EFFECTS OF APPLIED LACTIC ACID BACTERIA (LAB) ON FERMENTATION QUALITY OF GRASS SILAGES FROM AUSTRIAN DAIRY FARMS

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Abstract

Silage additives were evaluated using 600 Austrian grass silage samples from the LK Silage Project 2024. Homofermentative Lactic Acid Bacteria (LAB) improved fermentation by increasing lactic acid and reducing butyric acid and dry matter losses, while heterofermentative LAB increased acetic acid and aerobic stability. Economic evaluation showed that homofermentative LAB significantly reduced nutrient losses, highlighting the practical value of LAB additives in grass silage production.

Keywords: silage quality, fermentation losses, butyric acid, aerobic stability

INTRODUCTION

Ensiling of forage is a practical challenge to preserve the nutrients quantitatively and qualitatively for a longer period by inactivating microbial and feed-specific enzymes, i.e. to limit the decomposition processes to an unavoidable or desirable extent (Steinhöfel *et al.*, 2023). According to Zhang *et al.* (2023), the application of homofermentative Lactic Acid Bacteria (LAB-homo), like *L. plantarum*, improves the fermentation process, while heterofermentative Species (LAB-hetero, i.e. *L. buchneri*) increase aerobic stability (ASTA) after the silo is opened (Kung *et al.*, 2018). At Austrian dairy farms, the average amount of butyric acid (BA) of first cut grass silages is above 12 g/kg DM (SD = 10 g/kg DM) in the past ten years, due to low nitrate and too high clostridia-level in fresh grass (Resch, 2025). In the Austrian 'LK Silage Projects', a trend toward increased use of LAB silage additives was observed between 2003 and 2024. In the following evaluations, the fermentation success of the LAB treatment is assessed on the basis of the BA content and the formation of acetic acid (AA) or 1,2-Propanediol (1,2-PD) due to the activity of LAB-homo and LAB-hetero or a mixture of both types (LAB-Mix homo/hetero). In addition, the economic impact of successful LAB-homo fermentation is calculated, based on the results of the precise silage trial S-81 (Resch *et al.*, 2025), using the example of a dairy farm to illustrate the economic significance of LAB application in practice.

MATERIAL AND METHODS

In 'LK Silage Project 2024', a total of 600 grass silage samples were taken from trained persons across Austria, mainly from dairy farms. Determination of DM, nutrients, pH-value and volatile organic compounds (VOC) was performed with wet chemistry methods (VDLUFA, 2012) at the Rosenau feed laboratory in lower Austria. DM and nutrient correction of the silages was carried out by calculations of Weißbach and Kuhla (1995). Data of silage management, especially the application of silage additives was surveyed in detail using a questionnaire covering product information, dosing methods and application details (Resch, 2025). The calculation of losses due to ensiling (DM, Protein, Energy) is based on the test results of Resch *et al.* (2025) and the balancing method of Köhler *et al.* (2019). The protein loss in the silage was determined by subtracting of the mass of NH_3-N from total N, as NH_3-N is formed during N-degradation. Statistical analysis was carried out by procedure GLM (Statgraphics Centurion XVII). The mean differences were evaluated using the Tukey-HSD method and a confidence level of 95%.

RESULTS AND DISCUSSION

In 2024, 34% of analysed grass silages were treated with additives to improve silage quality. The majority (31%) was treated with LAB. However, only 3% of them got chemical ingredients. The following fermentation quality results of grass silages in table 1 refer to GLM-adjusted mean values for Dry Matter (DM), aNDFom and crude ash (CA). In comparison to untreated grass silage (CON), application of LAB effectively lowered the pH value and reduced the BA content, especially LAB-homo. Chemical ingredients had no statistical influence on BA-reduction. There was no significant effect of additives on formation of lactic acid (LA), but LAB-homo increased LA up to 70 g/kg DM. Treatment with LAB-hetero significantly increased acetic acid (AA) to 22 g/kg DM. According to Kung *et al.* (2018), aerobic stability (ASTA) is improved by an increase in AA with LAB-hetero. The formation of 1,2-PD > 5 g/kg DM confirms sufficient activity of *L. buchneri* via LAB-hetero or LAB-Mix (homo/hetero). In silage treated with LAB-homo, AA and 1,2-PD were lower than in CON and LA/AA ratio was

