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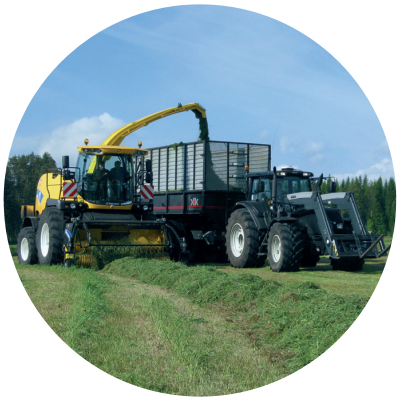

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Fatty acids composition of a variety of forages before and after ensiling

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Introduction There has been indications that dairy and beef products from grazing animals displayed improved long-chain fatty acids (LCFA) profile with regards to human's health than products that originate from animals fed with a diet with conserved forage or high-concentrate (Elgersma et al., 2004a; Fredriksson and Pickova 2007). However, the grazing season is limited, and the majority of the forage used in beef and milk production is consumed as preserved forage, mainly as silage. Since LCFA composition differs among forage crops, the aim of the study was to screen LCFA profile in forages commonly used in feeding of ruminants and monitor changes of LCFA during their ensiling process.

Material and methods Forages represented by rye-grass, meadow fescue, tall fescue, timothy, red and white clover, and bird's-food trefoil were manually harvested during the period 4-12 of June (first harvest). Forage crops were wilted in a drying cupboard at 25-27 °C to target dry matter (DM) level of approx. 350 g/kg. All crops were mechanically untreated. Samples were collected at the harvest time, after the wilting and at the end of ensiling period, and kept frozen at -18 °C. Wilting time for each forage crop was recorded. Forages were ensiled in black PVC silos without additive treatments for 120 days. Crude fat was extracted according to Lourenco et al. (2007). FA analyses were performed using gas chromatography as described by Apelqvist (1968). Fermentation profile of silage samples was determined in silage juice using HPLC.

Results and discussion Fermentation parameters indicated that clostridia activity in silages was very low. Concentrations of butyric acid, a typical marker of clostridia activity (Pahlow et al. 2003), were detected in trace amounts with the highest concentration of 2.3 g/kg dry matter (DM) in timothy silages. The average pH in all silages was found to be 5.2±0.4, with the lowest value in tall fescue silages 4.5±0.05. The LCFA profile and total fatty acids (FA) concentration of all forage crops during the ensiling process are demonstrated in Table 1. Grass forages, except timothy were found to have higher proportion of C18:3n-3 ($P<0.001$) but lower C18:2n-6 ($P<0.001$) than legumes. In contrast to the finding of Van Ranst et al. (2009), wilting of forages did not significantly reduce either the total FA content or proportions of C18:3n-3 and C18:2n-6, except in white clover (C18:3n-3) and bird's-food trefoil (C18:2n-6). Wilted meadow fescue, tall fescue, and timothy displayed even higher proportion of C18:3-n3 than in fresh crops. A possible explanation of the results can be fast wilting process in drying cupboard in the absence of light. Wilting time of forages did not exceed 24 hours, except for white clover and bird's-food trefoil (48 hours). The decrease in C18:3n-3 proportion ($P<0.001$) was, however observed in all silages, except for white clover. The proportion of C18:2n-6 in all grass silages was higher ($P<0.001$) in comparison with fresh and wilted forages. The effect of interaction between ensiling stage (wilting + ensiling) and forage type was demonstrated on C16:0, where proportion of C16:0 in grasses were lower ($P<0.001$) when wilted and ensiled, whereas the opposite trend was observed in legumes. Proportion of C18:0 in legumes followed the same trend ($P<0.001$) as C16:0. Furthermore, a significant effect of ensiling stage on reduction of C18:1cis-9 proportion in grasses was obtained.

