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Cooperative Extension Service

Interpreting Baleage Fermentation Test Results

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Baleage is the wrapping of bales of wilted forage such that anaerobic fermentation occurs. Most commonly made with large round bales, larger rectangular bales may also be stored as baleage.

Baleage is a beneficial option for making high-quality stored forage in Kentucky because it allows greater ability to harvest forages at optimum stages of maturity. In addition, the shortened time from cutting to baling/wrapping helps to avoid rain damage.

Baleage technology is well proven but not without challenges. Most of these challenges revolve around achieving a moisture content in the target range of 40% to 60%. A brief guide to making high quality baleage is at the end of this publication. Getting a fermentation report and fully understanding its terms will provide many insights into the adequacy of fermentation including how to recognize poor quality baleage.

Interpreting the key terms on a fermentation report

Moisture/Dry Matter (DM)

The moisture content (MC) of the forage as tested.

The MC of baleage should fall between 40% and 60% to be conducive to good fermentation and to inhibit the growth of clostridial bacterial. This moisture range is lower than that for chopped silage. Fermentation results are better when MC is between 50% and 60%. Baleage with MC below 50% will have limited lactic acid production and pH values usually above 5.0. With baleage, it is safer to be too dry (less than 40% MC) rather than too wet (above 65% MC) because undesirable, clostridial fermentation is more dominant at MC above 65%.

Research has shown that as long as wrapped bales are kept anaerobic (six layers of plastic, holes patched), baleage will be stable in storage even though pH and lactic acid values are less than optimum. This baleage will degrade quicker than well-ensiled material when re-exposed to oxygen, and each bale should be consumed in less than two days. The cold temperatures during winter also inhibit degradation of baleage re-exposed to oxygen.

Crude Protein

The estimate of the protein value of baleage, calculated by measuring nitrogen (N) content and multiplying by 6.25.

Higher crude protein values are associated with early cut forages (vegetative to early reproductive stage) and often indicate a higher level of readily fermentable carbohydrates.

Lactic Acid

The product of anaerobic fermentation of soluble sugars and carbohydrates by lactic acid bacteria.

Lactic acid values of 3% or greater are desired in baleage (DM basis). Lactic acid values are frequently below 3% in baleage and are generally lower than in chopped haylages because the fermenting bacteria (on the plant surface) have limited access to the fermentable, soluble carbohydrates inside plant cells. Lactic acid should be the dominant acid in well-fermented baleage, present in greater quantities than acetic, propionic, or butyric acids.

Getting a Fermentation Report of Ensiled Forages

- Allow forage to ferment for at least four weeks prior to sampling.
- Take a representative sample with a forage-coring device and seal sample in a ziplock-style freezer bag. Keep under ice or frozen until shipment to the forage laboratory.
- Send frozen in an insulated container to a commercial laboratory, specifying that they perform a test of the nutritive quality and the fermentation profile of the forage (two separate tests).

Acetic Acid

Acetic acid inhibits yeast and mold growth and helps keep baleage from spoiling during feeding.

Concentrations of acetic acid may be 1% to 4% (DM basis) and ideally no more than half of the lactic acid present. High acetic acid levels can reduce forage dry matter intake. Elevated acetic acid levels (>4%) can be caused by very high moisture (>75%), slow fermentation (possibly due to high protein content which buffers pH change), or loosely packed baleage. Some clostridial fermentations can produce excessive levels of acetic acid.

Propionic Acid

Propionic acid levels should be less than 0.5% to 1% (DM basis). High levels indicate that insufficient sugar was available for fermentation.

Butyric Acid

Butyric acid should be no more than 0.5% (DM basis) and ideally less. Cattle intake has been shown to be depressed by as little as 0.3% butyric acid. Elevated butyric acid means the baleage has undergone secondary fermentation by clostridial bacteria. High butyric acid levels are associated with very wet forages, forages contaminated with dirt and manure, and mature forages that do not undergo a quick pH drop.

Total Acids or Total VFA

Total acid or total VFA (volatile fatty acid) is the total of all the fermentation acids in a sample (lactic, acetic, propionic, and butyric and iso-butyric acids), expressed on a dry matter basis.

pH

The acidity of the baleage.

