Impact of Dry Matter at Ensiling on Final pH and Nutritive Value of Mixed Cool-Season Haylage

Teutsch, C.D.*; Teutsch, A. E.*
*University of Kentucky

Keywords: sweet hay; baleage; moisture; ensiling; nutritive value; pH.

Abstract. Harvesting hay as baleage can allow for more timely harvest, especially in spring months when curing conditions are not ideal. Forage conserved as baleage undergoes anaerobic fermentation in which the sugars are converted to lactic acid, lowering final pH. To successfully conserve forage as dry hay, moisture concentrations must be less than 18%. In contrast, the ideal moisture concentration for baleage is between 55 and 65%. There are a number of producers harvesting and wrapping hay that is not quite "dry enough" to bale but is too dry to ensile. This produces a product commonly referred to by producers as "sweet hay". The objective of this study was to evaluate the impact of dry matter at ensiling on the final pH and nutritive value of cool-season grasses. This study was conducted at the UK Research and Education Center located near Princeton, KY. Two mixed cool-season grass hay fields were sampled every two hours during daylight starting at cutting and ending when the hay was dry enough to bale. Each sample was immediately chopped into 2 to 3-inch lengths and sealed in a vacuum bag (3/4 full). After 6 weeks of fermentation, the vacuum bags were sampled. Final pH increased as DM at ensiling increased. Dry matter at ensiling had little impact on nutritive value. Our data indicate that if oxygen is excluded from the forage, ensiling in the range of 18 to 55% moisture may be a viable range management tool.

Introduction

Conserving hay as baleage can be a valuable tool that allows for a more-timely harvest, especially during times of the year where conditions are not optimal for curing (Henning et al., 2021). An additional advantage is that smaller quantities of forage can be ensiled at various times during the growing season. During the ensiling process, forage undergoes anaerobic fermentation where the sugars are converted to lactic acid reducing final pH of the forage. To optimize this process, the moisture concentration at ensiling should be between 55 and 65%. In contrast, to successfully conserve forage as dry hay, moisture concentrations must be less than 18% at baling. There has been a long-established moisture range (20 to 45%) in which neither hay nor silage conservation is optimized. Recently, producers have been challenging this range by baling and wrapping hay that is almost ¨dry enough¨ to bale. This forage is often referred to as ¨sweet hay¨, which likely undergoes a partial fermentation. The objective of this study was to evaluate the impact dry matter percentage at ensiling has on the final pH and nutritive value of cool-season grasses.

Methods and Study Site

The experimental design was a randomized complete block with five replications. The study was repeated. Two hay fields with mixed cool-season grass stands were used, with five sampling areas in each field. Grab samples from designated areas were collected starting at cutting and every two hours until dusk, starting again at 10:00 A.M. the following day (Figure 1). When the forage reached a moisture level adequate to bale, 18% moisture, sampling was concluded. The grab samples were processed immediately by chopping into 5 to 7.5 cm pieces, packing into a 1 l sized food saver bag ¾ of the way full, and vacuum sealing (Figure 1). The remaining sample was then weighed, dried, reweighed, and ground. The mini-silos were allowed to ferment for six weeks before sampling. Once opened, the pH was measured by submersing a subsample in deionized water for 30 min with periodic mixing before reading pH meter. The remaining sample was dried and ground for nutritive value determinations (Figure 2). Nutritive value of all samples were estimated using near infrared spectroscopy (McIntosh et al., 2022).

Total digestible nutrients (TDN) were calculated using the following equation TDN = 100.32 – 1.118 x ADF. Polynomial regression was used to determine the impact of dry matter at ensiling on the pH, crude protein (CP), and TDN.

Results and Discussion

Sample pH ranged from 4.6 to 6.0 and increased in a quadratic manner as dry matter at ensiling increased (Figure 3). This indicates that ensiling drier forage will result in incomplete fermentation. Crude protein decreased in a quadratic manner as forage dried (Figure 4). This decrease was not unexpected since it commonly occurs during hay making (Pitt, 1990). Acid and neutral detergent fiber (data not shown), TDN (Figure 5), and in vitro true dry matter digestibility (data not shown) were relatively unimpacted by dry matter at ensiling. The crude protein and energy concentrations in forage were low, most likely due to an advanced stage of maturity at harvest (Ball et al., 2015). The crude protein and energy levels in this experiment would support a gestating brood cow, but not a lactating brood cow (Figures 4 and 5).

