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[JTERA] Editor Decision

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Adnan Rafi Al Tahtawi <adnan.raf@polban.ac.id> Mon, 19 Dec 2022, 12:40

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Miss Lukhi Mulia Shitophyta:

We have reached a decision regarding your submission to JTERA (Jurnal Teknologi Rekayasa), "Variation of Acids on Pretreatment of Corn Stover for Enhancing Biogas Yield".

Our decision is: Revisions Required

Adnan Rafi Al Tahtawi
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Reviewer B:

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Thank you for informing me. | Noted with thanks. | Thanks a lot.

Variation of Acids on Pretreatment of Corn Stover for Enhancing Biogas Yield

Abstrak

Produksi biogas dari biomassa lignoselulosa telah mendapat perhatian dalam pengembangan bahan bakar terbarukan. Brangkasan jagung tergolong biomassa lignoselulosa. Pretreatment diperlukan untuk membantu pemecahan biomassa karena sifat rekalsitran dalam lignoselulosa. Penelitian ini bertujuan untuk membandingkan variasi asam untuk meningkatkan produksi biogas. Percobaan dilakukan dalam digester batch 1 L pada suhu kamar dengan asam yang berbeda yaitu HCl, H_2SO_4, and $C_2H_2O_4$ pada konsentrasi 0%, 5%, 10% dan 15%. Pretreatment asam dilakukan selama 24 jam. Hasil penelitian menunjukkan bahwa pretreatment $C_2H_2O_4$ memiliki dampak positif terhadap peningkatan hasil biogas. Hasil kumulatif biogas tertinggi sebesar 580,8 mL/gVS diperoleh pada $C_2H_2O_4$ 15%. Peningkatan konsentrasi asam menurunkan nilai pH awal. Nilai pH di bawah 6 menurunkan yield biogas.

Kata kunci: biogas, biomassa lignoselulosa, brangkasan jagung, pretreatment asam

Abstract

Biogas production from lignocellulosic biomass has gained attention in the development of renewable fuels. Corn stover belongs to lignocellulosic biomass. Pretreatment is needed to help the digestion of biomass due to its lignocellulosic recalcitrance. This study aims to compare the variations of acids for enhancing biogas production. The experiment was carried out in a 1 L batch digester under room temperature with different acids of HCl, H_2SO_4, and $C_2H_2O_4$ at concentrations of 0%, 5%, 10% and 15%. The acids pretreatment was performed for 24 hr. Results show that pretreatment of $C_2H_2O_4$ has a positive impact on increasing biogas yield. The highest cumulative yield of 580.8 mL/gVS is obtained at 15% $C_2H_2O_4$. The increase in acid concentrations decreases the initial pH value. The pH value below 6 reduces biogas yield.

Keywords: *acid pretreatment, biogas, corn stover, lignocellulosic biomass,*

thus enhancing accessibility to microbes and improving biogas production [9]. Acid pretreatments for lignocellulosic biomass have been conducted in previous studies. Jankociya et al. [10] studied the effect of acid and alkaline pretreatment on maize waste, rapeseed straw and wheat straw using NaOH and H_2SO_4. Amnuaycheewa et al. [11] expressed that organic acid (acetic acid, citric acid, and oxalic acid) pretreatment generated higher biogas than inorganic acid (hydrochloric acid) in biogas production from rice straw. Dasputa and Chandel [12] investigated the effect of hydrochloric acid and acetic acid on biogas production from the organic fraction of municipal solid waste. However, no studies have investigated the variation of acids on pretreatment of corn stover. Hence, the study aims to compare variations of acid pretreatment using sulfuric acid, hydrochloric acid, and oxalic acid for enhancing biogas production.

II. MATERIALS AND METHODS

FEEDSTOCK PREPARATION

Corn cobs were dried and cut into 1-2 cm by chopper. The fluid rumen of the cow as inoculum was obtained from Slaughterhouse in Yogyakarta.

