Perennial ryegrasses bred for contrasting sugar contents: manipulating fermentation and aerobic stability using wilting and additives (1) (EU FP V -Project 'SweetGrass')

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Introduction Higher concentrations of water-soluble carbohydrate (WSC) in silage offer ruminant nutrition and environmental attractions. Both successful field wilting and alternative silage additives provide the opportunity to manipulate silage WSC by modifying fermentation and/or improving aerobic stability. This experiment evaluated the fermentation and aerobic stability of silages made from perennial ryegrass cultivars of high or normal WSC genotype that differed in field wilting or additive use.

Materials and methods Aberdart (Ab; bred for high WSC) and Fennema (Fn; normal WSC) perennial ryegrasses were mown on 19 September 2002. Each was precision-chopped and ensiled in laboratory silos (6 kg) after a 0 or 24 h wilt. The additives applied to grass for three silos per treatment were (1) no additive, (2) Add-SafeR (85% ammonium tetraformate salt; Trouw Nutrition UK Ltd.) at 6 ml/kg, (3) *Lactobacillus buchneri, L. plantarum* and *Enterococcus faecium* (Pioneer Hi-Bred) at 3 ml/kg, (4) Powerstart (*L. plantarum* and *Lactococcus lactis;* Genus plc) at 3 ml/kg, (5) and (6) Kofasil Ultra (80 g hexamine, 120 g sodium nitrite, 150 g sodium benzoate, 50 g sodium propionate and 600 g water/kg; Addcon Agrar GmbH) at 2.5 or 5 ml/kg, (7) treatments 4 + 5, and (8) treatments 4 + 6. Silos were filled, sealed and stored (15^{0}C) for >100 d. Silage composition (n=3/treatment) and aerobic stability (n=2/treatment) measurements were made and the results subjected to 3-way analysis of variance.

Results Mean (s.d.) grass WSC and buffering capacity for unwilted and wilted Ab were 172 (6.1) and 178 (11.0) g/kg dry matter (DM) and 374 (22.8) and 364 (23.1) mEq/kg DM, respectively, with corresponding values for Fn of 158 (11.8) and 186 (5.7) g/kg DM and 379 (7.2) and 386 (7.6) mEq/kg DM. Unwilted and wilted silage DM values were 152 and 199 (s.e. 0.5; P<0.001) g/kg, respectively, and cultivar had no significant (P>0.05) effect. Wilting increased lactic acid/fermentation products (Table 1). Fn had a more lactic acid fermentation than Ab. Formic acid promoted the dominance of lactic acid in the unwilted silages and restricted fermentation in the wilted silages (reduced fermentation products; P<0.001). Except for unwilted Ab, the *L.buchneri* additive reduced (P<0.001) lactic acid and increased (P<0.05) acetic acid and ethanol. Powerstart increased lactic acid/fermentation products. Kofasil Ultra promoted a more lactic acid fermentation with unwilted Ab but had minor effect with wilted herbage. Little additivity occurred when Powerstart and Kofasil Ultra were co-applied. Unwilted silages were very stable when exposed to air. Powerstart increased susceptibility to aerobic deterioration while Add-SafeR, *L.buchneri* and Kofasil Ultra (high) improved stability with wilted silages.

Table 1 Chemical composition and aerobic stability of silages

Additive (A)		1		2		3		4		5		6		7		8			Significance		
Cultivar (C)		Ab	Fn	Ab	Fn	Ab	Fn	Ab	Fn	Ab	Fn	Ab	Fn	Ab	Fn	Ab	Fn	sem	C	A	CxA
pH	U[4]	4.6	4.2	3.7	3.8	4.5	4.5	3.8	4.0	4.4	4.6	4.1	4.2	3.8	4.1	4.0	4.1	0.05	0.08	***	***
	W[5]	4.2	4.0	4.0	4.1	4.5	4.3	3.8	3.9	4.1	4.1	4.2	4.2	3.9	4.0	4.1	4.2				
Lactic acid	U	243	605	755	760	278	75	762	737	382	374	547	537	819	686	854	837	19.0	**	***	***
(g/kg FP[1])	W	594	771	667	700	291	512	825	825	646	730	559	636	832	829	843	783				
NH_3N	U	88	80	100	107	84	143	60	74	94	111	88	96	59	85	67	72	2.8	**	***	***
(g/kg N)	W	109	76	105	99	106	78	51	58	93	78	90	83	60	70	67	70				
Butyric acid	U	0	0	0	0	0	0.5	0.5	1.0	0	0	1.9	10.0	0	1.4	0	0	1.07	**	***	0.06
(g/kg DM)	W	10.7	0.5	1.1	0	11.8	3.6	1.0	0	5.5	0	8.1	0	0.4	0	0	1.1				
Duration to	U	192	192	192	192	192	192	56	135	192	186	192	192	43	43	57	57	2.6	***	***	***
temp. rise[2]	W	96	88	192	192	192	192	55	61	192	109	192	192	66	81	192	192				
ATR to d5[3]	U	3	1	2	1	3	2	30	1	2	2	2	2	33	1	17	1	1.3	***	***	***
	W	12	11	2	1	3	3	46	25	1	6	2	1	26	11	2	1				

[1]FP=fermentation products (lactic+VFA+ethanol); [2]hours; [3]accumulated temp. rise to day 5 (^{0}C); [4]unwilt; [5]wilt; sem = CxA

Conclusions Cultivar had minor effects on ensilability indices, but Fn silages were better preserved. The partial wilt generally promoted a more efficient fermentation but poorer aerobic stability. The most consistent improvement in dominance by lactic acid was from Add-SafeR and Powerstart, but Powerstart silages were prone to aerobic deterioration. Add-SafeR, *L.buchneri* and Kofasil Ultra (high) improved aerobic stability with wilted silages.