

ABSTRAK
PERBANDINGAN EFEKTIVITAS BIOKOAGULAN BIJI KELOR
(Moringa oleifera) DALAM BENTUK SERBUK DAN EKSTRAK
CAIR TERHADAP PENURUNAN LIMBAH CAIR
INDUSTRI KARTON BOX

Industri karton box menghasilkan limbah cair yang mengandung padatan tersuspensi, bahan organik, residu perekat, dan sisa tinta yang menyebabkan tingginya kadar *Total Suspended Solids* (TSS), *turbidity*, dan *Chemical Oxygen Demand* (COD), sehingga berpotensi mencemari lingkungan apabila tidak diolah dengan baik. Penelitian ini bertujuan menganalisis karakteristik awal limbah cair industri karton box serta menentukan efektivitas biokoagulan biji kelor (*Moringa oleifera*) dalam bentuk serbuk dan ekstrak terhadap penurunan TSS, *turbidity*, COD, dan peningkatan pH menggunakan sistem *Jet Bubble Column*. Penelitian dilakukan dengan variasi dosis biokoagulan serbuk dan ekstrak masing-masing 1; 1,5; 3; dan 4,5 gram/mL serta waktu pengendapan 1–5 jam. Sampel limbah dihomogenisasi menggunakan *Jet Bubble Column* selama 2 menit, kemudian dilakukan proses koagulasi-flokulasi dan pengujian parameter. Karakteristik awal limbah menunjukkan nilai TSS 1.250 mg/L, *turbidity* 428 NTU, COD 987 mg/L, dan pH 6,61. Hasil terbaik biokoagulan serbuk diperoleh pada dosis 1,5 gram untuk TSS dan *turbidity* serta 3 gram untuk COD dan pH dengan efisiensi penurunan TSS 72%, *turbidity* 78%, COD 86%, dan peningkatan pH 6,20%. Sementara itu, biokoagulan ekstrak memberikan hasil terbaik pada dosis 3 mL dengan waktu pengendapan 3 jam, mampu menurunkan TSS 88%, *turbidity* 83%, COD 90%, serta meningkatkan pH menjadi 7,11. Dengan demikian, biokoagulan biji kelor efektif sebagai koagulan alami dalam pengolahan limbah cair industri karton box, dengan bentuk ekstrak yang menunjukkan kinerja yang lebih baik dibandingkan bentuk serbuk.

Kata kunci : biokoagulan, biji kelor (*Moringa oleifera*), limbah cair karton box, *jet bubble column*, TSS, *turbidity*, COD

ABSTRAC

COMPARATIVE OF MORINGA OLEIFERA SEED BIOCOAGULANTS IN POWDERED AND LIQUID EXTRACT FORMS ON THE REDUCTION OF WASTEWATER FROM THE BOX INDUSTRY

The cardboard box industry generates wastewater containing suspended solids, organic matter, adhesive residues, and ink remnants, which contribute to high levels of Total Suspended Solids (TSS), turbidity, and Chemical Oxygen Demand (COD), thereby posing a potential threat to the environment if not properly treated. This study aimed to analyze the initial characteristics of cardboard box industrial wastewater and determine the effectiveness of *Moringa oleifera* seed biocoagulants in powder and liquid extract forms for reducing TSS, turbidity, and COD, as well as increasing pH using a Jet Bubble Column system. The research was conducted using biocoagulant dosages of 1, 1.5, 3, and 4.5 g/mL for powder and extract forms, with settling times ranging from 1 to 5 hours. Wastewater samples were homogenized in a Jet Bubble Column for 2 minutes, followed by coagulation-flocculation and parameter analyses. The initial wastewater characteristics showed TSS, turbidity, COD, and pH values of 1,250 mg/L, 428 NTU, 987 mg/L, and 6.61, respectively. The best performance of the powdered biocoagulant was achieved at a dosage of 1.5 g for TSS and turbidity removal and 3 g for COD reduction and pH improvement, resulting in TSS, turbidity, and COD removal efficiencies of 72%, 78%, and 86%, respectively, with a pH increase of 6.20%. Meanwhile, the liquid extract biocoagulant showed the best results at a dosage of 3 mL with a settling time of 3 hours, achieving reductions of 88% for TSS, 83% for turbidity, and 90% for COD, while increasing the pH to 7.11. These findings indicate that *Moringa oleifera* seed biocoagulants are effective natural coagulants for treating cardboard box industrial wastewater, with the liquid extract form demonstrating superior performance compared to the powder form.

Keywords: Biocoagulant, *Moringa oleifera* Seeds, Cardboard Box Wastewater, Jet Bubble Column, Total Suspended Solids (TSS), Turbidity, Chemical Oxygen Demand (COD).