Silage inoculants affect animal performance as well as crop fermentation

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Inoculants

- Silage additives whose main ingredients are lactic acid bacteria

Purpose of Inoculants

- Lactic acid bacteria are the group of bacteria that ferment sugars in the crop and help preserve it.
- Help insure that the fermentation goes in the direction that you want it.

Different Types of Inoculants

- Traditional homofermentative types:
  - *Lactobacillus plantarum*, *L. casei*, *Pediococcus* species, *Enterococcus faecium*
- *Lactobacillus buchneri*, a heterofermenter
- Combination of homofermenters with *L. buchneri*

Scope of Talk

- What does a homofermentative silage inoculant do?
- Why are effects of inoculants on milk production important?
- Is there a good explanation as to why an inoculant would increase milk production?

Homofermenter vs. Heterofermenter

- Homofermenter

  1 6-C Sugar $\rightarrow$ 2 Lactic Acid

- Heterofermenter

  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)

End Product Comparison

- Lactic acid - strong acid; weak spoilage inhibitor; fermented in rumen
- Acetic acid - weak acid; good spoilage inhibitor; not fermented in rumen
- Ethanol - neutral; poor spoilage inhibitor; partially fermented in rumen
- Carbon dioxide - lost dry matter

So…

- If you want to preserve crop quality:
  - Lactic acid
- If you want a silage that doesn't heat:
  - Acetic acid
- In any case, you want to minimize ethanol, CO_2

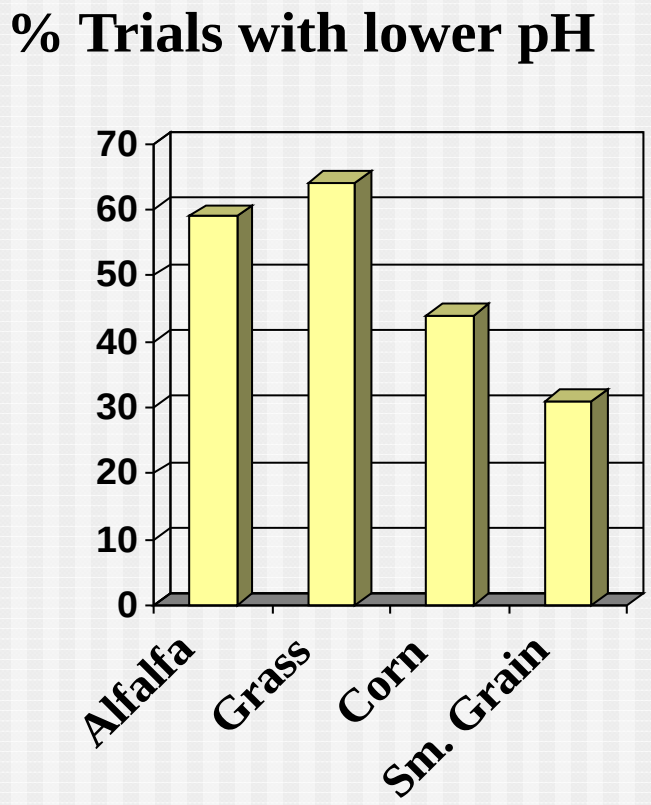
Homofermentative Inoculants - *Expectations*

- High lactic acid content, low other products
- Low pH
- Improved DM recovery
- Slightly better animal performance

Homofermentative Silage Inoculants - Results

pH

- Lower but not all the time
- Works more often in hay crop than whole-grain silages



(Muck and Kung, 1997)

Why Don't These Inoculants Always Work?

- Some products may be ineffective or misapplied
- It may be difficult to improve on the natural fermentation; e.g., corn silage
- Competition from the natural population
  - If inoculant population < 10% natural LAB, less likely the inoculant will work.

