

CHEMICAL PRESERVATION OF ALFALFA HAY AND SILAGE

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Introduction

A wide range of substances are being marketed throughout the forage world to enhance, preserve and otherwise modify hay and silage. Some of the products are ineffective, while the benefits of others depend on the correct application and some are used at rates far below that which is effective. Alfalfa can be made into high quality hay and silage without the use of additives if recommended practices are employed, however, when the use of best management practices is not enough, additives may make economic sense. Such is the case in N.W. Europe where the weather prevents haymaking, and the high moisture, high protein, low carbohydrate ryegrasses often cannot be properly wilted and are ensiled with direct acidification.

Chemical Preservation of Alfalfa Silage

Chemicals may be added to silage made from alfalfa to preserve or stabilize it. These preservatives, which either promote favorable fermentation or substitute for natural fermentation, improve the quality of the silage by decreasing the amount and activity of yeasts, molds, clostridia, and other microorganisms. Alfalfa has properties which can lead to silage of quite variable quality and its fermentation is much slower than that of corn. This can be partially attributed to lower concentrations of lactic acid bacteria, lower levels of their substrate (water soluble carbohydrates) and the higher buffering capacity of the constituents of the alfalfa itself. Alfalfa silage ferments slowly and usually keeps populations of yeasts and molds low so that it is quite stable when opened. These limitations to fermentation of alfalfa are usually overcome by wilting to reduce the water content to between 65% and 55%. J. O'Leary of the University of Kentucky found that *Lactobacillus* levels in first cut alfalfa were low and that inoculation with *Lactobacillus plantarum* (10⁸ bacteria/ton) may improve the rate of fermentation and silage quality.

Direct Acidification: Inhibitors of Fermentation

When the forage being made into silage is known to have characteristics which are unfavorable for good fermentation and silage stability, organic acids can be used to inhibit fermentation and to substitute for the naturally-produced lactic acid. While chemically-synthesized lactic acid is best, mixtures of formic acid and formaldehyde are the most cost-effective and widely used, especially in Europe. Addition of acid at the time of ensiling drops the pH quickly to pH 4 or so depending on the amount added, and inhibits growth of all microorganisms including the favorable

lactobacilli. As a result, silage is almost instantly stabilized, and, as a consequence, the energy used to produce lactic acid is conserved so that dry matter losses are reduced and feeding value enhanced. Formic acid-formaldehyde mixtures also have the advantage of 'protecting' silage protein from digestion in the rumen. These protected proteins are available for post-ruminal digestion, and therefore, effectively increase the protein content of the silage. Formic acid-formaldehyde treated silages are not as stable as naturally fermented silage when exposed to the air. Effective rates of formic acid when used for alfalfa are about twice the 5.6 lbs of actual formic acid per ton (0.28%) required to stabilize grass silage. Formic acid solutions are about 85% formic acid.

Effective formaldehyde concentrations for alfalfa silage vary with the protein content. For alfalfa with 20% crude protein a rate of 8 lbs/ton should be used. Formalin solutions are usually about 40% formaldehyde.

Currently, formic acid is approved for use in the U.S. at the rate of 2.25% of dry matter. Formaldehyde is not approved.

Inhibitors of Aerobic Deterioration

Alfalfa silage is subject to deterioration when exposed to the air, through the action of yeasts, bacteria, and molds. Propionic acid can be used to inhibit aerobic microorganisms which lead to the deterioration of silages, but high concentrations are needed and the amount increases with moisture content. Twenty-five lbs of propionic acid are needed per ton of corn silage at 66% M.C. to prevent dry matter losses but at 72% M.C. 50 lbs/ton are needed. Propionic acid should not be incorporated in properly wilted alfalfa silage but it could be applied to open surfaces of silage when being fed and exposed to the air.

Anhydrous Ammonia

Anhydrous ammonia is the most effective additive to corn silage available for it improves silage fermentation through buffering, reduces yeasts and molds and increases crude protein levels. Anhydrous ammonia or chemically related preservatives should not be applied to alfalfa silage.

Chemical Preservation of Alfalfa Hay

Alfalfa hay should be baled at 20% M.C. to minimize losses in dry matter and deterioration in quality. When baled above 20-25% M.C. aerobic microorganisms proliferate and consume large amounts of high quality nutrients. The heat produced by fermentation in wet hay may also result in the denaturation and condensation of the proteins to reduce protein digestibility. Further heat production may result in spontaneous combustion. When alfalfa is baled too dry, shattering of leaves reduces harvestable yield and quality. In Kentucky where weather ensures

that farmers will not be able to get alfalfa to 20% M.C. every hay cut, preservation as alfalfa between 20-35% M.C. may be a viable alternative to silage. Even when preservatives are to be added at the time of baling, farmers should ensure that M.C. % are as low as possible for this increases the effectiveness of the preservative, the rate of application, and, therefore, the cost.

Two types of hay preservatives are effective and available to Kentucky farmers:

1. Anhydrous ammonia
2. Propionic acid

Anhydrous Ammonia

Anhydrous ammonia applied at 25 lbs/ton of alfalfa hay at 32% M.C. (1.25%) reduced molds and heating and had little effect on dairy cow performance compared with hay at 19.5% M.C. according to Purdue work. Crude protein levels increased from 18.8 to 23.8% in the hay and 80% of the applied N was recovered. Ammoniation reduced the incidence of mold and the low levels of acid detergent insoluble nitrogen indicate that heating was minimal. The use of anhydrous ammonia for preservation of alfalfa silage in Kentucky may be limited by its availability, the cost of the material and the need for special equipment. The additional effect on the crude protein may make it worthwhile, however, as an inhibitor of molds and yeasts, it is probably not as cost effective as propionic acid.

Propionic Acid

Propionic acid is the most effective hay preservative available at the present time. Because of its obnoxious and corrosive properties it may be neutralized or half-neutralized with ammonia. It may also be marketed as a mixture with acetic acid, which is generally much less effective as a preservative but added to increase milk fat %. The dose rate required for satisfactory preservation increases with the moisture content of the hay. The ratio of propionic acid to water in the hay needed to prevent heating and molding is 1.25 units of propionic acid for every 100 units of water. The theoretical amount of propionic acid needed to preserve alfalfa hay at different moisture conditions is given in Table 1. The actual amount of propionic acid recommended in Kentucky is approximately twice these rates because of difficulties in achieving a uniform distribution. Propionic acid is most effective when the hay being treated is in the 20-30% M.C. range. It is less effective when the forages exceed 30% M.C., when poorly distributed, and when applied at low rates. Many of the commercial preparations available on the market which are based on propionic acid have labels which recommend rates of propionic and which are too low to function as effective preservatives.

For more information on this subject, get a copy of ID-46, Hay Preservatives, by Perry Clark, Gary Lane and Ken Evans from your county agent.

Table 1. Theoretical amount of propionic acid needed per ton of alfalfa hay at various moisture contents (M.C. %) for prevention of heating and molds.

<u>M.C.</u> <u>%</u>	<u>Dry Matter</u> <u>lbs/ton</u>	<u>Water</u> <u>lbs/ton</u>	<u>Propionic Acid (a.i.)</u> <u>lbs/ton</u>
20	1600	400	5.00
25	1500	500	6.25
30	1400	600	7.50
35	1300	700	8.75