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Artificial Neural Network Modeling of Biosorptive Removal of Arsenic(V) by a Low-cost Biomass

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Abstract

The presence of arsenic in drinking water has been recognized as a serious community health problem because of their toxic nature and therefore, its removal is highly essential. This paper deals with batch biosorption study for the removal of pentavalent arsenic ions from aqueous solutions using finely ground (250 µm) *Azadirachta indica* (neem) bark powder (AiBP) as a low-cost biosorbent. Employing the batch experimental setup, the effect of operational variables such as initial concentration of As(V), pH, biosorbent dose, contact time, temperature and agitation speed on the As(V) removal process were studied. Under optimized batch conditions, the AiBP could remove up to 86.6% of As(V) from contaminated water. The biosorbent dose had the most significant impact on the biosorption process. The artificial neural network (ANN) model developed from batch experimental data sets, provided reasonable predictive performance (R^2 = 0.951; 0.967) of arsenic biosorption. The study on equilibrium biosorption of batch operation revealed that Freundlich isotherm model gave the best fit to experimental data. The nature of biosorption of As(V) by AiBP was physisorption as inferred from the D–R isotherm model. The biosorption is pseudo second–order, exothermic and spontaneous.

Abbreviations

AiBP: *Azadirachta indica* bark powder;
ANN: artificial neural network;
D–R: Dubinin–Radushkevich;
SDDC: silver diethyl dithiocarbamate;
SEM: scanning electron microscopy.

1. Introduction

Groundwater enriched with arsenic in the form of arsenate [As(V)] and arsenite [As(III)] has emerged as a major concern on a global scale [1–6]. Exposure to arsenic through drinking water sourced from groundwater [1,2,7] poses a serious health hazards in several developing regions [2,8]. As high as, the WHO provisional guideline of 10 µg/L of arsenic in drinking water is now recognized as a worldwide problem in many countries, especially in the Southeast of Asia, including India, Bangladesh, and China [1,3]. A largest segment of population currently is at risk in the Bengal Basin area of Bangladesh and West Bengal in India [4,9,10]; however, it is remarkable that these two countries have retained the earlier WHO guideline of 50 µg/L as their standard of arsenic in drinking water [11,12]. About 70 million people are suffering from arsenic problem alone in these regions; this is perhaps the largest poisoning in world's history [13,14]. Today, in West Bengal, the arsenic contamination in groundwater, and eventually in drinking water, has been reported in the range from 50 to 3600 µg/L, with predominance of As(V) [9,10,15], over 111 blocks in 12 districts of the state [8,16]; affecting more than 34 million people [15]. Thus, the removal of As(V) from drinking water has received significant attention and major concern to many water utilities and governmental agencies.