

Oral presentation: 86

A novel potentiometric ion selective sensor based on piperine for determination of Fe³⁺ ions

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Iron plays a vital role in humans as iron deficiency cause anemia and overload of iron leads to haemochromatosis. In plants, chlorosis is a common plant disorder that arises as a result of iron deficiency, whilst excess iron leads to toxicity due to the formation of oxygen radicals. As a consequence, there is an imperative need for determination of iron in its ionic form and even in complex matrices. The purpose of this study is to develop a potentiometric solvent polymeric membrane ion selective electrode (ISE) using piperine, to be used efficiently in routine analysis of iron. The ISE was calibrated according to the Nernst equation, correlating the Fe³⁺ concentration with the potential of the ISE measured with respect to a Ag/AgCl reference electrode. Selectivity coefficients were measured using the separate solution method. The electrode exhibits a linear response towards Fe³⁺ ions in the citrate buffer medium over a concentration range of 1×10^{-4} to 1M (detection limit 6.3×10^{-5} M) with a Nerstian slope of 20.5 mV per decade. The electrode can be successfully used in the pH range 3.15 - 7.85 with a life-time of 3 months. It has fairly good discriminating ability towards Fe³⁺ ions among some other metal ions such as K⁺, Ca²⁺, Mg²⁺, Cu²⁺, Ba²⁺, Co²⁺, Al³⁺ and Cr³⁺ with selectivity coefficient of -2.11, -9.02, -10.38, -8.34, -8.12, -8.79, -8.41 and -3.69, respectively. Developed Fe³⁺ ISE was used to determine Fe³⁺ concentration in a pharmaceutical sample and the results produced by the sensor were comparable with those obtained using AAS. It proves the fact that, this sensor can be developed into a simple, cost effective alternate method in determining Fe³⁺ ion concentrations in biological and analytical samples.

Keywords: Calibration, detection limit, ion selective electrode, nerstian slope, selectivity coefficient