Effects of forage and grain legume-based silages supplemented with faba bean seed or rapeseed expeller on milk production and composition in dairy cows

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Introduction

Forage legumes, such as red clover (RC; *Trifolium pratense*), have gained interest in grassland cultivation due to their ability to fix nitrogen and increase carbon sequestration in the soil. Grain legumes, such as faba bean (FB; *Vicia faba*), can be harvested both as seed and whole-crop silage. In Northern conditions this offers a possibility not only to include FB as a locally grown protein source in dairy cow diets but also to use it as a forage after an unfavourable growing season (Palmio et al., 2022). Use of legume feeds decrease the reliance on synthetic nitrogen fertilizers and imported protein concentrates, thereby improving the economics and sustainability of dairy farms (Stoddard et al., 2009). Inclusion of RC in dairy cow rations has shown to alter milk yield, composition and fatty acid profile compared with grass silage (Vanhatalo et al., 2009; Halmemies-Beacheut-Filleau et al., 2014). Faba bean seed has previously been studied as an alternative for rapeseed, but data is scarce and inconsistent. The objective of this experiment was to investigate the effect of forage type (RC vs. FB rich silages) and concentrate type (FB vs. rapeseed expeller; RE) on milk production and composition in dairy cows.

Materials and Methods

A total of eight multiparous Nordic Red cows were used in a replicated 4 × 4 Latin square experiment with a 2 × 2 factorial arrangement of treatments. Each experimental period lasted for three weeks. The experimental diets were: 1) RC–grass silage (RCG) with RE, i.e. RCG-RE treatment, 2) RCG with FB, i.e. RCG-FB treatment, 3) FB-rich silage (2/3 of FB and 1/3 of grass silage; FBG) with RE, i.e. FBG-RE treatment, and 4) FBG with FB, i.e. FBG-FB treatment. Inclusion rate of rapeseed expeller and FB was isonitrogenous. All diets included oats, barley and a mineral mix, and were fed ad libitum as TMR. The RCG silage was prepared from secondary growth of mixed RC (51%), grass (49% mix of timothy, meadow fescue, Italian ryegrasss) sward harvested at a late growth stage, wilted for 24 h and ensiled into round bales, and contained (DM-basis): 42.2% NDF and 13.5% CP. The FB silage was prepared from green FB crop when pods were mainly filled. It was wilted for 48 h and harvested into round bales, and contained (DM-basis): 43.7% NDF and 16.9% CP. The grass silage was first cut timothy-meadow fescue grass stored in a bunker silo, and contained (DM-basis): 51.6% NDF and 16.5% CP. All silages were preserved with a preservative AIV2 Plus Na targeted at 6 L/1000 kg. The composition of the experimental feeds is presented in Table 1. Dry matter intake and milk yield were recorded daily. Milk samples were analysed for milk fat, CP, lactose, and urea, and milk fatty acid composition.

Table 1 Chemical composition of feed ingredients used in the experimental diets

Item	Faba beansilage	Grass silage	Red clover-grass silage	Faba bean meal	Rapeseed expeller	Barley and oats mix
DM, %	27.8	28.4	32.0	85.5	89.8	86.3
Chemical composition, % of DM						
Ash	7.59	10.3	8.78	3.80	6.71	2.79
NDF	43.7	51.6	42.2	14.2	26.2	22.1
Starch	3.06	0.120	1.46	33.2	2.85	45.0
Crude fat	0.861	2.49	2.70	1.35	12.3	3.68
OM	92.4	89.7	91.2	96.2	93.3	97.2
CP	16.9	16.5	13.5	31.8	34.5	13.7

Results and Discussion

Overall, there were no interactions between forage and concentrate types. Dry matter intake did not differ across diets averaging 26.7 kg/d. Milk yield was greater for RCG vs. FBG silage (36.1 vs. 35.1 kg/d; P=0.05) and was lower for FB vs. RC (34.5 vs. 36.7 kg/d; P<0.001). Milk protein and milk urea concentrations (Figure 1) decreased (P<0.001) and milk fat concentration tended to decrease (P=0.09) for cows fed RCG compared with cows fed FBG. Milk urea concentration was increased (P<0.001; Figure 1) by FB vs. RE. Further, milk protein yield tended to be lower (P=0.08) for cows fed RCG vs. FBG and was lower (P=0.002) for FB vs. RE (Figure 2).

