

## Quantification of the main digestive processes in ruminants: the equations involved in the renewed energy and protein feed evaluation systems.

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### Supplementary Material S1. List of abbreviations.

Abbreviation	Unit	Definition
a (a <sub>N</sub> , a <sub>St</sub> )	%	Soluble fraction (of N ; of starch)
b (b <sub>N</sub> , b <sub>St</sub> )	%	Soluble fraction (of N, of starch)
CH4/DOM	g/kg	CH4 in g/kg DOM
CP	g/kg DM	Crude protein (N×6.25)
D(t)	%	Fraction of a substrate degraded <i>in sacco</i> at time t (h)
DOM	g/kg DM	Digestible OM
DOMc	g/kg DM	Calculated DOM corrected for digestive interactions
DOMint	g/kg DM	OM digestible in the intestines
DOMm	g/kg DM	Measured DOM
dr	%	True digestibility of dietary proteins in the small intestine
ECH4	MJ/kg DMI	Energy lost as CH4
Ed	%	Digestibility of energy
ED(ED <sub>N</sub> , ED <sub>St</sub> )	%	Effective degradability (of N, of Starch)
ED <sub>6</sub> (ED <sub>6_N</sub> , ED <sub>6_St</sub> )	%	Effective degradability (of N, of Starch)calculated assuming kpt = 6%/h
EE	g/kg DM	Ether extract
endoCP	g/kg DM	Endogenous CP at duodenum
EU%EB	MJ/100 MJ	Percentage of gross energy lost in urine
FA	g/kg DM	Fattyacids
FADint	g/kg DM	Fatty acids digestible in the intestines
FADsi	g/kg DM	Fatty acids digestible in the small intestine
FAduo	g/kg DM	Fatty acids at duodenum
FCP	g/kg DM	Fermented CP in the rumen
Fduo <sub>i</sub>	g/kg DM	Duodenal flow of constituent <sub>i</sub>
Ffec <sub>i</sub>	g/kg DM	Fecal flow of constituent <sub>i</sub>
FL	kg DMI / 100 kg BW	Feedinglevel
FLref	kg MSI / 100 kg BW	FL of reference of a feedstuff in the table
FOM	g/kg DM	Fermentable OM
FP	g/kg DM	Fermentation products of silages
FractDint	g/kg DM	Fraction digestible in the intestines (applied to dietary proteins, starch, NDF and FA)
kct	%/h	Fractional passage rate of concentrate particles in the rumen
Kd	%/h	Fractional degradation rate of fraction b

kft	%/h	Fractional passage rate of forage particles in the rumen
klt	%/h	Fractional passage rate of liquids in the rumen
kpt	%/h	Fractional passage rate of particles in the rumen
micCP	g/kg DM	Microbial CP
NDCP	g/kg DM	Non digestible CP
NDF	g/kg DM	Neutraldetergentfiber
NDFDint	g/kg DM	NDF digestible in the intestines
NDFduo	g/kg DM	NDF at duodenum
NDFND	g/kg DM	Non digestible NDF
NMCPduo	g/kg DM	Non microbial CP at duodénum
NDCPSI	g/kg DM	Non digestible dietary protein in the small intestine
OM	g/kg DM	Organic Matter
OMd	%	Digestibility of OM (generic expression)
OMdc	%	Calculated OMd of the diet corrected for digestive interactions
OMdm	%	Measured OMd of the diet
OMtDR	g/kg DM	OM truly digested in the rumen
PCO	0<PCO<1	Proportion of concentrate
PDIA	g/kg DM	Alimentary protein digestible in the small intestine
PDIE	g/kg DM	Protein digestible in the small intestine when energy limits microbial synthesis
PDIME	g/kg DM	Microbial protein digestible in the small intestine when energy limits microbial synthesis
PDIMN	g/kg DM	Microbial protein digestible in the small intestine when fermentable N limits microbial synthesis
RDP	g/kg DM	Rumen degradable protein
RDSt	g/kg DM	Starch digestible in the rumen
resOMtDR	g/kg DM	Residual (non CP, non NDF) OM truly digested in the rumen
Rmic	g PDI/UF	Index for equilibrium between N and energy in the rumen
RPB	g/kg DM	Rumen protein balance
RUP	g/kg DM	Rumen undegradable protein
RUst	g/kg DM	Starch at duodenum
St	g/kg DM	Starch
StDint	g/kg DM	Starch digestible in the intestines
UF	UF/kg MS	Unité fourragère
$\Delta$ OMd	%	Digestive interaction on OMd
$\Delta$ OMd <sub>CO</sub>	%	Digestive interaction on OMd due to PCO
$\Delta$ OMd <sub>FL</sub>	%	Digestive interaction on OMd due FL
$\Delta$ OMd <sub>RPB</sub>	%	Digestive interaction on OMd due to RPB

