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Utilization of bivalve shell-treated *Zea mays* L. (maize) husk leaf as a low-cost biosorbent for enhanced adsorption of malachite green

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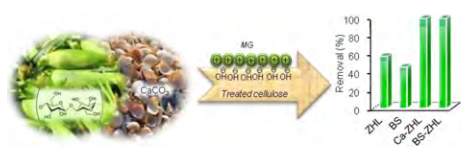
HIGHLIGHTS

- ▶ A low cost bivalve shell treated *zea mays* L. husk leaf biosorbent was developed.
- ▶ BS acts as a strong alkali pretreatment agent for ZHL.
- ▶ BS-ZHL enhanced the malachite green adsorption up to 81.5 mg g^{-1} (q_{max}).
- ▶ The experimental data agrees with the Langmuir isotherm model.
- ▶ The adsorption was controlled by the physisorption process.

GRAPHICAL ABSTRACT



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ABSTRACT

In this work, two low-cost wastes, bivalve shell (BS) and *Zea mays* L. husk leaf (ZHL), were investigated to adsorb malachite green (MG) from aqueous solutions. The ZHL was treated with calcined BS to give the BS-ZHL, and its ability to adsorb MG was compared with untreated ZHL, calcined BS and $Ca(OH)_2$-treated ZHL under several different conditions: pH (2–8), adsorbent dosage (0.25–2.5 g L^{-1}), contact time (10–30 min), initial MG concentration (10–200 mg L^{-1}) and temperature (303–323 K). The equilibrium studies indicated that the experimental data were in agreement with the Langmuir isotherm model. The use of 2.5 g L^{-1} BS-ZHL resulted in the nearly complete removal of 200 mg L^{-1} of MG with a maximum adsorption capacity of 81.5 mg g^{-1} after 30 min of contact time at pH 6 and 323 K. The results indicated that the BS-ZHL can be used to effectively remove MG from aqueous media.

1. Introduction

There is a growing recognition that malachite green (MG) should be removed from effluents to protect water resources because MG potentially has harmful effects on the liver, gills, kidneys, intestines and gonads of organisms (Daneshvar et al., 2007). Among the existing physical, chemical and biological methods, adsorption is the most commonly used method to remove dyes from water because adsorption is low cost, has a simple design, is easy to perform, is insensitive to toxic substances and can completely remove dyes, even from dilute solutions (Bingöl et al., 2012). Adsorption onto activated carbon, the most popular technique, has been used with great success. However, adsorbent-grade activated carbon is expensive, and the regeneration of activated carbon for reuse increases the cost (Gong et al., 2009). Therefore, there is growing interest in identifying more low-cost and effective alternatives to activated carbon, such as agro-industry waste (Abidin et al., 2011; Rahman et al., 2005), algae (Dotto et al., 2012), zeolite (Han et al., 2010) and sludge (Ong et al., 2010). However, the adsorption capacities of most of the

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