

INTISARI

Indonesia merupakan salah satu negara penghasil kelapa sawit terbesar di dunia, yang menghasilkan limbah cair berupa *Palm Oil Mill Effluent* (POME) dalam jumlah besar. Meskipun proses anaerobik mampu mengurangi kandungan polutan organik, hasil olahannya yang dikenal sebagai *Liquid Digestate of POME* (LDP) masih belum memenuhi standar baku mutu lingkungan. Penelitian ini bertujuan untuk mengidentifikasi laju pertumbuhan *Spirulina platensis* yang optimal melalui metode *Response Surface Methodology* (RSM) dengan memvariasikan konsentrasi LDP, durasi penyinaran, dan waktu aerasi; memodelkan kinetika pertumbuhan mikroalga; serta mengevaluasi efektivitas bioremediasi terhadap kandungan BOD dan COD. Hasil menunjukkan bahwa penambahan LDP secara signifikan meningkatkan kepadatan sel *Spirulina platensis* dan menurunkan kandungan BOD dan COD. Kondisi optimum diperoleh pada volume LDP sebesar 45%, durasi penyinaran 11,528 jam, dan waktu aerasi 4,76779 jam, dengan prediksi kepadatan sel mencapai 154×10^4 sel/mL, penurunan BOD sebesar 81,57%, dan COD sebesar 66,24%. Model Gompertz merupakan model matematis terbaik dalam menggambarkan kinetika pertumbuhan dengan nilai R^2 sebesar 0,9948 pada media LDP. Namun, analisis linier menunjukkan bahwa laju pertumbuhan sel tidak berpengaruh signifikan terhadap penurunan BOD dan COD, yang menandakan bahwa efektivitas bioremediasi juga ditentukan oleh kondisi lingkungan, komposisi limbah, dan keadaan fisiologis mikroalga selama kultivasi. Penelitian ini menegaskan bahwa *Spirulina platensis* memiliki potensi sebagai agen bioremediasi yang efektif dalam pengolahan lanjutan LDP, terutama pada kondisi kultivasi yang terkontrol.

Kata kunci: *Spirulina platensis*, *Liquid Digestate of POME*, Bioremediator, *Response Surface Methodology*, Kinetika Pertumbuhan, Mikroalga

ABSTRACT

*Indonesia is one of the largest palm oil producing countries in the world, which produces liquid waste in the form of Palm Oil Mill Effluent (POME) in large quantities. Although the anaerobic process is able to reduce the content of organic pollutants, the processed product known as Liquid Digestate of POME (LDP) still does not meet environmental quality standards. This study aims to identify the optimal growth rate of *Spirulina platensis* through the Response Surface Methodology (RSM) method by varying the LDP concentration, irradiation duration, and aeration time; modeling the kinetics of microalgae growth; and evaluating the effectiveness of bioremediation on BOD and COD content. The results showed that the addition of LDP significantly increased the cell density of *Spirulina platensis* and reduced the BOD and COD content. The optimum conditions were obtained at an LDP volume of 45%, an irradiation duration of 11.528 hours, and an aeration time of 4.76779 hours, with a predicted cell density reaching 154×10^4 cells/mL, a BOD reduction of 81.57%, and a COD reduction of 66.24%. The Gompertz model is the best mathematical model in describing growth kinetics with an R^2 value of 0.9948 in LDP media. However, linear analysis showed that the cell growth rate did not significantly affect the reduction of BOD and COD, indicating that the effectiveness of bioremediation is also determined by environmental conditions, waste composition, and the physiological state of microalgae during cultivation. This study confirms that *Spirulina platensis* has the potential as an effective bioremediation agent in the advanced processing of LDP, especially under controlled cultivation conditions.*

Keywords: *S. platensis, Liquid Digestate of POME, Bioremediator, Response Surface Methodology, Growth Kinetics, Microalgae*