



Tikrit Journal of Pure Science

ISSN: 1813 – 1662 (Print) --- E-ISSN: 2415 – 1726 (Online)

Journal Homepage: <http://tjps.tu.edu.iq/index.php/j>



Spectrophotometric Determination of sulphadiazine by oxidative coupling reaction with ortho-amino phenol as reagent

Aisha A. Abd , Ali I. Khaleel , Faiez M. Hamed

Department of Chemistry , College of Science, University Tikrit, Iraq

DOI: <http://dx.doi.org/10.25130/tjps.24.2019.070>

ARTICLE INFO.

Article history:

-Received: 24 / 4 / 2018

-Accepted: 5 / 9 / 2018

-Available online: / / 2019

Keywords: Spectrophotometric, sulphadiazine, determination, O-aminophenol, potassium periodate .

Corresponding Author:

Name: Aisha A. Abd

E-mail:

hamadalzreeg@gmail.com

Tel:

ABSTRACT

A simple, rapid and sensitive spectrophotometric method for determination of sulphadiazine (SDZ) in aqueous solution is described. The method is based on the oxidation of SDZ by potassium Periodate, and coupling with ortho-amino phenol to give a violet colour of maximum absorbance at 532 nm. Beer's law is obeyed over the concentration range of 5-40 µg /ml of SDZ with a ($R^2=0.9980$) and molar absorptivity 5581.6 L.mol⁻¹.cm⁻¹ and a relative error in the range of - 0.06 - 2.3 % and a relative standard deviation of not more than 0.31 %. The composition of the resulting product is also investigated and it is found to be 1:1. The method is successfully applied for the determination of SDZ in pure and pharmaceutical dosage forms, with recovery of not less than 101.1%.

Introduction

Sulphadiazine (SDZ), 4-amino-N-pyrimidin-2-yl-benzensulfonamide[1], its structural formula is shown in Illustration 1

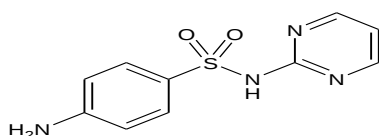


Illustration 1. Composition of sulphadiazine

The molecular formula is C₁₀H₁₀N₄O₂S, molecular weight of 250.3 gm/mol [2]. Sulphadiazine is one of the sulfonamide group, which belongs to the antibiotic group and is one of the oldest antibiotics that are still used so far. The sulphadiazine has several important applications in pharmaceuticals where it is used in injection molding[2,3].

A number of analytical methods for the determination of SDZ has been reported in the literature. These include high performance liquid chromatography coupled with on-line atmospheric pressure chemical ionization mass spectrometry (HPLC/APCI-MS)[4], cloud point extraction /flow injection-flame atomic absorption (CPE/FI-FAAS) spectrometry^[5], capillary zone electrophoresis[6],

inductively coupled plasma-atomic emission spectroscopy (ICP-AES)[7], liquid chromatography [8], UV-spectrophotometry [9], immune chromatographic assay [10], flow injection chemiluminescence[11], ion selective electrode [12]. Many UV-Visible spectrophotometric methods for the determination of SDZ have been developed. Most of them included diazotization of SDZ and then coupling with different coupling reagents, such as: 8-hydroxyquinoline [13], iminodibenzyl [14], histidine[15], γ-resorcinol acid[16], 2,5-dimethoxy aniline[17]. Other spectrophotometric methods are either based on the formation of charge transfer complex with alizarin derivatives[18], and with phenosafranin[19], or an oxidative coupling reaction of SDZ with 4-amino-N,N-dimethylaniline in the presence of dichromate [20], N,N-diethyl p-phenylenediamine sulphate and KIO₄ [21]. In the present work, a novel sensitive spectrophotometric method is developed for the determination of SDZ based on the oxidation of sulphadiazine by potassium periodate and coupling with ortho-amino phenol which results in the formation of purple product of λ_{max} at 532 nm .

Experimental

Appartus:

All absorption spectra are carried out by Spectro UV-VIS Double Beam Model UVD-3000/UV-3200 Dhaus with 1.0-cm quartz cells. Sensitive Balance type Sartorius BL 210S and Water bath type of Memmert are also used.

Chemicals

All chemicals used are of analytical grade.

Sulfadiazin solution (1000 µg / ml): It is prepared by dissolving 0.1 gm of SDZ in (1 ml) of hydrochloric acid (11.8 M) and the volume is completed to 1 ml with distilled water in a volumetric flask. Working solutions of SDZ is prepared by appropriate dilution of the stock solution with distilled water.

