Effect of supplementing grass silage with incremental levels of water soluble carbohydrate on *in vitro* rumen microbial growth and N use efficiency

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Introduction The efficiency of utilisation of N for milk production in dairy cows is often less than 25% and a shortfall in readily available carbohydrate to provide substrate for microbial growth is often cited as a potential problem. Grasses bred for their high water soluble carbohydrate (WSC) content have potential to address this issue but there is limited information on the level of sugar required to optimise rumen microbial growth efficiency. The objective of this experiment was to examine the effect of different concentrations of WSC on the efficiency of use of grass silage N under *in vitro* conditions.

Materials and methods Silage was prepared from a third cut of perennial ryegrass (cv Fennema) after treatment with a silage inoculant (Powerstart; Genus plc, Nantwich;10^6 cfu/g FM). An 8-vessel simulated rumen culture system (Rusitec) (Czerkawski & Breckenridge, 1977) was used and the experiment repeated on two occasions with fresh rumen fluid, giving 4 replicates per treatment. There were 4 treatments, basal silage alone (15 g DM/d) or mixed with 56, 97 or 168 g/d of a sucrose and inulin (fructan) mixture, ratio 60:40, prior to feeding. The silages ± sugar were fed to cultures every 24 h. Artificial saliva plus $(^{15}NH_4)_2SO_4$ as a microbial marker was infused continuously into the culture vessels at a rate of 0.7 volumes/d. Samples of washed bacteria, vessel contents and effluent were taken 7 d after the addition of $(^{15}NH_4)_2SO_4$. Flows of organic matter and ammonia-N concentration in the effluents were estimated and daily microbial N flows and efficiency were calculated from values for ^{15}N enrichment of the effluent and harvested microbial fractions. Statistical analysis utilised Genstat (2003) two-way analysis of variance and least significant differences.

Results The silage composition, prior to WSC supplementation was: DM, 270 g/kg; pH, 3.59; total N, 29.1 g/kg DM; ammonia-N, 75.6 g/kg TN; lactic acid, 121.7 g/kg DM and WSC, 14.9 g/kg DM. Thus, actual feed WSC concentrations were the equivalent of 15 (basal silage) and 71, 112 and 183 g of WSC/kg silage DM after sugar supplementation. Values for rumen parameters are shown in Table 1. Organic matter digestion and microbial N production increased up to the highest WSC level of 183 g/kg DM. This was reflected by the values for efficiency of microbial protein synthesis in terms of energy supply, where a small but non significant increase from 25 to 26 g microbial N (MN)/kg organic matter apparently digested (OMAD) was generally observed across all levels of supplementation, compared to the basal silage. A marked response was observed in N use efficiency (g MN/g feed input) for all levels of WSC supplementation, rising from 57% with the basal silage to 74% at 183 g WSC/kg DM.

Table 1 Effect of silage WSC concentration on rumen fermentation parameters in Rusitec

	WSC Concentrations (g/kg DM)				
	15	71	112	183	sed
OMAD (g/d)	9.39^a	10.42^b	10.75^b	11.94^c	0.167
Microbial N (MN; g/d)	0.250^a	0.295^{bc}	0.271^{ab}	0.326^c	0.0158
EMPS (g MN/kg OMAD)	26.96	28.65	25.84	27.37	1.735
Ammonia-N (mmol/l)	8.1^a	6.79^b	6.17^b	3.72^c	0.393
N use Efficiency (g MN/g feed N input)	0.57^a	0.68^{bc}	0.62^{ab}	0.74^c	0.037

OMAD, organic matter apparently digested; EMPS, efficiency of microbial protein synthesis. Values in rows with different superscripts differ significantly $P<0.001$.

Conclusions Microbial protein synthesis and N use efficiency increased up to the highest level of 18% WSC, which supports the view that low residual WSC in grass silage can contribute to the poor efficiency with which silage-N is used by ruminants. It also provides useful information for breeders developing new grass cultivars.

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References

Czerkawski, J. & G. Breckenridge (1977). Design and development of a long-term rumen simulation technique (Rusitec). *British Journal of Nutrition*, 38, 371–385.
Genstat (2003). Genstat 7. Lawes Agricultural Trust: Clarendon Press.