Evaluation of Various Biomass Feedstock for Degradability and Energy Content

K.J. Han

Louisiana State University Agricultural Center, School of Plant, Environmental, and Soil Sciences

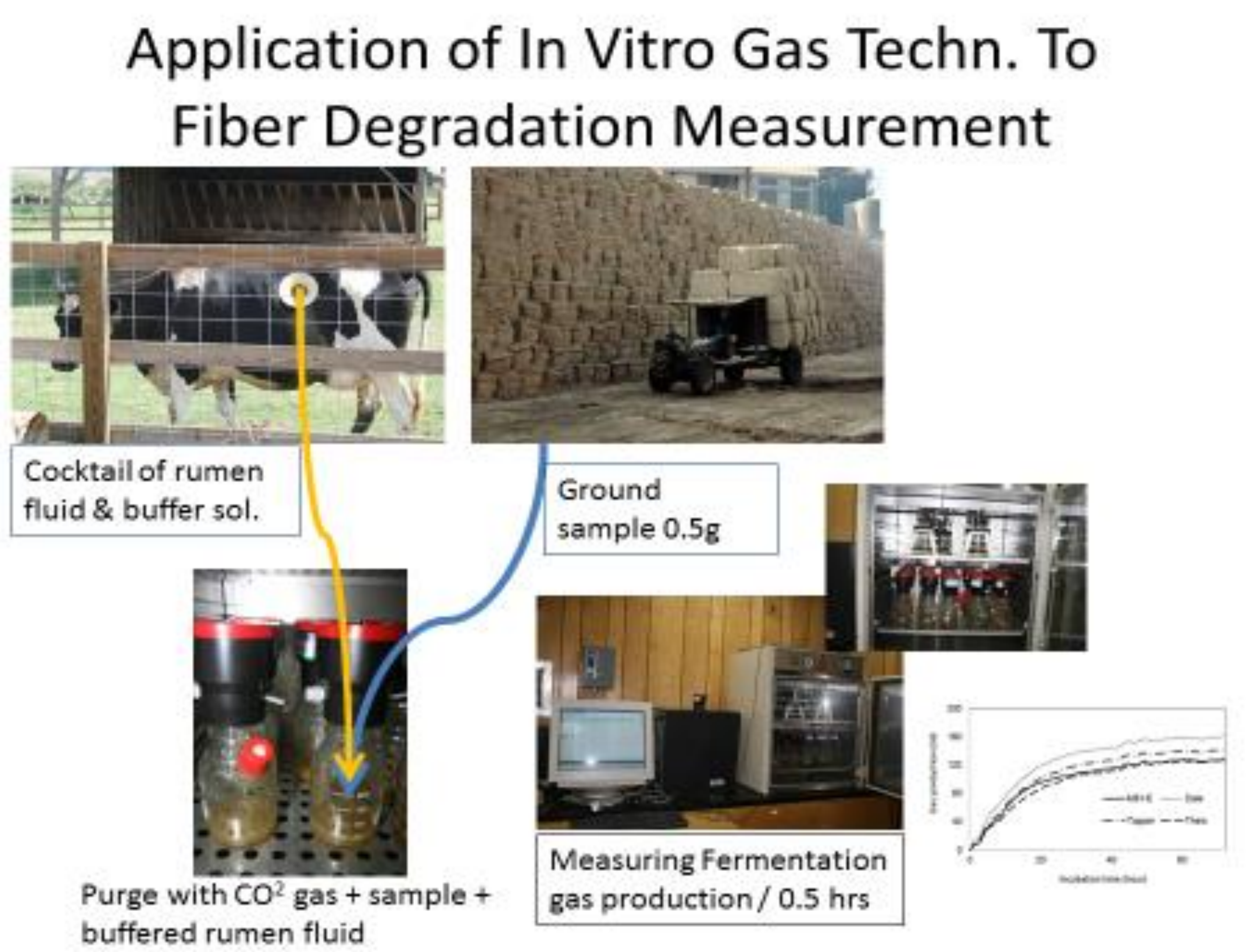
104 M.B. Sturgis Hall, Baton Rouge, LA 70803

Introduction

Bioethanol or co-firing is one of the most practical forms of energy production from lignocellulosic biomass with less conflict with food supply. Degradation of cellulose through hydrolysis is the pre-step of fermentation in the process of bioethanol production. The easiness of hydrolysis depends on cellulose/lignin characteristics in biomass. Unlike analysis of cellulose and lignin contents in biomass, *in vitro* ruminal fermentation assay may indicate ethanol production potential of biomass through fiber degradation/fermentation with a relatively little preparation (Weimer et al., 2005; Han et al., 2013). A study was conducted to investigate biofuel production potential of a range of lignocellulosic biomass targeting heat generation and ethanol production.

