

BIODEGRADASI LIMBAH PEWARNA TEKSTIL *CONGO RED* OLEH BAKTERI INDIGENOUS ASAL SEDIMEN MANGROVE TELUK BENOA

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ABSTRAK

Limbah cair tekstil mengandung pewarna azo *Congo Red* yang bersifat toksik dan sulit terdegradasi sehingga membutuhkan alternatif pengolahan yang efektif dan ramah lingkungan. Bakteri indigenous asal lingkungan tercemar berpotensi mendegradasi pewarna azo, namun potensi bakteri sedimen mangrove Teluk Benoa yang mengakumulasi limbah tekstil belum pernah dilaporkan. Penelitian ini bertujuan mengisolasi bakteri indigenous sedimen mangrove Teluk Benoa yang mampu mendegradasi *Congo Red*, serta mengevaluasi perbedaan kemampuan biodegradasi berdasarkan persentase penurunan konsentrasi. Penelitian eksploratif dan eksperimental dilakukan dengan isolasi, skrining, dan karakterisasi bakteri indigenous, uji biodegradasi menggunakan isolat dan konsorsium bakteri pada media yang mengandung *Congo Red*, serta analisis perubahan gugus fungsi dengan FTIR dan evaluasi toksisitas produk biodegradasi. Hasil isolasi dan skrining memperoleh 2 isolat potensial, yakni isolat BDG-L1 dan MTI-R1 dari sedimen mangrove Sungai Tukad Badung dan Sungai Tukad Mati, dengan karakteristik menyerupai *Bacillus* sp. dan *Enterobacter* sp. Isolat MTI-R1 memiliki persentase biodegradasi tertinggi (89,52%), disusul konsorsium BDG-L1 dan MTI-R1 (83,18%), dan isolat BDG-L1 (82,65%), sementara kontrol *Bacillus cereus* FNCC 0057 hanya mencapai 35,16%. Analisis FTIR menunjukkan hilangnya puncak gugus azo (N=N) pada 1556,97 – 1416,85 cm⁻¹ dalam spektrum produk biodegradasi oleh isolat MTI-R1, serta kromatogram LC-MS menunjukkan adanya metabolit intermediet benzidin, mengindikasikan terjadinya pemutusan gugus azo (N=N). Hasil uji toksisitas menunjukkan bahwa seluruh produk biodegradasi masih bersifat toksik terhadap benih ikan nila (*O. niloticus*), larva artemia (*A. salina*), dan kacang hijau (*V. radiata*), akibat terbentuknya metabolit intermediet toksik benzidin dari proses biodegradasi parsial. Bakteri indigenous sedimen mangrove Teluk Benoa, khususnya isolat MTI-R1 memiliki kemampuan dalam mendegradasi *Congo Red* melalui pemutusan ikatan azo, tetapi proses biodegradasi yang terjadi masih menghasilkan metabolit intermediet toksik.

Kata Kunci: Biodegradasi, bakteri indigenous, *Congo Red*, sedimen mangrove

BIODEGRADATION OF *CONGO RED* TEXTILE DYE WASTE BY INDIGENOUS BACTERIA FROM MANGROVE SEDIMENTS IN BENOA BAY

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ABSTRACT

Textile wastewater contains *azo dye Congo Red*, which is toxic and difficult to degrade, requiring effective and environmentally friendly treatment alternatives. Indigenous bacteria from contaminated environments have potential to degrade *azo dyes*, however biodegradation potential of bacteria isolated from Benoa Bay mangrove sediments which accumulated textile wastewater has not been reported. This study aimed to isolate indigenous bacteria from Benoa Bay mangrove sediments capable degrading *Congo Red* and evaluate differences in biodegradation capacity based on the percentage reduction in concentration. The explorative and experimental study involved isolation, screening, and characterization of indigenous bacterial isolates, biodegradation tests using bacterial isolates and consortia on media containing *Congo Red*, analysis of changes in functional groups using FTIR, and toxicity evaluation of biodegradation products. Isolation and screening process yielded 2 potential isolates, BDG-L1 and MTI-R1 from mangrove sediments in the Tukad Badung and Tukad Mati Rivers, with characteristics resembling to *Bacillus* sp. and *Enterobacter* sp. The MTI-R1 isolate exhibited highest biodegradation percentage (89.52%), followed by BDG-L1 and MTI-R1 consortium (83.18%), and isolate BDG-L1 (82.65%), whereas the *Bacillus cereus* FNCC 0057 achieved only 35.16%. FTIR analysis revealed the disappearance of the *azo (N=N)* group peak at 1556.97–1416.85 cm^{-1} in the spectrum of the biodegradation product produced by isolate MTI-R1, and the LC-MS chromatogram showed the presence of the intermediate metabolite benzidine, indicating the cleavage of the *azo (N=N)* group. Results of toxicity tests showed that all biodegradation products remained toxic to tilapia fry (*O. niloticus*), Artemia (*A. salina*) larvae, and mung beans (*V. radiata*), due to formation of toxic intermediate metabolite benzidine from partial biodegradation process. Indigenous bacteria from mangrove sediments of Benoa Bay, particularly MTI-R1 isolate, are capable of degrading *Congo Red* through the cleavage of *azo bonds*. However, the biodegradation process that occurs still produces toxic intermediate metabolites.

Keywords: Biodegradation, indigenous bacteria, *Congo Red*, mangrove sediment