Electrochemical Oxidation of Bisphenol A

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Bisphenol A is a phenolic environmental contaminant that has been actively studied due to its potential toxicity and high industrial production volume. There is evidence of the compound inducing oxidative stress and lipid peroxidation by the generation of reactive oxygen metabolites which eventually leads to oxidative cell damage. However, the nature and the mechanism by which bisphenol A reacts in biological systems remains unclear. Bisphenol A is poorly soluble in water and is more likely to reside in fat cells. Knowledge of the oxidative behaviour is important to investigate toxicity at the molecular level. The electrochemical behaviour of bisphenol A was examined using cyclic voltammetry in aprotic organic solvents, bulk electrolysis and chemical oxidation. It was found that bisphenol A undergo a chemically irreversible voltammetric oxidation process to form compounds that cannot be electrochemically converted back to the starting materials. Voltammetric responses also showed an adsorption process (whereby the oxidative peak currents (i_p^{ox}) diminished with repetitive scanning). Identification of the chemically oxidised product suggested that the oxidation mechanism of bisphenol can be considered to be similar to phenols in general. A combination of electrochemical and spectroscopic experiments have shown that bisphenol A can be chemically oxidised with 4 mol equiv of the one-electron oxidant $NO^+SbF_6^-$ in a four-electron/two-proton process to a relatively unstable dication intermediate that reacts quickly in the presence of water to form hydroxylated bisdienone in acetonitrile at 298 K. The results provide useful insights into the reactions that can occur during metabolism of bisphenol A and highlight the possibility of the role of bisdienone cation as a reactive metabolite in biological systems.