Materials & Methods

- Nine lignocellulosic biomass samples including switchgrass (Panicum virgatum), miscanthus (Miscanthus giganteus), sugarcane (Saccharum spp.), energycane (Miscanthus and Erianthus crosses), and sweet sorghum (Sorghum bicolor)
- Determination of ADF (acid detergent fiber) and ADL (acid detergent lignin) according to Robertson and Van Soest (1981)
- *In vitro* ruminal fermentation & determination of *in vitro* gas production parameters (Schofield et al., 1994)



Results & Discussion

Biomass of different sources demonstrated significant variation ($P < 0.01$) in energy content, fiber (as ADF), and lignin (ADL) as shown in Table 1. However, the pairwise comparison of energy content did not show a trend related to crop maturity or storage. There was a tendency of greater energy in perennial crops than sweet sorghums.

Table 1. Calorie, ADF (acid detergent fiber), and ADL (acid detergent lignin) in variety of biomass

Biomass	Calorie, cal/g	ADF, % DM	ADL, %DM
Early Maturity SS† Bagasse	4172ab‡	39.9bc	6.5bcd
Early Maturity SS	3847de	31.6de	5.4cd
Early Maturity SS at EH¶	3862cde	29.5de	4.7d
Medium Maturity SS Bagasse	4188ab	43.0b	9.0b
Medium Maturity SS	3940bcde	26.1e	5.3cd
Medium Maturity SS at EH	3853cde	31.2de	6.7bcd
Energy sorghum	4267a	35.7cd	6.0cd
Late Maturity SS Bagasse	4134abc	41.5bc	7.8bc
Late Maturity SS	3948bcde	27.7e	5.2d
Late Maturity SS at EH	3773e	28.8de	5.0d
Miscanthus	4228a	58.6a	14.0a
Switchgrass	4308a	59.2a	15.5a
Energy cane	4067abcd	53.9a	1.2e

†SS, sweet sorghum .
‡Numbers following the same letter(s) within the same column did not differ at P > 0.05.
¶ EH, early heading stage harvest

