SPECTROPHOTOMETRIC DETERMINATION OF MOLYBDENUM ION WITH ALIZARIN RED S REAGENT

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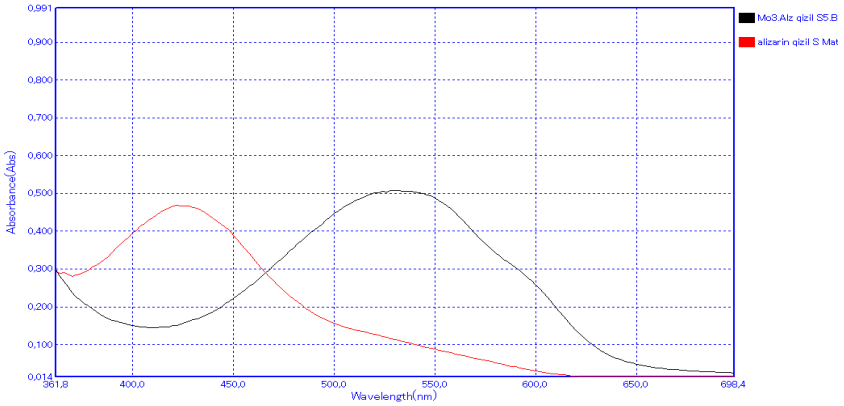
Abstract: The determination of molybdenum(VI) ions in environmental samples is an important analytical task. In this study, a spectrophotometric method for the determination of molybdenum(VI) ions is proposed. Alizarin Red S was selected as a sensitive analytical reagent, and the reflectance spectra of the molybdenum(VI)–Alizarin Red S system were recorded on an EMC-30PC-UV-1800 Spectrophotometer.

Key words: molybdenum, alizarin red s, reagent, spectrophotometric, complex.

Introduction. The determination of molybdenum(VI) ions in environmental samples is an important analytical task because molybdenum is widely distributed in natural waters, soils, industrial effluents, and plant systems, where its concentration must be carefully monitored due to both ecological and health-related concerns [1], [4], [6]. Although molybdenum is an essential trace element for many biological processes, its excessive accumulation in environmental matrices may lead to toxic effects, disturb soil–plant interactions, and increase human exposure through the food chain [4]–[6]. Recent studies have shown that the mobility, bioavailability, and environmental behavior of molybdenum strongly depend on matrix composition, pH, and geochemical conditions, which complicates its accurate determination in real samples [4], [6], [7]. (MDPI) In recent years, considerable attention has been devoted to the development of rapid, sensitive, and selective methods for molybdenum(VI) determination. Modern approaches include portable colorimetric test strips, polymer inclusion membrane-based sensors, fluorescent nanoplatforms, and improved spectrophotometric procedures for trace analysis [1]–[3]. These studies confirm that, despite the high accuracy of advanced instrumental techniques, spectrophotometric methods remain highly attractive because of their simplicity, low cost, operational convenience, and suitability for routine environmental analysis [1]–[3]. In addition, current environmental challenges, including molybdenum contamination in wastewater, agricultural systems, and industrial residues, further increase the demand for reliable analytical procedures applicable to different sample matrices [4], [5], [7], [8]. (MDPI) From this point of view, the use of sensitive organic chromogenic reagents remains a promising direction in the spectrophotometric determination of molybdenum(VI). Alizarin Red S is of particular analytical interest due to its ability to form colored complexes with metal ions and thus provide a convenient basis for optical measurement. Therefore, the development of a spectrophotometric method based on the interaction of molybdenum(VI) ions with Alizarin Red S is both theoretically and practically significant for the rapid and reliable determination of molybdenum in

environmental samples. Such an approach may contribute to expanding simple analytical tools for monitoring molybdenum in natural and technogenic objects [1]–[3]. The suitability of spectrophotometric strategies for real sample analysis is also supported by recent studies reporting successful Mo(VI) determination in water, food, and other complex matrices using optical and membrane-based sensing systems [1], [2]. (MDPI)

Methods: At present, a variety of methods are available for the determination of molybdenum(VI) ions in environmental samples; however, several limitations restrict their wide practical application. Among these methods, spectrophotometric techniques are widely used for the determination of metal ions because of their simplicity, sensitivity, and relatively low cost. In the present study, a spectrophotometric method for the determination of molybdenum(VI) ions was developed. Alizarin Red S (ARS) was selected as an organic analytical reagent for this purpose. The reflectance spectra of the molybdenum(VI)–Alizarin Red S system were measured relative to a reference solution using an EMC-30PC-UV-1800 spectrophotometer.



1-picute. Spectrum of the immobilized Alizarin Red S (ARS) complex with Mo(VI) ions: 1 - ARS (λmax = 428 nm); 2 - Mo(VI)–ARS complex (λmax = 530 nm).

The obtained results showed that the maximum absorption wavelength of Alizarin Red S was **λmax = 428 nm**, whereas the maximum absorption wavelength of its complex with molybdenum(VI) ions was observed at **λmax = 530 nm**. Thus, the difference in wavelengths was found to be **Δλ = 102 nm**. Such a significant bathochromic shift indicates the formation of a colored complex between molybdenum(VI) ions and Alizarin Red S. The high contrast of the reaction demonstrates that Alizarin Red S can be successfully used as a sensitive analytical reagent for the spectrophotometric determination of molybdenum(VI) ions.

Results: To determine molybdenum ions, technogenic water samples from the Shurtan Oil and Gas Production Department located in the Kashkadarya region were used, and the amount of molybdenum was determined using the introduction–recovery method.

Table 1

Results of the spectrophotometric determination of molybdenum (VI) in wastewater from the Shurtan Oil and Gas Production Department (n = 5; P = 0.95)

Me^{6+}	Entered, mg/l	Found, mg/l	S	Sr
	1,00	1,24±0,02	0,015	0,012

Mo^{6+}	1,50	1,86±0,06	0,051	0,027
	2,00	2,47±0,03	0,026	0,011

The results demonstrated that, in the sorption-spectroscopic determination of molybdenum ions, the S value did not exceed 0.051, while the Sr value did not exceed 0.027. These findings indicate that the proposed method is sufficiently precise and reliable for the determination of molybdenum ions in environmental samples.

Conclusion: The developed method enables the reliable determination of **molybdenum(VI) ions**, and the mechanism of complex formation between the analytical reagent and molybdenum(VI) ions was investigated. The optimum reaction conditions, the influence of interfering ions, and the stoichiometric ratios of the reaction were established. The low values of **S** and **Sr** confirm the satisfactory precision and reproducibility of the method, indicating its potential for wide application in the determination of molybdenum(VI) ions in environmental samples.

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