META-ANALYSIS: DM LOSS REDUCTION AND IMPROVEMENT IN AEROBIC STABILITY

ACROSS MULTIPLE CROPS, DRY MATTERS AND DURATION OF FERMENTATION

Ida Hindrichsen, Science Manager Silage, Novonesis
Rafael Camargo do Amaral, Global Technical Manager Silage, Novonesis
Bruno Ieda Cappellozza, Global Technical Manager Ruminant DFM, Novonesis
Kristian Lybek Witt, Sr. Global Portfolio Manager Silage, Novonesis

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Introduction

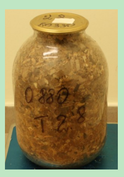
Silage inoculants are often developed for specific forage types, or even dry matter (DM) ranges within forage type. Practically, however, harvest will typically start when the forage dry matter is below optimum, continue when optimum dry matter conditions are met - and finish well beyond optimum DM concentrations of the crops. Feed shortages may dictate a shorter than recommended (60 days) anaerobic fermentation (AF). **Limitations in the flexibility of a silage inoculant** across dry matters and duration of AF may lead to increased complexity in switching from one type of inoculant to another as the harvest moves from wet to optimum to dry conditions – or worse: **not applying an inoculant at all**, with reduction in economic return as a consequence.

Objectives

The objective of this meta-analysis was to compile the **results of trials** conducted during **the past 10 years** using a combination of *Lactococcus lactis* and *Lentilactobacillus buchneri*, focusing on DM loss and aerobic stability of grass, grass/legume, alfalfa, and corn silages over a variety of dry matters and anaerobic fermentation times.

Materials and methods

The meta-analysis used in total **19 trials with 30 contrasts** conducted in Europe (Denmark, Germany, Italy, & Lithuania) on grass, grass/legume, alfalfa, and corn forages harvested at different DM (fresh or wilted) & two treatments for each forage type and duration of anaerobic fermentation (AF): 1) control (C), no inoculant applied, or 2) microbial-based inoculant (FC; *Lactococcus lactis* (DSM11037) and *Lentilactobacillus buchneri* (DSM22501); **SILOSOLVE® FC**, Novonesis, Lyngby, Denmark) applied at 150,000 CFU/g of fresh matter.



Grass at 20.8-56.3% DM, grass/legume at 32.8-35.9% DM, and alfalfa at 32.0-34.1% DM, was chopped to a length of 2–3 cm and whole-crop corn 32.6-38.9% to a length of 1-2 cm with a forage chopper and ensiled in 3-20 l **mini silos** (~1-10 kg) stored in controlled conditions (20.0 ± 1-1.6 °C) or **big bales** (350-850 kg) stored in outdoor ambient conditions. **Anaerobic fermentation** (AF) lasted from **2-120 days**, clustered as short (< ~2 weeks), medium (~1 month) or long (2-4 months) time. Aerobic stability was defined as the duration (in hours) for which the silage remained stable, i.e., before the temperature rose 2-3°C above ambient temperature. **Aerobic challenge** lasted **7-30 days**. 3-5 mini-silos or 5 bales per treatment (3-5 for fermentation quality and 3-5 for aerobic stability testing) were prepared. Each mini-silo or bale served as the experimental unit for statistical analysis, which was conducted using SAS software. The model included treatment as the main fixed effect, with statistical significance defined at $P \leq 0.05$.

Results

Across all crops, dry matters and duration of AF, the inoculation with *L. Lactis* and *L. buchneri* led to **consistent reduction in DM loss** (5.3% (C) vs. 4.0% (FC)) and **improvement in aerobic stability** (185 h (C) vs. 331 h (FC)). The ratio of significantly positive contrasts in the different crops is illustrated in **Figure 1.**