Natural LAB Populations

- Corn silage
  - Tends to have high natural population
- Alfalfa
  - Tends to have low natural population

Homofermentative Silage Inoculants - Results

Dry Matter Recovery

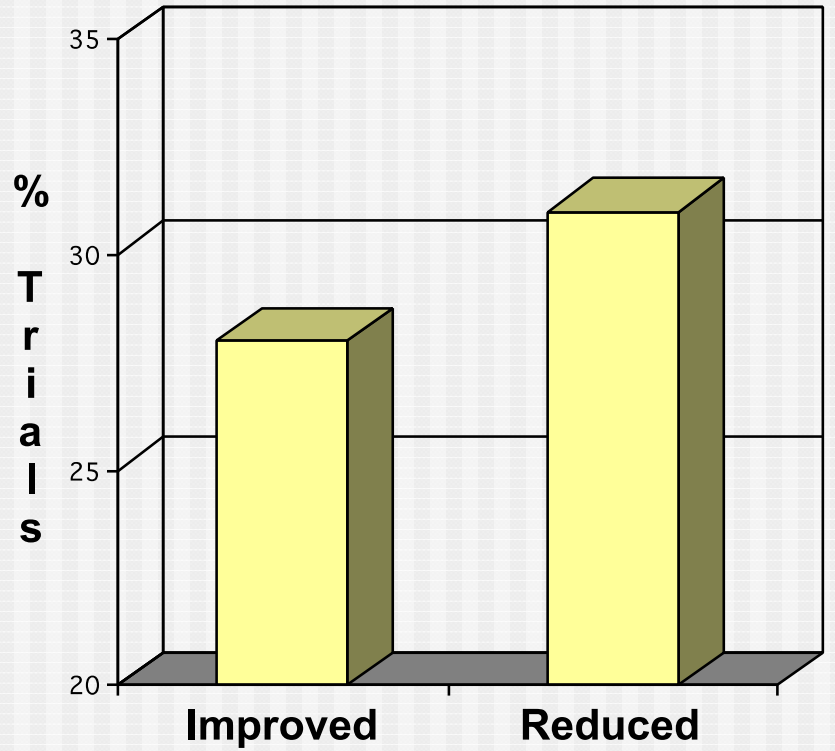
- Improved 38% of trials (Muck and Kung, 1997)
- Improvement when successful: 6%
- On average, 2-3% improvement

Homofermentative Silage Inoculants - Results

Bunk Life/Aerobic Stability

- Positive in hay crop silages
- Reductions largely in corn and small grain silages

Aerobic Stability in All Silages as Affected by Inoculants



(Muck and Kung, 1997)

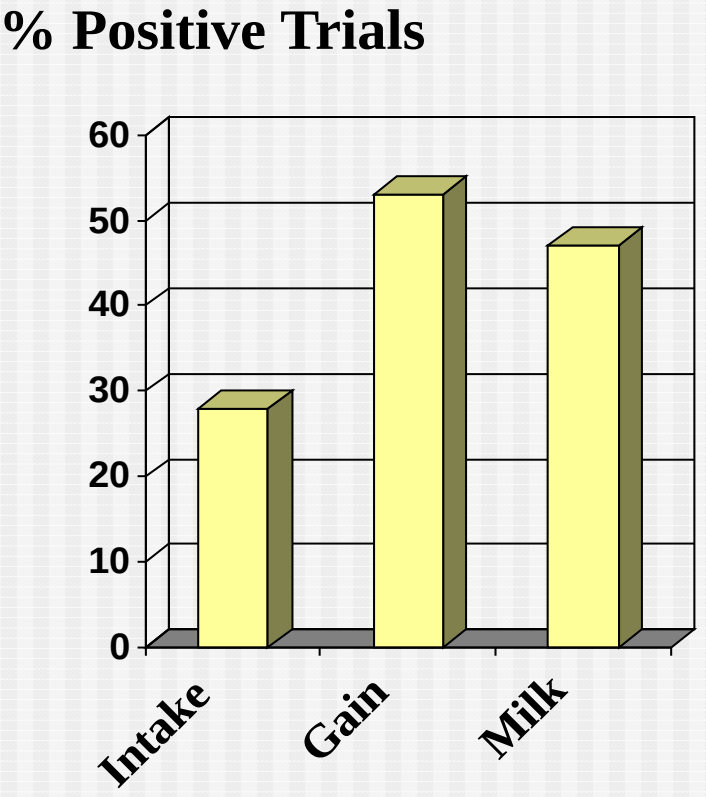
Reasons for Aerobic Stability Differences

