## Abstract

Generally, in most wastewater treatment plants in the world, produced sludge transferred to the anaerobic digestion unit is in poor condition in terms of organic matter content and C / N ratio. Therefore, various co-substrates are used to improve these parameters (increase them). The main purpose of the present work is to study the sewage sludge anaerobic co-digestion process with food waste. On the other hand, in both sewage sludge anaerobic digestion and co-digestion process in the wastewater treatment plants, there is no difference between primary and secondary sludge, and they are used as a single sludge. In other words, the different mixing ratios of these sludges and their impact on process efficiency in terms of biogas production, methane content, and volatile solids removal have not been investigated. Therefore, in this thesis in addition to studying different ratios of food waste as co-substrate in sewage sludge anaerobic digestion, various ratios of primary and secondary sludge have also been studied.

The experiments were carried out using seven batch reactors (R1-R7) under mesophilic condition. According to the obtained results, ratio of carbon to nitrogen (C/N) was a much more influential parameter than $VS_{Pr}$:$VS_{Sc}$ ratio on VS reduction and biogas production efficiencies. A second-order polynomial curve with a high regression coefficient fitted the data of VS reduction vs. C/N. The optimum C/N amount for reaching the highest VS removal was about 16. A high R-squared linear correlation was found between data of gas production and C/N ratio. According to the obtained linear trend, with increasing the C/N within the test range (8-19.7), the biogas production increased in a steady manner. Doubling of $VS_{Pr}$:$VS_{Sc}$ had a positive effect on both VS removal and biogas production unless C/N got farther from its optimum amount by increase of $VS_{Pr}$:$VS_{Sc}$. Doubling of $VS_{Pr}$:$VS_{Sc}$ also showed a positive influence on the digestate dewaterability. Although the highest biogas production belonged to R7 (FW mono-digestion), R5 ($VS_{FW}$:$VS_{SS}$ of 2:2 and $VS_{Pr}$:$VS_{Sc}$ of 1:1) showed the highest methane content (70.3%). Among different parameters including pH, ALK/sCOD and VFA/Alk, the latter one was distinguished as the most effective factor on the methane yield of the reactors. A synergistic gas production was observed for the reactors with 50% share of $VS_{FW}$ which most probably was attributed to lower values of free ammonia concentration in these reactors compared to those with 25% share.