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Development of Spectrophotometric Method for Aluminium Detection

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ABSTRACT

In this study, a spectrophotometry method for detection of Al^{3+} ion was developed using Alizarin Red S (ARS). ARS in the presence of Al^{3+} ion form brown complex solution. Al^{3+}-ARS complex formation was characterized by using UV-Vis spectrophotometer (UV-Vis). The developed method showed a linear response in the range of 1 ppm to 10 ppm with an isosbestic point of 436 nm. Moreover, photostability study indicates that ARS exhibited a stable reading for a duration of 6 hours. This method displayed high selectivity towards Al^{3+} ion concentration with no interferences from Pb^{2+}, Fe^{2+}, Cu^{2+} and Zn^{2+} ions. The ARS reagent was then immobilized in alginate to form film. Analysis using FTIR spectrophotometer shows that the presence of IR peak for ARS-alginate at 1107.44 cm^{-1}, 1474.09 cm^{-1}, 1637.77 cm^{-1} and 3405.76 cm^{-1}.

KEYWORDS: Spectrophotometry; Aluminium; Alizarin Red S

1 INTRODUCTION

Chemical sensor is a miniature device that can deliver real time information on the presence of specific compounds or ions in a complex sample [1]. In this study, ARS was used as indicator for Al^{3+} determination using UV-Visible spectrophotometer. ARS is an important class of organic compound that absorbs visible light and capable of forming complexes with cations [2]. It is usually used for metal extraction quantification and can form strong coloured complexes. Fig. 1 shows the chemical structure of ARS.

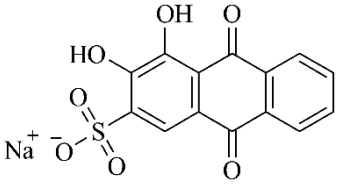

Fig. 1 Chemical structure of ARS

Aluminium (Al) is the third most abundant element in the earth's crust and contributes

about 8% of earth solid surface. It can also be found in most animal and plant tissues and in natural water [3]. There are various methods that have been used to determine Al^{3+} such as Atomic Absorption Spectrometry (AAS) and Inductively Coupled Plasma Atomic Emission Spectroscopy (ICP-AES) [4]. These methods involve complicated preparation procedures and long analysis time. Moreover, it uses advanced instrumentation and trained personnel to handle the instrument.

2 OBJECTIVE

The objectives of this study are to optimize the reactions between ARS and Al^{3+} ion in the solution and to immobilize ARS indicator in alginate.

3 SIGNIFICANCE (S)

The spectrophotometric method is relatively simple and do not involve complicated procedure. In addition, low usage of chemical and no advanced instruments involved.

4 METHODOLOGY/TECHNIQUE

All the characterization studies have been carried out using UV-Vis Spectrophotometer and the absorbance was recorded from 300 nm until 700 nm. Effect of Al concentration and interference study were carried out before immobilization of ARS in alginate.

For immobilization of ARS in alginate, 0.25 g sodium alginate (4% (w/w)) was mixed with 6.25 mL distilled water into a 50 mL beaker and was stirred for 3 hours using a magnetic stirrer until homogeneous. Then, 0.01 g of ARS reagent was poured slowly into the alginate solution. The ARS-alginate solution was poured into a customize mould (1.25 cm x 4 cm) that suits the size of cuvette and was dried for 3 to 5 days. Fourier Transform Infrared (FTIR) spectra was recorded using Perkin Elmer Spectrum 100 Optica ATR-IR.

5 RESULT

Figure 2 illustrates the UV-Vis spectrum for ARS, Al and Al-ARS complex solutions. The maximum wavelength of ARS appears at 423 nm while Al-ARS complex appears at 478 nm. The maximum wavelength for free ARS is at 425 nm while Al-ARS complex shows the maximum wavelength at 478 nm [5]. ARS change from yellow to reddish yellow when form complex with Al^{3+} [6].

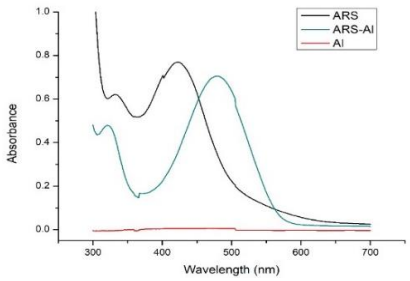

Fig. 2 UV-Visible spectrum of ARS, Al and Al-ARS complex with Al and ARS concentration of 20 ppm and 0.1 mM, respectively.

