Bioenergy Production Potential from Small Ruminant Manure

Claudia Sanchez[1] and Ann C. Wilkie[2]

[1] Department of Animal Sciences, College of Agricultural and Life Sciences

[2] Faculty Mentor, Soil and Water Science Department, University of Florida-IFAS, Gainesville, Florida

Abstract

Goats and sheep are widely reared on small farms in Florida since they require less land and feed than larger livestock, making them easier and less expensive to maintain. Their pellet-form manure facilitates materials handling – it can be easily collected and stored as solid material. The manure can be digested anaerobically to recover a sustainable, renewable energy source (methane). The nutrients remaining in the post-digestion effluent can also be land applied as an organic fertilizer. The objectives of this study were to characterize each manure type and determine their ultimate methane yields. Fresh sheep and goat manure pellets were collected locally and characterized for dry matter (DM), organic matter (OM), and chemical oxygen demand (COD). Methane index potential batch assays were conducted on the manure slurries at mesophilic temperature (35°C) for 40 days, in triplicate. Goat manure had higher DM and OM contents, resulting in a higher methane yield from goat (7.1 L CH_4/lb) versus sheep (5.1 L CH_4/lb) manure on a fresh weight basis. The goat manure reached 46% of its theoretical methane yield on a COD basis while sheep manure reached 42%. Future work will measure the nutrients in the liquid effluent to assess its biofertilizer value.

Introduction

Anaerobic digestion (AD) is a process whereby microbes convert organic matter into biogas when oxygen is absent. Manure can be used as a feedstock for AD to produce renewable energy in the form of biogas, which is mostly methane. This energy can be used on small farms for heating, cooking, and running machinery.

By capturing and using methane as an alternative to fossil fuels, greenhouse gas emissions can be reduced.

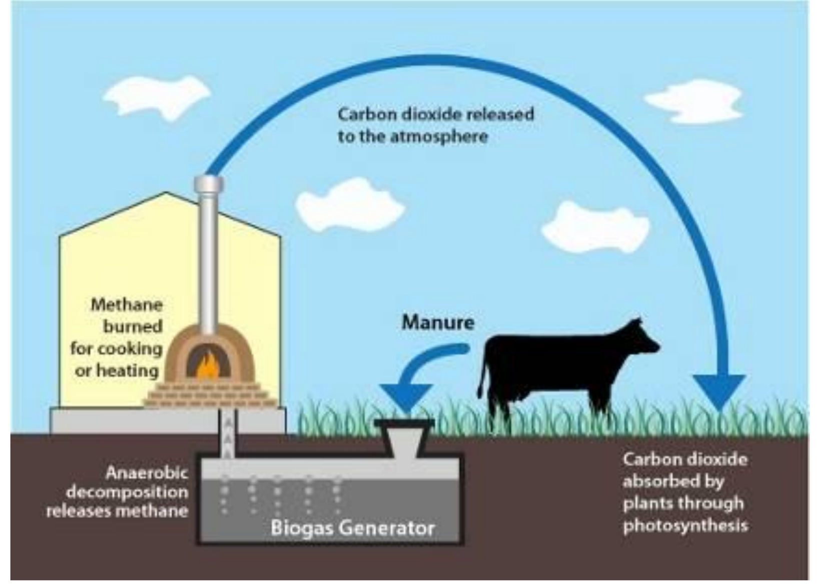


Figure 1. Carbon-Neutral Cycle – Manure to Methane

Local Goat Farm, Gainesville

Sheep at UF Animal Sciences

Why use Goat and Sheep Manure as AD Feedstock?

- Goats and sheep are ruminants with diverse microorganisms for digestion.
- Goat and sheep manure is readily available on small farms and in developing countries.
- High dry matter of manure allows for easier handling and placement into digester.
- Liquid effluent from digester contains nutrients for fertilizing plants.

Objective

Determine the methane yield of goat and sheep manure to assess their potential as a renewable energy source on small farms.

