Área: ELE

Disposable Gold-modified Electrochemical Sensors for Quantification of Nitrite and Nitrate in Drinking Water

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Highlights

Disposable electrochemical sensors made of conductive carbon ink and modified with gold and cadmium nanoparticles to detect nitrite and nitrate, sequentially. Fast analysis, cost-effective and low volume sampling technology.

Resumo/Abstract

Nitrite and nitrate ions are inorganic compounds available in nature from the nitrogen cycle and are also part of metabolic processes in various organisms. However, at high concentrations, these ions originated from the increasing use of agricultural fertilizers and food additives for bacterial control have generated a large increase in contamination of surface and underground water systems, causing eutrophication of rivers and lakes, as well as endocrine changes in living aquatic organisms. In humans, nitrate reduces to nitrite forms nitrosamines that are carcinogenic, causing esophageal and gastric cancer. The conversion of hemoglobin to methemoglobin also occurs, which can lead to death from respiratory failure due to low oxygen transport. Due to their toxicities, the Ministry of Health and the National Council for the Environment (CONAMA) defined that the maximum limit of nitrite and nitrate in drinking water should be 1.0 mgL^{-1} and 10.0 mgL^{-1}, respectively. The conventional analytical techniques, such as chromatography, spectrophotometry and chemiluminescence present precise results and high selectivity. However, they are expensive, time-consuming and require highly qualified professionals. Based on this, electrochemical sensors have emerged as a viable alternative, since they are easy-to-construct, portable, low cost and they are highly sensitive and enable on-site fast analyses. Electrochemical sensors can be modified with metallic nanoparticles in order to obtain improved sensitivity and selectivity by increasing the electroactive area, greater electron transfer, greater electrode conductivity and electrocatalytic effect. This work presents the electrodeposition of gold and cadmium nanoparticles on the surface of a conductive carbon ink electrode fabricated by screen printing on polyethylene terephthalate (PET) substrate for detection and quantification of nitrite and nitrate in drinking water. Gold electrodeposition was performed by chronoamperometry, applying -0.3 V for 600 s in a 1.5 $mmoL^{-1}$ tetrachloroauric acid solution. The characterization of the modified electrodes was performed by Cyclic Voltammetry, Scanning Electron Microscopy and Energy Dispersive Spectroscopy. The detection was performed by square wave voltammetry, monitoring the oxidation of nitrite (5.0 $mmolL^{-1}$) in $NaClO_4$ (0.1 $molL^{-1}$) + H_2SO_4 (pH 3) and the reduction of nitrate (5.0 $mmolL^{-1}$) catalyzed by the electrodeposition of cadmium (1.0 $mmolL^{-1}$) in $NaClO_4$ (0.1 moL^{-1}) +H_2SO_4 (pH 3). Nitrate generated a detection signal in the square wave voltammogram at -1.5 V, while nitrite was detected at 0.6 V. The next steps include the optimization of the quantitative detection of nitrite and nitrate by square wave voltammetry, for the further application in drinking water.

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