Figure 3 shows that the higher the concentration of Al, the higher the absorbance of Al-ARS complex. The increase in the concentration of Al had cause bathochromic shift from 423 nm to 467 nm. In addition, the spectrum shows an isosbestic point at 436 nm [7].

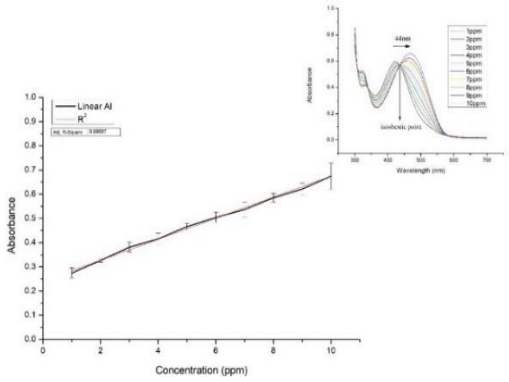

Fig. 3 Effect of Al concentration (1-10 ppm) with ARS concentration of 0.15 mM in acetate buffer solution pH 4.

Selectivity study has been carried out to study the effect of the presence of other interfering species such as Pb^{2+}, Cu^{2+}, Fe^{2+} and Zn^{2+} ions [8]. Interference study was carried out using separate and mix methods. Based on the study, both separate and mix methods show no significant interference from all the ions tested (Figure 4).

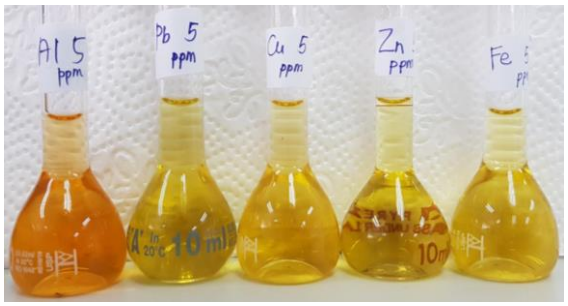

Fig. 4 Interference study (separate method) with concentration of each interfering species was fixed at 5 ppm in acetate buffer solution pH 4.

ARS has been immobilized in alginate to form ARS-alginate film. ARS-alginate solution has been poured into a mould and was dried for 3 to 5 days to form a film. The colour of the ARS-alginate film become darker as compared to the solution form. ARS-alginate film was cut into 1.25 cm x 4 cm before measurement using UV-Vis spectrophotometer (Figure 5). The size of ARS-alginate film is based on the size of cuvette used in the solution work method.

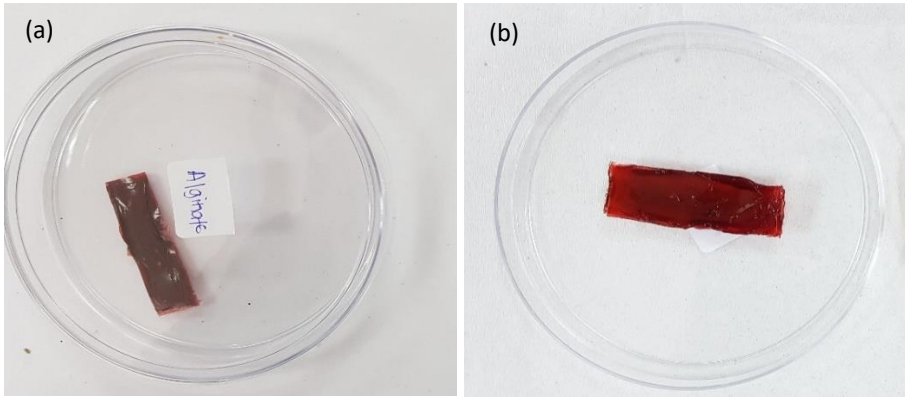

Fig. 5 ARS-alginate film immobilized with 0.01 g ARS (a) before and (b) after has been immersed in Al^{3+} ion solution.

6 CONCLUSION

A simple spectrophotometric method for detection of Al^{3+} ion has been developed. The spectrophotometric method was able to detect the Al^{3+} concentration in the range of 1-10 ppm. This method showed a good selectivity where the possible interfering ions such as Pb^{2+}, Fe^{2+}, Cu^{2+} and Zn^{2+} ions do not show any significant interference toward Al^{3+} determination. ARS indicator has been immobilized inside alginate to form ARS-alginate film.

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