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NEW SIMPLE AND RAPID SPECTROPHOTOMETRIC METHODS FOR THE DETERMINATION OF TRACE LEVEL GOLD(III) USING 2,2',3,4-TETRAHYDROXY-3'-SULPHO-5'-CHLORAZOBENZENE PRESENCE OF THE CATIONIC SURFACTANTS**P.R.Mammadov***Baku State University**poladazer@gmail.com*

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It is shown that gold(III) with 2,2',3,4-tetrahydroxy-3'-sulpho-5'-chlorazobenzene (TSXAB) the rapid reacts in pH 5–6 acidic solution to form brownish-yellow complex and in pH 4–5 acidic solution to form brownish complexes in the presence of the cationic surfactants – cetylpyridinium chloride (CPCl), cetylpyridinium bromide (CPBr) and cetyltrimethylammonium bromide (CTMABr). The absorption spectra of the Au(III)–TSXAB system is a curve with the maximum absorbance at 490 nm and molar absorption coefficient of $2.3 \cdot 10^4 \text{ l mol}^{-1} \text{ cm}^{-1}$ in aqueous media. The absorption spectra of the Au(III)–TSXAB–CPCl, Au(III)–TSXAB–CPBr and Au(III)–TSXAB–CTMABr systems is a curves with the maximum absorbances at 520, 520 and 540 nm and molar absorption coefficients of $3.78 \cdot 10^4$, $3.67 \cdot 10^4$ and $3.81 \cdot 10^4 \text{ l mol}^{-1} \text{ cm}^{-1}$ in micellar media respectively. The absorbance was linear for 0.584–5.61 mkg/ml of Au(III) in the Au(III)–TSXAB–CPCl, Au(III)–TSXAB system and 0.428–6.362, 0.435–6.221, 0.436–6.832 mkg/ml of Au(III) in the Au(III)–TSXAB–CPCl, Au(III)–TSXAB–CPBr and Au(III)–TSXAB–CTMABr systems, respectively. The Sandell's sensitivity for Au(III) were found to be 7 mkg cm^{-2} in Au(III)–TSXAB system and 5, 6, 5 mkg/cm in the Au(III)–TSXAB–CPCl, Au(III)–TSXAB–CPBr, Au(III)–TSXAB–CTMABr systems. The proposed methods was successfully used in the determination of Au(III) in several synthetic mixtures. The relative standard deviation ($n = 5$) was (0–2.0)%, for Au(III) indicating that this methods are highly precise and reproducible. The results obtained agree well with synthetic mixture samples analyzed by inductively coupled plasma optical emission spectrometry.

Keywords: *spectrophotometric, Au(III), determination, 2,2',3,4-tetrahydroxy-3'-sulpho-5'-chlorazobenzene, cationic surfactants.*

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Introduction

The large amounts of gold are still used in the manufacture of coins, medals, jewelry, art and also has a number of uses in industry, medicine, and other fields [1]. Therefore, it is clear that in the arsenal of analysts there must be simple and rapid methods to determine Au(III) in a wide concentration range with the highest possible sensitivity accuracy. Although many modern techniques, such as inductively coupled plasma atomic emission spectrometry (ICP-AES) [2], inductively coupled plasma mass spectrometry (ICP-MS) [3, 4], electrothermal atomic absorption spectrophotometry (EAAS) [5, 6], graphite furnace atomic absorption spectrophotometry (GFAAS) [7] are available for the determination of silver at trace levels in numerous complex materials.

Factors such as the low cost of instrument, technical know-how, consumable and costly maintenance of technique restrict the wider applicability of these techniques, particularly in laborato-

ries with limited budget in developing countries and for field work lack of any requirement for consumables and almost no maintenance, have caused spectrophotometric methods to remain a popular technique. The wide variety of spectrophotometric methods for determination of Au(III) have been reported, each chromogenic system has its advantages and disadvantages with respect to sensitivity, selectivity and convenience [8–12]. The azocompounds on the basis of pyroghallol had widely been applied for the determination of noble metal ions, this type of reagent has higher sensitivity and high selectivity [13]. In the search for more sensitive azocompounds on the base of pyroghallol reagent, in this work, a reagent 2,2',3,4-tetrahydroxy-3'-sulpho-5'-chlorazobenzene (TSXAB) was synthesized according to the method of [13] and a color reaction of TSXAB with Au(III) in aqueous and in the presence of the cationic surfactants was carefully studied. The aim of present study is to develop a simple direct spectrophotometric method

for the trace determination of Au with TSXAB in aqueous solutions, and in the presence of cationic surfactants, such as cetylpyridinium chloride, cetylpyridine bromide and cetyltrimethylammonium bromide in aqueous solutions.