ACID PRETREATMENT

Corn cobs were mixed with various chemical reagents of HCl, H_2SO_4 and $C_2H_2O_4$ with concentrations of 0% w/w, 5% w/w, 10% w/w and 15% w/w, respectively. Acid pretreatment was carried out at room temperature by soaking corn cobs in each chemical reagent for 24 hours.

BIOGAS PRODUCTION

The treated corn cobs were mixed with rumen liquid (1:1 ratio) and added water to adjust the total solid (TS) content of 22%, then the substrate was fed

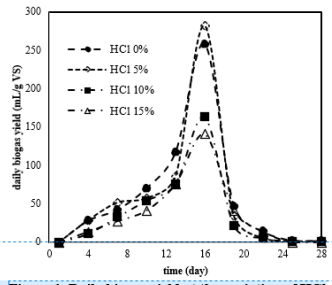
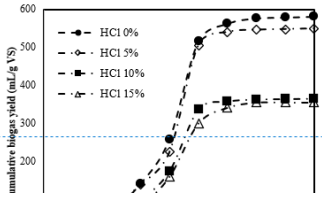


Figure 1. Daily biogas yield at the variation of HCl concentration

Biogas yields began on day 4 and then increased continuously until reaching peak yields of 258.4 mL/gVS, 282 mL/gVS, 163 mL/gVS, and 141,4 mL/gVS on day 16 at HCl concentrations of 0%, 5%, 10%, and 15%, respectively. Biogas production then decreased gradually from day 19 to day 28.

The highest concentration of HCl had no significant impact to improve biogas yield. HCl of 15% produced the lowest biogas yield as seen in Figure 2.



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- There is no explanation for why the graph rises quickly on the 16th day, then quickly reverses on the 19th day. What factors influence it, and how can this happen?
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Digestion (SS-AD). The biogas volume was measured every 3 days using the water displacement method.

III. RESULTS AND DISCUSSION

EFFECT OF HCL ON BIOGAS PRODUCTION

The effect of HCl on biogas production was identified by varying HCl concentrations, i.e., 0%, 5%, 10%, and 15%. Figure 1 presents the daily biogas yield for 28 days.

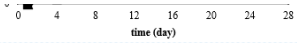

Figure 2. Cumulative biogas yield at the variation of HCl concentration

HCl of 0% obtained the highest cumulative yield of 563,7 mL/gVS followed by cumulative yields of 540.9 mL/gVS, 358,5 mL/gVS, and 342.3 mL/gVS at HCl concentrations of 5%, 10%, and 15%, respectively. Results showed that increasing HCl concentrations could not enhance biogas yield. This phenomenon may occur because acid pretreatment produces inhibitory compounds that may impede anaerobic digestion [13]. Hydrochloric acid produces furfural and hydroxy methyl furfural (HMF) which leads to the inhibition of methanogen activity[14].

- There is no explanation for why the graph rises quickly on the 16th day and is usually consistent on the 19th until 28th day. What factors influence it, and how can this happen?

EFFECT OF H_2SO_4 ON BIOGAS PRODUCTION

As presented in Figure 3, daily biogas yield started on day 4. The highest peak yield of 255 mL/gVS was obtained at 0% H_2SO_4, followed by peak yields of 266.1 mL/gVS, 158.6 mL/gVS, and 153.5 mL/gVS at H_2SO_4 concentrations of 5%, 10%, 15%, respectively on day 16. After reaching peak values, biogas production decreased regularly with

The highest cumulative yield of 503.9 mL/gVS was obtained at H_2SO_4 of 0%. H_2SO_4 of 5% obtained a higher cumulative yield of 480.1 mL/gVS than 10% H_2SO_4 and 15% H_2SO_4 with cumulative yields of 339.9 mL/gVS and 337.8 mL/gVS, respectively. Acid pretreatment generates inhibitor products like phenolic acids, furfurals, aldehydes, and 5-hydroxymethylfurfural [8]. It can inhibit methanogen activity and decrease biogas production.

