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Effect of moisture level and bale size on alfalfa hay quality

Abstract

Third cutting alfalfa was baled in large I-ton rectangular bales and in small conventional bales 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 ÌŠ F by 2 days post baling in a first peak and 133 ÌŠF in a second peak by the 11 th day. Moderate heating occurred in the high-moisture, small bales (l08° F) and medium-moisture, large bales(103 ÌŠF). Only the high-moisture, small and large bales had significant loss of dry matter during storage. Also, heating decreased the water soluble carbohydrate and increased the concentration of cell wall contents by the 120th day 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 bale hay. These data indicate that baling alfalfa hay in large bales at 22% moisture results in extensive heating, which negatively affects storage loss, nutrient content, and digestibility.; Dairy Day, 1985, Kansas State University, Manhattan, KS, 1985;

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EFFECT OF MOISTURE LEVEL AND BALE SIZE ON ALFALFA HAY QUALITY

A. Laytimi, C. Grimes, and K.K. Bolsen

Summary

Third cutting alfalfa was baled in large 1-ton rectangular bales and in small conventional bales 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, small and large bales had significant loss of dry matter during storage. Also, heating decreased the water soluble carbohydrate and increased the concentration of cell wall contents by the 120th day 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 bale hay. These data indicate that baling alfalfa hay in large bales at 22% moisture results in extensive heating, which negatively affects storage loss, nutrient content, and digestibility.

Introduction

Alfalfa hay has long been considered an important ingredient in dairy cattle rations. Its nutritive quality depends on the hay-making process, which is greatly affected by the uncontrollable factor, weather. Under unfavorable climatic conditions, making hay can result in substantial nutritive losses from the original crop. The losses, which may approach 50-60%, start in the field and continue through storage and feeding. Plant respiration after cutting, mechanical treatment, 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 achieving a rapid loss of moisture from the cut plant and baling it with minimum losses. However, optimum moisture level for efficient handling and safe storage of alfalfa hay has not been well established yet. Difficulties arise from interacting factors such as varying climatic conditions, bale types, bale size and density, and method of storage.

To reduce weather risk, leaf loss, and increase the potential of higher quality, alfalfa hay can be baled at higher moisture. However, this may result in overheating, molding, and nutrient damage during storage. Therefore, the objectives of this experiment were to study the effects of high, medium, or low-moisture levels and conventional or large bale size on alfalfa hay composition and digestibility.

Procedures

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

Irrigated, third cutting alfalfa was baled at three moisture levels, 10, 16 or 22% using the model 336 John Deere to produce 15 x 19 x 37 inch small rectangular bales or using the model 4800 Hesston to produce large rectangular bales of 49 x 49 x 98 inch. 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 thermocoupled for temperature measurement. Two thermocouple wires were inserted into each small bale and four into each large bale. Initial temperatures were recorded within 1 hour after baling and, 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 core-sampled using a Pennsylvania State University sampler within 1 hour after baling and then at 10, 17, and 120 days post baling. All samples were immediately frozen in liquid nitrogen until analyzed for moisture and chemical composition. All the bales were weighed initially and on 120th day after storage under a roof. They then were flaked and visually appraised from the fore to the butt end for color, aroma, mold, mildew, and dust. The six hay treatments were each ground and fed to 24 lambs in a three-period, collection and digestion trial. Total feed offered, feed refused, and daily urine and fecal outputs were recorded. Samples were analyzed in the laboratory and digestion coefficients were calculated.

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 peak temperatures 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 trend to that of the high-moisture, small bales, but the peak temperatures were lower.

For all the low-moisture hay and medium-moisture, small bales, there was no visible discoloration or mold growth. There was very little discoloration and molding in the high-moisture, small bales and medium-moisture, large bales. However, for 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 1 are initial weights and dry matter loss during storage. For both types of bales, initial weight increased with increasing moisture. Significant dry matter loss during storage occurred in the treatments that heated, ranging from 1.5% loss 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 in the hay.

Also shown in Table 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, when the difference in ground speed between the 4800 Hesston and the 336 John Deere balers is considered. Initial acid detergent insoluble nitrogen (ADIN) values were very high. Drill powered core sampling of the bales did result in heating of the probe from friction and very likely increased the amount of ADIN in the initial samples. Therefore, the values obtained here are in error and reflect the difficulty encountered with obtaining representative samples from cores.

With respect to 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%. However, the change after 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 insoluble lignin) and cell wall (CW) contents (mostly cellulose, hemicellulose, and lignin) were not affected by moisture level or bale size. The values were nearly identical (35.2 to 35.9% for ADF and 43.9 to 44.9% for CW), except for the unexpected ones for high-moisture, small bales (31.1% ADF and 38.2% CW) which were out of range and may have been in error. After 120 days of storage, changes in both ADF and CW contents were related to the heating that occurred in the bales. Their concentrations increased in the medium-moisture, large and in the high-moisture, small and large bales.

