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Potentiometric Determination of Strontium in Clinical Samples using Graphite Coated Ion Selective Electrode

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Abstract: ***Graphite coated electrodes have emerged as an important class of ion selective electrodes for the determination of various metal ions. In this study, a strontium ion selective electrode based on graphite has been fabricated and its use in the selective determination of strontium ions in clinical samples is revealed. The response obtained is compared with the ICP – AES method.***

Keywords: Strontium, graphite, ion – selective electrode, clinical samples

1. Introduction

Strontium is an alkaline earth metal widely present in the environment, soils, plants and human tissues. Its occurrence in the earth's crust is in the form of minerals like celestite ($SrSO_4$) and strontianite ($SrCO_3$). Strontium has a number of isotopes of which ^{90}Sr and ^{85}Sr are radioactive and are used in nuclear reactors [1]. ^{90}Sr with a radioactive half-life of 29 years is considered to be one of the most harmful products of radioactive fallout [2]. Its exposure has been associated to the cause of leukemia [3]. Also, due to its chemical similarity with calcium, it is known to gather into the biological systems and accumulates in the bones of vertebrates[4]. Thus, making the determination of Sr^{2+} very crucial. For this purpose, a very simple, cost effective and efficient method based on the use of strontium selective electrode by potentiometry is essential. Strontium has been reported to complex selectively by 18 membered crown ethers due to size compatibility [5]. Ditertbutylcyclohexano-18-crown-6 has high selectivity for strontium and has been used for the selective removal of strontium from nuclear waste solutions [6]. Taking this into consideration, graphite electrode was coated with membrane having optimum composition based on Ditertbutylcyclohexano-18-crown-6 as ionophore. Application of this electrode in the selective determination of strontium in clinical samples is studied.

2. Reagents

Analytical grade strontium nitrate, 99.5% pure sodium tetraphenyl borate (NaTPB) were obtained from LobaChemie. 98% pure o-nitrophenyloctylether (o-NPOE), 98% pure ditertbutylcyclohexano-18-crown-6 (DtBuCH18C6), were procured from Chemical Centre. 90% Carbon basis multiwalled carbon nanotube (MWNT) was obtained from Sigma-Aldrich, while analytical grade polyvinyl chloride (PVC) was obtained from Chemical International.

3. Experimental

Graphite electrode coated with membrane having optimum composition of 33.0% PVC (polymer matrix), 55.0% o – NPOE (plastcizer), 2.0 % MWNT (nanotube), 6.0% NaTPB (anion excluder) and 4.0% DtBuCH18C6 (ionophore) was fabricated [7].

Blood samples were collected from Bloodline Bloodbank, Thane, Maharashtra. Two blood samples were prepared using the blood of two different individuals. Serum was separated by centrifugation. 1.0 cm^3 of the blood serum was boiled with 6.0 cm^3 of conc. HNO_3 and 2.0 cm^3 of H_2O_2[8]. The samples were cooled, spiked with 10.0 cm^3 of 100 ppm Sr^{2+} and then diluted to 100 cm^3 in a standard flask.

Chicken bones were dried under sunlight for 3 days. It was then made into ash by heating on a silica crucible placed on an incinerator for half an hour. Both the samples were prepared by boiling 0.1 g of the ash with 10.0 cm^3 of conc. HNO_3 for half an hour. The samples were then cooled and filtered[9]. The filtrates were collected in two different 100 cm^3 standard flasks. The two samples were spiked with 1.0 $cm^3$and 10.0 cm^3 of 100 ppm Sr^{2+}respectively and then diluted up to the mark with distilled water.

Potentiometric measurements were made by using a digital dual channel Potentiometer Model (EQ-603). Potential response of the clinical samples and standard solutions of Sr^{2+} were measured against the reference saturated calomel electrode (SCE) using the following cell assembly $^{-}$SCE ⏐Sample analyte solution (Sr^{2+}) ⏐⏐membrane ⏐graphite^{+}

Concentration of strontium ions present in the sample was calculated using equation of the straight line obtained in the curve of E_{cell} vs. log C. Samples were also subjected to analysis by ICP – AES method.

4. Results and Discussion

A calibration curve of the cell potential measured against logarithm of the concentration of standard of Sr^{2+} is shown in Figure 1.

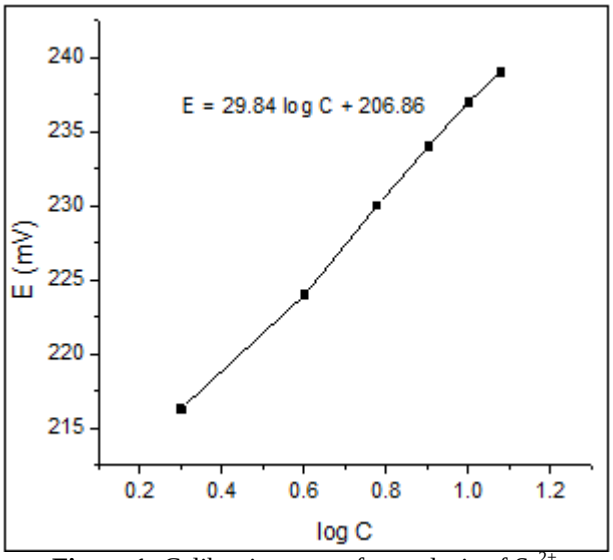

Figure 1: Calibration curve for analysis of Sr^{2+}

Concentration of strontium ions present in the sample was calculated by substituting the value of the potential of sample solution in the equation of the straight line obtained in the curve of E_{cell} vs. log C. The results obtained using the developed strontium selective electrode were found to be in good agreement with the ICP – AES method (Table 1).

Table 1: Determination of strontium in clinical samples by potentiometric method using fabricated electrode and by ICP – AES method

Sample No.	Concentration of Sr^{2+} (ppm)	
	ISE	ICP –AES
Blood 1	9.46	9.14
2	9.25	9.03
Bone 1	10.47	10.82
2	1.27	1.25

5. Conclusion

The method discussed in the present work involving use of graphite coated ion selective electrode offers a very simple, convenient and cheaper alternative for the determination of strontium ions in clinical samples over the expensive ICP – AES method.

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