Ortho-amino phenol(0.01M) : It is prepared by dissolving 0.054 gm of o-amino phenol in (2 ml) of HCl (11.8) and the volume is completed to 50 ml with distilled water in a volumetric flask.

Potassium periodate solution (0.01M) : It is prepared by dissolving 0.230 gm of KIO_4 in distilled water and the volume is completed to 1ml with distilled water in a volumetric flask.

Procedure for assay of sulphadiazine in pharmaceutical preparation

Solution liquid injection veterinary (VAPCOTRIM) Each 1ml contains 200 mg sulphadiazine, (100 ml) from this solution 0.5 ml (0.1 gm SDZ) in 100 ml volumetric flask, treated as in the way of SDZ standard solution and then 25 ml of this new solution is diluted by distilled water in a volumetric flask of 100 ml to obtain a solution of 250 µg/ml SDZ.

Results and discussion**Recommended Procedure:**

Aliquots of standard solution of sulphadiazine 2 ml of 20 µg/ml are transferred to a 25-ml calibrated flasks followed by adding 1.5 ml of potassium periodate (with waiting for five minutes), and 0.5 ml of ortho-amino phenol is added. The absorbance at 532 nm is measured against a reagent blank.

Study of the Optimum Reaction Conditions:

The effect of various parameters on the absorption intensity of the formed coloured product is studied and the reaction conditions are optimized.

1- Effect of kind and amount of oxidising agent and time of oxidation:

In this study, 1.5 ml of 1×10^{-2} M of different oxidizing agents are investigated, the results are shown in table 1, it is clear that KIO_4 is the best so it is used in the subsequent experiments. The optimum volume of oxidizing agent is found to be 1.5 ml. The oxidation is completed within five minutes.

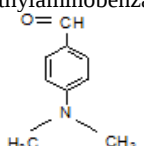
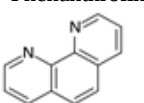
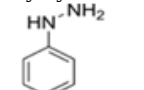
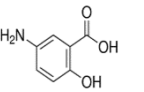
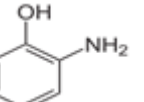
Table 1: Effect of type of oxidation agent

Oxidation agent (1×10^{-2} M)	Absorbance
KIO_3	0.143
KIO_4	0.437
$K_2Cr_2O_7$	0.392
$FeCl_3$	0.128

2- Effect of coupling reagent type:

Among various coupling reagent, Ortho-amino phenol showed the higher value of absorption. In this study 0.5 ml (1×10^{-2} M) of reagent, 1.5 ml of (1×10^{-2} M) KIO_4 . the results are shown in Table 2

Table 2: The effect of the coupling reagent type

Reagent (1×10^{-2} M)	Colour	Wave length (nm)	Absorbance
1, 4- Dimethylaminobenzaldehyde 	Yellow	452	0.016
1,10-Phenanthroline 	Colourless	313	0.77
Phenylhydrazine 	Colourless	304	0.260
5-aminosalicylic-acid 	Brown	435	0.094
Ortho-amino phenol 	Purple	532	0.440

3- Effect of coupling reagent amount:

This study is carried out by mixing different volumes (0.3 - 3 ml) of (1×10^{-2} M) ortho - amino phenol with constant volume (2ml) of 250 $\mu\text{g/ml}$ SDZ. The absorption when using (0.5 ml) of reagent showed a stability in the absorption value (0.475) while at higher volumes a higher values of absorption are obtained but the reading are not stable, so the volume of (0.5 ml) is choosed..

4- Effect of Temperture: The resulting product of the proposed meethod is studied at different temperatures. The reuslts indicate that the absoorbance values remain constant iin the tempeirature range 25-30 $^{\circ}\text{C}$, whereas, at higher temperatures thee absorbance valae decreases, indicating probably foor the dissociation of the prooduct . The coloured prooduct is stable foor more than 1 hors at rom temprature (25 $^{\circ}\text{C}$). Therefore thee degree of 25 $^{\circ}\text{C}$ is selected as the optimum temperature.

5- Effect of order of addition: The effect of order addition of the reactants are also investigated. The results are shown in table3 ,where the order S+O+R gives the highest value of absorption.

