

In Situ Rumen Degradability of Late Season Kudzu (*Pueraria montana* var. *lobata*) in Ruminally Fistulated Steers (*Bos taurus*)

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ABSTRACT

Kudzu (*Pueraria montana* var. *lobata*) is an invasive weed species native to eastern Asia affecting much of the southeastern United States. Its broad leaves and viny growth pattern allow it to outcompete native plant species for sunlight and nutrients. Kudzu is a leguminous plant making it a potentially ideal feed component for ruminant animals. Browsing ruminants in areas affected by kudzu could benefit production while functioning as a weed control method. This study assessed the nutritive quality of late season kudzu by evaluating the overall rumen degradability, rate of digestion, digestible fraction, and indigestible fraction in experimental bovine. In situ rumen degradability was analyzed using four ruminally fistulated steers as individual experimental units over two repeated trials. Samples were incubated at 1, 12, 24, 36, 48, 60, and 72h. Kudzu used in these trials was collected during September, making analysis in this study a reflection of degradability toward the end of the growing season. Data was analyzed as a randomized complete block design (RCBD) with repeated measures showing no significant differences between steers or trials ($P > 0.05$). Overall degradability across all steers and times was 69.79%. Significant changes in dry matter disappearance across all steers were observed at 1, 12, and 24h ($P < 0.05$) with values of 33.86%, 64.78% and 74.26% respectively, and highest observed degradability at 72h (79.55%). Incubation times between 24 and 72 hours were not used in determining rate of digestion as dry matter disappearances throughout these times were not significantly different ($P > 0.05$). Rate of digestion (k_d) was determined using linear regression to be $1.68\% \cdot h^{-1}$ along with digestible fraction (D_o) = 28.29% and indigestible fraction (U) = 22.03%. The results of this study show that this plant is beneficial for ruminant animal production throughout its growing season offering a useful kudzu control method.

INTRODUCTION

Kudzu is an invasive weed species native to Japan that has overtaken large spans of the Southern United States since its introduction in the late 19th century. Kudzu was first introduced for its ornamental nature boasting bright blooms, but was not widely distributed until its potential to prevent soil erosion was exploited. Campaigns in the early 20th century championed for a greater presence of this plant and applauded its quick growing ability and potential to conserve soils (Alderman, 2001). Additionally, Kudzu has been used in Chinese medicine for nearly 2000 years in treatment of fever, diarrhea, diabetes, and cardiovascular disease. Animal and cellular studies show effects of kudzu on the endocrine system and warrant more investigation into the biochemical nature of this species (Wong et al., 2011). It was not until 1974 that the USDA classified kudzu as a weed and it was in 1997 that this species was placed on the federal noxious weed list after realizing the devastating effects kudzu can have on native plant species and agricultural lands (Aldrich, 2000). Kudzu displays a viny growth pattern which offers a unique advantage over native plants in its ability to compete for sunlight and other nutrients. This plant can reproduce both sexually, through flowering in August, and asexually. These factors allow Kudzu to grow at a rate of 20-30 meters/year, ultimately reducing the amount of biodiversity normally seen in areas overwhelmed by this weed (Kartzinel et al., 2015).

Actions to combat kudzu's spread are warranted. While herbicides are often used in controlling kudzu, it may take years for these methods to eradicate the plant from an area. This method also raises concerns of residual herbicides leaching into the soil and causing adverse effects on other plants nearby (Berisford et al., 2006).

Kudzu is a leguminous species which offers reason to suspect it to be a viable feedstuff for ruminant animals. Kudzu has been shown to provide similar nutritive qualities to other common forages (Corley et al., 1997) bringing with it the potential to browse ruminants on areas affected by this plant as a means of control.

The objective of this research was to evaluate the rumen degradability (dry matter disappearance) and nutrient content of late season kudzu in ruminant animals; adding to and supporting data collected for this species at other points in its growing season.

MATERIALS AND METHODS

Sample: Kudzu leaf samples were collected from several middle Tennessee counties (Bedford, Cannon, Coffee, Lawrence, Maury, Rutherford, and Williamson). At each collection site, samples were randomly selected by tossing a ball into the patch of kudzu and collecting leaves from plants nearest the ball. Multiple collections were made in each location.

