Development of a novel highly sensitive voltammetric sensor electrode a TKAN modified based carbonaceous materials for dopamine measurement

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Keywords: Sensor Electrode, Surface Modification, Surface Characterization, TKAN, Dopamine
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The human brain has been called the most complex object in the known universe, and in many ways it's the final frontier of science. A hundred billion neurons, close to a quadrillion connections between them, and we don't even fully understand a single cell.

The importance of dopamine (DA, 3,4-dihydroxyphenyl ethylamine) in central nervous system function and pathology has driven investigation into how the neurotransmitter is controlled in the brain extracellular microenvironment (Wu et al., 2001). DA an important neurotransmitter of catecholamine class in the human brain, plays a significant role in the renal, cardiovascular, central nervous, and hormonal systems. Abnormalities in dopamine concentrations have been linked to several neurological disorders, for example, parkinsonism, epilepsy and schizophrenia (Wightman, 2006; Chumillas et al., 2013; Niv, 2013). In addition, DA is available as an intravenous medication, which acts on the sympathetic nervous system, to produce effects such as increasing heart rates and blood pressure (Sulzer, 2011). Therefore, detection and quantification of DA in vivo/vitro is a subject of great importance in the clinical medical practice.

Therefore, the development of a sensitive, simplicity, low cost, fast and selective method for determination is highly desirable for electrochemical analytical applications and diagnostic researches. DA is electrochemically active compound and can be determined by electrochemical techniques. In recent years, the development of voltammetric methods for their determination in human fluid such as urine and serum has received considerable interest (Habibi and Pournaghi-Azar, 2010). Up to now, electrochemical analytical techniques have attracted wide attention for DA determination due to their simplicity, low cost, high sensitivity and fast response (Wang et al., 2009; Li et al., 2013; Gao et al., 2013; Xu et al., 2014; Hu et al., 2014).

TKAN, 2-(2,4,5-trimethoxyphenyl)-1-(3-chlorophenyl)acrylonitrile molecule was used to modify the surface of glassy carbon (GC) electrode and electrochemical behaviour and properties were investigated in this study. Our main goal is to fulfil the quantitative determination of DA using TKAN modified GC as a sensor electrode. This developed modified sensor electrode was used for the determination of DA ions in real samples using differential pulse voltammetry, DPV. In this study besides CV and DPV techniques, EIS and SEM techniques were also used for the surface characterization of the modified surface. After modification and characterization operatings, the obtained TKAN/GC sensor electrode has become available for detection DA ions with determining optimum pH and incubation time. To do this; first of all, the calibration curve should be drawn depending on the concentration and peak current with utilizing read from voltammograms. For this purpose; in the range from 1.0 mM to 1.0 µM DA solutions in the pH 7 PBS buffer solution was set from standard solid dopamine hydrochloride. After that stage; the TKAN/GC sensor electrode was hold each of solution and their voltammograms were taken with DPV (Figure 1-B).

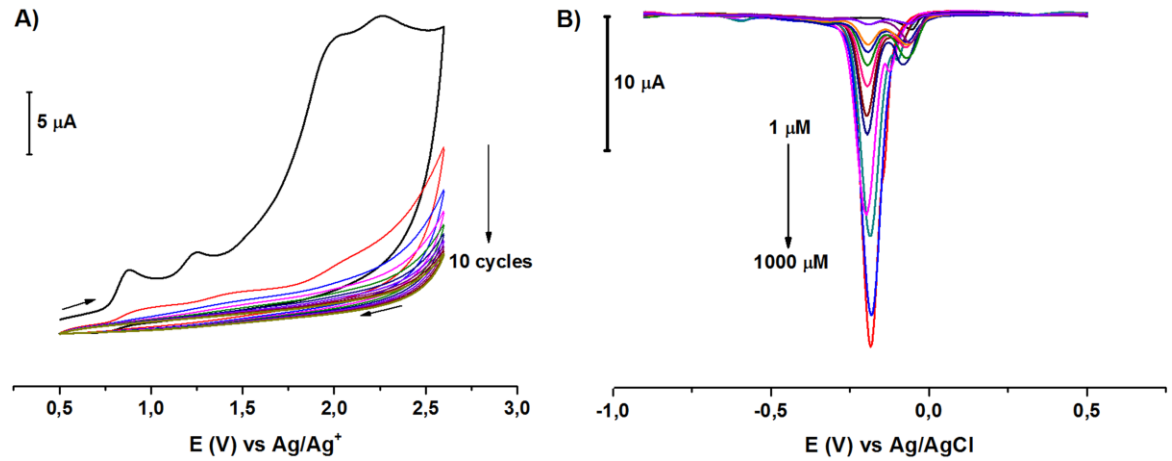

Figure 1. A) Modification voltammogram of 1 mM TKAN in 100 mM NBu_4BF_4 (in CH_3CN) vs. Ag/Ag^+/(10 mM) on bare GC electrode surface. Potential range from +0.5 to +2.6 V and sweep rate is 0.1 V s^{-1}. B) DPVs of different concentrations of Dopamine solutions (1.0 mM between 1.0 µM) on TKAN/GC. The measurements were performed in PBS, pH 7.0, vs. $Ag/AgCl_{(sat)}$. Sweep rate was 50 mV s^{-1}.

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Acknowledgement

We would like to thank to the Research Foundation of Necmettin Erbakan University, Konya-TURKEY (BAP-161210001) for financial support of this work.