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Determination of Trace Elements in Seawater and Table Salt after Solid Phase Extraction using a Chelate Resin Immobilizing Carboxymethylated Polyethyleneimine

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Summary

Chelate resins immobilizing carboxymethylated (CM) polyethyleneimine (PEI) were synthesized, and their extraction abilities for 21 elements were investigated. Various ethyleneimine compounds, which had the different number of ethyleneimine units, were immobilized on the methacrylate resin, and then the ethyleneimine compounds on the resins were carboxymethylated using various amounts of sodium monochloroacetate. With increasing the number of ethyleneimine units, the extraction abilities for some elements such as Ni Cu, and Cd were improved, whereas those for alkaline earth elements were little affected. On the other hand, the increase of carboxymethylation rate, which was defined as the ratio of the number of carboxyl group to that of nitrogen in the resin, CM/N, significantly improved the abilities for the elements such as Ni, Cu, and Cd and also for alkaline earth elements. The quantitative extraction of Ni and Mo were achieved using PEI resin, which was not carboxymethylated, at pH above 8.5 and below 8.5, respectively, whereas Ca was scarcely extracted over the pH range of 2-10. When PEI on the resin was carboxymethylated, the pH range in which Ni could be extracted widened to the acidic region, however, that for Mo narrowed. For CM-PEI resin with 0.36 of CM/N, the extraction percentage of Mo decreased and Ca was extracted at pH above 4.5. These results suggested that the extraction behavior of these elements seems to be closely related to the improvement of the coordinating ability and the decrease of the anion-exchanging ability of the resins with increasing CM/N. These results also indicated that the use of the chelate resin that was immobilized polyethyleneimine (MW = ca. 600) and then carboxymethylated (CM/N = 0.13) was preferable to the separation of trace elements in seawater and commercially available table salt. Therefore, the solid phase extraction using this resin was applied to the determination of 10 elements, including Cd, Co, Cu, Fe, Mn, Mo, Ni, Pb, V, and Zn, using inductively coupled plasma atomic emission spectrometry. The limits of detection were 0.001 μg/L (V) - 0.082 μg/L (Zn) when 500 mL of the sample solution was used. The proposed method was applicable to the analyses of certified reference materials (wastewater EU-L-1 and ground water ES-L-1) and commercially available table salt.