AGRI-VIEW

VOL. 33 - NO. 30 Thursday, July 26, 2007 Reprint - Page D-1

Additives Make Silage, TMRs More Stable

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After all the labor and expense tied up in planting corn and harvesting silage, the last thing producers want to have happen is heating and spoilage. Inoculating can help with silage fermentation quality. And in instances where spoilage is still a major factor, preservatives such as buffered propionic acid and newer inoculants designed to improve aerobic stability (like L. buchneri) can be used. Research suggests that treating silage with preservatives at ensiling is better than trying to treat a TMR.

Rapid removal of air from silage preventing air from infiltrating during storage and feedout can have "profound effects" on feed quality, says Limin Kung, Jr. at the University of Delaware's Dairy Nutrition and Silage Lab.

Exposure to air at the start of fermentation prolongs unwanted microbes that thrive in air and delays the growth of beneficial bacteria that produce lactic acid, leading to undesirable fermentation and loss of nutrients. Prolonged air infiltration during storage and feedout can lead to aerobic spoilage. "Silage that is unstable when exposed to air heats rapidly and spoils, leading to loss in dry matter (DM) and nutrients with the potential for production of undesirable compounds," says Kung, noting that dry matter loss due to spoilage in storage may be as high as 30 to 40 percent.

"Even short term exposure to air results in losses," he notes, pointing out that in one study, DM losses from corn silage exposed to air for just one to two days was measured to be as high as 6 percent. "In addition, much of the readily spoiled DM is of high quality." And besides an economic loss of nutrients, feeding spoiled silage to ruminants depresses intake and decreases production.

Aerobic stability is how much time silage remains cool and doesn't spoil after it's exposed to air. "Exposure to air is the first domino to fall that causes a chain reaction, ultimately resulting in spoiled feed," Kung remarks.

The "domino effect" is: silage exposed to air; dormant yeast that degrade lactic acid revive; yeast degrade lactic acid to carbon dioxide and water (producing heat); yeasts increase in the silage mass; the pH of silage rises because of lactic acid metabolism; molds (like Aspergillus, Fusarium and Pencillium) and aerobic bacteria (Bacilli) revive and further degrade the silage; massive spoilage.

Kung admits the exact causes of reduced intake and/or performance when animals consume spoiled silage aren't fully understood. "Detrimental yeasts may produce end products that might alter rumen fermentation. The direct consumption of spoiled nutrients may reduce performance, and the production of undesirable end products (mycotoxins) from further spoilage by molds and other organisms may also be a problem," he discusses. Nevertheless, producers often have problems when yeasts number a million per gram of silage. Under optimum conditions, yeasts can double in number in about two hours. It's quite normal for corn silage to start with 100,000 yeasts per gram; that sample could contain 1.6 million in just eight hours.

Here are some factors that may make silages more prone to aerobic spoilage:

- High starch or sugar content (yeast use sugar and starch as energy sources during fermentation) – High moisture corn and corn silage tend to be most prone to aerobic spoilage
- High DM content (high DM restricts fermentation and reduces acids that could prevent growth of yeasts and high DM crops are more difficult to pack and thus allow infiltration of air into the mass) – Haylage ensiled greater than 50 percent DM and corn silage ensiled over 40 percent DM
- Poor pack density (allows penetration of air into the silage) – Fill rate too fast and/or insufficient tractor weight
- Poor silage management (allows air penetration) – Slow silage removal, knocked down silage, uneven silage face, intermediate feeding piles, moved silage
- Poor management of plastic and weights (allows air to penetrate) – Torn bag silos, torn silo covers, insufficient weight on plastic, plastic pulled back too far in advance
- High ambient temperature (spoilage organisms grow faster in warmer weather) – More spoilage in the summer than winter months
- Addition of spoiled feeds to a TMR (spoiled feeds bring spoilage organisms to the TMR) – Spoiled wet distillers grains
- Overly dominant homolactic acid fermentation (high concentrations of lactic and very low concentrations of other organic acids that have antifungal properties) – An extremely dominant homolactic acid fermentation caused by microbial inoculation.

