The Role of Silage Inoculants

Lane O. Ely

University of Georgia

To understand the role of silage inoculants, one must understand the fermentation process to make silage. Silage is a form of preserved forage that can be fed at a later time. It is preserved by producing acids to lower the pH and the elimination of oxygen in the silage mass. Silage is produced so animals can be fed high quality forage year round.

The goal of the silage fermentation is to preserve as many nutrients as possible and have stable forage. The fermentation goes through several phases.

The first phase is the aerobic or removal of oxygen phase. It is characterized by cell respiration which uses the oxygen to produce CO_2, water and heat. Yeast and molds can also utilize nutrients during this phase. The process should go quickly as the longer it takes more nutrients will be used.

Phase II starts when the oxygen is depleted. Anaerobic bacteria begin to ferment the water-soluble carbohydrates (WSC) to produce acetic acid, some lactic acid and CO_2. PH declines from 6.5 in Phase I to 5.0 in this phase. This helps to inactivate some of the plant enzymes and to encourage lactic acid producing bacteria. Lactic acid is a stronger acid than acetic acids and therefore contributes to a more rapid decline in pH. Temperatures will start to decrease from the peak on Phase 1. This phase should be fairly rapid, lasting 24 to 72 hours. If it lasts longer, more of the WSC will be used with less lactic acid produced. Also other bacteria can grow that will utilize the protein. These bacteria include the clostridia and listeria.

Phase III is when the lactic acid bacteria (LAB) dominates the anaerobic fermentation. This is the longest phase. Carbohydrates are utilized to produce lactic acid and lower the pH. This phase continues until the pH drops below 4.2 and inhibits the activity of the bacteria. This phase should be completed by day 21.

Phase IV is the stable phase. If oxygen and moisture are kept out of the silage mass, it will remain stable and little further activity or loss of nutrients will occur. Silage can stay in this phase for years as long as moisture and oxygen are prevented from the silage mass.

Phase V is the feed-out period. There will be a secondary aerobic activity when oxygen is reintroduced at the silage face. Yeasts and molds can multiply and consume nutrients. Removing adequate minimum amounts of silage will help minimize their losses.

Good silage management is essential for a successful fermentation. The first step is to harvest the crop at the proper stage of maturity. As a crop matures, the dry matter (crop material) will increase but the digestibility will decrease. The proper stage will depend on the crop being harvested and the animal to be fed. Typically, this is early seed formation.

Crop moisture is critical. A crop too wet will result in a slower fermentation and the loss of WSC from run-off. Ideally, crop moisture should be between 65-70% and 20-35% dry matter. Most direct cut crops are 20-25% dry matter. Therefore, the crop needs to be wilted to increase the dry matter content. This results in an increase in respiration loss but will increase the efficiency of fermentation.

The next step in good silage management is to fill, as fast as possible, pack and seal the silo. Fast filling and packing will help to eliminate oxygen and to shorten the respiration phase.

Chop length can help with the packing and limit the oxygen trapped in the silage mass. Too short a cut will help the fermentation but will have a negative function on rumen activity.

Good management will help insure a successful fermentation but the proper bacteria are needed. Under normal conditions, the natural bacteria population is adequate for the fermentation but this can be very variable and not guaranteed.

The use of bacteria as a silage inoculant has been used for many years. One of the first areas of study was the level of bacteria to be added. It was found that the added inoculate needed to have a higher level of bacteria than the natural population to have an effect. Next various LABs were studied to select the most efficient species. Today many inoculants have been selected for specific crops.

The objective of adding inoculants is to increase the amount of lactic acid and to produce it in a shorter time. Looking at our fermentation pattern, this should increase dry matter recovery. Also the more rapid pH drop should decrease the breakdown of plant proteins.

A negative to the increased lactic acid is that the resulting silage has a shorter bank life during feed-out. Since acetic acid has an inhibiting effect on yeast and molds, it will increase bank life.

Silage inoculants should not be used as a substitute for poor management. Good silage management is necessary for the inoculants to function properly. Trials over the years have not always had positive results. Several factors could be contributing such as poor management, natural lactic acid bacteria population, and low WSC content. Crop specific bacteria have been developed and the use of these bacteria on other crops may have poorer results.

Should one use an inoculant? This question always needs to be asked. There is increasing evidence for increased DM recovery, digestibility and bank life. Some of the limitation s previously mentioned will influence their results.

When choosing inoculants, one should look at the research and data supporting the inoculant. Choose an inoculant that is crop specific for your cop. The inoculants should have 90 billion units of live bacteria to ensure that it will compete with the natural population.

It is recommended to apply the inoculants as a solution for better distribution. Application at the chopper gives the best distribution.

Inoculants are relatively inexpensive and help insure a fast, efficient fermentation. The difficulty is determining if one needs the inoculants as that cannot be predicted before ensiling a crop.