Screening of biological and non-biological materials for the biosorption of proteins

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Introduction

The adsorption of proteins on naturally occurring adsorbents were studied to evaluate the potential recovery of proteins from meat industry wastewaters. Spent peppermint tea (PM), powdered purple corn cob (PC), natural clay (NC) and chemically modified clay (MC) were investigated to elucidate the effects of pH, adsorbent dose, initial protein concentration, and desorption. Bovine serum albumin (BSA) and human hemoglobin (Hb) were investigated as model proteins.

Adsorption experiments

Triplicated batch adsorption experiments were carried out at room temperature by mixing an accurately weighed amount of the adsorbents with BSA and Hb solutions of known concentration in polyethylene tubes.

Preparation of the adsorbents

- PM and PC were obtained from local markets. PM and PC were rinsed with boiling hot water and deionized water, respectively, to extract colors and flavors. Pretreatment by Soxhlet extraction was necessary for both to remove any other dyes and impurities.
- Both adsorbents were oven-dried overnight at 50 degrees. PM and PC were sieved to a particle diameter between 100-200 micrometers and kept in plastic containers.
- Both natural (NC) and modified (MC) clays were purchased from Sigma-Aldrich and used without further treatment.

Effect of pH

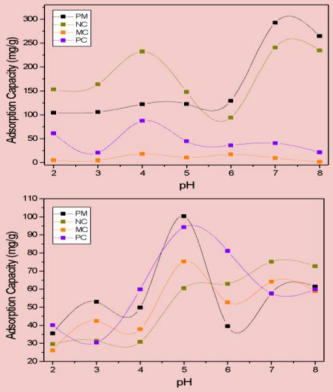

Figure 1: pH effect on the adsorption of BSA (top) and Hb (bottom) with biological and non-biological adsorbents

Effect of Adsorbent Dose

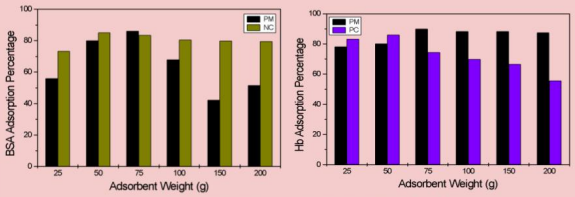

Figure 2: Effect of adsorbent mass on the adsorption of BSA (left) and Hb(right).

Desorption Studies

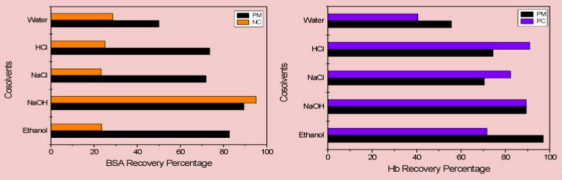

Figure 3: Desorption of BSA (left) and Hb (right) from the adsorbents by cosolvents.

Characterization of Adsorbents

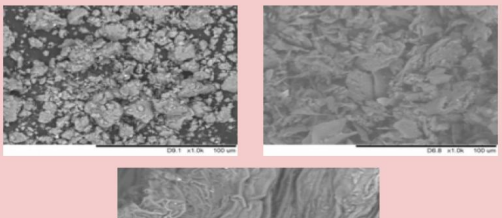

Figure 4: Scanning electron microscopy (SEM) at different magnification for the adsorbents: Natural Clay (left), Purple corn (right), and Peppermint (bottom).

Effect of Concentration

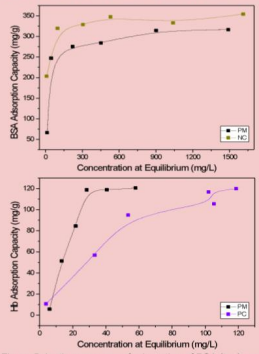

Figure 5: Isotherm curves of adsorption of BSA (top) and Hb (bottom) proteins.

Conclusions

- Adsorbents such as spent peppermint tea (PM), ground purple corn cob (PC) and natural (NC) and modified clays (MC) are cost-effective ecological alternatives to other commonly used adsorbents like polystyrene.
- For BSA, PM and NC adsorbents showed the highest adsorption, reaching adsorption capacities of 318 and 344 mg/g, respectively at pH 7.

References

- Baron, M., Revault, M., Moinville, S., Abadie, J. and Quiquampoix, H. 1999, J. Colloid Interface Sci., 214, 319-332
- Norde, W. and Anusiem, C. 1992, Colloids and Surfaces, 66, 73-80
- Navarro, A., Cuizano, N., Lazo, J., Sun-Kou, R. and Llanos, B. 2009, Sep. Sci. Technol., 44, 2491-2509.
- Francisco, O., Clark, C., Glor, H. and Khajehpour, M. 2019, RSC Adv., 9, 3416-3428.
- Kang, B., Tang, H., Zhao, Z. and Song, S. 2020, ACS Omega, 5, 6229-6239.

Acknowledgements

The authors are grateful to the Cuny Research Scholars Program and the Science Department at Borough of Manhattan Community College.