Volume 0
Issue 1 *Cattleman's Day (1993-2014)*

Article 1034

1986

Effect of moisture and bale type on alfalfa hay quality and digestibility

A. Laytimi

C. Grimes

K. Bolsen

Effect of moisture and bale type on alfalfa hay quality and digestibility

Abstract

Third cutting alfalfa was baled in large rectangular bales (1,400 to 1,800 lb) and in small conventional bales (70 to 90 lb) at three moisture levels: low 00%), medium (16%), and high (22%). During 120 days of storage under a roof, the high moisture, large bales heated the most, reaching 1280 F by 2 days post-baling in a first peak and 133 ÌŠF in a second peak by the 11th day. Moderate heating occurred in the high moisture, small bales (l08° F) and medium moisture, large bales (103 ÌŠF). Only the high moisture bales, either small or large, had significant dry matter loss during storage. Also, heating decreased water soluble carbohydrates and increased the concentration of cell wall contents by the end of storage. A three-period collection and digestion trial with lambs showed higher voluntary intakes of small bale hays than of large bale hays and higher intakes of high moisture hays than of low moisture hays. Also, the dry matter and crude protein digestibilities were lowest for the high moisture, large bales. Storing alfalfa hay in large bales at 22% moisture resulted in extensive heating, which increased storage loss and decreased nutrient content and digestibility.

Keywords

Cattlemen's Day, 1986; Kansas Agricultural Experiment Station contribution; no. 86-320-S; Report of progress (Kansas State University. Agricultural Experiment Station and Cooperative Extension Service); 494; Beef; Moisture; Quality; Digestibility

Effect of Moisture and Bale Type on Alfalfa Hay Quality and Digestibility

Ahmed Laytimi, Chuck Grimes, and Keith Bolsen

Summary

Third cutting alfalfa was baled in large rectangular bales (1,400 to 1,800 lb) and in small conventional bales (70 to 90 lb) at three moisture levels: low (10%), medium (16%), and high (22%). During 120 days of storage under a roof, the high moisture, large bales heated the most, reaching 128° F by 2 days post-baling in a first peak and 133° F in a second peak by the 11th day. Moderate heating occurred in the high moisture, small bales (108° F) and medium moisture, large bales (103° F). Only the high moisture bales, either small or large, had significant dry matter loss during storage. Also, heating decreased water soluble carbohydrates and increased the concentration of cell wall contents by the end of storage. A three-period collection and digestion trial with lambs showed higher voluntary intakes of small bale hays than of large bale hays and higher intakes of high moisture hays than of low moisture hays. Also, the dry matter and crude protein digestibilities were lowest for the high moisture, large bales. Storing alfalfa hay in large bales at 22% moisture resulted in extensive heating, which increased storage loss and decreased nutrient content and digestibility.

Introduction

Under unfavorable weather conditions, making alfalfa hay can result in nutrient losses of 50 or 60% of the original forage. The losses start in the field and continue through storage, processing, and feeding. Plant respiration after cutting, mechanical damage, and leaching contribute to field losses, whereas continued respiration, microbial activity, and chemical oxidation, which all lead to heating, contribute to storage losses.

Hay-making aims at rapid moisture loss from the cut forage and baling with minimum physical losses. However, the optimum moisture level for efficient handling and safe storage of alfalfa hay has not yet been well established. The optimum moisture might vary, depending on such factors as: forage species, climatic conditions, bale types, bale sizes, bale densities, methods of storage, and length of storage. The objectives of this experiment were to study the effects of high, medium, or low moisture levels and conventional or large bale types on alfalfa hay composition and digestibility.

Experimental Procedures

The alfalfa for this experiment was provided by Slentz-McAllister, Inc., and was baled near Lewis, Kansas on August 17 to 19, 1983.

Irrigated, third cutting alfalfa was baled at 10, 16, or 22% moisture using either a model 336 John Deere baler to produce 15 x 19 x 37 inch small rectangular bales or a model 4800 Hesston baler to produce large rectangular bales of 4 x 4 x 8 foot. There were 12 small bales and three large bales per treatment. The initial moisture of the windrows at baling was determined arbitrarily. The two balers ran simultaneously, side by side in adjacent windrows. As the bales came out of the balers, they were identified and thermocouple wires inserted for temperature measurement. Two thermocouple wires were placed into each small bale and four into each large bale. Initial temperatures were recorded within 1 hour after baling. Thereafter, temperatures were taken twice daily for the first 7 days and then once daily until each bale returned to its initial temperature.

All bales were weighed and core-sampled using a Pennsylvania State University sampler within 1 hour after baling and after 4 months of storage under a roof. Samples were immediately frozen in liquid nitrogen until analyzed. After storage, all bales were opened, flakes were separated, and they were visually appraised from end to end for color, aroma, mold, mildew, and dust.

Hay from each treatment was ground and fed to 24 lambs (four lambs per hay) in a three-period, collection and digestion trial. Total feed offered, feed refused, and daily urine and fecal outputs were recorded.

Results and Discussion

Only three bale treatments showed any temperature rise above ambient: 1) the high moisture, large bales, 2) the high moisture, small bales; and 3) the medium moisture, large bales. Two temperature peak were observed in the high and medium moisture, large bales. The first peaks occurred in the first 2 days of storage. The high moisture, large bales heated the most, reaching 128° F in the first peak and 133° F in the second peak, which lasted from the 11th to the 20th day. The high moisture, small bales followed a similar trend, reaching 117° F in the first peak in the first 2 days and 108° F in the second peak on day 11. The temperature change of the medium moisture, large bales followed a similar pattern, but the peak temperatures were lower.

