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Phytomining Logam Emas dari Tailing Tambang Emas Rakyat Menggunakan Tumbuhan Lokal

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ABSTRAK

Penelitian yang bertujuan untuk menkaji potensi L.crustacea, P.conjugatum, dan C.kyllingia untuk “phytomining” Hg dan Au di lakukan di laboratorium Universitas Brawijaya dan Universitas Mataram serta di lahan pertanian tercemar tailing tambang emas rakyat di Lombok Barat. Penelitian tahap pertama di lakukan di green house. Masing-masing bibit dari L.crustacea, P.conjugatum, dan C.kyllingia yang telah aklimatisasi selama 2 minggu ditumbuhkan selama 9 minggu pada 5 kg tailing. Amonium thiosulfat atau natrium sianida ditambahkan dalam bentuk larutan pada saat tanaman berumur 8 minggu dengan dosis 2g/kg untuk amonium thiosulfat dan 1g/kg natrium sianida. Pada saat panen (umur 9 minggu), tajuk dan akar di analisis konsentrasi Hg dan Au.

Hasil penelitian menunjukkan bahwa akumulasi merkuri tertinggi (30,09 ppm) dijumpai pada tajuk P.conjugatum dengan penambahan amonium thiosulfat. Secara rata-rata, penambahan amonium thiosulfat atau natrium sianida meningkatkan akumulasi Hg di tajuk sebesar 71% dan 48% dibandingkan dengan perlakuan tanpa penambahan bahan khelat. Penambahan amonium thiosulfat juga meningkatkan 19% akumulasi Hg dalam akar, penambahan natrium sianida meningkatkan 13% akumulasi Hg dibandingkan dengan perlakuan tanpa penambahan bahan khelat. Akumulasi Au tertinggi (859,8 ppb) dijumpai pada tajuk P. conjugatum dengan penambahan amonium thiosulfat. Pada akar, akumulasi Au tertinggi (64,7 ppb) juga dijumpai dalam akar P.conjugatum dengan penambahan amonium thisosulfat. Penambahan amonium thiosulfat atau natrium sianida meningkatkan akumulasi Au di tajuk sebesar 108% dan 34% dibandingkan dengan perlakuan tanpa penambahan bahan khelat. Penambahan amonium thiosulfat juga meningkatkan 78% akumulasi Au dalam akar, penambahan natrium sianida meningkatkan 50% akumulasi Au dibandingkan dengan perlakuan tanpa penambahan bahan khelat. Tahap kedua (tahun kedua) dari penelitian ini meliputi kegiatan (a) siklus kedua fitoekstraksi Hg dan Au oleh tiga species (percobaan di green house siklus kedua) dan (b) fitoekstraksi Hg dan Au oleh dua spesies terpilih (percobaan lapangan).

ABSTRACT

A study that was aimed to measure the potential of Lindernia crustacea, Paspalum conjugatum, and Cyperus kyllingia for phytomining of Hg and Au form soils contaminated with small-scale gold mining tailings Each seed of L.crustacea, P.conjugatum, and C.kyllingia which has grown acclimatization for 2 weeks for 9 weeks at 5 kg of tailings. Ammonium thiosulfate with a rate 2g/kg or sodium cyanide with a rate of 1g/kg was added when the plant reached 8 weeks old. At harvest (9 weeks), plant shoots and roots were analyzed Hg and Au contents. The results showed that the highest accumulation of Hg (30.09 ppm) was found in the shoot of P. conjugatum with the addition of ammonium thiosulfate. On average, the addition of ammonium thiosulfate or sodium cyanide increased the accumulation of Hg in the shoots by 71% and 48%, respectively, in comparison with the treatment without the addition of chelating agents. The addition of ammonium thiosulfate also increased 19% accumulation of Hg in the roots, and the addition of sodium cyanide increased accumulation of Hg by 13% compared to treatment without the addition of chelating agents. The highest accumulation of Au (859.8 ppb) found in the shoot of P. conjugatum with the addition of ammonium thiosulfate. In the roots, the highest accumulation of Au (64.7 ppb) found in the root P.conjugatum with the addition of ammonium thisosulfat. The addition of ammonium thiosulfate or sodium cyanide in increased the accumulation of Au in the shoots by 108% and 34%, respectively, compared to treatments without the addition of chelating agents. The addition of ammonium thiosulfate also increased 78% Au accumulation in the roots, while the addition of sodium cyanide increased 50% Au accumulation in the roots compared to treatments without the addition of chelating agent. The proposed second phase (second year) of this study includes (a) the second cycle of phytoextraction ofiHg and Au by the three species (second crycle green house experiment) and (b) phytoextraction of Hg and Au by two selected species selected (field experiment).

