Evaluation of Corn Silage Quality for Beef Cattle

Corn silage is widely used as an energy and roughage source for beef cattle. It can be used as the main forage source for cattle raised in feedlots or it can be fed in conjunction with other forages including pasture grasses. Corn silage is popular because it can generally produce more nutrients per acre than other crops. Harvesting corn for silage furnishes 50 to 60% more nutrients per acre for beef cattle than harvesting the grain alone. It is relatively high in metabolizable energy (ME) but is low in protein content. The grain in corn silage makes up about half the dry weight and two-thirds of the nutrient value. Cattle are easily transitioned from corn silage to a high-grain finishing ration. Corn silage is often used to furnish minimum roughage levels in high-grain finishing rations.

To reap the benefits of corn silage, it must be high quality. Factors that can affect silage quality include: hybrid selection, growth stage and moisture levels at harvest, the fermentation process, storage, and management of the removal rate. Finally, it is essential to get silage analyzed at a lab to determine dry matter content and nutrient levels before formulating rations.

Harvesting Corn Silage. Nutrients in corn silage are directly related to the percentage of dry matter (DM) in the silage. Thirty five percent DM is considered ideal for silage. Typically, corn at the R6 growth stage (also known as black layer) can have an average kernel moisture content of 30 to 35%; however, this can vary among hybrids and environmental conditions. Research has also shown that the corn growth stage during harvest can influence silage digestibility and ME. Silage should be harvested when corn grain is well dented but before the leaves turn brown and dry and when dry matter is between 30 to 40%. If ensiling is delayed and/or late, digestibility and weight gain can be reduced. Lastly, no matter what the maturity and moisture level, corn silage should be cut at 3/8 (unprocessed) to 3/4 inch long (processed) depending on whether the corn chopper had a processor, the storage structure, and packing capabilities.

Fermentation and Storage. Approximately three weeks after storage, the fermentation process is complete and silage is ready to be fed. In upright silos, silage spoilage can be avoided if two inches of the silage is removed daily in winter as well as three inches daily in the summer. In horizontal/trench silos, an additional inch per day should be removed during each season. Dry matter losses may be greater in trench than in conventional tower silos. The losses can be kept similar if trench silos are built with 12- to 16-feet side walls. This is because depth improves compaction, decreases oxygen, and reduces the percentage of total volume exposed to surface spoilage.

If silos drain, nutrients can be lost in the drainage. Horizontal and small tower silos have little seepage when DM levels range from 30 to 35%. However, large tower silos (30 feet X 70 feet) may have seepage even when silage is stored at 35% DM.

Opinions vary regarding the addition of enzymes, yeast cultures, or acid-forming bacteria to improve silage quality. Some specific examples are presented in Table 1.

Laboratory Analysis. Laboratory analysis should be completed on corn silage to determine dry matter content and nutrient levels for use when formulating rations. Table 1 defines the silage components that may be found on lab reports, and also includes factors that may influence components and how to interpret the results.
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Table 1. End products or silage components and factors that may affect each them.

