NRC protein evaluation system

NRC. 2001. Nutrient requirements of dairy cattle. Seventh revised edition. National Academy Press, Washington DC, USA, pp. 43-104 (informative)

Protein evaluation system – ruminants general principles

- distinction dietary protein in rumen degradable and undegradable
- kinetics (rate) of dietary protein degradation & digesta passage
- microbial protein ~ fermentable OM (constant microbial growth yield)
- proportion of microbial crude protein = true protein
- rumino-hepatic urea recycling
- duodenal absorption of true microbial protein
- duodenal absorption of true rumen undegradable dietary protein
- endogenous N losses from body into urine & faeces
- efficiency of conversion of metabolisable protein into animal protein
- protein requirements for maintenance or production

Differences with the 1994 Belgian-Dutch system and the NRC system - overview

1. Rumen degradation model & passage rate

2. Predicting passage of microbial protein (based on TDN)

3. Endogenous faecal N losses (g/d)

4. Amino acid submodel

Differences with the 1994 Belgian-Dutch system and the NRC system - overview

1. Rumen degradation model & passage rate

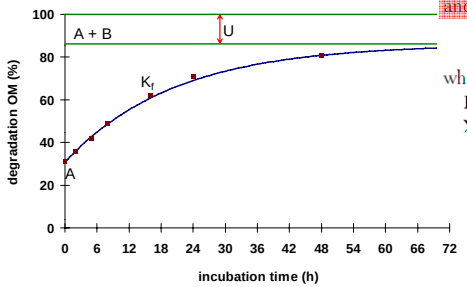
2. Predicting passage of microbial protein (based on TDN)

3. Endogenous faecal N losses (g/d)

4. Amino acid submodel

Rumen degradation model CP fraction

NRC 2001



$$RDCP = A + \frac{kf}{kf + kp} * B$$

$$BP = U + \frac{kp}{kf + kp} * B$$

Equation for estimating K_p of wet forages (i.e., silages and fresh forages)

$$K_p = 3.054 + 0.614X_1$$

where:
K_p = rate of passage from the rumen, %/h
X_1 = DMI, percentage of BW

Equation for estimating K_p of dry forages

$$K_p = 3.362 + 0.479X_1 - 0.007X_2 - 0.017X_3$$

where:
K_p = rate of passage from the rumen, %/h
X_1 = DMI, percentage of BW
X_2 = concentrate, percentage of diet DM
X_3 = NDF of feedstuff, percentage of DM

Equation for estimating Kp of concentrates

$$K_p = 2.904 + 1.375X_1 - 0.020X_2$$

where:
K_p = rate of passage from the rumen, %/h
X_1 = DMI, percentage of BW
X_2 = concentrate, percentage of diet DM

Differences with the 1994 Belgian-Dutch system and the NRC system - overview

1. Rumen degradation model & passage rate
2. Predicting passage of microbial protein (based on TDN)
3. Endogenous faecal N losses (g/d)
4. Amino acid submodel

Belgian-Dutch DVE-system (1994)

MP = FOM x 0.150

microbial growth yield

Fermentable organic matter

NRC-system (2001)

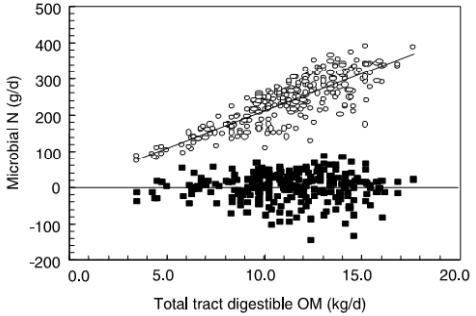


FIGURE 5-5 Plot of adjusted (open circles) and residuals (squares) for measured microbial N (g/d) versus measured total tract digestible OM (kg/d). Microbial N = 21.03 total tract digestible OM, $r^2 = 0.69$, $P < 0.001$, Sy = 38.1, n = 266).

