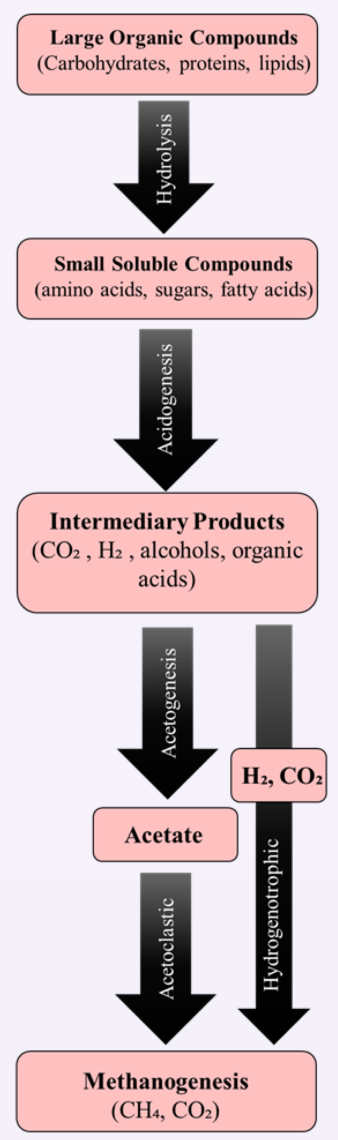
Assessing the Impact of Inoculum Sources on Specific Methane Yield using Biomethane Potential Tests

Hugh Thomas Harris, Tyler Wright, Tania Datta

Department of Civil and Environmental Engineering, Tennessee Tech University

INTRODUCTION

Anaerobic digestion is the process by which microorganisms break down biodegradable material in an oxygen free environment, resulting in biomethane production. Through its recovery, biomethane can be used as a renewable energy source. To evaluate the potential methane yield from any biodegradable material, a biomethane potential (BMP) test is typically conducted. This test, first proposed by Owen et al. 1979, is a quick and inexpensive assay to estimate the specific methane of any substrate through anaerobic digestion. Although BMP tests are simple, they still lack a standard protocol, making results among studies inconsistent and often incomparable. Many researchers have performed studies on parameters such as substrate particle size, mixing method, and temperature temperature, and their impact on specific methane yield derived from BMP tests. However, to date, certain parameters, such as inoculum sources have not be extensively evaluated.



STUDY OBJECTIVE

In order to evaluate the impact of different inoculum sources on the specific methane yield, the aim of this study ***is to evaluate the specific methane yield variability in BMP tests using inoculums from municipal wastewater, agricultural, and industrial anaerobic digesters.***

METHODOLOGY

Inoculum and Substrate Characterization:

Inocula were obtained from:

- Wastewater Inoculum - Nashville Biosolids Division
- Agriculture Inoculum - USDA farm, Bowling Green, KY
- Industry Inoculum - DuPont Tate & Lyle Bio Products

Table 1: Characterization Parameters and Methods

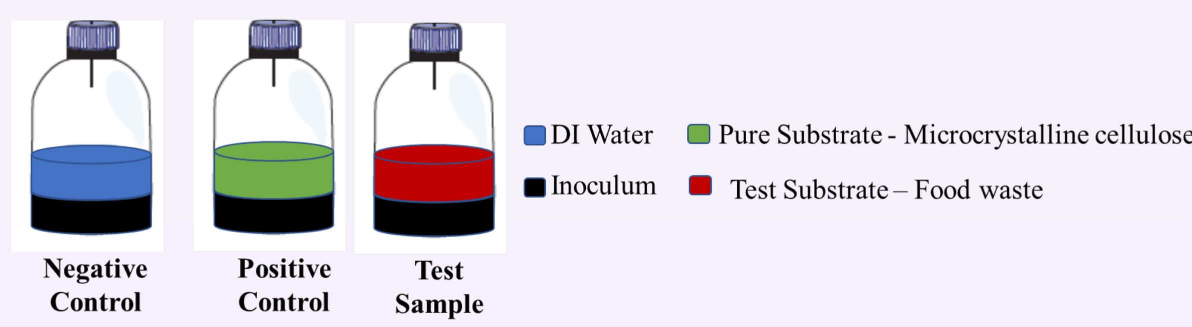
Parameter Analyzed	Analysis Method
Alkalinity	Standard Method: 2320 B
Ammonia	HACH Method 10031
Chemical Oxygen Demand	HACH Method 8000
Total Phosphorus	HACH Method 10127
Total Nitrogen	HACH Method 10072
pH	Fisher Scientific accumet AE15
Total/Volatile Solids	Standard Methods 2540

