BIOREMEDIASI LOGAM KROMIUM MENGGUNAKAN KOMBINASI FORMULA KONSORSIUM BAKTERI *Bacillus licheniformis*, *Bacillus paralicheniformis*, DAN *Brevibacillus borstelensis* SECARA *IN VITRO*

SKRIPSI

Diajukan untuk memenuhi sebagian syarat memperoleh gelar Sarjana Sains
Program Studi Biologi

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FAKULTAS PENDIDIKAN MATEMATIKA DAN ILMU PENGETAHUAN ALAM
UNIVERSITAS PENDIDIKAN INDONESIA

2025

BIOREMEDIASI LOGAM KROMIUM MENGGUNAKAN KOMBINASI FORMULA KONSORSIUM BAKTERI *Bacillus licheniformis*, *Bacillus paralicheniformis*, DAN *Brevibacillus borstelensis* SECARA *IN VITRO*

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PERNYATAAN

Dengan ini saya menyatakan bahwa skripsi dengan judul "Bioremediasi Logam Kromium Menggunakan Kombinasi Formula Konsorsium Bakteri *Bacillus licheniformis*, *Bacillus paralicheniformis*, dan *Brevibacillus borstelensis* secara *In vitro*" ini beserta seluruh isinya adalah benar-benar karya saya sendiri. Saya tidak melakukan penjiplakan atau pengutipan dengan cara-cara yang tidak sesuai dengan etika ilmu yang berlaku dalam masyarakat keilmuan. Atas pernyataan ini, saya siap menanggung risiko/sanksi apabila di kemudian hari ditemukan adanya pelanggaran etika keilmuan atau klaim dari pihak lain terhadap keaslian karya saya ini.

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KATA PENGANTAR

Puji syukur kehadirat Allah Subhanahu wa Ta'ala atas segala rahmat dan karunia-Nya sehingga penulis dapat menyelesaikan skripsi yang berjudul "Bioremediasi Logam Kromium Menggunakan Kombinasi Formula Konsorsium Bakteri *Bacillus licheniformis*, *Bacillus paralicheniformis*, dan *Brevibacillus borstelensis* secara *In vitro*", sebagai salah satu syarat untuk memperoleh gelar Sarjana Sains (S1) pada Program Studi Biologi, Fakultas Pendidikan Matematika dan Ilmu Pengetahuan Alam, Universitas Pendidikan Indonesia. Shalawat serta salam semoga senantiasa tercurah kepada Nabi Muhammad SAW, beserta keluarga, sahabat, dan seluruh umat beliau hingga akhir zaman.

Skripsi ini bertujuan untuk mengidentifikasi kombinasi spesies bakteri yang paling optimal dalam formula konsorsium sebagai agen bioremediasi logam krom pada limbah industri penyamakan kulit. Diharapkan hasil penelitian ini dapat memberikan kontribusi ilmiah dalam pengembangan strategi pengelolaan lingkungan berkelanjutan serta menjadi referensi dalam perancangan produk bioteknologi berbasis konsorsium bakteri resisten logam berat.

Penulis menyadari bahwa penyusunan skripsi ini masih jauh dari sempurna. Oleh karena itu, penulis sangat mengharapkan kritik dan saran yang membangun demi perbaikan di masa mendatang. Semoga skripsi ini dapat memberikan manfaat bagi semua pihak yang membutuhkan.