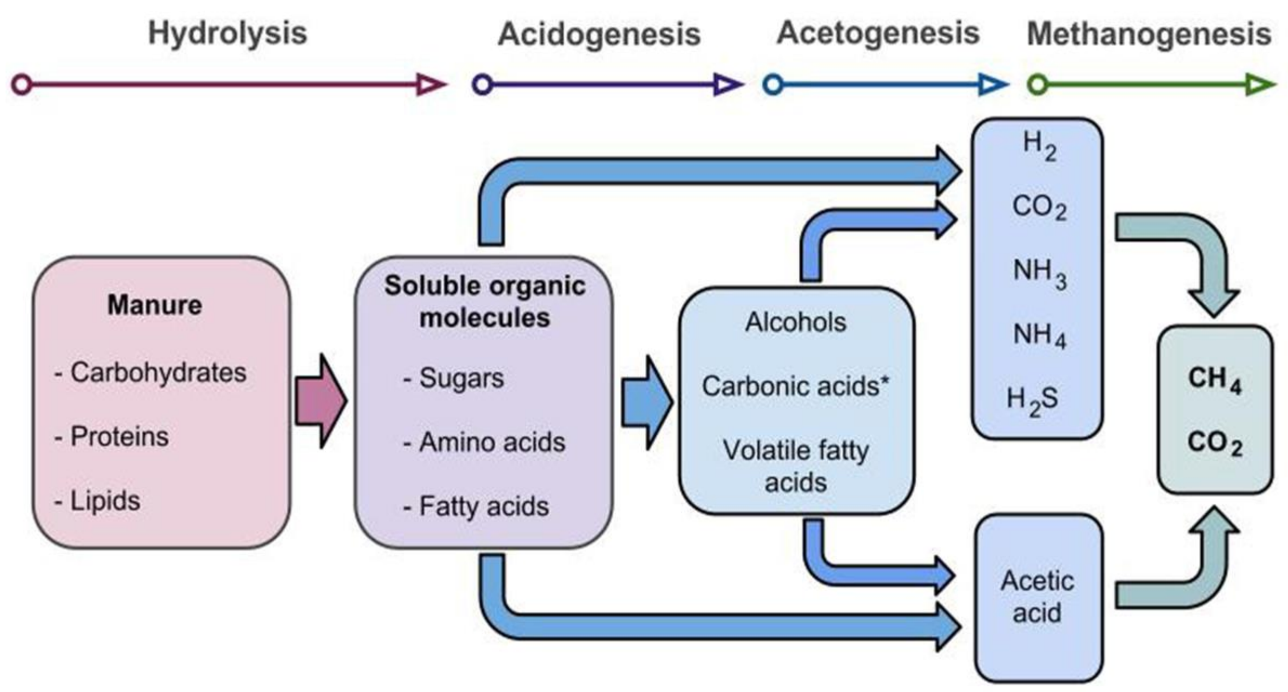
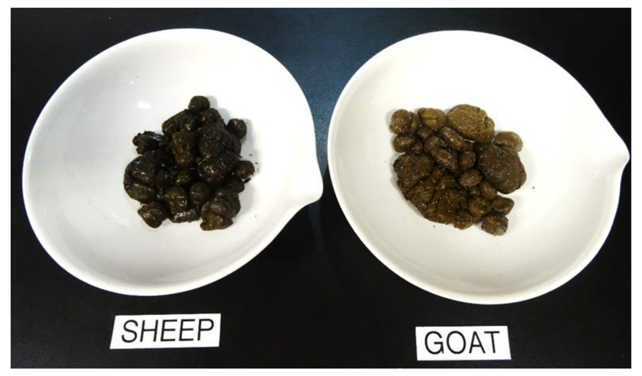
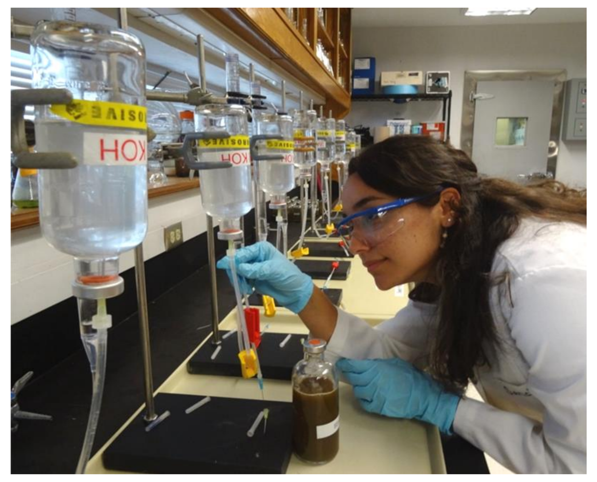