<table>
<thead>
<tr>
<th>End Product</th>
<th>Description and Factor that may effect the End Product</th>
<th>Corn Silage (30-40%)</th>
<th>High Moisture Corn (70-75%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>pH</td>
<td>pH is a measure of acidity. It is affected by the buffering capacity of the crop. Two samples may have the same pH, but different concentrations of acids. Corn silages rarely have a pH &gt; 4.2. Corn silage that does have a pH &gt; 4.2 is associated with extremely dry (&gt;42% dry matter) silages that are overly mature or drought stricken.</td>
<td>3.7 - 4.2</td>
<td>4.0 - 4.5</td>
</tr>
<tr>
<td>Lactic acid (%)</td>
<td>Lactic acid should be the primary acid in good silage. This acid is stronger than the other acids in silage and is usually responsible for most of the drop in silage pH. Reasons for low lactic acid are usually due to restricted fermentation caused by: high DM content, cold weather, or the sample being taken after considerable aerobic exposure that can degrade the lactic acid. Silages high in butyric acid typically have low lactic acid.</td>
<td>4.0 - 7.0</td>
<td>0.5 - 2.0</td>
</tr>
<tr>
<td>Acetic acid (%)</td>
<td>High concentrations of acetic acid (&gt;3-4% of DM) can take place from extremely wet silages (&lt;25% DM), prolonged fermentations (due to high buffering capacity), loose packing, or slow silo filling. Silages with high acetic acid energy and DM recovery are typically less than desired. Because the addition of ammonia raises the pH which prolongs fermentation, silages treated with ammonia also tend to have higher concentrations of acetic acid than untreated silage. Lactobacillus buchneri is a microbial inoculant created to try and improve aerobic stability of silage. It can raise acetic acid concentrations however; production of acetic acid from this organism should not be mistaken for poor fermentation. The effect of high concentrations of acetic acid (&gt;4-6% of DM) in silages fed to animals is unclear. Past studies found that DM intake was reduced when silage contained high acetic acid concentrations; however, those results have not been consistent. Decreased intake may be due to factors associated with a poor fermentation and not with acetic acid specifically. In recent studies, animals showed no indication of reduced intake when fed silages high in acetic acid due to inoculation with the bacteria Lactobacillus buchneri for improved aerobic stability. If intake problems occur due to silages with excessively high acetic acid (&gt;5-6% of DM), the amount of that silage fed should be reduced. Other options for managing these silages include: aerating the silage for a day to volatilize the acetic acid, removing the silage and then gradually reincorporating it back into the diet over a 2–3 week period, and partially neutralizing the silage with sodium bicarbonate prior to feeding (about 0.5-1% addition on DM basis).</td>
<td>1.0 - 3.0</td>
<td>&lt;0.5</td>
</tr>
<tr>
<td>Propionic acid (%)</td>
<td>Chemical additives containing propionic acid can be the most effective at increasing the concentration of this acid in silages. These additives can range markedly in their percentage of active ingredients but most products will increase the concentration of propionic acid at ensiling from 0.0-0.15% and 0.015-0.30% (DM basis) if added at 2-4 lb per ton of wet (~35% DM) silage. There are also biological additives that are supposed to increase the propionic acid concentration of silage. These additives usually contain bacteria from the Propioni bacteria family. According to the University of Wisconsin, research suggests that these organisms are usually unable to compete in normal silage environments and are therefore typically ineffective.</td>
<td>&lt;0.1</td>
<td>&lt;0.1</td>
</tr>
</tbody>
</table>
| Butyric acid (%) | High concentrations of butyric acid (>0.5% of DM) indicate that the silage has gone through the poorest fermentation, known as clostridial fermentation. These silages typically are:  
• low in nutritional value and have higher acid detergent fiber (ADF) and neutral detergent fiber (NDF) levels because the soluble nutrients have been degraded.  
• high in concentrations of soluble proteins and may contain small protein compounds called amines that have sometimes shown to adversely affect animal performance.  
• high in butyric acid which has been linked to inducing ketosis in lactating cows. Total removal or dilution of poor silage is recommended. | 0 | 0 |
| Ethanol (%) | High concentrations of ethanol are usually an indicator of excessive metabolism by yeasts. Dry matter recovery can be worse in silages with large numbers of yeasts. These silages may also be prone to spoilage when the silage is exposed to air. Usual amounts of ethanol in silages are low (< 1-2% of DM). In addition, extremely high amounts of ethanol (> 3-4% of DM) in silages may cause off flavors in milk. | 1.0 - 3.0 | 0.2 - 2.0 |
| Ammonia-N (% of CP) | Silage can have higher concentrations of ammonia for the following reasons:  
• Silage is too wet (< 30% DM) due to the potential of clostridial fermentation.  
• Silage is packed too loosely and filled too slowly.  
• Silage has excessive protein breakdown in the silo from a slow drop in pH or clostridial action.  
High amounts of ammonia alone should not have a negative effect on animal performance if the total dietary nitrogen portions of the silage are in balance. Conversely, if high ammonia contributes to excess amounts of ruminally-degraded protein (RDP), this could have a negative effect on milk and reproductive performance.  
To look for excess RDP, blood or milk urea nitrogen concentrations can be checked. Silage with high concentrations of ammonia coupled with butyric acid may also have significant concentrations of other undesirable end products, such as amines, that may reduce animal performance. | 5.0 - 7.0 | <10 |

Source: Kung and Shaver 2001

Sources:

Individual results may vary, and performance may vary from location to location and from year to year. This result may not be an indicator of results you may obtain as local growing, soil and weather conditions may vary. Growers should evaluate data from multiple locations and years whenever possible. ALWAYS READ AND FOLLOW PESTICIDE LABEL DIRECTIONS. Technology Development by Monsanto and Design(SM) is a servicemark of Monsanto Technology LLC. All other trademarks are the property of their respective owners. ©2019 Monsanto Company. AWWW07130.