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Greenness and whiteness evaluation of *ex-situ* small-sized electrothermal vaporization capacitively coupled microplasma optical emission spectrometry for *on-site* battery operated micro-solid phase extraction of Cu(II), Cd(II), Pb(II) and Zn(II) from river water

^{1,2}Eniko Covaci*, ¹Augustin-Catalin Mot, ^{1,3}Adrian-Ioan Dudu, ^{1,2}Tiberiu Frentiu

¹ Babes-Bolyai University, Faculty of Chemistry and Chemical Engineering, 11 Arany Janos, 400028, Cluj-Napoca, Romania

² Babes-Bolyai University, Research Centre for Advanced Analysis, Instrumentation and Chemometrics, Arany Janos 11, 400028 Cluj-Napoca, Romania

³Enzymology and Applied Biocatalysis Research Center, Faculty of Chemistry and Chemical Engineering, Babes-Bolyai University, Arany Janos 11, 400028 Cluj-Napoca, Romania

Corresponding author: e-mail: eniko.covaci@ubbcluj.ro

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The study presents the greenness and whiteness evaluation of an *on-site* battery-operated micro-solid phase extraction (μ -SPE) of Cu(II), Cd(II), Pb(II) and Zn(II) from river water using dithizone-functionalized C18 cartridges and determination by *ex-situ* capacitively coupled microplasma optical emission spectrometry after vaporization from a small-sized electrothermal vaporization device of Rh coiled filament. The assessment was carried out using two of the most objective tools freely available online, namely the AGREEprep metric, used for greenness evaluation of the sample preparation procedure, and the RGB 12 algorithm, used for redness, greenness, blueness and whiteness characterization of the whole analytical determination. The AGREEprep metric highlighted a greenness score of 60%, mainly due to the *on-site* sample processing, energy-free operation due to the battery-operated experimental setup, reusability of the dithizone-functionalized C18 cartridges and fully miniaturized instrumentation. The RGB 12 algorithm, on the other hand, provided redness/greenness/blueness/whiteness degrees of 92/68/91/84%, respectively, due to the substantial improvement of the limits of detection by the high preconcentration factors of the analytes, cost-efficiency of miniaturized instrumentation, time efficiency by simultaneous analysis and operational simplicity. A comparative assessment with conventional bulky laboratory instrumentation, including graphite furnace atomic absorption spectrometry and inductively coupled plasma optical emission spectrometry, revealed lower greenness (53% and 41%) and whiteness scores (73% and 67%). Overall, the microplasma-based method demonstrated a highly sustainable and efficient alternative for trace metal analysis in environmental water samples.

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