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PRELIMINARY SCREENING OF FOOD-WASTE-DERIVED BIOADSORBENTS FOR CARBAMAZEPINE REMOVAL

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Introduction

The occurrence of emerging micropollutants in aquatic environments, particularly persistent pharmaceutical compounds such as carbamazepine (CBZ), has become an increasingly pressing global environmental concern. Despite growing international research efforts, the development and application of advanced, sustainable, and green technologies for the removal of such contaminants remain relatively limited in Romania. Within this context, the valorization of agro-food waste as low-cost bioadsorbents offers a sustainable and circular alternative. The aim of this study was to investigate the potential utilization of locally sourced, un-carbonized, and chemically unprocessed biomass powders derived from agro-food residues for carbamazepine removal from aqueous solutions. The influence of operational parameters such as pH, contact time, adsorbent dose on the initial CBZ concentration was evaluated using HPLC (high-performance liquid chromatography) technique. These parameters play crucial roles in adsorption processes, as they can significantly affect both the solution and the characteristics of the adsorbent. The preliminary results provide an initial assessment of the potential of these readily available agro-food residues as low-cost materials for CBZ removal and support further investigation of their adsorption performance and applicability in water treatment.

Materials and methods

The carbamazepine (analytical purity) was processed from Sigma Aldrich, Germany. Ultra-pure water, utilized as aqueous medium was obtained in-house using a Milli-q system. Five types of food waste (onion - O, potato - P, egg - E, walnut - W, and avocado - A peels) were tested as potential bioadsorbents in a preliminary assessment of their capacity to remove CBZ from aqueous solutions. The batch adsorption experiments were conducted in 50 mL stoppered Erlenmeyer flasks containing a 10 mg/L CBZ in ultrapure water and 0.2 g of each biomass powders. The experiments were carried out at 25 ± 1 °C, under continuous agitation at 150 rpm using an automatic orbital stirrer. The pH of the solutions was adjusted to 3, 7 or 11, and the effect of contact time was preliminary assessed at 0, 3 and 24 hours. The residual CBZ concentration in the aqueous phase was determined by high-performance liquid chromatography (HPLC), using an Agilent 1200 system.

Results and conclusions

HPLC analysis showed that CBZ removal depended on both the type of food-waste-derived material and the pH of the aqueous medium (Figure 1). Among the five materials tested, walnut-derived biomass (CBZ-W) showed the highest and most consistent performance, with removal increasing over the 24 h contact period at all investigated pH values and reaching approximately 13% at pH 3, 12% at pH 7, and 9.4% at pH 11. Avocado-derived biomass (CBZ-A) also showed promising performance, particularly at pH 7 after 3 h, where removal increased from approximately 8.2% to nearly 12% after 24 h. Considerably lower efficiencies were obtained at pH 3 and 11. Onion-derived biomass (CBZ-O) displayed lower but generally increasing removal efficiencies with contact time, with the best results obtained under acidic conditions. Potato-derived biomass (CBZ-P) showed relatively low and stable removal, generally below 5%, while eggshell-derived material (CBZ-E) exhibited the lowest efficiency, with values mostly below 2%.

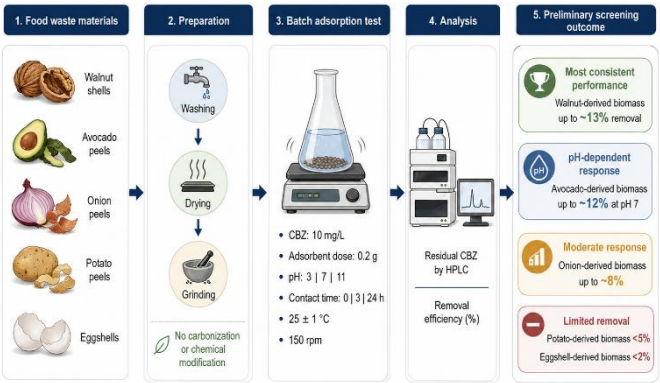


Figure 1 - Preliminary results supported further optimization and adsorbent characterization

The preliminary screening identified walnut-derived biomass as the most promising material across the investigated pH range, while avocado-derived biomass showed favorable performance specifically at neutral pH. Onion biomass showed moderate potential, whereas potato and eggshell materials were less effective under the tested conditions. As only three contact times were evaluated, these findings represent preliminary trends and require further confirmation through additional adsorption experiments and material characterization.

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