Conclusions There were differences in LCFA profile prior and during ensiling process between grasses and legumes. Proportions of C18:3n-3 from total LCFA content in silages were lower than in fresh crops, except for timothy and tall fescue. Unexpectedly, the impact of wilting on reduction of total FA content and favourable C18:3n-3 was not observed which could be the result of fast wilting process in drying cupboard.

Table 1. Total fatty acid (FA) content and fatty acid composition in tested forages during ensiling process.

Forage	Ensiling stage	DM	C16:0	C18:0	C18:1 cis-9	C18:2 n-6	C18:3 n-3	Total FA
		g/kg	g/100g total FA					mg/g DM
Rye-grass	fresh	191	17.3[a]	1.4[b]	3.4[a]	12.7[b]	62.2[a]	14.7
Rye-grass	wilted	365	17.6[a]	1.6[a]	2.4[b]	11.9[b]	62.6[a]	13.0
Rye-grass	silage	349	16.4[b]	1.4[b]	2.0[b]	14.1[a]	60.7[b]	18.0
SEM			0.20	0.03	0.15	0.28	0.38	1.74
Meadow f.	fresh	191	17.6[a]	1.2[b]	3.5[a]	12.5[b]	62.9[b]	16.3
Meadow f.	wilted	385	16.5[b]	1.4[a]	2.4[b]	12.3[b]	64.3[a]	16.7
Meadow f.	silage	362	17.5[a]	1.1[b]	2.5[b]	14.3[a]	60.4[c]	17.3
SEM			0.15	0.03	0.07	0.14	0.28	2.57
Tall fescue	fresh	229	17.5[a]	1.5[ab]	5.6[a]	10.9[b]	61.8[c]	13.9[b]
Tall fescue	wilted	374	16.4[b]	1.6[a]	3.2[b]	10.1[b]	65.7[a]	13.4[b]
Tall fescue	silage	343	15.6[b]	1.2[b]	3.0[b]	12.4[a]	63.4[b]	17.4[a]
SEM			0.23	0.08	0.27	0.23	0.32	0.89
Timothy	fresh	261	17.4[a]	1.8	3.8[a]	19.6[b]	53.7[b]	11.6
Timothy	wilted	400	16.0[b]	1.9	2.9[b]	18.8[b]	56.6[a]	12.7
Timothy	silage	374	16.3[b]	1.7	3.1[b]	21.1[a]	52.0[b]	13.7
SEM			0.13	0.06	0.17	0.30	0.69	0.98
red clover	fresh	169	16.1[b]	2.2[b]	2.0	19.5	57.2[a]	19.8
red clover	wilted	346	17.7[a]	2.7[a]	1.7	18.0	56.2[a]	16.1
red clover	silage	311	17.7[a]	2.7[a]	2.1	19.3	52.8[b]	17.2
SEM			0.16	0.08	0.34	0.45	0.86	0.93
white clover	fresh	165	16.7[b]	2.2[b]	3.1[a]	16.7	57.3[a]	14.7[a]
white clover	wilted	462	19.7[a]	3.0[a]	2.8[ab]	16.8	52.2[b]	10.0[b]
white clover	silage	447	19.3[a]	2.8[a]	2.8[b]	16.6	51.9[b]	15.0[a]
SEM			0.17	0.05	0.09	0.34	0.46	0.21
Bird's-food	fresh	179	16.7[b]	1.7[b]	1.5	17.7[a]	58.0[a]	16.2
Bird's-food	wilted	535	16.5[b]	1.8[b]	1.3	16.3[b]	59.0[a]	15.0
Bird's-food	silage	521	18.9[a]	1.9[a]	1.4	17.3[a]	53.8[b]	16.6
SEM			0.16	0.06	0.11	0.11	0.30	1.79
Probability	Forage		***	***	***	***	***	***
	Stage		**	***	***	***	***	***
	Int.		***	***	***	***	***	NS

[a,b,c] Significant (P<0.05) differences within forages and between ensiling stage; *, ** and *** at P<0.05, P<0.01 and P<0.001, respectively.; NS – not significant; FA – fatty acids; DM – dry matter.

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