The Effect of Preservatives on The Feeding Value of Grass Silage

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The Effect of Preservatives on the Feeding Value of Grass Silage

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The value of silage in a dairy cattle feeding program has been demonstrated by numerous feeding investigations and through the practical experience of dairy farmers all over the country. A large part of the silage fed in this country is made from corn, however, in recent years the production of grass silage has more than doubled. It is estimated that approximately 55,000 tons of hay-crop silage was produced in Virginia in 1956.

Although it is possible by careful wilting to make good grass silage without the addition of preservatives, most farmers feel that the use of such materials are good insurance. Thus, over the years many different materials have been used and much has been written concerning their value as preservatives.

It was the objective of the work herein reported to determine the effect of some of the more recently recommended preservatives or conditioners on the feeding value of hay crops ensiled without wilting.

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[1] Deceased.

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REVIEW OF LITERATURE

The literature pertaining to the making and feeding of hay-crop silage, including the effect of various preservatives and the ensiling process, is extensive as evidenced by the reviews of Bender and Bosshardt (2), Huffman (12), Le Clerc (17), Monroe et al. (19), Ingham (13), and Barnett (1).

Reference will be made here only to the more recent studies in which the feeding value of preserved and unpreserved hay-crop silage has been compared.

In a study of the value of sodium meta-bisulfite as a silage conditioner, Gorden, et al. (9) found that the preservative did not enhance the feeding value of the silage as determined with lactating dairy cows. In latter studies with high moisture hay-crop silage, Gorden et al. (10) observed that the addition of bisulfite, and to a lesser extent Kylage,* decreased the dry matter losses of the silage. Feeding trials with milking cows showed no essestial differences in milk production, body weight gains, or digestibility of the dry matter of the treated and untreated silages. Still later work by the same group (11) showed that Kylage gave inconsistent results with respect to silage preservation, however, as in the earlier work there was no essential difference in the feeding value of untreated and Kylage treated silage.

Dufour et al. (8) were unable to show any significant difference in feed intake, weight gains or milk production between sulfur dioxide and untreated grass-legume silage containing 80% moisture. Workers at the Pennsylvania Station (16) showed that grass silage preserved with sulphur dioxide was equal in feeding value to that preserved with hominy. No unpreserved silage was included in the test.

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* A material containing chiefly sodium nitrite and calcium formate.

In a study covering a period of two years, the Cornell workers (22) found that unwilted grass-legume silage preserved with molasses, brewer's dried grains, or sodium bisulfite was not superior in feeding value to the unpreserved silage.

Voelker & Becker (21) found that sodium chloride or sodium bisulfite did not improve the feeding value of wilted alfalfa silage stored in bunker silos.

The Pennsylvania workers (4, 6, 7) have consistently reported that sodium bisulfite silage was higher in digestibility than unpreserved silage and very recent results from the Northern Virginia Pasture Research Station indicate that bisulfite increases the digestibility of grass silage. Data from the Cornell Station (22), the Beltsville Station (9, 10, 11, 15), and earlier results from the Northern Virginia Pasture Research Station (3) do not confirm these reports. Jones et al. (14) have shown that sodium bisulfite was not superior to dried molasses beet pulp with respect to their effect on the digestibility and total digestible nutrient content of grass silage.

EXPERIMENTAL METHOD

The work was conducted over a 3-year period. All of the forages were harvested by the direct-cut method and stored in tower silos.

The feeding value of the silages was determined with producing cows. Silage consumption, milk production, body weight changes and digestibility data were used in evaluating the silages. The forage was sampled for proximate analysis as the silos were being filled and silage samples for analysis were taken during each digestion trial. Sampling was started two days prior to the beginning of the digestion trial and samples were taken daily (at each feeding) until two days before the end of the trial. These samples were composited and sub-sampled for analysis.

1954-55

The forage used the first year was pre-bloom alfalfa. Sodium bisulfite at the rate of 8 lb. per ton of fresh material was added to one silo; a molasses-urea mixture (60 lb. molasses, 15 lb. urea per ton of fresh material) to a second silo. A third silo was filled with untreated forage. The bisulfite and urea were added to the silage by means of a hopper mounted on the blower. The molasses was applied to the fresh forage by hand just before the material entered the blower pipe.

The experimental design for the feeding trial was that suggested by Cochran et al. (5). Twelve cows in four groups of three cows each were used. The trial was divided into three, 28-day periods. This design allowed each cow to receive each of the silages during the feeding trial. A 14-day preliminary period during which time all cows were fed alike preceded the first experimental period. The cows were changed abruptly from one silage to another with no change-over time between.

