Botanical composition of clover-grass silages affects milk yield in dairy cows

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Abstract

The botanical composition of clover-grass silage is said to affect nutritive value and nutrient degradation kinetics. But does the production response of the cow reflect the standard chemical analysis which underlies the determination of feed value, and the morphological differences between grasses and clover? This study aims to investigate the effect of clover-grass silages differing in botanical composition on feed intake and milk yield. A 4×4 Latin square was carried out with first-cut 2013 silages under controlled conditions. Silage based on perennial ryegrass with white clover gave the highest intake and energy-corrected milk (ECM) yield together with a tall fescue-based silage. The latter was surprising, given the general lower organic matter digestibility of tall fescue. Silage based on perennial and hybrid ryegrass with red and white clover produced the lowest intake and ECM. Unexpectedly, the measured variable which correlated best with the results was the content of red clover in the silages: intake and ECM decreased linearly with increasing content of red clover. This may, however, be confounded with effects of grass varieties among treatments. Results indicate that intake and production response may not be described solely by a standard chemical analysis of the silage, and that botanical effects have an effect on the cows.

Keywords: feed efficiency, forage, clover-grass mixtures, red clover

Introduction

High voluntary feed intake, which is of utmost importance for high milk yields, depends, among others, on the physical characteristics and the chemical composition of the forage. In broad terms the content of neutral detergent fibre (NDF) and NDF digestibility of the forage determines feed uptake and organic matter digestibility (OMD) of the formulated ration. It is well known that the digestion properties in the cow of the NDF fraction from forage grasses and legumes are different, and high intake and production potential of clover silages compared with grass silages are reported (Dewhurst *et al.,* 2003; Moorby *et al.,* 2009). However, in previous studies, silages from pure stands of grass and clover have often been prepared and then a graded proportion made on a dry matter (DM) basis. This does not directly apply to farming situations in normal practice, where clover-grass mixtures for silage often consist of many different grass and clover varieties. More knowledge on the botanical effects of clover-grass mixtures on feed intake, milk production, and biology of the cow is needed. The purpose of this investigation was to study the effect of clover grass silages based on 4 different grass mixtures on milk yield and milk composition, as well as feed intake, and seek to elucidate if there are differences between different clover-grass mixtures which cannot be determined by a standard chemical analysis.

Materials and methods

The investigation was based on a feeding trial which was carried out at the Danish Cattle Research Centre (DKC), Aarhus University. To include the variation normally found in clover-grass silage within a grass mixture, sixteen different lots of clover-grass silage based on 4 grass mixtures bought from Danish milk producers were transported to DKC and wrapped. All silages were of the 1st cut of 2013, and all were harvested within a time span of 1 week. The silage from each farmer was typically a mix of up to 3-year leys, but was dependent on a grass mixture. The silages were selected mainly on basis of OMD and DM, and needed to be generally well-fermented. The experimental design was an incomplete replicated 4×4 Latin square with 4 experimental periods of 21 days. 49 Danish Holstein cows in 4 groups according

to lactation number and lactation stage were randomly allocated to treatments. The treatments were clover-grass silage based on the 4 grass mixtures, all of which consisted of perennial ryegrass (PR) and white clover (WC) (Trt 35) but differed with the addition of hybrid ryegrass and red clover (RC) (Trt 42), Festulolium and RC (Trt 45), and tall fescue (Trt 36). These mixtures allows for some comparison to be made between different grass varieties and between red and white clover. Within each treatment, the 4 respective silages were fed to the cows in separate periods. The cows were fed a partial mixed ration (PMR) consisting of clover-grass silage, corn silage, rapeseed cake, soybean meal, barley (rolled), mineral and vitamin premix, and $CaCO_3$. The PMR fed to the cows alone differed in the type of clover-grass silage, which constituted 30% of the PMR on DM basis and was formulated to a crude protein minimum of 16.5% of DM. The forage-to-concentrate ratio was 70:30. The cows were offered 3 kg of concentrate per day in the milking robot. The MIXED procedure in SAS (version 9.3; SAS Institute Inc., Cary, NC, USA) was used for statistical analyses. Treatment, period, and square were described as fixed effects and cow within square and cow within period as random effects. DM intake and milk yield were analysed using the average from the last 7 days of the periods. Data are presented as LSMEANS ± residual errors of the means. Significance was declared at $P \leq 0.05$, and tendencies were considered at $0.05 < P \leq 0.10$. Differences between treatment means were examined using the PDIFF option of the LSMEANS statement. Correlations between relevant variables were made using the PROC CORR statement.

Results and discussion

The cows on Trt 35 and 36 tended to have increased PMR intake compared with cows on Trt 42 and 45 (Table 1). There was no difference in concentrate intake between treatments. The total DM intake turned out significantly lower with Trt 42 compared with Trt 35 and 36.

