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RESEARCH ARTICLE

Application of central composite design for optimization of the removal of humic substances using coconut copra

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Abstract Coconut copra is a potential biosorbent for removal of humic substances from peat swamp runoff. In this paper, response surface methodology was applied to evaluate the optimum conditions for removal of humic substances from peat swamp runoff using modified coconut copra. Batch adsorption experiments were conducted according to central composite design. Results show that the quadratic model is best fitted for predicting the removal efficiency with regression coefficients closer to 1 and a lower root mean square error. Dosage is found to have significant influence on the removal efficiency with $p < 0.05$. Response surface models further identified the optimum dosage, contact time and temperature at 4.56 g modified coconut copra per 100 mL peat swamp runoff, 42.9 min and 56.8 °C/329°K, respectively attaining the maximum removal efficiency of 88.19 %. The predicted removal efficiency was confirmed experimentally under the modelled optimum conditions; the removal efficiency attained (86.54 %) was in good agreement with the predicted value.

Keywords Biosorbent · Coconut copra · Central composite design · Humic substances · Response surface methodology

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Introduction

Humic substances are the products of biological and chemical decomposition of living organisms. They are found in abundance in black water and swampy areas, causing dark brown and yellowish colour in water. The presence of humic substances in water can have a significant impact on the treatability of the water and the efficiency of chemical disinfection process. They are believed to be the precursors to the formation of carcinogenic disinfection by-products. A previous study revealed that water tainted by peat swamp leachate contained a higher quantity of trihalomethanes compared to water from non-peat water sources [1].

In the conventional water treatment system, humic substances are removed using the coagulation and flocculation approach [2–4] requiring excess amount of coagulant and are generally limited by high operational and material costs. Other adsorbents such as activated carbon, zeolite, and mesoporous silica have also been employed for isolation of humic substances but these adsorbents are very expensive. Considering the cost and huge quantity of water treated, these adsorbents are less attractive. Biosorption is an alternative gaining increasing attention for its advantages of low cost and abundant availability. Sim et al. [5, 6] examined the adsorption ability of a spectrum of agricultural biomass in removing humic substances, and reported coconut copra with promising adsorption capacity. The biomass is relatively richer in carboxyl functional groups. The untreated coconut copra was evidenced to remove an average of 50 % of humic substances from peat swamp runoff, higher than other selected biomasses including banana trunk, coconut husk, empty fruit bunch, groundnut shell, rice husk, sago waste, saw dust and sugarcane bagasse with removal efficiency ranging between 11 and 40 %, based on the spectrophotometric approach. Upon