Fermentation of forage leads to a drop in pH due to the production of acetic and lactic acids. Ideally baleage should have a pH of 5.0 or below to inhibit secondary fermentation by clostridial bacteria. However, the pH necessary to inhibit clostridial fermentation depends on the type of forage (grass vs. legume) and the moisture content of the baleage (Figure 1). Legumes do not need to be as acidic as grasses to inhibit clostridial growth. Most importantly, clostridial bacteria are inhibited by MC below 60%.

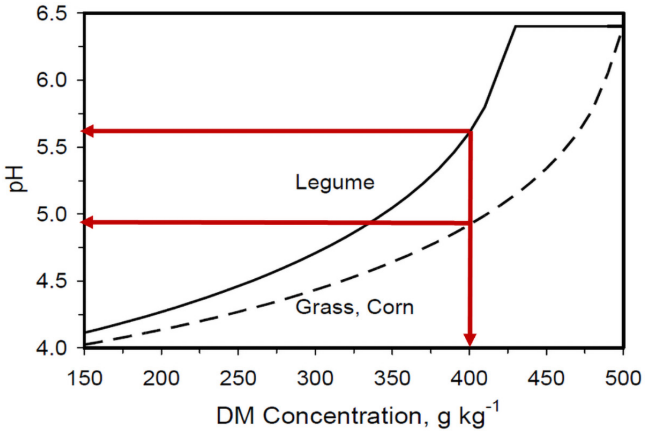

Figure 1. The effect of DM (dry matter) concentration and forage type on the minimum pH to inhibit the growth of *Clostridium tyrobutyricum*. At 40% DM (400g DM per kg of baleage, equivalent to 60% moisture), the pH required to inhibit the growth of *C. tyrobutyricum* is around 5.0 for grasses and 5.7 for legumes, as indicated by the red arrows (from equations reported by Liebensperger, R.Y. and R.E. Pitt, 1987, Grass Forage Sci. 42:297).

Ammonia, Crude Protein Equivalent

The amount of ammonia (NH_3) present in baleage expressed as crude protein.

Some ammonia in baleage is acceptable. Excessive amounts indicate that clostridial fermentation has taken place.

Ammonia-N, Percent of Total N

The proportion of the total nitrogen present in a forage that is ammonia.

Ammonia-N levels above 15% are associated with high butyric acid content and indicate clostridial fermentation has occurred.

Ash

The fraction of the forage that is inorganic minerals.

Standing forage is about 8% to 10 % ash (DM basis). Elevated ash content (>11%) indicates that the baleage has been contaminated with dirt. Dirt is the primary way clostridial bacteria get into baleage.

Observations matter

To assess the quality of baleage fermentation, observations can tell you a lot. Good baleage will have a pleasant odor, while butyric acid baleage can have a putrid odor. Squatting bales and seeping effluent are indications of overly wet forage which has likely undergone undesirable fermentation. Finally, wrapped bales with large rips or punctures, especially when formed soon after baling, will lead to poor fermentation in that area and in extreme cases, botulism.

If you make baleage, you need to know how well your forage has fermented by sending a core sample, frozen, to a commercial laboratory for analysis. The definitions above will aid in interpreting the results found in that report.

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Considerations for Making High Quality Baleage

- Harvest at the late boot stage for grasses and early bloom for legumes.
- Using a mower-conditioner will speed wilting of alfalfa and tall growing summer annuals but is not necessary for baleage production
- Setting the mower swath as wide as possible will enhance the surface area exposed to sunlight and increase the drying rate.
- Wilt to 55-65% moisture.
- Set rake correctly to reduce soil in the forage.
- Start to bale at the higher end of the acceptable MC range. Moisture content drops quickly during warm, sunny conditions.
- Ensure that bales are tightly compacted. Size uniformity is especially helpful when inline wrappers are used because this facilitates a more air-tight seal at the junction between bales.
- Make bales slightly smaller than dry hay to keep weight manageable.
- Use net wrap, plastic twine, or untreated sisal twine.
- Wrap bales the same day that they are made.
- Wrap at storage site.
- Use a minimum of six layers of a high-quality uv-stabilized silage film made for bale silage.
- Monitor bales for damage to the plastic and repair holes immediately with a uv-stabilized tape designed for silage film.
- Feed all bales by the next season.

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