Model Bioteknologi Degradasi Mikroplastik Berbasis Bakteri Indigenous Tempat Pembuangan Akhir Cipayung Kota Depok

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Abstrak

Pencemaran mikroplastik semakin meningkat setiap tahunnya dan berpotensi menimbulkan risiko kesehatan bagi masyarakat. Kebijakan pemerintah terkait pengelolaan mikroplastik menggunakan model ekonomi sirkular dan model 3R (reduce, reuse, recycle) terus dilaksanakan, namun belum menyelesaikan tantangan di lapangan. Sehingga diperlukan alternatif pengelolaan mikroplastik melalui teknologi degradasi menggunakan mikroorganisme. Penelitian ini bertujuan untuk mengembangkan model bioteknologi degradasi mikroplastik berbasis bakteri indigenous berasal dari Tempat Pembuangan Akhir (TPA) Cipayung Kota Depok. Penelitian ini merupakan penelitian kuantitatif dengan pendekatan observasional, penilaian risiko kesehatan dan eksperimental. Studi observasional dilakukan untuk mengidentifikasi mikroplastik pada sampel tanah dan air bersih serta mengetahui jenis dan kemampuan isolat bakteri dalam mendegradasi mikroplastik. Pendekatan eksperimental untuk mengembangkan model bioteknologi degradasi mikroplastik berbasis bakteri indigenous. Hasil penelitian menunjukkan bahwa konsentrasi mikroplastik di tanah TPA Cipayung bervariasi antara 8.400–152.000 partikel/kg, sementara pada air bersih yang dikonsumsi masyarakat berkisar antara 1.889–5.444 partikel/L, dengan variabilitas tingkat risiko kesehatan terkategori Risk Quotient (RQ) > 1. Empat isolat bakteri potensial, yaitu Rummeliibacillus pycnus NBRC 101231, Stenotrophomonas acidaminiphila JCM 13310, Microbacterium arborescens DSM 20754, dan Streptomyces thermolineatus DSM 41451, efektif mendegradasi mikroplastik melalui penurunan berat, perubahan struktur kimia (Fourier Transform Infrared Spectroscopy), serta pembentukan biofilm, lubang dan retakan (Scanning Electron Microscope). Model bioteknologi degradasi mikroplastik dikembangkan dalam bentuk produk liofilisasi biomassa bakteri, menggunakan isolat Rummeliibacillus pycnus NBRC 101231. Saran yang diajukan adalah perlunya penetapan regulasi batas aman mikroplastik di lingkungan serta mendukung pengembangan bioteknologi degradasi mikroplastik berbasis biomassa bakteri sebagai solusi pengelolaan yang berkelanjutan. Untuk penelitian selanjutnya, diperlukan uji implementasi dan akseptabilitas model bioteknologi ini untuk memastikan efektivitas dan penerimaan di tingkat masyarakat. <hr /> Microplastic pollution continues to increase annually, creating potential threats to public health. Government policies related to microplastic management, which rely on circular economy models anda 3R model (reduce, reuse, recycle), are being implemented, but have yet to address the challenges in the field. Therefore, alternative microplastic management strategies that utilize degradation technologies with microorganisms are required. This study aimed to develop a biotechnology model for microplastic degradation based on indigenous bacteria sourced from the Cipacung Landfill, Depok City. This study employed a quantitative approach that combined observational, health risk assessment and experimental methods. Observational study was conducted to identify microplastics in soil and clean water samples, and to determine the types and capabilities of bacterial isolates in degrading microplastics. The experimental approach was applied to develop a biotechnological model for microplastic degradation based on indigenous bacteria. The study results

show that the concentration of microplastics in the soil at the Cipayung Landfill varies between 8.400-152.000 particles/kg, while in clean water consumed by the community, it ranges between 1.889-5.444 particle/L with variability in health risk levels categorized as Risk Quotient (RQ) >1. Four potential bacterial isolates, Rummeliibacillus pycnus NBRC 101231, Stenotrophomonas acidaminiphila JCM 13310, Microbacterium arborescens DSM 20754, and Streptomyces thermolineatus DSM 41451, were effective in degrading microplastics. This was demonstrated through weight reduction, changes in the chemical structure (Fourier Transform Infrared Spectroscopy), and the formation of biofilms, holes, and cracks (Scanning Electron Microscope). Biotechnology model for microplastic degradation was developed in the form of a lyophilized bacterial biomass product, utilizing the isolate Rummeliibacillus pycnus NBRC 101231. The proposed recommendations include establishing safe limits for microplastics in the environmnent and supporting the development of biotechnology for microplastic degradation based on bacterial biomass as a sustainable management solution. For future research, implementation trials and acceptability assessments of this biotechnology model are needed to ensure its effectiveness and community acceptance.