RINGKASAN

Pada berbagai pertambangan emas skala kecil di Indonesia, proses amalgamasi yang dikuti dengan proses sianidasi umumnya digunakan untuk memperoleh emas. Dalam proses ini merkuri yang tersisa dalam 'tailing' akan membentuk senyawa sianida-merkuri yang terlarut kedalam tanah dan air yang membahayakan lingkungan tanah dan air. Oleh karena itu perlu dilakukan upaya untuk mengelola tailing tersebut. Teknologi sederhana yang berbasis tanaman yang dapat memenuhi kebutuhan di atas adalah "phytomining', dimana kegiatan pertanian dan ekstraksi emas dapat diperoleh secara simultan. Kegiatan phytomining adalah menanam tanaman hiperakumulator pada limbah tambang logam berkadar rendah, dan kemudian memanennya dan membakar biomasnya untuk menghasilkan 'bioore' Hasil penelitian terdahulu menunjukkan bahwa Lindernia crustacea (L.) F., Paspalum conjugatum L., dan Cyperus kyllingia Endl.merupakan tiga spesies yang berpotensi untuk digunakan sebagai fitoremediator Hg pada lahan pertanian yang tercemar limbah tambang emas rakyat yang mengandung Hg. Karena Hg merupakan bahan utama yang banyak digunakan dalam proses penambangan emas rakyat, maka tumbuhan tersebut diharapkan juga mampu mengakumulasi emas. Tujuan penelitian ini adalah mengkaji potensi tiga spesies tumbuhan tersebut untuk "phytomining" melalui kajian pertumbuhan sebelum implementasi lapangan. Penelitian dilakukan selama dua tahap (dua tahun) di laboratorium Universitas Brawijaya dan Universitas Mataram serta di lahan pertanian tercemar limbah tambang emas rakyat di Lombok Barat.

Percobaan pot dilakukan di green house di lokasi lahan pembuangan tailing tambang emas proses sianidasi di Desa Sekotong Tengah, Kecamatan Sekotong, Kabupaten Lombok Barat. Penelitian dilakukan pada bulan April sampai dengan Nopember 2013. Masing-masing bibit dari L.crustacea, P.conjugatum, dan C.kyllingia yang telah diaklimatisasi selama 2 minggu ditumbuhkan selama 9 minggu pada 5 kg tailing. Untuk memaksimalkan pertumbuhan tanaman, semua tailing di dalam pot diberi pupuk phonska (setara 100 kg /ha). Untuk memacu serapan logam tersebut maka perlu ditambahkan bahan kimia, yaitu ammonium thiosulfat [$(NH_4)_2S_2O_3$] atau natrium sianida (NaCN). Berkaitan dengan hal di atas, maka dalam penelitian ini 3 species tumbuhan tersebut ditumbuhkan tanpa penambahan khelat dan dengan penambahan khelat amonium thiosulfat atau natrium sianida. Dengan demikian terdapat 9 perlakuan yang kemudian disusun dalam rancangan acak lengkap dengan 3 ulangan. Amonium thiosulfat atau natrium sianida ditambahkan dalam bentuk larutan 150 mL dengan dosis 2g/kg untuk amonium thiosulfat dan 1g/kg natrium sianida. Pada saat panen (umur 9 minggu), tajuk dan akar dipisahkan, di cuci, ditimbang, kemudian di keringkan selama 12 jam pada 70^0C untuk analisis kandungan Hg dan Au. Kandungan Hg dianalisis dengan menggunakan F732-S Cold Atomic absorption Mercury Vaporanalyzer (Shanhgai Huaguang Instrument Company). Kandungan Au ditetapkan dengan Graphite Furnace Analyzer yang dikombinasikan dengan Atomic Absorption

Shectophotometer, type AAnalyst 50, PerkinElmer, UK.