Table 3: order of addition

	order of addition	Absorbance
I	S+O+R	0.475
II	O+S+R	0.437
III	R+O+S	0.298

S is sulphadiazine , O is KIO_4 , R is ortho-amino phenol

6- Effect of base

This study is achieved by adding different sizes (0.5 - 2.5 ml) of ammonium hydroxide (0.5 M) to (2ml) of sulphadiazine (250 $\mu\text{g/ml}$) with (1.5 ml) of potassium periodate (1×10^{-2} M) then coupling with (0.5 ml) of ortho-amino phenol (1×10^{-2} M) , The solubility of the solutions is measured at 532 nm wavelength compared to the solution of each solution & the results are recorided in the table 5

Table 4 : Effect of base in the reaction of sulfadiazine with reagent ortho-amino phenol

ml of 0.5M NaOH	Absorbance
0.0	0.475
0.5	0.468
1	0.459
1.5	0.450
2	0.442
2.5	0.435

The above table shows that the addition of base solution leads to a slight decrease in the absorption of the colored product and therefore it does not used in subsequent experiments

7- Time of stability

After addition the reactants and dilution with distilled water in (25 ml) volumtric flask thee violet product iis directly appeared and no increase in absorption is observed after time of five minutes , and the color is stable for 60 minutes at least (table 8).

Table 5 : Stability of the reaction product sulphadiazne with ortho-amino phenol

Time, minute	Abs
5	0.475
10	0.473
15	0.475
20	0.474
25	0.475
30	0.476
35	0.477
40	0.476
45	0.476
50	0.477
60	0.476

Absorption Spectra

A purple-coloured product of λ_{max} at 532 nm is formed when 2 ml of sulphadiazine (250 $\mu\text{g/ml}$) is oxidized with 1.5 ml of potassium periodate (1×10^{-2} M) then coupling with 0.5 ml of ortho-amino phenol (1×10^{-2} M). Figure 2 showws the spectra of the formed purple product formed and tthe reagent blaank.

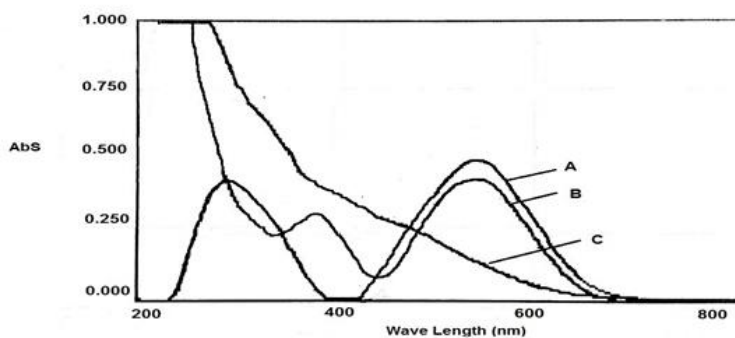


Figure 1. (A) Spectrum oof sample against reagent blank
(B) Spectrum of sample against distilled water, (c) Spectrum of blank against distilled water

Calibration Graph :

Employing the optimum conditions ,in series of volumetric flasks of 25 ml, (0.5-4ml) of sulphadiazine (250 $\mu\text{g/ml}$) , 1.5 ml (1×10^{-2} M) of potassium periodate and 0.5 ml (1×10^{-2} M) of ortho-

amino phenol are added. A liinear calibration graph foor sulphadiazine is obtained (Figure 2), which sows that Ber's law is obeeyed over the concentrtrtion range of 5-40 $\mu\text{g/ml}$ with R^2 of 0.9989. The molar

absorptivity of the purple product formed is found to be $5581.6 \text{ L.mol}^{-1} \cdot \text{cm}^{-1}$.

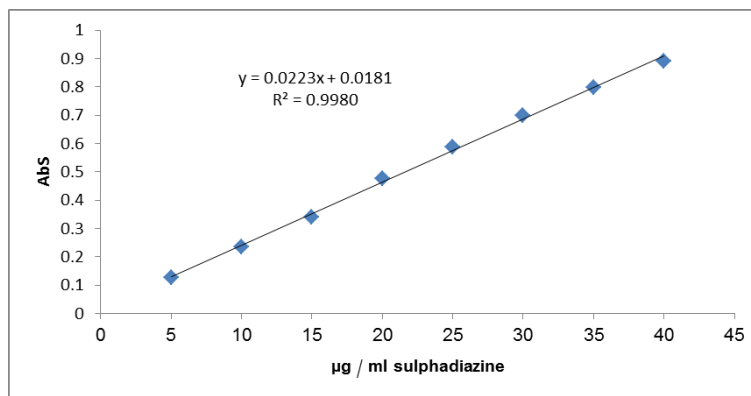


Figure 2. Calibration graph of sulphadiazine

3.4 Precision and Accuracy: sulphadiazine is determined at two different concentrations. The value of relative error, relative standard deviation and

recovery are calculated, the results are shown in Table 6. A satisfactory precision and accuracy are obtained.