In addition to the silage the cows were fed average quality first and second cutting alfalfa hay and a concentrate ration composed of 370 lb. ground shell corn, 360 lb. ground oats, 150 lb. wheat bran, 100 lb. cottonseed meal, 10 lb. salt and 10 lb. steamed bonemeal.

Silage was fed ad libitum. The level of hay intake was started at the rate of approximately 1 lb. per 100 lb. liveweight and intake was held constant throughout the trial. Grain was started at the beginning of the first period at a rate which would supplement the nutrients furnished by the roughage in sufficient quantities to supply the minimum Morrison requirements (20). Adjustments in grain intake were made weekly according to the method recommended by Lucas et al. (18).

The cows were weighed on three consecutive days at the beginning and end of each experimental period. One-day composite milk samples were taken weekly for butterfat test.

Digestion trials employing Cr_2O_3 and the "grab sampling" technique were conducted during the last week of each experimental period. Fecal collections were made on two consecutive days and all animals were included in each trial.

1955-56

A mixture of millet, soybeans, sudan grass and sorghum was used the second year. One silo was filled with unpreserved material and one with material to which 8 lb. of sodium bisulfite per ton had been added. The bisulfite was added as in first year.

A single reversal trial employing 12 cows was used to determine the feeding value of the silage. The experimental periods were 28-days in length.

Medium quality alfalfa hay and a concentrate mixture consisting of 440 lb. ground shell corn, 440 lb. ground oats, 100 lb. cottonseed meal, 10 lb. salt and 10 lb. bonemeal were fed in addition to the silage.

The feeding was the same as during the first year except grain admustments were made at 2-week intervals instead of weekly.

Body weights were taken for all cows on three consecutive days at the beginning and end of each experimental period.

Digestion trials were conducted during both experimental periods. In Period 1 the total collection method was used involving nine animals. During the second period, digestibility estimates were obtained as in the first year. All cows were used except one which had a throat infection at the time the trial was conducted.

1956-57

The forage ensiled consisted largely of a mixture of sudan grass and soybeans. The preservatives used were sodium bisulfite (8 lb. per ton) and Kylage (5 lb. per ton). One silo was filled with untreated forage. The preservatives were broadcast over the top of each load of fresh forage before it entered the silo.

The experimental design for testing the feeding value of the silage and the number of cows used was the same as in the first year. The periods were 21 days instead of 28 in length, however.

Medium quality alfalfa hay was again fed with the silage. The grain mixture used was composed of 250 lb. snapped corn, 200 lb. ground oats, 400 lb. barley, 130 lb. cottonseed meal, 10 lb. salt and 10 lb. steamed bonemeal.

Grain was fed during the first experimental period at a rate which would supplement the nutrients furnished by the forage in sufficient amounts to supply the minimum Morrison requirements (20). The amounts fed during the second and third periods were an adjustment downward made uniformly for all cows (18). Hay was fed at the rate of 0.5% of bodyweight and held constant throughout the experiment.

Body weights were taken as in the two previous years.

Digestion trials were conducted as in the first year except the collections were made over 6-day periods and only six of the 12 cows were used.

EXPERIMENTAL RESULTS

General Quality of Silage.

Bisulfite and Kylage were effective in producing silage which had a pleasant aroma and which resembled fresh forage in physical appearance. On the other hand, the urea-molasses treated silage was quite similar to the

unpreserved silage being dark in color and possessing a disagreeable, clinging odor.

Composition of Feeds.

The chemical composition of the fresh forage as it went into the silo is given in Table 1.

Table 1. Chemical Composition of Fresh Forage.

	D.M.	Per cent of dry matter				
		Protein	Fat	Crude Fiber	Nitrogen-free Extract	Ash
1954-55						
Bisulfite	23.0	18.4	2.1	21.8	46.8	10.9
Urea-molasses	23.6	19.2	2.2	20.8	46.5	11.3
Untreated	22.3	17.6	2.0	23.0	47.1	10.3
1955-56						
Bisulfite	20.9	11.1	2.0	30.1	49.0	7.8
Untreated	19.4	12.1	2.1	31.8	47.3	6.7
1956-57						
Bisulfite	24.7	11.1	1.4	29.5	47.1	10.9
Kylage	20.2	10.6	1.4	33.4	46.3	8.3
Untreated	19.2	11.4	1.2	34.0	44.4	9.0

1956-57

The forage ensiled consisted largely of a mixture of sudan grass and soybeans. The preservatives used were sodium bisulfite (8 lb. per ton) and Kylage (5 lb. per ton). One silo was filled with untreated forage. The preservatives were broadcast over the top of each load of fresh forage before it entered the silo.

