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Abstract

The objectives of this study with whole-plant corn silage were to determine the effects of forage density after packing, and sealing technique on yeast and mold populations; and to examine the relationship between the microbial and chemical changes in the silages during the fermentation process and storage period. Whole-plant corn was harvested at 80% milkline (36% DM) and ensiled at three densities (D): D1, 23.2; D2, 33.2, and D3, 43.3 lb/ft3. Half of the silos for each density were sealed immediately after filling (S, sealed) and the other half of the silos were sealed 48 hours after filling (DS, delayed seal). The experiment was arranged in a completely randomized design with treatments being combinations of two factors: three densities (D1, D2, D3), and two sealing techniques (S, DS). There were two 3-quart capacity PVC laboratory silos per treatment. Silos were opened after 150 days, and the chemical and microbial compositions of the silages determined. Silage pH and lactic acid content were indicative of an efficient preservation. Yeast and mold populations at day 0 were high, and most of the yeasts were lactate-assimilating yeasts (LAY). LAY populations at day 0 were high, with values of 5 log10 colony forming units (CFU) per g of fresh material. Low packing density and delayed sealing resulted in higher LAY populations (P<0.01).

Keywords

Cattlemen's Day, 2002; Kansas Agricultural Experiment Station contribution; no. 02-318-S; Report of progress (Kansas State University. Agricultural Experiment Station and Cooperative Extension Service); 890; Beef; Corn silage; Aerobic deterioration; Packing density

A STUDY OF THE CHEMICAL AND MICROBIAL CHANGES IN WHOLE-PLANT CORN SILAGE DURING FERMENTATION AND STORAGE: EFFECTS OF PACKING DENSITY AND SEALING TECHNIQUE

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Summary

The objectives of this study with whole-plant corn silage were to determine the effects of forage density after packing, and sealing technique on yeast and mold populations; and to examine the relationship between the microbial and chemical changes in the silages during the fermentation process and storage period. Whole-plant corn was harvested at 80% milkline (36% DM) and ensiled at three densities (D): D1, 23.2; D2, 33.2, and D3, 43.3 lb/ft^3. Half of the silos for each density were sealed immediately after filling (S, sealed) and the other half of the silos were sealed 48 hours after filling (DS, delayed seal). The experiment was arranged in a completely randomized design with treatments being combinations of two factors: three densities (D1, D2, D3), and two sealing techniques (S, DS). There were two 3-quart capacity PVC laboratory silos per treatment. Silos were opened after 150 days, and the chemical and microbial compositions of the silages determined. Silage pH and lactic acid content were indicative of an efficient preservation. Yeast and mold populations at day 0 were high, and most of the yeasts were lactate-assimilating yeasts (LAY). LAY populations at day 0 were high, with values of 5 $\log_{10}$ colony forming units (CFU) per g of fresh material. Low packing density and delayed sealing resulted in higher LAY populations ($P<0.01$).

(Key Words: Corn Silage, Aerobic Deterioration, Packing Density.)

Introduction

Aerobic deterioration of silage is a complex process and probably depends on the establishment and/or survival of aerobic spoilers during the fermentation and storage phases. If the levels of microorganisms responsible for deterioration are high, aerobic stability is likely to be short regardless of the chemical constituents.

The factors influencing deterioration include oxygen (amount and exposure time), composition of the microbial population, substrate type and quantity (e.g., water soluble carbohydrates and organic acids), stage of maturity at harvest, density of the silage, ambient temperature, and temperature of the silage mass. Better packing and more rapid sealing are generally thought to improve aerobic stability of a silage. Inadequate sealing allows air to penetrate and/or remain entrapped in the ensiled material for long periods and subsequent nutrient losses can be considerable.

Research has shown that silages with at least 5 $\log_{10}$ CFU yeasts per g were very susceptible to aerobic spoilage. This critical value for yeast numbers depends on the condition that the yeast population is made up principally of lactate-utilizing organisms. Such yeasts can initiate deterioration in all types of silage exposed to air.

The objectives of this study with whole-plant corn silage were to determine how forage density after packing, and delayed sealing influence yeast and mold populations; and to examine the relationship between the microbial and chemical changes in the silages during fermentation and storage.

Experimental Procedures

Whole-plant corn was harvested at 80% milkline (36% DM) on September 21, 1999. It was precision chopped to approximately 12 mm, ensiled in laboratory silos and stored for 150 days at ambient temperature. Whole-plant corn silage was ensiled at three fresh matter densities: D1, 23.2; D2, 33.2, and D3, 43.3 lb/ft^3. Half of the silos for each density were sealed immediately after filling (S = sealed) and the other half of the silos were sealed 48 hours after filling (DS = delayed seal).