Table 6. Accuracy and precision of the proposed method.

Taken sulphadiazine (µg/ml)	Found µg/ml	relative error	Recovery %	Average recovery %	RSD %
20	0.475	2.3	102.3	101.1	0.31
35	0.798	-0.06	99.9		0.18

Average of five determinations

Limit of detection: The limit of detection is also calculated. The absorbance of lowest concentration in

calibration curve is measured for five times, The results are shown in Table 7.

Table 7. Limit of detection

Amount of sulphadiazine (µg/ml)	Average of absorption value	RSD %	Limit of detection (µg/ml)
5	0.128	0.0015	0.175

Average of five determinations

3.5 The stoichiometry of the color product:

The stoichiometry of the reaction between sulphadiazine and o-amino phenol is investigated

using Job method and mole ratio method; the results obtained (Figure 3, 4) show that the ratio is 1:1 drug to reagent.

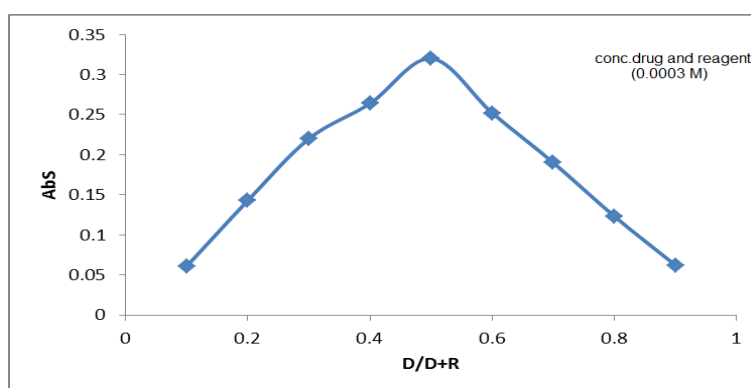


Figure 3. Job's method

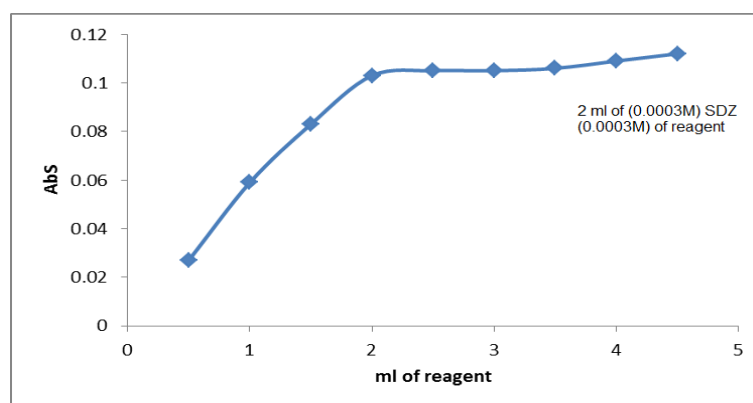


Figure 4 . Mole ratio method

The suggested mechanism of reaction may be as the following route:

