Analysis of Biochar Impact on Ruminal Fermentation of Several Different Quality Forages

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Rationale

Cattle and dairy production have been cited as major methane emission sources contributing to greenhouse gases. In addition to having an environmental impact, methane produced during ruminal fermentation results in a substantial loss of ingested energy. It has been found that different types of carbohydrate in cattle diets influence ruminal methane production by shifting the dominance of methane-producing microorganisms in the rumen. Previous research has studied the effectiveness of biochar to suppress methane production. Biochar is the product obtained after pyrolysis of biomass at a high temperature, with the temperature of pyrolysis known to affect the characteristics of the resulting biochar.

Objectives

A study was conducted to quantify the impact of biochar temperatures on ruminal gas production and digestibility of several different quality forages using a replicated factorial experiment.

Materials and Methods

Hay samples of ALF (pre-bud stage alfalfa), HQB (high-quality bermudagrass), and LQB (low-quality bermudagrass) were ground to 1-mm particle size after oven drying. Before the *in vitro* testing, samples were analyzed for nutrient value using a DS2500 near infrared spectroscopy (Foss, Eden Prairie, MN). Biochar produced at 662 or 2700°F were added to the hay samples at 1% of DM weight and ruminal fermentation tests were conducted according to Goering and Van Soest (1970). Ruminal gas accumulation was measured every 30-min using Ankom gas modules (Ankom Technology, Macedon NY). Gas accumulation was analyzed using repeated measure analysis. Forage quality (FT) and biochar temperature (BT), and interaction between FT and BT were consider fixed effect. The incubation batches were considered a random effect.

Results

The three forages differed in the nutrient values as presented in Table 1. The mean *in vitro* true digestibility of ALF and HQB were similar while LQB was lower than the other two forages by 29% unit (Fig. 1). The zero biochar was greater than those of the two biochar treated hays by up to 7% (Fig. 1). The hays incubated with the biochar produced at the two different temperatures did not differ among themselves in digestibility.

The *in vitro* gas accumulation pattern interpreted using a repeated measure analysis indicated significance of linear and quadratic functions of the incubation time (Table 2). The parameters of the gas accumulation curves ($y = \gamma + \alpha \times time + \beta \times time^2$), such as intercept, linear slope, and quadratic slope, were highly significant.

Table 1. Nutrient value of ALF (alfalfa hay), HQB (high quality bermudagrass), and LQB (low quality bermudagrass).

Forage	ADF	NDF	CP	Lignin
ALF	24.7	28.5	23.6	6.12
HQB	33.2	52.2	14.8	7.36
LQB	46.2	67.6	7.01	6.91

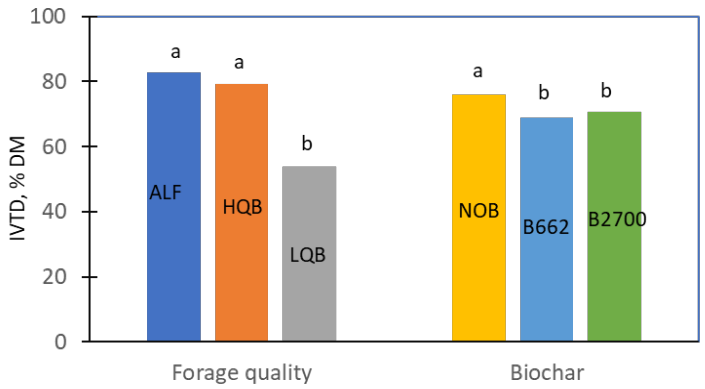

Fig. 1. Mean of IVTD (in vitro true digestibility) by forage (ALF, alfalfa; HQB, high quality bermudagrass; LQB, low quality bermudagrass) and biochar (NOB, zero biochar; B662, biochar produced at 662°F; B2700, biochar produced at 2700°F).

The ruminal gas accumulation rates (slope) of forage incubated with lower temperature biochar (B662) consistently demonstrated a faster gas accumulation rate than high-temperature biochar (B2700).

Table 2. Parameters of ruminal gas production curves of ALF (alfalfa hay), HQB (high quality bermudagrass), and LQB (low quality bermudagrass) treated with B662 (biochar produced at 662°F) or B2700 (biochar produced at 2700°F).

	Parameter		
Treatment	Intercept	Time linear	Time quadratic
ALF + B662	17.9*	3.00***	-0.038***
ALF + B2700	14.5**	2.21***	-0.027***
HQB + B662	6.75*	2.30***	-0.025***
HQB + B2700	1.91**	2.14***	-0.023***
LQB + B662	7.9	1.89***	-0.021***
LQB + B2700	7.0**	1.36***	-0.016***

Conclusions

Based on the obtained results, applied biochar may suppress ruminal fermentation of forage, and biochar produced at different temperatures may suppress ruminal gas production in different patterns. Further analysis, including gas composition and various quality hays, will validate the obtained results.

Reference

Goering, H.K. and Van Soest, P.J., 1970, Forage fiber analysis (apparatus, reagents, procedures and some applications), Agricultural Handbook No. 379 ARS-USDA, Washington, DC.