Investigating the Methane Potential of Sweetpotato Culls

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Abstract

Sweetpotatoes can be grown for human consumption (table variety) or as a feedstock for bioethanol production (industrial variety). Industrial-type sweetpotatoes are generally drier with higher starch and less sugar contents than table sweetpotatoes. Whether grown for human consumption or biofuel production, agricultural residues such as culls (rotten or damaged sweetpotatoes) are generated during harvest. Cull rates for sweetpotatoes are generally 30% of the overall crop yield, and thus culls represent excess biomass that can be anaerobically digested for methane production. Anaerobic digestion is an effective means of converting organic matter into methane in an oxygen-free environment. The objective of this research was to determine the methane potential of culls from a common table variety (Beauregard) and an industrial-type (CX-1) sweetpotato. Methane index potential (MIP) batch assays for both types of culls were conducted at mesophilic (35ºC) temperature, in triplicate. The positive controls for the MIP assays included glucose, cellulose and starch. The results indicated that the Beauregard culls had twice the soluble sugar content of the CX-1 variety and were easily biodegraded. The methane production from the Beauregard culls reached 95% of the theoretical methane yield after 22 days, and followed the trend of the glucose control.

Introduction

Sweetpotatoes are highly productive and a source of energy which has potential contribution to food supplies especially in poorer countries. The industrial-type sweetpotatoes have been developed to improve bioenergy production by creating a higher content of starch. The culls, which are damaged and unsuitable roots and are normally considered as 'waste', represent a substantial fraction of the crop (Woolfe *et al.* 1992). This study shows how sweetpotato culls are resourceful and have potential to produce renewable energy in the form of methane through the anaerobic digestion process.

Objective

- To determine the amount of methane that can be produced from sweetpotato culls. Beauregard (table variety) and CX-1 (industrial variety) culls were evaluated.

Figure 1. Beauregard Cull

Figure 2. CX-1 Cull

Methods

Feedstock characterization
- pH, brix, chemical oxygen demand (COD), total solids (TS), and volatile solids (VS)

Methane potential batch assays
- lab-scale (in triplicate)
- anaerobic conditions
- mesophilic (35ºC)
- 22-day digestion period
- used glucose, cellulose, and starch for control assays
- used digested flush dairy manure for inoculum
- 3M KOH barrier solution to remove CO_2

Figure 2. Feedstock & Control Substrates for MIP assays

Results

	Beauregard	CX-1
pH	6.0	5.9
Brix (%)	5.8	2.6
TS (%)	21.8 ± 0.3	33.8 ± 0.1
VS (%)	94.0 ± 0.1	90.9 ± 0.1
COD (gCOD/gTS)	1154	1067

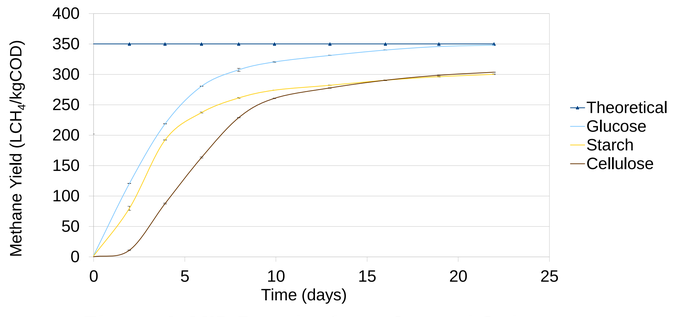

Figure 4. MIP Results from Control Substrates

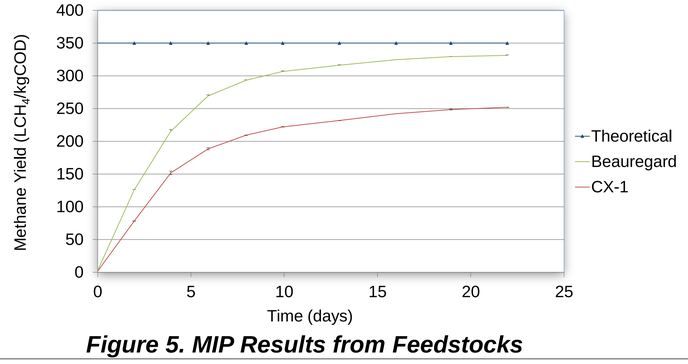

Figure 5. MIP Results from Feedstocks

Results (continued)

TS concentrations showed that the industrial-type sweetpotato cull was much dryer (34%) than the table variety (22%), which is a common characteristic of sweetpotatoes grown specifically for energy recovery. This characteristic is important to promote the storage life of the culls so that they can be an available feedstock for a longer period of time. The COD and VS were both higher for the table sweetpotato, indicating more organic matter which is available for methane conversion.

The results of the MIP assays show that table variety sweetpotato produced a higher methaney yield compared to industrial-type sweetpotato. After 22 days, the methane yield for the Beauregard culls reached 331 LCH_4/kgCOD (95% of theoretical) and CX-1 culls reached 252 LCH_4/kgCOD (73% of theroretical) corrected at standard temperature and pressure (STP). Sweetpotato culls remaining in the field after harvest were evaluated for methane potential with similar methods and the methane yield was 316 LCH_4/kgVS, corrected at STP; however, the type of sweetpotato was not reported in this study (Ge *et al.*, 2014).

Conclusions

- The control assays demonstrated that the inoculum (digested flush dairy manure) had sufficient microbial activity to completely convert glucose to methane in 22 days.
- The table variety (Beauregard) had a higher sugar content and was more easily degraded and produced more methane than the industrial-type variety (CX-1), as shown by the overall methane yields.
- The culls of both varieties represent an unused biomass that can favorably be used as feedstocks for anaerobic digestion.

Future Work

Future work entails determining the cull rate from both types of cultivars to calculate the quantity of methane that could be produced from one acre of sweetpotatoes. An agronomic field study is in progress to determine the root yields and cull rates from both types of sweetpotatoes.

References

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