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Opinion Article

Dark Fermentation: A Green Solution for Food Waste Conversion

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DESCRIPTION

Dark fermentation is a new technology that converts food waste into bioenergy, specifically hydrogen and methane. This process involves the anaerobic digestion of organic matter by a group of bacteria, which produces hydrogen as a byproduct. Food waste is a substrate for dark fermentation because of its high glucose content and availability. The process normally starts with waste processing, followed by inoculation with hydrogen-producing bacteria in an anaerobic environment. To increase hydrogen yield, critical operating factors such as pH, temperature, and hydraulic retention time must be tuned.

It can be used with other processes such as anaerobic digestion to produce methane (biohythane). However, scaling up dark fermentation for commercial bioenergy generation still presents problems. These include low hydrogen yields, inhibitors, and the requirement for effectiveness. Despite these limitations, dark fermentation has enormous potential for sustainable waste management and renewable energy production. As study continues to improve the process and solve technological challenges, it may become a viable method for converting food waste into clean biofuels.

Dark fermentation is a biological hydrogen production process. In the absence of light and oxygen, facultative and obligate anaerobes undergo dark fermentation. During dark fermentation, bacteria interact with the substrate, producing hydrogen. The substrate for dark fermentation includes lignocellulosic biomass, carbohydrate sources such as industrial effluent, sugary crop residues, and municipal solid waste. The biomass pretreatment has a major impact on the efficiency of the dark fermentation in the first step. Other parameters that can influence efficiency include the type of microbe utilized and the sugar amount of the substrate.

As food waste creation has increased, the scientific community has been encouraged to transform it into valuable resources. Hydrogen energy, with its purity, high energy content, and ability to prevent global warming, provides a sustainable alternative to fossil fuels. This study investigates the implications on the process stability and energy recovery of manufacturing batch fermentative biohydrogen from food waste.

Several renewable organic wastes have been investigated as potential substrates for dark fermentative biohydrogen production, including sake lees, cassava, sago, glycerol, rice straw, vegetable waste, food waste, date seeds, sugarcane molasses, corn stover, alligator weed, oil palm sap, and wheat straw. Palm Oil Mill Effluent (POME), a substantial amount of wastewater created during the palm oil extraction process, is another renewable organic waste being extensively studied as a substrate for biohydrogen synthesis. It has been investigated to use both pure and mixed cultures as the inoculum in the dark fermentation reactor.

A mixed culture system is generally more favorable and practical than a pure culture system since it has a diverse range of microbial communities capable of rapidly degrading a wide range of substrates. Furthermore, it is not necessary to maintain a strict aseptic condition, which simplifies handling and reduces operational costs. It is, nevertheless, a biochemically complex environment due to the coexistence of biohydrogen producers, non-biohydrogen producers, and biohydrogen consumers such as methanogens and homoacetogens in mixed culture. Despite extensive research, there remains a lack of understanding of the biological processes involved in dark fermentation for biohydrogen production, including the specific microbial community and trophic relationships. This aspect gives a more accurate description of methane-producing fermentation systems.

The classic definition of a microbiome is a collection of microorganisms with specialized characteristics and metabolic activities that interact with their surroundings to form a unique ecological niche. The word "microbiome" or "microbiota" refers to a collection of living microorganisms that includes bacteria, archaea, fungus, microalgae, and protists, but excludes phages, viruses, plasmids, prions, viroids, and free DNA. The phrase "microbiome" refers to the microbiota, including its structural components, metabolites/signal molecules, and environmental

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influences. Microbiomes are made up of free DNA, viroids, plasmids, prions, phages, viruses, and plasmids.