Nutritive value of silage from perennial ryegrass, plantain and lucerne pastures in south west Victoria

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Abstract

During spring in south west Victoria, the supply of pasture often exceeds requirements for grazing. Conservation of the surplus pasture as silage provides a storage of fodder for later use. This project compared the nutritive value of silage from perennial ryegrass (*Lolium perenne* L.), plantain (*Plantago lanceolata* L.) and lucerne (*Medicago sativa* L.). The three pastures were sown in a randomised complete block (RCB) design with four replications in spring 2009. Plot size was approximately 1 ha. Silage was cut and baled on 5-8th December 2011. On 16th January 2012, sampling occurred for crude protein (CP), *in vitro* dry matter digestibility (*IV*DMD), neutral detergent fibre (NDF), water soluble carbohydrate (WSC) and metabolisable energy (ME). Lucerne silage generally had the highest CP (16.48%DM) and lowest NDF (44.65%DM), but WSC levels in the lucerne were also low (6.35%DM). The plantain had the highest WSC levels (10.53%DM), but lowest *IV*DMD (56.33%DM) and ME (8.08 MJ/kgDM). Modelling suggested that perennial ryegrass silage of the tested quality, used as a feedlotting ration for weaned lambs in February, was sufficient to meet maintenance requirements but was not sufficient to achieve growth rates above 35 g/day. Modelling also suggested, as a supplement for ewes on dry pasture in March, silage alone was not sufficient to meet maintenance requirements. The timing of silage cutting is important and it is likely that improved silage nutritive value could be achieved had the swards been cut at an earlier stage of maturity.

Key Words

Silage quality, conserved fodder, hay, legumes, herbs, diet selection

Introduction

The seasonal nature of pasture growth in south west Victoria requires the integrated management of grazing and pasture conservation as hay or silage to maximise pasture utilisation and improve seasonal feed supply. The feeding value of silage depends on a range of factors, such as pasture species, ensile treatments and harvest date. Lucerne silage can be used as an alternative to grain or to supplement green pasture without causing adverse effects on lamb eating quality (Hopkins et al. 1995). The use of lucerne silage has resulted in predicted lamb growth rates of 125 g/day, with higher weight gains achieved when grain was added to the ration (Stanley 2003). Lamb performance from plantain silage remains unknown, but the species has a range of potential benefits due to high DM production and high condensed tannin concentrations (Moorehead and Piggot 2009; Ramırez-Restrepo and Barry 2005). It was hypothesised that lucerne and plantain silage in south west Victoria would have nutritive value equal to or higher than perennial ryegrass silage and that this would result in higher predicted lamb and ewe liveweight gains from rations containing silage.

Materials and method

Site description

The experiment was conducted at the Department of Primary Industries research farm at Hamilton, Victoria, Australia (37º50’S, 142º04’E; elevation 200 m). The site has a temperate climate with long term (1963-2011) average annual rainfall of 685 mm which is winter dominant. The long term (1965-2011) average maximum and minimum daily air temperatures in the warmest month (February) are 26ºC and 11ºC and in the coolest month (July) are 12ºC and 4ºC. The soil is a tertiary/quaternary basalt. The soil mapping unit a Monivae gravelly loam (Northcote 1979). Soil fertility (0-10 cm) on 7th October 2009 was pH(H_20) 5.6-5.7, P (Olsen) 13-19 mg/kg, K (Skene) 99-120 mg/kg and S (KC140) 9-10 mg/kg.

Experimental design

Three pasture species were sown on field plots in an RCB design with four replications. The field plots were approximately 1 ha in size (400-600 m long and 16-18 m wide), with the experimental site being 30 ha in total. The pastures were monoculture swards of perennial ryegrass (cv. Banquet II), plantain (cv. Tonic) or lucerne (cv. Stamina GT6).

Site establishment and management

The pastures were direct drilled on 2-3rd November 2009, with 100 kg/ha mono-ammonium phosphate (MAP) (10%N, 22%P, 0%K, 2%S with 0.05% Mo). Sowing depth was approximately 3 cm, with open drill rows. The site was rolled after sowing. Sowing rates were 27 kg/ha for the perennial ryegrass, 6.2 kg/ha for the plantain and 11.4 kg/ha for the lucerne. All plots received 50 kg/ha of MAP (10%N, 22%P, 0%K and 2%S) on 7th July 2010, and 267 kg/ha of a superphosphate/urea mixed fertiliser (6.9%N, 7.5%P, 0%K, 9.3%S, 16.1%Ca) on 15th March 2011. The swards consisted predominantly of the sown species. Throughout 2010 and 2011, the plots were rotationally grazed by sheep. The plots were destocked on 8th November 2011. Silage was cut, wrapped and baled on 5-8th December 2011. No additives or conditioning was used.