Experimental part

Instrumentation

The absorbance of solutions was measured with a Perkin Elmer (United States) (Model: Lambda-40) double-beam UV/VIS spectrophotometer and with a KFK-2 photoelectrocolorimeter (Russia), with 1 cm matched quartz cells.

The pH values of solutions was controlled on the Ionomer İ-121 (Russia) with glass electrode customized by standart bufer solutions.

A Perkin Elmer (United States) (Model: Optima-2100DV) Inductively Coupled Plasma Optical Emission Spectrometer (ICP-OES) was used for comparing the results.

Standard solutions

A 10^{-2} M 100 ml standard solution of Au was prepared by dissolving 1.967 g of Au (purity 99.99%) in aqua regia by warming, evaporating the solution to dryness, dissolving the residue in hydrochloric acid, evaporating the solution to half its volume, cooling and diluting with water to 100 ml in calibrated flask. Working solutions were prepared by appropriate dilution of standard solution. The gravimetric method (using hydrogen peroxide) was used for controlling of gold(III) concentration in the standard solution [1].

2,2',3,4-tetrahydroxy-3'-sulpho-5'-chlorazobenzene (TSXAB) ($2 \cdot 10^{-3}$ M). The reagent was synthesized according to the method [13]. The solution was prepared by dissolving the requisite amount of TSXAB in a known volume of distilled water and ethanol (1:1). More dilute solution of the reagent was prepared as required.

Cationic surface-active substances (CSAS). $1 \cdot 10^{-2}$ M cationic surface-active substances (surfactants) – cetylpyridine chloride (CPCl), cetylpyridine bromide (CPBr) and cetyltrimethylammonium bromide (CTMABr) was preparing by dissolving the requisite amounts of surfactants in distilled water.

Aqueous ammonia solution. A 100 ml solution of aqueous ammonia was prepared by

diluting 10 mL of concentrated NH_3 (28%–30%) ACS grade with distilled water. The solution was stored in a glass bottle.

EDTA solution. A 100 ml stock solution of EDTA (0.1% w/v) was prepared by dissolving 128 mg of ethylenediaminetetraacetic acid, disodium salt dehydrate in 100 ml distilled water.

Other solutions. Solutions of a large number of inorganic ions and complexing agents were prepared from their grade, or equivalent grade, water soluble salts.

Results and discussion

Au(III) with 2,2',3,4-tetrahydroxy-3'-sulpho-5'-chlorazobenzene rapidly reacts in pH 5–6 acidic solution to form brownish-yellow complex and in pH 4–5 acidic solution to form brownish complexes in presence of the cationic surfactants.

Absorption spectra. The absorption spectra of the Au(III)–TSXAB– is a curve with the maximum absorbance at 490 nm and an average molar absorption coefficient of $2.3 \cdot 10^4 \text{ l mol}^{-1} \text{ cm}^{-1}$ in aqueous media. The absorption spectra of the Au(III)–TSXAB– CPCl, Au(III)–TSXAB–CPBr and Au(III)–TSXAB–CTMABr systems is a curve with the maximum absorbances at 520, 520 and 540 nm and average molar absorption coefficients of $3.78 \cdot 10^4$, $3.67 \cdot 10^4$ and $3.81 \cdot 10^4 \text{ l mol}^{-1} \text{ cm}^{-1}$ in micellar media, respectively (Figure).