Microbial Community Analysis:

Table 2: Substrates for Determining Microbial Community in Inocula (Angelidaki et al., 2009)

Population	Substrate Concentration
Hydrolytic	1 g amorphous cellulose/L
Acidogenic	1 g glucose/L
Proteolytic	1 g casein/L
Acetogenic	0.5 g propionic/L; 0.5 g n-butyric/L
Acetoclastic	1 g acetic acid /L
Hydrogenotrophic	Over-pressure of 1 atm of a mixture of H_2/CO_2 (80/20)

Biomethane Potential Experiment Setup:



- Inoculum-substrate ratio of 2.0 (VS basis) was maintained
- VS loading of the substrate was 3 g/L
- Temperature was maintained at 35°C
- Reactors were mixed on an orbital shaker, as well as inverted daily

RESULTS

Table 3: Inoculum and Food Waste Characterizations

Sample ID	Food Waste	WRRF Digester	Farm Digester	Industrial Digester
pH	6.12	7.45	7.41	7.24
Alkalinity (g/L)	3.4	4.7	6.8	1.9
COD (g/L)	234.20 ± 2.8	30.7 ±0.91	49.9 ± 2.86	12.2 ± 1.96
Total Nitrogen (g/L N)	8.93 ± 0.06	1.97 ± 0.38	4.07 ± 0.32	1.2 ± 0.17
Ammonia (g/L N)	0.07 ± 0.01	0.95 ± 0.006	1.01 ± 0.006	0.14 ± 0.006
Total Phosphorus (g/L P)	3.13 ±0.06	0.62 ± 0.01	1.63 ± 0.19	0.63 ± 0.01
Total Solids (g/L)	166.10 ± 39.04	31.06 ± 0.002	60.03 ± 0.002	22.95 ± 0.003
Volatile Solids (g/L)	156.72 ± 37.97	17.41 ± 0.001	37.88 ± 0.001	18.61 ± 0.002

