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Bio-Hydrogen Production from Sewage Sludge and Landfill Leachate by Dark and Photo Fermentation

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Abstract **-** This study explores an innovative biological approach to produce bio- hydrogen from organic waste substrates such as wastewater sludge and landfill leachate, employing dark and photo fermentation methods. In dark fermentation, the process occurs in the absence of light, whereas photo fermentation takes place in a well-lit environment. Microorganisms are pivotal in both methods, breaking down organic materials to generate hydrogen gas [1, 2].
The research meticulously compares the efficiency and performance of dark and photo fermentation in generating bio-hydrogen from these waste sources. Controlled experiments, utilizing a controlled-environment flask, were conducted. Initially, separate dark and photo fermentation processes were applied to sewage sludge [2]. Subsequently, experiments involving a 70%–30% mixture of sewage sludge and landfill leachate were conducted for both fermentation methods. Key variables such as pH, temperature, substrate concentration, and duration of experiments were strictly regulated [3, 4].
Results revealed significant bio-hydrogen production from wastewater sludge alone and in combination with landfill leachate in both dark and photo fermentation processes [4]. Dark fermentation of pure sewage sludge demonstrated superior bio- hydrogen yield, reaching 116.20 µL, equivalent to 23.24% of the total gas volume produced during the 87-hour experiment. In comparison, photo fermentation of the same substrate yielded 76.56 µL, constituting 15.31% of the total gas volume.
Furthermore, when a mixture of wastewater sludge and landfill leachate was utilized, dark fermentation outperformed photo fermentation, producing 67.63 µL of bio-hydrogen (13.53% of the total gas volume), while photo fermentation produced 63.37 µL, accounting for 12.67% of the total gas volume. Thus, the overall comparison demonstrates that dark fermentation of pure sewage sludge yields the highest bio-hydrogen production.

Keywords**:** bio-hydrogen production, organic waste substrates, wastewater sludge, landfill leachate, dark fermentation, photo fermentation, microorganisms, controlled experiments, hydrogen gas, renewable energy.

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