Methane production from liquid waste: leachate from composting of biowaste and glycerine

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Introduction

The organics- and nitrogen-rich leachate (L) from composting of biowaste have fermentative potential; thus, before its discharging into the environment, it is proposed to be anaerobically treated. Anaerobic digestion has many advantages, such as not only organic waste treatment but also renewable energy generation (biogas). Another liquid waste product is waste glycerine (Gly) from saponification, which is characterized by a high content of organics and low nitrogen content, thus, it does not constitute a suitable substrate for mono-fermentation. However, these two liquid waste products can be co-fermented. Leachate can serve as a solvent for glycerine and provides more stability to the reactor due to the high alkalinity content needed for the fermentation process. In addition, leachate provides macro- and micronutrients that are important for bacterial growth. The aim of the study was to determine the methane potential of the leachate (L) from composting of biowaste and of the mixtures of leachate and waste glycerine (Gly) from saponification.

Materials and Methods

Leachate from composting of biowaste

Leachate, a composting waste by-product was collected from a full-scale composting process and then used in the study (Table 1). The leachate had a high organics content of 41260 mg COD/L, but also high nitrogen content of 1438 mg N_{tot}/L. The COD/N_{tot} ratio was ~29.

Waste glycerine

Waste glycerine is a by-product of saponification production, which is characterized by a high content of organics and low nitrogen content. The concentration of organics and nitrogen compounds in Gly was 100000 mg COD/L and 600 mg N_{tot}/L, respectively. The COD/N_{tot} ratio was ~170 (Table 1). In this study, Gly was diluted (100 g per 1L).

Organization of the experiment

The experiment was conducted in the Automated Methane Potential Test System (AMPTS II) under mesophilic conditions (37^{o}C) at an initial organic loading rate (OLR) of 7.5 kg COD/m^3 (Figure 1). Inoculum, which was anaerobically digested sewage, was collected from a closed mesophilic chamber located in the full-scale municipal wastewater treatment plant. The following variants of the experiment were used: L only, three mixtures of L and Gly in the proportions of 70:30, 60:40, and 50:50 (v/v), which resulted in raw Gly content of 3, 4, and 5% (v/v). The mixtures have the COD/N_{tot} ratios of ca. 55, 69, 86, respectively (Table 1).

Results and Discussion

The effectiveness of anaerobic co-digestion was determined based on the removal of organic compounds (expressed as COD, VFA), and the production of methane-rich biogas. During the first few days, over 80% of the total MPs were achieved, and the maximum cumulative MPs, of ca. 300 L/kg COD_{added}, were reached by the 10th day of measurements (Figure 2). This means that L from biowaste composting and Gly from saponification can be successfully co-fermented and the methane potential of the L and the mixtures of L and Gly is high. However, the addition of 3-5% of raw Gly slowed down the MP. This resulted from the fact, that during the first days of the measurements, VFA was intensively produced, which correlated with a slight reaction decrease (to 6.21-6.52 pH) (Figure 3). With 3% Gly content in the mixture with L, high concentration of VFA (ca. 3000 mg/L) was noted up to 3rd day of measurements. With 4% and 5% of Gly content, this high VFA concentration maintained up to 4th and 5th day of the methane production. After VFA concentration decreased, the reaction recovered up to a value higher than 7 pH, and methane was intensively produced.

Conclusions

The present study has shown that leachate from biowaste composting and glycerine from saponification can be successfully co-fermented. However, glycerine slowed down the production of methane, because VFAs accumulated. Thus, the share of glycerine should be established under operational conditions not to disturb methane co-fermentation.

Table 1. Characteristics of leachate (L) and mixtures of leachate and glycerine (L:Gly)

Characteristics	Units	L	L:Gly 70:30	L:Gly 60:40	L:Gly 50:50
COD	mg/L	41260	58882	64756	70630
N_{tot}	mg/L	1438	1067	943	819
COD/N_{tot}	–	~29	~55	~69	~86

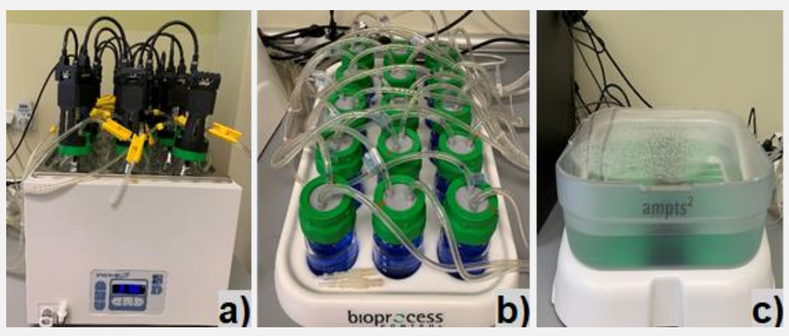

Figure 1. The AMPTS II device
a) water bath,
b) CO_2 absorption trap,
c) gas volume measuring device

