**ORAL PRESENTATION**

# Anaerobic co-digestion of wheat straw with food waste and cattle manure: Optimization of processing parameters (ISR, C/N, TS %) for enhanced biogas yield

Ali Mohammad Rahmani[1, 2], Banafsha Ahmed[1], A. A. Kazmi[1], Chandra Shekhar P. Ojha[3], Vinay Kumar Tyagi[1]

[1]Environmental Biotechnology Group (EBiTG), Department of Civil Engineering, Indian Institute of Technology Roorkee, India, 247667
[2]Water and Environmental Engineering Group, Department of Civil Engineering, Kandahar University, Afghanistan
[3]Department of Civil Engineering, Indian Institute of Technology Roorkee, India, 247667

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Presenting author email: alimr.212@gmail.com

## *Introduction*

The major waste streams of agro-waste and municipal solid waste have been increasing loads on the environment that is beyond its assimilation capacity and meanwhile the high standard of living put forth the need for a more sustainable and secure energy source. Anaerobic co-digestion (AcoD) is a promising technology to tackle waste streams and provide sustainable energy resources. In this study, the anaerobic co-digestion of wheat straw (WS) with food waste (FW) and cattle manure (CM) was investigated for enhanced biogas production since the mono digestion of wheat straw is hydrolysis limiting. Moreover, the processing parameters, namely, inoculum to substrate ratio (ISR), carbon to nitrogen ratio (C/N), and total solid percentage (TS%), of the process were optimized since a different combination of the lignocellulosic biomass may need specific processing parameters.

## *Materials and methods*

The wheat straw was obtained from a village near Roorkee, India. The food waste was collected from the students' mess of the institute. The waste contained leftovers of cooked food such as vegetables, rice, bean, fruit, eggshells, etc., and cattle manure was obtained from the nearby dairy.

Four batch assays were performed to check co-digestion (mixtures of: WS, WS+FW, WS+CM, WS+FW+CM) effects and optimize ISR (0.5. 1.0, 1.5 and 2.0), C/N (20, 25, 30 and 35) and TS% (5, 7.5, 10 and 12.5). All assays were performed sequentially and the optimized conditions of the previous batch assays were assigned for the next batch assays. All the physical-chemical parameters, namely, total chemical oxygen demand (COD), soluble COD, ammonia nitrogen ($NH_3$-N), volatile fatty acid (VFA) total Kjeldahl nitrogen (TKN) were analyzed as per standard methods (APHA, 2017). The lignocellulosic analysis of WS was determined by sequential extraction (Li et al., 2004) and the daily biogas yield was measured by pressure differential of reactor and ambient using a manometer (OMEGA HHP350, USA). Four models, namely, first-order model (FM), modified Gompertz model (GM), logistic model (LM), and transference model (TM) were used to predict the kinetic constants, maximum daily biogas yield, cumulative biogas yield, and lag phase concerning the experimental data and to determine how fit the experimental data are against the models.

## *Result and Discussion*

The best co-digestion was WS+FW+CM, which had a 20% higher biogas yield (416 L /kgVS $_{added}$), compared to mono digestion and 21% volatile solids (VS) degradation. The optimized ISR, C/N, and TS% were 2, 35, and 12.5%, respectively. They yielded 24%, 18%, and 80% more biogas compared to mono digestion, respectively. Moreover, they had a VS removal of 30%, 36% and 48%, respectively. Although higher TS% (10 and 12.5) have some lag phase at the initial stage but later managed to achieve higher biogas production. The kinetics analysis of the optimized batch assays determined that the estimated specific rate constants were 0.08, 0.12, 0.083, and 0.084, respectively, for WFC, ISR2, CN35 and TS12.5. The experimental data of the optimized batch assays fit well in all the models and it ranges from 0.882 to 0.999 in terms of the coefficient of discrimination.

