Removal of Hg in single- and multi-component systems by agricultural wastes

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1. Introduction – The contamination of water is a worldwide concern due to the harmful effects on the environment and human health. Hazardous substances like arsenic, cadmium, lead and mercury are easily bioaccumulated in the organism's tissues and amplified along the food chain. Among the available separation techniques, sorption is the most applied to remove contaminants from aqueous streams, since it is eco-friendly and cost-effective, allowing to use an immense variety of sorbents. Agricultural wastes, largely available, are mainly composed by lignin and cellulose that contain functional groups with capability to bind different contaminants in solution [1]. Several studies have considered them as biosorbents of metals and metalloids. Nevertheless, most of them evaluate the biosorbent performance in single-component systems that are far away from real wastewaters. Although they are important to determine the capacity of the biosorbent, more complex solutions are required to a correct assessment of the efficiency under competitive effect. Here, three different biosorbents, produced from eggshells, banana and potato peels, were tested in the removal of Hg in single- and multi-component systems (containing As, Cd and Pb) in realistic low concentration, 50 µg L^{-1}.

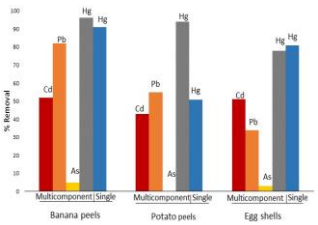

Image 1 Removal efficiencies

2. Experimental – Batch experiments were carried out at temperature of 295±1K and water pH of 6.3. Single-component solutions of Hg (50 µg L^{-1}) and multi-component solutions of Hg, Cd, Pb and As (50 µg L^{-1}) were prepared by fortifying natural waters with elemental commercial stock solutions (1000 mg L^{-1}). A biosorbent mass of 0.5 g L^{-1} was used, and solutions were magnetically stirred at 800 rpm.

3. Results and Discussion – Image 1 shows the biosorbents removal efficiency. Considering the multi-component system, the selectivity followed the order Hg>Cd>Pb>>As. According to the chemical speciation, at the pH studied, As is mostly present in anionic form, which probably explains the lack of removal. Hg removal by banana peels and egg shells was not affected by the presence of competitive elements, highlighting the high uptake ability and affinity toward Hg. Furthermore, the presence of more elements enhanced Hg elimination by potato peels, pointing to a synergistic effect in the sorption. Such behaviour might be ascribed to the rise of the concentration gradient between solution and biosorbent, resulting in a higher driving force that promotes metal removal. In terms of performance, banana peels achieved the lowest residual concentrations, being able to remove more than 90% of Hg in both systems.

4. Conclusions – Despite the competitive effect, all the biosorbents displayed higher selectivity for Hg and were able to reduce the content of the remaining elements (except As). This demonstrates that agricultural wastes can be valued as promising alternatives for a successful water remediation.

5. References – [1] A. Bhantnagar, M. Sillanpää, A. Witek-Krowiak, Chemical Engineering Journal **270**, (2015) p. 244-271.8.