Nutritive value

Silage sampling occurred on 16th January 2012. The number of silage bales per plot varied due to differences in plot size and herbage mass, and between 20-24 silage cores were collected per plot, divided equally among the bales produced in each plot (Table 1). Samples were collected using a corer with a 2 cm diameter and length of 20 cm. The corer was inserted into the curved side of the bale at a perpendicular angle and driven into the centre. The cores were bulked, placed in air tight bags and stored in an iced esky. A sub-sample was dried at 60°C for 48 hours and then analysed for CP, *IV*DMD, NDF, WSC and ME using near infrared spectroscopy (NIR). Near infrared spectra were collected using an XDS Rapid Content Analyser (Foss Analytical AB, Sweden) in conjunction with WinISI II v1.04 software (Infrasoft International, LLC, PA, USA). The NIR calibrations were prepared using the procedures of the Australian Fodder Industry Association (2011). Referencing methods were as follows: CP by the Dumas Method (combustion), *IV*DMD by the pepsin-cellulase technique, amylase NDF by ANKOM, WSC by water extraction-anthrone and ME was a calculated value from *IV*DMD.

Predicted liveweight gains

GrazFeed™ (Donnelly et al. 2002) was used to predict liveweight gains from silage and grain based feed rations for two livestock scenarios. The first scenario predicted the liveweight gains of weaned lambs during February at Hamilton. The lambs were Polwarth x medium merino males, six months old with a shorn weight of 30 kg and adult weight of 50 kg. The lambs were feedlotted, with no access to pasture. The second scenario predicted liveweight gains for ewes at day 30 of gestation during March at Hamilton. The ewes were single bearing Polwarth x medium merinos, 24 months old with a shorn weight of 50 kg and a fleece depth of 3 cm. The ram was a Polwarth x medium merino, 70 kg in weight. Weather conditions were based on site averages. For each livestock scenario, three feed rations were compared; (1) silage only, (2) 50:50 silage:grain, or (3) grain only. The silage only diets used the parameters listed in Table 2 to compare perennial ryegrass, plantain or lucerne silage. The grain ration was 75% oats and 25% lupins. The oats had 90%DM, 66%*IV*DMD, 11.5 MJME/kgDM and 10%CP. The lupins had 90%DM, 73%*IV*DMD, 12.4 MJME/kgDM and 30%CP. In all feed rations, the March ewes had 1.5 t DM/ha of dead temperate pasture, 3 cm in height, with 45% digestibility and 5.5%CP, with no legume in the sward and no green matter on offer.

Statistical analysis

Nutritive value data were analysed by analysis of variance (ANOVA) using an RCB model, blocking by replicate. The statistical package used was GenStat® Release 12.1 VSN International, Hemel Hempstead, UK. Differences between treatments are only discussed where they were statistically significant according to Fisher's protected least significant difference (LSD *P*=0.05) (Steel and Torrie 1980).

Results

On replicates 1, 2 and 3, each pasture species produced a similar number of silage bales. For the perennial ryegrass and plantain, bale production was higher on replicate 4 than any of the other replicates, but the lucerne produced a similar number of bales on all replicates. On replicate 4, the perennial ryegrass produced four times more and the plantain three times more bales than the lucerne.

Table 1. The number of silage bales cut from each pasture species per replicate, with the number of silage cores taken from each bale

	Perennial ryegrass		Plantain		Lucerne	
	Bales	Cores/bale	Bales	Cores/bale	Bales	Cores/bale
Replicate 1	4	5	3	7	5	4
Replicate 2	3	7	3	7	3	7
Replicate 3	5	4	7	3	6	4
Replicate 4	21	1	11	2	5	4

The lucerne had higher CP than the perennial ryegrass or plantain, which did not differ significantly from each other (Table 2). The plantain had the lowest *IV*DMD, with *IV*DMD for the perennial ryegrass and lucerne being similar. NDF was generally highest in the perennial ryegrass and lowest in the lucerne, with the plantain being intermediate. WSC content was generally highest in the plantain and lowest in the lucerne, with the perennial ryegrass being intermediate. There was no difference in the DM content of the species.

Table 2. CP (%DM), *IV*DMD (%DM), NDF (%DM), WSC (%DM), ME (MJ/kgDM) and DM content (%DM) of perennial ryegrass, plantain and lucerne silage, with LSD's for comparing pasture species

	Perennial ryegrass	Plantain	Lucerne	LSD (*P=0.05*)
CP	8.17[b]	9.45[b]	16.48[a]	2.04
*IV*DMD	61.68[a]	56.33[b]	61.28[a]	3.63
NDF	57.65[a]	50.75[ab]	44.65[b]	7.12
WSC	9.23[ab]	10.53[a]	6.35[b]	4.00
ME	9.00[a]	8.08[b]	8.95[a]	0.62
DM content	52.99[a]	57.92[a]	54.17[a]	10.95

Means with the same letter do not differ (P=0.05).