Conclusions

These data indicate that if air is excluded from the forage, dry matter at ensiling had little impact on the nutritive value of the forage. Ensiling "almost" dry hay may be a viable rain management tool for forage and livestock producers. However, to optimize fermentation, it is still recommended that forage be ensiled at a DM concentration of 35 to 45%.

References

Ball, D.M., C.S. Hoveland, and G.D. Lacefield. 2015. Southern Forages, fifth edition, modern concepts for forage crop management. IPNI, Peachtree Corners, GA.

Henning, J.C., C.D. Teutsch, and S.R. Smith. 2021. Baling Forage Crops for Silage. AGR-173. UK Cooperative Extension Service, Lexington.

McIntosh, D., B. J. Anderson-Husmoen, R. Kern-Lunbery, P. Goldblatt, R. Lemus, T. Griggs, L. Bauman, S. Boone, G. Shewmaker, and C. Teutsch. 2022. Guidelines for Optimal Use of NIRSC Forage and Feed Calibrations in Membership Laboratories (Second Edition). The University of Tennessee Press, Knoxville, TN.

Pitt, R.E. 1990. Silage and hay preservation. NRAES-5, Ithaca, NY.

Teutsch, C.D., B. Sears, S.R. Smith, J.C. Henning, and D.W. Hancock. 2018. Baleage: Frequently Asked Questions. AGR-235. UK Cooperative Extension Service, Lexington.

Figure 1. Grab samples were collected from the field (left), transported to the lab where they were chopped into 5 to 7.5 cm pieces (middle) and ensiled in vacuum bags (right).

Figure 2. After six weeks of fermentation, silos were opened (top left) and a sample from each was submersed in distilled water for pH determination (top left and bottom). The remaining sample was dried and ground for nutritive value determination.

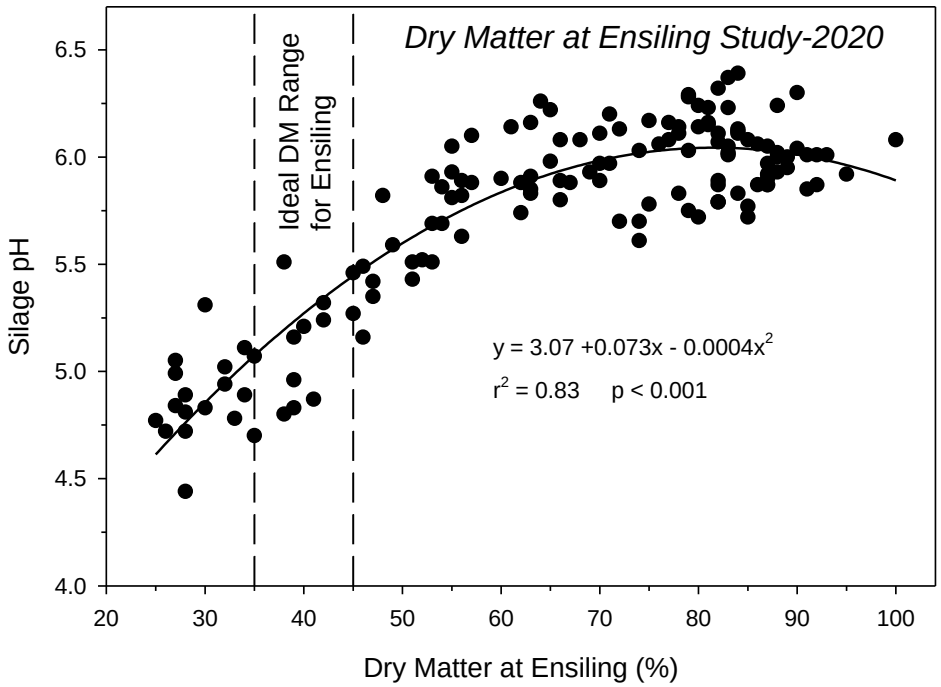

Figure 3. Impact of dry matter at ensiling on the final pH of cool-season grass baleage.

