*Ann. Rech. Vét.* 1979, **10** *(2/3)*, 303-306.

# PREDICTING EQUATIONS OF N DUODENAL FLOW IN DAIRY CATTLE EFFECTS OF LEVEL OF FEEDING AND PROPORTION OF CONCENTRATE IN THE DIET

M. JOURNET and R. VERITE

*Laboratoire de la Production Laitière, I.N.R.A., Centre de Recherches Zootechniques et Vétérinaires de Theix 63110 Beaumont, France*

Several proposals have been made recently for estimating the nitrogen value of feeds or diets in terms of the quantity of amino acids flowing at the duodenum or absorbed in the small intestine. Practical systems (see Verite *et al.*, 1979) have been formulated to express this easily from simple characteristics of foods : 1°/ digestibility of organic matter that affects the amount of microbial N synthetized in the rumen ; 2°/ solubility or degradability of nitrogen that affects the quantity of nitrogen non-degraded in the rumen. Most of the systems take into account the needs of microorganisms for soluble nitrogen degradable in ammonia.

The two feed and microbial nitrogen fractions flowing out of the rumen can be also modified by the level of feeding related to the level of production, composition of the diet (roughage/concentrate ratio), level of energy supply compared to energy needs, physiological state, etc.

The object of this study was to predict the Non Ammonia Nitrogen (NAN) duodenal flow for dairy cows (principally) at different levels of milk production and fed approximately according to their energy needs by adjusting the supply of concentrate :

— Firstly, NAN duodenal flow was related to DOM and to *in vitro* non fermentable nitrogen intakes. Additional effects of level of feeding and percentage of concentrate in the diet were also studied.

— Secondly, the observed NAN duodenal flows were compared to the predicted values in the PDI system used in France (Verite *et al.*, 1979) and possible improvement of these values by taking into account the two preceding factors and the level of energy supply compared to energy needs were studied.

## Material and Methods

NAN flow at the duodenum was measured using chromium oxide and PEG as markers, on cows and heifers fitted with a simple duodenal cannula. Digeta samples were taken every 2 hours, day and night on 2 or 3 consecutive days. 58 individual measurements of N duodenal flow were obtained from 4 experiments carried out on 12 cows producing from 0 to 32 kg mil2, and 4 heifers. Diets were composed of maize silage and urea, a mixed meal of soya and rapeseed (1/1) which had or had not been formaldehyde treated, and concentrate (cereals and beet pulp). A 4 × 4 latin square design was used in each experiment over 4 week periods to compare either formaldehyde treatment of meal, level of treated meal or level of urea. Maize silage was given in limited amounts in trials 1 and 4 and *ad libitum* in trials 2 and 3. Characteristics of the diets are given

*Table 1.* - Characteristics of the diets and individual variations

| TRIALS | I | II | III | IV |
|---|---|---|---|---|
| ANIMALS | Cows | Cows | Cows | Heifers |
| Number | 16 | 14 | 12 | 16 |
| DOM (kg/day) | 6.2<br>(4.3 - 8.1) | 8.7<br>(6.5 - 10.7) | 9.1<br>(6.3 - 12.2) | 4.8<br>(3.9 - 6.1) |
| Non deg N in vitro intake (g/day) | 106<br>(40 - 191) | 136<br>(98 - 185) | 176<br>(89 - 266) | 46<br>(38 - 61) |
| Concentrate in the diet (% DM) | 18<br>(0 - 35) | 43<br>(32 - 51) | 36<br>(24 - 42) | 0 |
| Level of feeding (L) (1) | 1.9<br>(1.4 - 2.6) | 2.5<br>(2.1 - 2.9) | 2.6<br>(1.9 - 3.2) | 1.4<br>(1.1 - 1.8) |
| Energy intake % Energy needs (2) | | 98<br>(83 - 112) | 92<br>(83 - 115) | |

(1) $L = \frac{DOM}{0.033\ W^{0.75}}$ ; (2) $\frac{DOM}{0.033\ W^{0.75} + 0.35\ L}$

*Table 2.* - Predicting equations of NAN duodenal flow in relation to :
1°/ Intake of digestible organic matter (DOM) and *in vitro* non degradable nitrogen (Non deg N)
2°/ Level of feeding intake ($L = \frac{DOM}{0.33\ W^{0.75}}$) and percentage of concentrate in the diet (% Con) (% of dry matter)

| Group | Number of animals | Equation | Regression | $R^2$ | Syx | Mean |
|---|---|---|---|---|---|---|
| Cows + heifers | 58 | 1 | NAN(1) = 22.62 DOM** + 0.687 Non deg N** + 4.3 | 0.930 | 24.6 | 239.2 |
| Cows | 42 | 2 | NAN(1) = 23.86 DOM** + 0.60 Non deg N + 8.6 | 0.886 | 27.4 | 276.9 |
| Cows + heifers | 58 | 3 | NAN(2) = 0.594 Non deg N*** + 13.48 L + 0.467% Con + 19.37 | 0.580 | 3.2 | 33.5 |

Significant level : * 5 p. 100 ; ** 1 p. 100 ; *** 1 p. 1000
(1) g/animal/day
(2) g/kg DOM ; L, % Con, Non deg N are also related to DOM Intake (kg).

in table 1. Total collection of faeces during the last week of each period allowed the DOM value of the diet to be calculated. *In vitro* N degradability (6 hours) was measured using a modified version of the method of Verite and Journet (1973). Values were between 57 to 72% for maize silage, 0 to 5% for treated meal, nearly 35% for non-treated meal, and 20% for concentrate.

