PREDICTION OF DUODENAL PROTEIN FLOW IN RUMINANT

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Introduction

Estimation of protein flow to duodenum is a keypoint for all modern protein systems. Prediction relations based on simple feed characteristics have been obtained most often by separate estimations of the microbial and feed fractions and from limited data basis. In the revision of the French PDI system (Vérité et al., 1988), a global approach relating directly duodenal protein flow to feedstuff characteristics was made from all data available in literature in order to cover a large range of feeding situations and of methodologies.

Materials and Methods

The data set on duodenal NAN flow (duod-NAN) used arises from INRA experiments and available literature: more than 300 references were reviewed including data on some 800 to 900 diets, each as a mean of several animals. Half of them were discarded due to atypical conditions, shortage of degradable N supply, insufficient number of results per laboratory or lack of essential information. Finally the 405 remaining diets (94 from INRA) fed to sheep (142), young cattle (101) or cows (162) originate from 20 different laboratories (each with 10 to 50 data). Multiple regression analysis, on a within lab basis, relate doud. NAN to feedstuffs characteristics: 1) fermentable organic matter (FOM) to account for microbial N synthesis, 2) *in sacco* undegradable protein (SUDN x 6.25), measured by the standardized method of Michalet-Doreau et al. (1987), as a relative index of feed protein flow and 3) non-digestible OM (NDOM) to account for endogenous N. FOM was devised from usual analytical characteristics (FOM = DOM − Lipids − FP − SUDN x 6.25) assuming that energy from lipids, fermentation products in silage (FP) and undegradable protein (SUDN x 6.25) is of little or no use to microbes.

Results and Discussion

The preferred model gives the following relation (table 1):

duod.NAN = 23.2 x FOM + 1.11 x NNDS + 5.3 x NDOM

Microbial protein flow would be 23.2 g N/kg FOM. On average, it is equivalent to 20.2 g N/kg DOM which is in the usual range of direct estimations; however it varies from 21 g N/kg DOM for fresh grass, hay or grain to 16 g with grass silage and even less with low-degradable protein sources. By-pass protein is greater (1. 11) than *in sacco* UDN contrary to usual assumptions in other systems, probably because *in sacco* processes or assumptions (passage rate, microbial contamination, effect of grinding...) do not fit totally with real conditions. The amount of endogenous N (5.3 g/kg NDOM) is roughly equivalent to 1.7 g/kg DM and perhaps a little lower than other estimates.

Average laboratories deviations between measured and predicted flows were smaller than 10% for 13 laboratories over 20, but the "bias" was somewhat greater for several others (table 2). There is no clear evidence that it could originate from differences between diets or animals (see later). Apart from inadequancy of the model, one can expect artefact effects due to errors when extrapolating degradability values from our tables and, most probably, to differences between methods of measurement. It is worth noting that within laboratory residual coefficient of variation (c.v.) was most generally greater when bias was greater; the residual cv was in the range of 7 to 12 % for half of the labs but 14.5 % on average (table 2). Microbial synthesis appeared slightly lower in high concentrate diets (22.1 g N/kg FOM) than on forage diets (23.7 g) or mixed diets (25.4 g), in accordance with several direct observations. For similar diet characteristics, duodenal N flows did not differ between sheep and cattle

TABLE 1. PREDICTION OF DUODENAL PROTEIN FLOW (duod.NAN) FROM VARIOUS ENERGY (x1) AND NITROGENOUS (x2) FEEDSTUFFS PARAMETERS AS PREDICTORS FOR MICROBIAL AND FEED PROTEIN AND NON-DEGRADABLE ORGANIC MATTER (NDOM) FOR ENDOGENOUS PROTEIN

X1	X2	a	b	c	R2	Residual CV %
FOM	SUDN	23.2	1.11	5.3	.63	14.5
FOM	NT	17.8	0.48	5.0	.63	14.5
RDOM	SUDN	14.1	1.56	19.6	.73	18.2
DOM	SUDN	22.2	0.96	4.5	.53	14.5

According the model: duod. NAN/X1 = 2 (+ team effect) + b * X2/X1 + c * NDOM/X1) with DOM=digestible OM as measured, RDOM=rumen degraded OM as measured, FOM=fermentable OM in feed (=DOM-lipid-SUDN-FP in feed), SUDN=in sacco undegradable N, NT=total N,

FP = fermentation products in silage,

X1 and NDOM are in kg/kg OM, X2 and duod.N in g N/kg OM.

TABLE 2. PREDICTION OF DUODENAL NAN FLOW FROM FOM, SUDN AND NDOM[1] FOR DIFFERENT LABORATORIES

Laboratory	N	"Bias"[2] (%)	CV[3] (%)	Laboratory	N	"Bias"[2] (%)	CV[3] (%)
Sheep				Newcastle	21	8.7	9.5
Hurley	16	12.4	11.5	Sydney	15	−13.3	15.6
Palmerston	9	15.0	15.7	Cows			
Adelaide	11	−25.4	21.1	Wisconsin	27	−0.3	25.0
Alberta	11	−0.6	10.5	Inra-Rennes	32	4.3	7.5
Hannah	14	0.5	10.2	Lelystad	15	11.2	7.2
Rowett	23	−6.3	7.2	Copenhag	24	16.0	14.9
Inra Theix	40	-3.1	12.2	Rostock	12	5.4	11.9
Blacktown	18	1.0	14.4	Braunschweig	15	−0.7	8.7
Young Cattle				Kiel	15	−5.4	7.2
Oklahoma	48	−15.4	19.8	Inra Rennes	22	3.0	14.1
Hurley	17	10.0	17.1				

[1] See table 1.

[2] Average deviation (measured-predicted)

[3] Within residual coefficient of variation

but values were higher on cows (25.0 g N/kg DOM) than on young cattle (20.3) possibly confounded with laboratory and intake level effects. In cattle but not in sheep, there was a slight tendency to increased duod-NAN with increased feed intake.

Surprisingly, rumen degraded OM (RDOM) decreased prediction accuracy compared to DOM and FOM (table 1) probably because of its measurement error. DOM and NT gave a similar accuracy as FOM and SUDN on our set of data on diets but they are probably less adequate for feedstuffs evaluation for which the range of variation is much higher.

(**Key Words**: Duodenal Protein, Microbial Synthesis, Degradability)

Literature Cited

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