Comparing the *in vivo* dry matter digestibility of perennial ryegrass in sheep and dairy cows

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Abstract

Pre-grazing herbage mass (PGHM) affects grass quality and intake. Higher PGHM swards usually have lower dry matter intake (DMI) and *in vitro* dry matter digestibility (DMD) than lower PGHM swards, leading to reduced performance in lactating dairy cows. *In vivo* digestibility experiments involving cows are often laborious and expensive and, as a result, sheep are often used instead. The objective of this experiment was to compare the *in vivo* DMD of perennial ryegrass (*Lolium perenne* L.) at high and low PGHM in lactating dairy cows and wether sheep. A Latin-square design experiment was repeated twice (TS1 (April-May) and TS2 (July-August)) using eight wether sheep and eight spring-calving lactating dairy cows to determine the *in vivo* DMD of two different PGHM swards (1,700 kg dry matter (DM) ha^{-1} (low mass; LM) and 4,000 kg DM ha^{-1} (high mass; HM)). There were no interactions between PGHM, animal species and TS. The *in vivo* DMD of perennial ryegrass reduced from LM to HM and from TS1 to TS2. There was a tendency for cows to have lower *in vivo* DMD of perennial ryegrass than sheep. The greater *in vivo* DMD of LM compared to HM may be due to the greater proportion of leaf and lower true stem proportion in LM. As there were no interaction effects on *in vivo* DMD, sheep DMD and cow DMD are similar to each other across all PGHM and all seasons.

Keywords: digestibility, cows, sheep, perennial ryegrass

Introduction

Grass is a cheap and nutritious feed and Shalloo (2009) identified grass quality and grass utilisation as key components of profitability in grass-based dairy production systems. Dry matter digestibility (DMD) is a common measurement of grass quality. High sward DMD is essential to the delivery of good nutrition to dairy cows. In order to provide high DMD grass to dairy cows it is essential to measure factors that affect sward quality. A major factor is pre-grazing herbage mass (PGHM), which has a substantial effect on the DMD of a sward (Wims *et al.*, 2010). There is further need to quantify the effects of PGHM on DMD, including sward morphology measurements in order to understand these effects more clearly. Also, as sheep are routinely used as the model animal for *in vivo* digestibility evaluation, the suitability of using sheep as a model animal for predicting digestibility in dairy cows must be evaluated.

Materials and methods

Eight wether sheep and eight spring-calving lactating dairy cows were used to determine the *in vivo* DMD of two treatments; namely, two different PGHM (1,700 kg dry matter (DM) ha^{-1} – low mass (LM) and 4,000 kg DM ha^{-1} – high mass (HM)). A Latin square design experiment (2 (treatments) × 2 (periods)) was repeated twice (time stage (TS) 1: April-May 2014, TS2: July-August 2014). Each TS had two periods of 12 days per period: six days adaptation phase and six days measurement phase (MP). The sheep and cows were housed in individual stalls to allow for individual feeding and for total faecal collection. Sheep were blocked on body weight (TS1 51±2.0 kg, TS2 67±3.9 kg), while cows were blocked on body weight (TS1 547±29.2 kg, TS2 509±34.7 kg), milk yield (TS1 26.2±3.16 litres day^{-1}, TS2 24.4±1.99 litres day^{-1}) and milk solids yield (TS1 2.2±0.51 kg day^{-1}, TS2 1.86±0.10 kg day^{-1}) at the start of each TS.

Fresh grass was cut daily using a Pottinger mower and silage wagon (Pottinger M. GmbH, Grieskirchen, Germany). Sheep and cows were fed grass *ad libitum* (110% of DMI) and grass DMI was recorded daily. Pre-grazing herbage mass was measured using a Gardena hand shears (Accu 60, Gardena Int. GmbH, Ulm, Germany) and a 0.25 m^2 quadrat four times during each period. On day 8 of each period a 40 g sample of each PGHM was separated into leaf, pseudostem, true stem and dead proportions >4 cm. During the MP, a representative sample of the grass offered to, and faeces voided by, each sheep and cow was collected daily. The daily grass and faeces samples were dried and then bulked to give one sample of each per PGHM per MP for each species. Dry matter digestibility was calculated as (kg DM ingested – kg DM output in faeces) kg^{-1} DM ingested. The DMD data were analysed using PROC MIXED in SAS (2002). Pre-grazing herbage mass, period within TS, TS, species and the interactions between TS, species and PGHM were included as fixed effects. Animal was included as the random effect. The sward morphology data were analysed using PROC MIXED in SAS (2002). Fixed effects included PGHM, period within TS, TS, and the interaction between TS and PGHM.

