Hydrogen production from cotton wastes by mean of dark fermentation

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Abstract
Dark fermentation of textile wastes is discussed in the paper. In the experiment were used cotton wastes. Before fermentation the cotton was hydrolyzed using 0.1 M of HCl. The inoculum was pretreated using heat shocked for 0.5 h at temperature of 105°C. The fermentation was carried out under conditions: load 5 g/l, pH in the range 5 by 0.1 M of HCl, and oxygen in small quantities was added. The oxygen flow rates (OFR) was 0.008 ml/h. The fermentation was carried out at temperature of 40 °C for one day. In reactors with pretreated inoculum (pH 5) biogas was detected and its content (hydrogen carbon monoxide, carbon dioxide and nitrogen) were determined. Methane was not produced during experiment. The volume of hydrogen for process performed at temperature 40°C 0.168 dm^3 of at biogas content 43%.
Keywords: dark fermentation, hydrogen, methane, cotton

1. Introduction

Dark fermentation is a kind of anaerobic digestion, during which carbohydrates are transferred into hydrogen, organic acid and carbon dioxide (Detman et al. 2018). According to initial assesments cotton waste are a potential source of hydrogen (Sołowski 2016). As in earlier research, related to sour cabbage fermentation, microaeration (stimulating hydrogen production) (Sołowski, et al 2018) was applied. In this paper results of cotton waste fermentation tests are shown and discussed.

2. Materials and Methods

The fermentation process of cotton wastes was performed in reactors (jars) of volume 2 dm^3. As inoculum, sludge from a biogas plant in Lubań (Pomerania Region), 5 g/l volatile suspended solids (VSS), were applied to each batch of cotton waste. The reactors were kept under mesophilic conditions (40°C). A substrate (load VSS 5 g/l), delivered from 100% cotton lab coats, was milled and hydrolysed using 0.1 M acidic solution during 2 hour. Then a cotton was added to reactors, pH was 5 The inoculum before process was treated by heat shock for 0.5 h at temperature of 105°C. The oxygen flow rates (OFR) was 0.008 ml/h. The biogas production was determined using the Owen method, but its content was registered using a TCD Gas Chromatograph (GC).

Table 1. Comparison of hydrogen production from different substrates (batch process)

Type of substrate/pretreatment	Hydrogen Yield (ml H2/g subs.)	Type of inoculum	Process conditions (g/l/°C/pH)	References
Cotton waste/105°C, 30 min	34	Heat shocked	(5/40/5.0 microaeration)	This article
Cotton stalk/no	72.7	Bacteria from wild carp intestine	40/37/8	(Li et al. 2018)
Cow dung compost/2 %HCl + 8-min microwaves	0.5	Dung Compost	(25/36/7.0)	(Fan et al. 2006)
Sunflower cornstalk /diluted HCl	2.3	Activated Sludge	(5/35/5.5)	(Monlau et al. 2013)
Microalgal biomass/ heat shock	20.9	Activated Sewage Sludge	(10/30/7)	(Batista, Gouveia, and Marques 2018)
Aspen wood/centrifugation	195	Hot spring culture	1.23/50/7	(Phummala et al. 2014)
Depackaging wastes/none	1.4	Untreated sludge	(4/37/7)	(Noblecourt et al. 2018)

3. Results

The GC spectra allowed determination of methane, hydrogen, carbon monoxide, carbon dioxide and nitrogen concentrations. The fermentation process with pretreated inoculum (initial pH ~ 5) was continued for 5 hours at temperature 40°C, the biogas contained carbon dioxide, nitrogen and hydrogen.

The results of hydrogen production from cotton were compared with results of dark fermentation of other substrates - see Table 1. The hydrogen yields was larger than from cow dung, microalgal biomass or sunflower but twice less than from cotton stalk and 6 time less than from aspen wood.

4. Summary

Cotton at VSS 5 g/l can be a good source of hydrogen. The hydrogen production was at OFR 0.008 ml/h and temperature of fermentation 40°C i.e. 0.168 dm^3 of at biogas content 43% and no methane. The phenomena will be investigated further.

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