Effects of SiloSolve Inoculants on Silage Quality, Dairy Performance, and Production Efficiency

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The challenge

Spoilage microorganisms that reduce the nutritional value with subsequent impact on economic returns

Challenges for good quality silage

Aerobic stability
Problem indicators:
- Growth of yeast and mold
- Heat formation (at feed out)
- Dry matter loss
- Very high pH values

Proper fermentation
Problem indicators:
- Slow decrease of pH
- Growth of clostridia
- Bad smell
- Loss of nutrients & dry matter
- Poor palatability

Ensiling problems

- Long period of sitting
- Unsuitable maturity stage of crop
- Dirty crops and silos
- Poor application of silage additive
- Too short compaction time
- Too long time to cover silo
- Air leakage into silo
- Opening of silo during warm weather
- Poor emptying technique
- Low emptying rate

Why aerobic deterioration?

- Destruction of the cover
- Slow progress when removing silage
- Poor compaction
SensSilage

Mean temperature of all the sensors is found. If one sensor temp increases with 2 °C (3.6 °F) → alarm to the farmer!

Type of Inoculant?
Crop and dry matter conditions determine the product selection

Success factors for an effective ensiling with bacterial silage inoculants

- An effective strain
- A stable strain
- The right formulation

Relies on:
- Strong R&D
- State of the art production facilities and quality control

Bacterial inoculants

A good silage inoculant starts with bacteria selection

Bacterial strains are selected due to their unique functions

Cyt. Hansen are experts in strain research, and we are using robot technology to screen strains

Focusing on function

Improved aerobic stability
Improved fermentation and production
Reduction of Clostridium, yeast, and molds

Finnish dried culture
Inoculant bacteria differences

**Homofermenter vs. Heterofermenter**

- **Homofermenter**  
  - *L. plantarum*  
  - Most efficient  
  - 1 6-C Sugar → 2 Lactic Acid
  - Less efficient

- **Heterofermenter**  
  - *L. buchneri*  
  - 1 6-C Sugar → 1 Lactic Acid + 1 Acetic Acid + CO₂  
  - 1 6-C Sugar → 1 Lactic Acid + 1 Ethanol + CO₂  
  - 1 Lactic Acid → 1 Acetic Acid + CO₂

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Production of bacterial silage inoculants

1. Fermentations
2. Concentration
3. Cryo treatment
4. Casting in liquid nitrogen
5. Freeze drying
6. Grinding
7. Mixture bacteria with carrier

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**Lactic acid bacteria**

- Produce lactic acid from sugars
- Are acid tolerant - out-compete other bacteria (e.g. pathogens)
- Well documented bio-preservatives in fermented dairy products, meats, vegetables and silage
- Preservation of the nutritional value of silage
- Rapid and efficient fermentation
- Long lasting effect (beyond silo opening)
- No safety risk
- Small volumes

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**End Product Comparison**

- Lactic acid: strong acid, weak spoilage inhibitor, fermented in rumen to primarily propanoate (very efficient)
- Acetic acid: weak acid, good spoilage inhibitor, not fermented in rumen
- Ethanol: neutral, good spoilage inhibitor, partially fermented in rumen
- Carbon dioxide: lost dry matter

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**Silage competence platform**

![Silage competence platform diagram]
Mini-silos - What do we measure

Additives and organic acid

Additives and pH value

How does your silage smell?

Aerobic stability of corn silage

Additives and ethanol and ammonia

Whole-crop maize ensiled at ca. 27% DM (73% moisture), Delgopoulo 2010, Jones-Jakiwko, Team 80008.
**Additives and NDF and digestibility**

<table>
<thead>
<tr>
<th>NDF</th>
<th>NDF2D</th>
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<tbody>
<tr>
<td>70.5</td>
<td>70.2</td>
</tr>
<tr>
<td>70.4</td>
<td>70.3</td>
</tr>
</tbody>
</table>

*Chr Hansen data from trials 80046, 80057, 80039, 80066, 80007, 80098, 80050*

**Reduction of Clostridia**

Wet silage is at risk for undesired clostridial fermentation causing protein breakdown and subsequent reduced palatability.

- Bacteria strains which reduce clostridia

**Bacteria inoculants reduce dry matter loss**

*Chr Hansen research: decreases dry matter loss - on average 35%*

Preservation of dry matter is essential in obtaining a good feed utilization and profitability.

