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Abstract

Numerous commercial silage additives, whose manufacturers claim will improve silage quality, are available to Kansas farmers and ranchers. We believe that these claims must ultimately be documented with farm-scale research. To date, Manhattan and Ft. Hays farm-scale silo results clearly indicate that a few silage additives do improve silage quality and are cost-effective. Several of them have consistently reduced "in silo"? losses. But results probably will not be favorable with all additives under every farm condition. Nor will research results obtained with one commercial product in our trials also apply to other products on the market, however similar in ingredient formulation.

Keywords

Cattlemen's Day, 1984; Kansas Agricultural Experiment Station contribution; no. 84-300-S; Report of progress (Kansas State University. Agricultural Experiment Station and Cooperative Extension Service); 448; Beef; Silage; Silo; Quality

Silage Additive Update: 1984

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Summary

Numerous commercial silage additives, whose manufacturers claim will improve silage quality, are available to Kansas farmers and ranchers. We believe that these claims must ultimately be documented with farm-scale research. To date, Manhattan and Ft. Hays farm-scale silo results clearly indicate that a few silage additives do improve silage quality and are cost-effective. Several of them have consistently reduced "in silo" losses. But results probably will not be favorable with all additives under every farm condition. Nor will research results obtained with one commercial product in our trials also apply to other products on the market, however similar in ingredient formulation.

Introduction

With few exceptions, all crops grown can be harvested and fed as silage. A fact that has been recognized in Kansas for nearly a century (Shelton, 1889). Since silage is a product of anaerobic fermentation, the primary objectives in making it are to achieve and maintain oxygen-free conditions and to produce enough lactic acid to conserve the crop. When made by suitable techniques, silage should be well-preserved and lose a minimum of nutrients. That has been the goal since silage making was introduced in the U.S. over a century ago.

Both the chemistry and microbiology of silage fermentation are known. McDonald (1980) attributed the changes that occur during ensiling to the following activities: plant enzymes, lactic acid bacteria, clostridial bacteria, enterobacteriaceae, and yeasts. Only lactic acid bacteria have a "positive" effect on silage quality and their development must be encouraged. The other four activities are "negative" and their effects must be minimized and/or eliminated.

The dominance of lactic acid bacteria during the ensiling can only be achieved by controlling: (1) the moisture content of the crop; (2) the buffering capacity of the silage; (3) the availability of water-soluble carbohydrates; (4) the type of bacteria present; and (5) the speed of the fermentation (ie. rate of pH decline). The control of silage fermentation also involves proper harvesting, storing, and feeding techniques. These include: selecting a suitable crop; harvesting at the correct stage of maturity; ensiling at the right moisture content; cutting or chopping the crop finely; filling of the silo rapidly and sealing it to maintain anaerobic conditions; selecting a suitable silo structure; feeding the silage rapidly so that surface exposure is minimized; and using an effective silage additive.

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It is generally recognized that the "unavoidable" changes in nutritional value of the ensiled crop are small and the "unavoidable" losses in silage DM are low. These are presented in Table 7.1. Although the technology necessary to make high quality silage with a minimum loss is well established, on-farm practices and conditions often produce less than ideal silage.

The idea of using an "additive" to increase silage quality or to improve silage preservation is not new. Early in this century, Kansas farmers were using molasses and other carbohydrates (Hunter and Bushnell, 1916). In the 1960's and 70's, urea and other forms of NPN were used to increase the protein content of corn silage. Today, lactic acid bacteria and enzyme additives have been promoted widely with the expressed claim of "a more rapid and efficient production of lactic acid."

Silage fermentation aids may include lactic acid-producing micro-organisms, nutrients required by these lactic acid producers, and enzymes and/or micro-organisms that increase the availability of fermentable carbohydrates and other nutrients. Hundreds of products are commercially available that meet the "fermentation aid" definition.

Silage Additive Results

Do commercial fermentation aids improve silage quality in farm silos? There is not a clear consenus of opinion. Why? First, most of the commercial products have never been tested adequately either in laboratory or farm silos. Second, many evaluations are based on individual bias or on results from laboratory silos which can be misleading. When conducting additive research in farm silos, all silages must be harvested, stored, and fed using similar techniques. In theory, each silo should contain the same homogeneous material. In practice, this is difficult to achieve. Silage is complex and the factors that affect its quality are interactive (ie. crop suitability x chop length x silo structure).

