IMPROVEMENT IN PERFORMANCE OF ANAEROBİC DIGESTION VIA CONDUCTIVE MATERIALS; GRANULAR ACTIVATED CARBON AND HEMATITE

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Conventional anaerobic digestion (AD) is a widely used process for the treatment of wastes and to generate methane from wastes. Low methane yield, low organic removal and lower rate are drawbacks for AD systems[1,2].

- **Conductive material (CM) can improve performance of AD by direct interspecies electron transfer (DIET)**
- **Lag time can be reduced by CM**

Aim of the Study

In this study, we aimed to increase the performance of AD for cattle manure digestion by supplementation of two different conductive material, hematite (Fe_2O_3) and granular activated carbon (GAC) and to investigate the effect of CM amount.

Methodology

Inoculum: Anaerobic digester seed

Substrate: Cattle manure from a biogas plant

Diffferent GAC concentration

- 20 g/L GAC
- 40 g/L GAC
- 60 g/L GAC

Different Fe_2O_3 concentration

- 20 mM Fe
- 50 mM Fe

Table 1. Inoculum and sustrate characterization

Parameter	Inoculum	Susbtrate
pH	7.5	7.8
Total solid (%)	3.34 ± 0.01	12.18 ± 0.06
Volatile solid (%)	1.76 ± 0.01	9.45 ± 0.05
Volatile solid/Total solid (%)	52.68 ± 0.39	77.55 ± 0.04
Chemical oxygen demand (mg COD/L)	30,027 ± 61	151,743 ± 6446
Phosphorus (mg PO4/L)	-	35.3 ± 1.6
Ammonia (mg NH3-N/L)	-	1897 ± 117

Table 2. Experimental Design

Reactor	Inoculum	Substrate	Conductive material (GAC/Fe_2O_3)
Blank	+	-	-
AD	+	+	-
GAC-20	+	+	GAC (20 g/L)
GAC-40	+	+	GAC (40 g/L)
GAC-60	+	+	GAC (60 g/L)
Fe-20	+	+	Fe_2O_3 (20 mM Fe)
Fe-50	+	+	Fe_2O_3 (50 mM Fe)

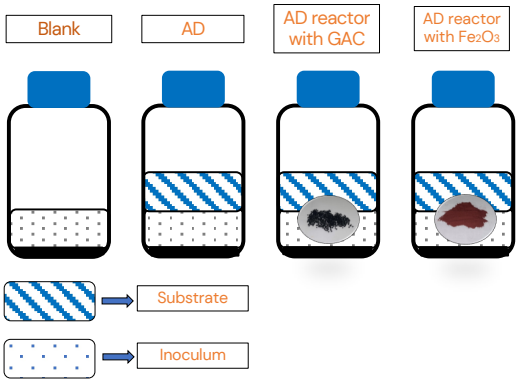

Figure 1: Representation of experimental design

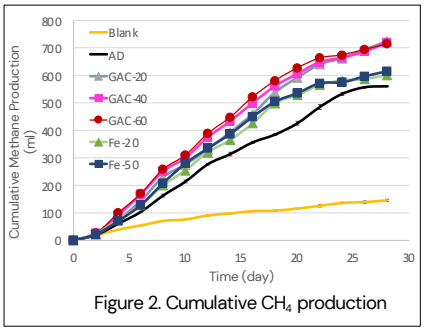

Figure 2. Cumulative CH_4 production

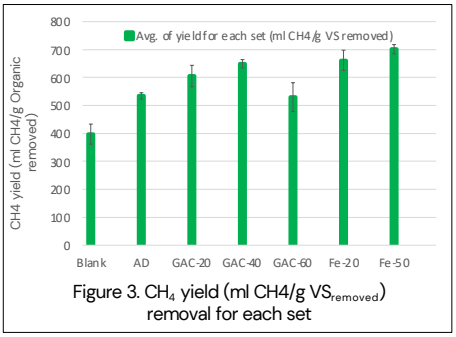

Figure 3. CH_4 yield (ml CH4/g $VS_{removed}$) removal for each set

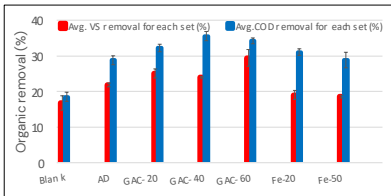

Figure 4. VS and COD removal for each set

Table 3. Modified Gompertz fitting parameters

	AD	GAC-20	GAC-40	GAC-60	Fe-20	Fe-50
P (ml)	671	828	777	767	657	648
Rm (ml/d)	27	36	38	40	34	36
λ (d)	2.4	2.5	2.0	2.1	2.5	2.5

P: Methane production potential (mL) ;
Rm: Maximum methane production rate (mL/d);
λ: lag-phase time (d)

Results

- 30% higher cumulative CH_4 production in all GAC reactor than conventional AD reactor
- 21% higher CH_4 yield (ml CH_4/g $VS_{removed}$) in all GAC reactor than conventional AD reactor
- 11% higher cumulative CH4 production in Fe-50 reactor than conventional AD reactor
- 17% decrease in lag time in GAC-40 with respect to conventional AD reactor
- 1.48 times higher CH_4 production rate in GAC-60 reactor and 1.33 times higher CH_4 production rate in Fe-50 reactor

Conclusions

- Application of conductive material (GAC and Fe_2O_3) enhanced CH_4 production with respect to conventional AD reactor
- Lag time for the digestion decreased by the supplementation of conductive material
- No significant difference among GAC reactors in cumulative production
- Conductive material is a promising approach to improve the performance of conventional AD process

References

1. Johnravindar, D., Liang, B., Fu, R., Luo, G., Meruvu, H., Yang, S., Yuan, B., & Fei, Q. (2020). Supplementing granular activated carbon for enhanced methane production in anaerobic co-digestion of post-consumer substrates. Biomass and Bioenergy, 136, 105543.

2. Liu, Y., Li, X., Wu, S., Tan, Z., & Yang, C. (2021). Enhancing anaerobic digestion process with addition of conductive materials. Chemosphere, 276, 130449. https://doi.org/10.1016/j.chemosphere.2021.130449

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