**Homofermentative Silage Inoculants-Summary of Published Trial Results (Muck, 2012)**

- **Dry Matter Recovery**
  - Improved in 38% of trials (Muck and Kung, 1997)
  - Improvement when successful: 8% absolute
  - On average of all trials, 2-3% absolute improvement
  - Increased dry matter recovery will usually pay for the inoculant

**Does a small hole matter?**

- Holes in the plastic must be repaired as soon as possible
- A 1 mm hole in bale may result in 300 to 400 liters of air
- Good compaction reduces problem

**Avoid top spoilage**

- Most spoilage at the top due to poor compaction
- Put plastic on side walls in bunker to reduce top spoilage
Inoculants result in higher Intake

As a consequence of reducing undesired conversions in the silage, both feed intake and the overall energy intake will increase.

![Graph showing the impact of inoculants on feed intake]

Control | Inoculant
---|---
15.9 | 16.4
30.9 | 31.5
45.9 | 46.4
100.0 | 100.0

Does inoculant affect cow performance?

“The effects of inoculants on gain or milk production in livestock have been greater than expected (Weinberg and Muck, 1996). In fact, there are a significant number of reported cases where animal performance has been increased even though there was either no or only minor changes in pH or silage fermentation products. ... However, beyond scientific curiosity, improvements in animal performance provide a bigger return to the farmer than improvements in DM recovery. So there is incentive both scientifically and in helping farmers choose effective inoculants to understand how LAB silage inoculants affect livestock.”

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Inoculants improve milk production

Improved feed conversion (FCM/DW): 1.72 vs. 1.54

Increased milk fat:
2.93 lbs/day vs 2.86 lbs/day

Increased milk protein:
2.42 lbs/day

Increased milk lactose:
4.20 lbs/day vs. 4.00 lbs/day

![Graph showing the impact of inoculants on milk production]

Control | Inoculant
---|---
23.0 | 25.6
29.5 | 32.0
36.0 | 38.5
42.5 | 45.0

Silage Inoculants and Fiber Digestibility and Fermentation of Corn Silage

<table>
<thead>
<tr>
<th>Treatment</th>
<th>pH</th>
<th>Lactic Acid</th>
<th>Acetic Acid</th>
<th>Soluble Protein</th>
<th>Lactate</th>
<th>NDF Digestibility</th>
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<tbody>
<tr>
<td>Control</td>
<td>3.91</td>
<td>4.1</td>
<td>1.60</td>
<td>3.65</td>
<td>2.6</td>
<td>52.8</td>
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<tr>
<td>Inoculant</td>
<td>3.79</td>
<td>4.6</td>
<td>1.41</td>
<td>3.42</td>
<td>3.3</td>
<td>55.6</td>
</tr>
</tbody>
</table>

+ 5.3% in vivo NDF Digestibility

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Homofermentative Silage Inoculants - Results

Animal Performance
- Typical improvements when worked: 3 to 5%

![Graph showing animal performance improvements]

Ref. Muck and Kang, 1997

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Economic value of silage inoculants - Assumptions

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Value</th>
<th>Parameters</th>
<th>Control</th>
<th>Inoculant</th>
</tr>
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<tbody>
<tr>
<td>Dairy herd size</td>
<td>1000</td>
<td>Dairy herd size</td>
<td>34.5</td>
<td>36.5</td>
</tr>
<tr>
<td>Milk price, $/100 lbs</td>
<td>19.5</td>
<td>DM loss (%)</td>
<td>5</td>
<td>2</td>
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<tr>
<td>Price of silage, $/dry ton</td>
<td>90.0</td>
<td>CFU (%)</td>
<td>8.25</td>
<td>8.25</td>
</tr>
<tr>
<td>Price of 49% SBM, $/ton</td>
<td>400</td>
<td>NHE value, $/TN</td>
<td>9.1</td>
<td>7.8</td>
</tr>
<tr>
<td>Price of silage additive, $/ton</td>
<td>0.90 - 1.20</td>
<td>FCM, lbs/cow/year</td>
<td>25.028</td>
<td>25.632</td>
</tr>
</tbody>
</table>

Corn silage treated with B. clovei MC and used in a dairy trial at the University of Florida, Gainesville.
Benefits of using inoculant, 1000 cows

ROI ranges between 7.7 and 10
Additive cost ranges between $13,582 and $19,263

Future challenges

- Better knowledge of mode of action of lactic acid bacteria in silage
- Better prediction of changes in silage quality during fermentation
- Improve consistency of bacterial efficacy
- Better correlation between silage analyses and animal performance

Conclusions - Science-based Bacteria Inoculants will:

- Provide consistent performance
- Increase in silo dry matter recovery on average of 2-3%
- Increases production by 3-5%
- Increase fiber digestibility

Most money in using inoculants from increased milk yield

Thank You!