The effect of enzyme-treatment on the nutritive value of high-temperature dried lucerne for ponies

Jo-Anne M. D. Murray[1,2], Annette C. Longland[1], Meriel J. S Moore-Colyer[2] and Catherine Dunnett[3]

Institute of Grassland and Environmental Research, Aberystwyth[1], Institute of Rural Studies, University of Wales and Aberystwyth[2] and Dengie Crops Ltd, Asheldam[3]

Introduction

Fibre-based diets help to maintain normal fermentation conditions in the large intestine of the horse; conversely concentrate diets high in starch can be detrimental to hindgut function (*McLean* et al. 2000). Therefore, there is a need to develop feeding strategies that meet the nutrient requirements of working horses whilst maintaining gut health and integrity. Consequently, the ability to reduce the concentrate portion of the diet with a high-energy, fibre-based feed is desirable. Fibrolytic enzymes have been used as direct applications in ruminant diets as a means of increasing the nutritive value of the feed and improving animal productivity (*Beauchemin* et al. 2003) by enhancing the digestibility of plant structural carbohydrates (*Spoelstra* 1991). Increased degradation of plant material in the gastrointestinal tract of the horse would be beneficial to the overall energy balance of the animal, and reduce or even preclude the need for supplementary cereal grains. Therefore, the objective of this experiment was to evaluate the effect of a fibrolytic enzyme treatment on the nutritive value of high-temperature dried (HT) Lucerne fed to ponies.

Materials and Methods

An 8 X 8 Latin-square design experiment was used to evaluate the effect of four levels of enzyme treatment (0 [WC] 2.3 [DE1], 4.7 [DE2] and 8.9 L tonne-1 DM [DE3] (evaluated alongside four additional treatments [data not presented]) applied 20 h prior to high-temperature drying (800°C) on the nutritive value of high-temperature dried (HT) Lucerne for ponies. Eight mature Welsh-cross ponies were fed each diet at 1.75% dry matter (DM) of bodyweight in two equal meals per day at 12-hour intervals. Each experimental period consisted of a 10 day adaptation phase and a five day recording phase when in vivo apparent digestibilities of dry matter (DMD), organic matter (OMD), crude protein (CPD), gross energy (GED), acid detergent fibre (ADFD), neutral detergent fibre (NDFD) and non-starch polysaccharide (NSPD) were determined. Digestible energy (DE) values were also calculated (GE content of the diet x GED). Data were analysed using Latin Square ANOVA in Genstat Release 5.1 (Lawes Agricultural Trust, Harpenden, UK).

Results

Total diet in vivo digestibilities are given in Table 1. Total diet DMD and CPD were not affected by enzyme-treatment. However, OMD was significantly ($P<0.05$) reduced in DE1 and DE2 compared to WC and DE3. A significant ($P<0.05$) reduction in NDFD was also observed in DE1 and DE2 compared to WC and DE3 (438 and 452 g kg^{-1} vs. 501 and 497 g kg^{-1}, respectively). TNSPD also decreased significantly ($P<0.05$) in DE1 and DE2 in comparison to the control (551 and 578 vs. 608 g kg^{-1}, respectively). Similar DE values were recorded for each experimental diet, averaging 9.61 MJ kg^{-1}.

Table 1 Total diet in vivo apparent digestibilities (dry matter [DMD], organic matter [OMD], crude protein [CPD], acid detergent fibre [ADFD], neutral detergent fibre [NDFD], gross energy [GED] and digestible energy [DE] for high-temperature dried Lucerne treated with four levels of a fibrolytic enzyme (0 [WC] 2.3 [DE1], 4.7 [DE2] and 8.9 L tonne-1 DM [DE3] (g kg-1 unless stated otherwise).