NRC-system (2001)

MP = TDOM x 0.130

microbial growth yield

Total digestible organic matter

TDOM = TDN – (EE - 1) x 2.25

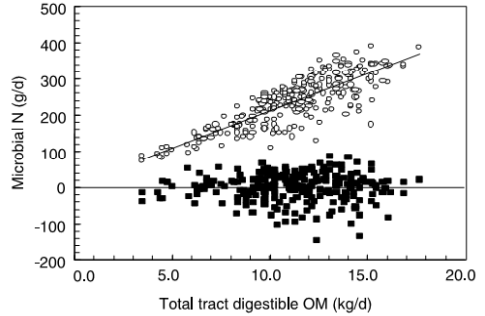


FIGURE 5-5 Plot of adjusted (open circles) and residuals (squares) for measured microbial N (g/d) versus measured total tract digestible OM (kg/d). Microbial N = 21.03 total tract digestible OM, $r^2 = 0.69$, $P < 0.001$, Sy = 38.1, n = 266).

Undegradable protein balance (OEB)

- Belgian-Dutch DVE/OEB 1994
  OEB = $MCP_{Nitrogen}$ - MCP_{Energy}

- NRC 2001

  In summary, it is assumed that the yield of MCP is 130 g/kg of TDN (discounted) intake and that the requirement for RDP is 1.18 × MCP yield. Therefore, yield of MCP is calculated as 0.130 × TDN (discounted TDN, see Chapter 2) when RDP intake exceeds 1.18 × MCP yield. When RDP intake is less than 1.18 × TDN-predicted MCP, then MCP yield is calculated as 0.85 of RDP intake (1.00/1.18 = 0.85).

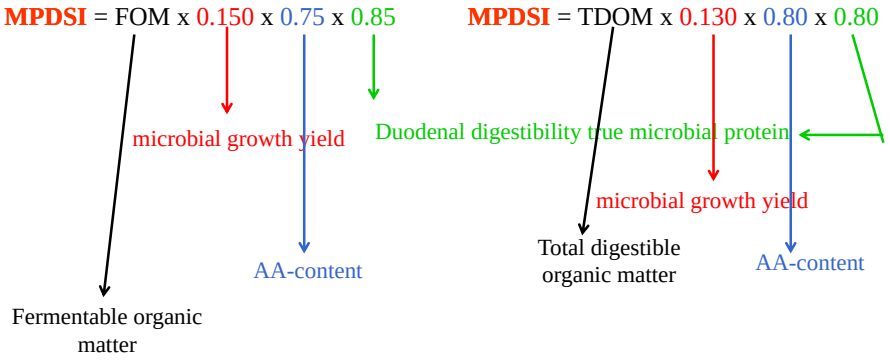
Protein evaluation system – ruminants general principles

- distinction dietary protein in rumen degradable and undegradable
- kinetics (rate) of dietary protein degradation & digesta passage
- microbial protein ~ fermentable OM (constant microbial growth yield)
- proportion of microbial crude protein = true protein
- rumino-hepatic urea recycling
- duodenal absorption of true microbial protein
- duodenal absorption of true rumen undegradable dietary protein
- endogenous N losses from body into urine & faeces
- efficiency of conversion of metabolisable protein into animal protein
- protein requirements for maintenance or production

Belgian-Dutch DVE-system (1994)

NRC-system (2001)

TPDSI = BPDSI + MPDSI - MDPL



Differences with the 1994 Belgian-Dutch system and the NRC system - overview

1. Rumen degradation model & passage rate

2. Predicting passage of microbial protein (based on TDN)

3. Endogenous faecal N losses (g/d)

4. Amino acid submodel

Belgian-Dutch DVE-system (1994)

TPDSI = BPDSI + MPDSI - MDPL

MDPL = UDM x 0.0075

↓

UDM = 1000 - DOM - DCA

NRC-system (2001)

Endogenous N (g/d) = DMI (kg/d) x 1.9

Differences with the 1994 Belgian-Dutch system and the NRC system - overview

1. Rumen degradation model & passage rate

2. Predicting passage of microbial protein (based on TDN)

3. Endogenous faecal N losses (g/d)

4. Amino acid submodel (for info p.69-85)