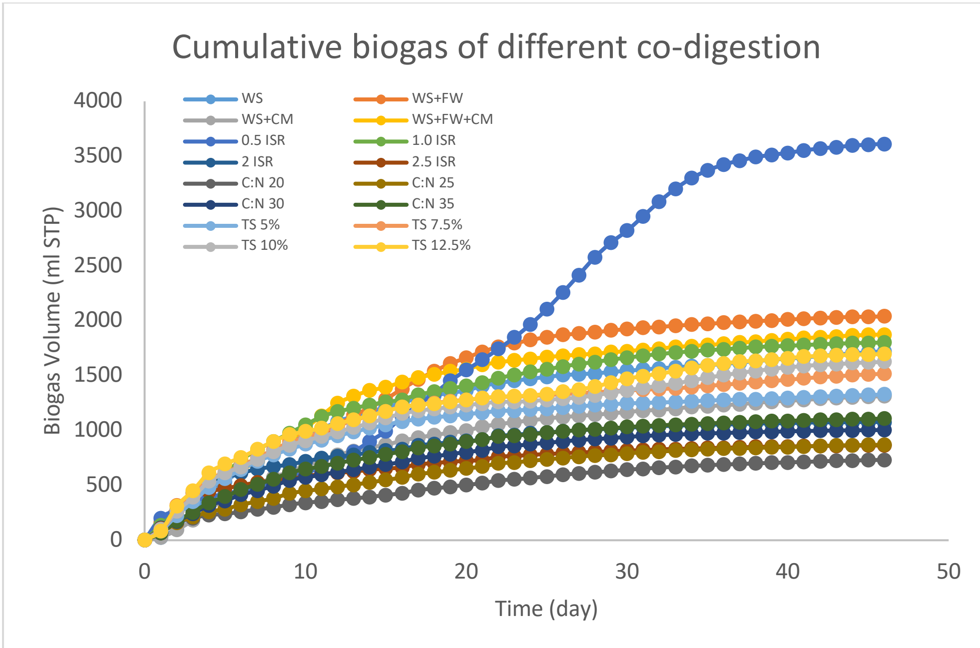


Figure 1: Cumulative biogas production of different mixtures with different ISR, C/N and TS%

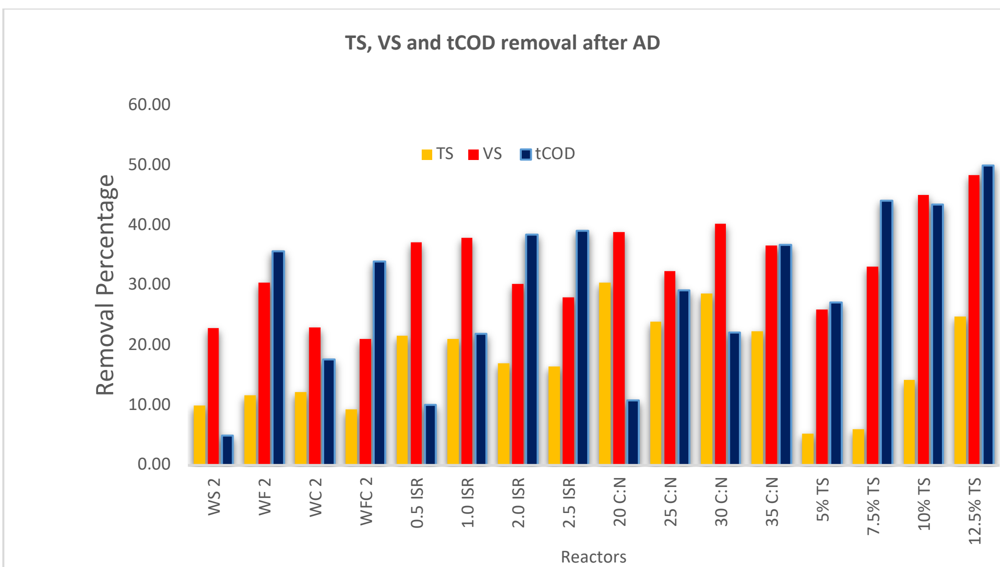


Figure 2: TS, VS and tCOD degradation of the substrate after AD

## *Conclusion*

Different process parameters of anaerobic digestion (ISR, C/N and TS%) were optimized at four different batch assay experiments in sequence. The co-digestion had a 20% higher biogas yield when compared to mono digestion of the same amount of VS of the WS, FW and CM. ISR of 2 and 2.5 had the same biogas yield but considering the reactor volume, the ISR 2 was optimum and had a 30% higher biogas yield compared to mono digestion of the substrates. The C/N of 35 had a 17% higher biogas yield while TS% of 12.5 had an 80% higher biogas yield compared to mono digestions. The TS%, VS% and tCOD of the mixture during AcoD was removed up to 50%. The VS% removals for the optimized batch assays (three-substrates co-digestion, ISR2, C/N35 and TS% 12.5) were 21%, 30%, 36% and 48%, respectively, which is showing an increasing trend. Moreover, the last optimized batch assay showed more stability compared to other assays. The compatibility of all experimental data was best with the already practiced models (GM, FM, TM, and LM) with $R^2$=0.999.

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