Silage Fermentation Problems

by Joel Bagg, Forage Specialist, OMAFRA

When we make corn silage and haylage, we are using our skills as microbiologists, just like winemakers, brewers and composters. As a biological system, silage making doesn't always work perfectly. During an anaerobic silage fermentation, microorganisms feed on sugars and other soluble carbohydrates in the forage material and produce organic acids, such as lactate and acetate. This lowers the pH and creates an environment where the resulting silage is preserved. We sometimes have less success making silage, because of management, the weather and what we have to work with.

An efficient fermentation is desirable for 2 reasons:

- to preserve nutrients to optimize livestock intake and performance, and
- to minimize forage dry matter lost in the fermentation process and spoilage at feedout. Fermentation losses can be 12 - 15% with a good fermentation, and much higher with a poor one. Spoilage losses can be significant.

We know what we have to do to make good silage - cut at the right maturity and moisture, chop at the right length, use inoculants strategically, keep it anaerobic (without oxygen) by filling the silo quickly, adequate packing, covering and sealing it well and right away, face management, etc, etc. However, sometimes things don't go well and we end up with high fermentation losses, poor nutrient quality and palatability, and silage that wants to spoil easily. It can be useful to determine what went wrong and know how to avoid that the next time.

Common Silage Problems

When we encounter problem silage, it is usually the result of incorrect moisture or the presence of oxygen. Odours can be good indicators. Here are a few problems that we might smell and what might have caused it.

1. Rancid, Fishy Odour

This is butyric acid resulting from clostridia contamination from soil. Clostridia silage can result from cutting or raking too close to the ground, soil from packing tractor tires, "splash" from rain, or manure applied too late after the previous cutting. Butyric acid also commonly results from silage that is too wet (> 70% moisture). As well as its foul odour, this silage sometimes has a slimey, sticky texture. Haylage can clump into characteristic "butryic balls". Fermentation losses of non-structural carbohydrates are high, so ADF levels are high. Protein is degraded. Palatability, intake, and digestible energy are low, and livestock performance is poor. We saw lots of this in 2008, when we struggled to get haylage made between frequent rains.

2. **Mouldy With A Musty Odour**

Mouldy silage results in high dry matter losses, as well as poor palatability and livestock performance. This spoilage is the result of aerobic (oxygen) conditions from poor

packing, slow filling, low moistures, poor sealing, slow feedout, or poor face management. If the silage is still hot, microbial activity and spoilage is still underway.

3. **Vinegar Odour**

Acetic acid is more commonly known as vinegar. Lactic acid is the most desirable product of fermentation because it is produced most efficiently, with the least dry matter losses. Too much acetic acid relative to lactic acid means the fermentation was less than optimally efficient, and possibly could have benefited from a commercial lactic acid bacteria (LAB) inoculant.

4. Sweet Odour

This smell is likely high concentrations of ethanol produced by spoilage yeasts, mixed with acetic acid. Fermentation losses were likely high and this silage will be prone to heating and spoiling in the bunk. Desirable lactic acid has little smell.

5. Ammonia Odour

This indicates excessive protein breakdown to ammonia and amines, which could be due to a clostridia fermentation or high pH.

6. Carmelized Odour

This heat damaged haylage is dark in colour with a tobacco odour. In severe cases it can smell burnt, indicating excessive heating. Heat-damaged silage is the result of forage that is too dry. Protein becomes bound and is less digestible. ADF-N (unavailable nitrogen) can be measured in a laboratory.

Fermentation Analysis

A newer technology available in silage problem-solving is fermentation analysis. It enables us to objectively quantify what we subjectively see and smell. This can be especially useful when poor livestock performance cannot be explained by nutrient analysis. Fermentation analysis is available in Ontario from Agri-Food Laboratories, and some U.S. labs. Typical fermentation end product concentrations are listed in Table 1.

Table 1 – Typical Levels of Silage Fermentation End-Products (dry matter basis)

	Corn Silage	**Legume Haylage** >65% moisture	**Legume Haylage** <55% moisture	**Grass Haylage**
pH	3.7 – 4.2	4.3 – 4.5	4.7 – 5.0	4.3 – 4.7
lactic acid %	4 – 7	7 – 8	2 – 4	6 – 10
acetic acid %	1 - 3	2 – 3	0.5 – 2.0	1 – 3
propionic acid %	< 0.1	< 0.5	< 0.1	< 0.1
butyric acid %	0	< 0.5	0	0.5 – 1.0
ethanol %	1 – 3	0.5 – 1.0	0.5	0.5 – 1.0
ammonia-N (% of CP)	5 - 7	10 – 15	< 12	8 - 12

Source - Dr Limin Kung, University of Delaware

1. **High pH**

A high pH indicates a poor or restricted fermentation that will be less stable and result in poor bunk life and more spoilage at feeding. Legume haylage has a higher buffering capacity than grass haylage and corn silage, and quite often has a higher pH.

2. **Low Lactic Acid**

Lactic acid should make up over 65-70% of the total silage acids, with a lactic/acetic acid ratio of at least 3:1. Lactic acid is the most effective in lowering pH, and is what we are trying to improve by using a commercial LAB inoculant.

3. **High Acetic Acid**

Acetic acid levels greater than 3 – 4% can result from poor fermentations, especially if lactic acid levels are significantly low. Buchneri inoculants are sometimes added to corn silage and high moisture corn to produce acetic acid late in the fermentation to improve bunk life. Don't mistake this for a poor fermentation.

4. **High Ethanol**

High ethanol indicates yeast that reduces dry matter recovery and makes the silage more prone to mould and feedout spoilage. Off-flavours in milk can also sometimes result.

5. **High Ammonia-N**

This indicates excessive protein breakdown and possibly excess ruminally-degraded protein. Levels greater than 12 – 15% can be a problem for the dairy nutritionist.

6. **Butyric Acid**

This is the bad one! If it it accompanied by high percent moisture and/or high ash content, then that confirms what management issue needs to be corrected. In the silo, butyric acid results in high losses of dry matter and digestible energy. In the ruminant it results in poor intakes and metabolic problems. If possible, silage high in butyric acid should be discarded. Dr Gary Oetzel, University of Wisconsin, recommends the following butyric acid daily limits to prevent off-feed and ketosis in dairy cows:

- fresh cows - < 50 grams
- early lactation - <150 grams
- all other lactating cows - < 250 grams.

Diagnostic Tool

Whatever the results of your fermentation analysis, the reality is that you're likely stuck with the silage you have for the year. But, using what you see and smell, combined with a fermentation analysis as a diagnostic tool can help in identifying what can be improved in your silage making in the years ahead. For more information on silage making, refer to the OMAFRA Forage Website www.omafra.gov.on.ca/english/crops/field/forages.html#storage.