Highly sensitive electrochemical detection of dopamine using Graphene quantum dots capped with gold nanoparticles in glassy carbon electrode

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Abstract:

Dopamine (DA) is one of the naturally occurring catecholamine's in the mammalian central nervous system, which acts as a vital part in neurotransmission. The changes in DA concentration can lead to serious illnesses such as schizophrenia and Parkinson. DA is an electrochemical active compound that can be determined by electrochemical methods. Electrochemical techniques have attracted great interest in many cases, since these techniques have fast detection responses, low costs and with merits of low detection limits and high accuracy. However, a major problem for the electrochemical detection of DA in real biological matrices is the coexistence of some interfering compounds.

Nanocomposite materials formed by a combination of nanoparticles of noble metals or metal oxides with graphene quantum dots have emerged as new materials overcoming such drawbacks. On one hand, nanoparticles, in particular gold nanoparticles (AuNPs), have many splendid properties: high conductivity, large specific surface area and superior catalytic properties. They can be combined with numerous biological molecules, and does not interrupt biological activity. Owing to the aggregation, AuNPs are inactive without basic supports, thus the search for a support led to the use of nanostructured carbon such as graphene. Graphene quantum dots (GQDs) are chosen as supporting material for AuNPs in the development of a modified sensitive glassy carbon electrode. Their high electrical conductivity, large surface area and biocompatibility make to this material as attractive support for electrochemical applications.

Herein, a novel and facile approach to detect trace amounts of dopamine based on $AuNPs_{(TMSPED)}$-GQDs modified electrode is proposed. Nanocomposites with sizes less than 10 nanometers were obtained by an ecofriendly method using a sonochemical process. $AuNPs_{(TMSPED)}$-GQDs nanocomposites were characterized using different spectroscopic techniques. The morphology of synthesized nanocomposites was confirmed using transmission electron microscopy (TEM). Prepared $AuNPs_{(TMSPED)}$-GQDs nanocomposites were applied in the electrochemical detection of dopamine (DA) using cyclic voltammetry (CV), differential pulse voltammetry (DPV), and amperometric (i-t) techniques. The obtained modified electrode showed a high sensitivity and strong catalytic activity during the detection of dopamine. A linear relationship between dopamine concentration and current response was obtained using the amperometric method with a wide linear range of concentration 0.005 - 2.1 µM, high sensitivity (0.007 $nm\mu A^{-1}$), very good reproducibility with a limit of detection of 5 nM. The practical application of method was demonstrated in the determination of dopamine in spiked pharmaceutical samples with satisfactory results.

Biography

Dr. Vinoth Victor Postdoctoral Researcher in Chemistry at the Universidad catolica de la santisima concepcion (UCSC), Chile and graduated as MS in 2010. He then joined the research group of Prof. S. Anandan at the National Institute of Technology (NIT), Tiruchirappalli. He received her PhD degree in 2017 at the same institution. After one year postdoctoral fellowship supervised by Dr Héctor Valdés at the laboratorio de tecnologías limpias (LTL), Chile he obtained the position of an Associate Professor at the UCSC. He has published more than 70 research articles in SCI(E)

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