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UCAPAN TERIMA KASIH

Puji syukur penulis panjatkan kepada Allas SWT. atas karunia dan izin-Nya penulis dapat menyeselaikan segala bentuk proses penulisan skripsi dengan judul "Bioremediasi Logam Kromium Menggunakan Kombinasi Formula Konsorsium Bakteri *Bacillus licheniformis*, *Bacillus paralicheniformis*, dan *Brevibacillus borstelensis* secara *In vitro*". Penulis menyampaikan ucapan terima kasih kepada berbagai pihak yang secara langsung maupun tidak langsung berjasa dalam proses penyelesaian skripsi ini :

1. Bapak Dr. Wahyu Surakusumah, M.T. selaku dosen pembimbing I serta Ibu Dr. Hj. Diah Kusumawati, M.Si. selaku dosen pembimbing II yang senantiasa membimbing penulis melalui ilmu, nasihat, dan motivasi sehingga penulis dapat menyelesaikan segala bentuk proses pengerjaan skripsi.
2. Dewan Bimbingan Skripsi yaitu Ibu Dr, R. Kusdianti, M.Si. dan Ibu Dr. Any Aryani, M.Si. yang turut memberi informasi dan membimbing proses administrasi skripsi.
3. Ibu Dr. Any Aryani, M.Si. selaku pembimbing akademik penulis selama empat tahun menimba ilmu di Program Studi Biologi, Universitas Pendidikan Indonesia ini.
4. Ibu dan Bapak dosen penguji dan *reviewer* yang telah memberi masukan serta saran membangun kepada penulis, sehingga dapat menulis skripsi dengan lebih baik.
5. Ibu dan Bapak dosen Program Studi Biologi UPI yang telah memberikan ilmu kepada penulis selama menimba empat tahun menimba ilmu diperkuliahan.
6. Ibu dan Bapak PLP yang telah memberikan fasilitas selama perkuliahan, ucapan terima kasih khususnya untuk Bapak Rahadian Juansah, S.Pd. dan Bapak Try Kurniawan Muttaqien, S.Si.
7. Kepada mereka yang terlibat secara langsung dalam sebelum, saat, dan setelah pengambilan data penulis : Teh Nur Aziema, Salma Setia Nurhaliza beserta keluarga, Dendu Noutera, Dini Indriani, Hilda Nur Azizah dan Vino Bayu Christofan.

8. Kepada Ulya Salsa Maulidina yang dalam setiap doa, dukungan, dan semangatnya telah menjadi alasan penulis untuk tetap melangkah hingga akhir.
9. Kepada mereka yang telah terlibat secara tidak langsung namun memberikan dukungan moral, doa, dan suntikan semangat kepada penulis: Shiva Aulia Sari, Tulalit, dan Abdul Faqih Fajar Sidik beserta keluarga.
10. Kepada seluruh rekan BioChuaks 2021 seperjuangan yang telah bersama-sama menempuh perkuliahan dengan baik sejak awal hingga akhir perkuliahan terkhusus sahabat-sahabat "Pemancing", Abdul Faqih Fajar Sidik, Agung Huda Prasetyo, Azkaifa Syawqie Hardhaneszha, Fajri Khoirul Rizki, Fathan Ahmad Fadhil, Muhammad Iklil Nurfuad, Nendi Vedriadi, dan Vinno Bayu Christofan.
11. Kepada seluruh rekan ABC21 seperjuangan terkhusus laki-laki ABC21 yang telah bersama-sama menempuh perkuliahan di Prodi Biologi dan Pendidikan Biologi.
12. Kepada pihak lain yang telah terlibat dalam proses penulisan skripsi ini yang tidak dapat disebutkan satu-persatu.

Khusus kepada keluarga kecil yang selalu hadir memberikan dukungan penuh, baik secara moral maupun materi selama masa studi di Program Studi Biologi UPI. Meskipun penulis mungkin belum mahir mengungkapkan rasa cinta dan sayang secara langsung, namun melalui tulisan ini penulis ingin menyampaikan rasa syukur yang mendalam atas kehadiran Papa, Mama, Adik, Om, Tante, dan Atok dalam kehidupan penulis. Terima kasih telah menjadi sumber kekuatan dan semangat dalam setiap langkah.

