Butyric Acid In Silage: Why It Happens

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The Problem

When butyric acid is in silage, be prepared for:

- Reduced intake
- Potential health problems - ketosis
- And for problems to get worse with time
How Does The Butyric Acid Get There?

- Produced by clostridia - bacteria on the crop at ensiling
  - Anaerobic bacteria: grow only when there is no oxygen
  - Spores, not active cells
How Is Butyric Acid Produced By Clostridia?

Fermentation of sugars or lactic acid:

Sugar or 2 Lactic $\to$ Butyric + 2CO$_2$ + 2H$_2$

- Dry matter loss - 51%
- Energy loss - 18%
- Raises pH if lactic acid is fermented
What Else Can Clostridia Produce?

- Some ferment amino acids, producing various compounds:
  - Amines
  - Ammonia
  - Acetic, propionic and other acids
  - Carbon dioxide

- Some of the amines & other compounds may be responsible for reduced intake
How Do The Clostridia Get On The Crop?

Two Key Sources:

- **Soil**
  - Rain splash during wilting
  - Lodged forages

- **Manure**
  - If applying manure to alfalfa or grass, apply right after taking a cutting
When And Where Will Clostridia Grow In The Silo?

- Butyric acid will not occur just because there are clostridial spores on the crop.
- Lactic acid bacteria (LAB) are faster than clostridia.
- Generally the LAB produce sufficient acid and lower pH enough to keep clostridia from growing.
When And Where Will Clostridia Grow In The Silo?

So we typically find clostridia and butyric acid:

- Where pH from LAB fermentation has not gotten low enough to keep clostridia from growing
- In spoiled areas where pH has risen
When And Where Will Clostridia Grow In The Silo?

- In both cases, generally it takes at least several months before you see much butyric acid.

- When butyric acid becomes noticeable, the amount of butyric acid will keep increasing with time.
How Do You Keep Clostridia From Growing In The Silo?

- Get the pH sufficiently low and keep it that way.

- However, the critical pH is affected by dry matter content and crop.
Critical pH to Stop Clostridia

Based on Leibensperger and Pitt, 1987
Critical pH to Stop Clostridia

At 30% DM, need a pH of 4.7 in alfalfa and 4.4 in grass or corn to keep clostridia in check.
Silage Management Keys To Minimizing Clostridia

- Minimize soil, manure contamination
- Corn Silage:
  - Seldom seen except in spoiled areas or from over-application of ammonia or urea
- Alfalfa or Grass Silage:
  - Wilt sufficiently (30+% DM)
  - If rained on during wilting, needs to be drier
  - If wrapped bales, 40+% DM for alfalfa
Silage Management Keys To Minimizing Clostridia

- What if you need to ensile on the wet side?
  - Start feeding out as soon as you can after active fermentation is over (~ two weeks).
Butyric Acid in Silage: How to Deal with It?

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Butyric Acid Silage – Increased Risk for Ketosis!

- Adds to other risk factors for ketosis:
  - fat cows
  - pen moves before or after calving
  - over-crowding
  - low energy intake
  - high protein diet
  - high fat diet
Mechanism for Increased Ketosis Risk

- Cow converts excessive butyric acid from the silage to a ketone body
  - \( \beta \)-hydroxybutyric acid (BHB or BHBA)
  - one enzymatic step in the liver
  - source of the BHBA does not matter (off-feed, DA, fatty liver, or silage)
Blood

↑ Butyric Intake

↓ Propionate
↓ Amino Acids

GI Tract

↑ Butyric Absorbed

↓ DMI

Blood

↑ BHBA

NEFA

↑ BHBA

Body Fat

↓ Glucose
↓ Amino Acids

Liver

Oxidation of Fatty Acids

Incomplete!
Other Problems with Clostridial Silages

- Amines (protein breakdown)
  - putrescine, cadaverine
  - may be toxic and/or depress intake
- NH$_3$ (high protein solubility)
  - requires calories to convert to urea
  - may depress intake
Other Problems with Clostridial Silages

- Ingestion of clostridial organisms
  - silage clostridia are usually not pathogens (e.g., *C. perfringens*)
  - clostridial spores are already plentiful in the environment and in feed
- *Might* increase risk for hemorrhagic bowel syndrome (HBS), sudden deaths
Action Plan – Clostridial Silages

1. *Diagnosis* - confirm the presence and amount of butyric acid in the silage
   - smell (especially if bring indoors)
   - pH (expect >4.8 pH)
   - laboratory organic acid analysis (gives exact amount of butyric acid)
2. *Daily Intake* – calculate butyric acid intake from silage

- lab analysis result $\times$ silage DM intake

**example:**
- 1.84% butyric acid in silage DM
- 10 lbs (4.5 kg) silage DM intake
- total butyric intake = 83.5 grams/day
3. *Divert* the butyric acid silage away from pre- and post-fresh cows
  - zero tolerance for butyric acid in these groups of cattle
  - buying hay is cheaper than dead cows, DA’s, open cows, etc.
Action Plan – Clostridial Silages

4. *Dilute* the butyric acid silage for the remaining cattle

- less than 50 grams of butyric acid per day

- example:
  - 1.84% butyric acid in silage DM
  - total butyric intake < 50 grams/day
  - silage intake < 6.0 lbs DM/day
5. Decay the butyric acid
   - knock down and spread out for a few days before feeding
   - some butyric will volatilize
   - the silage won’t spoil - butyric acid makes silage very aerobically stable
   - resample to check for loss of butyric acid
6. Dispose of silage with very high (>2%) butyric acid content
   • if >2.0% butyric acid the maximal feeding rate is 5.5 lbs DM
   • bad silage can be good fertilizer
What to Do for the Cows?

- Monitor for ketosis more intensively
- Treat ketotic cows promptly
- Limit other risk factors for ketosis
Other Silages on the Farm?

- If other silages might have clostridial fermentation:
  - feed sooner, not later!
Questions?