Hasil penelitian menunjukkan bahwa akumulasi merkuri tertinggi (30,09 ppm) dijumpai pada tajuk P. conjugatum dengan penambahan amonium thiosulfat. Angka ini melebihi nilai ambang batas konsentrasi merkuri dari 0,001% atau 10 mg/kg dari total berat kering. Secara rata-rata, penambahan amonium thiosulfat atau natrium sianida meningkatkan akumulasi Hg di tajuk sebesar 71% dan 48% dibandingkan dengan perlakuan tanpa penambahan bahan khelat. Penambahan amonium thiosulfat juga meningkatkan 19% akumulasi Hg dalam akar, penambahan natrium sianida meningkatkan 13% akumulasi Hg dibandingkan dengan perlakuan tanpa penambahan bahan khelat. Nilai TF (translocation factor), yaitu rasio akumulasi Hg dalam tajuk dengan Hg dalam akar pada tiga spesies tanaman menunjukkan bahwa semua tanaman memiliki nilai TF > 1 yang berarti bahwa tiga spesies tersebut dapat digunakan sebagai fitoekstraktor merkuri. Akumulasi Au tertinggi (859,8 ppb) dijumpai pada tajuk P. conjugatum dengan penambahan amonium thiosulfat. Pada akar, akumulasi Au tertinggi (64,7 ppb) dijumpai dalam akar P.conjugatum dengan penambahan amonium thisosulfat. Penambahan amonium thiosulfat atau natrium sianida meningkatkan akumulasi Au di tajuk sebesar 108% dan 34% dibandingkan dengan perlakuan tanpa penambahan bahan khelat. Penambahan

amonium thiosulfat juga meningkatkan 78% akumulasi Au dalam akar, penambahan natrium sianida meningkatkan 50% akumulasi Au dibandingkan dengan perlakuan tanpa penambahan bahan khelat.

Tahap kedua (tahun kedua) dari penelitian ini meliputi kegiatan (a) siklus kedua fitoekstraksi Hg dan Au oleh tiga species (percobaan di green house siklus kedua) dan (b) fitoekstraksi Hg dan Au oleh dua spesies terpilih (percobaan lapangan). Pada fitoekstraksi siklus kedua di green house, pot yang masih berisi media tanam setelah panen umur 9 minggu (siklus pertama) kemudian ditanami lagi L.crustacea, P.conjugatum, dan C.kyllingia untuk siklus kedua. Penanaman siklus kedua ini untuk memastikan serapan maksimum Hg dan Au dari media tailing. Prosedur pelaksanaan dan analisis sama dengan percobaan siklus pertama. Dua dari tiga spesies yang paling banyak mengakumulasi Hg dan Au akan digunakan untuk pengujian lebih lanjut, yaitu fitoekstraksi Hg dan Au oleh dua spesies terpilih (percobaan lapangan).Dua spesies tumbuhan terbaik (paling banyak menyerap Hg dan Au) hasil percobaan tahun 1, akan ditanam pada bak penampung tailing pada lokasi proses sianidasi. Plot / dam tailing tersebut dibuat dengan ukuran panjang 1 m, lebar 1 m, tinggi 40 cm yang beralaskan plastik polyethelen. Pada umur 8-9 minggu setelah tanam, ditambahkan 2g/kg amonium thiosulfat atau 1/g/kg natrium sianida d dalam bentuk larutan 150 mL. Pada saat panen (umur 10 minggu), tajuk dan akar tanaman di analisis kandungan Hg dan Au.

SUMMARY

In artisanal and small-scale gold mine area of Indonesia, gold is recovered through a two-stage process of amalgamation and cyanidation. In this process the mercury is left in the 'tailing' will form a cyanide-mercury compounds are dissolved into the soil and ground water and the water environment membayakan. Therefore, efforts should be made to manage the tailing. A simple plant-based technology that can meet the needs of the above is phytomining, where agriculture and extraction of gold can be obtained simultaneously. Phytomining is growing hiperakumulator plants on low-yield mining waste, and then harvest and burn the biomass to produce 'bio-ore' Results of previous studies show that Lindernia crustacea (L.) F., Paspalum conjugatum L., and Cyperus kyllingia Endl. were three species that have the potential to be used as Hg accumulators in farmland contaminated with gold mine tailing containing Hg. Because Hg is widely used in the small scale gold mining process, then the plant is also expected to accumulate gold. The purpose of this study was to measure the potential of the three plant species for phytomining of Hg and Au.

