

EVALUATION OF MODELS WHICH PREDICT AMINO ACID FLOW TO THE INTESTINE

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Several models have recently been proposed to predict the amount of dietary protein and nonprotein nitrogen that is absorbed in amino acid form from the ruminant intestine (Burroughs *et al.*, 1975; Satter and Roffler, 1975; Journet and Verite, 1977; Kaufmann, 1977; Roy *et al.*, 1977). There are only limited data on the amount of amino acids absorbed from the intestine when different rations are fed, but there is considerable information on the flow of amino acids or non ammonia nitrogen through the abomasum or to the duodenum on a variety of rations. This published information was used to test the five models for their ability to predict the supply of amino acids to the intestine.

In order to test the models it was necessary to have data on nonammonia nitrogen or amino acid flow to the intestine as well as intake of dry matter, organic matter, nitrogen, nonprotein nitrogen and total digestible nutrients. Organic matter and dry matter digestibilities were also needed. Literature reports often did not include all of the above information, thus making it necessary to make some assumptions and use estimated values for missing information. Organic matter was assumed to be 96% of dry matter, and dry matter digestibility was assumed to be 96% of organic matter digestibility. Other assumptions were that urea con-

tained 45% nitrogen, and amino acid flow was equal to $6.25 \times$ amino acid nitrogen flow. Literature reports without energy intake and digestibility values were rejected from the data bank. When available, published estimates of protein solubility and degradability were used. Otherwise, best estimates were used. A total of 62 studies having information on protein flow to the abomasum or intestine met the stated minimum criteria.

To test the validity of the model predictions for nonammonia nitrogen or amino acid flow to the intestine, regression analysis was performed by regressing *in vivo* measurements on model prediction values (see tables 1 and 2). Perfect agreement would result in an intercept of 0, a slope of 1, and a coefficient of determination (r^2) of 1. The means for the prediction values were also compared to the literature values. Confidence intervals were calculated for the intercept and slope of the regression lines at the (a) .95, (b) .99, and (c) .999 levels of probability. Superscripts for the intercept or slope indicate the probability level of the confidence interval which does not contain 0 in the case of the intercept or 1 in case of the slope. No superscript indicates $P < .95$. The superscripts for the predicted means indicate the probability that they are from the same population as the measured

mean ($a = .01 < P < .05$; $b = .001 < P \leq .01$; $c = P \leq .001$). No superscripts indicate $P > .05$. A positive intercept indicates an under prediction when protein flow is low and a negative intercept indicates an overprediction. A slope of less than 1 indicates an overprediction and greater than 1 an underprediction for high protein flows to the intestine.

In vivo values derived from the literature were analyzed as one group (as in tables 1 and 2) and then subdivided into groups of particular types of rations, levels of intake, or whether fed to cattle or sheep.

The model of Burroughs *et al.* tended to underestimate nonammonia nitrogen or amino acid flow in all cases except for nonammonia nitrogen flow when low protein diets were fed. This may be due to a low efficiency of microbial protein production which the model assumes, and/or the low estimates of undegraded protein assigned to some feed proteins. Protein escape rates in this model are especially low for alfalfa and grasses.

The model of Journet and V erit e does well in estimating nonammonia nitrogen and

amino acid flow to the intestine. The only indication of systematic error is that their model may overestimate undegraded protein by equating undegraded protein to 65% of the insoluble protein. This is suggested by the tendency to overestimate amino acid flow when high protein rations are fed. There is also a tendency with this model to overestimate amino acid flow when rations containing urea are fed. This model generally performs better for cattle than sheep in that values for sheep are more often overestimated.

The model of Kaufmann (1977) predicts flow of protein to the intestine quite well, but tends to underestimate *in vivo* values for cattle. The reason may be the low value (.3) assumed for the undegraded protein, since use of the model results in greater error for the medium and high protein rations than for low protein rations. This is further indicated in that predictions tend to be low for rations containing no urea but not for rations containing urea.

The model of Roy *et al.* tends to underestimate flow of protein to the intestine but usually gives higher values than Burroughs

Table 1. — Equations for measured nonammonia nitrogen flow (NANF) regressed on model estimates for nonammonia nitrogen flow¹ (ENANF)

Model	Regression equation	r ²	Mean
Burroughs <i>et al.</i>	NANF = -1.30 + 1.31 ^c ENANF	.940	37.4 ^b
Journet and Verit�e	NANF = -1.30 + 1.05 ^c ENANF	.971	46.6
Kaufmann	NANF = -1.26 + 1.14 ^c ENANF	.967	43.1 ^c
Roy <i>et al.</i>	NANF = -.76 + 1.19 ^c ENANF	.964	40.5 ^c
Satter and Roffler	NANF = 1.12 + 1.00 ENANF	.966	46.4
	NANF = -2.26 + 1.00 nitrogen intake	.960	50.1 ^b
	NANF =		47.6

¹ A total of 224 *in vivo* mean observation.

Table 2. — Equations for measured amino acid flow (AAF)¹ regressed on model estimates for amino acid flow (EAAF)

Model	Regression equation	r ²	Mean
Burroughs <i>et al.</i>	AAF = -16.64 + 1.37 ^c EAAF	.965	244 ^c
Journet and Verit�e	AAF = -10.60 + .99 EAAF	.982	331 ^a
Kaufmann	AAF = -14.39 ^a + 1.14 ^c EAAF	.982	291 ^b
Roy <i>et al.</i>	AAF = -24.14 ^b + 1.26 ^c EAAF	.976	271 ^c
Satter and Roffler	AAF = 1.50 + .98 EAAF	.979	324
	AAF = -22.81 ^b + .86 ^c crude protein intake	.973	397 ^c
	AAF =		318

¹ A total of 120 *in vivo* mean observations were used, with 1-6 animals constituting each mean observation.

et al. This model uses a microbial growth efficiency that is lower than all models except for that of Burroughs *et al.* Many feeds are also considered to be 80% degraded. This may be too high for some of the feeds, resulting in low predictions of protein flow.

The model of Satter and Roffler appears to give the most accurate predictions of the models tested. This model does, however, tend to overpredict protein flow when rations containing more than 75% digestible dry matter are fed.

All models, except possibly that of Burroughs *et al.* do a better job of predicting nonammonia nitrogen or amino acid flow to the intestine than does nitrogen intake or crude protein intake. According to the r^2

values, all predictions were more accurate for cattle than for sheep.

The r^2 values tended to be lower for the equations describing nonammonia nitrogen flow than for those predicting amino acid flow. This indicates that the analyses of nonammonia nitrogen includes more than just amino acids. Since amino acid flow to the abomasum/intestine is of greater interest and importance, this data should be given greater weight.

The obvious conclusion is that nitrogen or crude protein intake alone are not accurate indicators of protein flow to the intestine in ruminants. All of the models have greater predictive accuracy than can be obtained with crude protein, but some of the models appear to be better than others.

References

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