ABSTRAK

Bioremediasi Logam Kromium Menggunakan Kombinasi Formula Konsorsium Bakteri *Bacillus licheniformis*, *Bacillus paralicheniformis*, dan *Brevibacillus borstelensis* secara *in vitro*

Industri penyamakan kulit umumnya menggunakan chromosal B sebagai bahan penyamak kulit yang mengandung logam krom, namun sebagian krom akan terbuang sebagai limbah yang mencemari lingkungan. Salah satu metode penanganannya adalah bioremediasi, di mana penggunaan konsorsium bakteri terbukti lebih efektif dibandingkan isolat tunggal. Penelitian ini bertujuan menentukan kombinasi spesies bakteri paling optimal dalam formula konsorsium sebagai agen bioremediasi logam krom. Bakteri diisolasi dari tanah rizosfer tumbuhan di sekitar bak limbah penyamakan wilayah Sukaregang, Kabupaten Garut. Seleksi dilakukan terhadap isolat yang menunjukkan resistensi tertinggi terhadap krom. Isolat terpilih kemudian diidentifikasi melalui uji morfologi, biokimia, dan analisis molekuler berbasis gen 16S rRNA. Berdasarkan analisis tersebut, diperoleh tiga spesies bakteri: *Bacillus licheniformis*, *Bacillus paralicheniformis*, dan *Brevibacillus borstelensis*. Konsorsium dibentuk berdasarkan uji kompatibilitas dan laju pertumbuhan yang menunjukkan interaksi sinergis antar spesies tanpa dominansi atau antagonisme. Uji efisiensi bioremoval menunjukkan bahwa kombinasi ketiga spesies menghasilkan efisiensi tertinggi sebesar 32,71% dalam inkubasi 14 jam. Spesies *B. licheniformis* dan *B. paralicheniformis* berperan dominan dalam proses bioremoval, sementara semua bakteri dalam konsorsium mampu bertahan dalam kondisi toksik logam krom. Temuan ini diharapkan dapat menjadi referensi ilmiah dalam mendukung pengembangan teknologi bioremediasi yang lebih spesifik dan aplikatif untuk menangani pencemaran logam krom, serta menjadi dasar pemanfaatan bakteri resisten sebagai agen bioremediasi pada limbah industri penyamakan kulit.

Kata Kunci: Bioremedisi, Konsorsium bakteri, Limbah Logam Krom, 16S rRNA, Efisiensi Bioremoval

ABSTRACT

Bioremediation of Chromium Using a Bacterial Consortium Composed of Bacillus licheniformis, Bacillus paralicheniformis, and Brevibacillus borstelensis In vitro

The leather tanning industry commonly uses chromosal B as a tanning agent containing chromium; however, part of this chromium is discharged as waste, polluting the environment. One remediation strategy is bioremediation, in which bacterial consortia have proven more effective than single isolates. This study aimed to determine the optimal combination of bacterial species in a consortium formulation for chromium bioremediation. Bacteria were isolated from rhizosphere soil near tanning wastewater ponds in Sukaregang, Garut Regency. Selection was based on isolates exhibiting the highest chromium resistance. Selected isolates were identified through morphological and biochemical tests, as well as 16S rRNA gene-based molecular analysis. Three species were obtained: Bacillus licheniformis, Bacillus paralicheniformis, and Brevibacillus borstelensis. Consortium formulation was guided by compatibility tests and growth rate assessments, revealing synergistic interactions without dominance or antagonism. Bioremoval tests showed that the three-species combination achieved the highest efficiency of 32.71% after 14 hours of incubation. B. licheniformis and B. paralicheniformis played dominant roles, while all species tolerated chromium toxicity with varying contributions. These findings may serve as a scientific reference for developing targeted and applicable bioremediation technologies to address heavy metal pollution. Furthermore, the study underscores the potential of metal-resistant bacteria as effective bioremediation agents and highlights the value of biochemical and molecular identification in assessing bacterial potential for treating industrial wastewater, particularly chromium-containing leather tanning effluent.

***Keywords**: Bioremediation, Bacterial consortium, Chromium Waste, 16S rRNA, Bioremoval Efficiency.*

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