Results and discussion

No significant interaction effects between animal species, TS and PGHM were found on *in vivo* DMD (Table 1). This was an important finding as it indicated that the species effect on DMD was consistent across the different times of the year evaluated, and across different PGHM. There was a tendency (P=0.09) for sheep to have greater *in vivo* DMD than dairy cows. Average sheep DMD was +13 g kg^{-1} compared to average cow DMD (739 g kg^{-1}). The similarity of the two species is in contrast to the findings of Reid *et al.* (1990) who found that cows have greater DMD than sheep. However in that study, non-lactating dairy cows were used and grass was fed as hay. The lower DMD in cows in this study may be due to the greater level of intake by the cows (the cows consumed 2.93% of bodyweight, compared to 2.17% of bodyweight consumed by sheep). The greater intake could result in faster passage rate of feed through the lactating cows, resulting in decreased feed digestibility, as found by Shaver *et al.* (1986). There was an effect of PGHM on *in vivo* DMD as LM swards had greater DMD than HM swards (P<0.01). This is similar to the findings of Curran *et al.* (2010) who found that high PGHM swards (2,400 kg

Table 1. The effect of pre-grazing herbage mass (PGHM) on grass *in vivo* dry matter digestibility (DMD) in wether sheep and spring-calving lactating dairy cows in two time stages (TS).

	PGHM	Species	DMD (g kg^{-1})
TS1 (April-May)	High	Sheep	756
		Cow	745
	Low	Sheep	783
		Cow	774
TS2 (July-August)	High	Sheep	730
		Cow	697
	Low	Sheep	740
		Cow	739
Significance[1]		SED	15.0
		PGHM	**
		TS	***
		Species	†
		PGHM × TS	ns
		PGHM × Species	ns
		TS × Species	ns
		PGHM × TS ×Species	ns

[1] SED = standard error of difference; ** P<0.01; *** P<0.001; †<0.1; ns = not significant.

Table 2. The effect of pre-grazing herbage mass (PGHM) on sward leaf, stem and dead proportions in two time stages (TS).[1]

	TS1 (Apr-May)		TS 2 (Jul-Aug)		SED	Significance[2]		
	High PGHM	Low PGHM	High PGHM	Low PGHM		PGHM	TS	PGHM × TS
Leaf %	43.5	59.5	45.8	69.8	4.0	***	†	ns
Pseudostem %	24.3^{a}	26.3^{a}	19.5^{ab}	12.5^{b}	2.3	ns	**	*
True stem %	22.3	8.5	23.8	3.3	4.3	**	ns	ns
Dead %	9.5^{ab}	6.0^{a}	11.5^{ab}	14.3^{b}	2.2	ns	**	†

[1] SED = standard error of difference. Values in rows with different superscript letters are significantly different.

[2] * P<0.05; ** P<0.01; *** P<0.001; †<0.1; ns = not significant.

DM ha^{-1} >4 cm) had lower *in vitro* organic matter digestibility than low PGHM swards (1,600 kg DM ha^{-1} >4 cm). This result was explained by the fact that the LM swards had a greater leaf proportion and lower true stem proportion than the HM swards (P<0.01) (Table 2). The TS also had an effect on *in vivo* DMD with greater DMD in TS1 swards than in TS2 swards (P<0.01). The dead proportion of swards was greater in TS2 than in TS1, which may have contributed to the reduction in DMD. Garry *et al.* (2014) found similar effects of PGHM and sward morphology on *in vivo* DMD when evaluated with sheep alone.

Conclusions

There were no effects of the interaction between PGHM, TS and animal species on *in vivo* DMD, despite a tendency for animal species to differ for DMD. Calculations relating to organic matter digestibility are pending and will allow definitive conclusions to be made regarding the relationship between cow and sheep digestibility. Both PGHM and time of year have significant effects on sward digestibility. *in vivo* DMD was greater in low PGHM swards with greater leaf proportion and in swards in spring.

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