The experimental design for testing the feeding value of the silage and the number of cows used was the same as in the first year. The periods were 21 days instead of 28 in length, however.

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Grain was fed during the first experimental period at a rate which would supplement the nutrients furnished by the forage in sufficient amounts to supply the minimum Morrison requirements (20). The amounts fed during the second and third periods were an adjustment downward made uniformly for all cows (18). Hay was fed at the rate of 0.5% of bodyweight and held constant throughout the experiment.

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Chemical analysis revealed that the silages fed in 1954-55 were higher in crude protein and ether extract (fat) and lower in crude fiber than the silages fed the following two years. These differences are to be expected when the forages ensiled are taken into consideration. The silages fed the first year were also higher in ash content than the silages fed the second and third year, however, these differences are not considered to be of major importance.

It is interesting to note that the urea-molasses silage fed the first year was lower in crude protein content than either the untreated or bisulfite silage. Theoretically, the quantity of urea added increased the crude protein content of the silage approximately 2 per cent. The reason for this lower protein value is not definitely known, however, it is probably due to sampling error.

Feeding Results.

Feed consumption, milk production, efficiency of feed utilization and body weight changes of the animals for the first, second and third years are summarized in Tables 3, 4 & 5, respectively.

Table 3. Feed Consumption, Milk Production, Efficiency of Feed Utilization and Body Weight Change.

1954-55

Items Compared	Silage Treatment		
	Bisulfite	Urea	Untreated
Feed consumed per cow per day, lb.			
Silage	61.2	58.7	61.3
Hay	11.4	11.7	12.0
Grain	11.3	10.6	11.3
Feed D.M. consumed per cow per day, lb.			
Silage	17.0	15.6	14.7
Hay	9.7	9.9	10.2
Grain	9.8	9.2	9.8
Total	36.5	34.7	34.7
4% FCM produced per cow per day, lb.	40.2	38.8	40.0
4% FCM produced per cow per day during last 7 days of each experimental period, lb.	39.0	38.9	38.0
Silage D.M. consumed per 100 lb. 4% FCM produced, lb.	42.4	40.2	37.3
Gain in body weight per cow per day, lb.	0.64	0.79	0.32

Table 4. Feed Consumption, Milk Production, Efficiency of Feed Utilization and Body Weight Changes.

1955-56

Items Compared	Silage Treatment	
	Bisulfite	Untreated
Feed consumed per cow per day, lb.		
Silage	64.9	66.5
Hay	9.4	9.4
Grain	7.9	8.1
Feed D.M. consumed per cow per day, lb.		
Silage	15.2	15.2
Hay	7.7	7.7
Grain	6.9	7.1
Total	29.8	30.0
4% FCM produced per cow per day, lb.	30.7	30.8
4% FCM produced per cow per day during last 7 days of each experimental period, lb.	29.0	30.4
Silage D.M. consumed per 100 lb. 4% FCM produced, lb.	49.2	49.3
Gain in body weight per cow per day, lb.	0.20	0.41

Table 5. Feed Consumption, Milk Production, Efficiency of Feed Utilization and Body Weight Changes.

1956-57

Items Compared	Silage Treatment		
	Bisulfite	Kylage	Untreated
Feed consumed per cow per day, lb.			
Silage	75.5	80.2	78.2
Hay	6.1	5.6	5.8
Grain	8.0	7.9	7.8
Feed D.M. consumed per cow per day, lb.			
Silage	17.8	18.4	15.9
Hay	5.3	4.9	5.1
Grain	6.9	6.8	6.8
Total	30.0	30.1	27.8
4% FCM produced per cow per day, lb.	26.4	27.8	27.0
4% FCM produced per cow per day during last 7 days of each experimental period, lb.	25.6	27.6	27.8
Silage D.M. consumed per 100 lb. 4% FCM produced, lb.	68.1	66.2	59.3
Gain in body weight per cow per day, lb.	-0.10	-0.19	-1.24

In 1954-55 all of the silages were consumed at essentially the same rate, however, the molasses-urea appeared to decrease palatability slightly. Total dry matter intake on the bisulfite ration was somewhat higher than for the other two rations due to the increased intake of dry matter from the bisulfite silage.

The production of 4% FCM was not significantly affected by the kind of silage fed, however, when a comparison was made of the milk produced on each ration during the last 7 days of the experimental periods, it was observed that production was better maintained on the urea-molasses and bisulfite silages than on the untreated silage.

As shown in Table 3, the dry matter of the untreated silage was more efficiently utilized for milk production than either of the other silages.

All of the animals on the experiment gained weight, however, the gain on the untreated silage ration was somewhat lower than on the other two rations.

