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Carbon paste electrode modified with pine kernel peroxidase immobilized on pegylated polyurethane nanoparticles for dopamine detection

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Abstract – A carbon paste electrode based on pine kernel, a seed from Araucaria angustifolia, for the determination of dopamine in pharmaceutical products was developed. The biodevice was constructed by the immobilization of peroxidase extracted from the plant homogenate on pegylated polyurethane nanoparticles. The analytical curve was linear for dopamine concentrations from 9.9×10^{-5} to 1.6×10^{-3} mol L^{-1}. The recovery of dopamine (pharmaceutical sample) ranged from 97% to 103%. The results obtained with the proposed device were comparable with those obtained by the official method in agreement at the 95% confidence level.

The immobilization of enzymes onto support materials has been proposed in the last years as a form to decrease mass-transfer limitations in analytical devices. Support material, which plays an important role in the utility of an immobilized enzyme, should be readily available and non-toxic, and also should provide a large surface area suitable for enzyme reaction, and substrate and product transport with the least diffusion restriction. A carbon paste electrode based on pine kernel, a seed from Paraná pine (Araucaria angustifolia), for the determination of dopamine in pharmaceutical products was developed [1]. The biodevice was constructed by the immobilization of peroxidase extracted from the pine kernel homogenate on pegylated polyurethane nanoparticles (Fig. 1). Square-wave voltammetry (SWV) experiments were performed to investigate the performance of the modified carbon paste electrode (Fig. 2). The best analytical response was obtained for a 75:15:10% (w/w/w) composition of graphite powder:mineral oil:polyurethane nanoparticles containing 2.5 units of peroxidase mg^{-1} of carbon paste, 0.1 mol L^{-1} phosphate buffer solution (pH 6.5), 2.0×10^{-3} mol L^{-1} hydrogen peroxide, 80mV pulse height and 60 Hz frequency. The analytical curve was linear for dopamine concentrations from 9.9×10^{-5} to 1.6×10^{-3} mol L^{-1} (r = 0.9995) and the regression equation was found to be $\Delta I = 2.1 + 7.4 \times 10^{3}$ [dopamine] with a limit detection of 9.0×10^{-6} mol L^{-1}. The recovery of dopamine from pharmaceutical samples ranged from 97% to 103% and the results obtained using the proposed modified carbon paste electrode and those obtained by the official method are in agreement at the 95% confidence level.

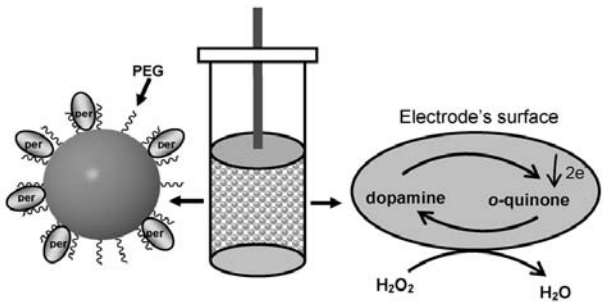

Figure 1: Schematic representation of the enzymatic process among dopamine in the presence of hydrogen peroxide and peroxidase (per) immobilization on pegylated.

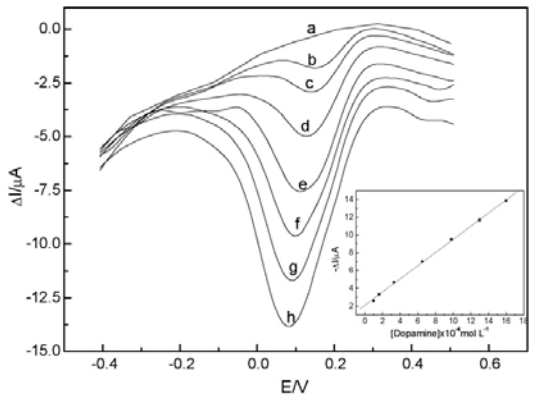

Figure 2: Square-wave voltammograms obtained using the modified carbon paste electrode for (a) blank in 0.1 mol L^{-1} phosphate buffer solution (pH 6.5) containing 2.0 ×10−3 mol L^{-1} hydrogen peroxide, and dopamine solutions at the following concentrations: (b) 9.9×10^{-5}; (c) 1.6×10^{-4}; (d) 3.3×10^{-4}; (e) 6.5×10^{-4}; (f) 9.8×10^{-4}; (g) 1.3×10^{-3}; (h) 1.6×10^{-3} mol L^{-1} at pulse height 80 mV, frequency 60 Hz and increment 2.0 mV. Inset: the analytical curve of the electrode proposed.

[1] FRITZEN-GARCIA, M. B.; OLIVEIRA, I. R. W. Z.; ZANETTI-RAMOS, B. G.; FATIBELLO-FILHO, O.; SOLDI, V.; PASA, A. A.; CRECZYNSKI-PASA, T. B. Sensor and Actuators B, 139, (2009) 570.