Dealing with Heating in Hay to Maintain Feeding Value

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Producers face several obstacles in putting up high-quality hay such as frequent rains and high humidity, which make it difficult to ensure adequate drying prior to baling. Often it is necessary to bale hay wetter than desirable to beat approaching weather in order to salvage a crop that is windrowed in the field to dry. And sometimes, it may just be more convenient to manage around other business or family commitments. Further, research has shown that controlling spontaneous heating is crucial to producing and maintaining dairy-quality hay[1]. Fortunately, solutions are available to help manage those challenges.

Points to Consider:

1. Research at the University of Wisconsin showed that spontaneous heating in hay can substantially reduce digestibility and feeding value[1].
2. Kemin on-farm research in Nebraska[2] illustrated the effects of microbial activity plus diurnal changes in ambient temperature on hay and its feeding value. It also showed that treatment with a multiple-organic-acid hay preservative during baling significantly reduced the impact of spontaneous heating in hay.
3. Microbial activity + environmental heating = a big threat if not managed properly.

Most commonly, spontaneous heating in hay is caused by the microbial activity that occurs when spoilage organisms, like molds and yeasts, become activated at higher moistures and consume nutrients in the crop. Their metabolic activity can generate tremendous amounts of heat, causing what is known as a Maillard (browning) reaction that changes the chemical composition of the crop nutrients, rendering them less nutritious for the animal.

What impact does heating have on hay quality? Recent research by W.K. Coblentz and P.C. Hoffman[1] measured the effects of spontaneous heating on forage quality. A total of up to 8.0 points of Total Digestible Nutrient (TDN) was lost in alfalfa-orchardgrass hay simply from 30 days of 20˚-30˚ heating above ambient temperatures. It was concluded that the reduced energy density within heated hay was likely due to shrinkage in the available cell solubles in the crop. Heating of the magnitude described can only come from microbial activity.

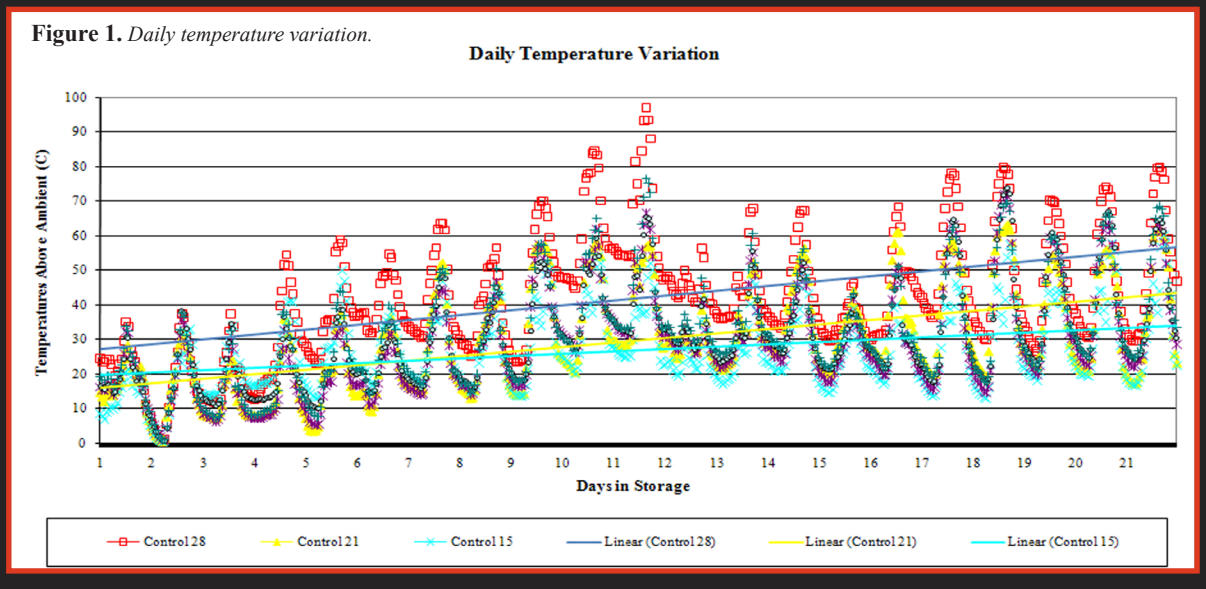
Table 1. *Treatment difference in accumulated Heat Units during 21 days of storage.*

