Pulling back the curtain to see the real actors in silage fermentation

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The stage where silage fermentation occurs contains many different actors with different endings to the story. The main set of actors are villains provided by Mother Nature called epiphytic flora who derive energy by degrading forage. The other set of actors are the physical components of ensiling (packing, covering) and the competing bacteria (inoculants).

Act I. Ensiling. During this act, forage should be packed as soon as possible to help exclude air (anaerobic). The main reason is that there are a large set of destructive bacteria which require air to grow. Once it is packed, the forage should be covered with an oxygen limiting barrier and external water kept out.

Act II. Inoculating. Bacteria are applied to produce lactic acid. The most common bacteria are *Enterococcus faecium, Pediococcus spp.* and *Lactobacillus plantarum.* These bacteria are called homofermentive bacteria since they make lactic acid and need to be applied in excess of $1x10^5$ CFU/g and have sugar available to them to overwhelm the villains. Ideally, only 2-2.5% acetic acid is made by the villains before the pH reaches a point to inhibit further degradation. In corn silage, the pH should be below 4.

Act III. Super villains rebound. When there is a concern about aerobic stability, a *L. buchneri* inoculant can be added to the forage that over time will degrade lactic acid and make equal amounts of acetic acid, 1,2-Propanediol and CO_2 (AEM 67:125). The *L. buchneri* needs to be added at a rate of $4x10^5$ CFU/g in order to produce sufficient levels of acetic in the low pH forage. Only the acetic acid is responsible for increasing the aerobic stability of silage. BUT, the production of the acetic acid is also associated with additional dry matter loss as CO_2 is produced. Sometimes, lurking on the sidelines is another villain, called *L. diolivorans*, converting the 1,2-Propanediol to 1-propanol and propionic acid (IJSEM 52:639). This fermentation profile is an example of corn silage that was treated with a homofermentive inoculant in order to achieve a low pH (3.8). In this situation, the fermentation was "hijacked" by native, acid-tolerant *L. buchneri* that continued to grow at low pH and produce acetic acid and 1,2-propanediol that was further converted by *L diolivorans* to 1-propanol and propionic acid. Due to the acid tolerant (<3.8) nature of this villain, there are no known remedies. The slightly elevated ethanol is likely caused by yeast, whose growth may also be contributing to the high, unexpected levels of acetic acid. This is a good example of the "unknowns" that affect ferentations!

Lactic Acid and Volatile Fatty Acids:		
Lactic Acid	2.73	%DM
Acetic Acid	4.04	%DM
Propionic Acid	0.35	%DM
Butyric Acid	ND	%DM
Iso-butyric Acid	ND	%DM

Alcohols, Acetates, and Lactates:		
1,2 propanediol	1.060	%DM
1-propanol	0.467	%DM
Methanol	0.022	%DM
Ethanol	0.858	%DM

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