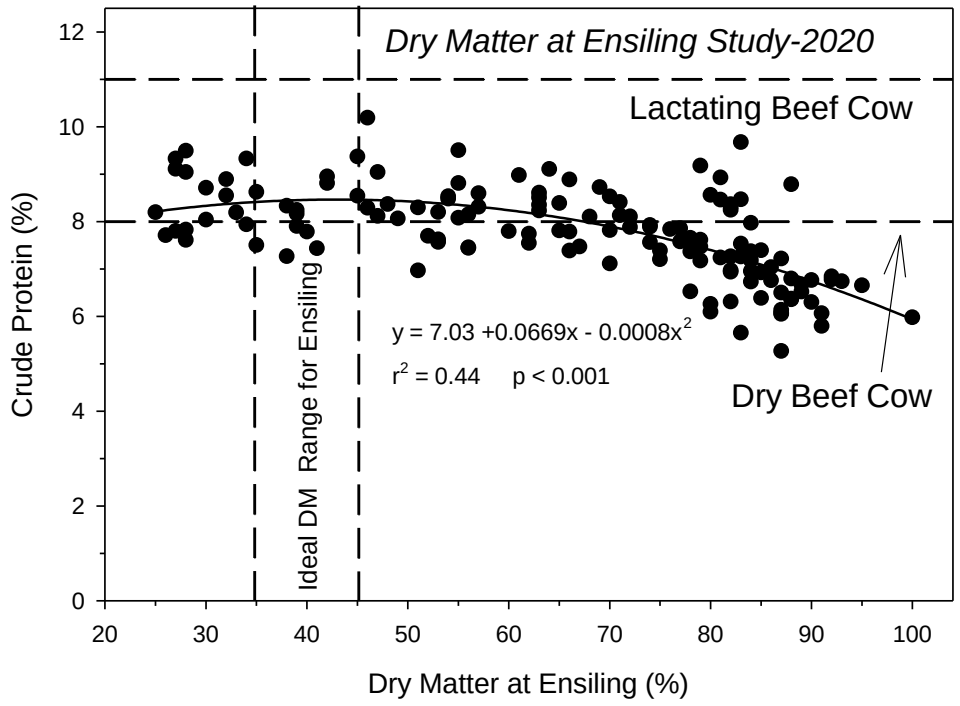

Figure 4. Impact of dry matter at ensiling on the crude protein of cool-season grass baleage.

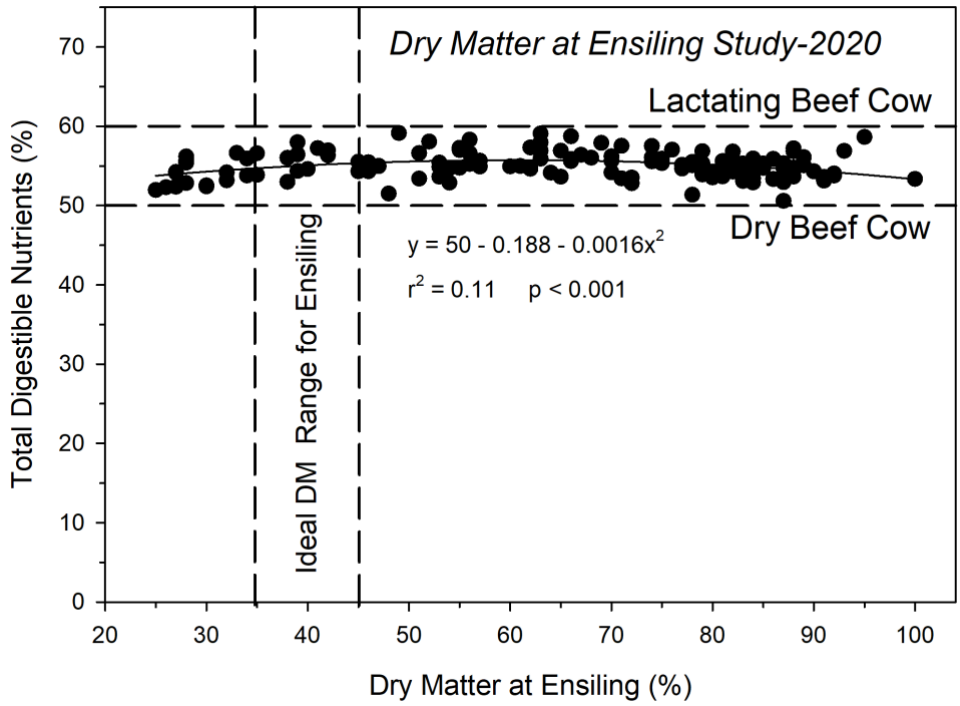

Figure 5. Impact of dry matter at ensiling on the total digestible nutrients of cool-season grass baleage.