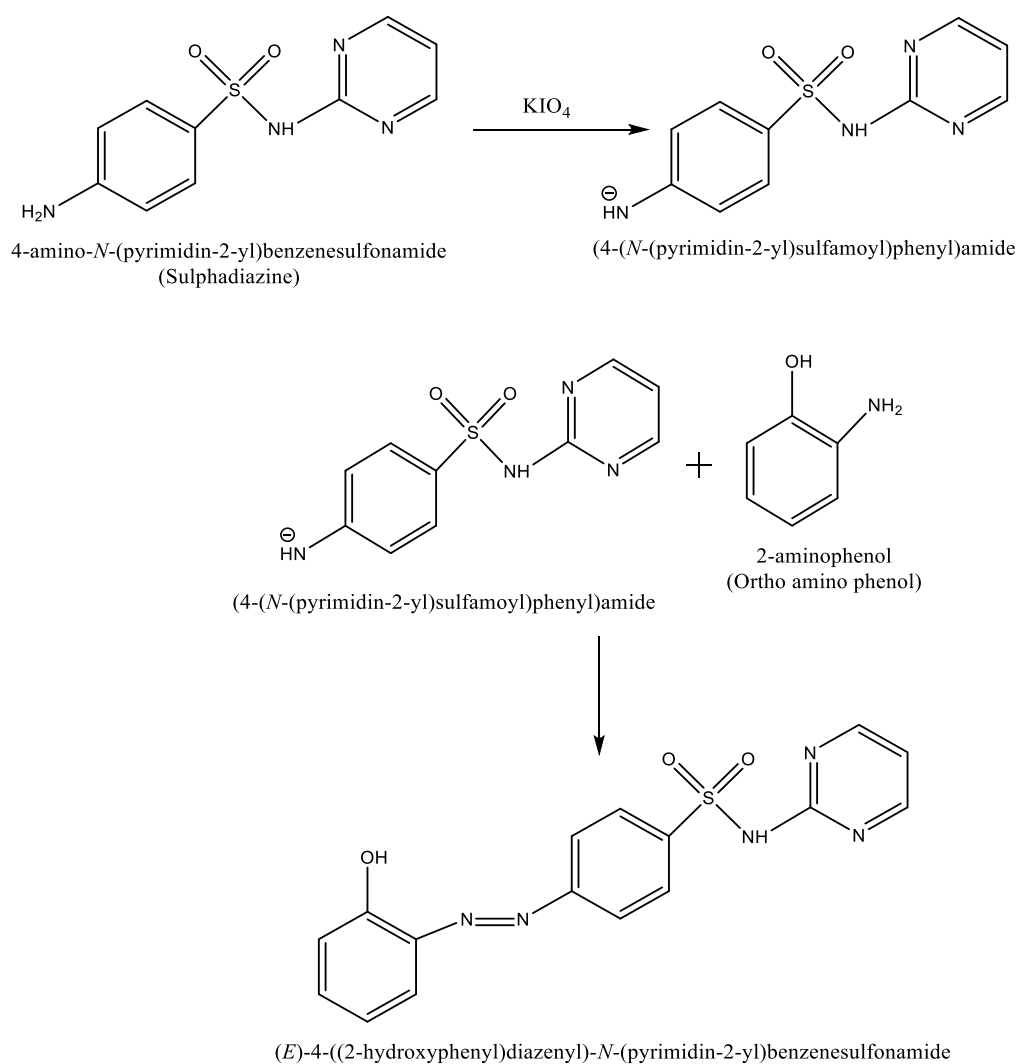


Illustration 2. Probable product formation pathway

3.7 Analytical application :

Direct method

Different sizes (1.5 ml, 2 ml) of sulphadiazine preparation in 25 ml volumetric flask are pipetted and (1.5 ml) of potassium periodate (1×10^{-2} M) (five

minutes waiting) (0.5 ml) of ortho-amino phenol (five minutes waiting) are add and diluted to the mark with distilled water, Absorption is measured (average of five readings) for every Solution at 532 nm wavelength. The results are shown in table 8

Table 8 : Results of sulfadiazine determination in the veterinary method by direct method

Veterinary product	Sulphadiazine (µg/ml) Taken	Found	Relative error %	Recovery %	RSD %
VAPCOTRIM	15	0.346	2.06	102	0.43
	20	0.469	-1.2	98,7	0.31

Average of five determinations

Standard additions method

Solution liquid injection veterinary (VAPCOTRIM) containing sulphadiazine have been analyzed. In order to demonstrate the efficiency and accuracy of the proposed method and to show that the developed method is free from interferences', this method is applied. A fixed quantity (0.3 ml , 0.4 ml) of the veterinary solution at a concentration of 250 µg / ml is added in a series of 2ml volumetric flasks, then

increasing volumes (0.5-2.5ml) of the standard sulphadiazine solution at a concentration of 250 µg / ml are added followed by an addition (1.5 ml) of potassium periodate (waiting for 5 minutes) and then (0.5 ml) of ortho-amino phenol is added. The above solutions are treated in the same way as in the calibration curve an absorption is measured for all solutions at 532 nm wavelength. The results are shown in the table 9.

