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A potentiometric ion selective sensor based on piperine for determination of Fe(III) in the presence of Fe(II)

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Ferric ion is one of the most essential transition metal ions, which plays a vital role in many biological systems. Both deficiency and excess of Fe(III) ions can cause serious disorders such as anaemia in humans and chlorosis in plants. Therefore, quantitative determination of Fe(III) ions is crucial for maintaining the balance of many biological and environmental systems. The purpose of this study is to develop and characterize a potentiometric solvent polymeric ion selective membrane electrode for the determination of Fe(III). Piperine was used as the ion selective ligand. The complex formation constant (log β_{ILn}) of piperine ligand with Fe(III) in the polymeric membrane is determined as 1.04 ± 0.04 using the sandwich membrane method. Apart from the ionophore, the membrane consists of a PVC matrix with ortho-nitrophenyloctyl ether (NPOE) as the plasticizer and potassium tetrakis (4-chlorophenyl borate) as the ion exchanger. The mass ratio of components of the membrane was maintained to be 1:1:66:132 (piperine : ion exchanger : PVC : NPOE). The ion selective electrode (ISE) was calibrated for different Fe(III) concentrations in 0.02 M citrate buffer medium using open circuit potential (OCP) measured against Ag/AgCl reference electrode. The response curve showed a super-Nernstian slope with the value 30.4 mV/decade with a limit of detection (LOD) of 1.26 $\times 10^{-4}$ M. The electrode equilibrated with a less than 10 s response time and the reported results were quite reproducible. Most importantly, the ISE showed higher selectivity towards Fe(III) over many other cations such as Fe(II), Cr(III), Al(III), Ba(II) and K(I) with selectivity coefficients -6.04, -3.68, -3.27, -6.80, -3.93, respectively which were determined within a concentration range from 1×10^{-4} M to 1×10^{-1} M. The selectivity coefficients are quite promising as it exhibits the ability of the ISE to distinguish between Fe(III) and Fe(II), which is a major interfering cation in Fe(III) determination. Thereby the developed ISE could be used in quantitative determination of Fe(III) ions. Further experiments are being carried out to improve the lower detection limit that is required for biological sample analysis.

Keywords: Fe(III) ion selective, potentiometry, solvent polymeric membrane electrode, piperine, complex formation constant

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