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Green and facile synthesis of water-soluble carbon dots from ethanolic shallot extract for chromium ion sensing in milk, fruit juices, and wastewater samples†

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Self-functionalized carbon dots (CDs) were prepared from ethanolic shallot extract to obtain a total phenolic precursor. The total phenolic extract was then heated at 180 °C for four hours in an autoclave. Only 1 mg L^{-1} of CDs had high fluorescence emission at 430 nm after excitation at 340 nm and manifested a high selectivity for Cr(VI) ions. The inter- and intra-day emission stability, pH, ionic strength, solvent effect, Stern–Volmer constant, incubation time, speciation of Cr(III) and Cr(VI) ions, and ion selectivity of the as-prepared CDs were investigated in detail. The proposed method was validated in 20–100 μM linearity with $y = 2.2346x$ as the set-zero intercept linear equation, 0.9981 as the correlation coefficient, 3.5 μM as the limit of detection (LOD), 11.7 μM as the limit of quantification (LOQ), and 2.78% and 5.29% as the intra-day and inter-day relative standard deviations (RSD), respectively. The recovery of drinking water, milk, soymilk, fruit juices (apple and coconut), tap water, and chromium-coated industrial waste water by the investigated Cr sensor was found to be 78.58–119.69%. Therefore, the proposed Cr(VI) sensor had superior advantages of sensitivity, selectivity, rapidity, and reproducibility.

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Introduction

Waste recycling is imperative to hinder the serious threats of human activities to the environment. Household waste, domestic waste, or residential waste can be classified as solid waste comprising garbage and rubbish, such as bottles, cans, clothing, compost, disposables, food packaging, food scraps, newspaper, magazines, and yard trimmings. Solid waste also contains hazardous household waste that enters the water, air, and soil.[1] The biohazardous waste can cause serious health issues in humans when it is transferred *via* contaminated food. In addition, the contamination can cause air pollution that impacts the respiratory system. Water and soil pollution can be detrimental to agriculture produce, and the toxic compounds are transferred to human *via* food chain. Even so, the wastes still have some concealed benefits usefully.[2] Solid waste contains carbohydrates, protein, lipid, and phytochemicals; hence, after separation, these chemicals can be reused.

Moreover, terpenoids, alkaloids, sulfur-containing compounds, and phenolic compounds contain heteroatoms in food scraps from a plant.[3] According to the chemical structures of carbon and plant metabolites, sp^2 and sp^3 carbon arrays are tailored to create different nanostructures, such as carbon nanotubes, fullerenes, graphene, and diamond.[4] Diamond possesses an sp^3 carbon structure and is generally used in jewellery and cutting works. Fullerenes, nanotubes, and graphene possess an sp^2 carbon structure and are often applied to conductors, semiconductors, solar cells, heated insulators, touch screens, luminescence cell labelers, biosensor, and chemical sensors.[5]

Carbon also has several derivative structures, such as carbon fibers, onions, rods, and carbon dots (CDs), which are generally used for sensing applications. CDs as new zero-dimensional carbon nanomaterials have drawn much attention due to their positive features, including ease of synthesis, low toxicity, excellent fluorescence properties, good photochemical stability,

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