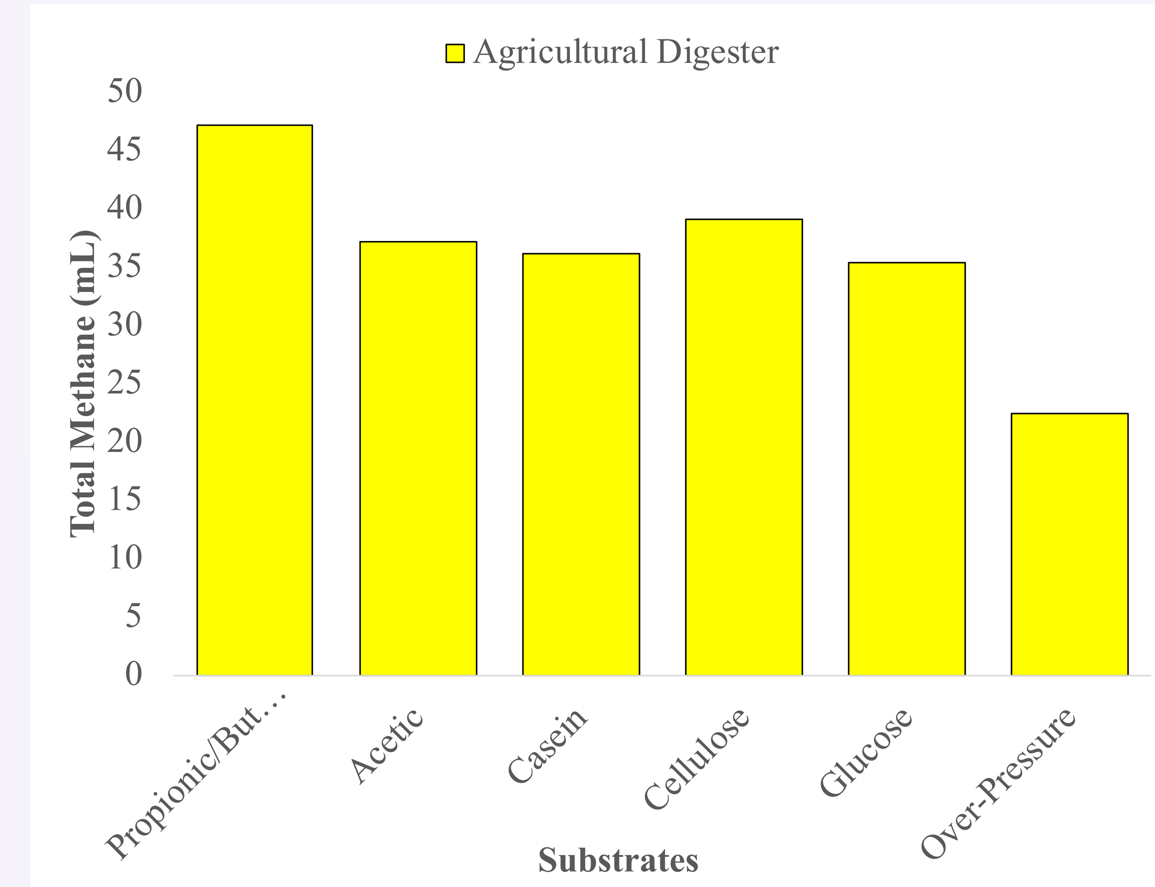


Figure 1: Farm Digester Dominate Community Results

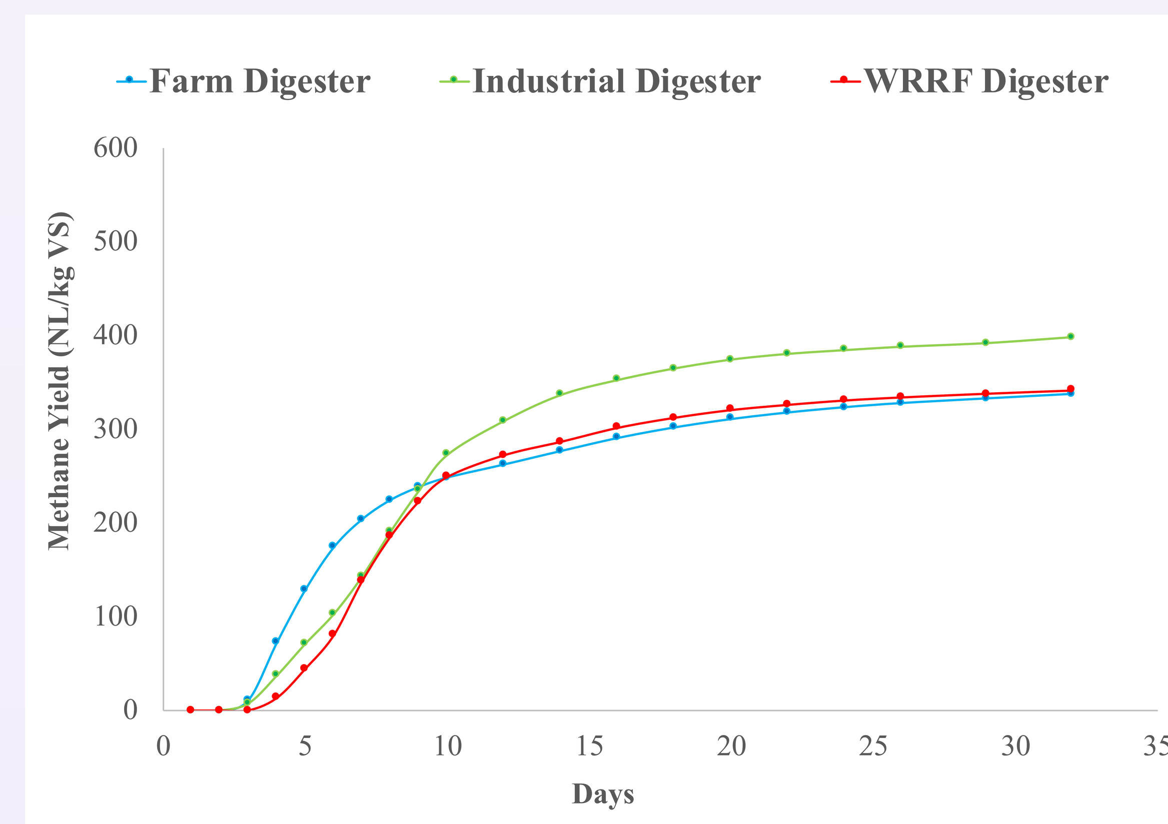


Figure 2: Cumulative Methane comparison between different inocula digesting positive control

