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**Heavy metals determination in tea and its removal utilising cattails, typha spp**

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## ABSTRACT

In this work, dried *Typha angustifolia* (TA) leaves also known as the common cattail were used as an adsorbent in Pb(II) adsorption in synthetic aqueous solutions. Adsorption studies were conducted in batch mode. Batch adsorption studies using TA were conducted and proved to be able to adsorb Pb(II) effectively with the optimized dosage of 0.6g. Adsorption equilibrium was achieved within 8 hours with an effective removal percentage of 86.04%. Adsorption kinetics was further evaluated using four kinetic models such as the pseudo-first order, pseudo-second order, intraparticle diffusion and Elovich model. Fitting of the data were done based on linear regression analysis. The sorption kinetic data fitted best to the pseudo-second order model with an  $R^2$  of 0.9979 followed closely by the Elovich model with an  $R^2$  of 0.9952. For the isotherm studies, the adsorption system fitted the Langmuir model best as compared to the Freundlich, Temkin and D-R model. The  $R^2$  achieved for the Langmuir model was 0.9903. The maximum adsorption capacity calculated from the Langmuir model was 51.02 mg/g with a maximum removal after 24 hours at 89%. This proves that adsorption occurred via monolayer coverage of the adsorbate at the outer layer of the adsorbent. The optimized adsorption conditions were then applied to tea infusion that has been initially spiked with a fixed concentration of lead. Three types of brands of teas were used which were Lipton, Boh and Sabah tea. In all 3 brands, the concentration of lead found was below 0.2 mg/g. Each brand was then spiked with different concentrations of lead to investigate the effects of the presence of caffeine in tea towards the adsorption performance of the leaves. It was found that the adsorption performance of the leaves increased with increasing amounts of lead in the tea infusion which was contrary to in distilled water. The percentage of removal achieved in tea infusion was 38.22% (Lipton), 36.23% (Boh) and 29.86% (Sabah tea) as compared to water at 6% for 1000 mg/L of lead. From the study, dried *Typha angustifolia* successfully adsorbed lead in both water and tea infusion with the performance improving in the presence of tea.

## ABSTRAK

Dalam kajian ini, daun kering *Typha angustifolia* (TA) digunakan untuk menyerap ion Pb(II) dalam larutan akues sintetik. Kajian penyerapan dijalankan dalam mod pukal. Kajian penyerapan dengan menggunakan TA membuktikan bahawa ion Pb dapat diserap dengan menggunakan jisim optimum daun sebanyak 0.6 g. Proses penyerapan mencapai keseimbangan dalam 8 jam dengan peratus penyingkiran 86.04%. Kinetik penyerapan dinilai berdasarkan beberapa model iaitu tertib pseudo-kedua, tertib pseudo-pertama, 'intraparticle diffusion' dan model Elovich. Kesesuaian data diuji dengan menggunakan model regresi linear. Data kinetik penyerapan lebih mematuhi model kadar tertib pseudo-kedua dengan nilai  $R^2$  0.9979 diikuti oleh model Elovich dengan  $R^2$  0.9952. Untuk kajian isoterma penyerapan, sistem penyerapan didapati lebih mematuhi model Langmuir jika dibandingkan dengan model penyerapan Freundlich, Temkin dan D-R. Nilai  $R^2$  yang dicapai untuk model isoterma Langmuir ialah 0.9903. Muatan maksimum penyerapan yang dihitung berdasarkan model Langmuir ialah 51.02 mg/g dengan penyingkiran maksimum sebanyak 89% selepas 24 jam. Ini membuktikan bahawa penyerapan monolapisan berlaku oleh bahan terjerap ke atas lapisan luar bahan penyerap. Keadaan penyerapan yang telah dioptimumkan diaplikasikan dalam air bancuhan teh yang telah dipaku dengan kepekatan larutan plumbum tertentu. Kepekatan plumbum yang didapati dalam setiap sampel teh yang digunakan adalah dibawah 0.2 mg/g. Setiap jenama teh yang digunakan kemudiannya dipaku dengan kepekatan plumbum yang ditentukan untuk menguji kesan kehadiran kafein dalam teh terhadap keberkesanan penyerapan daun. Kajian mendapati bahawa prestasi penyerapan daun bertambah dengan kepekatan larutan plumbum yang digunakan dalam air teh yang bertentangan dengan prestasi daun dalam air suling. Peratus penyingkiran dalam air teh ialah 38.22% (Lipton), 36.23% (Boh) dan 29.86% (Sabah tea) jika dibandingkan dengan 6% untuk larutan plumbum berkepekatan 1000 mg/L. Berdasarkan kajian ini, daun kering *Typha angustifolia* berjaya menyerap plumbum dalam air dan air teh dengan keberkesannya bertambah dalam kehadiran air teh.