**Supplementary Material S2.** *Calculation of the renewed energy and protein values of feeds and diets.*

**The NE value**

Only calculation of ME is presented here, since efficiency of ME utilization to NE has not been revised (INRA, 2007). The calculation of ME is as follows:

$$ME = DE - ECH4 - UE$$

$$DE = GE * Ed * 0.01$$

GE calculated from chemical composition according to INRA 2007

Ed calculated from OMd, according to INRA 2007

$$OMd = [\sum_i (OMd_i * POM_i)] - \Delta OMd \quad [24]^1$$

$$\Delta OMd = \Delta OMd_{FL} + \Delta OMd_{CO} + \Delta OMd_{RPB} \quad [25]$$

$$\Delta OMd_{FL} = 2.74 (FL - FL_{ref}) \quad [19]$$

$$\Delta OMd_{RPB} = -0.060 (RPB - RPB_{ref}) \quad [23]$$

$$\Delta OMd_{CO} = 6.5 / (1 + (0.35/PCO)^3) \quad [20]$$

$$ECH4 = CH4/DOM * DOM * 12.5 * 4.18 * 0.001$$

$$CH4/DOM = 45.42 - 6.66 FL + 0.75 FL^2 + 19.65 PCO - 35.0 PCO^2$$

$$- 2.69 FL \times PCO \quad [48]^1$$

$$DOM = MO \times 0.01 OMd \quad [27]$$

$$EU = EU\%GE * GE * 0.01$$

$$EU\%GE = 2.9 + 0.017 CP - 0.47 FL - 1.64 PCO \quad [49]^1$$

**The metabolisable protein value (PDI)**

Given that prediction of microbial protein has been revised to account for interactions between energy and nitrogen in the rumen, only the PDIE value is used in practice.

$$PDIN = PDIA + PDIMN$$

$$PDIE = PDIA + PDIME$$

$$PDIA = RUP * dr * 0.01$$

$$RUP = CP * (1 - 0.01 ED_N) \quad [9]$$

<sup>1</sup>For tabulated values,  $\Delta OMd = 0$ ,  $FL = FL_{ref}$ ,  $PCO = 0$ ,  $RPB = 0$

$$ED\_N = a\_N [100/(100+klt)]+b\_N [kd/(kd+kpt)] \quad [5]$$

$$klt = 5.35 + 2.18 FL - 3.71 PCO^2 \quad [3]^1$$

$$kpt = kft (1-PCO) + kct PCO \quad [4]$$

$$kft = 2.02 + 0.88 FL - 3.13 PCO^2 \quad [1]^1$$

$$kct = 2.53 + 1.22 FL - 2.61 PCO^2 \quad [2]^1$$

dr according to *in situ* data (INRA 2007)

$$ordr = (RUP-NDCPSI) / RUP * 100 \quad [42]$$

$$NDCPSI = NDCP - 2.69 - 0.106 micCP - 0.022 NDNDF \quad [45]$$

$$PDIMN = RDP * 0.8 * 0.8$$

$$RDP = CP * 0.01 ED\_N \quad [8]$$

$$PDIME = micCP*0.8 *0.8$$

$$micCP = 40.7 - 0.114 RPB + 75.6 \cdot 10^{-3} FOM + 8.07 PCO \quad [40]^1$$

$$RPB = -14.2 + (PDIMN-PDIME)/(0.8*0.8) \quad [12]''$$

$$FOM = DOM - PDIA - StDint - NDFDint - FADint - FP \quad [26]'$$

$$StDint = 0.826 St (1-0.01 ED\_St) \quad [29]'$$

$$ED\_St = a\_St [100/(100+klt)]+b\_St [kd/(kd+kpt)][5]$$

$$NDFDint = NDFduo-NDNDF \quad [32]$$

$$NDFduo = 11.4 + 1.08 NDNDF \quad [31]$$

$$NDNDF = 591 - 6.09 OMd \quad [30]$$

$$FADint = 6.0 + 0.599 FAduo \quad [34]$$

$$FAduo = 9.7 + 0.75 FA \quad [33]$$