Effect of Preservation Method on Nutritive Value of Kudzu Forage

Diva Rigney[1,], Abbigail R.Hines[2], Courtney Heaton[3], and W. Brandon Smith[4]*

[1] Undergraduate Student, Department of Animal Sciences, Auburn University, Auburn University
[2] Graduate Student, Department of Animal Sciences, Auburn University, Auburn University
[3]Lecturer, Department of Animal Sciences, Auburn University, Auburn University
[4]Assistant Professor, Department of Animal Sciences, Auburn University, Auburn University

Kudzu *(Puerarira montana [Lour.] Merr.*) is a drought tolerant perennial leguminous vine native to Asia. The species was brought to the United States as an ornamental crop that became a solution for soil erosion during the Dust Bowl when southern farmers were encouraged to plant the now invasive species. In the 1950s, kudzu was removed from the cover crop list, and was later labeled as an invasive plant species by the USDA (Everest et al., 1999). Early research on kudzu as a pasture crop found that it has a high nutritive value and nitrogen-fixation ability. The leaf was found to have a higher nutritive value than what was recommended by the National Research Council (Glass and Al-Hamdani, 2016). The leaf has been found to be rich in crude protein at 17.5% (Corley et al., 1997) which is comparable to alfalfa values at 18.7% (NRC, 2012). The leaf has also had similar neutral detergent fiber (NDF) and acid detergent fiber (ADF) values, 48.1% and 38.2%, (Corley et al., 1997) to that of alfalfa, 46.0% and 36.9% respectively. (NRC, 2012). However, research on kudzu was abandoned for years, making animal data on the usage limiting (Gulizia et al. 2019). Recent efforts in sustainable agriculture have renewed interest in the potential use of kudzu.

The purpose of this study was to evaluate the effects preservation method on nutritive value and digestibility of kudzu forage. Our experiment was conducted as a completely randomized design. A single treatment factor (preservation method) was employed with two levels (fresh or sun-cured [representing the haying process]).

For this experiment, we selected a stand of kudzu on a private property in Auburn, Alabama. Two independent plots at this location were identified for harvest. Herbage was sampled from each plot by hand-clipping at a quadrat (0.25 m^2) four random locations within each plot to determine biomass. Total herbage was removed using a two-wheeled tractor (BCS Model 853, BCS American, Oregon City, OR) fitted with a sickle-bar mower attachment. Fresh kudzu was immediately removed from each plot. Sun-cured kudzu (representing the haying process) was removed once a target moisture of 20% was achieved (determined by microwave testing).

Samples of forage from each level of the treatment factor were dried at 50°C in a forced air oven for 72 h following collection. Oven-dried samples were ground to pass through a 2-mm screen using a Wiley mill, and a subsample was ground to pass through a 1-mm screen. Fiber fractions (NDF and ADF) were assayed sequentially according to the procedures of Vogel et al. (1999) using an ANKOM2000 and ANKOM DELTA Fiber Analyzers. Acid detergent lignin (ADL) was assayed on the ADF residues according to the procedures of AOAC (2000). Crude protein (CP) was measured using the Kjeldahl method (AOAC, 2000). In vitro true disappearance (IVTD) was also measured (Vogel et. al 1999) using the ANKOM DaisyII incubator.

Data was analyzed using SAS v. 9.4 (SAS Institute, Inc., Cary, NC, USA). All response variables were analyzed using the generalized linear mixed models procedure (PROC GLIMMIX) in SAS. For measures of nutritive value, the model included the fixed effect of preservation method. For in vitro true disappearance, the model included the fixed effect of preservation method and the random effects of incubation vessel and inoculum source. Denominator degrees of freedom were adjusted

* Corresponding author: dnr0009@auburn.edu

using the second-order Kenward-Roger approximation method (Kenward and Roger, 2009). Least squares means were computed for the main effect of preservation method. The α-level for mean differences was set at 0.05. Means separations were performed based on F protected t-tests using Tukey-Kramer's HSD (Kramer, 1956).

