Opportunity Feedstocks for Biogas Production

Gage Daniel J. LaPierre[1] and Ann C. Wilkie[2]

[1] School of Natural Resources and Environment, College of Agricultural and Life Sciences
[2] Faculty Mentor, Soil and Water Science Department, University of Florida-IFAS, Gainesville, Florida

Abstract

In 2012, the International Energy Agency estimated the world's electricity consumption at 155,505 terawatt-hours (TWh), with most (80%) generated from fossil fuels. Thus, worldwide carbon dioxide emissions are rising, making the search for affordable renewable energy sources a prime interest for society. The production of biogas (methane) from anaerobic digestion of organic matter is receiving renewed attention. The objective of this research was to determine the methane yield from two potential feedstocks: rabbit manure and Spanish moss (*Tillandsia usneoides*). The feedstocks were collected locally, dried at 60˚C for 72 hours and ground to 1 mm with a Wiley mill. Fresh samples were analyzed for dry matter (DM) and organic matter (OM) according to Standard Methods. Chemical oxygen demand (COD) was measured to determine a theoretical methane yield potential for each feedstock. Methane index potential (MIP) batch assays were conducted at 35°C for 30 days, in triplicate. Methane yields for rabbit manure (207 L CH_4/kg COD) and Spanish moss (165 L CH_4/kg COD) reached 59% and 47% of their theoretical methane yield, respectively, within 30 days. Rabbit manure and Spanish moss are suitable feedstocks for anaerobic digestion and could serve as co-digestion feedstocks in local biogas applications.

Introduction

Cuniculture, the practice of breeding and raising domestic rabbits, is expanding as an alternative livestock enterprise in developing nations. Rabbit characteristics including size, rapid growth rates, and pelletized manure, contribute to affordable management costs and potential for alternative energy which are both very appealing for developing countries[1]. The utilization of rabbit manure as a biogas feedstock could prove to be highly advantageous for energy production in developing nations, especially since it's pelletized form facilitates material handling.

Another relatively unexplored feedstock for anaerobic digestion is Spanish moss. Due to the reality that Spanish moss is readily available in large quantities, it could prove useful in small farms in the southeast as a supplemental feedstock for farm-scale digesters.

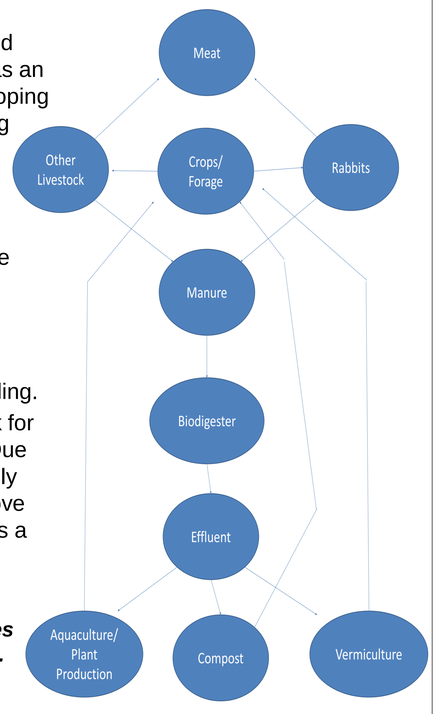
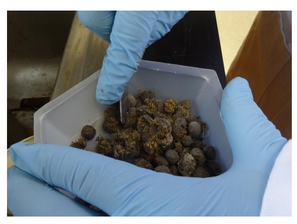


Figure 1. Flow diagram for potential uses of rabbit manure for small farms (right) .



Fresh Rabbit Manure

Spanish moss

Objective

Determine the ultimate methane yield from opportunity feedstocks, namely rabbit manure and Spanish moss, through anaerobic digestion.

