Effects of *Lactobacillus buchneri* DSM 13573 on the fermentation and the aerobic stability of silages as affected by inoculation rate

C. Kalzendorf[1] and H. Auerbach[2]

[1]Chamber of Agriculture Lower Saxony, 26121 Oldenburg, Germany, Email: christine.kalzendorf@lwk-niedersachsen.de, [2]ADDCON EUROPE GmbH, 06749 Bitterfeld-Wolfen, Germany, Email: horst.auerbach@addcon.com

Introduction In order to improve aerobic stability of silages, heterofermentative lactic acid bacteria inoculants of the *Lactobacillus buchneri* (LB)-type have been widely used. However, there have been discussions about the least required inoculation rate (IR). Positive effects of increased IR have been observed by Kleinschmidt and Kung (2006), but some of the LB strains, which are used in commercial inoculants across the world, were not included in the analysis. Therefore, the aim of this study was to test specifically the effects of *Lactobacillus buchneri* DSM 13573 on the fermentation and the aerobic stability of different silage types.

Material and methods A total of six ensiling experiments was conducted from 2006 to 2009, using different forages, which were ensiled 1.5 L glass jars (n=3 per treatment) and stored at 20 °C. Details on dry matter (DM) of the ensiled forages, IR of *Lactobacillus buchneri* DSM 13573 and ensiling conditions are summarized in table 1. Silage fermentation pattern was analyzed by HPLC (lactic acid) and GC (volatile organic acids, alcohols). Losses of DM were calculated according to Weissbach (2005). Aerobic stability (ASTA) was measured by the temperature method, and silage was considered unstable if its temperature had increased by 2 K above ambient. The ASTA testing period was set at 10 days for trials 1, 2, 5, 6 and at 7 days for trials 3 and 4. Statistical analyses by ANOVA were performed by employing the PROC MIXED of SAS, version 9.2. Significant differences were declared at $P<0.05$, and pair-wise comparisons between least square means were performed by using the Tukey´s test.

Table 1 Forage types, DM level, IR and ensiling conditions used in the lab-scale trial series.

Trial no	Forage type	DM (%)	IR (cfu/g forage) LB1	IR (cfu/g forage) LB2	Ensiling conditions
1	Whole-crop maize	38.0	$1x10^5$	$5x10^5$	60 days fermentation, no air ingress
2	Whole-crop maize	45.1	$1x10^5$	$5x10^5$	90 days fermentation, no air ingress
3	High-moisture corn	61.6	$1x10^5$	$4x10^5$	49 days fermentation, air ingress for
4	High moisture corn	63.6	$1x10^5$	$4x10^5$	on day 28 and 42
5	Natural grassland	40.6	$1x10^5$	$5x10^5$	109 days fermentation, air ingress for 1 day on day 102
6	Ryegrass	39.2	$1x10^5$	$5x10^5$	107 days fermentation, air ingress for 1 day on day 100

Results and discussion Significant interactions were observed between trial and treatment for all variables (table 2). This may be explained by the use of different types of forages and varying ensiling conditions. Lower lactate and higher acetate concentrations that are normally associated with the use of LB were not found in the two maize trials. In all other trials, acetate contents were increased by inoculation, but only in the high-moisture corn experiments a dose-dependent effect on this parameter was detected. Application of LB consistently increased the concentration of 1,2-propanediol, the co-product of anaerobic lactate degradation by LB. This finding clearly confirmed the activity of the added LB. Most importantly, ASTA was improved by LB treatment across all silage types, and inoculation rate did not affect ASTA in any of the trials.

Table 2 Effects of *L. buchneri* DSM 13573 on DM losses, fermentation and aerobic stability.