Moisture	High	Medium	Low	Medium	
Treatment	Untreated	Untreated	Untreated	FRESH CUT Plus 8 lbs/ton	FRESH CUT Plus 12 lbs/ton
Heat Units	416	248	165	180	203
	d	c	a	b	b

Columns with different letters differ (P<0.05).

Less commonly, hay can also be impacted by the gradual heat gain from daily exposure to atmospheric heating. In an experiment conducted for Kemin by Sapienza Analytica, LLC, (Slater, IA)[2], 24-hour continuous electronic monitoring

Figure 1. *Daily temperature variation.*



of ambient day/night temperatures for 21 days showed both the daily variability in bale temperature as well as heat-gain over time (Figure 1); the patterns of internal bale temperature mimic the temperatures of the day. However, the data showed a noticeable increase in overall bale temperature over ambient (just the environment). When ambient heat is combined with heating from microbial activity, a dangerous threshold heat level can be reached quickly.

Many studies have shown that microbial activity can be controlled by the use of a premium hay preservative during baling. Among its 40 years of work on mold and yeast control, Kemin hay research in 2005 showed there is a combination of moisture, product used, and application rate at which a hay preservative will limit the heat generated in a bale with >12% moisture and reduce the amount of heat-damaged protein produced during storage.

In this research, the net effect of treating with a preservative was an increase in nutritive value of the hay and improved visual appearance of the bales compared to untreated hay. Field research tracked the heat units produced in individual bales stored in an open-sided pole barn with conditions associated with first (May) and fifth (October) cuttings. Those times of year are typically characterized by minimal climatic conditions suitable for drying cut forage to low moisture content in fewer than five days.

There were three moisture levels that were compared in the study: wet = >26%, medium = 20-26%, and dry = <20%. Each of the bales in the Kemin study was fitted with four temperature probes. The data were then converted into Heat Units (HU = daily maximum temperature minus daily minimum temperature divided by two).

There was a statistical advantage ($P<0.05$) for the reduction of HU produced by the bales made at low moisture compared to high moisture (165 HU vs. 248 HU). Both low and medium untreated bales were considerably lower in accumulated HU than those untreated bales made at high moisture (165 HU vs. 248 HU vs. 416 HU, respectively).

Treatment with FRESH CUT® Plus hay preservative showed a significant lowering of HU produced ($P<0.05$) when compared to untreated bales at high and medium moisture. Results showed there is an optimum application rate by moisture level in hay for products like FRESH CUT Plus, above which more product is superfluous and below which microbial activity will not be adequately controlled. In the study, there was an upper limit in hay moisture (≥27%) above which baling can be a risk even when using a preservative (Figure 1).

Figure 1 shows variation in temperature in a hay bale (higher during day, lower at night; linear regression lines are included. The data appear as expected with high moisture consistently above medium and low. Medium begins to depart from low by Day 12.

What conclusions can be reached based upon the findings of this trial?

1. Bale temperature is dynamic, even in 15% moisture hay.
2. It is possible to bale "too wet."
3. Producers can bale sooner and manage around other farm issues if using the correct additive.

Resources

1. "Effects of spontaneous heating on fiber composition, fiber digestibility, and in situ disappearance kinetics of neutral detergent fiber for alfalfa-orchardgrass hays." W.K. Coblentz, USDA-ARS, US Dairy Forage Research Center, Marshfield, WI, and Hoffman, P.C., University of Wisconsin, Madison. J. Dairy Sci. 92:2875-2895.

2. "Enhancing the value of your hay crop while reducing risk by using FRESH CUT® brand Plus hay preservative." Presentation by Donald Sapienza, Ph.D., January 2007, Land O'Lakes Elite Conference. Taken from Kemin Technical Report 40278.