



NOTE

Spectrophotometric Determination of Strontium in Tea Leaf Sample

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The optimum colour conditions of strontium(II) with *p*-acetylarsenazo were studied and the colour system has been successfully used in the determination of strontium content in tea leaf sample. In a $\text{NH}_3\text{-NH}_4\text{Cl}$ buffer medium of pH 10.39, strontium(II) and *p*-acetylarsenazo formed a blue complex of 1:2. The maximum absorption wavelength of the complex is 644 nm. A good linearity is presented between the concentration range of 0.3-4.5 $\mu\text{g/mL}$ of strontium(II) and absorbance (*A*) and its linear regression equation is: $A = 0.123C$ (C : $\mu\text{g/mL}$) + 0.0317, with a regression coefficient of 0.9961. The apparent molar absorption coefficient is $1.38 \times 10^4 \text{ L mol}^{-1} \text{ cm}^{-1}$ at 644 nm. Detection limit of the method is 0.083 $\mu\text{g/mL}$.

Key Words: Spectrophotometry, Strontium, *p*-Acetylarsenazo, Tea leaf.

Strontium is a necessary microamount element of human body, being the natural tissue component forming the skeletons and teeth of human body. Strontium still can reduce death ratio of the disease of heart vein. In tea leaf many kinds of micro elements are contained. By drinking tea, human being can absorb the strontium present in tea leaf. Thus, determination of strontium in tea leaf has important significance.

The common methods for the determination of strontium are atomic absorption spectrometry, inductively coupled plasma-atomic emission spectrometry, spectrophotometry, *etc.*¹⁻³. Since spectrophotometry has a series of the advantages of operation simplicity, cheap instrument price, *etc.*, it is more suitable for the determination of strontium and has higher applied value. Although some analytical systems for the determination of strontium have been proposed in recent years such as *m*-carboxyl-carboxyazo⁴, *p*-bromocarboxyazo-*m*⁵, dibromo-*p*-methyl-arboxylarsenazo⁶, the selectivity for lead, rare earths is very poor. Thus, establishment of new photometric system for the determination of strontium has very important significance all the same. *p*-Acetylarsenazo (ASApA) was ever used for the spectrophotometric determination of rare earths⁷. In this studies optimum conditions of the colour reaction of strontium(II) and *p*-acetylarsenazo (ASApA) and system properties were studied in the $\text{NH}_3\text{-NH}_4\text{Cl}$ buffer solution. Operation of the method is simple and convenient and the reaction is sensitive. The present method has been successfully applied in the determination of strontium in tea leaf with satisfactory results.

Sr^{2+} working solution (10 $\mu\text{g/mL}$): The standard stock solution of Sr^{2+} was prepared by placing 0.1685 g of SrCO_3 in 30 mL of water and by adding 1 mL of concentrated hydrogen chloride for dissolution. The mixture was stirred until after CO_2 emitted and diluted to 100 mL with water and shaken to obtain 1 mg/mL of Sr^{2+} stock solution. The working solution was prepared by dilution.

***p*-Acetylarsenazo [0.1 % (w/v)] solution:** *p*-Acetylarsenazo solution was prepared by dissolving 0.1000 g of ASApA in 100 mL of water.

$\text{NH}_3\text{-NH}_4\text{Cl}$ buffer solution (pH = 10.39): The buffer solution was prepared by mixing 94.12 mL of 0.1 mol/L ammonia and 5.88 mL of ammonium chloride. All of the chemicals used were of analytical reagent grade and distilled water was used throughout the study.

A 722S spectrophotometer (Shanghai Linggunag Technique Co., Ltd., China) with a 1.0 cm cell was used for measuring the absorbance.

General procedure: Two 10-mL volumetric flasks were taken. Into one of them was added 2.0 mL of 10 $\mu\text{g/mL}$ Sr^{2+} working solution (sample system), while in the other the Sr^{2+} was not added (blank system). 1.0 mL of $\text{NH}_3\text{-NH}_4\text{Cl}$ buffer solution (pH = 10.39) and 1.2 mL of 0.1 % (w/v) ASApA solution were in turn added and diluted to the mark with water. Using 1 cm cell, with the corresponding reagent blank as reference, the absorbance was measured at 644 nm.

Absorption spectra: Fig. 1 is the absorption curves of corresponding components. In the $\text{NH}_3\text{-NH}_4\text{Cl}$ medium, the

TABLE-1
 ANALYTICAL RESULTS OF SAMPLE

Sample	Found ($\mu\text{g/g}$)	Average ($\mu\text{g/g}$)	Relative standard deviation (%)	Added ($\mu\text{g/g}$)	Recovered ($\mu\text{g/g}$)	Recovery (%)	Atomic absorption spectrometry ($\mu\text{g/g}$)
Tea leaf	15.45, 15.14, 15.74, 15.82, 15.81, 15.80, 15.88, 15.12, 15.92, 15.45, 15.80, 15.70, 15.99	15.66	1.81	1.50	1.54	102.9	15.65

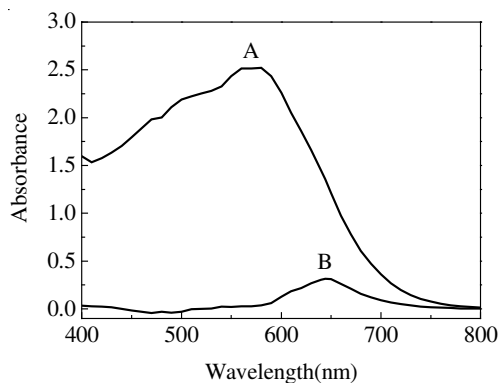


Fig. 1. Absorption spectra: (A) ASApA (against water); (B) complex (against reagent blank). pH 10.39; $[\text{Sr}^{2+}] = 2.28 \times 10^{-5} \text{ mol/L}$; $[\text{ASApA}] = 1.73 \times 10^{-4} \text{ mol/L}$

maximum absorption of ASApA (curve A) is located at 580 nm and the maximum absorption of the complex (curve B) is at 644 nm. 644 nm was selected as the measurement wavelength.