All samples were dried overnight at 60°C then ground to pass through a 0.2 mm sieve. A composite of all samples was created by placing the ground plant material in a large bucket and mixing thoroughly. Approximately 8g of sample were placed in 56 50µ ± 10µ porosity Dacron bags. These bags were heat sealed three times to ensure no loss of sample through leaking. All bags were labeled with the animal number, incubation time, and replication (ex: A1 24H).

Experimental units in this study were four ruminally fistulated steers (*Bos taurus*). Two identical trials were conducted in successive weeks with a three day rest period between trials for cattle recovery. All four experimental bovine were fed mixed grass hay (*ad libitum*), soybean meal (9.09 kg d⁻¹), and a free-choice mineral supplement beginning three days before each trial and remained on this regimen until the trials were complete. At incubation times (1h, 12h, 24h, 36h, 48h, 60h, 72h) the Dacron bags were soaked for 20 minutes at 39°C to minimize lag time for microbial activity in the rumen. Samples were placed into the ruminally fistulated steers by insertion of a mesh laundry bag containing the Dacron bags into the digestive fluid of the rumen. Two samples were inserted per steer at each incubation time. In this way, the first incubation time corresponded to the 72 hour collection while the last samples placed would reflect the one hour incubation period. As a control, 0h samples were prepared and processed as all other samples but without inclusion in the rumen environment.

Removal: At the end of the 72-hour trial period, the mesh laundry bags were removed and placed in ice water (0°C) to stop any microbial activity.

Rinsing: Bags were agitated in warm water (39°C) for one minute before being spun dry for an additional two minutes. This was repeated five times per bag with batches separated by steer.

Drying: Fully rinsed Dacron bags were placed in a 60°C drying oven for 24 hours. Weights of dry bags were recorded and used to calculate dry matter disappearance (DMD).

Nutrient analysis: All duplicates were combined and analyzed using near-infrared reflectance spectroscopy (NIRS) to determine neutral detergent fiber (NDF), acid detergent fiber (ADF), and hemicellulose content of the residual kudzu. Samples of unincubated dried, ground kudzu were also analyzed to determine nutrient composition (Table 2)

Calculation of Dry Matter Disappearance: $(1 - ((\text{Dried Dacron bag} + \text{Sample Weight Post-incubation}) - \text{Dacron Bag Weight}) / ((\text{Dacron Bag} + \text{Sample Weight}) - \text{Dacron Bag Weight}) \times \text{Dry Matter}) \times 100$

Statistical Analysis: Data was analyzed as a randomized complete block design (RCBD) using mixed procedure of SAS (SAS institute, 2017) to determine the significance of dry matter disappearance on our data set. Each steer was considered an experimental unit and incubation times were the only treatment analyzed.

RESULTS

- Earlier collection times of kudzu samples (earlier in growing season) evaluated in a recent study (Gulizia et al., 2019) show similar dry matter disappearance and digestible fractions to those observed in late season kudzu (Tables 1 & 2).
- Significant changes ($P < 0.05$) in dry matter disappearance was observed between the 1h, 12h, and 24h placements, but there was no significant changes in dry matter disappearance after the 24h placement (Figure 1).
- No significant differences were observed for dry matter disappearance between steers ($P < 0.05$) (Table 3).

CONCLUSION

- Late season kudzu appears to have a relatively high digestible fraction and rate of digestion, showing promise for its use as a forage for browsing ruminants that can be used as a control method of this invasive species.
- Results from this study should be considered an addition to the existing catalog of data outlining the nutritive value of kudzu in ruminant animals. The unique difference observed in this data set is due to the late collection period.

Table 1: Total D_o , U, K_d , L, and Degradability of Late Season Kudzu by Steer Across All Times and Trials

	Steer 1	Steer 2	Steer 3	Steer 4	Average
Digestible Fraction (D_o), %	9.6938	26.8046	36.2163	40.4515	28.29155
Indigestible Fraction (U), %	21.675	22.538	22.2129	21.6789	22.0262
Rate of Digestion (k_d), %/hr	1.768	2.169	1.0398	1.7282	1.67625
Lag Time (L), hr	1.091	0.4803	0.4531	0.3076	0.583
Overall Degradability, %	70.5736	69.9121	68.4671	70.1907	69.785875

