Effect of herbaceous biomass and food waste addition in anaerobic digestion of sewage sludge

学 位 論 文 概 要

学位請求論文（Dissertation）

Title： Effect of herbaceous biomass and food waste addition in anaerobic digestion of sewage sludge

題目：下水汚泥の嫌気性消化における草本系バイオマスおよび食品廃棄物の混合効果

専攻（Division）：環境科学専攻

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学位論文概要（Dissertation Summary）

1. Introduction

Anaerobic digestion (AD) is a biological process through which biodegradable organic matters are degraded by organisms and methane gas is produced. By AD, it is possible to stabilize organic wastes as well as produce energy, thus it is widely studied and applied to treat waste biomass such as sewage sludge. To promote the construction of a system aiming at more effective waste treatment and resource recycling in small towns, anaerobic digestion of sewage sludge generated from small-scale facilities, waste food and herbaceous biomass generated in local town, were conducted in the present study. The study was focusing on 1) effect on digesting performance and microbial community structure by the addition of waste fried tofu and the effect of organic loading; 2) the effect on dewaterability of digested sludge by the addition of rice straw; and 3) variation of dissolved organic matters (DOM) in digested sludge by the addition of rice straw.

2. Materials and methods

Three continuous experiments were conducted in the present study. 1) Thermophilic anaerobic digestion of sludge generated from an oxidation ditch process and waste fried tofu was conducted with the substrates concentrations increasing gradually. Methane gas yield, digesting performance was evaluated. PCR-DGGE technology was applied to analyze the microbial community structure. 2) Mesophilic co-digestion of sewage sludge and rice straw was conducted using 10 L reactors, and methane gas yield of rice straw (RS) was evaluated. Dewatering characteristics of digested sludge were analyzed and a dewatering experiment was conducted using a belt filter press to study the dewaterability. 3) Mesophilic co-digestion of sewage sludge and rice straw was conducted using 1 L reactors, DOM of digested supernatant, such as proteins, humic matters and carbohydrates were measured. Three-dimensional excitation–emission matrix (EEM), and fluorescence regional integration (FRI) technique was applied to study the DOM species and relative contents. Biodegradability of digested liquid was also evaluated.

3. Results and discussion

In experiment 1), thermophilic digestion was conducted stably when substrates concentrations were below 7% for sludge digestion and 7.2% for co-digestion. Fried tofu addition greatly contributed to the methane gas production and showed an obvious impact on bacteria structure, while little difference in archaea structure was recognized. Results of experiment 2) indicated that methane gas potential of pre-treated RS was 0.28 L/g-TS, and dewaterability of digested sludge was improved significantly due to RS addition. Final amount of digested residues was increased due to RS addition, however, since the dewaterability was improved, the generated amount of dewatered sludge will not increase significantly. Results of experiment 3) showed that the addition of RS obviously increased organic matters in digested liquid, of which the main contents were humic matters. Results of EEM biodegradability evaluation showed that humic matters produced from RS were less biodegradable as compared to that generated from sludge; organic matters in digested liquid of co-digestion was resistant to biodegrade under aerobic condition.