CAN A BIOLOGICAL SILAGE INOCULANT PRESERVE HIGH-MOISTURE HAY?

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Introduction

Successful hay production relies on dry weather to achieve a target moisture content below 15%, which helps minimize the risk of fire. Certain strains of lactic acid bacteria possess the ability to utilize oxygen during the initial aerobic phase of ensiling (Hindrichsen et al., 2012). Applying these strains in combination with heterofermentative lactic acid bacteria to high-moisture hay can generate anaerobic conditions in the core of the bale, promoting anaerobic fermentation. Meanwhile, the surface of the bales can naturally dry during storage.

Objectives

The objective of the study was to investigate the effects of a commercial silage inoculant containing a combination of oxygen-scavenging lactic acid bacteria (LAB) *Lactococcus lactis* and heterofermentative *Lentilactobacillus buchneri*, and a commercial chemical feed additive separately on the fermentation and hygienic quality of high-moisture grass hay prepared in large round bales.

Materials and methods

The grass was harvested at the flowering stage and wilted to a dry matter content (DM) of 67.7-77.1%. It was chopped to a theoretical particle length of 4.5 cm and harvested into round big bales with a diameter of 1.2 m, using a round baler set to the highest possible pressure. Five bales were prepared for each treatment group. The control bales (CON) remained untreated, while the inoculated bales (FC) were treated with SiloSolve® FC (Novonesis, Lyngby, Denmark) in a dosage of 200,000 total colony-forming units (CFU) per gram of forage including *L. buchneri* (DSM22501) and *Lactococcus lactis* (DSM11037). The CHEM bales were treated with a chemical silage additive, consisting of a mixture of 259 g/l sodium benzoate and 94 g/l sodium propionate, applied at a dosage of 4.1 liters per ton of forage. The bales were stored on their flat ends without being wrapped in plastic. A data logger (Haytech) was inserted into the center of the top of each bale for temperature monitoring. After 102 days of aerobic storage, the bales were cut into upper and lower halves using a silo block cutter. Samples were collected from both the core area and outer layers to assess nutritional value, fermentation parameters, and hygienic quality, including counts of lactic acid bacteria, Clostridia, aerobic bacteria, yeast, and mold. Data were analyzed using the PROC MIXED procedure in SAS, with treatment as the main fixed effect. Statistical significance was defined at $P < 0.05$.

Results

During storage, microbial activity resulted in a significant increase in bale temperature, with recorded peaks reaching up to 60 °C. Most bales attained their maximum temperature within the first two days. This was followed by a slight cooling period, after which temperatures rose sharply again. Cooling occurred slowly and was not completed by the end of the trial.

The moist hay in the bales dried out throughout the storage period, as indicated by the DM content (Table 1).

Table 1. Characteristics of high-moisture hay bales (n=5 per treatment) prepared without inoculation (CON) or treated with SiloSolve® FC (FC), and a chemical additive (CHEM).

Treatment	CON		FC		CHEM	
Sampling place	core	outer layer	core	outer layer	core	outer layer
DM %	83.3	82.9	83.4	83.1	84.1	83.1
pH	5.45[a]	7.21[b]	5.59[a]	7.16[b]	5.79[ab]	6.68[ab]
Lactic acid g/kg DM	4.0[a]	2.4[a]	3.0[ab]	2.0[b]	2.7[ab]	2.1[b]
Acetic acid g/kg DM	(0.4)	0.8[a]	nd	0.7[a]	nd	0.6[a]
LAB Log_{10} CFU/g	1.8	1.9	2.4	1.3	1.9	1.3

DM = dry matter; LAB = lactic acid bacteria. Values in rows with different superscript letters are different at $P < 0.05$; nd – not detectable. Values in brackets were detected in less than three repetitions.

The synthesis of acids was very weak across all variants and sampling zones. No acetic acid was detected in the core of the FC bales, indicating *that L. buchneri* did not perform effectively under these conditions. The low numbers of LAB suggest that the additives did not affect microbial activity during storage.

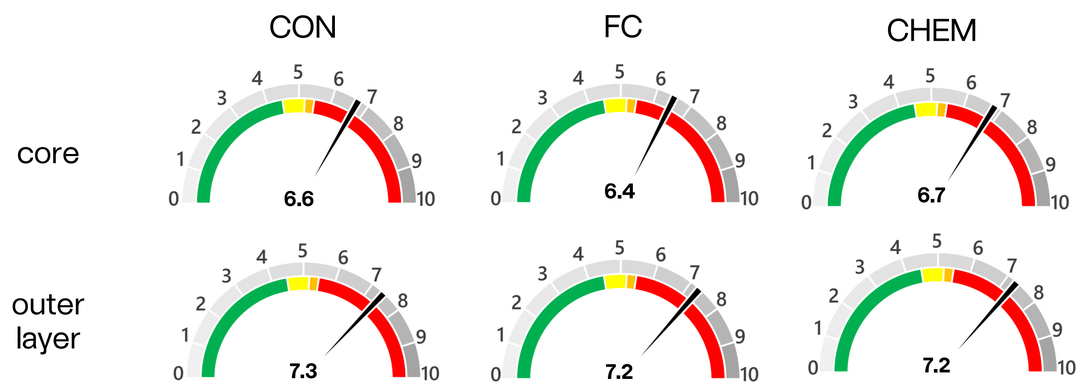

Figure 1. Contamination of hay in the outer layer and core of bales (n=5 per treatment) prepared without inoculation (CON) or treated with SiloSolve® FC (FC), and a chemical additive (CHEM). by mould group 5 (pred. *Aspergillus* spp., *Wallemia* spp.) in Log_{10} CFU/g, according to VDLUFA (2004)

Yeasts were below the detection limit in all bales. Molds were dominated by Aspergillus species detected in the core and outer layer in all bales and reached numbers up to 8 Log_{10} CFU/g (Figure 1). According to the VDLUFA (2024), hay containing molds of Aspergillus species exceeding 6 Log_{10} CFU/g is classified as excessively spoiled and unsuitable for animal feed.

Discussion

The results of the study indicates that, on the one hand, the moisture content was too low to allow the growth and metabolism of applied bacteria. On the other hand, the anaerobic conditions were not established in the core of the bales.

Neither a bacterial inoculant nor a chemical additive based on salts effectively prevented spoilage in hay bales, with moisture contents ranging from 23 % to 32 %. While minimal fermentation occurred in the core areas, it was insufficient to inhibit the activity of undesirable microorganisms, resulting in compromised bale quality. For high-moisture hay, wrapping bales in plastic may offer a more effective preservation method when wilting to moisture levels below 15 % is not achievable

Reference:
Hindrichsen I.K., Augustsson, E.U., Lund, B., Jensen, M.M., Raun, M., Jakauskas, J., Vrotniakiene, V. & Ohlsson, C., (2012) Characterisation of different lactic acid bacteria in terms of their oxygen consuming capacity, aerobic stability and pathogen inhibition. In: Kuoppala, K., Rinne, M., & Vanhatalo, A. (eds). Proceedings of the XVI International Silage Conference, Hämeenlinna, Finland, 2012, pp. 105.

VDLUFA (2024) Arbeitskreis Futtermittelmikrobiologie. Orientation values for the assessment of the microbiological quality of feedstuffs (co-applicable document on the VDLUFA association method 28.1.4 MB III Procedural instructions for microbiological quality assessment), Update: 16.12.2024, available at https://www.vdlufa.de/wp-content/uploads/2024/12/Orientation-values-2024.pdf

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