The importance of reducing the loss of nutrients in the silo is universally accepted. It is our opinion that DM recovery is the most important criteria by which to evaluate commercial fermentation aids. It includes total losses from respiration, fermentation, effluent, surface waste, and aerobic deterioration prior to and during feeding.

At Manhattan and Ft. Hays, 19 farm-scale silo trials with either fermentation aid additives (microbial inoculants or enzymes) or non-protein nitrogen (NPN) additives were conducted from 1975 to 1983 using corn, alfalfa, or forage sorghum. Silages were evaluated using five response criteria: (1) ensiling temperature; (2) DM recovery; (3) aerobic deterioration; (4) nutritional value (digestibility or cattle performance); and (5) beef gain per ton of crop ensiled. Only DM recoveries for control and additive-treated silages are presented here (Table 7.2). We interpret these data as being generally positive for the inoculant or enzyme additives tested but less positive for NPN's, particularly with "wetter" forage sorghum silages.

Ensiling temperature and cattle performance results for several fermentation aid additives are presented in articles beginning on page 27 of this report.

References

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Table 7.1. Nutrient Losses in Silage Making and Their Causing Factors.[1]

Process	Classified as	Approximate losses (%)	Causing factors
Residual respiration	unavoidable	1-4	Plant enzymes.
Fermentation	unavoidable	3-8	Micro-organisms.
Effluent	mutual	3->7	DM content.
or		or	
Field losses by wilting	unavoidable	3->7	Crop, weather, and technique.
Secondary fermentation	avoidable	0->5	Crop DM content and environment in silo.
Aerobic deterioration during storage	avoidable	0->6	Crop, filling time, silo, and sealing.
Aerobic deterioration after unloading (heating)	avoidable	0->10	As above plus unloading technique and season
		Total 7- >40	

[1]Data adapted from Zimmer, E. 1980. Efficient silage systems. Forage Conservation in the 80's. Occas. Symp. No. 11, British Grassland Soc.

Table 7.2. Feedable Dry Matter Recovery for Control and Additive-treated Corn, Alfalfa, and Forage Sorghum Silages in 19 Farm-scale Trials Conducted From 1975 to 1983 at Manhattan and Ft. Hays.[1]

Year and silage DM (%)	Additive treatment	Recovery of feedable DM[2]	Year and silage DM (%)	Additive treatment	Recovery of feedable DM[2]
	corn			forage sorghum	
1975 (38)	control	80.9	1977 (29)	control	84.1
	Silo-Best®	87.5		Silo Guard	92.0
1976 (35)	control	87.4	1979 (33)	control	91.0
	Silo Guard®	93.7		Cold-flo®	84.9
1978 (44)	control	88.7		Sila-bac	90.7
	Cold-flo®	91.5	1981 (43)	control	84.4
	Sila-bac®	91.7		LSA-100	76.2
	Silo-Best	91.3		1177	87.0
1979 (37)	control	93.3	1982 (30)	control	85.6
	Cold-flo	88.5		Fermentrol®	87.8
	Ensila Plus®	94.1		urea	83.6
1980 (33)	control	87.3	1982 (25)	control	77.2
	Silo-Best	88.7		Silo Guard II®	84.0
	Sila-ferm®	87.4			
			1982 (25)	control	77.2
1981 (36)	control	89.0		Silo-Best	82.3
	1177®	91.4			
			1982 (25)	control	77.2
				1177	79.1
6-trial corn avg:	all 16 silages	89.5			
	control	87.8	*1979 (30)	control	82.1
	inoculant or enzyme	90.7		Sila-bac	85.0
	NPN	89.5			
			*1979 (32)	control	87.3
				Sila-bac	90.2
	alfalfa		*1980 (30)	control	78.1
				LSA-100	77.2
				Sila-bac	81.1
1979 (36)	control	84.6	*1981 (29)	control	80.0
	Ensila Plus	90.0		LSA-100	76.0
	Silo Guard	89.7			
	Sila-lator®	90.4			
			11-trial sorghum avg:	all 26 silages	83.0
1980 (33)	control	82.0		control	82.2
	Sila-bac	82.0		inoculant or enzyme	85.9
	Silo Guard	86.2			
				NPN	79.6

1 All corn and alfalfa silage trials were conducted in 10 x 50 ft concrete stave silos at Manhattan.

All forage sorghum trials were conducted in the silos at Manhattan except trials with one asterisk (*) which were conducted in 10 x 40 ft concrete stave silos at the Ft. Hays Branch Expt. Sta. under the supervision of John Brethour.

2 Percent of the DM ensiled.