2022

XXX Encontro de Jovens Pesquisadores

e XII Mostra Acadêmica de Inovação e Tecnologia

UCS A UCS É PRA QUEM BUSCA INOVAR O FUTURO!

METHANE AND VOLATILE FATTY ACIDS PRODUCTION FROM POULTRY LITTER WITH THE USE OF ENZYMATIC PRE-TREATMENTS

Metanogênicas

LDM Laboratório de Diagnóstico Molecular

PIBIC/CNPq

Authors: Mariana Dalsoto Smiderle, Janaina Iltchenco, Suelen Paesi

INTRODUCTION

Anaerobic digestion (AD) is a natural process that occurs in free-oxygen environments, when different microorganisms interact to transform organic matter – such as animal manure – into biogas and value-added by-products [1]. Brazil is the third biggest chicken producer and exporter worldwide, with 14.329 millions of tons produced in 2021 [2], demanding the correct management of this amount of residues generated to avoid environmental and health issues. Biogas is composed mainly by methane (CH4) and carbon dioxide (CO2), and it can be used for the production of electrical and thermal energy, or it can be purified and used as fuel. AD offers, then, an efficient system of treatment, thus producing green energy [3]. Considering that poultry litter is constituted of lignocellulosic material and is hard to degrade, the use of pre-treatments for its optimal usage in biogas production is applied [4]. Therefore, the objective of the study was to check methane and volatile fatty acids production from poultry litter, using commercial enzymes as pre-treatment.

BIOGAS

MATERIALS AND METHODS

Setup of bioassays and biogas production analysis

1

Commercial Cellulase (E) at 0,25%, 0,5%, 1% and 2%

Commercial Pectinase (O) at 0,02%, 0,04%, 0,08%, 0,1% and 1%

ACTIVATION PRE-TREATMENT

E → 55 °C for 18 h
O → 30 °C for 1 hour, pH 5.5

BIOASSAYS

C1 → CA + L
C2 → CA + L + E 0,25%
C3 → CA + L + E 0,5%
C4 → CA + L + E 1%
C5 → CA + L + E 2%
C6 → CA + L + O 0,02%
C7 → CA + L + O 0,04%
C8 → CA + L + O 0,08%
C9 → CA + L + O 0,1%
C10 → CA + L + O 1%

Poultry litter (CA) at 60% v/v

Granular sludge (L) at 10% v/v

2

Orbital shaking 140 rpm a 37 °C for 30 days

3

Gas chromatography Dani Master Automatic Sample

(Helium as carrier gas)

*The maximum methane production was evaluated according to Gompertz, and the bioassays were compared through the two-way ANOVA and the Tukey post hoc test.

Volatile fatty acids (VFA) analysis

1

Initial (I)
Final (F)

2

Samples were centrifuged at 10.000 rpm for 10'

3

The **supernatant** was filtered through a **0,2 µm** membrane

4

Methanol dilution (1:5)

5

Gas chromatography GC/MS, Shimadzu-QP 2010 Ultra

RESULTS AND DISCUSSION

When it comes to bioassays using commercial cellulase pre-treatment, the biggest methane production was found in CA + L + E 2% (667,57 mL), 22% higher than the control bioassay, while the biggest production in the commercial pectinase pre-treatment bioassays was in CA + L + E 0,1% (Table 1). Cellulases can degrade complex polymers found in lignocellulosic biomass, helping to improve digestibility during anaerobic digestion [5], while the biologic treatment in granular sludge helps to disrupt lipoprotein structures from de cell wall [6]. When statically analyzed, the bioassays using commercial cellulase (C2 – C5) didn't show significative difference. Weide et al. [7] observed that although the addition of enzymes helped the degradation of lignocellulose-rich substrates, the addition of cellulases on the anaerobic digestion of poultry litter didn't improve methane production – the income was only 17,7% higher when compared to the control bioassay by the end of 60 days.

On the other hand, the bioassays in which the commercial pectinase was added showed difference between them. Pectinases are often found in studies with enzymatic mixtures for use in AD, resulting in the increase of the methane yield by the end of the process [8].