TMRs more vulnerable

"Because silages are often incorporated into TMRs, the stability of the TMR may also be an issue on many farms," notes Kung. A survey of TMRs in Delaware, Pennsylvania and Maryland over two years revealed that more than half of 30 TMRs sampled within one hour of being made) spoiled in less than 12 hours when incubated at a controlled lab temperature around 72 degrees. "On these farms, the TMR had the potential to spoil in the feed bunk even if these farms were feeding twice daily," says Kung. "Additionally, the sampled TMR would have spoiled even quicker if they were incubated at ambient temperatures encountered during an average summer day (high of 80 to 90 degrees)." He says the numbers of yeasts were greater and aerobic stability of these TMRs generally shorter than what's usually observed in lab silages alone, the reason being the silages used to make the TMRs had likely already gone through some degree of aerobic exposure and spoilage before being mixed into the TMR.

Reduce spoilage

Buffered propionic acid enhances aerobic stability of silage. These products are generally non-corrosive and safe to handle.

"Undissociated propionic acid has strong antifungal properties, and the fraction of propionic acid that is undissociated is dependent on pH. At the pH of a standing crop (about 6) only about 1 percent of the acid is in the undissociated form, whereas at a pH of 4.8, about 50 percent ofthe acid is undissociated.

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The undissociated acid functions both by staying active on the surface of microorganisms and competing with amino acids for space on active sites of enzymes and by altering the cell permeability of microbes," he explains of how it functions.

Applications of buffered "prop" range from 1 to 6 pounds per ton of silage. He questions the efficacy of low application rates. "For example, if we added two pounds of a product that contained 65 percent propionic acid to 35 percent DM corn silage, this would increase the propionic acid content in that silage by 0.18 percent on a DM basis." In previous studies they've found that, as expected, the effectiveness of prop-based additives increases with higher applications rates.

A less commonly used additive to control yeasts and molds is anhydrous ammonia (5 to 7 pounds per ton). Operator safety during application is a major drawback. Rations with ammonia treated silage must also be carefully balanced for proper amounts of rumen-degradable and undegradable protein.

Urea, he notes, is generally less effective at improving aerobic stability than ammonia.

Bacterial inoculants (based on homofermentative lactic acid bacteria) are commonly added to silages to improve fermentation and increase DM and energy recovery. "However, most of these inoculants do little to inhibit growth of yeasts because they tend to maximize the production of lactic acid (poor antifungal activity) and decrease the accumulation of volatile acids that have good antifungal activity," Kung explains. A literature summary showed that treating with classical homolactic acid-based inoculants improves aerobic stability about a third of the time and have not effect about a third of the time, while making aerobic stability worse about a third of the time.

More recently, Lactobacillus buchneri (i.e. L. buchneri), which Kung refers to as an "obligate heterolactic acid bacterium – has been used as a silage inoculant to enhance aerobic stability of corn silage, as well as sorghum, barley, alfalfa, ryegrass and orchardgrass silages. He says a "moderate increase in the concentration of acetic acid has been the hallmark of this effect."

Multiple studies show that inoculating with L. buchneri decreases the concentration of lactic acid and increases the concentration of acetic acid in corn silage. Treating corn silage even with lower application rates of L. buchneri has resulted in a 10-fold decrease in numbers of yeasts compared to untreated silage, and higher rates decreased yeasts by more than 100-fold. Associated with these lower numbers of yeasts was improved aerobic stability. And Kung notes that preliminary concerns about potential large losses of DM from silages treated with L. buchneri because of its heterolactic nature don't appear to be substantiated by studies.

"The loss of DM in corn silage by the higher application of L. buchneri was one percentage point more than for untreated silage. Relative to the potential beneficial effects of improved aerobic stability during storage and feeding, these losses are small," he says, adding that "although some have suggested that high levels of acetic acid in silages may depress intake, research studies have shown that ruminants fed silages treated with l. buchneri consumer the same amount of DM when compared to counterparts fed untreated silages."

And while most research on improving the aerobic stability of silages has dealt with the stability of the silages alone, there is good evidence, says Kung, that if silages are stable, their resulting TMR will also be stable. In two studies, TMRs made with silages treated with L. buchneri were more stable than TMRs made from untreated silages.

When to use additives

Kung provides some scenarios when producers should use additives to enhance aerobic stability. He says they may be called for to treat "historic problems of silages heating in the silos" due to oversizing, slow feedout rate, poor packing and filling. Corn silage or high moisture corn that'll be stored more than six to nine months or fed during hot weather are also "good candidates" for treatment.