Effect of acidity: The experimental results showed that over the range of pH 9.26-10.88 the colour reaction was stable and the sensitivity was the highest and in the experiment the $\text{NH}_3\text{-NH}_4\text{Cl}$ of pH = 10.39 was employed as the reaction medium. When the amount of the buffer solution was 0.8-1.2 mL, the absorbance was the largest and stable. In the experiment, 1.0 mL was selected as the optimum amount.

Amount of chromogenic agent: The experimental results showed that when the amount of 0.1 % (W/V) ASApA chromogenic agent was in the range of 1.0-1.5 mL, the absorbance was the largest and stable. This article selected 1.2 mL.

Order of addition reagent: Order of addition reagent has not effect on the experimental results. Experimentally employed order was: $\text{Sr}^{2+} + \text{NH}_3\text{-NH}_4\text{Cl} + \text{ASApA}$.

Complex composition and stability: Molar-ratio method and continuous variation method were applied to ascertain the stoichiometric composition Sr(II) and ASApA of the complex. The complex ratio of Sr(II)-ASApA (1:2) complex was indicated by both methods.

At room temperature, the colour reaction can instantly complete and the formed complex can be stable for 1.5 h at least.

Working curve: Different amount of the Sr^{2+} standard solution were taken and colour development was made according to the general procedure for the determination of absorbance and for drawing working curve. The results indicated that under the optimum experimental conditions. Beer's law was obeyed over the range of 3-45 $\mu\text{g}/10 \text{ mL}$ (0.3-4.5 $\mu\text{g}/\text{mL}$) for Sr^{2+} amount. A linear regression equation was: $A = 0.123C$ ($C: \mu\text{g}/\text{mL}$)-0.0317, with a correlation coefficient of $\gamma = 0.9961$. The apparent molar absorption coefficient of the complex was $\epsilon_{644 \text{ nm}} = 1.38 \times 10^4 \text{ L mol}^{-1} \text{ cm}^{-1}$.

For 11 parallel determinations of 3.0 $\mu\text{g}/\text{mL}$ Sr^{2+} , the relative standard deviation obtained was 1.13 %, indicating that the precision of the method is excellent and the reproducibility of experimental determination was good. For 11 parallel determinations of blank reagent, standard deviation obtained was 0.34 %. The detection limit of the method calculated $3S/K$ (S is standard deviation, K is the slope of working curve) was 0.083 $\mu\text{g}/\text{mL}$.

Effect of co-existing ions: Under the optimum experimental conditions, in a 10 mL system for the determination of 20 μg of Sr^{2+} and within a relative error of less than $\pm 5 \%$, the allowed amounts of co-existing ions are as follow (in μg): Na^+ (2000), Cd^{2+} (2000), Zn^{2+} (1000), Sn^{2+} (500), Co^{2+} (60), Ni^{2+} (60), Ca^{2+} (20), Mg^{2+} (10), Mn^{2+} (4), Cu^{2+} (2), Pb^{2+} (2), B^{3+} (200), Fe^{3+} (40), Al^{3+} (4), Cr^{3+} (2), La^{3+} (2), Bi^{3+} (2), Ti^{4+} (0.2), NO_3^- (2000), Cl^- (2000), F^- (300), OAc^- (4000), VO_3^- (400), SO_4^{2-} (1000), SiO_3^{2-} (400), WO_4^{2-} (40), MoO_4^{2-} (40), PO_4^{3-} (500).

Analysis of tea leaf: 80 g of tea leaf was accurately weighed, desiccated in an oven at 100 $^\circ\text{C}$ for 4 h, placed in a muffle oven at 650 $^\circ\text{C}$ for ashing for 6 h and then taken out to be cooled. The tea leaf ash was transferred to a 100-mL beaker, dissolved by concentrated nitric acid and heated in an electric cooker until it was completely dissolved. The contents was dissolved in water and transferred to a 25-mL volumetric flask and diluted to the mark with water. 0.7 mL of the solution was taken and strontium content was determined according to the general procedure. Meanwhile, atomic absorption spectrometry was used for comparison. The determined results are presented in Table-1.

Conclusion

The work reports the optimum experimental conditions of spectrophotometric determination of strontium(II) using *p*-acetylarzenazo as chromogenic reagent. At 644 nm, Beer's law was obeyed over the range of 0.3-4.5 $\mu\text{g}/\text{mL}$ for strontium(II) concentration and the regression equation of working curve was: $A = 0.0123C$ ($C: \mu\text{g}/\text{mL}$)-0.0317. The detection limit of the method was 0.083 $\mu\text{g}/\text{mL}$. The present method has been satisfactorily applied to the determination of strontium content in the tea leaf.

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