Effect of acidity. Of the various pH 0–12 studied, pH 5.0–6.0 found to be the best acid environment for the Au(III)–TSXAB system and pH 4.0–5.0 for the Au(III)–TSXAB– CPCl, Au(III)–TSXAB–CPBr and Au(III)–TSXAB–CTMABr systems at room temperature $(25 \pm 5)^\circ\text{C}$. The absorbance of the reagent solution and the all systems depends on the medium pH; therefore, the absorption spectra are studied relatively to a blank experiment against the background of control experiment (R and R+CSAS), which was prepared in the same conditions.

Effect of time. The reaction is fast. Constant maximum absorbance was obtained after 10 min for Au(III)–TSXAB system in aqueous media and 5 min for Au(III)–TSXAB– CPCl, Au(III)–TSXAB–CPBr and Au(III)–TSXAB–CTMABr systems in micellar media, respectively.

Absorption spectra of Au(III)-TSXAB (1), Au(III)-TSXAB-CPCl (2), Au(III)-TSXAB-CPBr (3) and Au(III)-TSXAB-CTMABr (4).

Effect of temperature. The absorbance at different temperatures, 0–80°C, of a 25 ml solution of all systems was measured according to the standard procedure. The absorbance was found to be strictly unaltered through-out the temperature range of 10–40°C. Therefore, all measurements were performed at room temperature (25±5)°C.

Stoichiometry. The component ratio in the complexes was found using the method of isomolar series, the Starik and Barbanell relative yield method and the equilibrium shift method. All the methods showed that the component ratio were 1:2 in the double Au(III)-TSXAB system and 1:2:2 in the triple Au(III)-TSXAB-CPCl, Au(III)-TSXAB-CPBr, Au(III)-TSXAB-CTMABr systems. The number of protons displaced upon complexation was determined by the Astakhovs method, and the indicated component ratio in the complexes was confirmed [14].

Effect of the reagent and cationic surfactants concentration. Different molar excesses of TSXAB and cationic surfactants were added to a fixed Au(III) concentration and the absorbance was measured according to the standard procedure. It was observed that a 1 mkg/ml of silver metal (optical path 1 cm in length), the reagent and cationic surfactants molar ratios produced a constant absorbance of Au(III)-TSXAB-CPCl, Au(III)-TSXAB-CPBr, Au(III)-TSXAB-CTMABr systems. For all subsequent measurements, 2 ml of $2 \cdot 10^{-4}$ M TSXAB reagent and 4 ml of $2 \cdot 10^{-4}$ M cationic surfactants was added.

Analytical performance of the methods

Calibration graph. The effect of metal concentration was studied in the range of 0.01–100 mkg/ml, distributed in four different sets (0.01–0.1, 0.1–1, 1–10 mkg/ml) for convenience of the measurement. The absorbance was linear for 0.584–5.61 mkg/ml of Au(III) in the Au(III)-TSXAB system and 0.428–6.362 mkg/ml, 0.435–6.221 mkg/ml, 0.436–6.832 mkg/ml of Au(III) in the Au(III)-TSXAB-CPCl, Au(III)-TSXAB-CPBr, Au(III)-TSXAB-CTMABr systems respectively. From the slope of the calibration graph, the average molar absorption coefficient was found to be $2.3 \cdot 10^4$ l mol⁻¹ cm⁻¹ for Au(III)-TSXAB system and $3.78 \cdot 10^4$ l mol⁻¹ cm⁻¹, $3.67 \cdot 10^4$ l mol⁻¹ cm⁻¹ and $3.81 \cdot 10^4$ l mol⁻¹ cm⁻¹ in the Au(III)-TSXAB-CPCl, Au(III)-TSXAB-CPBr, Au(III)-TSXAB-CTMABr systems respectively. The selected analytical parameters obtained as a result of the optimization experiments are summarized in Table 1.

Precision and accuracy. The precision of the present method was evaluated by determining different concentrations of Au (each analyzed at least five times). The relative standard deviation ($n=5$) was (0–2.0) %, for 0.1–8 mkg of Au(III), indicating that this method is highly precise and reproducible. The Sandell's sensitivity for Au(III) made up 7 mkg/cm² in Au(III)-TSXAB system and 5mkg cm⁻², 6 mkg cm⁻², 5 mkg cm⁻² in the Au(III)-TSXAB-CPCl, Au(III)-TSXAB-CPBr, Au(III)-TSXAB-CTMABr systems respectively.