"Consider treating specific silos or parts of a silo relative to summer feeding," he mentions. "Treating an entire silo or all of your silage may not be justifiable if the problem occurs for only a few weeks out of the year." However, he admits, "it is extremely difficult to predict in advance whether silage will remain cool."

Silage moved from one silo structure to another and purchased silage that's moved and exposed to air for several days before feeding should be considered for treatment.

Kung notes, though that spraying the face of a bunk with a propionic acid-based preservative probably isn't useful because only silage on the immediate face is protected, as air can penetrate deeply into a silage mass.

Moving silage

When moving silage, do it as quickly as possible and in the coolest weather possible. Packing density and plastic management will be critical to keep moved silage stable. "On many large dairies, it is now quite common to find several days worth of silage to be fed in temporary piles – brought in from other farms or silos and dumped at a staging area," says Kung. "During hot weather, this can be a worse-case scenario, because the moved silage is usually not repacked to exclude air." For moved silage and feeding piles, add preservatives that contain antifungal compounds (i.e. buffered propionic acid, sorbates, benzoates, acetic acid and so on) at the time of moving to enhance stability. Go with 2 to 6 pounds per ton.

He says, though, that a "better idea" would be to consider treating those silages at the time of ensiling with an additive to enhance aerobic stability (i.e. chemical additives or L. buchneri). He mentions that microbial based additives and ammonia are ineffective on forages that have already fermented.

Checking spoilage in a TMR

When dealing with heating and spoilage issues in a TMR, first try to determine the cause of the problem and fix that. If nothing can be done, then preservatives – commonly referred to as "TMR-savers" – based on buffered propionic acid are available that can be added directly to the TMR to improve aerobic stability.

Kung says the degree to which silage has spoiled in the silo and ambient temperatures will decide doses to stop spoilage in the bunk. "Thus if poor bunk management has allowed silage to spoil considerably in the silo before mixing into the TMR, high levels of additives – perhaps 6 to 8 pounds of additive per tone of TMR – may be required to prevent further spoilage in the feed bunk," he says.

To stop heating in the feed bunk with such preservatives, start with a high dose for several days. "This should temporarily fix the problem right away and also 'clean out' the equipment and feed bunks," says Kung. If stability in the bunk has been achieved, producers can slowly back off to a lower level that keeps the TMR from heating in the bunk.

"Use caution when adding any feed to a TMR that has begun to spoil prior to mixing. For example, wet distiller's grains spoils rapidly in warm weather and incorporating even a small amount of this into a TMR can make it extremely prone to aerobic spoilage, even if the silages were moderately stable," he warns.

For short-term use, TMR-savers can be helpful but they aren't economical for long-term use because the rates of addition are very high, says Kung. "For example, even added only at 4 pounds per ton of TMR, the equivalent would be adding 8 pounds of

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the product per ton of forage," he compares. "In addition, stopping further heating and spoilage in the feed bunk does nothing to stop the initial heating and loss of nutrients that occurred in the silo."

If given a choice, he says data from his lab suggests that it's better to control yeasts at ensiling rather than after the fact in a TMR. "Remember that the more yeasts that are present in the silage and TMR, the higher the dose of a TMR-saver will be needed to keep the feed from spoiling," he states.

Diagnosing problems

Silage or TMRs that are spoiling due to air exposure often have a distinct moldy smell and heat rapidly. "Heat itself is not an absolute indicator of spoilage in silage because large silos often retain relatively high core temperatures even in the winter. Thus, steam coming from the silage mass during silo removal is not necessarily a sign of aerobic spoilage," he reminds. In a recent survey, he noted core silage temperatures as high as 90 degrees in some silage for as long as 90 days. In contrast, aerobically spoiled silage can often hit temperatures as high as 120 to 130 degrees for short periods of time.

Silage can be sent to a lab to determine fermentation end products, yeasts and molds. Make sure the sample is representative of what's actually being fed. Samples for microbial analyses should be kept refrigerated – not frozen – and sent to the lab as quickly as possible (preferably stored with ice packs). This will minimize growth of yeasts and molds during transit and thus give a false reading.