supply of nitrogenous materials to and uptake from the small intestine (SI) of calves consuming the basal ration are given in table 1. Nearly 80% of the non-ammonia nitrogen (NAN) reaching the SI was of microbial origin and the proportions of methionine and cyst(e)ine in the digesta NAN were low (1.51 and 1.45 g/16 g NAN respectively). The apparent digestibility of methionine in the SI was greater while that of cyst(e)ine was less than the apparent digestibility of total NAN (table 1). Methionine supplied approximately 60% of the sulphur-amino acids apparently absorbed from the SI.

Table 1. — Supply of nitrogenous materials (mg/$W^{0.75}$/d) to and apparent absorption from the small intestine (SI) of calves given the basal diet*.

Nutrient	Flow to duodenum	Apparent absorption from SI
Non-ammonia nitrogen (NAN)	1530	960
Microbial NAN	1210	nd
Methionine	144	101
Cyst(e)ine	139	70

* Excluding nitrogen in the duodenal infusate
nd. not determined

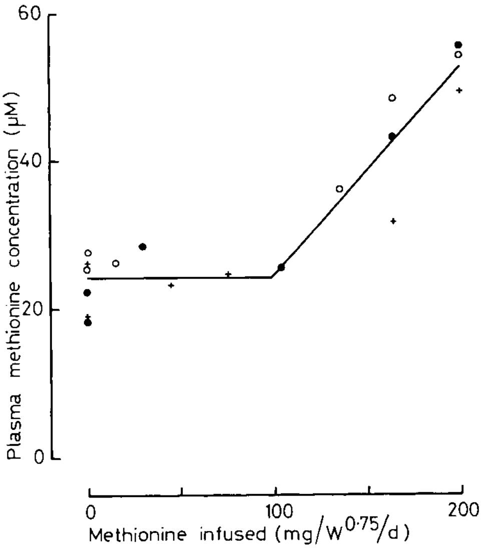

Fig. 1. — Plasma methionine concentrations in 3 calves given various amounts of methionine by intra-duodenal infusion.
+ calf 168; ● calf 788 ; O calf 789.

2. *Responses to methionine infusion*

The changes in plasma methionine concentration with changes in intra-duodenal infusion of methionine are illustrated in figure 1. The dose-response relationship pooled for the 3 calves was described by two straight lines. At low levels of methionine infusion, there was little change in plasma methionine concentration and the model was constrained to have a slope of zero in this phase. Plasma methionine concentration increased rapidly and linearly at high levels of methionine infusion (fig. 1). The fitted lines minimised the residual variation and the multiple correlation coefficient was 0.94. The requirement for additional methionine was assessed as the methionine infusion rate (99 mg/$W^{0.75}$/d) at the break-point.

3. *Calculation of sulphur-amino acid requirements*

For calves weighing between 90-170 kg and gaining approximately 0.5 kg/d, the methionine requirement (200 mg/$W^{0.75}$/d) was calculated as the sum of methionine apparently absorbed from the SI on the basal ration (101 mg/$W^{0.75}$/d) plus the methionine infusion rate at the break-point (99 mg/$W^{0.75}$/d). Including cyst(e)ine apparently absorbed from the SI (70 mg/$W^{0.75}$/d) yielded a total sulphur-amino acid requirement of 270 mg/$W^{0.75}$/d. For a calf weighing 135 kg, these estimates correspond to 7.9 g methionine and 10.7 g methionine + cyst(e)ine absorbed from the SI per day.

Assuming that the total NAN from the SI (1235 mg/$W^{0.75}$/d) was just adequate for the calf growth rate obtained, then the methionine and methionine + cyst(e)ine requirements as a proportion of absorbed NAN were estimated to be 2.59 and 3.50 g/16 g NAN respectively.

Discussion

Since most of the N in the diet was supplied by barley protein and urea both of which are extensively degraded in the rumen, the observation that most of the NAN reaching the SI was of microbial origin (table 1) was as expected. The relative digestibilities in the SI of NAN, methionine and cyst(e)ine were also in agreement with published data (Armstrong and Hutton, 1975).

The only comparable study of methionine requirements of the growing ruminating calf is that by Williams and Smith (1974) but these workers did not estimate amino acid uptake from the SI. However, for calves weighing 110-160 kg and growing at 0.4 kg/d, Williams and Smith estimated that for 2 basal rations supplying respectively 7.5 and 9.8 g methionine + cyst(e)ine per day to the SI, an additional 4.4 g methionine/d could be supplied by abomasal infusion before plasma methionine concentration began to rise steeply. In the present experiment, the requirement for a calf weighing 135 kg was met when the basal ration supplied 11.2 g methionine + cyst(e)ine per day to the duodenum together with an intra-duodenal infusion of 3.9 g methionine/d.

It is concluded that monitoring plasma amino acid concentrations in response to post-ruminal supplementation with the first limiting amino acid appears to provide reasonable estimates of amino acid requirements. However, these estimates are valid only for the conditions of each particular experiment and do not allow ready extrapolation to animals in different physiological states or producing at different rates.

Acknowledgements

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