- Aerobic stability
  - Improved by lower pH
  - Reduced by decreasing acetic acid
- Hay crop silages
  - Lower pH from inoculants offsets reductions in acetic acid
- Corn silage
  - Little reduction in pH possible so loss of acetic acid by inoculants could reduce stability

Homofermentative Silage Inoculants - Results

Animal Performance

- Typical improvements when worked: 3 to 5%



(Muck and Kung, 1997)

Homofermentative Silage Inoculants – ROI

- Improved DM recovery, 2-3% on average
  - Treat 1000 tons as fed: $1000
  - Save 25 tons as fed
  - If each ton saved is worth $40 or more, you break even.
- Improved animal performance 3-5% when effective
  - Assume 3 lbs. milk/cow/day when effective
  - If effective 50% of the time, 1.5 lbs. milk/cow/day
  - With milk at $16 per 100 lbs., $0.24 extra income/cow/day
  - If cow is eating 60 lbs. silage as fed/day, then inoculant cost is $0.03/cow/day.

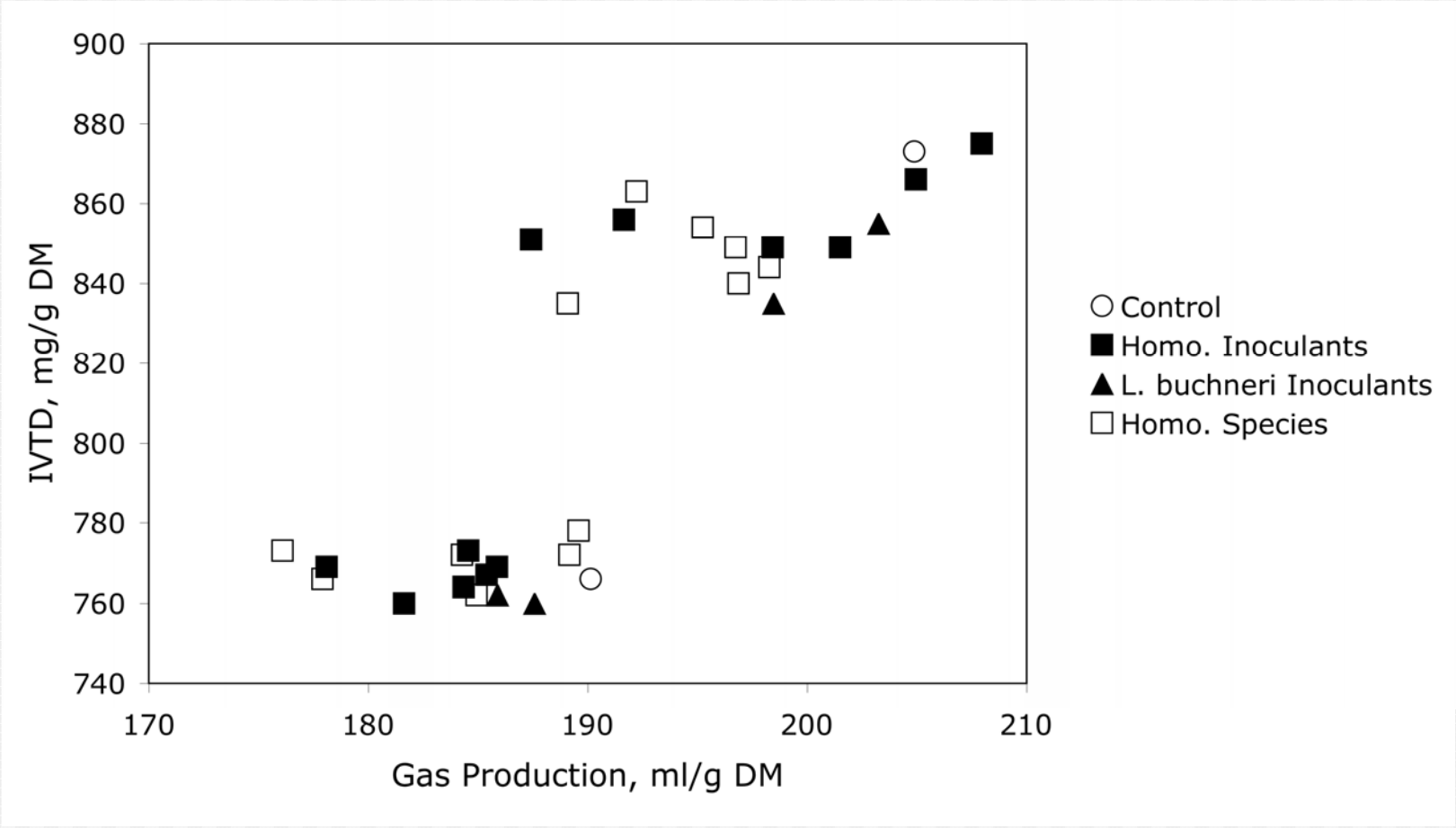
Bottom Line on ROI from a Homofermentative Inoculant

