Biohydrogen production from coffee waste: overcoming challenges through bioprospecting, pretreatment, and optimization

Alejandra Carolina Villa Montoya\textsuperscript{ab}, Raissa Cristina da Silva Mazareli\textsuperscript{b}, Edson Luiz Silva\textsuperscript{b}, Maria Bernadete Amâncio Varesche\textsuperscript{b}
Antioquia Institute of Technology / Medellín-Colombia and University of São Paulo/ São Carlos-Brazil

Coffee waste from post-harvest processing contains high carbohydrate content and autochthonous microorganism which can be used in biofuel production. The objective of this study was to screen the factors that affect H2 production from coffee waste, focusing on the bioprospection of a consortium of bacteria and fungi, selection of pretreated conditions in a hydrothermal reactor, optimization of hydrogen production, and taxonomic and functional characterization of the microbial community. Multifactorial experimental designs and response surface were applied to evaluate the effects of pH (4.0-7.0), temperature (30-50°C), agitation (0-180 rpm), headspace (50-70%), percentage of bioaugmentation (without microbial consortium up to 20%), concentration of coffee pulp and husk (2-6 g/L), coffee processing wastewater (7-30 gCOD/L) and yeast extract (0-2 g/L). Husk/pulp hydrothermal pretreatment with a severity between 3.2 and 4.2 and co-digestion of coffee waste (wastewater, pulp and husk, pulp and husk pretreated in the hydrothermal system, and liquid fraction from pretreatment) were studied. Autochthonous consortium (bacteria and fungi) was selected from the waste and the taxonomic and functional profile were analyzed. Hydrothermal pretreatment of 180°C for 15 min and waste co-digestion improved up to 7 times the H2 production when compared to in natura waste. In the optimized reactor were observed Clostridium (87.9%), Lactobacillus (1.7%), Kazachstania (18.6%), and Saccharomyces (16.3%) with genes related to lignin, phenol, cellulose, lignocellulose, and pectin degradation, as well as the production of organic acids, alcohols, and H2. Conditions for maximal hydrogen production of 3.04 LH2/Ld were at a pH 7.0, 7 g/L pulp and husk, and 30% headspace. In conclusion, the application of multifactorial design studies, bioprospection of microorganisms from waste, and pretreatment of lignocellulosic biomass are prominent tools for overcoming challenges of biohydrogen production from agricultural waste such as the coffee industry.

Keywords: codigestion, hydrothermal pretreatment, metagenomic, microbial consortium, multifactorial design.

Biography:

Alejandra V. Montoya is a microbiologist (Universidad de Antioquia, Colombia), with MSc in Agricultural Microbiology (Universidade Estadual Paulista, UNESP, Brazil) and Ph.D in Sciences emphasized in Sanitary Engineering (Universidade de São Paulo, USP, Brazil). She is currently a Professor and researcher at Tecnológico de Antioquia, Colombia. Her research experience has focused on topics related to the biological production of hydrogen and methane, wastewater treatment, lignocellulosic waste, characterization of microbiomes using molecular tools, the microbiology of aerobic and anaerobic systems, and degradation of inhibitory and toxic compounds.