Similarly, Trt 42 and 45 produced lower milk yield compared with Trt 35 and 36 (Table 2) and Trt 42 alone produced lower energy-corrected milk (ECM) yield than Trt 35 and 36. Nevertheless, the differences in milk yield among treatments were modest. The response on milk yield could not be explained by differences in OMD between clover-grass mixtures as Trt 35 and 36 had the same milk yield but differed in OMD. Indeed, Trt 36 based on tall fescue (75% of grass seed mixture) had on average the lowest OMD (76.8±0.58) while Trt 35 had the highest OMD (79.6±0.78). The lower OMD with Trt 36 was no surprise as tall fescue generally has lower OMD than PR. The rather surprisingly higher milk yield with the tall fescue-based clover-grass silage may be partly related to the fact that the PMR was mixed well in a Cormall horizontal feed mixer for 45 minutes to ensure a homogenous ration and minimize feed sorting at the feeding table. One might speculate that this helped to increase the accessibility and surface area of cell walls for microbial attachment and enzyme activity. Trt 42 produced lower milk fat yield compared with the other treatments, while a tendency for a reduction in milk fat percentage was observed especially with Trt 35, but also with 42. The numerically lower milk fat percentage with Trt 35 may be a result of dilution by increased milk yield. Lower milk fat content with RC silage compared to grass

Table 1. Feed intake with 4 different clover grass mixtures in dairy cows.[1]

	Clover-grass mixture[2]				SEM	*P*-value
	Trt 35	Trt 36	Trt 42	Trt 45		
PMR, kg DM d^{-1}	21.2	21.3	20.8	20.8	0.25	0.08
Concentrate, kg DM d^{-1}	2.4	2.4	2.3	2.3	0.04	0.37
Total feed intake[3], kg DM d^{-1}	23.6^{ac}	23.7^{a}	23.1^{b}	23.2^{bc}	0.25	0.04

[1] PMR = partial mixed ration; DM = dry matter; SEM = standard error of the mean.

[2] Treatments: Trt 35 = perennial ryegrass (PR)-white clover (WC); Trt 36 = tall fescue-PR-WC; Trt 42 = PR-hybrid ryegrass-WC-red clover (RC); Trt 45 = Festulolium-PR-RC-WC.

[3] Values with different superscripts in the same row differ significantly ($P \leq 0.05$).

Table 2. Milk yield and composition, and feed efficiency with 4 different clover-grass mixtures in dairy cows.[1]

	Clover-grass mixture[2]				SEM	*P*-value
	Trt 35	Trt 36	Trt 42	Trt 45		
Yield[3]						
Milk, kg d^{-1}	38.5^{a}	38.3^{a}	37.6^{b}	37.8^{b}	0.7	0.05
ECM, kg d^{-1}	38.6^{a}	38.7^{a}	37.7^{b}	38.2^{ba}	0.6	<0.01
Fat, kg d^{-1}	1.53^{a}	1.54^{a}	1.49^{b}	1.53^{a}	0.03	<0.01
Protein, kg d^{-1}	1.32^{a}	1.31^{ab}	1.29^{b}	1.29^{b}	0.02	0.05
Composition						
Fat, %	3.99	4.07	4.01	4.08	0.06	0.07
Protein, %	3.45	3.44	3.47	3.44	0.03	0.20
Feed efficiency (kg ECM kg^{-1} DM)	1.65	1.64	1.64	1.66	0.02	0.83

[1] ECM = energy-corrected milk yield; DM = dry matter; SEM = standard error of the mean.

[2] Treatments: Trt 35 = perennial ryegrass (PR)-white clover (WC); Trt 36 = tall fescue-PR-WC; Trt 42 = PR-hybrid ryegrass-WC-red clover (RC); Trt 45 = Festulolium-PR-RC-WC.

[3] Values with different superscripts in the same row differ significantly ($P \leq 0.05$).

silage has been observed previously (Steinshamn, 2010) and this red clover effect may help to explain the reduced milk fat concentration with Trt 42. Surprisingly, it was found that the measured variable with best correlation to the milk yield response was the content of red clover in the clover-grass silages (determined by NIRS based on a red clover calibration under development at the authors' own lab). Hence, milk yield decreased linearly with increasing content of red clover. This may be confounded with effects of grass varieties among treatments. Nevertheless, milk fat concentration was not decreased with Trt 45. Milk protein yield was lower with Trt 42 and 45; however, not different from Trt 36. Differences however between treatments were small. Interestingly, feed efficiency (kg ECM kg^{-1} DM) did not differ between treatments.

Conclusions

The investigation showed that feed intake and production response of the cows could not be described solely by a standard chemical analysis of the clover-grass silage. The study indicates that botanical effects may be of importance for the cows, and points to the content of red clover relative to white clover and grasses in silage under farming conditions in practice, as a possible negative factor on feed intake and milk production. The results warrant further investigation.

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