- If inoculant only improves DM recovery, you will at least breakeven and most likely make a small profit.
- If the inoculant improves milk production, you will get a big return on your investment.

So…

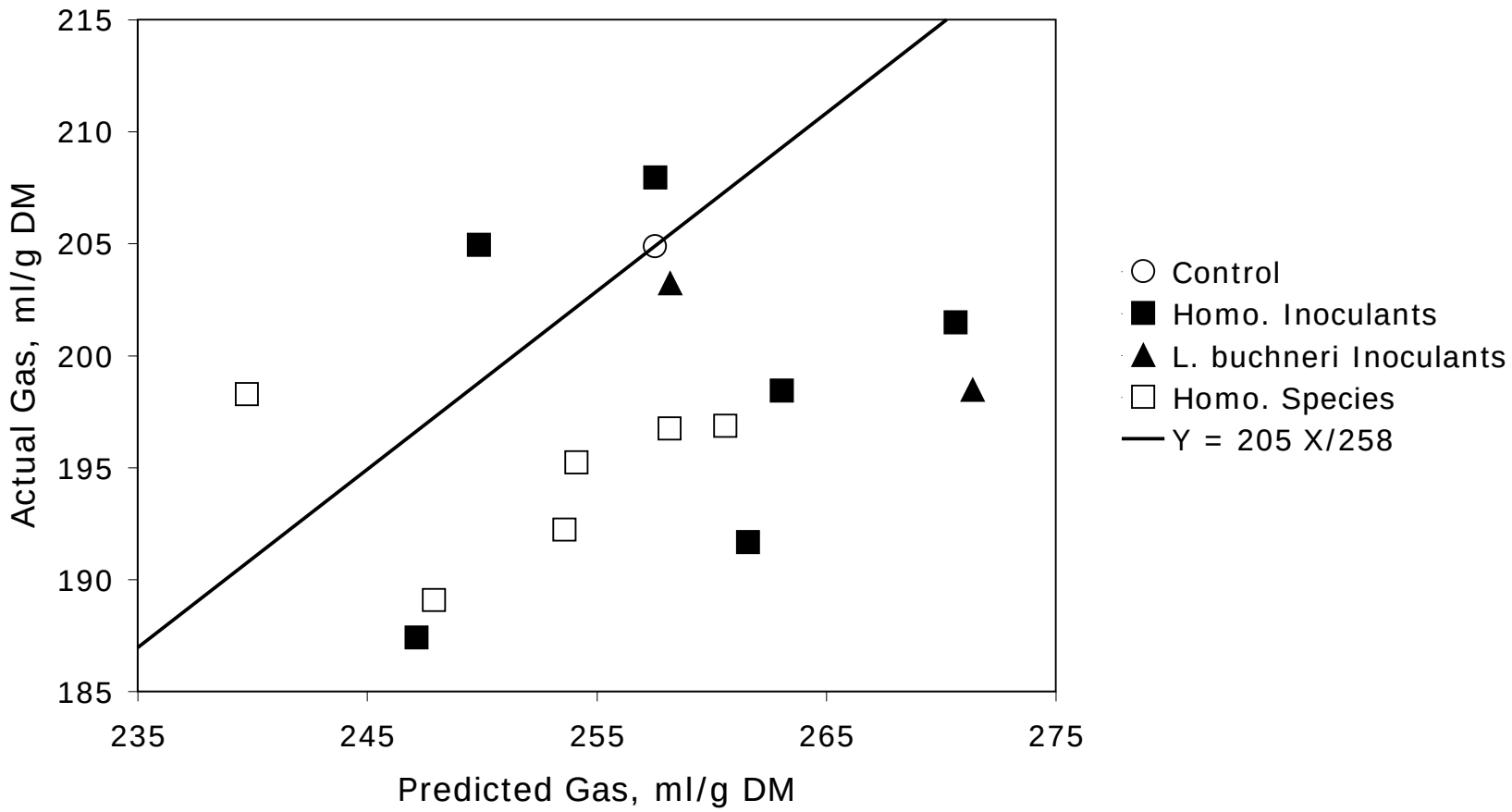
- How can a homofermentative inoculant improve milk production by 2 to 3 lbs. per cow per day?
- Can we expect all homofermentative inoculants to improve milk production that much?