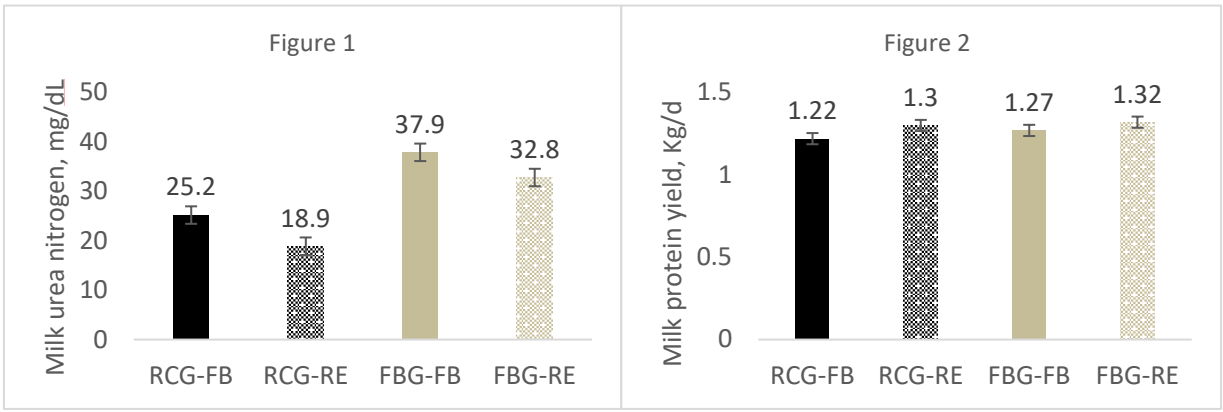

Figure 1 & 2 Milk urea nitrogen concentration (mg/dL) and milk protein yield (kg/d) in mid-lactation dairy cows receiving two types of forage (red clover-rich silage or faba bean-rich silage; RCG or FBG) and two types of protein concentrates (faba bean meal or rapeseed expller; FB or RE).

Of milk fatty acids (Table 2), short-chain fatty acids (SFA) were decreased by RCG vs. FBG and increased by FB vs. RE (P<0.001), whereas concentration of monounsaturated fatty acids (MUFA) was increased (P=0.04) by RCG vs. FBG, and lower (P<0.001) for FB vs. RE. In particular, 18:1n-9 concentration was lower (P<0.001) for FB vs. RE. Poly-unsaturated fatty acids were also greater (P<0.001) for RCG vs. FBG. Further, 18:2n-6 and 18:3n-3 were greater (P<0.001) for RCG vs. FBG, and 18:2n-6 greater whereas 18:3n-3 was lower (P≤0.05) for FB vs. RE. In addition, cis-9,trans-11 CLA was lower (P<0.001) for FB compared with RE.

Table 2. Effect of forage or concentrate type on milk fatty acid composition in mid-lactation cows

	Treatment					P-value		
Fatty acid	RCG-FB	RCG-RE	FBG-FB	FBG-RE	SEM	Forage type	Concentrate type	Interaction
SFA	78.1	72.7	79.6	73.8	0.66	<0.001	<0.001	0.54
MUFA	17.7	22.9	16.8	22.5	0.53	0.04	<0.001	0.34
PUFA	2.96	3.06	2.44	2.41	0.120	<0.001	0.42	0.10
18:1n-9	0.090	0.173	0.084	0.175	0.0064	0.43	<0.001	0.17
18:2n-6	1.51	1.47	1.36	1.26	0.059	<0.001	0.02	0.25
18:3n-3	0.719	0.769	0.396	0.403	0.0250	<0.001	0.05	0.11
cis-9trans,trans 11 CLA	0.268	0.366	0.251	0.346	0.0210	0.12	<0.001	0.87

Conclusions

Red clover silage resulted in greater milk yield compared with FBG, while RE resulted in greater milk and milk protein yields of the two protein concentrates. Milk fatty acid profile was altered by both forage and concentrate type, reflecting the differences in fatty acid content and composition of the different feeds. Red clover silage resulted in lower SFA concentrations and greater 18:2n-6 and 18:3n-3 concentrations compared with FBG. Furthermore, cows fed FB had a greater SFA and lower 18:1n-9 and cis-9,trans-11 CLA concentrations compared with cows fed RE.

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