Effect of foreign ions. The effect of over 30 cations, anions and complexing agents on the determination of only 1 mkg/ml of Au(III) was studied. The criterion for interference was

an absorbance value varying by more than 5% from the expected value for Au(III) alone. The results are given in Table 2.

Table 1. Selected analytical parameters obtained by optimization experiments

Parameters	Studied range	Selected value			
		Au(III)–TSXAB	Au(III)–TSXAB–CPCl	Au(III)–TSXAB–CPBr	Au(III)–TSXAB–CTMABr
Wavelength/ $\lambda_{\max}$, nm	200–800	490	520	520	540
Wavelength/ λ_{opt} , nm	–	490	540	540	540
pH	0–12	5–6	4–5	4–5	4–5
Time, h	1 – 24h	5–10 min	5–6 min	5–6 min	5–6 min
Temperature, $^{\circ}\text{C}$	0–80 $^{\circ}\text{C}$	25 $\pm$ 5 $^{\circ}\text{C}$	25 $\pm$ 5 $^{\circ}\text{C}$	25 $\pm$ 5 $^{\circ}\text{C}$	25 $\pm$ 5 $^{\circ}\text{C}$
Au(III):TSXAB:CSAS	1:10–10:1	1:2	1:2:2	1:2:2	1:2:2
Molar absorption coefficient, $\text{l mol}^{-1}\text{cm}^{-1}$	–	2.30 $\cdot 10^4$	3.78 $\cdot 10^4$	3.67 $\cdot 10^4$	3.81 $\cdot 10^4$
Linear range/mkg l^{-1}	0.01–10	0.584–5.61	0.428–6.362	0.435–6.221	0.436–6.832
lg β	–	8.58	11.58	11.26	12.88
Sandell's sensitivity/mkg cm^{-2}	0.1–10	7	5	6	5
Relative Standard	0–5	0–2	0–2	0–2	0–2

Table 2. Tolerance limits of foreign ions, tolerance ratio [Ions(x)]/Au (w/w)

Ions x	Au(III)–TSXAB	Au(III)–TSXAB–CPCl	Au(III)–TSXAB–CPBr	Au(III)–TSXAB–CTMABr	[12]
Na(I)	100	110	115	150	100
K(I)	100	145	150	180	100
Mg(II)	120	160	160	180	100
Ca(II)	120	170	170	180	100
Cr(III)	120	175	175	185	100
Fe(III)	30	45	45	55	25
Cu(II)	60	80	80	95	50
Cd(II)	100	130	130	140	100
Hg(II)	105	145	145	160	100
Mo(II)	105	135	145	160	100
Co(III)	110	150	150	165	100
Zn(II)	115	140	150	160	100
Be(III)	110	150	150	155	100
Sn(IV)	25	35	35	40	25
Mn(II)	120	155	155	155	100
V(V)	30	50	50	60	25
Ag (I)	25	45	45	45	25
Ga(III)	100	120	120	130	100
La(III)	110	140	140	150	100
Ta(IV)	110	140	140	150	100
Ni(II)	120	155	155	165	100
Pb(II)	25	35	35	45	25
NO_3^-	250	270	270	285	200
SO_4^{2-}	110	1250	1250	1250	1000
Cl^-	1150	1220	1220	1240	1000
F^-	120	125	135	145	100
HCO_3^-	130	145	155	170	100
$\text{C}_2\text{O}_4^{2-}$	1100	1140	1140	1250	1000
EDTA	650	730	760	780	500
$\text{C}_4\text{H}_4\text{O}_6^{2-}$	260	280	280	300	200
CH_3COO^-	110	130	130	140	75