Tab. 1: Effect of different silage additives on fermentation parameters of grass silage

forage treatment	samples		pH	LA	AA	PA	1,2-PD	BA	ETH	NH_3-N	WSC
	n	%		g	g	g	g	g	g	%	g
no additive (CON)	396	66.0	4.48^{b}	56.8^{a}	12.7^{a}	0.4^{a}	2.2^{a}	7.8^{b}	6.8^{a}	6.0^{b}	63.8^{b}
LAB-homo	28	4.7	4.27^{a}	70.0^{a}	9.8^{a}	0.3^{a}	1.9^{ab}	1.6^{a}	5.5^{a}	5.3^{ab}	55.8^{ab}
LAB-hetero	50	8.3	4.30^{a}	62.4^{a}	22.1^{b}	0.6^{a}	11.8^{c}	4.2^{ab}	6.3^{a}	6.2^{ab}	39.7^{a}
LAB-Mix (homo/ hetero)	107	17.8	4.34^{a}	59.5^{a}	14.1^{a}	0.3^{a}	6.3^{b}	3.7^{a}	5.6^{a}	5.1^{a}	50.4^{a}
chemical additive	19	3.2	4.38^{ab}	60.5^{a}	12.9^{ab}	0.5^{a}	2.6^{ab}	9.9^{ab}	12.6^{a}	6.0^{ab}	49.7^{ab}

Abbreviations: pH (pH-value), LA (lactic acid), AA (acetic acid), PA (propionic acid), 1,2-PD (1,2-Propanediol), BA (butyric acid), ETH (Ethanol), NH_3-N (Ammonia-N in % of total N), WSC (Water soluble carbohydrates)

GLM–adjusted means: DM = 378 g/kg FM; aNDFom = 414 g/kg DM; CA = 100 g/kg DM. Means with different superscript letters (a, b, ab) within a column differ significantly ($P < 0.05$).

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above 3.0, so ASTA tends to decrease. N-Degradation to ammonia-N was reduced by LAB-Mix and we observed no effect of additives on ethanol content. With regard to water soluble carbohydrates (WSC), LAB-hetero significantly decreased WSC.

In silage trial S-81(Resch *et al*., 2025), LAB-homo reduced DM losses in wet grass silage (23.7% DM) during ensiling by 6.8% compared to CON (11.7%). Applied to an example on an agricultural scale with a harvest yield of 100 tons of dry matter, this corresponds to a gain of 6,800 kg of silage dry matter through the use of LAB-homo. This benefit of LAB-homo corresponds to the harvest yield of approx. 2.3 hectares of grassland forage or 680 feeding days for dairy cows with a daily grass silage DM intake of 10 kg DM/cow per day. In this trial, energy losses (ME) were reduced by 8.7% and protein quality losses by as much as 14% compared to CON, demonstrating that the use of LAB-homo can also be highly successful in terms of feed value.

CONCLUSION

In the application of LAB for grass silage, two successful effects have emerged in the 'LK Silage Project 2024' under practical conditions in Austria. On the one hand, LAB-homo improved lactic acid formation and the fermentation process, so that on average it was possible to reduce BA-formation significantly and thus also DM losses. The downside of this application is a tendency toward poorer ASTA. On the other hand, heterofermentative LAB (*L. buchneri*, etc.) were also able to reduce BA formation. However, this required more energy in the form of WSC. Nevertheless, LAB-hetero resulted in increased AA levels and thus improved ASTA, which is particularly necessary at higher air temperatures and deficits in compaction, as well as low feed consumption at the silo face. For farmers who cannot clearly decide between the two possibilities, LAB-MIX (homo/hetero) additives represent an alternative, but those are often less successful in terms of fermentation and ASTA effects.

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