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**Pengaruh Penambahan Asam Humat dan Nanosilika terhadap Recovery Logam Tanah Jarang dari Red Mud
menggunakan Imperata cylindrica**
Fazia Almas Nathifa, Prof. Himawan Tri Bayu Murti Petrus, S.T., M.E., D.Eng.; Ir. Agus Prasetya, M.Eng. Sc., Ph.D.
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INTISARI

Peningkatan produksi alumina menyebabkan akumulasi limbah *red mud* dalam jumlah besar yang umumnya disimpan pada kolam terbuka. Meskipun bersifat alkalis dan berisiko terhadap lingkungan, *red mud* mengandung logam tanah jarang dan logam strategis yang berpotensi dimanfaatkan. Namun, konsentrasinya yang rendah menyebabkan pemulihannya dengan metode konvensional kurang ekonomis. Penelitian ini bertujuan untuk mengevaluasi kemampuan *Imperata cylindrica* dalam merecovery logam dari *red mud* serta menganalisis pengaruh penambahan asam humat dan nanosilika terhadap pertumbuhan, biomassa, dan toleransi tanaman. Penelitian dilakukan pada skala polybag menggunakan media *red mud* 100% dengan variasi asam humat 1, 3, dan 5% serta nanosilika 5, 10, dan 15 mg. Pemanenan dilakukan pada hari ke-14 dan ke-28. Konsentrasi logam pada media, akar, dan daun dianalisis menggunakan ICP-OES, kemudian dievaluasi melalui BCF, TF, dan PE. Optimasi biomassa hari ke-14 dilakukan menggunakan Design-Expert.Hasil penelitian menunjukkan bahwa *Imperata cylindrica* mampu menyerap Ga, Nd, dan logam mayor dari media *red mud*, tetapi akumulasinya lebih dominan pada akar dibandingkan daun. Nilai BCF Ga >1 tetapi TF <1, sedangkan akumulasi dan translokasi Nd meningkat pada beberapa perlakuan setelah 28 hari. Pada logam mayor, Fe dan Al cenderung tertahan pada akar, sedangkan K lebih dominan pada daun. Penambahan asam humat dan nanosilika memengaruhi akumulasi logam dan pertumbuhan tanaman, tetapi responsnya tidak selalu linier. Hasil Design-Expert menunjukkan kondisi optimum pertumbuhan awal pada asam humat 5% dan nanosilika 5 mg, dengan prediksi biomassa 47,1708 g dan *desirability* 0,954. Biomassa aktual tertinggi juga diperoleh pada kombinasi tersebut, yaitu 48,4605 g. Dengan demikian, *Imperata cylindrica* berpotensi mengakumulasi logam tanah jarang dari media *red mud*.

Kata kunci: Asam humat, nanosilika, logam tanah jarang, *Imperata cylindrica*, *red mud*

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ABSTRACT

The increasing production of alumina has resulted in the accumulation of large quantities of red mud, which is commonly stored in open ponds. Although red mud is highly alkaline and poses environmental risks, it contains rare earth elements and strategic metals that have potential value. However, their low concentrations make recovery using conventional methods less economically feasible. This study aimed to evaluate the ability of Imperata cylindrica to recover metals from red mud and to analyze the effects of humic acid and nanosilica addition on plant growth, biomass, and tolerance. The experiment was conducted at the polybag scale using 100% red mud as the growing medium, with humic acid variations of 1, 3, and 5% and nanosilica variations of 5, 10, and 15 mg. Harvesting was carried out on days 14 and 28. Metal concentrations in the medium, roots, and leaves were analyzed using ICP-OES and evaluated using the Bioconcentration Factor (BCF), Translocation Factor (TF), and Process Efficiency (PE). Day-14 biomass optimization was performed using Design-Expert. The results showed that Imperata cylindrica was able to absorb Ga, Nd, and major metals from red mud, although their accumulation was more dominant in the roots than in the leaves. Ga exhibited BCF values greater than one but TF values below one, whereas Nd accumulation and translocation increased in several treatments after 28 days. Among the major metals, Fe and Al tended to be retained in the roots, whereas K was more dominantly accumulated in the leaves. The addition of humic acid and nanosilica affected metal accumulation and plant growth, although the responses were not always linear. Design-Expert analysis showed that the optimum condition for early plant growth was obtained with 5% humic acid and 5 mg nanosilica, resulting in a predicted biomass of 47.1708 g and a desirability value of 0.954. The highest actual biomass was also obtained under this combination, reaching 48.4605 g. Therefore, Imperata cylindrica shows potential for accumulating rare earth elements from red mud.

Keywords: *Humic acid, nanosilica, rare earth elements, Imperata cylindrica, red mud*