Methane and Nutritional Potential of Industrial Sweetpotato Vine Components

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Abstract

In the southeastern United States, an industrial sweetpotato (CX-1) has the potential for utilization as an energy crop for bioethanol production. The sweetpotato vines are an agronomic co-product that is usually discarded. The vines can be harvested for animal feed or anaerobically digested to generate biogas. In order to maximize the energetic and nutritional value of the vines, the different components (leaves, petioles, and stems) were evaluated separately. The components were characterized for total solids (TS), volatile solids (VS) and chemical oxygen demand (COD). The ultimate methane potential for each component was measured using methane index potential (MIP) batch assays conducted for 30 days at 35˚C, in triplicate. Crude protein (CP) and fiber were determined to evaluate vine suitability for animal feed. Of the three components, the sweetpotato petioles had the highest methane yield (310 L CH_4/kg VS) and should be utilized extensively for energy production. The leaves contained the highest concentrations of CP (25.7 ± 0.2% DM), even higher than spinach, and thus are better suited for livestock or human consumption. These findings have important implications for complete utilization of sweetpotato vines, regardless of whether the roots are grown for consumption in the developing world or as biofuel crops in the US.

Introduction

Sustainable Cycle: In order to reduce reliance on fossil fuels within the bioethanol conversion process, a more sustainable approach is to utilize sweetpotato byproducts, specifically the vines, as an alternative energy source. The aerial vines can be anaerobically digested to produce biogas (methane) and biofertilizer. The biofertilizer can be used to grow more sweetpotato while the methane can be used directly to offset energy requirements associated with the bioethanol refinery.

CX-1 Vine Components: There are three primary components that make up the vines, namely the leaves, petioles, and stems. Each of these components has a significantly different structure, composition and nutritional value[1]. Therefore, each component would likely have a different methane potential in the context of anaerobic digestion.