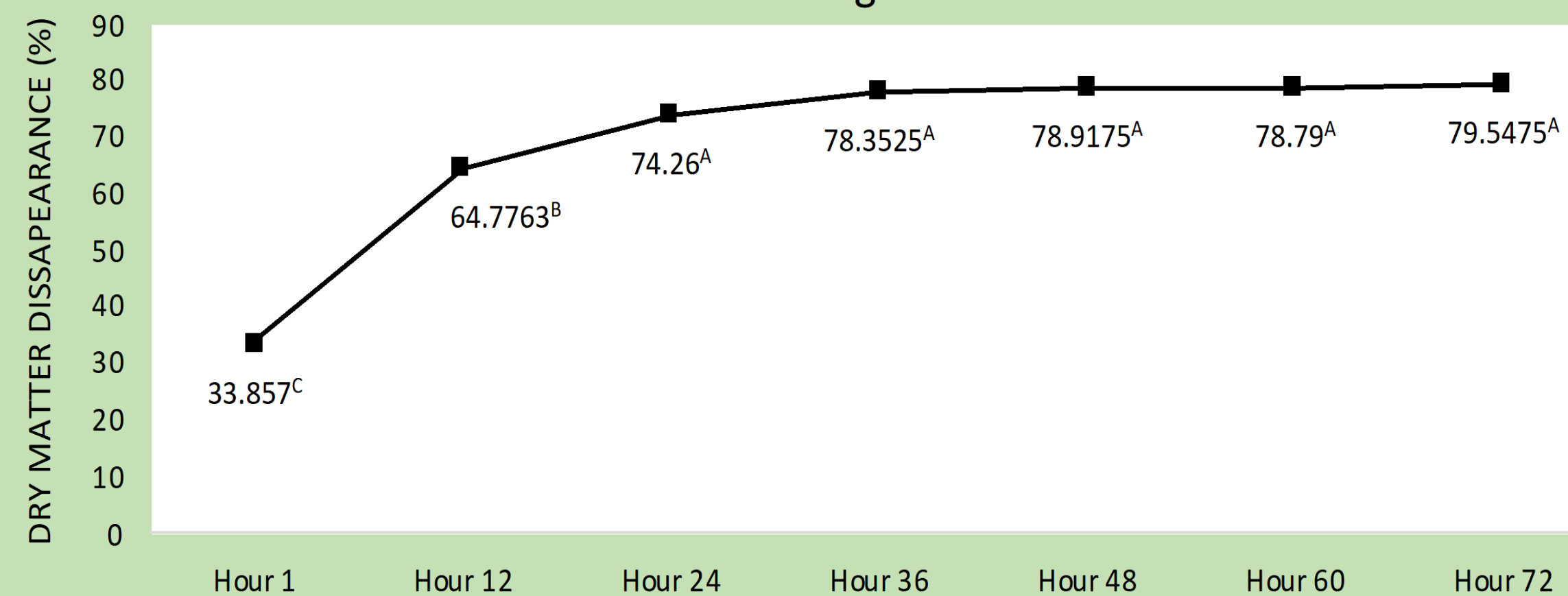
Table 2: NIR Nutritional Analysis of Late Season Kudzu

NUTRIENT	Value
DM, %	92.231
FAT, %	1.916
ASH, %	8.526
ADF, %	24.078
LIGNIN, %	6.692
STARCH, %	1.193
CA, %	1.56
K, %	1.466
MG, %	0.461
P, %	0.286
CP, %	27.392

Table 3: Total Mean Degradation of Late Season Kudzu By Steer

STEER	DMD %	SEM ¹	LETTER GROUP ²
1	70.5736	2.1189	A
2	69.9121	2.1189	A
3	68.4671	2.1189	A
4	70.1907	2.1189	A

Figure 1: Mean Dry Matter Disappearance Across all Steers by Incubation Time Combining Data From Both Trials¹



¹The superscripts (A-C) show that the dry matter disappearances observed at these times are different ($P < 0.05$).

²SEM refers to the standard error of the mean as used to determine significant differences in dry matter disappearance.

³The identical letter groups show there is no difference between steers ($P < 0.05$).



One of the steers (*Bos Taurus*) used during this study



A hillside covered in kudzu displaying viny growth.



Detailed view of kudzu leaves.



A cannula of one of the steers used in this study. This structure allows access to the rumen.

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