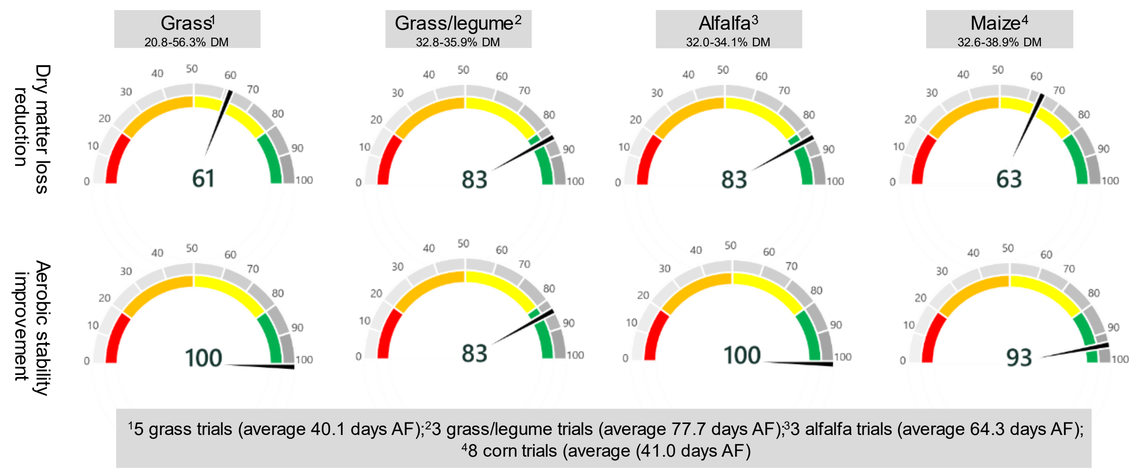


Figure 1. % of trials with significantly improved dry matter loss reduction and aerobic stability by applying FC ($P < 0.05$) across fermentation duration, ensiled on average 46.7 days (2-120 days range)

Across all crops, the inoculation with *L. lactis* and *L. buchneri* led to an **increasing reduction in DM loss with increased duration of AF** (3.0% vs. 2.9%; 5.8% vs. 4.5%; and 8.4% vs. 4.6% for (C) and (FC) at short, medium and long AF, respectively). In addition, an **improvement in aerobic stability** with increased duration of AF could be observed (150h vs. 193h; 191h vs. 363h; and 200h vs. 479h for (C) and (FC) at short, medium and long AF, respectively), **Figure 2.**

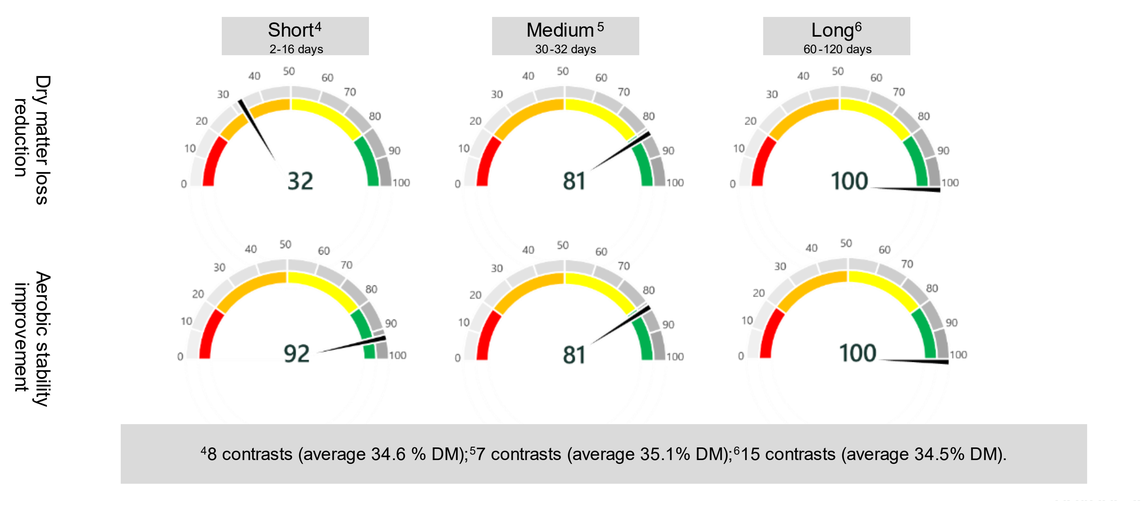


Figure 2. % of trials with significantly improved dry matter loss reduction and aerobic stability by applying FC ($P < 0.05$) across crops at average 34.7 % DM (20.8-56.3% DM range), ensiled from 2-120 days.

Discussion

Dry matter loss is an inherent part of silage making. The inclusion of heterofermentative species, such as *L. buchneri,* is known to increase DM loss due to the formation of acetic acid, which – in contrast – is required to obtain aerobic stability during feed out. To obtain aerobic stability, the anaerobic fermentation needs to run for at least 30-60 days (Muck *et al*., 2018). The present meta-analysis verifies, however, that the combination of *L. lactis* (DSM11037) and *L. buchneri* (DSM22501) **(SILOSOLVE® FC)** significantly **improved DM loss reduction** in > 30% and **increased aerobic stability** in more than 90% of the contrasts **after less than 2 weeks of fermentation** (short). Overall SiloSolve® FC reduced dry matter loss in more than 60% of the contrasts and improved aerobic stability in more than 80% of the contrasts across all crops, dry matters and duration of AF tested, demonstrating the versatility of the silage inoculant.

References:
Muck, R.E.; Nadeau, E.M.G.; McAllister, T.A.; Contreras-Govea, F.E.; Santos, M.C.; Kung, L. Silage review: recent advances and future uses of silage additives. *J. Dairy Sci.* **2018,** *101,* 3980–4000.

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