Low-thermal pre-treatment of organic fraction of municipal solid waste – effect of solubilisation

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1. Introduction

Organic fraction of municipal solid waste (OFMSW) is regarded as sustainable and readily available resource for the extraction of energy and production of numerous organic compounds. However, anaerobic digestion (AD) – the most popular method used for different type of wastes such as sewage sludge, agricultural and food waste - is limited by hydrolysis (Kasinath et al. 2021). As a consequence, methane yield production during anaerobic digestion of OFMSW is strongly limited. Thus, currently several methods which can be applied for highly effective solubilisation of OFMSW, such as e.g.: mechanical, chemical, biological and thermal.

Thermal pre-treatment techniques used prior to anaerobic digestion can be divided into two basic groups - low-thermal (<100°C) and thermal hydrolysis (≥100°C). Usually, higher effective degradation of organic matter can be obtained using thermal hydrolysis. In many cases, this technique is not profitable due to energy consumption of this process, which are relatively high. For this reason, in recent years low-thermal pre-treatment of OFMSW have become increasing popularity (Kelessidis & Stasinakis, 2012).

The aim of this study is the investigation of the effect of temperature on the hydrolysis of OFMSW, which was carried under the anoxic conditions.

2. Materials and methods

In those experiments, an artificial food waste substrate resembling a hypothesized average composition of OFMSW (particular for the region of Northern Poland) was utilized. The substrate was minced and then thermally pre-treated at three different temperatures: 45, 50 and 55°C no longer than 3 days. Directly after the pre-treatment, samples were centrifuged (50,000g, 10 000 RPM, 30 min, 20°C). The supernatant (which represented the liquid or soluble phase) were stored at 4 °C before analysis, not longer than 24h. In order to control the efficiency of the low-thermal pre-treatment of OFMSW, soluble chemical oxygen demand (sCOD) as well as concentration of volatile fatty acids (VFAs) have been determined using Hach Lange DR 3900 spectrophotometer and the corresponding cuvette tests system.

3. Results

A results of LT-PT of substrates used in this study is degradation and transfer of some particulate matter into the supernatant. An overview of the results is shown in figures 1 and 2. Based on this, it can be statement that sCOD values significantly increase after LT-PT with duration time 24h (intensive degradation of organic matter occurs mainly in the initial phase of process). The disintegration degree – the percentage of the particulate organic mass undergone hydrolysis, was highest after three days of pre-treatment (around 30 %). The release of VFAs into the liquid phase increases with the duration time of LT-PT. The highest values of VFAs were obtained for substrates pre-treated by 72h at 50°C, although results for each temperature allow to achieve increase of VFAs concentration in comparison to untreated substrate over 20%.

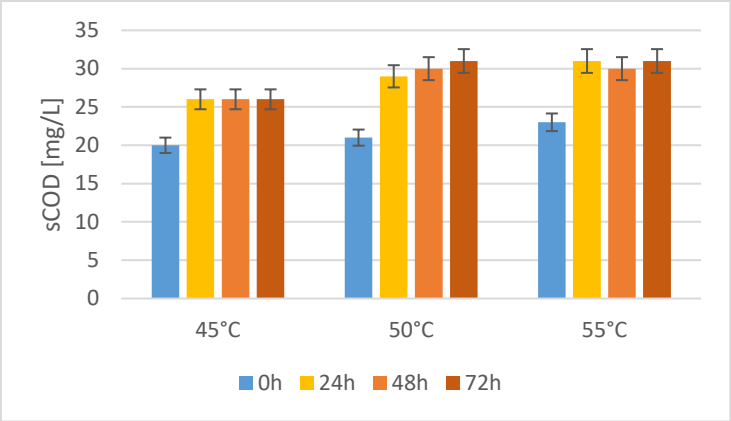

Fig.1. Changes in soluble chemical oxygen demand concentrations during LT-PT of food waste.

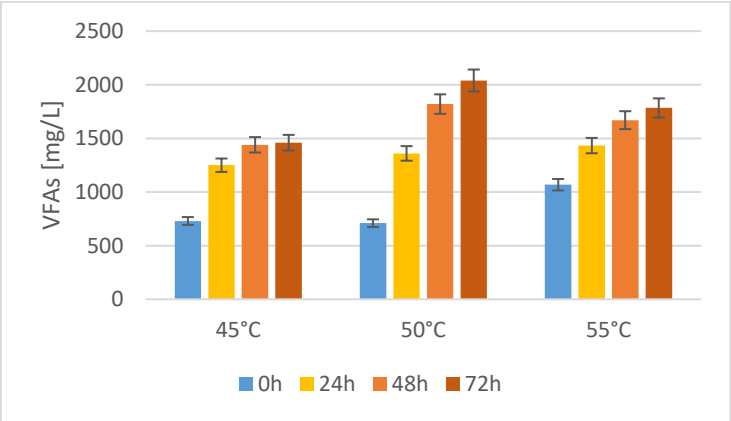

Fig.2. Changes in volatile fatty acids concentrations during LT-PT of food waste.

4. Conclusions

Low-thermal pre-treatment at temperatures ranging from 45 to 55°C results highly effective solubilisation of OFMSW. Increase of sCOD and VFAs concentration in this substrate after LT-PT confirm higher bioavailability of organic substances, which can be readily used by methanogenic bacteria. Therefore, low-thermal pre-treatment of OFMSW can be regarded as a promising method to enhance waste biomass processing into a wide variety of bio-based products and/or bioenergy.

5. References

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