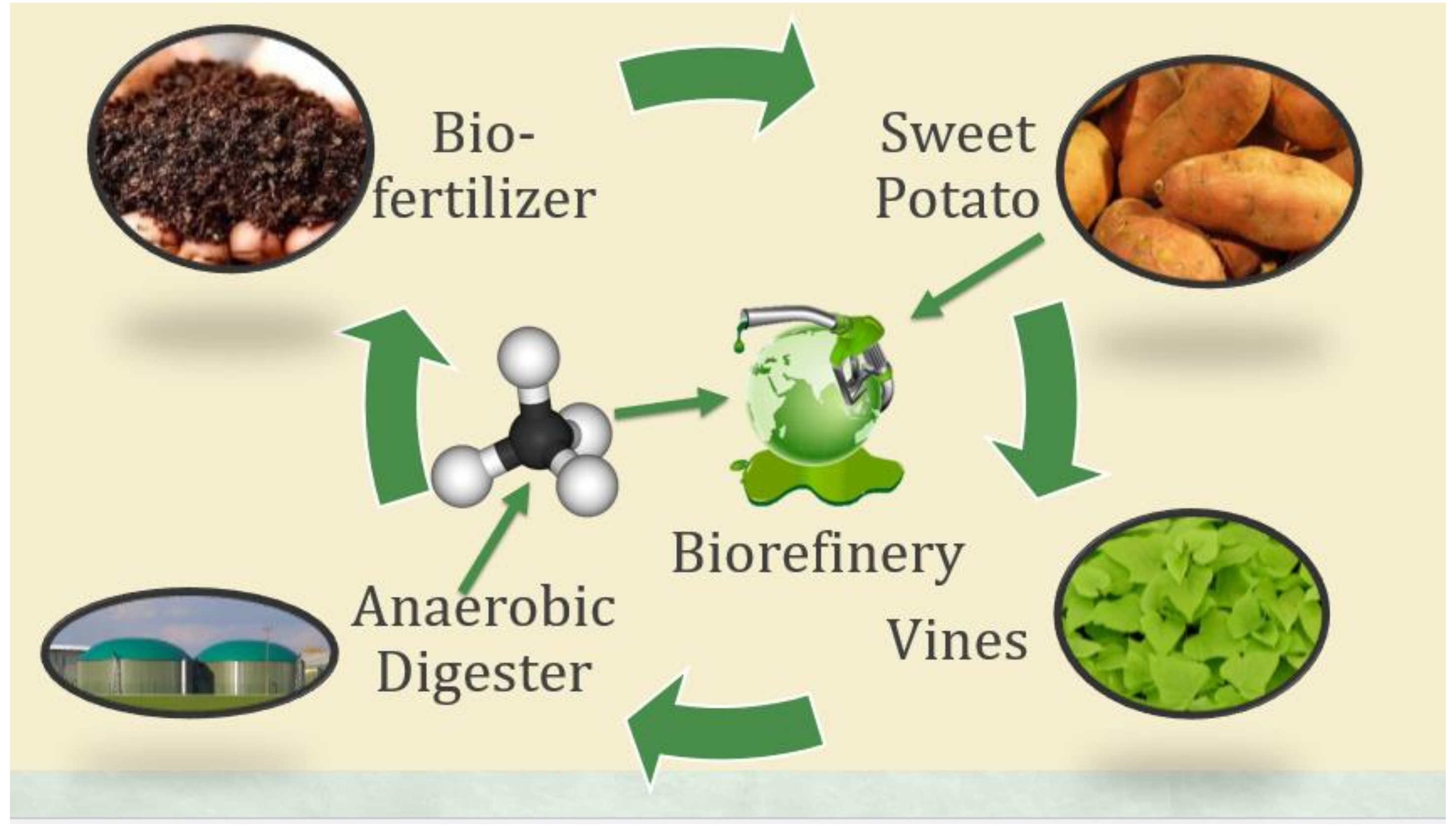


Figure 1. Utilization of Sweetpotato Vines in Bioenergy Cycle

Objective

Determine the most efficient and beneficial utilization of industrial sweetpotato vine components (leaves, stems, and petioles) by evaluating the methane and nutritional potential of each component.