Shown in Table 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 higher for the small bales than for the large bales at each moisture level. Second, intake increased with increasing moisture level in both the small and the large bales.

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

Table 1. Effect of moisture and bale size on alfalfa hay composition (DM basis).

Bale characteristics	Moisture, % 10 Initial	10 End*	16 Initial	16 End	22 Initial	22 End
Large bales						
Wt., lbs of DM	1098.0	1098.0	1376.3	1355.2	1560.0	1388.2
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
ADF, %	35.2	34.2	35.5	36.2	31.1	32.3
CW, %	44.6	42.1	44.9	45.2	43.9	47.1
Small bales						
Wt., lbs of DM	50.8	50.4	56.0	55.4	70.6	66.9
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
ADF, %	35.5	34.1	35.7	34.2	31.1	32.3
CW, %	44.9	44.9	44.9	44.7	38.2	47.7

*The end was on 120th day of storage.

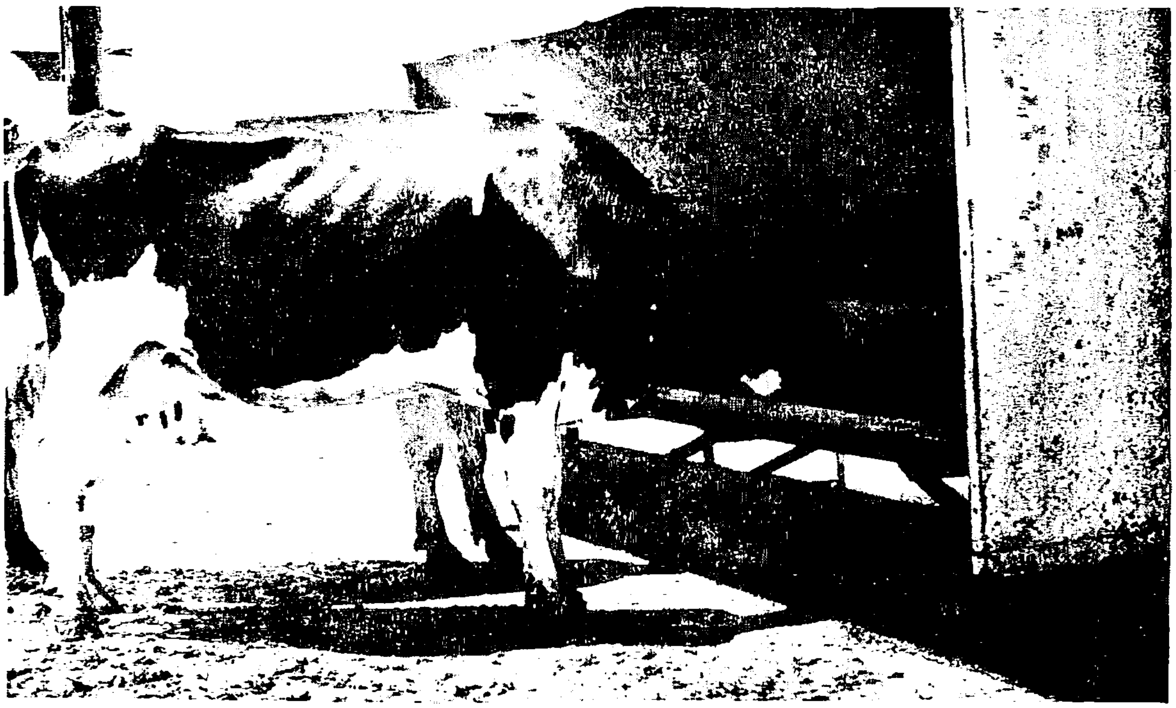

Table 2. Effect of moisture and bale size on alfalfa hay voluntary intake and digestibility by lambs.

Bale size and moisture	Intake lbs/day	Digestibility, %			
		DMD	Nitrogen	ADF	Cell wall
Low moisture (10%)					
small bales	3.80	61.9[a]	78.9[a]	42.9	41.9
large bales	3.63	60.6[a]	75.1[a]	40.3	40.3
Medium moisture (16%)					
small bales	3.85	60.5[a]	73.9[a]	42.5	44.1
large bales	3.74	60.7[a]	74.8[a]	45.9	45.3
High moistue (22%)					
small bales	3.90	60.9[a]	74.6[a]	47.5	47.2
large bales	3.83	57.0[b]	64.5[b]	41.6	43.0

[a,b]Means in the same column differ (P<.05).

DM = Dry matter.

ADF = Acid detergent fiber.