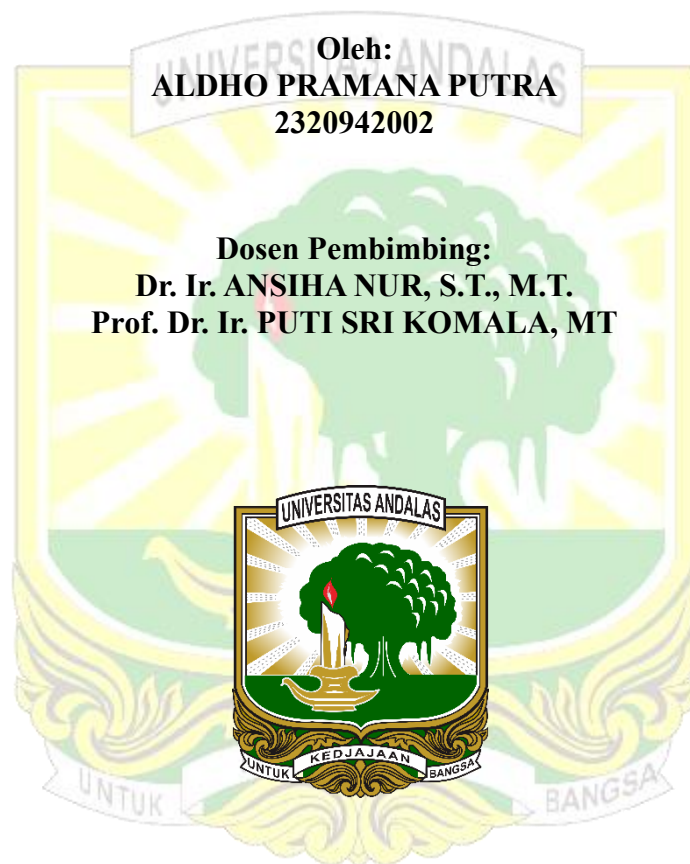


**ANALISIS EFEKTIVITAS EKOENZIM DARI LIMBAH
KULIT BUAH DALAM PENYISIHAN COD DAN BOD PADA
AIR DANAU ARTIFISIAL SECARA BATCH**

TESIS



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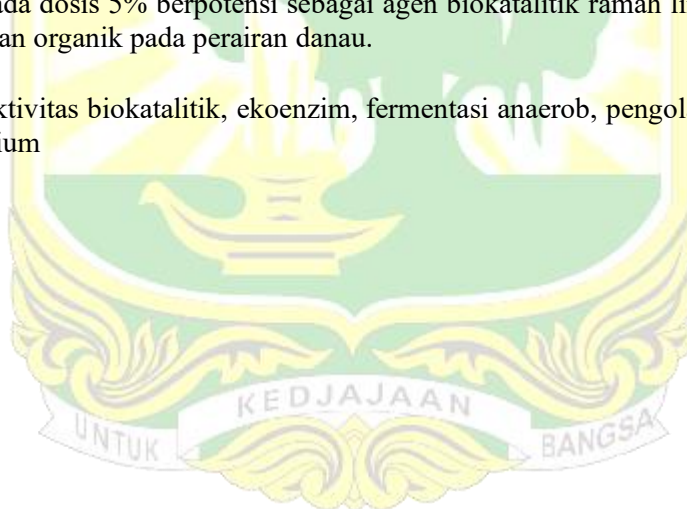
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ABSTRAK