Do Inoculants Improve *In Vitro* Dry Matter Digestibility?

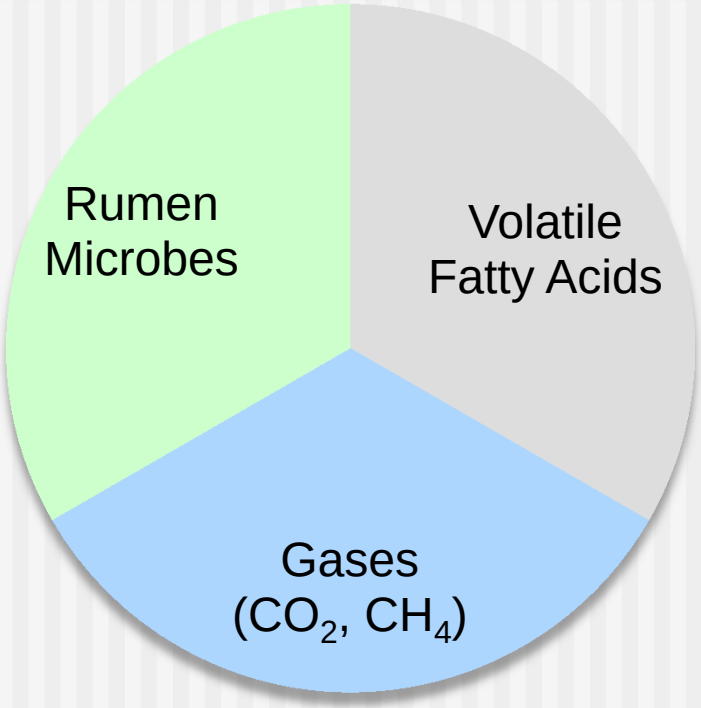


They didn't in two alfalfa silage trials that we ran, but…

Gas Production: Lower on Some Inoculants Than Predicted



Main Products of Rumen Fermentation



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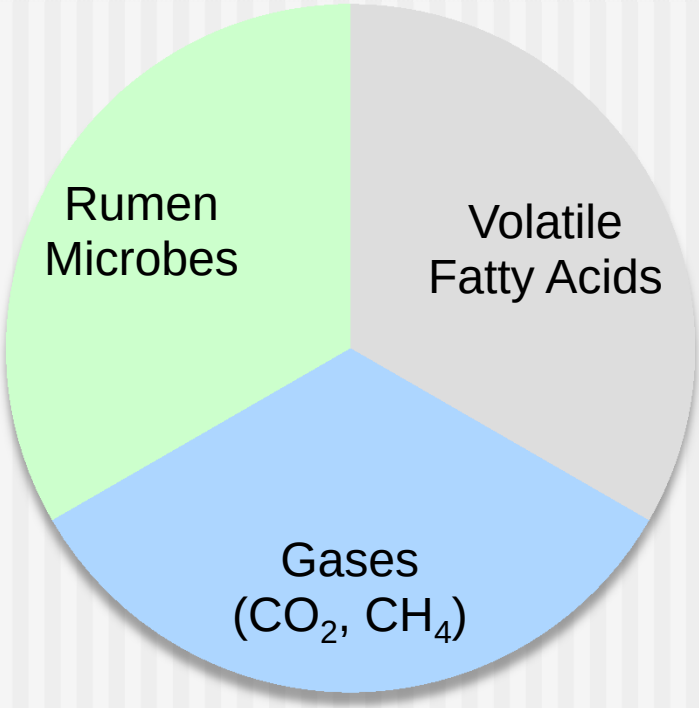
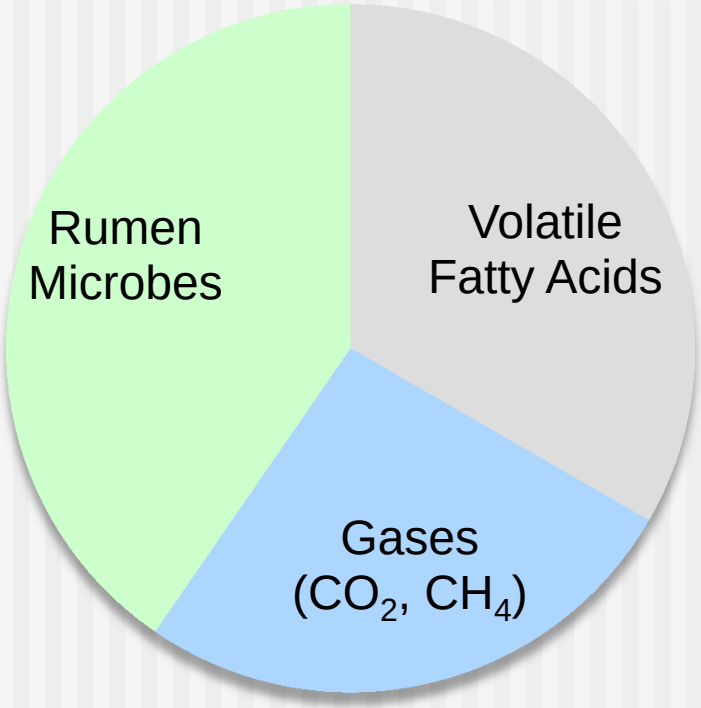


Untreated?



Inoculated?

In Vitro Microbial Biomass Production from Lab Silages

Treatment	Rumen Microbes (mg/100 mg digested)
Untreated	35.4
LP-EF	35.5
LP	37.9
Lpe	39.0
LL	38.0

Inoculated silages from 3 of the 4 inoculants produced 8% more rumen microbes than untreated.

That could support up to 4 lbs. more milk/cow/day.

Lactating Cow Trial: Alfalfa Silage Quality

Characteristics	Untreated	L. plantarum MTD/1
DM, %	51.5	49.1
pH	4.93	4.56
Crude protein, % DM	25.0	25.2
NDF, % DM	31.9	31.9
ADF, % DM	24.1	24.1
Ash, % DM	10.2	9.8

Alfalfa silage was fed at 50% of ration along with corn silage, HMC, and soy hulls.

Ration: 16.2% CP, 27.3% NDF

Lactating Cow Trial: Performance/Cow/Day

Characteristics	Untreated	L. plantarum MTD/1
DM Intake, lbs.	56.0	56.9
Milk, lbs.	87.3	89.1
Fat, %	3.80	3.79
Protein, %	2.81	2.78
Lactose, %	4.82	4.89
MUN, mg/dL	12.7	11.6

The 10% reduction in milk urea N indicates better N utilization by the cows on the inoculated silage, suggesting more rumen microbe production.

What More Do We Need to Know?

- Confirm that more rumen microbes were produced in our trial.
- Figure out why certain inoculants are causing silages to produce more rumen microbes.
- Confirm that the *in vitro* test really does screen for inoculants that can produce a significant animal response.

The Bottom Line

- Sound evidence that some inoculants can increase rumen microbe production *in vitro*
- These increases can explain the milk production increases observed with some inoculants.
- The inoculant we tested in a production trial increased milk and reduced MUN like we expected.

The Bottom Line

- We now have increased confidence that some inoculants can truly increase milk production 2 to 4 lbs./cow/day.
- More research is needed to understand why this is happening.
- We may have a tool for looking for better inoculants in the future.

Questions?