There was no visible discoloration or mold growth in any of the low moisture hays or in the medium moisture, small bales. There was very little discoloration or mold growth in the high moisture, small bales or the medium moisture, large bales. However, in the high moisture, large bales, the discoloration and mold growth were more apparent, very extensive, and heaviest in the fore, center, and butt portions, respectively.

Shown in Table 44.1 are the dry weights initially and after storage. For both bale types, initial dry matter per bale increased with increasing moisture. Significant dry matter loss during storage occurred in the treatments that heated, ranging from 1.5% in the medium moisture, large bales to 11.0% in the high moisture, large bales. The heating and the subsequent dry matter loss reflect the activity of thermophilic microbes.

Also shown in Table 44.1 is the chemical composition change of the hay from initial to the 120th day of storage. In the small bales, initial crude protein (CP) content decreased from 18.5 to 16.5% as moisture level decreased, indicating higher field loss of leaves at the low moisture level. In general, the initial CP was lower in the large than in the small bales at each moisture level. This is not surprising, considering the difference in ground speed between the 4800 Hesston and the 336 John Deere balers. Initial acid detergent insoluble nitrogen (ADIN) values were very high.

Powering the core sampler with an electric drill caused the probe to heat from friction, and might have increased the amount of ADIN in the initial samples. This demonstrates the difficulty of obtaining representative samples from cores.

For water soluble carbohydrates (WSC), the initial content of the hay was not affected by moisture level or bale size. The content ranged from 6.5 to 7.0 percent. However, WSC loss during 120 days of storage was closely related to the amount of heating and bale size. At each moisture level, large bales lost more WSC than small bales and the loss increased to approximately 62% in the high moisture, large bales.

Initial acid detergent fiber (ADF) (mostly cellulose and lignin) and cell wall (CW) contents (mostly cellulose, hemicellulose, and lignin) were not affected by moisture level or bale type. The values were nearly identical (35.2 to 35.9% for ADF and 43.9 to 44.9% for CW), except for high moisture, small bales (31.1% ADF and 38.2% CW). These figures were unexpected and may represent sampling or analytical error. Both ADF and CW concentrations increased, probably because of heating in the medium moisture, large and in the high moisture, small and large bales.

Shown in Table 44.2 are voluntary intakes and digestibility coefficients of the six alfalfa hays. Although the voluntary intakes were statistically similar, two trends were observed. First, intake was always higher for the small bales than for the large bales. Second, intake increased with increasing moisture level in both bale types.

The high moisture, large bales had the lowest dry matter (57.0%) and crude protein (64.5%) digestibilities, indicating nutrient damage as a result of heating during storage. The other five hays had similar dry matter and crude protein digestibilities, ranging from 60.5 to 61.9% and 73.9 to 78.9%, respectively. Neither ADF nor CW digestibilities were affected by bale moisture or size.

Table 44.1. Effect of Moisture and Bale Type on Alfalfa Hay Storage Losses and Change in Chemical Composition

Bale Characteristics[1]	Moisture 10% Post-baling	10% Post-storage	16% Post-baling	16% Post-storage	22% Post-baling	22% Post-storage
Large Bales:						
Wt., lb of DM	1098.0	1098.0	1376.3	1355.2	1560.0	1388.2
Wt. Change, %	—	0	—	-1.5	—	-11.0
	% of the Hay DM					
CP	15.9	15.4	15.8	16.0	16.2	17.0
ADIN	.306	.215	.183	.208	.209	.320
WSC	7.0	5.3	6.5	4.6	6.8	2.6
CW	44.6	42.1	44.9	45.2	43.9	47.1
ADF	35.2	34.2	35.5	36.2	35.9	38.2
Small Bales:						
Wt., lb of DM	50.8	50.4	56.0	55.4	70.6	66.9
Wt. Change, %	—	-.8	—	-1.1	—	-5.2
	% of the Hay DM					
CP	16.5	15.7	16.8	16.5	18.5	18.3
ADIN	.306	.177	.326	.173	.307	.184
WSC	6.7	6.6	6.7	6.1	6.8	5.4
CW	44.9	44.9	44.9	44.7	38.2	47.7
ADF	35.5	34.1	35.7	34.2	31.1	32.3

[1]CP = crude protein, ADIN = acid detergent insoluble nitrogen, WSC = water soluble carbohydrates, CW = cell wall contents, and ADF = acid detergent fiber.

Table 44.2. Effect of Moisture and Bale Type on Alfalfa Hay Voluntary Intakes and Digestibilities by Lambs

Item[1]	Moisture and Bale Type 10% Small	10% Large	16% Small	16% Large	22% Small	22% Large
Voluntary Intake, lb of DM/Day	3.80	3.63	3.85	3.74	3.90	3.83
	Digestibility, %					
DM	61.9[a]	60.6[a]	60.5[a]	60.7[a]	60.9[a]	57.0[b]
CP	78.9[a]	75.1[a]	73.9[a]	74.8[a]	74.6[a]	64.5[b]
CW	41.9	40.3	44.1	45.3	47.2	43.0
ADF	42.9	40.3	42.5	45.9	47.5	41.6

[1]CP = crude protein, CW = cell wall contents, and ADF = acid detergent fiber.

[a,b]Values with different superscripts differ (P<.05).