Electrode Oxidation of Cholesterol for Sterol Determination in Biological Samples

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Cholesterol is an essential component in mammalian cell membranes. However, clinical studies have shown that an increase in the serum cholesterol concentration is a risk factor of atherosclerosis, leading to ischemic heart diseases. Therefore, the determination of cholesterol in serum is an important laboratory test in hospitals.

Although cholesterol is not thought to be a redox compound, this molecule has been found to be electrochemically oxidized at a carbon electrode in an acetonitrile solution. An electrolytic product of cholesterol was characterized by infrared spectroscopy, one- and two-dimensional nuclear magnetic resonance, and matrix-assisted laser desorption/ionization time-of-flight mass spectrometry. The three techniques confirmed the formation of cholesta-4,6-dien-3-one from cholesterol, suggesting that this reaction is a four-electron, four-proton electrochemical process [1].

The electrochemical oxidation of cholesterol was applied to the development of a method for the determination of cholesterol by high performance liquid chromatography with electrochemical detection (HPLC-ECD). The separation was carried out with a C30 column and acetonitrile-2-propanol (9:1, v/v) containing 50 mmol/L lithium perchlorate as a mobile phase. The detection was made by an electrochemical cell consisted of a glassy carbon (GC) working electrode, an Ag/AgCl reference electrode, and a stainless steel (SUS) auxiliary electrode, where an applied potential at +1.9 V vs. Ag/AgCl|3.5 mol/L KCl|salt bridge (1 mol/L NaNO3)|test solution|GC or SUS was given to the GC working electrode. By this method, total cholesterol and free cholesterol in human serum were determined with the recovery of more than 90% and the RSD (n=6) of less than 3.0% [2a], providing an alternative tool for the serum cholesterol determination. Using a similar analytical system of HPLC-ECD, it was possible to determine serum cholestanol [2b], serum phytosterols [2c], and serum lathosterol [2d], showing the applicability of this method to the diagnoses of cerebrotendinous xanthomatosis, phytosterolemia, and lathosterosis, respectively.

References