Wastes: Solutions, Treatments and Opportunities III

Selected Papers from the 5th International Conference Wastes 2019, September 4-6, 2019, Lisbon, Portugal

Edited By *Candida Vilarinho, Fernando Castro, Margarida Gonçalves, Ana Luísa Fernando*

Edition	1st Edition
First Published	2019
eBook Published	8 August 2019
Pub. location	London
Imprint	CRC Press
DOI	https://doi.org/10.1201/9780429289798
Pages	614 pages
eBook ISBN	9780429289798
Subjects	Bioscience, Engineering & Technology, Environment & Agriculture

Share

Citation

Dark fermentation sludge as nitrogen source for hydrogen production from food waste

J. Ortigueira & P. Moura
LNEG I.P., Laboratório Nacional de Energia e Geologia, Unidade de Bioenergia, Lisboa, Portugal

C. Silva
Instituto Dom Luiz, Faculdade de Ciências, Universidade de Lisboa, Lisboa, Portugal

ABSTRACT: The biological conversion of food waste (FW) into hydrogen (H_2) by anaerobic fermentation is associated with high production costs and complex supplementation requirements. The present study focused on the simplification of the H_2 production through dark fermentation (DF) by reusing its residual solid fraction, herein referred as DF-sludge, as nitrogen source for a subsequent FW conversion. The non-sterile FW fermentation with addition of *C. butyricum* as H_2-producing microorganism and supplemented with two nitrogen sources was compared: ammonium chloride (NH_4Cl) or DF-sludge. The maximum biogas productivity, H_2 production yield and H_2 cumulative production were obtained with the DF sludge supplementation, reaching values of 433.3 ± 34.3 mL biogas $(L\ h)^{-1}$, 194.2 ± 24.4 mL H_2 g_{sugar}^{-1} and 3.2 ± 0.0 L H_2 L^{-1}, respectively. The use of DF sludge improved the fermentation efficiency on H_2 production by 40 %, underlining the impact of nutrient recycling in *C. butyricum* fermentative performance.

1 INTRODUCTION

Over the past decade, the scientific community has emphasized the environmental and economic impact of wasted food products (Scherhaufer et al. 2018). The act of throwing out food due to inefficient production and consumption practices, reaches farther than the mere gesture. It represents the loss of all resources required for its production as well as those necessary for its proper treatment and disposal. According to the Food and Agriculture Organization of the United Nations, approximately 88 billion tonnes of food waste (FW) were discarded in the 28 countries of the European Union in 2013, a wastage that represents up to 186 Mt $CO_{2\text{-eq}}$ carbon emissions (Scherhaufer et al. 2018). While FW prevention is a required target in the majority of legislation packages dealing with this problem (Corrado & Sala 2018), it is not feasible to assume that it will be possible to reduce or eliminate this type of waste in a nearby future. Therefore, several studies focus the possibility of FW valorisation.

Food waste is a highly heterogeneous mixture of chemical components, containing water, carbohydrates, proteins, fat, among others. This composition makes it an interesting substrate for dark fermentation (DF), a biological process which consists on the anaerobic conversion of carbohydrates into hydrogen (H_2), organic acids, such as butyrate and acetate, and compost (Ortigueira et al. in press). Hydrogen is considered to be an extremely interesting bioenergy carrier as it has a considerably high energy density (120 MJ kg^{-1}), is storable at -253 ºC in the liquid form or in the gaseous form at high pressures of 300-700 bar, and its combustion is not associated to carbon or sulphur emissions (Dutta et al. 2014). However, the low production yields which are normally associated with biological conversion systems tend to inflate the production costs and difficult the implementation at industrial scale. One strategy commonly used for costs reduction involves the minimisation of the nutrient requirements in the culture media and/or its replacement by cheaper alternatives. These alternatives should be, in principle, easily attainable, readily available in large quantities, renewable and environmentally friendly (Han et al. 2016). Dark fermentation sludge can be defined as the solid residue obtained after completion of the biological con-