	WC	DE1	DE2	DE3	s.e.d	Sig.
DMD	578	554	568	567	11.3	ns
OMD	565^{b}	534^{a}	540^{a}	549^{ab}	11.5	P<0.001
CPD	641	653	658	634	14.8	ns
ADFD	467^{ab}	440^{a}	460^{ab}	487^{b}	14.8	P<0.01
NDFD	501^{b}	438^{a}	452^{a}	497^{b}	13.5	P<0.001
GED	531	520	531	534	17.4	ns
Total NSP	608^{c}	551^{a}	578^{ab}	589^{bc}	13.4	P<0.001
DE (MJ kg^{-1} DM)	9.56	9.63	9.64	9.61	0.317	ns

Values in rows not sharing common superscripts differ significantly ($P<0.05$)

Discussion

The effect of enzyme treatment on nutrient digestibility of forages has produced equivocal results (*Beauchemin* et al. 1995, *Hunt* et al. 1995, *Krause* et al. 1998, *Yang* et al. 1999, *Kung* et al. 2000). In the present study, the use of enzyme treatment resulted in a significant reduction in the apparent digestibility of OM, NDF and TNSP digestibility in diets DE1 and DE2 relative to the control diet and DE3. A reduction in the apparent digestibility of enzyme-treated diets has been observed by others in sheep (*Jaakola* 1990, *Jacobs* et al. 1991) and cattle (*Jacobs* and *McAllan* 1991), whereby DM, OM, ADF and NDF digestibilities were significantly reduced in enzyme-treated silages. In these studies, the ADF and NDF contents were lower in the enzyme-treated silages compared to the untreated control. Therefore, these authors postulated that the use of enzymes resulted in the breakdown of the more readily degradable fibrous fraction during ensilage, resulting in silage with lower, but less degradable ADF and NDF residues. In the present study, the fibrous fractions, depicted by the ADF, NDF and TNSP content, of the enzyme-treated Lucerne appeared similar in comparison to the control forage, although the NDF contents of DE1 and DE2 (464 and 449 g kg^{-1} DM, respectively) were marginally lower in comparison to the control and DE3 (480 g kg^{-1} DM), and subsequently the NDF digestibility of these two diets was significantly lower in comparison to the control and DE3. This reduction in NDF content and NDF digestibility may be attributed to losses occurring during the 20 h incubation period that took place prior to HT drying. The enzyme additives may have degraded the more digestible fraction of the cell wall polysaccharides during this period, resulting in a more recalcitrant residue. This is entirely conceivable since, at treatment, the DM of the herbage was 320 g kg^{-1} FM and the manner in which the her-

bage was stored prior to drying may have resulted in microbial fermentation of the reducing sugars released though enzyme treatment. Nonetheless, it is unclear why this did not appear to occur in DE3.

Hainze et al. (2003) also reported reduced fibre digestibility of an enzyme-treated Lucerne-based based diet fed to horses. The authors of this work were also unclear as to why enzyme treatment failed to stimulate, but actually decreased, fibre degradation. They postulated that this might be due to the exogenous enzymes blocking enzyme binding sites that would otherwise be occupied by microbial enzymes. Reduced digestibility has also been observed in ruminants (*Krause* et al. 1998) and has been attributed to the application of excess exogenous enzymes. Total bacterial numbers in ruminal fluid have been seen to increase quadratically to increasing levels of enzyme addition (*Nsereko* et al. 2002). At moderate levels of enzyme activity disruption of the surface structure of the forage either before or after ingestion was beneficial, but, when applied at high levels this beneficial effect has been seen to cease. Instead excess exogenous enzyme attached to the feed appeared to restrict microbial attachment and therefore limited the digestion of the forage. However, this does not explain the results reported here, since decreased digestibility was noted at the lower levels of enzyme application. It is possible that in the current study the lower levels of enzyme addition were insufficient to elicit cell wall degradation but instead blocked microbial enzyme binding sites, whereas at the highest level of exogenous enzyme application, a moderate effect on cell wall breakdown may have occurred but not to a level that differed significantly from the untreated control.

Conclusion

The addition of a fibrolytic enzyme preparation capable of hydrolysing forage polysaccharides resulted in a significant decrease in the digestibility of the fibrous fraction of HT Lucerne at the lower application levels. However, no clear conclusions could be drawn as to why this occurred and further work is required to investigate a possible mechanism for this reduced fibre digestibility.

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J. M. D. Murray
Royal (Dick) School of Veterinary Studies
University of Edinburgh
Easter Bush, Midlothian, EH25 9RG, UK
Jo-Anne.Murray@ed.ac.uk