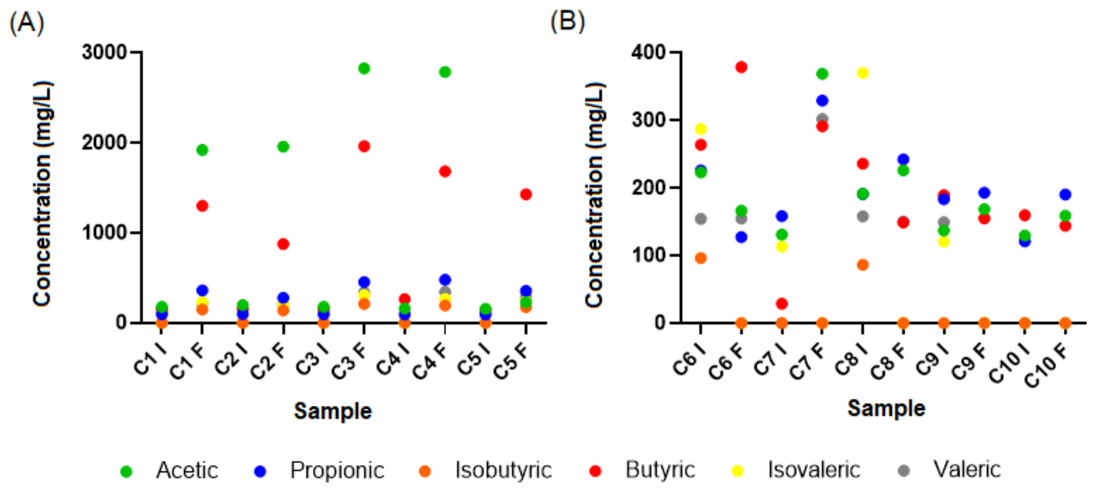
Table 1 - Methane production parameters of the bioassays using enzymatic pre-treatment, according to Gompertz: maximum methane production; maximum speed of production; and *lag* phase.

Bioassay	Maximum methane production (mL)	Maximum speed of production (mL/d)	*Lag* phase (d)
C1	561,46 **a**	22,61	0,51
C2	521,12 *	31,59	0,93
C3	469,61 *	32,28	1,26
C4	566,66 *	61,9	7,26
C5	667,52 *	27,13	2,71
C6	635,15 **a**	28,45	0,55
C7	636,45 **a**	27,24	0,35
C8	606,09 **b**	17,37	2,21
C9	656,84 **a**	23,57	0,65
C10	648,12 **ab**	21,37	0,56

*The bioassays didn't show significant statistical difference.

All of the acids analyzed were found in the samples of the bioassays. In the commercial celulase bioassay, initial samples showed lower concentration and variability of acids, while the final samples showed more significative levels of acetic and propionic acids – the sample C3 F showed the highest concentration of acetic acid, with 2828,235 mg/L (Figure 1a). In a previous study using poultry litter it was observed similar results in VFA analysis, with an increase on the production, being identified the same acids as analyzed here [9]. In the commercial pectinase bioassay (Figure 1b), it was observed isovaleric acid in initial samples and the presence of acetic, propionic and butyric acid was constant in initial and final samples. Acetic acid is an important intermediate for methane production, while propionic and butyric are converted into hydrogen [10].

Figure 1 – Production of volatile fatty acids from poultry litter, using enzymatic pre-treatment. (A) Commercial celulase (B) Commercial pectinase



FINAL CONSIDERATIONS

Even with more studies being necessary to fully comprehend the benefits of enzymatic pre-treatment in anaerobic digestion, enzymes have been used for the production of biogas from lignocellulosic residues with the purpose of offering more substrate for the microorganisms. Also, the VFA production already occurs in the biogas production metabolic pathway, but enzymes can optimize the process. These acids are precursors of by-products that are converted into methane, resulting in the increase or decrease of biogas production.

REFERENCES

[1] XU et al. **J. Hazard. Mater.**, 2020, v. 389, 121847.
[2] Associação Brasileira de Proteína Animal. **Relatório Anual 2021.**
[3] TOWN, J. R.; DUMONCEAUX, T. J. **Appl Microbiol Biotechnol**, 2016, v. 100, p. 1009-1017.
[4] THOMAS, L.; PARAMESWARAN, B.; PANDEY, A. **Renew. Energy**, 2016, v. 98, p. 9-15.
[5] ABRAHAM et al. **Bioresour. Technol.** 2020, v. 301, 122725.
[6] CHRISTY et al. **Renew. Sustain. Energy Rev.** 2014, v. 34, p. 167-173.
[7] WEIDE et al. Biomass and Bioenergy. 2020, v. 132.
[8] RAJIN, M. Green Energy Technol. 2018, p. 55-70.
[9] WANG, F. et al. **Int. J. Environ. Res. Public Health**, 2019, v. 16, n. 12.
[10] AL-SULAIMI, I. N. et al. **Fermentation**, 2022, v. 8, p. 184.

Acknowledgements

UCS UNIVERSIDADE DE CAXIAS DO SUL

CNPq Conselho Nacional de Desenvolvimento Científico e Tecnológico