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# Simultaneous Determination of Nutrients in Seawater using Capillary Zone Electrophoresis

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Summary

We have developed capillary zone electrophoresis (CZE) procedure for the determination of nutrients in environmental waters: $NH_4^+$ in river and sewage waters, $NO_2^-$, $NO_3^-$, and $PO_4^{3-}$ in seawaters. However the method cannot determine all nutrients ($NO_2^-$, $NO_3^-$, $PO_4^{3-}$, Si, and $NH_4^+$) simultaneously. Our current emphasis purpose is to enhance the sensitivities for the simultaneous determination of $NO_2^-$ and $NO_3^-$ in seawater and develop a CZE procedure for simultaneous determination of nutrients in seawater. (I) To improve the reproducibility and enhance the sensitivity of the method for the determination of $NO_2^-$ and $NO_3^-$, several conditions were examined: the effect of rinsing the capillary with 1 mol/l NaOH before analysis, the addition of $Br^-$ to the background electrolyte (BGE), variation of the injection mode (vacuum and electrokinetic injection (EKI)) for the terminating ion (600 mmol/l acetate), the pH (3.4, 3.6, 4.7) of the BGE, and the effect of $SO_4^{2-}$ in the BGE. (II) To examine the feasibility of simultaneous determination of all analytes, cationic surfactants (hexadimethrine bromide (HDB), didodecyldimethylammonium bromide (DDAB), and cetyltrimethylammonium chloride (CTAC)) to reverse the electroosmotic flow (EOF), concentrations of the BGE (sodium borate, 10-50 mmol/l), detection wavelength, and BGE composition. The following results were obtained. (I) The reproducibility was improved by rinsing the capillary and using the BGE containing $Br^-$: the relative standard deviation (RSD) of peak area obtained for $NO_2^-$ and $NO_3^-$ were 1.0 and 0.80%, respectively. The reproducibility was improved and the sensitivity was slightly enhanced using the EKI mode for the terminating ion. The sample injection volume could be increased using the BGE (pH 4.7). Also it was expected to increase the injection volume of the terminating ion using the BGE without $SO_4^{2-}$. (II) All nutrients were detected simultaneously using the BGE (pH 10) with the reversed EOF (0.1 mmol/l DDAB) and direct UV detection (190 nm). When the BGE concentration was 50 mmol/l, higher peak heights and lower RSDs (peak area: 1.4-3.7%, peak height: 1.8-4.7%, migration time: 0.022-0.60%) were obtained. Using an artificial seawater containing 560 mmol/l NaCl, 0.1 g/l KBr, 0.2 g/l $NaHCO_3$, 0.03 g/l $H_3BO_3$, and 3 mmol/l CTAC as the BGE, $NO_2^-$ and $NO_3^-$ in seawater were detected as positive peaks (210 nm) and $PO_4^{3-}$ as a negative peak (195 nm), simultaneously.