There was no statistically significant effect of preservation method on NDF (P = 0.45), ADF (P = 0.50), ADL (P = 0.39), or CP (P = 0.79) concentrations (Table 1). However, sun cured kudzu had a greater (P < 0.01) IVTD than did fresh kudzu (Figure 1).

Table 1. Nutritive value of fresh and sun-cured (hay_ kudzu harvested in Auburn, AL.

Preservation method	NDF %	ADF %	ADL %	CP %
Fresh	54.50	40.00	20.10	11.52
Hay	51.65	37.48	14.96	11.13

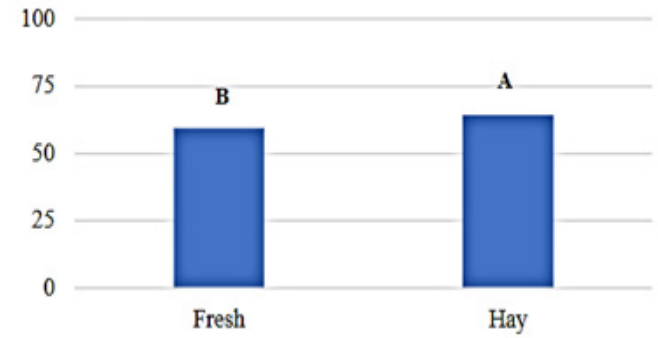


Fig. 1. In vitro true disappearance (IVTD) of fresh and sun-cured (hay) kudzu forage harvested in Auburn, AL.

To understand the context in which kudzu forage may be beneficial for livestock operations, it is helpful to compare it to more commonly used leguminous species. According to NRC (2012), alfalfa presents NDF, ADF, and CP concentrations of 46%, 37%, and 19% respectively. Similarly, perennial peanut has been documented to have NDF, ADF, and CP concentrations of 46%, 34%, and 11%, respectively (Eckert et al., 2010). In our study, regardless of preservation method, kudzu had greater NDF concentrations and similar ADF concentrations, while CP concentrations were more similar to perennial peanut than to alfalfa.

Seasonality has also been shown to play a significant role in nutritive value of kudzu forage. The kudzu harvested in our study would be considered late season (harvested in October 2022). A study by Gulizia et. al (2019) found that kudzu leaves in late season had NDF, ADF, and CP concentrations of 45.7%, 26.2%, and 26.7%, respectively. The differences in our samples and those of Guliza et al. (2019) are likely due to their samples only containing the leaf portion of kudzu and our samples containing both leaf and stem portions. While dry matter demand was influenced based on age variability, the rumen degradability of kudzu was similar across early and late season kudzu. However, early season kudzu was found to be more rumen degradable than late season kudzu as the plant is younger with limited stores of carbohydrates. Producers could utilize this information to manage kudzu growth for the purpose of livestock browsing. The research of Guliza et al. (2019) showed that kudzu is a nutritious and highly degradable legume for the ruminant diet.

In summary, while preservation method of kudzu forage had no effect on nutritive value parameters (NDF, ADF, ADL, or CP), there was a measurable improvement in digestibility in the sun-curing (i.e., haying) process. Regardless of treatment, nutritive value and digestibility estimates obtained from this experiment are interpreted to mean that kudzu may represent a viable, low-quality roughage for use in ruminant livestock production systems

Statement of Research Advisor

Diva's work with an unorthodox and novel forage species is setting the foundation for further work in the Ruminant Nutrition Laboratory at Auburn University. Data from her experiment will form the basis for future student endeavors in novel forage and byproduct feeding systems, ultimately contributing to a more efficient and sustainable beef production model for Alabama. Diva aided in the development of the research protocol and was solely responsible for the assays described herein. The skills that she developed through this experience will serve her well in her next stage as a ruminant nutrition master's student.

- Dr. Brandon Smith, Department of Animal Sciences, College of Agriculture

References

[1] Ag Guide. 2020. Guide for the care and use of agricultural animals in research and teaching. 4th edition. American Dairy Science Association, American Society of Animal Science, and Poultry Science Association. Champaign, IL.

[2] AOAC. 2000. Official Methods of Analysis, 17th ed. Association of Official Analytical Chemists, Gaithersburg, MD.

