EVALUATION OF PIG FARM EFFLUENT INOCOLUM TO OBTAIN BIOPRODUCTS

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ABSTRACT

Pig farming stands out as one of the main income-generating activities in rural areas, generating a large amount of waste that can cause environmental damage. On the other hand, the use of waste as fertilizer is the main form of disposal on rural properties, and is an environmentally sustainable alternative, as well as reducing the cost of buying commercial fertilizers. An alternative to this application is treatment by anaerobic digestion, which can generate added-value products (biogas and/or organic acids). Therefore, the aim of this study was to evaluate pig farm effluents as inoculum, in natura and self-fermented, using glycerol, a by-product of biodiesel production, as a substrate. The fermentations produced predominantly acetic acid and ethanol, as well as other acids such as butyric, isobutyric, valeric, propionic, etc. The medium containing fresh inoculum showed a greater amount of total soluble metabolites when compared to the self-fermented inoculum.

Keywords: Anaerobic fermentation. organic acids. Inoculum.

1 INTRODUCTION

The world is increasingly concerned with environmental protection policies, mainly aimed at producing new sources of energy and renewable products. Anaerobic biodigestion has been used as an alternative for minimizing environmental liabilities, mainly from agro-industry. The main product of this process is biogas[1]. However, this treatment method can also be used to generate organic acids.The high yields of hydrogen production are accompanied by the production of organic acids, soluble metabolites generated in acidogenesis[2].

The aim of this study is to evaluate the production of bioproducts, volatile organic acids (AOVs), from anaerobic fermentation, using residual glycerin from the transesterification of oils and fats to produce biodiesel as a carbon source for microbial metabolism, using pig farm effluent as an inoculum.

2 MATERIAL & METHODS

Inoculum and Pre-Treatment

The inoculum used in the reactors, pig farm effluent, was subjected to heat treatment at 90ºC for a period of 15 minutes and then cooled in an ice bath until it reached a temperature of 25ºC, in order to inhibit the development of methane-producing microorganisms and select direct spore-forming anaerobic bacteria such as *Clostridiumsp*[3,4].

After the pre-treatment phase, in order to evaluate the best condition for bioproducts production, the inoculum was subjected to 2 variations: in natura and self-fermented.

To obtain the inoculum through the natural fermentation process (self-fermentation), the waste was placed in an open container, such as a 1L beaker, covered with insect screen for a period of 100 hours and exposed to the environment for microbial growth6. The in natura inoculum, on the other hand, is used raw without any treatment, except thermal treatment to inactivate the methanogenic bacteria.

Fermentation

Batch experiments were carried out in triplicate, developed in reactors with a useful capacity of 100 mL with a reaction medium of 50 mL. In all treatments, a 90% v/v crude glycerol solution was maintained, a fixed concentration of 50 g/L, and 10% of the experimental volume of the inoculum. In reactor 1 (in natura inoculum) and in reactor 2 (self-fermented inoculum) 45 mL of crude glycerol and 5 mL of the respective inoculum were added. All experiments were prepared with the adopted methanogenesis inhibition strategy and with replacement of the atmospheric air present in the headspace of the flasks through the bubbling of gaseous nitrogen (N_2) to establish the anaerobiosis of the fermentation process.[5]The experiment was carried out over a period of 20 days under mesophilic conditions, with a temperature of 30 ± 1 °C maintained in a refrigerated incubator without orbital agitation (shaker), model MA380, without agitation. The reaction pH was adjusted to 5.0 by adding HCl, with the maximum added being set at 2 mL L^{-1}, as well as CH_3COOH (acetic acid) when this maximum value was not sufficient.

Chromatographic analyzes

Soluble metabolites (volatile organic acids, acetone and alcohols) were determined by the headspace extraction method using an HS-20 automatic sampler coupled to a GC 2010 gas chromatograph, both from Shimadzu (Software Lab Solutions) with a SUPELCOWAXTM 10 column, with a fused silica capillary (30 m×0.25 mm×0.25 μm), with hydrogen as the carrier gas and a flame ionization detector (FID). The analysis solution consisted of 1g of NaCl, 2mL of the reactor sample, 200 μL of 2M sulfuric acid and isobutanol (70μL 1g/l), crotonic acid (100 μL 700mg/L) as internal standards.

3 RESULTS & DISCUSSION

Glycerol, used as a substrate for fermentative bacteria, was consumed over 480 h of fermentation by the microorganisms present in the pre-treated inoculum: fresh and self-fermented. The production of Total Soluble Metabolites (TSM) was 7056.9 and 5020.4 mg/L as well as a production of Total Organic Acids (TOA) of 5355.4 and 4171.2 mg/L, respectively for fresh and self-fermented inoculum, in Figure 1.

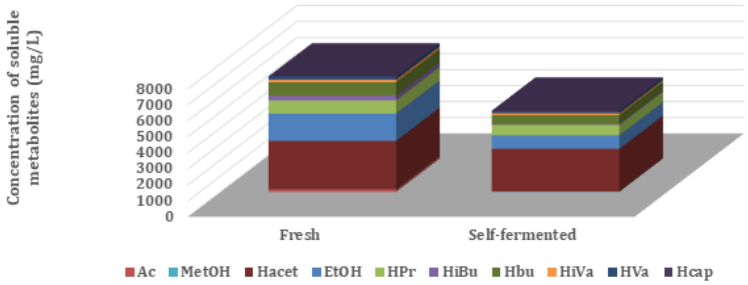

Figure 1: Concentration of soluble metabolites from anaerobic digestion of glycerol using swine effluent.

It was found that the in natura inoculum produced more bioproducts, possibly because it was used after heat treatment. Unlike the self-fermented inoculum, which underwent self-fermentation for 100 hours after heat treatment, this probably activated hydrogen-consuming microorganisms. The medium containing fresh inoculum showed a ratio of acetic and butyric acids of approximately 3, while the same parameter was 5 when using self-fermented inoculum. Studies show that the level of expression of the hydrogenase gene is higher when compared to the in natura inoculum, indicating high H_2 production and a higher acetic and butyric acid ratio[7].

4 CONCLUSION

The result revealed that anaerobic fermentation of glycerol can potentially be used to generate higher value-added products. It was possible to produce organic acids from residual glycerol using piggery effluent. Among the main organic acids found, acetic, propionic and butyric acid were the most generated, as well as other acids and soluble metabolites such as ethanol. The results indicate that organic acids were produced more when using the in natura inoculum than the self-fermented one, resulting in around 5355.4 mg/L and 4171.2 mg/L of total organic acids, respectively.

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ACKNOWLEDGEMENTS

Federal University of Alagoas