Additive type affects dry matter losses, fermentation pattern, aerobic stability and clostridia counts of baled red clover-grass silage

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Introduction Silage quality may be impaired by the growth of undesired spoilage micro-organisms, e.g. clostridia, yeasts and moulds. As reviewed in detail by Kung *et al*. (2003), homofermentative lactic acid bacteria (LAB_{ho}) inoculants are known to improve fermentation by suppressing clostridia by rapidly decreasing pH. However, they frequently increase susceptibility to heating by fungi if silages are exposed to air during feed-out. Heterofermentative lactic acid bacteria (LAB_{he}) products of the *Lactobacillus buchneri*-type as well as antimycotic chemicals (e.g. sodium benzoate, potassium sorbate) are used to enhance aerobic stability. The combination of either of those two additive types with LAB_{ho} aims at concurrently improving the fermentation process and the aerobic stability (AS) of silage (Auerbach *et al*., 2013). As most silage trials are conducted using laboratory silos, the aim of this study was to compare the effects of different additive types regarding the quality of red clover-grass silages produced in big round bales.

Material and methods A third cut red clover-grass ley (75%/25%) was mown on September 4, 2011 in Skara, south-west Sweden, wilted to 30-35% dry matter (DM), chopped and ensiled in big round bales by a stationary baler (Orkel MP 2000). The wilted herbage contained (DM based): 9.9% ash, 15.8% CP, 9.6% water-soluble carbohydrates (WSC) and 44.2% NDF. The following additives, produced by ADDCON EUROPE GmbH, were applied on the chopper: KOFASIL LAC (KLAC) containing LAB_{ho} (*Lactobacillus plantarum* DSM 3676, DSM 3677), inoculation rate (IR): $1x10^5$ cfu/g; KOFASIL S (KS), containing LAB_{he} (*Lactobacillus buchneri* DSM 13573), IR: $1x10^5$ cfu/g; KOFASIL DUO (KDUO), combination of KLAC and KS, IR: $2x10^5$ cfu/g, KOFASIL COMBI (KCOM), combination of KLAC (IR: $1x10^5$ cfu/g) and a mixture of sodium benzoate and potassium sorbate (270 g/t). All additives were compared with an untreated control (CON). Five replicate bales per treatment were produced and stored outside for 121 days. Samples from individual bales were taken by drilling and subjected to analysis for pH and ammonia-N, lactate (HPLC), volatile acids and alcohols (GC), WSC (anthrone method) and clostridia (MPN method). The DM losses were calculated according to Weissbach (2005). The AS was measured by the temperature method and silages considered unstable if its temperature had increased by 3 °C above ambient. Data were statistically evaluated by using PROC GLM of SAS, version 9.3. When a significant *F*-test was detected (P<0.05), a pair-wise comparison between LSMEANS was performed by employing the Tukey´s test (P<0.05).

Results and discussion With the exception of AS, which was high across treatments (>11 days), an overall treatment effect was detected for all variables (Table 1). Silages of the treatments KLAC, KDUO and KCOM showed lower DM losses and higher WSC concentrations than that of CON, indicating a more efficient fermentation process. This was reflected by lower pH and ammonia levels as well as higher lactate contents. Concentrations of butyric and propionic acids and of all measured alcohols were low in CON but were further reduced by inoculants containing LAB_{ho}. Clostridia growth was inhibited by treatments KLAC and KDUO when compared with CON. The sole use of LAB_{he} in KS resulted in the typical fermentation pattern of *Lactobacillus buchneri*, which is characterized by anaerobic lactate degradation to acetic acid and 1,2-propanediol, resulting in higher DM losses. Obviously, this inoculant type was not capable of improving the fermentation process of the red clover-dominated ley. The beneficial effects of all LAB_{ho}-containing additives on silage quality can very likely be attributed to a faster acidification rate during the initial phases of fermentation than was observed in untreated silage. This parameter was measured in laboratory silos, which were filled with the same material that was used in the bales. On the contrary, the effect of LAB_{he} on pH after 3 days of fermentation was only marginal (KLAC: 4.43 *vs*. KDUO: 4.49 *vs*. KCOM: 4.47 *vs*. KS 4.87 *vs*. CON: 5.13).

Table 1 Effects of additive type on DM losses, fermentation pattern, aerobic stability and clostridia counts in red clover-grass silage (n=5 bales per treatment).

Parameter	CON[1]	KLAC[1]	KS[1]	KDUO[1]	KCOM[1]	SEM	*P*-value
DM loss (%)	4.8^{ab}	3.3^{c}	5.7^{a}	3.5^{c}	3.8^{bc}	2.51	<0.0001
WSC[2]	4.9^{d}	8.7^{b}	3.9^{d}	6.9^{c}	11.8^{a}	0.27	<0.0001
pH	4.48^{b}	4.27^{c}	4.76^{a}	4.28^{c}	4.22^{c}	0.021	<0.0001
Ammonia-N (% total N)	10.7^{a}	8.1^{b}	11.3^{a}	8.1^{a}	8.3^{a}	0.21	<0.0001
Lactic acid[2]	77.4^{b}	102.7^{a}	57.7^{c}	105.1^{a}	104.8^{a}	1.78	<0.0001
Acetic acid[2]	24.4^{b}	16.4^{cd}	31.1^{a}	19.7^{bc}	13.6^{d}	1.25	<0.0001
Butyric acid[2]	3.4^{b}	0.3^{c}	6.1^{a}	0.4^{c}	0.1^{c}	0.40	<0.0001
Propionic acid[2]	1.1^{b}	0^{c}	2.1^{a}	0.1^{c}	0^{c}	0.08	<0.0001
Ethanol[2]	5.2^{b}	2.5^{c}	7.5^{a}	2.8^{c}	2.1^{c}	0.25	<0.0001
n-Propanol[2]	1.8^{b}	0^{c}	3.6^{a}	0.2^{c}	0^{c}	0.11	<0.0001
1,2-Propanediol[2]	1.7^{b}	0.6^{b}	4.5^{a}	1.1^{c}	0.6^{b}	0.28	<0.0001
Aerobic stability (days)	13.4	11.4	13.3	12.2	13.5	0.55	0.06
Clostridia (lg MPN/g)	4.6^{ab}	1.8^{c}	4.9^{a}	1.7^{c}	2.6^{bc}	0.53	<0.001

[1]for description see Material and methods, [2]g/kg DM, [a-d]LSMEANS in rows bearing unlike superscripts differ ($P<0.05$)

Conclusions Only the use of additives containing LAB_{ho} alone or in combination with LAB_{he} and antimycotic substances, respectively, concurrently improved fermentation and ensured high aerobic stability. Consequently, those additives can be recommended for red clover-dominated silages, in which clostridia growth accompanied with poor fermentation quality is to be expected.

References

Auerbach, H., P. Theobald, K. Weiss and E. Nadeau. 2013. Effect of inoculant type on dry matter losses, fermentation pattern, yeast count and aerobic stability of green rye silages. In: 12. BOKU-Symposium Tierernährung. Mair, C., M. Kraft, W. Wetscherek and K. Schedle (Eds), 179-185.

Kung, L.Jr., M.R. Strokes and C.J. Lin. 2003. Silage additives. In: Silage Science and Technology. Buxton D.R., R.E. Muck and J.H. Harrison (Eds), 305-360.

Weissbach, F. 2005. A simple method for the correction of fermentation losses measured in laboratory silos. In: Silage production and utilisation. Park, R.S. and M.D. Stronge (Eds), 278.