Alfalfa Haylage: Avoiding the Colostridic Time Bomb


Alfalfa haylage has become a staple in the diets of high-producing dairy cows across the nation due primarily to its significant contributions of crude protein and physically effective fiber (peNDF) in most TMR, but still it remains one of the most difficult and challenging forages to ensile properly. Proper fermentation is predicated upon a controlled, anaerobic process whereby water soluble carbohydrates (WSC; primarily glucose, fructose and sucrose) are converted to lactic acid by lactic acid bacteria (LAB) leading to a dramatic decline in pH and resulting in long-term forage preservation.

Numerous factors affect silage quality, including: moisture (dry matter content), forage buffering capacity, ash content, temperature, total protein, and volume of air per volume of forage (Jaster, 1995). Alfalfa is especially challenging to ensile due to its buffering capacity and less-than-ideal quantity of WSC. Several of the aforementioned factors represent Critical Control Points (CCP) where significant management intervention can enhance fermentation and preservation; therefore, potentially avoiding the Colostridic time bomb.

**What is the Colostridic Time Bomb?**

The primary culprit organism is a rod-shaped, gram-positive bacterium that grows under anaerobic conditions and produces butyric acid, acetic acid and hydrogen gas – Clostridium tyrobutyricum. Not only significant in the spoilage of alfalfa haylage, this organism is responsible for the late-blowing defect in cheese that can cause considerable challenges in cheese making and storage.

Butyric acid is the primary indicator that alfalfa haylage has gone ‘Butyric’ or ‘Clostridic’, leading to a reduction in sugar, elevation in pH, degradation of protein (proteolysis), increase in DM loss, ‘off’ odors, and poor feed out performance with potential health effects when fed to high-producing dairy cows.

We recently viewed and analyzed several alfalfa haylage bunkers and piles in Wisconsin that yielded some interesting points for discussion. Specifically, what environmental factors negatively impact alfalfa haylage or what management interventions can significantly improve alfalfa haylage fermentation and preservation at Critical Control Points throughout the process?

**Moisture**

Colostridic layering or spoilage in alfalfa haylage can be linked to excessive moisture content. This moisture could be due to the crop at harvest and improper wilting time, deep windrows or a result of environmental rewetting conditions at harvest, such as rain or heavy dew. To visually assess moisture in relation to butyric acid, we evaluated data compiled from legume samples submitted to Rock River Laboratory, Inc. since 2011 and generated the following figures. Figure 1 shows the relationship between legume moisture and butyric acid.

Across a broad range of moisture levels (~30-60%), butyric acid concentration averages approximately 0.50-0.55% for all samples classified butyric (> 0.50% butyric acid); however, when moisture exceeded 65% (35% DM) butyric acid concentration increased significantly. Therefore, in order to avoid a ‘Colostridic Time Bomb’ event, ideally keep alfalfa moisture below 65% (DM above 35%).

**Water soluble carbohydrates (WSC)**

Water soluble carbohydrates (sugars) are important for good fermentation. Alfalfa is lower in WSC than corn, making it more difficult to ferment. The carbohydrate content of grasses increases from 6:00 am to 6:00 pm; whereas, the carbohydrate content of legumes, specifically alfalfa, increases from 6:00 am to noon (McDonald et al., 1991). Particular attention should be paid to time of day and environmental conditions at cutting in order to ensure the highest WSC content possible.

![Figure 1](source: Rock River Laboratory, Inc., 2011-present, >45,000 samples)

**Figure 1** Average butyric acid concentration across all moisture levels in legume samples

Notice the fairly linear increase in concentration of butyric acid as moisture increases from 25% to 65% across more than 45,000 samples. Wetter haylage is more prone to Colostridic spoilage and higher levels of butyric acid.

To take this one step further, we sorted only those legume samples with butyric acid levels above 0.5% on a DM basis, and those data are shown in Figure 2.

**Figure 2** Average butyric acid concentration across all moisture levels in legume samples above 0.5% butyric acid

![Figure 2](source: Rock River Laboratory, Inc., 2011-present, >30,000 samples)
Ash
Higher-than-normal ash levels in alfalfa haylage can be a result of picking up additional ash from the soil during harvest and wilting, or substantial dry matter (sugar) losses due to a secondary fermentation event. Note, with the inclusion of additional soil at harvest comes the potential for higher numbers of Clostridia spores to be ensiled with the forage.

The challenge with interpreting ash content of fermented alfalfa haylage is trying to determine a 'cause-and-effect' relationship versus a 'result'. Specifically, did the higher ash content lead to a higher tendency for a 'Clostridic Time Bomb' event or was the higher ash content simply a result of increased dry matter loss due to secondary Clostridial fermentation? In either case, Clostridia will continue to consume WSC which should be preserved and will be beneficial to high-producing cows. Although Figure 3 shows the association between butyric acid concentrations and ash content of legume samples, it does not confirm a 'cause-and-effect' versus a 'result' relationship.

Critical Control Points (CCP):
CCP #1 - Target DM for alfalfa haylage ideally should be 38-42% (58-62% moisture) in order to minimize the likelihood of a 'Clostridic Time Bomb' event, but realize that actual DM going into the bunker or pile realistically will fall between 35 and 45% (55-65% moisture) for this target. Nonetheless, by targeting ~40% DM, the vast majority, if not all alfalfa harvested for silage will be at a moisture detrimental to widespread growth of Clostridia.

CCP #2 - Apply a researched-backed bacterial inoculant designed to inhibit Clostridial fermentation in order to capitalize on the limited WSC and drive fermentation toward producing lactic acid and a low terminal pH.

Some of the highest quality alfalfa haylage we saw in Wisconsin was produced by Steve Abel at Abel Dairy Farms, LLC, between Eden and Fond du Lac, Wisconsin. Abel’s alfalfa haylage plan includes timely cutting and wilting. Alfalfa is conditioned so as to have less forage in contact with the soil during wilting. Obviously, Best Management Practices (BMP) for alfalfa for various locations and environmental conditions during harvest may require modifications to this recommendation, especially if a rewetting event is expected.

Steve credits several key management factors as helping them to avoid the 'Clostridic Time Bomb' including communication and decision-making. “Each piece of our farming equipment has a two-way radio for rapid, on-demand communication among everyone involved in the haylage-making and storage process,” said Abel.

From a decision-making perspective, someone has to be empowered and willing to make the tough decisions on when to start and stop if moistures are outside the ideal range. “There are two of us who make the decisions on when to start and stop. That way there is shared blame when things don’t go right,” Abel said jokingly, and continued, “The bottom line is someone has to make the tough decisions and the owner should be one who is directly involved even if it is a custom harvest situation.”

Buffering capacity
Alfalfa has a natural buffering capacity primarily due to protein and Ca content. This buffering capacity requires additional production of lactic acid in order to drop the pH of the fermented forage to a stable, terminal pH. Solely relying on the epiphytic (naturally occurring) lactic acid bacteria to drive lactic acid production and the concurrent drop in pH, potentiates a 'Clostridic Time Bomb' event.

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References

Figure 3
Average butyric acid concentration across all ash levels for legume samples

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Source: Rock River Laboratory, Inc., 2011-present, n>45,000 samples

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