

## RINGKASAN

Proses pertambangan emas menghasilkan limbah yang mengandung logam berat seperti Hg, Cu, dan Pb. Logam tersebut dapat merusak ekosistem dan menurunkan kualitas tanah. Logam Cu bersifat toksik bagi organisme dan mengganggu proses biologis tanah, sehingga diperlukan perbaikan melalui bioremediasi menggunakan mikroorganisme. Bakteri nitrifikasi dipilih sebagai agen bioremediasi karena mampu memanfaatkan Cu pada tanah asam bekas tambang emas. Terdapat 9 isolat bakteri nitrifikasi (SA12, SA14, SA25, SA26, SA37, BA11, BA12, BA26, dan BA38). Namun, toleransi dan viabilitasnya terhadap Cu pada tanah asam bekas tambang emas belum diketahui. Penelitian ini bertujuan untuk mengetahui toleransi isolat bakteri nitrifikasi terhadap logam Cu, viabilitas isolat bakteri nitrifikasi pada tanah asam bekas tambang emas, dan kemampuan isolat bakteri nitrifikasi dalam mendegradasi logam Cu pada tanah asam bekas tambang emas.

Penelitian dilakukan menggunakan metode survei dan eksperimental. Metode survei dilakukan untuk mengetahui toleransi bakteri nitrifikasi terhadap logam Cu, sedangkan metode eksperimental dilakukan untuk mengetahui kemampuan isolat bakteri nitrifikasi terpilih dalam menurunkan konsentrasi logam Cu dan viabilitasnya pada tanah asam bekas tambang emas. Data toleransi bakteri nitrifikasi terhadap logam Cu dianalisis secara deskriptif. Data viabilitas isolat bakteri nitrifikasi pada tanah asam bekas tambang emas dan kemampuan isolat bakteri nitrifikasi dalam mendegradasi Cu dianalisis menggunakan *Analysis of Variance* (ANOVA) pada tingkat kepercayaan 95% dan 99%, dan dilanjutkan dengan uji Beda Nyata Jujur (BNJ) pada tingkat kepercayaan 95%. Karakteristik fenotipik isolat bakteri terpilih dianalisis secara deskriptif komparatif mengacu pada *Bergey's Manual of Determinative Bacteriology*.

Hasil penelitian menunjukkan bahwa isolat SA14, SA37, BA12, BA26, dan BA38 memiliki kemampuan toleransi logam Cu hingga konsentrasi 200 ppm. Viabilitas isolat SA14, SA37, dan BA26 pada tanah asam bekas tambang emas memiliki rerata sebesar 4,78, 5,08, dan 5,03 log CFU/mL pada medium *Nitrosomonas Agar*, serta sebesar 4,74, 4,70, dan 4,72 log CFU/mL pada medium *Nitrobacter Agar*, yang menunjukkan kemampuan adaptasi dan kelangsungan hidup isolat pada kondisi cekaman lingkungan. Isolat SA14 dan SA37 mampu menurunkan konsentrasi logam Cu pada tanah asam bekas tambang emas, dengan isolat SA37 menunjukkan penurunan tertinggi sebesar 20%.

**Kata Kunci:** *Bakteri nitrifikasi, bioremediasi, logam Cu, tanah tambang emas, viabilitas*

## SUMMARY

The gold mining process produces waste containing heavy metals such as Hg, Cu, and Pb. These metals can damage ecosystems and reduce soil quality. Cu is toxic to organisms and disrupts soil biological processes, requiring remediation through bioremediation using microorganisms. Nitrifying bacteria were selected as bioremediation agents because they are able to utilize Cu in acidic soil from former gold mines. There are nine nitrifying bacterial isolates (SA12, SA14, SA25, SA26, SA37, BA11, BA12, BA26, and BA38). However, their tolerance and viability to Cu in acidic soil from former gold mines are unknown. This study aims to determine the tolerance of nitrifying bacterial isolates to Cu metal, the viability of nitrifying bacterial isolates in acidic soil from former gold mines, and the ability of nitrifying bacterial isolates to degrade Cu metal in acidic soil from former gold mines.

The study was conducted using survey and experimental methods. The survey method was used to determine the tolerance of nitrifying bacteria to Cu metal, while the experimental method was used to determine the ability of selected nitrifying bacterial isolates to reduce Cu metal concentration and their viability in acidic soil from former gold mines. Data on the tolerance of nitrifying bacteria to Cu metal were analyzed descriptively. The data on the viability of nitrifying bacterial isolates in acidic soil from former gold mines and the ability of nitrifying bacterial isolates to degrade Cu were analyzed using Analysis of Variance (ANOVA) at a confidence level of 95% and 99%, followed by a Tukey Honestly Significant Difference (HSD) at a confidence level of 95%. The phenotypic characteristics of selected bacterial isolates were analyzed descriptively and comparatively with reference to Bergey's Manual of Determinative Bacteriology.

The results of the study indicate that isolates SA14, SA37, BA12, BA26, and BA38 have Cu metal tolerance up to a concentration of 200 ppm. The viability of isolates SA14, SA37, and BA26 in acidic soil from former gold mines has an average of 4.78, 5.08, and 5.03 log CFU/mL on Nitrosomonas Agar medium, and 4.74, 4.70, and 4.72 log CFU/mL on Nitrobacter Agar medium, indicating the adaptability and survival of the isolates under environmental stress conditions. Isolates SA14 and SA37 were able to reduce the concentration of Cu metal in acidic soil from former gold mines, with isolate SA37 showing the highest reduction of 20%.

**Keywords:** *Bioremediation, Cu metal, gold mining soil, nitrifying bacteria, viability*