Figure 2. Biochemistry of the Anaerobic Digestion Process

Methods

- **Manure characterization** for dry matter (DM), organic matter (OM), pH, conductivity, alkalinity, and total COD according to standard methods[1].
  - DM (drying at 105°C for 24 hrs)
  - OM (ashed at 550°C for 2 hrs)
- **Methane Index Potential (MIP) Assays[2]:**
  - Conducted at 35°C over 40 days
  - Triplicate assays for each feedstock
  - Manure in wet slurry form (diluted 1 part manure to 3 parts water)
  - Methane gas measured using volumetric displacement method





MIP Assays

Results

Table 1. Characterization of Manure

	Goat Manure	Sheep Manure
pH	6.95 ± 0.05	8.10 ± 0.07
Conductivity (mS/cm)	1.71 ± 0.14	1.85 ± 0.16
Alkalinity (mg $CaCO_3$/L)	7500 ± 132	8033 ± 76
Dry Matter (%)	39.4 ± 0.9	25.3 ± 0.5
Organic Matter (% DM)	87.9 ± 0.3	84.4 ± 0.4
Total COD (mg/g DM)	1208 ± 64	1071 ± 59

- Sheep manure had a higher pH and alkalinity than goat manure.
- Goat manure had higher DM than the sheep manure and these values are consistent with those previously reported by Cu et al. (2015) for goat (35.3%) and sheep (25.4%) manure[3].