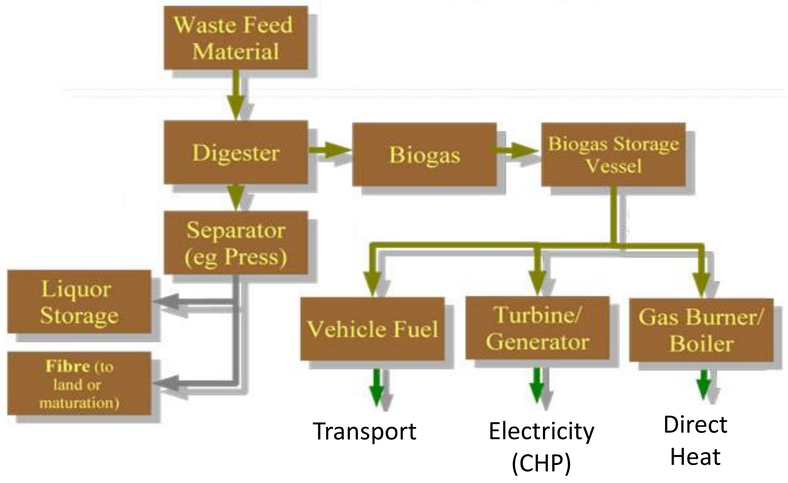


Figure 2. Overall scheme for anaerobic digestion and associated products.

Methods

- Feedstocks were gathered locally, dried at 60˚C and ground to 1mm using a Wiley Mill
- Analyzed fresh samples for dry matter (DM) and organic matter (OM) according to Standard Methods[2]
- Measured chemical oxygen demand (COD) to determine theoretical methane yield
- Conducted batch methane index potential (MIP) assays[3] at mesophilic temperature of 35°C for 30 days in triplicate
  - Volume of methane gas was measured routinely
  - Methane gas was corrected to standard temperature and pressure (STP)
  - Controls included an inoculum blank and glucose, cellulose, and starch were used to measure the activity of the inoculum

Ground Spanish Moss

Ground Rabbit Manure

Results

Table 1. Characterization of feedstocks.

	Rabbit Manure	Spanish Moss
COD (mg/g DM)	1098 ± 45	1079 ± 85
DM (%)	68 ± 2	31 ± 1
OM (%)	91 ± 1	96 ± 1

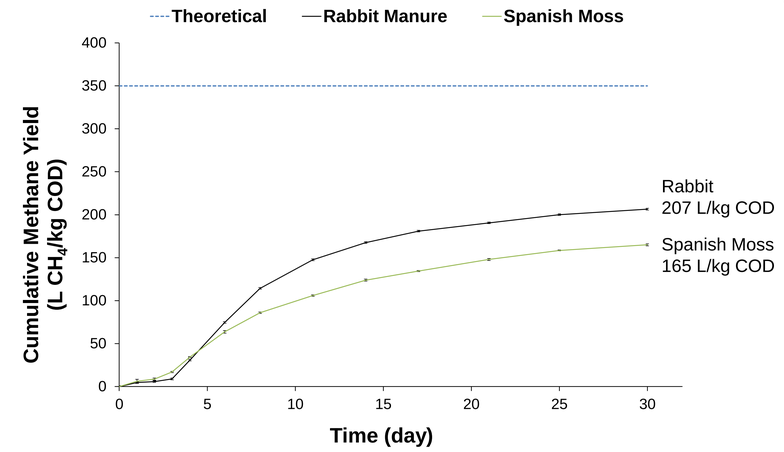


Figure 3. Cumulative Methane Yields for Feedstocks.

- Rabbit manure reached 59% of its theoretical methane yield, while Spanish Moss reached 47% of its theoretical yield.
- Both feedstocks reached over 90% of their respective ultimate methane yield within 21 days, which should be considered if these feedstocks are utilized in large-scale digestion processes.
- In regards to cuniculture, approximately 600 rabbits would produce 1.35 tons of fresh manure per month[4], which equates to 208 m^3 of methane.

Conclusions

- Rabbit manure had a higher ultimate methane potential (207 L CH_4/kg COD) than Spanish Moss (165 L CH_4/kg COD).
- Rabbits are a relatively inexpensive livestock that can provide significant protein as well as bioenergy from their manure.
- Both rabbit manure and Spanish Moss are locally available biomass with methane potential. Utilization as co-digestion feedstocks in local biogas digesters should be explored.

References

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Acknowledgements

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