EFFECT OF $C_2H_2O_4$ ON BIOGAS PRODUCTION

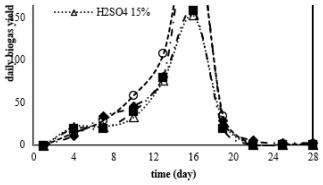

Figure 3. Daily biogas yield at the variation of H_2SO_4 concentration

Results showed that adding concentrations of H_2SO_4 had no positive impact on biogas production as proven in Figure 4.

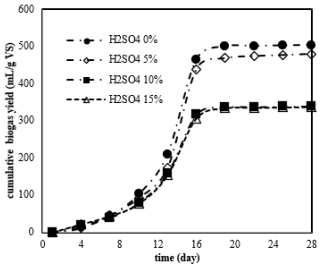

Figure 4. Cumulative biogas yield at the variation of H_2SO_4 concentration

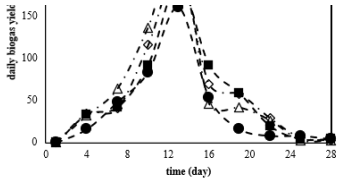

Figure 5. Daily biogas yield at the variation of $C_2H_2O_4$ concentration

Biogas yield began on day 4 for all concentrations of $C_2H_2O_4$ then biogas increased gently until attaining peak yield on day 13 with peak yields of 161 mL/gVS, 203,5 mL/gVS, 189,8 mL/gVS, and 229,03 mL/gVS for $C_2H_2O_4$ concentrations of 0%, 5%, 10%, 15%, respectively.

Increasing the concentration of $C_2H_2O_4$ from 10% to 15% increased cumulative yield from 536.9 mL/GV to 580.8 mL/gVS. Increasing $C_2H_2O_4$ from 0% to 5% also improved cumulative yield from 398, 5 mL/gVS to 561 mL/gVS. As shown in Figure 6 the highest cumulative yield was obtained at $C_2H_2O_4$ concentration of 15%.

- There is no explanation for why the graph rises quickly on the 16th day, then quickly reverses on the 19th day. What factors influence it, and how can this happen?

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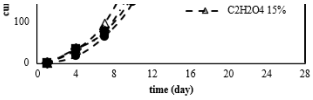

Figure 6. Cumulative biogas yield at the variation of $C_2H_2O_4$ concentration

Pretreatment of $C_2H_2O_4$ enhanced biogas yield than pretreatment of HCl and H_2SO_4. It may occur that $C_2H_2O_4$ can be produced by microbial fermentation and degraded easily compared to H_2SO_4. $C_2H_2O_4$ also generates fewer inhibitors and higher catalytic activity [15]. Therefore, pretreatment of $C_2H_2O_4$ had a positive impact on biogas production.

PH FUNCTION

The constancy of the process was evaluated via pH value. The pH was checked at initial and final conditions. pH is a crucial factor affecting anaerobic digestion performance. The ideal pH for anaerobic digestion is between 5.5 and 8.5 [16]. Table 1 presents the initial and final pH at various concentrations of acids.

Table 1. Initial and final pH values

Acid Concentrations	Initial pH			Final pH		
	HCl	H_2SO_4	$C_2H_2O_4$	HCl	H_2SO_4	$C_2H_2O_4$
0%	6	6	6	7	6	9
5%	6	6	6	7	6	8
10%	4	4	6	5	5	8
15%	2	2	4	3	3	6

During the experiment, the initial pH was 6 for conversion and small biogas yield [18].

IV. CONCLUSION

Corn stover is lignocellulosic biomass which not easily degraded by microbes. Acid pretreatment is utilized to enhance biogas yield. The best yield enhancement was achieved on pretreatment of $C_2H_2O_4$ with a $C_2H_2O_4$ concentration of 15%. The increase in HCl and H_2SO_4 concentrations could not enhance biogas yield, on the contrary, increasing concentrations of $C_2H_2O_4$ has a positive effect on the enhancement of biogas production. Increasing acid concentrations also affect pH conditions and biogas production. The low pH at initial and final conditions causes inhibition problems and decreases biogas production.

ACKNOWLEDGEMENT

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[2] S. Abanades *et al.*, "A critical review of

- There is no conclusion about which concentration value is the best to recommend.

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