dairy guidelines

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SILAGE ADDITIVES

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Most of the forage fed to Virginia dairy cattle is in the form of silage. However, the quality of this silage is extremely variable. Commercial silage preservatives are available. Do any of them help to maintain silage quality? Before attempting to answer this question, we should understand the silage fermentation process.

Proper Ensiling Techniques are Essential

Crops should be harvested at stages of maturity associated with optimal yield and quality. Best corn silage yields, and maximal animal intake, occur at the late dough stage. For hay crops, early harvesting insures maximal energy and protein levels and provides for early regrowth and greater nutrient yield per season. Alfalfa should be in the prebloom stage, while grasses should be just past heading.

To stimulate the most desirable fermentation in the silo, an anaerobic or oxygen-free atmosphere is necessary. To promote anaerobic conditions, the silo should be filled rapidly and packed tightly to exclude as much air from the silage mass as possible. The dry matter content should be between 32 to 45% for an upright silo and 30 to 40% for a horizontal silo. Poor preservation, seepage, and reduced intake occur when silage is too wet. Silages with too high a dry matter content are difficult to pack and consequently excessive air is trapped in the silage mass. The end result is a slow fermentation with higher temperatures, which reduces protein solubility and digestibility.

To compensate for the packing problem, many farmers will finely chop their silage. You can chop silage too fine for dairy cattle. Fine silage lowers fat test and contributes to digestive problems. Silage should be chopped at 1/4 inch, preferably 3/8 inch.

The presence of oxygen in silage is detrimental because it extends plant respiration. Aerobic fermentation reduces plant substrates, promotes growth of yeasts and molds, and decreases animal acceptability. The desired anaerobic fermentation is typified by the production of lactic acid and limited amounts of acetic and butyric acid. Very little protein is broken down to ammoniacal nitrogen (Table 1). The production of increased amounts of butyric acid and ammoniacal nitrogen is a good indication of poor silage fermentation.

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Table 1. Differences in fermentation products between good and poor quality silage (USDA, 1977)

	Good silage	Poor silage
Silage pH	3.8	5.3
Silage acids (% of dry matter)		
Lactic	4.2	.2
Acetic	3.3	6.4
Butyric	.02	3.6
Ammoniacal nitrogen (% of DM)	5.8	38.3

Numerous products have been promoted as silage additives. The choice includes bacterial fermentation products, such as enzyme preparations, lactic acid producing bacteria, or microorganisms that increase carbohydrate fermentation; products that inhibit undesirable bacterial and mold activity, including propionic or formic acids, formaldehyde, ammonium isobutyrate, and salts of benzoic or sorbic acid; and nutritional additives which raise the protein, mineral, carbohydrate or dry matter content (e.g., ammonia, molasses, grains, limestone, etc.).

Organic Acids

Although the addition of formic acid to silage was first proposed in 1923, interest was not wide-spread. In the 1960's, USDA scientists found that treatment of direct-cut alfalfa silage resulted in lower storage losses, decreased breakdown of protein to ammoniacal nitrogen, and decreased production of all acids. Although the results were encouraging, subsequent studies revealed that other additives were more effective. Although preservation of wilted alfalfa with formic acid, formaldehyde, or propionic acid reduced protein breakdown, formaldehyde was more effective. Studies with formic acid or formic acid plus formaldehyde resulted in silage of greater digestibility and greater silage consumption. These products have not been approved for use as silage additives.

Propionic acid was found to be an effective means of preventing mold growth in high moisture grain corn. This probably stimulated research into its possibility as a silage preservative. The addition of 12-20 lb propionic acid per ton of wilted hay crop silage will control heat damage to protein, molding, and fermentation losses. Also it prevents heating of the silage after removal from the silo. Both propionic acid and ammonium isobutyrate are effective in reducing heat development, acid detergent insoluble nitrogen, and fungal activity in alfalfa haylage, while improving nitrogen utilization.