In 1955-56 the silages were again consumed in approximately equal amounts with the unpreserved silage being consumed at a slightly higher rate. On a dry matter basis, however, the intake of the preserved and unpreserved silage was identical.

The production of 4% FCM was likewise practically identical for the two rations as was the production during the last week of each period.

Apparently, the two silages were equally well utilized for milk production.

Body weight gains were higher for the animals on the untreated silage ration than on the bisulfite ration.

The intake of silage during the 1956-57 trials appeared to be increased by the addition of Kylage. On the other hand, sodium meta-bisulfite appeared

to decrease silage consumption. As can be seen in Table 5, the untreated silage was consumed at essentially the same rate as the Kylage treated silage and at a slightly higher level than the bisulfite silage. There was very little difference between the Kylage and bisulfite silages with respect to dry matter intake, however, the intake of the untreated silage was lower than either of the preserved forages.

The average production of 4% FCM for the entire experiment as well as for the last 7 days of each period was significantly lower ($P < .05$) for the bisulfite silage ration than for either the Kylage or untreated silage rations. Milk production on the Kylage ration was significantly better ($P < .05$) than on the untreated silage ration.

As shown in Table 5, the efficiency of utilization of the untreated silage was considerably higher than either of the other silages.

During the 1956-57 trials, all of the cows lost weight. The weight loss was greatest for the cows on the unpreserved silage ration.

Digestibility of Rations.

The preservatives used did not appear to appreciably affect the digestibility of the various feed nutrients of the whole ration (Table 6). There was a tendency, consistent from year to year, for the bisulfite silage ration to be higher in crude protein digestibility than the other rations. On the other hand, in 1956-57 the digestibility of fat, crude fiber and nitrogen-free extract was lower for the bisulfite ration than for either the Kylage or unpreserved silage ration.

Table 6. Average Coefficients of Apparent Digestibility of the Experimental Rations.

Ration	Dry matter	Crude protein	Fat	Crude fiber	Nitrogen-free extract
	%	%	%	%	%
1954-55					
Bisulfite	60.4	67.3	56.6	50.1	67.2
Urea-molasses	59.6	64.8	55.2	49.8	66.0
Untreated	59.1	66.1	55.7	50.2	64.2
1955-56					
Bisulfite	62.3	68.7	66.1	57.4	64.0
Untreated	61.6	64.8	62.7	55.4	64.5
1956-57					
Bisulfite	51.1	58.2	45.7	42.1	53.2
Kylage	52.8	55.1	54.1	48.2	56.1
Untreated	52.4	55.5	51.5	48.2	55.3

SUMMARY

The use of sodium meta-bisulfite, Kylage and a mixture of urea and molasses as preservatives for unwilted hay-crop silage was studied over a 3-year period to determine their effect on the feeding value of the silage for dairy cows. The forages ensiled consisted of pre-bloom alfalfa, a mixture of millet, soybeans, sudan grass and sorghum, and a mixture of sudan grass and soybeans. Bisulfite was added at the rate of 8 lb. per ton; Kylage at the rate of 5 lb. per ton; and the urea-molasses mixture at the rate of 75 lb. per ton of fresh material (15 lb. urea, 60 lb. molasses).

Twelve cows were used each year. In the first and third year a double change-over experimental design was employed. A single reversal trial was run the second year. The experimental periods varied from 21 to 28 days in length. The silages were fed in complete rations. Digestibility of the total ration was determined each year by the total collection method or the Cr_2O_3 grab-sampling technique.

Under the conditions of these trials, neither sodium meta-bisulfite nor a mixture of urea and molasses sufficiently increased the palatability, feeding value or digestibility of silage to warrant their use. Limited data indicate that Kylage may increase the milk producing value of grass silage.

There was a tendency for the cows on the preserved silage rations to better maintain their body weight, however, this effect was not consistent. In general the dry matter of the unpreserved silage was more efficiently utilized for milk production than that of the preserved silage.

The sodium meta-bisulfite and Kylage were effective in controlling obnoxious silage odors and in improving the physical appearance of the silage.

The molasses-urea mixture, on the other hand, did not favorably affect the odor or appearance of the silage.

The results of this study indicate that no increase in palatability or feeding value of grass silage could be expected as a result of using either sodium meta-bisulfite or a molasses-urea mixture as preserving agents.. It is indicated that Kylage may be of some value in increasing milk production from hay crop silage. If the farmer is concerned with the odor of the silage he feeds, the results suggest that either bisulfite or Kylage is of value in favorably influencing this particular characteristic. However, at current prices and recommended application rates, the farmer would be paying approximately 50 to 60 cents per ton of forage ensiled for better smelling silage.

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