The laboratory silos were 3-quart polyvinyl chloride (PVC) laboratory silos. Two silos from each treatment were opened and sampled for chemical and microbial analyses at days 1, 3, 7 and 150. The experiment was arranged in a completely randomized design with two replications, and treatments being combinations of two factors: three densities (D1, D2, D3), and two sealing techniques (S, DS).

Results and Discussion

The chemical composition of the corn silages after 150 days of storage is shown in Table 1. Silage pH and lactic acid content were indicative of an efficient preservation. No effects of packing density and sealing technique were observed on pH and lactic acid. The microbial composition of the corn silages after 150 days of storage is presented in Table 2. Yeast and mold populations at day 0 were high, and most of the yeasts were lactate-assimilating (LAY). LAY populations at day 0 were high, with values of 5 $\log_{10}$ CFU per g of fresh material.

Low packing density and delayed sealing both resulted in higher LAY populations. LAY in delayed sealed silages were higher than in their sealed counterparts, 7.65 vs. 6.02 $\log_{10}$ CFU per g of fresh material (Figure 1). LAY population was highest in the D1 silages (7.18 $\log_{10}$ CFU per g of fresh material) and lowest in the D3 silages (6.41) (Figure 2), which generally agrees with other researchers who have compared LAY and packing density.

Results of our study show the importance of air to yeast growth during the fermentation and storage phases. Both low packing density and delayed sealing resulted in higher LAY populations. Silage management practices that eliminate air, including both effective sealing and high packing density, should enhance aerobic stability by reducing the number of microorganisms responsible for aerobic deterioration.

Table 1. Chemical Composition and pH of the Corn Silages Before ensiling (day 0) and After 150 Days of Storage

	DM (%)		pH		Lactic Acid[1]	
	Day		Day		Day	
Treatment	0	150	0	150	0	150
D1S	35.8	36.9	5.6	4.2	0.2	6.5
D1DS	35.8	33.8	5.6	4.2	NA	4.7
D2S	35.8	NA	5.6	NA	0.6	5.9
D2DS	35.8	24.1	5.6	4.1	NA	5.6
D3S	35.8	35.2	5.6	4.1	NA	NA
D3DS	35.8	33.5	5.6	4.1	NA	3.9

[1]Percent of the silage DM.

Table 2. Microbial Composition ($\log_{10}$ CFU per g of fresh material) of the Corn Silages Before Ensiling (day 0) and After 150 Days of Storage

	Y and M[1]		LAY[2]		LAB[3]	
	Day		Day		Day	
Treatment	0	150	0	150	0	150
D1S	6.0	7.3	NA	NA	6.7	6.7
D1DS	5.7	5.7	5.7	5.7	7.9	6.9
D2S	NA	NA	NA	5.5	NA	NA
D2DS	5.5	5.5	NA	NA	6.2	8.0
D3S	NA	NA	NA	NA	7.2	7.2
D3DS	5.7	3.4	5.6	5.6	8.6	8.6

[1]Yeast and mold.
[2]Lactate-assimilating yeast.
[3]Lactic acid bacteria.

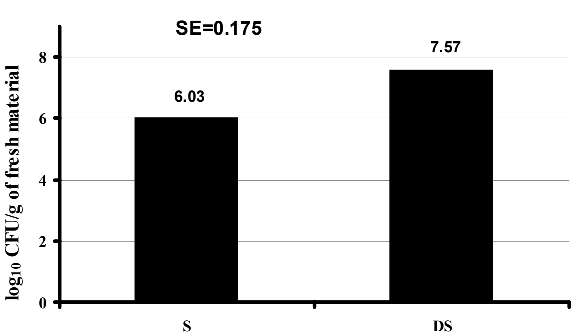

Figure. 1. Lactic Acid-Assimilating Yeast Populations in the Corn Silages After 150 Days of Storage. Effect of Sealing Technique.

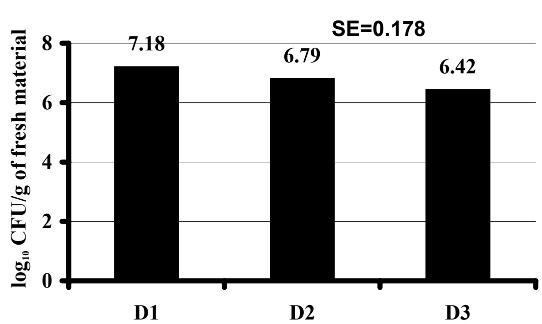

Figure 2. Lactic Acid-Assimilating Yeast Populations in the Corn Silages After 150 Days of Storage. Effect of Packing Density.