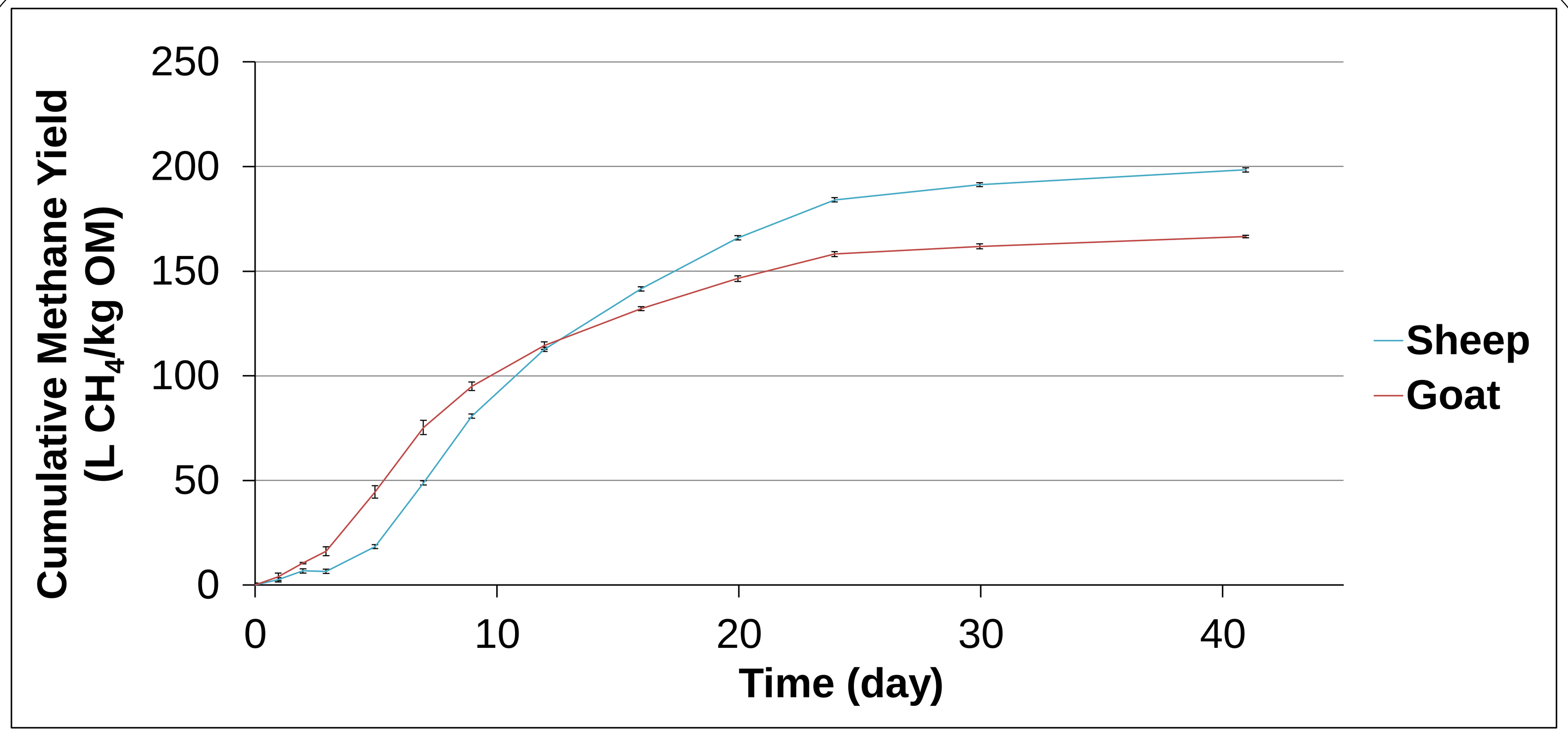


Figure 3. Cumulative Methane Yields for Sheep and Goat Manure

Table 2. Methane Yields of Manure

Methane yield	Goat Manure	Sheep Manure
L CH_4/kg OM	166.53 ± 0.58	198.39 ± 1.57
L CH_4/lb fresh manure	7.1	5.1

Approximately 94% of the methane production occurred within the first 24 days of the experiment. Goat manure reached 46% of its theoretical methane yield compared to 42% for sheep manure on a COD basis. Methane yields are consistent with the literature for goats (170 L CH_4/kg OM) but much higher than those reported for sheep (151 L CH_4/kg OM)[3].

Conclusions

- Goat manure had a higher organic matter content than sheep manure, thus more methane was produced on a fresh matter basis.
- Both goat and sheep manure are viable feedstocks for anaerobic digestion and could provide a renewable, sustainable energy source for small farms.

Future Work

Measure nutrient concentrations in the liquid effluent to determine its post-digestion biofertilizer value.

References

1. APHA. (2012). *Standard Methods for the Examination of Water and Wastewater*. 22nd ed. Washington DC: American Public Health Association/American Water Works Association/Water Environment Federation.
2. Wilkie, A.C., Smith, P.H. and Bordeaux, F.M. (2004). An economical bioreactor for evaluating biogas potential of particulate biomass. *Bioresource Technology* **92**(1), 103-109. doi:10.1016/j.biortech.2003.08.007
3. Cu, T., Nguyen, T., Triolo, J.M., Pedersen, L., Le, V., Le, P., and Sommer, S.G. (2015). Biogas production from Vietnamese animal manure, plant residues and organic waste: Influence of biomass composition on methane yield. *Asian-Australasian Journal of Animal Sciences* **28**(2), 280-289. doi:10.5713/ajas.14.0312

Acknowledgements

This research was conducted as part of the *2015-2016 CALS University Scholars Program* at the University of Florida, Gainesville, Florida.