[3] Corley, R. N., A. Woldeghebriel, and M. R. Murphy. "Evaluation of the nutritive value of kudzu (Pueraria lobata) as a feed for ruminants." Anim. Feed Sci. Technol. 68(1-2), pp. 183-188, (1997).

[4] Eckert, J. V., R. O. Myer, L. K. Warren, and J. H. Brendemuhl. "Digestibility and nutrient retention of perennial peanut and bermudagrass hays for mature horses." J. Anim. Sci. 88(6), pp. 2055-2061, (2010).

[5] Everest, J. W., J. H. Miller, D. M. Ball, and M. Patterson. 1999. Kudzu in Alabama History, Uses, and Control. ANR65.

[6] Goering, H. H., and P. J. Van Soest. 1970. Forage fiber analysis (apparatus, reagents, procedures, and some applications). Agr. Handbook No. 379, USDA.

[7] Glass D. and S. Al-Hamdani. "Kudzu Forage Quality Evaluation as an Animal Feed Source." Am. J. Plant Sci. 7(4), pp. 702-707, (2016).

[8] Gulizia, J. P., K. M. Downs, and S. Cui. "Kudzu (Pueraria montana var. lobata) age variability effects on total and nutrient-specific in situ rumen degradation." J. Appl Anim. Res. 47(1), pp. 433-439, (2019).

[9] Kenward, M. G., and J. H. Roger. "An improved approximation to the precision of fixed effects from restricted maximum likelihood." Comput. Stat. Data Analy. 53(7), pp. 2583-2595, (2009).

[10] Kramer, C. Y. "Extension of multiple range tests to group means with unequal numbers of replications." Biometrics 12(3), pp. 307-310, (1956).

[11] Mabjeesh, J., M. Cohen, and A. Arieli. "In Vitro

[12] Methods for Measuring the Dry Matter Digestibility of Ruminant Feedstuffs: Comparison of Methods and Inoculum Source." J. Dairy Sci. 83(10), pp. 2289-2294, (2000).

[13] Mullenix, K., and D.L. Rankins, Jr. 2018. Nutrient requirements of beef cattle. Retrieved September 27, 2022, from https://www.aces.edu/blog/topics/beef/nutrient requirements-of-beef-cattle/?cn-reloaded=1 (November 27, 2018).

[14] NRC. 2012. Nutrient requirements of beef cattle. 11th rev ed. Washington (DC). Natl. Acad. Press.

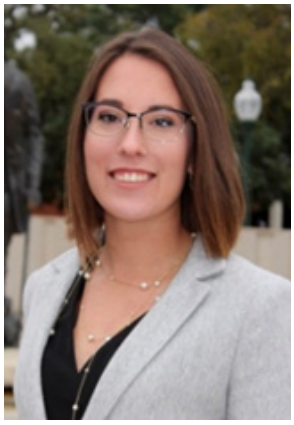
[15] Ricci, P., A. J. Romera, J. C. Burgres, H. H. Fernandez, and C. A. Camgiano. "Precision and Accurary of Methodologies for Estimating In Vitro Digestibility of Thinopyrum ponticum (Tall Wheatgrass) Hay and Haylage Fed to Beef Cattle." The Professional Animal Scientist. 25(5), pp. 625-632, (2009).

[16] Tilley, J. M. A, and R. A. Terry. "A two-stage technique for the in vitro digestion of forage crops." Grass Forage Sci. 18, pp. 104-111, (1963).

[17] Vogel, K. P., J. F. Pederson, S. D. Masterson, and J. J. Toy. "Evaluation of a filter bag system for NDF, ADF, and IVDMD forage analysis." Crop Sci. 39, pp. 276-279, (1999).

Authors Biography

Diva Rigney is a senior pursuing a B.S. degree in Animal Sciences at Auburn University.



Abbigail Hines is PhD student pursing a PhD in Ruminant Nutrition at Auburn University.

Courtney Heaton is a lecturer and Equine Extension Specialist in the Department of Animal Sciences at Auburn University.

W. Brandon Smith is an assistant professor of Ruminant Nutrition in Forage Systems in the Department of Animal Sciences at Auburn University.