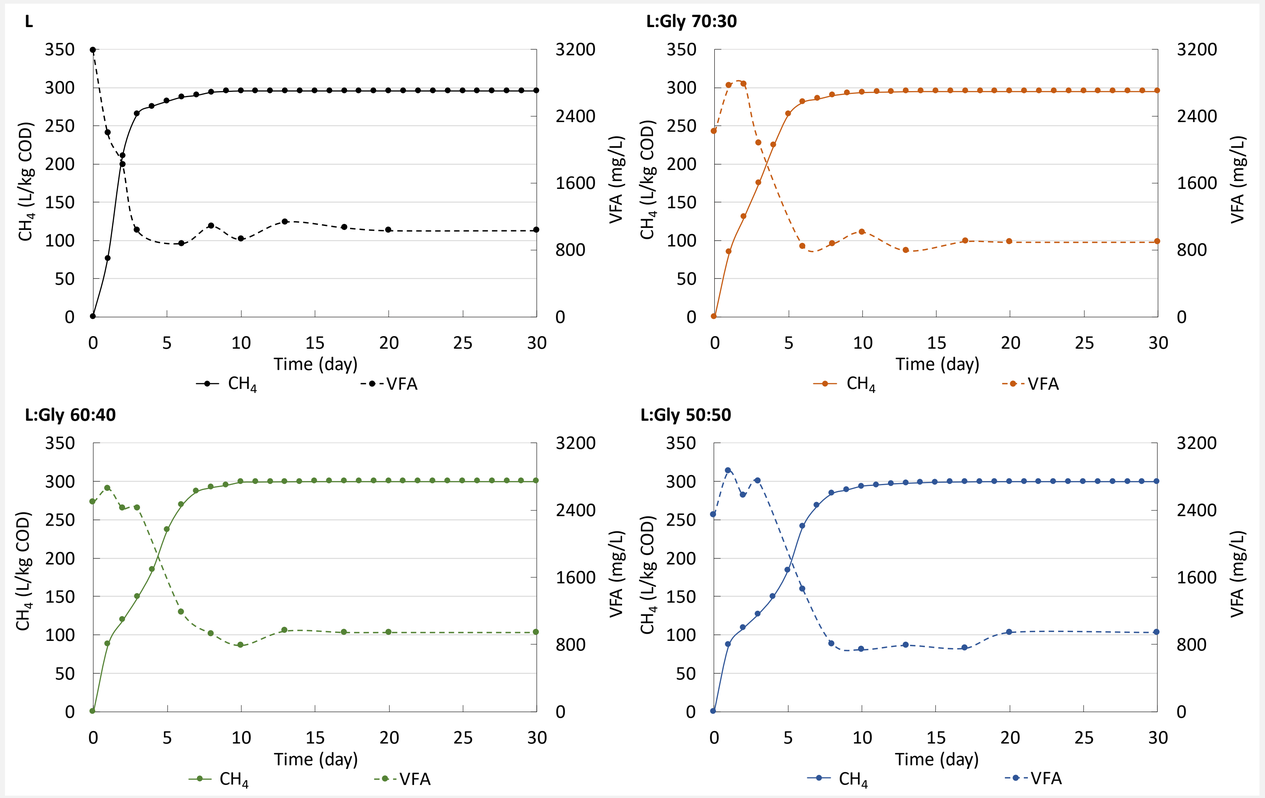

Figure 2. Methane production and VFA concentration during the experiment

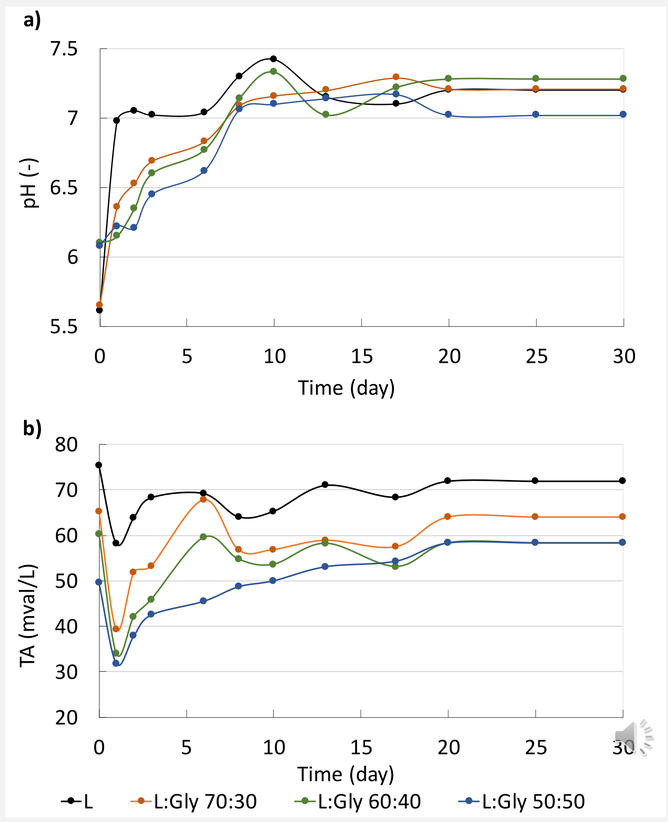

Figure 3. Changes in pH (a) and TA (b) during the experiment of L and L:Gly mixtures

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