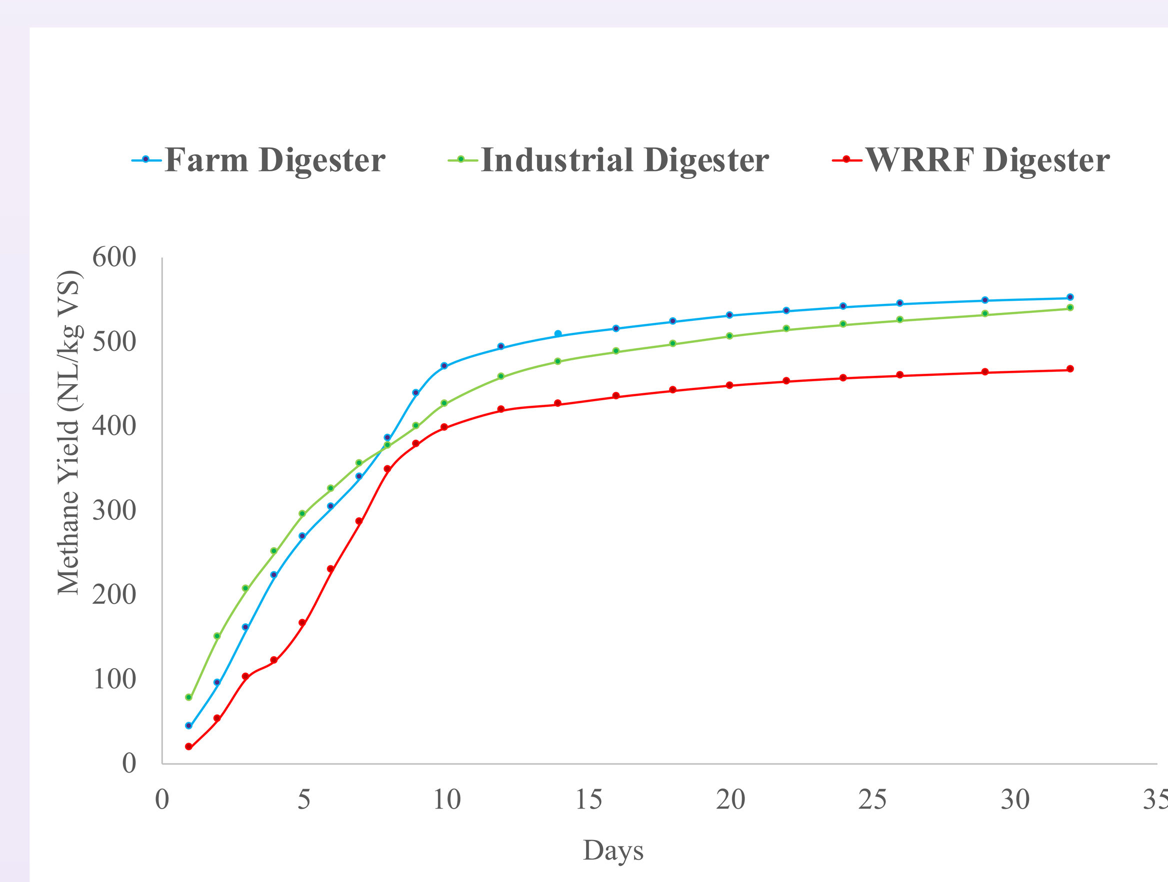


Figure 3: Cumulative Methane comparison between different inocula digesting food waste

Table 4: Inocula Rate Constants

Inoculum	Rate Constant (1/day)
Farm Digester	0.148
Industrial Digester	0.154
WRRF Digester	0.136

CONCLUSIONS

- The agricultural digester produced a higher specific methane during digestion of food waste
- The industrial digester had the highest specific methane yield for microcrystalline cellulose
- The BMP tests indicated that inoculum source does not have a significant impact on specific methane yield
- Inoculum source does have an impact on the rate of the reaction. The rate constant in the digestion of food waste was higher for inocula that were exposed to complex carbohydrates than that obtained from a water resource recovery facility.
- Based upon these results, unless speed is necessary, inoculum source will not have a significant effect on specific methane yield

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