PhytoMilk: Effects of botanical composition and harvest system of legume/grass silage on fatty acid, α-tocopherol and β-carotene concentration in organic forage and milk

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Abstract

Red clover and high proportion of forage in dairy cow diet increases the concentration of bioactive substances in milk, e.g. unsaturated fatty acids and antioxidants. In the present experiment twenty-four Swedish Red dairy cows were fed three silages in a Latin Square design to study the effect of silage botanical composition and harvest time on milk fatty acid, α-tocopherol and β-carotene concentration. The silages were red clover/grass silage (mixture of first and second cut), red clover/grass silage (mixture of first, second and third cut) and birdsfoot trefoil/grass silage (mixture of first and second cut). Botanical composition and harvest system affected silage vitamin and fatty acid concentration with higher concentrations of α-linolenic acid, α-tocopherol and β-carotene in red clover/grass silage (mixture of three harvests). Milk linoleic and α-linolenic acid concentration was higher with the two red clover diets but α-tocopherol, β-carotene and retinol concentration was not affected.

Introduction

Forages contain in general small amounts of lipids; the concentration of crude fat in e.g. timothy was 2.7 % of DM (Arvidsson et al., 2009). Despite this, forage give main contribution to the total intake of lipids in dairy cows. The fatty acid composition and concentration in forage varies with both species and harvest time (Van Ranst et al., 2009) and this affects dairy milk. Feeding red clover silage has given higher concentrations of n-3 fatty acids and other polyunsaturated fatty acids in milk compared to feeding white clover silage (Steinshamn & Thuen, 2008). With higher concentration of unsaturated fat in milk there is a need for more antioxidants (e.g. α-tocopherol, β-carotene) to reduce the oxidation of these

fatty acids (Al-Mabruk et al., 2004). The concentration of α-tocopherol and carotenoids in forage is affected by specie and harvest date and influences the concentration in dairy milk (Tramontano et al., 1993; Noziere et al., 2006).

The aim of this study is to investigate the effects of organic silage botanical composition and harvest system on forage and milk linoleic acid, α-linolenic acid, α-tocopherol and β-carotene concentration.

Material and methods

The effect of different legume silages on milk fatty acid, α-tocopherol and β-carotene concentration was studied in a feeding experiment at Röbäcksdalen Research Center, Swedish University of Agricultural Sciences, Umeå, Sweden (63°45'N, 20°17'E, 5 m altitude). Twenty-four multiparous Swedish Red dairy cows in mid lactation were used in a change-over design with three 3-weeks periods. Treatments were: (R2) red clover (*Trifolium pratense* L., Betty)/timothy (*Phleum pratense* L., Grindstad)/meadow fescue (*Festuca pratensis* Huds., Kasper) silage mixture of first and second cut with 42 % DM red clover; (R3) red clover/timothy/meadow fescue silage mixture of first, second and third cut with 38 % DM red clover; (B2) birdsfoot trefoil (*Lotus corniculatus* L., Oberhaunstaedter)/timothy silage mixture of first and second cut with 16 % DM birdsfoot trefoil. All cows were fed silage *ad libitum* and 6 kg concentrate/day fed separately (42 % rape seed cake, 35 % barley, 20 % peas, 1 % molasses and 2 % vitamins/minerals). The silages were prewilted and stored in bunker silos. Silage additive Proens® (formic acid (60-66 g/100g) and propionic acid (25-30 g/100g)) was added. Samples of forage were taken daily in the last week of each period and pooled together. Milk samples were taken during four consecutive milkings at the end of each period. Fatty acid concentration and composition were analyzed using GC and α-tocopherol, β-carotene and retinol concentrations were analyzed using HPLC.

Results and discussion

The statistical analysis is not yet completed and therefore only means and standard deviations are shown.

Table 1. Mean forage intake, milk yield and concentrations of linoleic acid, α-linolenic acid, α-tocopherol, β-carotene and retinol in forages and milk when feeding red

clover/grass silage mix of first and second harvest (R2), red clover/grass silage mix of first, second and third harvest (R3) and birdsfoot trefoil/grass silage mix of first and second harvest (B2).

		Diets					
		R2		R3		B2	
		mean	SD	mean	SD	Mean	SD
Forage	Intake (kg DM/day)	14.7	3.2	12.8	3.5	15.4	4.1
	Linoleic acid (g/kg DM)	3.91	0.29	4.19	0.18	4.18	0.09
	α-linolenic acid (g/kg DM)	9.68	0.83	12.14	0.80	8.12	0.13
	α-tocopherol (mg/kg DM)	22.4	2.4	37.2	4.1	20.2	2.8
	β-carotene (mg/kg DM)	31.0	6.6	49.4	3.1	28.1	0.9
Milk	Yield (kg ECM/day)	27.2	4.8	27.4	5.0	27.4	5.3
	Linoleic acid (g/kg milk)	0.72	0.10	0.72	0.11	0.66	0.11
	α -linolenic acid (g/kg milk)	0.28	0.05	0.29	0.05	0.20	0.04
	α-tocopherol (mg/kg milk)	1.57	0.38	1.60	0.42	1.63	0.35
	β-carotene (mg/kg milk)	0.31	0.07	0.30	0.07	0.28	0.07
	Retinol (mg/kg milk)	0.42	0.08	0.40	0.08	0.39	0.07

There was highest forage intake with diet B2 (table 1). The lower intake of R3 was not expected as early harvested forage gives higher DM intake than later (Vanhatalo et al., 2008). R3 had the highest concentration of α-linolenic acid, α-tocopherol and β-carotene indicating advantages with harvesting at an earlier stage of maturity. The concentration of α-linolenic acid in R3 was slightly higher than found in a similar study (Steinshamn & Thuen, 2008). The proportion of birdsfoot trefoil was 16 % in forage B2. A previous study have shown higher α-tocopherol and β-carotene concentrations in pure birdsfoot trefoil than in pure red clover (Danielsson et al., 2008). This was not seen in B2 although the concentration of α-tocopherol in general was higher in pure birdsfoot trefoil than in pure red clover (data not shown).

There was no difference in milk yield between diets. The milk concentration of linoleic and α-linolenic acid was lower in B2 than in R2 and R3 but the concentration of α-tocopherol, β-carotene and retinol did not differ. Due to the low proportion of birdsfoot trefoil in B2, linoleic and α-linolenic acid concentration in milk was more effected by timothy than by the legume. Grass silage lowers linoleic and α-linolenic acid concentration in comparison with red clover silages (Al-Mabruk et al., 2004; Vanhatalo et al., 2007).

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