The study was conducted over two stages (two years) in the laboratory of UB and the University of Mataram and contaminated farm waste people's gold mine in West Lombok. A pot experiment was conducted in a green house built at the field site of gold mine tailings in the amalgamation process of Sekotong District of, West Lombok from April to November 2013. Each seed of L.crustacea, P.conjugatum, and C.kyllingia which was grown for 9 weeks at 5 kg of tailings. To maximize plant growth, all tailings in pots were fertilized with Phonska (equivalent to 100 kg / ha). To stimulate the uptake of Hg and Au ammonium thiosulfate [(NH4) 2S2O3] or sodium cyanide (NaCN) was added to each pot at 8 weeks after planting. Nine treatments were arranged in a completely randomized design with three replicates. Ammonium thiosulfate or sodium cyanide was added in the form of a solution of 150 mL at a dose of 2g/kg ammonium thiosulfate and of 1g/kg sodium cyanide. At harvest (9 weeks), plant shoots and roots were separated, washed, weighed, then dried for 12 hours at 70^0C for the analysis of Hg and Au contents. Hg concentration were analyzed using the F732-S Cold Atomic Absorption Mercury Vaporanalyzer (Shanhgai Huaguang Instrument Company). Au concentration was determined using a Graphite Furnace Au Analyzer combined with Atomic Absorption Shectophotometer, type AAnalyst 50, PerkinElmer, UK.

The results showed that the highest accumulation of mercury (30.09 ppm) was found in the shoot of P. conjugatum with the addition of ammonium thiosulfate. This figure exceeded the threshold value of mercury concentration of 0.001% or 10 mg / kg of total dry weight. On average, the addition of ammonium thiosulfate or sodium cyanide in increased the accumulation of Hg in the shoots by 71% and 48%, respectively, in comparison with the treatment without the addition of chelating agents. The addition of ammonium thiosulfate also increased 19% accumulation of Hg in the roots, and the addition

of sodium cyanide increased accumulation of Hg by 13% compared to treatment without the addition of chelating agents. The TF (translocation factor) value, which is the ratio of the accumulation of Hg in the shoot to Hg in the root in three plant species showed that all plants have the TF values> 1 indicating that the three spsesies can be used as Hg phytoextrators. The highest accumulation of Au (859.8 ppb) was found in the shoot of P. conjugatum with the addition of ammonium thiosulfate. At root, the highest accumulation of Au (64.7 ppb) was also found in the root of P.conjugatum with the addition of ammonium thisosulfat. The addition of ammonium thiosulfate or sodium cyanide increased the accumulation of Au in the shoots by 108% and 34%, respectively, compared to treatment without the addition of chelating agents. The addition of ammonium thiosulfate also increased 78% of Au accumulation in roots, while the addition of sodium cyanide increased 50% of Au accumulation compared to treatment without the addition of chelating agents.

The proposed second phase (second year) of this study includes (a) the second cycle of phytoextraction ofiHg and Au by the three species (second crycle green house experiment) and (b) phytoextraction of Hg and Au by two selected species selected (field experiment). In the second cycle of phytoextraction to be conducted in a green house, pots which still contains planting medium after harvest of 9 weeks (first cycle) are used for planting L.crustacea , P.conjugatum, and C.kyllingia for the second cycle. The second planting cycle is aimed to ensure maximum uptake of Hg and Au. Experimental procedures are similar to the first cycle experiment. Two of the three most abundant species in accumulating Hg and Au will be used for further phytoextraction measurements of Hg and Au in the field. Two of the best plant species, will planted in the tailing dam located at the location of the cyanidation process. A plot (1 m length, 1 m wide, 40 cm high) layered by polyethelen plastic will be prepered in the tailing dam for planting the selected two plant species. At the age of 8-9 weeks after planting, ammonium thiosulfate added 2g/kg or 1/g/kg sodium cyanide solution. At harvest (10 weeks), plant shoots and roots are subjected to Hg and Au anayses.

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