From the 64 individual original records of NAN duodenal flow, 6 were omitted : 3 correspond to a very low level of soluble N in the diet, and 3 others were a result of nutritional troubles.

## Results and discussion

Different predicting equations for NAN duodenal flow were studied (table 2) :

1°/ the coefficients of variation for predicted NAN flow from total digestible organic matter and *in vitro* non degradable N intakes were around 10% for the 58 individual records on cows and heifers (equation 1) and for the 42 records on cows only (equation 2). These coefficients are very close to those used in the PDI system (21.5 g/kg DOM and 0.65 *in vitro* non degradable N).

*Table 3.* - *Differences (Δ)* (g/animal/day) between observed NAN duodenal flow and predicted flow from the general equation used in the PDI system [1]

Correction effects for level of energy feeding (L), percentage of concentrate in the diet (% Con), and level of energy supply/energy needs (E/needs) [2]

| Group | Number of animals | Regression equation | $R^2$ | Syx | Mean |
|---|---|---|---|---|---|
| Cows | 42 | ΔNAN = − 28.1 L + 1.53** % Con + 36.4 | 0.230** | 24.1 | 20.1 |
| Cows + heifers | 58 | ΔNAN = − 30.0** L + 1.42*** % Con + 45.2 | 0.281** | 21.2 | 16.3 |
| Limited maize silage | 32 | ΔNAN = − 21.1 L + 0.063 % Con + 38.1 | 0.214** | 16.2 | 3.8 |
| Ad lib. maize silage | 26 | ΔNAN = − 44.5** L + 1.59* % Con + 81.7 | 0.298** | 20.5 | 31.6 |
| | 26 | ΔNAN = − 40.2* L + 1.97** % Con + 0.92 E/needs - 32.4 | 0.390** | 19.5 | 31.6 |

(1) NAN (g) = 21 DOM + 0.65 N non deg N ; DOM = digestible organic matter (kg) ; Non deg N = Non degradable N in vitro (6 hrs).

(2) For L and E/needs see table 1 ; significant level : * 5 p. 100, ** 1 p. 100, *** 1 p. 1000.

*Table 4.* - Differences between observed and predicted values of NAN duodenal flow (g/animal/day) according to level of milk production, with an increase in the percentage of concentrate in the diet when the level of feeding increases at the same rate as the milk production level (from equation with 58 animals, table 3)

| Milk production kg/cow/day | Level of feeding | Percentage of concentrate (% DM) | | | |
|---|---|---|---|---|---|
| | | 0 | 20 | 40 | 60 |
| 0 | 1 | 15 | 43 | 72 | 100 |
| 12 | 2 | − 15 | 13 | 42 | 70 |
| 24 | 3 | − 45 | − 17 | 12 | 40 |

Normal range of variation of level of feeding and percentage of concentrate for normal fed cows with maize silage given *ad libitum.* ( `- - -` )

2°/ Level of feeding (energy intake/maintenance needs) and percentage of concentrate in the diet did not significantly affect NAN flow at the duodenum when it was expressed per kg of DOM (equation 3). The percentage of concentrate was signigicant at the 10% level. $R^2$ value was lower than in the preceding equations but coefficients for predicting NAN flow from DOM (near 20) and from *in vitro* non degradable N (near 0.60) were very similar.

3°/ Difference between the observed values and the predicted values in the PDI system for the NAN at the duodenum were calculated. The mean observed value did not differ greatly from the predicted value. It was 16 g/animal/day (7 %) higher (table 3).

Some improvements in predicted values could be obtained by taking into account the level of feeding and the percentage of concentrate in the diet. Both had a significant effect and explained nearly 30% of the difference between observed and predicted values for the total records, but the effects were opposite : the predicted value tended to overestimate NAN flow when the level of feeding was high, and to underestimate it when the percentage of concentrate was high. The effect of the two factors was more pronounced when maize silage was given almost *ad libitum.* The level of energy intake as % energy needs did not significantly affect the predicted NAN duodenal flow, but its range of variwtion was low.

4°/ However, for cows with different levels of milk production but fed according to their needs, the predicted value from PDI system was very close to the measured one. In fact, the level of feeding (/maintenance needs) and percentage of concentrate generally increased simultaneously. So these two factors with opposite effects had little effect. However with high concentrate diets uncorrected values for the percentage of concentrate led to an underestimated nitrogen value of the diet.

Few reports in literature have predicted NAN duodenal flow on dairy cows in normal conditions of feeding and have studied the effect of the level of feeding and the percentage of concentrate in the diet.

Tamminga *et al* (1979) obtained an increase of NAN flow when the level pf intake of dairy cows was increased independently of their production ; the main reason was a decrease in ruminal N degradation. The diets used were high in concentrate and had not exactly the same proportion of concentrate. In our study the level of feeding varied mainly in accordance with the level of production and did not seem to affect NAN duodenal flow when it was predicted directly from DOM and non degradable N intakes. The microbial activity and rate of passage of feeds in the rumen, and consequently the microbial protein synthesis and N degradability in the rumen are probably modified less when the level of intake varies according to the level of milk yield or stage of lactation (Journet and Remond, 1976) than when it varies independantly.

Mac Meniman *et al.,* 1976, reported a lower microbial protein yield related to organic matter digested in the rumen with concentrate diets compared with roughage diets but the supply of easily degradable N in the rumen seemed to be insufficient in many cases.

Our results were obtained with maize silage diets for a certain range of milk production, and more results on different diets and conditions of feeding and at different physiological stages have to be obtained. Measures of the quantity of amino acids absorbed in the small intestine may be a more accurate measure for studying these effects.

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