Trial	Treatment	DML[1] (%)	pH	Lactate (g/kg DM)	Acetate	Ethanol	1,2-PD[2]	ASTA[3] (days)
1	Control	10.4^{aBC}	3.64^{aA}	53.0^{aC}	10.3^{aC}	20.8^{aE}	0^{aA}	3.8^{a}
	LB1[4]	5.5^{aABC}	3.67^{aA}	50.5^{aD}	10.8^{aB}	25.1^{aD}	2.0^{bA}	10.0^{b}
	LB2[5]	5.4^{aABC}	3.67^{aA}	54.0^{aC}	11.1^{aB}	24.6^{aD}	2.7^{cAB}	10.0^{b}
2	Control	7.2^{bC}	3.84^{aB}	33.1^{aB}	5.8^{aB}	8.2^{aD}	0^{aA}	6.9^{a}
	LB1[4]	4.2^{aA}	3.85^{aB}	47.3^{bD}	7.3^{aA}	8.2^{aC}	1.5^{bA}	10.0^{b}
	LB2[5]	4.3^{aA}	3.89^{bB}	36.5^{aB}	8.0^{aA}	8.3^{aC}	2.2^{cA}	10.0^{b}
3	Control	3.5^{aA}	3.98^{aC}	23.2^{baA}	2.1^{aA}	2.4^{aA}	0^{aA}	1.0^{a}
	LB1[4]	3.7^{aA}	4.05^{aCD}	12.0^{aA}	6.6^{bA}	2.3^{aA}	1.1^{aA}	6.3^{b}
	LB2[6]	3.7^{aA}	4.01^{aBCD}	13.2^{aA}	8.9^{cA}	2.3^{aA}	3.8^{bB}	7.0^{b}
4	Control	3.6^{aA}	4.03^{aC}	19.2^{bA}	2.3^{aA}	3.0^{aAB}	0^{aA}	1.8^{a}
	LB1[4]	3.6^{aA}	4.03^{aC}	21.5^{bB}	6.6^{bA}	2.5^{aA}	1.8^{bA}	7.0^{b}
	LB2[6]	3.7^{aA}	4.04^{aC}	11.1^{aA}	7.6^{cA}	2.5^{aA}	2.2^{bA}	7.0^{b}
5	Control	6.6^{aC}	4.53^{bD}	38.7^{aB}	16.6^{aCD}	4.0^{aBC}	1.5^{aB}	2.7^{a}
	LB1[4]	7.4^{bC}	4.39^{aE}	32.2^{aC}	36.3^{bD}	5.8^{bB}	15.8^{bC}	10.0^{b}
	LB2[5]	7.7^{bC}	4.40^{aE}	29.9^{aB}	34.3^{bC}	6.2^{bB}	15.8^{bD}	10.0^{b}
6	Control	5.7^{aB}	4.09^{aC}	53.9^{bC}	19.1^{aD}	4.7^{aC}	0^{aAB}	2.3^{a}
	LB1[4]	6.5^{bB}	4.11^{bD}	31.8^{aC}	28.7^{bC}	6.9^{bBC}	10.5^{bB}	10.0^{b}
	LB2[5]	6.7^{cB}	4.17^{cD}	32.1^{aB}	29.7^{bC}	5.7^{abB}	13.1^{cC}	10.0^{b}
Significance level (ANOVA F test)								
Trial (n=6)		***	***	***	***	***	***	-
Treatment (n=18)		*	*NS*	***	***	*NS*	***	***
Trial x Treatment		***	***	***	***	**	***	-

[1]dry matter losses; [2]1,2-propanediol; [3]aerobic stability; [4]IR:100,000 cfu/g; [5]IR: 400,000 cfu/g; [6]IR: 500,000 cfu/g; - due to different periods for aerobic stability testing only one-way ANOVA performed; LSMEANS in columns bearing unlike superscripts within experiment and capital superscripts within treatments differ (Tukey´s test), $*P<0.05$, $**P<0.01$; $***P<0.001$, *NS* not significant,

Conclusions *Lactobacillus buchneri* DSM 13573 consistently improved aerobic stability of different types of silages. There was no additional benefit in terms of efficacy in using higher inoculation rates than $1x10^5$ cfu/g fresh forage, which is recommended by the manufacturer.

References

Kleinschmidt, D.H. and L. Kung, Jr. 2006. A meta-analysis of the effects of *Lactobacillus buchneri* on the fermentation and the aerobic stability of corn and grass and small-grain silages. J. Dairy Sci. 89:4005-4013.

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.