Corn Silage Additives

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Most Common Additives in U.S.

- Inoculants
  - Standard inoculants
  - *Lactobacillus buchneri*
  - Combination inoculants

- Propionic acid
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
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
Homofermentative Inoculants - Expectations

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

- High lactic acid content, low other products
- Low pH
- Improved DM recovery
- But…
Homofermentative Silage Inoculants - Results

Animal Performance

- Typical improvements when worked: 3 to 5%

(Muck and Kung, 1997)
Why Such An Improvement In Animal Performance?

- We don’t know for sure
- Current studies:
  - Specific to the strain: Not all *L. plantarum* strains are the same
  - Some strains appear to be boosting rumen microbial growth, a major source of amino acids to the cow
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)
Homofermentative Silage
Inoculants – Return On Investment

- 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 $20 per 100 lbs., $0.30 extra income/cow/day
  - If cow is eating 60 lbs. silage as fed/day, then inoculant cost is $0.03/cow/day.
L. buchneri Inoculants - Expectations

- Higher acetic acid content
- Slightly elevated pH
- Improved DM recovery from less spoilage, offsetting more fermentation losses
- Animal performance - ??
  - Keeping silage cool – benefits intake
  - High acetic acid – reduces intake?
L. buchneri Inoculants - Reality

- Higher acetic acid content
- Slightly elevated pH
- Improved DM recovery from less spoilage offsetting more fermentation losses
- Animal performance
  - Little evidence of performance improvements
**L. buchneri** Inoculants – ROI

- **Improved DM recovery, 1-2% on average**
  - Treat 1000 tons as fed: $1500
  - Save 15 tons as fed
  - If each ton saved is worth $40, DM recovery alone won’t pay for using the product: $600 benefit at a cost of $1500.

- **Improved animal performance**
  - If silage would be cool normally, **no** animal benefit to using
  - If silage would be heating normally, assume a 4 lbs. DM reduction in TMR intake and a 3 lbs. loss milk/cow/day
  - Avoidance of heating gives $0.60 more milk income/cow/day with $20 milk at a cost of ~$0.045/cow/day, for a cow eating 60 lbs. as fed silage.
Combination Silage Inoculants - Expectations

- Best of both worlds ideally
- Good fermentation except elevated acetic acid
- DM recovery and animal performance of a standard homofermentative inoculant
- Bunk life/aerobic stability of *L. buchneri*
- One company has a *buchneri* with ferulic acid esterase to improve NDF digestibility
Combination Silage Inoculants - Reality

- Too early to tell
- Several published small-scale studies
  - Combinations have shown effects of both *L. buchneri* and homofermentative bacteria
    - Faster fermentation - from homofermenters
    - Aerobic stability - similar to *L. buchneri*
    - Final fermentation products, pH - similar to *L. buchneri*
    - Esterase-containing *buchneri* is improving *in situ* NDFD 0 to 7 percentage units
Combination Silage Inoculants - ROI

- Too early to tell but....
- Most expensive inoculants, ~ twice that of standard homofermentative inoculants
- So DM recovery will not be enough to cover the cost of these products
- A positive ROI depends on getting more milk.
Propionic Acid

- Great inhibitor of yeasts and molds
- Some products are mixture of propionic and acetic acids
  - Acetic acid is cheaper but not as effective at inhibiting molds as prop
- Products applied at ensiling: typically applying 2 to 4 lbs./ton
Purpose of Propionic Acid

- Improved bunk life/aerobic stability
- Effective IF applied at or above label rates
- Effectiveness drops off when rates are too low
Propionic Acid ROI

- Cost side varies substantially depending on the product, but generally more expensive than *L. buchneri* inoculants

- Return side: virtually identical to *L. buchneri* inoculants
  - The producer makes money when you prevent heating
  - If heating would not have occurred, you lose money using propionic.
Which Additive Should You Recommend to the Producer?

The choice depends on your goals.
Aerobic Stability Problems

- Is the problem a management problem that can be solved without an additive?

- Corn Silage:
  - *L. buchneri* inoculant
  - Propionic acid
Issues with *L. buchneri*

- However, slow grower that takes 45-60 days storage time before having much effect
- So, not an answer to heating problems with immature silage; propionic acid is the best solution for this case
- Not a solution at feeding time
Make a Good Silage Better

Homofermentative inoculants are the best route to improve DM recovery, animal performance

- Good fit for hay crop silages, HMC
- Best success under:
  - Good harvesting conditions
  - Very good silo management
Make a Good Silage Better

- Corn Silage:
  - Homofermentative inoculants can reduce aerobic stability
  - Inconsistent success rate
  - Best fit: silage to be fed in cool weather
My Take on Corn Silage Additives

- Corn silage for cool/cold weather feeding
  - No additive or…
  - Homofermentative inoculant with good research on improved animal performance with corn silage

- Corn silage for warm weather if heating occurs with good silo management
  - *L. buchneri* or a combination inoculant or…
  - Propionic acid