Penurunan kualitas air danau akibat meningkatnya beban pencemar organik merupakan permasalahan lingkungan yang serius, terutama pada danau perkotaan yang menerima masukan air limbah domestik. Penelitian ini bertujuan menganalisis ekoenzim berbahan limbah kulit buah sebagai agen biokatalitik dalam penyisihan *Chemical Oxygen Demand* (COD) dan *Biochemical Oxygen Demand* (BOD) pada air danau artifisial. Air danau artifisial dibuat menggunakan glukosa sebagai sumber bahan organik, dengan konsentrasi yang disusun berdasarkan nilai COD Danau Cimpago sebesar 212 mg/L. Ekoenzim diproduksi dari limbah kulit pisang, jeruk, semangka, pepaya, nanas, dan campuran kelimanya dengan perbandingan 3:1:10 (kulit buah:molases:air) melalui fermentasi anaerob selama tiga bulan. Pengujian dilakukan secara duplo menggunakan reaktor batch 500 mL pada kondisi aerob skala laboratorium dengan variasi dosis ekoenzim 5%, 10%, dan 15% selama 12 hari. Parameter yang diamati meliputi pH, suhu, DO, COD, dan BOD, sedangkan aktivitas biokatalitik enzim amilase, lipase, dan protease hanya diuji pada ekoenzim hasil fermentasi. Data dianalisis menggunakan *One-Way* ANOVA dan model kinetika reaksi. Hasil menunjukkan bahwa ekoenzim kulit pepaya memiliki aktivitas amilase 0,521 U/mL, lipase 0,466 U/mL, dan protease 0,00695 U/mL serta memberikan kinerja penyisihan terbaik. Dosis optimum 5% mampu menurunkan COD dari 212 menjadi 60 mg/L (71,7%) dan BOD dari 21,2 menjadi 5,38 mg/L (74,6%). Analisis *One-Way* ANOVA menunjukkan perbedaan yang signifikan antarperlakuan ($p < 0,05$), sedangkan penyisihan COD dan BOD mengikuti model kinetika orde pertama dengan konstanta laju reaksi (k) 1,0037–1,0815 hari⁻¹ dan 0,8001–1,0387 hari⁻¹. Disimpulkan bahwa ekoenzim kulit pepaya pada dosis 5% berpotensi sebagai agen biokatalitik ramah lingkungan untuk penyisihan bahan organik pada perairan danau.

Kata kunci: aktivitas biokatalitik, ekoenzim, fermentasi anaerob, pengolahan air, reaktor skala laboratorium



ABSTRACT

The deterioration of lake water quality due to increasing organic pollutant loads has become a serious environmental issue, particularly in urban lakes receiving domestic wastewater inflows. This study aimed to evaluate the performance of fruit peel-derived eco-enzymes as biocatalytic agents for the removal of Chemical Oxygen Demand (COD) and Biochemical Oxygen Demand (BOD) from artificial lake water. The artificial lake water was prepared using glucose as the organic substrate, with its concentration adjusted to represent the COD concentration of Lake Cimpago (212 mg/L). Eco-enzymes were produced from banana, orange, watermelon, papaya, and pineapple peels, as well as a mixture of all five fruit peels, using a 3:1:10 ratio (fruit peels:molasses:water) through three months of anaerobic fermentation. Experiments were conducted in duplicate using laboratory-scale aerobic batch reactors 500 mL with eco-enzyme dosages of 5%, 10%, and 15% over a 12-day period. The monitored parameters included pH, temperature, dissolved oxygen (DO), COD, and BOD, while the biocatalytic activities of amylase, lipase, and protease were determined only for the fermented eco-enzymes. Data were analysed using one-way ANOVA and reaction kinetic models. The results showed that papaya peel eco-enzyme exhibited amylase, lipase, and protease activities of 0.521 U/mL, 0.466 U/mL, and 0.00695 U/mL, respectively, and achieved the highest removal performance. The optimum dosage of 5% reduced COD from 212 to 60 mg/L (71.7%) and BOD from 21.2 to 5.38 mg/L (74.6%). One-way ANOVA indicated significant differences among treatments ($p < 0.05$), while COD and BOD removal followed a first-order kinetic model with reaction rate constants (k) of $1.0037\text{--}1.0815\text{ day}^{-1}$ and $0.8001\text{--}1.0387\text{ day}^{-1}$, respectively. It was concluded that papaya peel eco-enzyme at a 5% dosage has the potential to serve as an environmentally friendly biocatalytic agent for the removal of organic matter from lake waters.system.

Keywords: anaerobic fermentation, Eco-enzymes , biocatalytic activity, laboratory-scale reactor, water treatment

