Development of water lettuce (*Pistia* spp.) based biochar filter for the treatment of industrial wastewater: a green approach

K. M. P. I. Jayathilake[1,2], P. M. Manage[1] and F. S. Idroos[1,*]

[1]Centre for Water Quality and Algae Research, Department of Zoology, University of Sri Jayewardenepura, 10250, Sri Lanka
[2]Faculty of Graduate Studies, University of Sri Jayewardenepura, 10250, Sri Lanka

Biochar (BC) is a viable wastewater treatment agent. Water lettuce (*Pistia* spp.) an invasive aquatic plant in Sri Lanka has been used in this study to produce BC by pyrolysis. Industrial water was filtered through activated and non-activated BC samples having 65–125 mm and 125–250 mm particle sizes. Filter with sand and gravel served as standard for comparison. The filter unit containing activated BC showed higher treatment efficiency. pH was reduced from 8.72 ± 0.01 to 6.87 ± 0.01; biological oxygen demand (BOD_5) from 57 ± 1.73 to 15.67 ± 1.15 ppm; chemical oxygen demand (COD) from 512 to 128 ppm, total Kjeldahl nitrogen (TKN) from 158.67 ± 2.89 ppm to 33 ppm, ammoniacal nitrogen from 22.63 to 3.13 ± 0.01 ppm; chromium from 0.0625 to 0.0245 ppm, and zinc from 0.9886 to 0.2105 ppm. Optimization study revealed that the BC integrated filter units could be used to treat wastewater in three cycles. Thereafter their efficiency is reduced. The BCs with small particle size (65–125 mm) recorded the highest treatment efficiency. This particle size showed 99.72% turbidity reduction. Reduction of total phosphate, ammoniacal nitrogen, total suspended solids, COD, nitrate, BOD_5 and TKN was recorded as 97.82%, 91.49%, 88.38%, 88.18%, 87.44%, 84.38% and 84.38% respectively. BC derived from *Pistia* spp. has proven to be promising adsorbent for wastewater treatment. Findings of the study show a long-term green wastewater treatment method that makes effective use of an invasive aquatic plant.

Keywords: Biochar, *Pistia* spp., wastewater, water quality parameters.

produced from different biomasses[8]. Its manufacturing relies on the thermal breakdown of organic matter. For BC production, pyrolysis is usually carried out at temperatures between 300°C and 500°C (ref. 9). Relative yield of BC by pyrolysis is determined by operating parameters such as time, heating rate, temperature, nitrogen flow, and so on[10]. Type of biomass feedstock and its water content substantially influence the structure and properties of BC and their adsorption capacity[10]. Several chemical, physical, and molecular changes occur during pyrolysis that influence the adsorption and immobilization of the target pollutants by the BC[11]. Adsorption is influenced by the surface area, porosity, surface charge, functional groups and mineral content of the BC[12]. BC is effective as a filter medium to treat wastewater and is getting popular with unique physical and chemical properties[13–15]. When compared with conventional soil and sand filtration systems, BC filtration systems show improved treatment efficiency and minimize the spread of contamination from hazardous chemicals in the effluents[13,16].

BC engineering is the process of producing activated or modified forms of BC[17]. Activation of BC improves its physical and chemical properties which leads to improve the absorption capacity of BC. Chemical activation is a heat treatment method in which BC combines with a chemical activating substance at temperatures between 450°C and 900°C (ref. 18). Chemical activation agents include zinc chloride ($ZnCl_2$), sulphuric acid (H_2SO_4), phosphoric acid (H_3PO_4) and potassium hydroxide (KOH)[19,20]. Chemical activation has many advantages over physical activation, including a larger surface area, lower temperature,