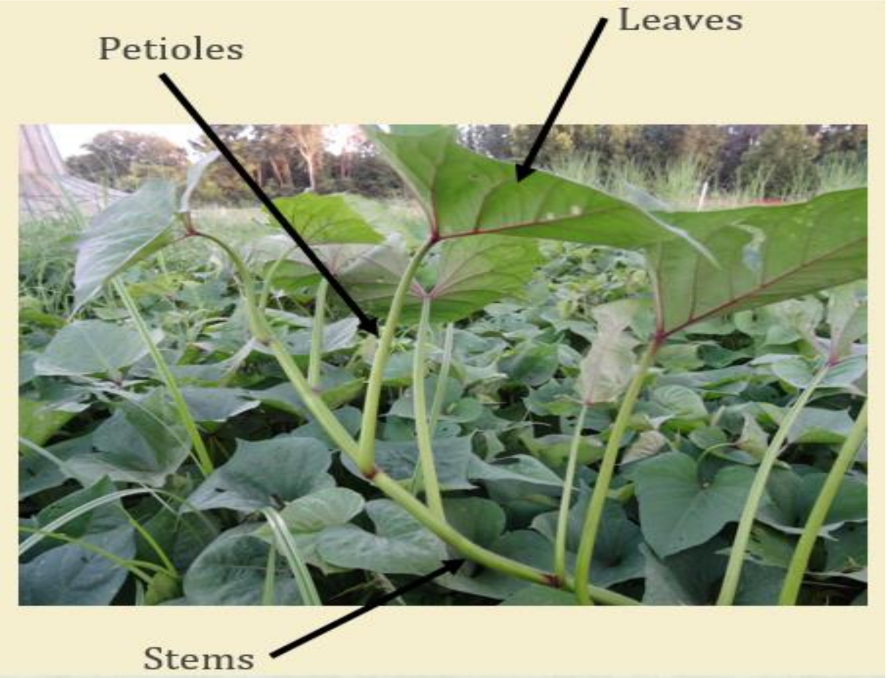


Figure 2. Sweetpotato Vine Components

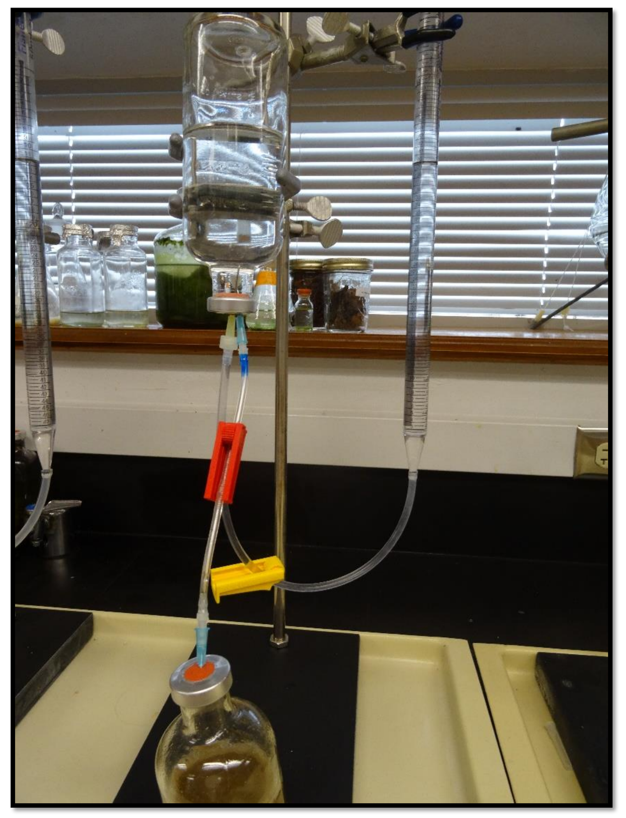
Methods

Sample Preparation:

- Vines were harvested by hand and separated into leaves, stems, and petioles.
- Vine components were dried at 60˚C and milled into 0.85 mm particle size for homogeneity using a Wiley Mill.
- Samples were characterized using Standard Methods[2]
  - Total Solids (TS)
  - Volatile Solids (VS)
  - Chemical Oxygen Demand (COD).

Methane Index Potential (MIP) Assays[3]:

- Batch assays were conducted at 35°C over 30 days in triplicate.
- Methane gas measurements were taken routinely and corrected to standard temperature and pressure.
- Controls included inoculum only as a baseline and inoculum with glucose, cellulose, and starch as positive controls.



MIP Assays

Results

Table 1. Feedstock Characteristics

	Petioles	Leaves	Stems
COD (mg COD/g DM)	753 ± 65	893 ± 59	989 ± 51
TS (%)	9.4 ± 0.5	17.8 ± 0.5	15.3 ± 0.9
VS (%)	88.3 ± 1.1	87.9 ± 0.4	93.8 ± 0.4