Higher dry matter corn silages may benefit by the addition of propionic acid. No effect upon intake or milk production occurred when 35-39% dry matter corn silage was treated with propionic or formic acid. However, addition of propionic acid to 41-46% dry matter corn silage caused an increase in dry matter intake and milk production. Addition of 10-20 lb propionic acid per ton of higher dry matter corn silage should improve silage fermentation. Michigan State University estimated that this would increase income over feed cost by 9¢ per cow daily, using 1976 prices. Addition of urea eliminates the value of the acid treatment.

Other suggestions are to treat only the last few loads that go on the top to minimize top spoilage or treat that proportion of silage that will be fed during hot weather. This should delay heating.

Microbial Cultures and Enzyme Preparations

There is very little scientific information to show the pros or cons of these silage additives. Some microbial cultures or enzyme preparations are supposed to promote a desired fermentation by producing lactic acid. Research at the University of New Hampshire showed no reduction in fermentation losses when wilted hay crop silage was treated with dried bacteria or enzyme preparations. A combination of organic acids, antioxidants, and flavor compounds resulted in lower silage temperature (4-10^{o}F), and improved digestibility.

Results with lactobacilli inocula have been variable. A product with enzymes from a yeast and lactic acid producing bacteria were beneficial when fed to steers but not to lactating dairy cows (Michigan State Univ.). The greatest advantage to microbial additives may be to alfalfa, but the economic return is questionable. These additives do not appear to be beneficial to corn silage where lactic acid fermentation is sufficient.

Non-Protein Nitrogen

Non-protein nitrogen (NPN) will increase the protein content of corn silage. It is a way of feeding NPN without possible intake problems that occur when a NPN-containing concentrate is fed at milking time. The disadvantages are that NPN source must be added at ensiling, and is therefore less flexible, and can result in reduced consumption if the silage is too dry.

Various forms of NPN are shown in Table 2. Urea should be distributed uniformly throughout the silage to avoid toxicity and should not be added to silage which is over 42% dry matter. The concentrate must contain no urea. Monoammonium phosphate and ammonia-water mixtures provide additional nitrogen and phosphorus or other minerals. Sulfur content is probably low and this mineral should be supplemented.

The ammonia-molasses-mineral additive has been effective. Herds feeding corn silage (below 40-42% dry matter) at one feeding per day may find it beneficial to use this additive.

A new process is cold flow ammonia which is supposed to be easier to apply to corn silage than urea and cheaper than ammonia-water mixtures. Compressed gaseous ammonia is converted to cold liquid ammonia. It adds nitrogen to the silage and reduces top spoilage. However, certain precautions are necessary with NPN additives. Ammonia gas can build up in the silo. It has been suggested that one-third to one-half load of untreated silage should be blown into the silo before entering it.

Conclusions

Good management needs no additive. On the other hand, preservatives will not correct the problems caused by sloppy management practices. You must start with a high quality crop. The ensiling process will not make an inferior crop any better. Ensile at the proper dry matter content, chop at 3/8 inch, and fill rapidly.

Acceptable additives for corn silage include propionic acid, anhydrous ammonia, monoammonium phosphate, or ammonia mixtures. If the dry matter exceeds 40-42%, the addition of propionic acid may be desirable. Do not use NPN additives at these higher dry matter levels. If silage is to be fed only once-a-day, one of these additives might reduce the heating which occurs after aeration.

Propionic acid might prove beneficial with alfalfa silage. Formic acid and formaldehyde allow ensiling of wetter silage without the adverse fermentation that occurs in direct-cut silage; however, these products have yet to be approved.

Table 2. Non-protein nitrogen additives to corn silage (Minnesota, 1976)

	Nitrogen (%)	Nitrogen loss (%)	Level of addition (lb per ton)
Urea	45	10-15	10
Monoammonium phosphate	11	5	20
Premixed ammonia-water	20-30	10-15	25
Commercial ammonia-water	14	5	60
Commercial urea-molasses	6		80
Anhydrous ammonia	81		6
Cold flow		20-30	
Gas only		40-50	
Water (in solution)		5-15	