CONCLUSION AND RECOMMENDATION

Bio-flocculated sludge generated from SST (post–UASB) is the potential co-substrate for OFMSW for anaerobic co-digestion due to its characteristics of high pH 7.9±0.2, high moisture content %94.76±0.6, low %TS 5.24 ± 1.18, COD 52.22 ± 4.03 mg/gm and having potential to generate specific biogas yield 419.44±11.59 L/kg VS_{added} under optimum conditions. The anaerobic co-digestion process of OFMSW and bio-flocculated sludge operated with different mixing ratios shows high $VS_{removal}$ efficiency with a mixing ratio of 90:10 and 75:25 of 77.87% and 85.97% respectively. 75% (wet mass) of OFMSW, when co-digested with 25% (wet mass) of bio-flocculated sludge from SST, can achieve a specific methane yield of 256.44±12.98 L/kg VS_{added} and volumetric methane generation rate of 0.89 L/L/d which is quite higher than mono-digestion of OFMSW. The dynamic pattern of methane generation is approved by the presence of aceticalstic methanogens. Kinetic model Modified Gompertz model validates the experimental methane yield with non-linear regression with goodness to fit R^2 0.99 with the prediction of maximum methane production rate 137.49 L/kg VS_{added}*d and hydrolysis rate constant (k) 0.664. This shows acceptance of a mixing ratio of 75:25 for anaerobic co-digestion of OFMSW and bio-flocculated sludge which is extremely satisfactory due to the availability of substrate in field conditions.

The lab-scale semi-continuous flow anaerobic reactor operated with a 75:25 mixing ratio of OFMSW and bio-flocculated sludge with varied %TS range and varied loading rate, reactor performed well with an OLR range of 2 to 3 gm VS/L/d due to high biogas yield and $\%VS_{removal}$ efficiency. Kinetic parameters are developed for cumulative biogas yield with the First Order kinetic model, Modified Gompertz model and Logistic Function model with R^2 0.98 to validate the experimental biogas yield for anaerobic co-digestion process for a semi-continuous flow reactor. Kinetic constants obtained for semi-continuous flow anaerobic reactor with Stover Kin-cannon model (maximum removal rate constant U_{max} = 31.74, Saturation rate constant K_B = 86.02), Grau's Second-Order kinetic constants (a = 0.578, b = 3.1) contribute for prediction of substrate removal efficiency.

Prediction model developed using Feed Forward Neural Network (FFNN) fitting application (fitnet) simulate experimental data of $\%VS_{removal}$ and methane yield with goodness to fit R^2 more than 0.96 for anaerobic co-digestion process operated under semi-continuous flow while prediction model using ANN-PSO with R^2 of 0.80 and ANFIS with gauss2 membership function with R^2 of 0.90 shows versatility of different modelling approach in accurate prediction of methane yield. FFNN modelling with fitnet application is quite an acceptable modelling technique due to its robustness and accuracy in prediction whereas ANFIS requires very little time in the prediction of methane yield.

Metagenomic sequencing analysis 16SrRNA shows the presence of Lachnospiracea, Lactobacillacea and Clostridiaceae are the dominant families with Anaerostignum, Lactobacillus and Clostridium Sensu Stricto genus found with high levels of abundance. They are dominant for the fermentation process of the anaerobic co-digestion process. Lachnospiraceae and methanogens or acetogens have the potential for the direct conversion of lignocellulose to methane and other value-added biochemicals. The Anaerostignum genus found in abundance is of the same order level as Lachnospirales of the Lahnospiraceas family and from the Firmicutes phylum.

Anaerobic co-digestion of OFMSW and bio-flocculated sludge from SST is a key to solving solid-liquid waste management problems with in-house substrate availability within the ULBs with minimal pretreatment to achieve waste-to-energy goals.

RECOMMENDATIONS

- Pilot-scale anaerobic digester using OFMSW and bio-flocculated sludge should be operated.
- Field-operated data can improve the accuracy of an Artificial Neural Network-based prediction model for methane yield.
- Life Cycle Assessment to evaluate environmental impact assessment and circular economy of the anaerobic co-digestion process of OFMSW and bio-flocculated sludge.
- Microbial insight using metagenomic analysis of each phase of the anaerobic co-digestion process of OFMSW and bio-flocculated sludge (post-UASB)