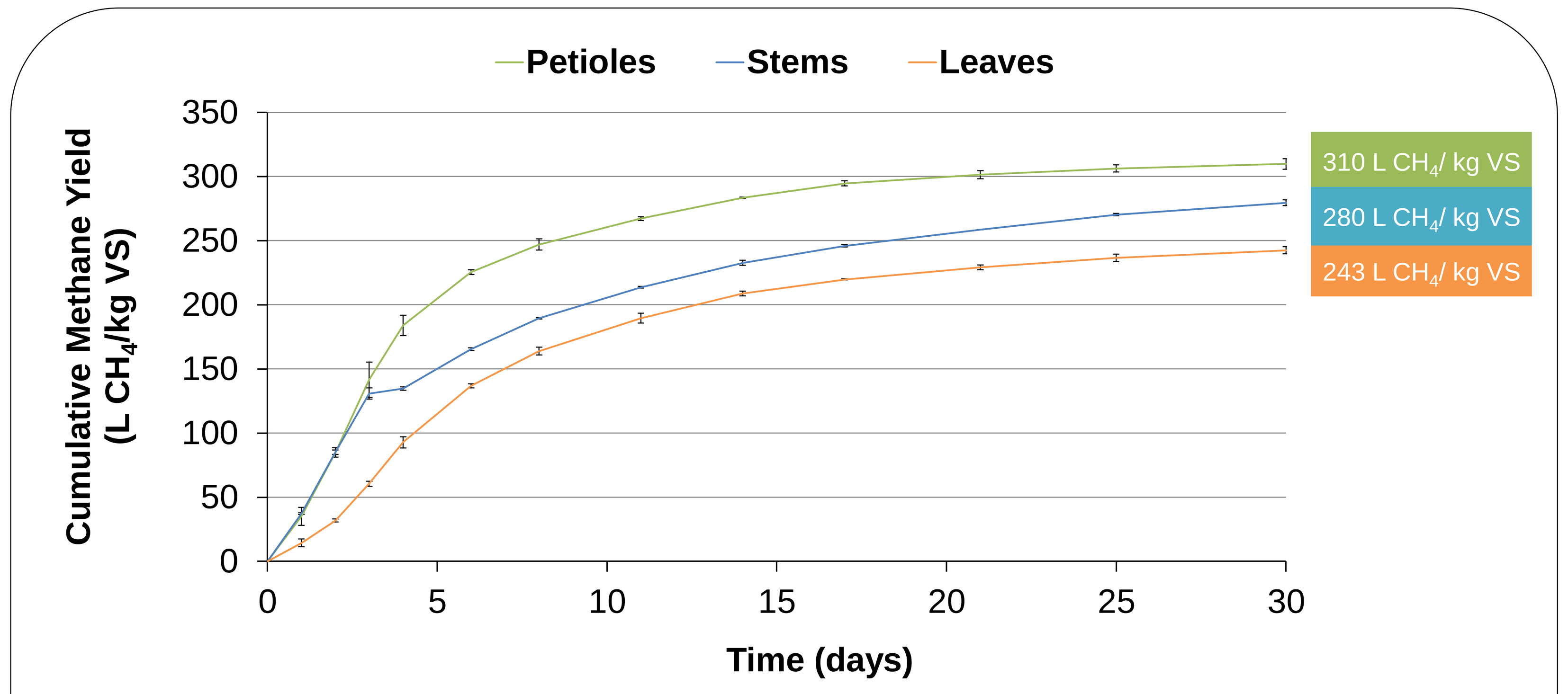


Figure 3. Cumulative Methane Yields for Sweetpotato Vine Components

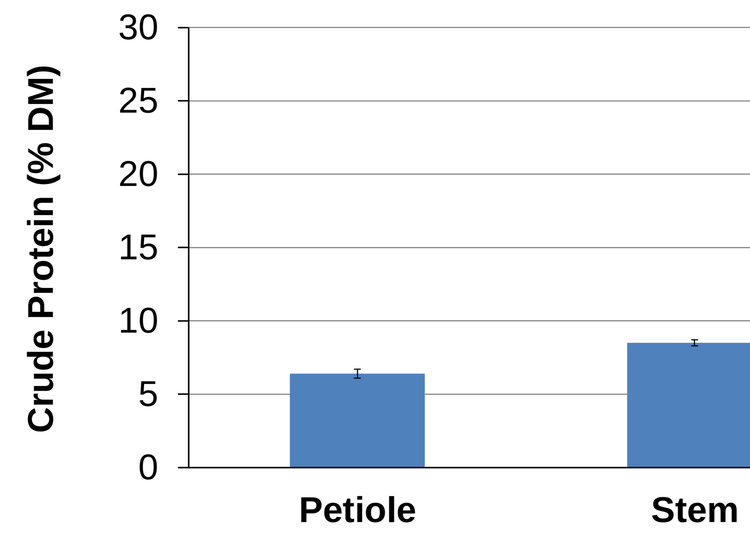


Figure 4. Crude Protein (Dry Matter Basis)

While the petioles had a relatively low CP concentration, they were digested faster and had higher ultimate methane yields than the leaves and stems. For petioles, more than 90% of the methane was produced within two weeks, and they reached 100% of their theoretical methane potential (calculated on a COD basis) during the 30-day digestion period.

Conclusions

- Petioles had the highest methane potential (310 L CH_4/kg VS added), while the leaves had the highest crude protein content (25.7% DM).
- The most beneficial use of sweetpotato vines is to separate the leaves for animal consumption and use the stems and petioles as a source of biogas.

References

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