Effects of SiloSolve inoculants on silage quality, dairy performance, and production efficiency

Christer Ohlsson and Bill Braman
Chr Hansen
The challenge

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

- Long period of wilting
- 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
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
Why aerobic deterioration?

- Destruction of the cover
- Slow progress when removing silage
- Poor compaction
Mean temperature of all the sensors is found. If one sensor temp increases with 2 °C (3.6 °F) → alarm to the farmer!
Bacterial inoculants
Focusing on function

Improved aerobic stability

Improved fermentation and production

Reduction of *Clostridium*, yeast, and molds

Freeze dried culture
Type of Inoculant?

Crop and dry matter conditions determine the product selection

- High sugar/Low protein
- Corn, Cereal, Grass, Alfalfa
- Low sugar/High protein
- Improved aerobic stability
- Enhanced fermentation
- Low Clostridia inhibition, Fungi control
- High Dry matter concentration
Success factors for an effective ensiling with bacterial silage inoculants

An effective strain

A strain that performs every time and outcompetes spoilage microorganisms

A stable strain

A strain that delivers the same result every time

The right formulation

A stable product that ensures the right concentration of silage inoculants during use

Relies on:

Strong R&D

State of the art production facilities and quality control
A good silage inoculant starts with bacteria selection

Bacterial strains are selected due to their unique functions

Chr. Hansen are experts in strain research, and we are using robot technology to screen strains
Production of bacterial silage inoculants

1. Fermentation
2. Centrifugation
3. Cryo treatment
4. Cooling in liquid nitrogen
5. Freeze drying
6. Grinding
7. Mixing bacteria with carrier
Inoculant bacteria differences

**Homofermenter vs. Heterofermenter**

- **Homofermenter** - *L. plantarum*
  1 6-C Sugar $\rightarrow$ 2 Lactic Acid

- **Heterofermenter** - *L. buchneri*
  1 6-C Sugar $\rightarrow$ 1 Lactic Acid + 1 Acetic Acid + CO$_2$
  1 6-C Sugar $\rightarrow$ 1 Lactic Acid + 1 Ethanol + CO$_2$
  1 Lactic Acid $\rightarrow$ 1 Acetic Acid + CO$_2$ (*L. buchneri*, not all heteros)

Most efficient

Less efficient
End Product Comparison

- Lactic acid- strong acid, weak spoilage inhibitor, fermented in rumen to primarily propionate (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
Silage competence platform

Controlled information

- Culture-experiments
- Microbial-interaction
- Plant and Microbial-interaction
- Mini silo – reduced time with stored/sterile material
- Mini silo – with silage material and 3 months duration

Complex-info

Model system

Original system
Mini-silos - What do we measure

Each bag is sprayed with 8ml ~ 1.5E+05 CFU/g plant material

Vacuum packed, stored @ 25° C for 3 months

Dry matter

Cell count, LAB

Un-treated corn from field

1000g/bag

6 kg/treatment

Dry matter

pH

Cell count, LAB

Yeast & Mold

LAB

Yeast & Mold

Bacilli spores

pH

Bottles @ room temp.

Small organic acids; Day 7

Gas samples; Day 0-3

pH; day 0 & 7

Bottles @ room temp.

Temperature - continuous

Dry matter

Cell count

LAB

pH

Dry matter

Small org acids

Volatile org. acids

Aerobic stability; 7 days @ room temp.

Bacilli spores

Yeast & Mold

Cell count

LAB

pH

Bacilli spores
Additives and pH value

Chr Hansen data from trials 80046, 80057, 80059, 80086, 80087, 80088, 80089
Whole-crop maize ensiled at ca. 27% DM (73% moisture), Baisogala 2010. Jonas Jatkauskas. Trial 80088.
Additives and organic acid

Chr Hansen data from trials 80046, 80057, 80059, 80086, 80087, 80088, 80089
How does your silage smell?
Additives and ethanol and ammonia

Chr Hansen data from trials 80046, 80057, 80059, 80086, 80087, 80088, 80089
Additives and NDF and digestibility

chr Hansen data from trials 80046, 80057, 80059, 80086, 80087, 80088, 80089
Reduction of *Clostridia*

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

Bacteria strains which reduce clostridia

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**Clostridium Log CFU/g**

- Control: 5,011 cfu/g
- *L. Lactis* SR3.54: 16 cfu/g

Swedish patent nr 511828.
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

<table>
<thead>
<tr>
<th>Trials</th>
<th>Control</th>
<th>Inoculant</th>
</tr>
</thead>
<tbody>
<tr>
<td>80057</td>
<td>12</td>
<td>6</td>
</tr>
<tr>
<td>80087</td>
<td>10</td>
<td>4</td>
</tr>
<tr>
<td>80088</td>
<td>8</td>
<td>6</td>
</tr>
<tr>
<td>80089</td>
<td>6</td>
<td>2</td>
</tr>
<tr>
<td>80093</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>800130</td>
<td>12</td>
<td>6</td>
</tr>
</tbody>
</table>

Six trials with grass, corn and alfalfa
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
- 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.
Do you have data with inoculated corn silage that demonstrate increased DM and energy intake?
Inoculants improve milk production

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

Reduced milk fat:
3.43% vs 3.48%

Reduced milk protein:
2.82% vs 2.93%

Corn silage fed to cows for >90 days. Trial 80148, Florida. Assumed 305 milking days
Previous slide shows ECM on x axis, but FCM on y axis??

Could you show daily fat and protein yield in lbs. and not %
Homofermentative Silage Inoculants - Results

Animal Performance

- Typical improvements when worked: 3 to 5%

% Positive Trials

Ref. Muck and Kung, 1997
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.”

Quote by Dr. Richard Muck-USDA Forage Lab, Madison, WI International Silage Conference, 2012
### Treatment pH

<table>
<thead>
<tr>
<th>Treatment</th>
<th>pH</th>
<th>Lactic Acid</th>
<th>Acetic Acid</th>
<th>Soluble Protein</th>
<th>Lactate:Acetate</th>
<th>NDF Digestibility</th>
</tr>
</thead>
<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>
</tr>
<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

K.S. Bolsen - Kansas State University
Inoculants improve milk production

Improved feed conversion (ECM/DMI): 1.40 vs. 1.36
Increased milk fat: 4.24% vs 4.16%
Increased milk protein: 3.17% vs 3.15%

Alfalfa silage fed to cows for 92 days. Trial 80087, Lithuania. Assumed 305 milking days
The Lithuania trial results are too low and the data will be dismissed. Prefer we delete this trial.
## 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>
</thead>
<tbody>
<tr>
<td>Dairy herd size</td>
<td>1000</td>
<td>Dry matter, %</td>
<td>34.5</td>
<td>36.5</td>
</tr>
<tr>
<td>Milk price, $/100 lbs</td>
<td>19</td>
<td>DM loss, %</td>
<td>5</td>
<td>2</td>
</tr>
<tr>
<td>Price of silage, $/wet ton</td>
<td>90</td>
<td>CP, %DM</td>
<td>8.05</td>
<td>8.25</td>
</tr>
<tr>
<td>Price of 49% SBM, $/ton</td>
<td>400</td>
<td>NH₃-value, %</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 SiloSolve MC and used in a dairy trial at the University of Florida, Gainsville
Benefits of using inoculant, 1000 cows

ROI ranges between 7.7 and 10

Additive cost ranges between $13,582 and $15,293
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
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
Thank You!

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