Table 3. Determination of Au(III) in synthetic mixtures

Sample	Composition of mixture (mkq/ml)	Proposed method			ICP-OES	
		Au(III) mkq/ml		Recovery $\pm s^b$ (%)	Au(III) mkq/ml Found	Recovery $\pm s$ (%)
		Added	Found ^a			
A	Au ³⁺	1.5	1.52	102 $\pm$ 0.3	1.51	101 $\pm$ 0.3
		2.0	2.04	104 $\pm$ 0.2	2.02	102 $\pm$ 0.2
B	As in A + Cu ²⁺ (25)+ Fe ³⁺ (25)	1.5	0.51	101 $\pm$ 0.4	0.52	102 $\pm$ 0.4
		2.0	2.03	103 $\pm$ 0.2	2.02	102 $\pm$ 0.2
C	As in B+Mg ²⁺ (25)+Co ³⁺ (25)	1.5	1.51	101 $\pm$ 0.2	1.50	100 $\pm$ 0.2
		2.0	2.02	102 $\pm$ 0.2	2.01	101 $\pm$ 0.2
D	As in C +Cr ³⁺ (25)+Ca ²⁺ (25)	1.5	1.49	98 $\pm$ 0.2	1.495	99 $\pm$ 0.1
		2.0	2.02	102 $\pm$ 0.1	2.025	101 $\pm$ 0.1
E	As in D +Ag ⁺ (25)+Hg ₂ ²⁺ (25)	1.5	1.48	97 $\pm$ 0.3	1.49	97 $\pm$ 0.3
		2.0	2.02	102 $\pm$ 0.2	2.01	101 $\pm$ 0.2

^a Average of five analysis of each sample; ^b The measure of precision is the standard deviation (s).

Applications

The Au(III)–TSXAB–CTMABr system was successfully applied to the determination of Au(III) in a series of synthetic mixtures of various compositions (Table 3).

Determination of Au(III) in synthetic mixtures. Several synthetic mixtures of various compositions containing Au(III) and diverse ions of known concentrations were determined by the present method using EDTA as a masking agent; the results were found to be highly reproducible. The results of synthetic mixtures analysis by the spectrophotometric method were found to be in excellent agreement with those obtained by ICP-OES. The results are given in Table 3. Accurate recoveries were achieved in all solutions.

General Procedure

To synthetic mixtures samples of various compositions containing 1-2 mkg/ml Au(III) in 25 ml volumetric flask was mixed with 2 ml of $2 \cdot 10^{-4}$ M TSXAB reagent solution and 4 ml of $2 \cdot 10^{-4}$ CTMABr solution with subsequent followed by the addition of 5 ml initial solution of EDTA (0.1mass.% w/v). The mixture was diluted up to the mark with pH 5 buffer solutions. After 5 min the absorbance was measured at 540 nm against the background of the corresponding reagent. The gold(III) content in the synthetic mixtures sample was determined using a concurrently prepared calibration graph.

Conclusion

In the present work, a simple, rapid, sensitive and selective methods was developed for the determination of Au(III) in difficult sample matrices. Therefore, this methods can be successful-

ly applied to the monitoring of trace amounts of Au(III) in industrial and natural samples.

References

1. Busev A.I., Ivanov V.M. Analiticheskaya himiya zolota. M.: Nauka, 1973. 263 s.
2. Steharnik M., Todorović M., Manojlović D. Determination of trace elements in refined gold samples by inductively coupled plasma atomic emission spectrometry. J. Serb. Chem. Soc. 2013. No 7. P. 565–577.
3. Yim S., Choi M., Chae J. Direct determination of gold in rock samples using collision cell quadrupole ICP-MS. J. Am. Soc. Mass Spectrom.. 2012. № 1. P. 17117–8.
4. Juvonen R., Lakomaa T., Soikkeli L. 2002. Determination of Au and the platinum group elements in geological samples by ICP-MS after nickel sulphide fire assay: difficulties encountered with different types of geological samples. Talanta. 58:595–603.
5. Jiang W., Z., Hu B., Duan J. Electrothermal vaporization inductively coupled plasma atomic emission spectrometry for the determination of Au, palladium, and platinum using chelating resin YPA4 as both extractant and chemical modifier. Talanta. 2004. 63: P. 585–292.
6. Medved J., Bujdos M., Matús P., Kubová J. Determination of trace amounts of gold in acid-attacked environmental samples by atomic absorption spectrometry with electrothermal atomization after preconcentration. Anal Bioanal Chem. 2004. No 1. P. 60–65.
7. Kryazhov A., Panova S., Kolpakova N., Pshenichkin A. Determination of Au, Pb, Ni and Co in Mineral Raw Materials by Atomic Absorption Spectroscopy with Graphite Furnace. Procedia Chem. 2014. No 10. P. 437–440.
8. Balcerzak M., Kosiorek A., Swiecicka E. Morin as a spectrophotometric reagent for Au. J. Anal. Chem. 2006. V. 61. P. 119–23.
9. El-Zawawy F.M., El-Shahat M.F., Mohamed A.A. Spectrophotometric determination of silver and Au with 5-(2,4-dihydroxybenzylidene)rhodanine and cationic surfactants. Analyst. 1995. V. 120. P. 549–54.

