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Respons Anatomis dan Histokimia Chrysanthemum morifolium Ramat. Terhadap Perlakuan Limbah Cair Batik
Fiola Oktaweni, Dr. Dra. Maryani, M.Sc.
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RESPONS ANATOMIS DAN HISTOKIMIA *Chrysanthemum morifolium* Ramat. TERHADAP PERLAKUAN LIMBAH CAIR BATIK

INTISARI

Limbah cair batik dapat mengandung logam berat seperti aluminium (Al) yang jika konsentrasinya melebihi ambang batas membahayakan makhluk hidup. *Chrysanthemum morifolium* Ramat. merupakan agen fitoremediasi yang mampu beradaptasi terhadap cekaman logam berat melalui perubahan struktur anatomi dan produksi metabolit sekunder. Oleh karena itu, penelitian ini dilakukan untuk menganalisis respons anatomis, histokimia dan kemampuan *C. morifolium* Ramat. dalam mengakumulasi logam berat dari limbah cair pewarnaan batik. *C. morifolium* Ramat. ditanam pada media tanah dan organik siap pakai (1:1) dengan perlakuan konsentrasi limbah cair pewarnaan batik 0% sebagai kontrol negatif, 25%, 50%, 75%, 100% dan larutan Al ($AlCl_3$) 50 ppm sebagai kontrol positif. Data kuantitatif anatomis, pertumbuhan akar, batang dan daun serta akumulasi logam berat dianalisis menggunakan SPSS One Way ANOVA dengan uji Duncan taraf kepercayaan 95% sedangkan data kualitatif morfologi dan distribusi metabolit sekunder pada akar, batang dan daun dianalisis secara deskriptif. Hasil penelitian menunjukkan perlakuan limbah cair pewarnaan batik 100% dan larutan Al 50 ppm menghambat pertumbuhan krisan meliputi tinggi tanaman, jumlah daun segar, panjang akar, berat basah dan berat kering akar serta tajuk. Penurunan parameter anatomis pangkal dan ujung akar dengan peningkatan ketebalan dinding xilem dan periderm pangkal akar. Perlakuan yang sama pada batang menyebabkan penurunan ketebalan epidermis, korteks, stele dan berkas pengangkut diserta peningkatan ketebalan dinding xilem. Pada daun perlakuan yang sama juga menyebabkan penurunan diameter costa, luas berkas pengangkut, jumlah trakea, ketebalan epidermis abaksial dan adaksial, mesofil, densitas dan lebar bukaan stomata serta densitas trikoma pada permukaan abaksial dan adaksial. Perlakuan limbah cair pewarnaan batik 100% dan larutan Al 50 ppm meningkatkan terpenoid, flavonoid, alkaloid pada xilem akar, batang dan daun, trikoma dan sklerenkim batang serta trikoma dan floem pada daun, alkaloid terdistribusi pada periderm akar, epidermis dan mesofil daun, serta lignin pada xilem di tiga organ. Nilai *Bioconcentration Factor* (BCF) akar lebih besar dari daun dengan nilai *Translocation Factor* (TF) kecil dari 1 menunjukkan tanaman cenderung melakukan fitostabilisasi.

Kata Kunci: Anatomi, *Chrysanthemum morifolium* Ramat., Fitoremediasi, Limbah Tekstil, Morfologi

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ANATOMICAL AND HISTOCHEMICAL RESPONSE of *Chrysanthemum morifolium* Ramat. to BATIK LIQUID WASTE TREATMENT

ABSTRACT

Batik liquid waste may contain heavy metals such as aluminium (Al), which at concentrations exceeding the threshold can be harmful to living organisms. *Chrysanthemum morifolium* Ramat. is a phytoremediation agent capable of adapting to heavy metal stress through changes in anatomical structure and the production of secondary metabolites. This study was conducted to analyze the anatomical, histochemical responses and the ability of *C. morifolium* Ramat. to accumulate heavy metals from batik dyeing wastewater. *C. morifolium* Ramat. was planted in soil and organic matter medium (1:1) with batik dyeing wastewater at concentrations of 0% as a negative control, 25%, 50%, 75%, 100%, and Al solution ($AlCl_3$) at 50 ppm as a positive control. Quantitative data on anatomical, physiological of root, stem, and leaf growth, as well as heavy metal accumulation, were analyzed using SPSS One Way ANOVA Duncan's test at a 95% confidence. Qualitative data on morphology and secondary metabolites distribution in organs were analyzed descriptively. The results showed 100% batik dyeing wastewater and 50 ppm Al solution treatment inhibited chrysanthemum growth, including plant height, number of fresh leaves, root length, fresh and dry weights of roots and shoots. There reduced base dan tip root anatomical parameters with an increase in xylem wall thickness and periderm. The same treatments on stems caused a reduction in the thickness of the epidermis, cortex, stele, and vascular bundles, along with an increase in xylem wall thickness. In leaves, the same treatments also resulted in a decrease in costa diameter, vascular bundle area, number of tracheae, abaxial and adaxial epidermis thickness, mesophyll thickness, stomatal density and aperture width, as well as trichome density on both abaxial and adaxial surfaces. The 100% batik dyeing wastewater and 50 ppm Al solution treatments increased terpenoid, flavonoid, and alkaloid contents in the root, stem, and leaf xylem, stem trichomes and sclerenchyma, as well as trichomes and phloem in leaves; alkaloids were distributed in the root periderm and leaf epidermis and mesophyll, while lignin was found in the xylem of all three organs. The Bioconcentration Factor (BCF) value for roots was higher than that for leaves, with a Translocation Factor (TF) value of less than 1, indicating that the plant tends to perform phytostabilization.

Keywords: Anatomy, *Chrysanthemum morifolium* Ramat., Phytoremediation, Textile Waste, Morphology