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Physicochemical characteristics of attached biofilm on granular activated carbon for thermophilic biohydrogen production

Abstract

In this study, thermophilic biohydrogen production by a mixed culture, obtained from a continuous acidogenic reactor treating palm oil mill effluent, was improved by using granular activated carbon (GAC) as the support material. Batch experiments were carried out at 60 °C by feeding the anaerobic sludge bacteria with a sucrose-containing synthetic medium at an initial pH of 5.5 under anoxic conditions. The physico-chemical characteristics of the attached biofilm were evaluated after extraction of the extracellular polymeric substances (EPSs) of the biofilm using the formaldehyde-NaOH method. The main component of the biofilm was protein (60%), while the carbohydrate content accounted for 40% of the EPS. Two major absorption bands at approximately 3400 cm-1 and 1650 cm-1, characteristics of the stretching vibrations of hydroxyl and amino groups, respectively, were identified in the FT-IR spectra, confirming the composition of the EPS. Observations using scanning electron microscopy (SEM) illustrated the attachment of rod-shaped bacterial cells on the GAC at 60 °C. A maximum hydrogen production rate of 4.3 mmol L-1 h-1 and a hydrogen yield of 5.6 mol H2 per mol sucrose were obtained from this attached biofilm system. The major soluble metabolites of fermentation were acetic acid and butyric acid. The results showed that the granular activated carbon enhanced the biohydrogen production by stabilizing the pH and microbial metabolites and therefore could be used as a support material for fermentative hydrogen production under thermophilic conditions on a large scale.

Keywords

Activated carbon; Biofilms; Butyric acid; Carbon; Granular materials; Metabolites; Palm oil; Scanning electron microscopy; Stretching; Sugar (sucrose)