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# CO-DIGESTION OF *SPIRULINA* SP. WITH LIGNOCELLULOSIC WASTE IN BATCH-SCALE BIOREACTORS FOR SUSTAINABLE BIOREFINERY DEVELOPMENT

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## Abstract

*Spirulina*, an ancient cyanobacterium, is emerging as a potent candidate for anaerobic co-digestion processes, attributed to its resilience, rapid proliferation, cost-effectiveness, and environmental sustainability. This study meticulously optimized key cultivation parameters—pH (7.5–11.5), temperature (20–40 °C), light intensity (4000–8000 lux), incubation period (20–40 days), and inoculum concentration (1–10%)—for the heterotrophic growth of *Spirulina* sp. NCIM 5143. The primary objective was to maximize biomass yield to facilitate efficient biofuel production and assess its potential for co-digestion with rice straw in advanced biogasification. Optimization led to significant enhancements in biomass yield and biochemical profile, notably increasing total chlorophyll, carbohydrate, protein, and lipid content, thereby highlighting *Spirulina* sp. NCIM 5143's viability as a superior feedstock for bioenergy applications. Optimal conditions, including a pH of 11.671, a temperature of 26.0391 °C, a luminescence of 4000.02 Lux, an incubation time of 39.372 days, and an inoculum size of 10.00% were obtained. Kinetic evaluation of biogas productivity using the modified Gompertz equation revealed significant insights. Notably, in mono-digestion scenarios, digester C demonstrated superior biogas yields, production rates, and shorter lag phases across different seasons. Conversely, co-digestion analysis highlighted digester E's dominance in kinetic parameters, indicating enhanced biogas productivity. Here, the maximum biogas generation potency (P) of 148.45 ml/g VS, with the highest rate of biogas generation ($R_m$) of 4.48 ml/g/d, and the shortest lag phase ($\lambda$) of 2.66 days was obtained. These findings highlight the significant potential of *Spirulina* as a pivotal contributor to efficient biofuel synthesis, aligning seamlessly with the broader goals of sustainable biorefinery development. The results advocate for intensified research and application in renewable energy production, positioning *Spirulina* as a key resource in advancing the transition towards sustainable energy systems.

*Key words:* biogasification, co-digestion**,** microalgae, modified gompertz equation, optimization

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