10. Fujita Y., Mori I. and Matsuo T. Spectrophotometric determination of Au(III) by an association complex formation between Au thiamine and phloxine. Anal. Sci. 1999. V. 15. P. 1009–12.
11. Gangadharappa M., Reddy P.R., Reddy V.R. and Reddy S. Direct spectrophotometric determination of Au(III) using 2'-aminoacetophenone isonicotinoyl hydrazone (2-AAINH). J. Indian Chem. Soc. 2004. V. 81. P. 525–7.
12. Rubina M., Jamaluddin A., Najma M., Khan H. A simple and selective spectrophotometric method for the determination of trace gold in real, environmental, biological, geological and soil samples using bis(salicylaldehyde) orthophenylenediamine. Anal. Chem. Insights. 2008. V. 3. P. 75–90.
13. Gambarov D.G. Novyi class fotometricheskikh reagentov – azosodinenii na osnove pirogallola. Dis... dok. him. nauk. M.: MGU. 1984. S. 380.
14. Bulatov M.I. Kalinkin N.P. Prakticheskoe rukovodstvo po fotometricheskim metodam analiza. L.: Himia. 1986. 432 s.

YENİ SADƏ VƏ SÜRƏTLİ SPEKTROFOTOMETRİK ÜSULLARLA QIZILIN(III) 2,2', 3,4-TETRAHİDROKSİ-3'-SULFO-5'-XLORAZOBENZOL İLƏ KATION TİP SƏTHİ-AKTİV MADDƏLƏR İŞTİRAKINDA TƏYİNİ

P.R.Məmmədov

Qızıl(III) 2,2',3,4-tetrahidroksi-3'-sulfo-5'-xlorazobenzol (TSXAB) ilə pH 5–6 turşuluqlu mühitdə sürətlə reaksiyaya girərək qəhvəyi-sarı rəngli kompleks və pH 5–6 turşuluqlu mühitdə kation tip səthi aktiv maddələr- cetilpiridin xlorid (CPCl), cetilpiridin bromid (CPBr) və cetiltrimetilammonium bromid (CTMABr) iştirakında isə qəhvəyi rəngli komplekslər əmələ gətirir. Au(III)–TSXAB sisteminin işıq udma spektrində maksimum 490 nm-də və molyar udma əmsallı $2.3 \cdot 10^4$ l mol⁻¹sm⁻¹ müşahidə olunur. Au(III)–TSXAB–CPCl, Au(III)–TSXAB–CPBr və Au(III)–TSXAB–CTMABr TSXAB sistemlərinin işıq udma spektrlərində maksimumlar 520, 520 və 540 nm dalğa uzunluqlarında müşahidə olunur və molyar udma əmsalları isə uyğun olaraq $3.78 \cdot 10^4$, $3.67 \cdot 10^4$ and $3.81 \cdot 10^4$ l mol⁻¹ sm⁻¹ qiymətlər alır. Optiki sıxlığın xəttiliyi Au(III) üçün 0.584–5.61 mkg/ml miqdarında Au(III)–TSXAB sistemində və 0.428–6.362 mkg/ml, 0.435–6.221 mkg/ml, 0.436–6.832 mkg/ml miqdarlarında isə uyğun olaraq Au(III)–TSXAB–CPCl, Au(III)–TSXAB–CPBr və Au(III)–TSXAB–CTMABr sistemlərində olur. Sendel həssaslığı Au(III) üçün Au(III)–TSXAB sistemində 7 mkg cm⁻² və Au(III)–TSXAB–CPCl, Au(III)–TSXAB–CPBr və Au(III)–TSXAB–CTMABr TSXAB sistemlərində isə 5, 6, 5 mkg/cm müəyyən edilmişdi. Təklif olunan metodlar qızılın (III) bir neçə sintetik qarışıqlarda təyininə uğurla tətbiq olunmuşdu. Nisbi standart kənara çıxma Au(III) üçün (0–2.0)% olmağı, bu üsulların yüksək dəqiqliyinin və təkrarlılığının olduğunu göstərir. Alınan nəticələr sintetik qarışıq nümunələrinin induktiv əlaqəli plazma optik emissiya spektrometriyası üsulu ilə analizinin nəticələri ilə müqayisə edilmişdi.

