



Sewage Sludge–Derived Biochar as a Sustainable and Green Dispersive Solid-Phase Adsorbent for the Clean-up of QuEChERS Extracts: First Application to the LC–MS/MS Analysis of Contaminants of Emerging Concern in Edible Crops

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The QuEChERS extraction method is widely used for the multi-residue analysis of micropollutants in food matrices. However, due to the complexity of such matrices, a clean-up step is generally required, commonly performed by dispersive solid-phase extraction (d-SPE) with commercial sorbents such as primary secondary amine or graphitized carbon black (GCB). These materials are often expensive and may exhibit non-specific adsorption toward certain analytes. In this study, a biochar obtained from the pyrolysis of sewage sludge (SS-BC) was evaluated, for the first time, as a dispersive solid-phase extraction (d-SPE) sorbent in the clean-up step of QuEChERS extracts from rocket, tomato, and strawberry. The method targeted a broad spectrum of emerging contaminants, including 23 analytes belonging to pharmaceuticals (PhCs), perfluoroalkyl substances (PFASs), and sunscreen agents (SAs). The performance of SS-BC was compared with that of conventional sorbents such as graphitized carbon black (GCB) and styrene-divinylbenzene copolymer (SDVB), assessing recovery efficiency (R), matrix effect (ME) mitigation, and apparent recovery (AR%). When applied at 10 mg/mL extract, SS-BC achieved strong ME suppression for all analytes, though recovery values varied ($R\% \approx 36\text{--}67\%$), showing a strong inverse correlation with the number of aromatic rings and a direct relationship with molecular size and hydrophobicity. SS-BC proved particularly effective for PFAS analysis ($AR\% \approx 96\text{--}136\%$, depending on the matrix), whereas a combination of SS-BC and SDVB yielded improved recoveries for both aromatic and non-aromatic compounds. The greenness of the proposed QuEChERS procedure was compared with previously reported methods, achieving the highest sustainability score (0.53 vs. 0.35–0.47). Overall, SS-BC emerges as a sustainable, low-cost, and bio-based alternative to GCB for d-SPE clean-up in QuEChERS workflows, allowing efficient analysis of diverse emerging contaminants across a wide range of physicochemical properties (Log D at pH 7 ranging from 2 to 6.8) in complex, pigmented crop extracts. [1]

References

1. Renai L. et al., *Microchemical journal*, 218 (2025), <https://doi.org/10.1016/j.microc.2025.115198>