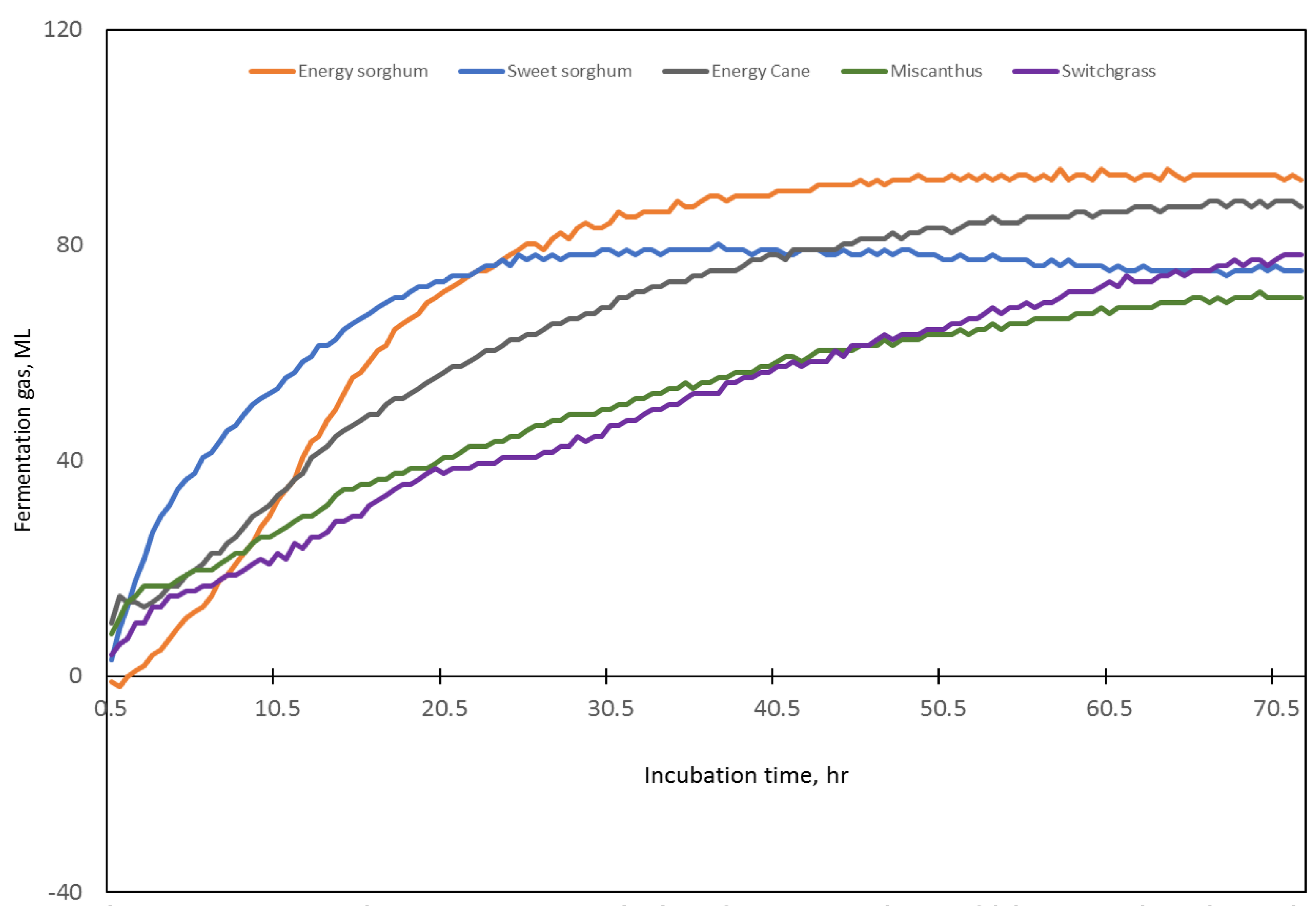


Fig. 1. Fermentation gas accumulation from a variety of biomass incubated with buffered rumen fluid for up to 72 hrs.

Table 2.In vitro ruminal fermentation parameters determined by a single pool logistic model.

Feed stock	Fermentation pool	Fermentation rate	Lag time
Energy cane	88.0a	2.45bc	-
Energy sorghum	88.4a	3.91a	3.24
Sweet sorghum	92.0a	3.74ab	-
Mistcanthus	64.7b	1.38c	0.75
Swithchrass	73.6b	1.36c	-

†Numbers following the same letter(s) within the same column did not differ at P > 0.05.

The ADF and ADL in perennials (miscanthus, switchgrass, and energycane) were greater than that in sorghums ($P < 0.01$). The *in vitro* ruminal fermentation assey demonstrated somewhat unique gas accumulation patterns by the different sources of biomass (Fig. 1). Switchgrass and miscanthus reached asymptote at a later point in incubation time in comparison to sorghum. As quantified parameters shown in Table 2, fermentation pool size and fermentation rate of the biomass was in the order of sweet sorghum, energycane, switchgrass and miscanthus.

Conclusion

Based on fiber, lignin, and ruminal fermentation parameters of the tested biomass, fiber composition and hydrolysis/fermentation potential vary in the sources of biomass (perennials vs. annuals). Higher fiber and higher lignin content in some perennial biomass seem to negatively affect *in vitro* ruminal gas production, indicating lower hydrolysis/fermentation potential in the bioethanol production process.

References

Weimer PJ, Dien BS, Springer TL, Vogel KP (2005) In vitro gas production as a surrogate measure of the fermentability of cellulosic biomass to ethanol. Applied Microbiology and Biotechnology, **67**, 52-58.

Han, K.J., W.D. Pitman, M. Kim, D.F. Day, M.W. Alison, M.E. McCormick, and G. Aita. 2013. Ethanol production potential of sweet sorghum assessed using forage fiber analysis procedures. GCB Bioenergy %: 358-366.

Robertson JB, Van Soest PJ (1981) The detergent system of analysis and its application to human foods. In: The Analysis of Dietary Fiber (eds James WPT, Theander O) pp. 123-158. Marcell Dekker, New York.

Schofield P, Pitt RE, Pell AN (1994) Kinetics of fiber digestion from in vitro gas production. Journal of Animal Science, 72, 2980-2991.

Acknowledgement

This study was partially funded by the USDA AFRI grant.