Açar sözlər: spektrofotometrik, Au(III), təyin, 2,2',3,4-tetrahidroksi-3'-sulfo-5'-xlorazobenzen, kation tip səthi-aktiv maddələr.

НОВЫЙ ПРОСТОЙ И БЫСТРЫЙ СПЕКТРОФОТОМЕТРИЧЕСКИЙ МЕТОД ОПРЕДЕЛЕНИЯ СЛЕДОВЫХ КОЛИЧЕСТВ ЗОЛОТО (III) С ИСПОЛЬЗОВАНИЕМ 2, 2',3,4-ТЕТРАГИДРОКСИ-3'-СУЛЬФО-5'-ХЛОРАЗОБЕНЗОЛА В ПРИСУТСТВИИ КАТИОННЫХ ПОВЕРХНОСТНО-AКТИВНЫХ ВЕЩЕСТВ

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Показано, что золото(III) с 2,2',3,4-тетрагидрокси-3'-сульфо-5'-хлоразобензолом (ТСХАБ) быстро реагирует в кислой среде при pH 5–6 с образованием коричневатого-желтого комплекса и при pH 4–5 с образованием коричневых комплексов в присутствии катионных поверхностно-активных веществ – хлорида цетилпиридиния (ЦПСи), бромида цетилпиридиния (ЦПБр) и бромида цетилтриметиламмония (ЦТМАБр). Спектры поглощения Au(III)–ТСХАБ представляют собой кривую с максимальным светом поглощением при 490 нм и молярным коэффициентом поглощения $2,3 \cdot 10^4$ моль⁻¹см⁻¹ в водных средах. Спектры поглощения систем Au(III)–ТСХАБ–CPCl, Au(III)–ТСХАБ–CPBr и Au(III)–ТСХАБ–CTMABr представляют собой кривую с максимальными светом поглощением при 520, 520 и 540 нм. и молярные коэффициенты поглощения составляют $3.78 \cdot 10^4$, $3.67 \cdot 10^4$ и $3.81 \cdot 10^4$ моль⁻¹см⁻¹ соответственно. Подчиняемость закону Бера Au(III) в двойной системе Au(III)–ТСХАБ наблюдалось в пределах 0.584–5.61 мкг/мл, а в тройных системах Au(III)–ТСХАБ–ЦПСи, Au(III)–ТСХАБ–ЦПБр, Au(III)–ТСХАБ–ЦТМАБр – в пределах 0.428–6.362, 0.435–6.221 и 0.436–6.832 мкг мл⁻¹ соответственно. Чувствительность Сэнделла для Au(III) составила 7 мкг/см в системе Au(III)–ТСХАБ, и 5, 6, 5 мкг/см в системах Au(III)–ТСХАБ–ЦПСи, Au(III)–ТСХАБ–ЦПБр и Au(III)–ТСХАБ–ЦТМАБр. Предложенные методы были успешно использованы при определении Au(III) в нескольких искусственных смесях. Относительное стандартное отклонение составляло (0–2.0)% для Au(III), что свидетельствует о высокой точности и воспроизводимости этих методов. Полученные результаты хорошо согласуются с образцами искусственной смеси, проанализированными методом оптической эмиссионной спектроскопии с индуктивно связанной плазмой.

Ключевые слова: спектрофотометрический, Au(III), определение, 2,2',3,4-тетрагидрокси-3'-сульфо-5'-хлоразобензол, катионные поверхностно-активные вещества.