ISGC 2019 May 13rd - 17th

N°320 / OC
TOPIC(s) : Waste valorization / Biomass conversion

Acidogenic fermentation of coffee wastes as a step of a bioplastic production process

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PURPOSE OF THE ABSTRACT

The coffee industry generates high amounts of residues, like spent coffee grounds (SCGs). These are produced during the brewing process of coffee and are still very rich in lipids and sugars, making their valorization through biological processes feasible. SCGs can be a potential substrate for many added-value products.
Amongst these, bio-based polymers stand out as candidates due to the current need for environmental-friendly alternatives to plastics. Polyhydroxyalkanoates (PHAs) are biodegradable polymers with similar properties to traditional plastics and can be produced from complex carbon sources by mixed microbial cultures (MMC). The combined use of MMC and low-cost substrates can lead to a significant reduction in the production cost of these polymers.
Since MMC cannot use directly the carbohydrates and fatty acids of SCGs to produce PHAs, the conversion of organic compounds of SCGs into short-chain organic acids (SCOAs) constitutes the first step of acidogenic fermentation. Considering this, the aim of the work was to develop and optimize the acidogenic fermentation of SCGs as the first step for the production of PHAs by MMC.
The study of acidogenic fermentation of SCGs started by testing different sources of inoculum. Three sources were evaluated in batch mode: an anaerobic MMC, an aerobic MMC and an anaerobic MMC submitted to a heat pretreatment. The aerobic inoculum resulted in the most diverse SCOAs profile, with acetic, propionic, butyric and valeric acids, and a maximum concentration of 1.68 gSCOA/L after 15 days of operation. This was the inoculum selected for subsequent studies.
Two different reactor configurations were used. A Continuous Stirred-Tank Reactor (CSTR) was first tested and showed SCOAs production only in the first 12 days, decreasing over time after an initial maximum concentration of 0.52 gSCOAs/L. The SCOAs profile obtained had acetic, propionic, butyric and valeric acids. The results can be explained by the decreased in biomass concentration observed over time, an indication that the 3-day retention time (SRT/HRT) imposed to the reactor were too low.
To overcome this issue the reactor configuration was changed to a Fluidized Bed Biofilm Reactor (FBBR). A better performance was achieved, with a maximum of 1.53 g/L of SCOAs in the beginning of operation and a similar SCOAs profile as the CSTR. A decrease in acids production was again observed in the initial phase of operation. However, under these conditions, the culture was able to maintain a lower but constant concentration of acetic acid of 0.07 g/L. Several operational conditions that include hydraulic retention time, sludge retention time and organic load are being studied in order to optimize the acidification yields.
In addition, and to further improve the acidification step, different pretreatments of the substrate were conducted in order to decrease the complexity of components of SCG and increase fermentable sugars. These methods included acidic and alkaline hydrolysis, microwaves, ultrasounds, and heat. The different hydrolysates were characterized and tested in batch assays and the most efficient pretreatment would be applied to the FBBR

substrate.

FIGURES

FIGURE 1

FIGURE 2

KEYWORDS

Acidogenic Fermentation | Mixed Microbial Cultures | Spent Coffee Grounds | Polyhydroxyalkanoates

BIBLIOGRAPHY