For the February lambs, the grain only diet maximised predicted liveweight gains (176 g/day). The lowest predicted lamb liveweight gains occurred on the silage only diets, with the plantain silage not meeting maintenance requirements and the simulated lambs losing weight. Of the silage based diets, predicted lamb liveweight gains were highest from the perennial ryegrass silage, followed by the lucerne, and lowest on the plantain silage. For the gestating ewes, predicted ewe liveweight gains were maximised by the grain only supplement (78 g/day) and were lowest on the silage only supplements, which were insufficient to meet maintenance requirements. Where grain and silage were offered, predicted liveweight gains were higher on the perennial ryegrass silage diet, relative to the lucerne and plantain silages.

Table 3. Predicted liveweight gains (g/day), supplement intake (kg/day) and pasture intake (kg/day) for the weaned lambs in February and early gestation ewes in March at Hamilton, Victoria

	February Lambs		March Ewes		
	Weight gain	Supplement intake	Weight gain	Pasture intake	Supplement intake
Perennial ryegrass silage only	35	0.82	-35	0.00	0.79
Plantain silage only	-1	0.70	-106	0.00	0.63
Lucerne silage only	10	0.68	-89	0.00	0.62
Perennial ryegrass silage with grain	119	1.08	37	0.01	0.97
Plantain silage with grain	92	1.02	18	0.00	0.92
Lucerne silage with grain	102	1.01	24	0.01	0.91
Grain only	176	1.10	78	0.07	0.99

Discussion

Statistics from Victoria's Feedtest laboratories (Feedtest. 2012) indicate that, in 2010/11, average nutritive values from grass silages were 46.5%DM, 13.0%CP, 66.8%*IV*DMD, 10.1 MJME/kgDM and 54.0%NDF, and for legume silages were 58%DM, 20.7%CP, 65.5%*IV*DMD, 9.9 MJME/kgDM and 54.0%NDF. The silage cut at Hamilton had nutritive values below these industry averages, especially the plantain, in terms of both digestibility and protein availability. There was a large degree of variation between the replicates in this research due to physical differences between the paddocks. Replicate 4 had slightly higher soil fertility and was located further down-slope than the other three replicates, which were located close together. This resulted in the better establishment and subsequent productivity of the replicate 4 swards. These differences were overcome to a degree by blocking by replicate in the statistical analysis.

Digestibility is the key determinant of livestock production from silage, with a 1% decrease in digestibility reducing DM intake by 50 g/day (Fitzgerald 1987). Under the tested conditions, silage supplements alone were insufficient to meet the nutrient requirements of ewes in early gestation grazing dead pastures, and low digestibility silages such as the plantain were also insufficient to meet the requirements of growing lambs. The provision of grain in the diet enabled liveweight gains, but these gains were lower than have been reported from previous studies using silage and grain rations, due to the low digestibility of the silages. For example, previous research has reported that lambs can achieve daily growth rates of 125 g/day on lucerne silage without a grain supplement if the silage has an ME content of 10 MJ/kg DM (Stanley 2003) and 167 g/day where a ration of oats and lupins was also provided (Hopkins et al. 1996). In south west Victoria, dry

pastures can be inherently low in CP during autumn and lucerne silage is a potential dietary source, though its ME content is below the requirements for growing lambs and ewes in early gestation.
The primary determinants of silage digestibility are harvest date and sward maturity at harvest. The low digestibility of the silage cut at Hamilton is most likely due to the December harvest date and long period of accumulation prior to cutting, resulting in the harvest of large quantities of senescent and lignified material. The optimal harvest date for first cut perennial ryegrass swards is at ear emergence. This achieves the optimum balance between pasture DM production and digestibility, with digestibility declining after ear mergence occurs (Jacobs et al. 1998; Keady et al. 2000). For late flowering cultivars of perennial ryegrass, such as Banquet II, ear emergence usually occurs in November or early December, depending on climatic conditions and prior grazing/defoliation management. For long stemmed species, such as lucerne, digestibility can be improved by minimising the amount of stem material harvested and by managing chop length, with a 1 cm decrease in chop length increasing DM intake by 56 g/day (Fitzgerald 1987).

Conclusion
This research suggests that perennial ryegrass, lucerne or plantain silage cut in December under the tested conditions resulted in the conservation of relatively low nutritive value feed. Modelling indicated that the silage had sufficient nutritive value to meet the maintenance requirements of weaned lambs, but not of ewes in early gestation. Lucerne silage provided a source of dietary protein. Further research is needed to determine the effects of earlier cutting times, especially for species like plantain.

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