Table 9: The application of proposed method for determination sulphadiazine in VAPCOTRIM pharmaceutical preparation

Pharmaceutical Formulation	Drug Amount Present(µg/ml)	Drug Content Found (mg)	Recovery %	Average recovery %
VAPCOTRIM	3	3.03	101	101.1
	4	4.05	101.2	

4. Conclusion

A simple, rapid, precise, and sensitive spectrophotometric method has been developed for the determination of sulphadiazine in aqueous solution based on its oxidative coupling reaction

with ortho-amino phenol in the presence potassium Periodate .The proposed method does not require temperature control or solvent extraction step; the method is applied successfully for the determination of SDZ in its pharmaceutical preparation.

References

- Michael, M. (2008). Chemical Fate of Sulfadiazine in Soil Mechanisms and Modelling Approaches, p.1.
- British Pharmacopoeia, (2005). The Requirements of the 5th Ed. of the European pharmacopoeia.
- British Pharmacopoeia, (2001). The Requirements of the 3rd Ed. of the European pharmacopoeia.
- Combs, M.T.; Ashraf-Khorassani, M. and Taylor, L.T. (1999). *Journal Pharm. Biomed Anal.*, **(19)**:301-308.
- Dadfarnia, S.; Hajishabani, A. and Rad, H.F. (2011). *Journal Chin. Chem. Soci.*, **(58)**:503-508.
- Berzas, N.J.J.; Castaneda, P.G. and Guzman, B.F.J. (200). *Journal Chromatogr.*, **A(918)**:205-210.
- Qi-Oi, S.; Xiao-Ling, W.; Dong-Mei, L. and Di, G. (2010). *Chinese Journal Pharm. Anal.*, **36(2)**:117-124.
- Valentina, G. et al (2009). *Anal. Chim. Acta.*, **(1)**:18-23.
- Kothacota, V. et al. (2011). *Intern. Journal Pharm. Biolog.*, **2(4)**:167-1171.
- Wang, X. et al. (2007). *Journal Chromatogr.*, **B(847)**:289-295.
- Liu, H.; Ren, J.; Hao, Y.; He, P. and Fang, Y. (2007). *Talanta*, **(72)**:1036.
- Ayman, H.K.; Sofia, A.A.; Goreti, M.F. and Felismina, T.C.M. (2009). *Anal. Sci.*, **(25)**:365- 371.
- Nagaraja, P.; Naik, S.D.; Shrestha, A.K. and Shivakumar, A. (2007). *Acta Pharm.*, **(57)**:333-342.
- Nagaraja, P.; Sunitha, K.R.; Vasanth, R.A. and Yathirajan, H.S. (2002). *Eur. Journal Pharm. Biopharm.*, **(53)**:187-192.
- Nabeel, S.O. and Raeeid, M.K. (2006). *Raf. Journal Sci.*, **17(4)**:25-35.
- Salim, A. and Haseeb, Y.S. (2013). *Raf. Journal Sci.*, **24(6)**:61-73.
- Mahdi, M.I. and Kadim, K.H. (2015). Spectrophotometric determination of Sulfadiazine in Various Sample by coupling with 2,5-dimethoxy aniline, Chemistry Department, College of Science, Babylon University, **15(1)**.
- Amin, A.S.; El-Sayed, G.O. and Issa, Y.M. (1995). *Micro chem. Journal*, **(51)**:367-373.
- Al-Attas, A.S. (2003). *Saudi Pharm. Journal*, **11(3)**:141-145.
- Al-Abachi, M.Q. and Al-Talib, S.M. (1995). *Journal Edu. Sci.*, **(22)**:172-185.
- Nagaraja, P.; Shrestha, A.K.; Shivakumar, A. and Gowda, A.K. (2010). *Acta Pharmaceutica Zagreb Croatia*, **60(2)**:217-227.

التقدير الطيفي لعقار السلفادايازين بتفاعل الاقتران التأكسدي مع كاشف اورثو-أمينو فينول.

عائشة أحمد عبد , علي إبراهيم خليل , فائز محسن حامد

قسم الكيمياء , كلية العلوم , جامعة تكريت , تكريت , العراق

الملخص

تم وصف طريقة طيفية بسيطة, سريعة وحساسة لتقدير عقار السلفادايازين (SDZ) في المحلول المائي. اعتمدت هذه الطريقة على أكسدة SDZ ببيريولات البوتاسيوم والاقتران مع كاشف اورثو-أمينو فينول ليعطي ناتج ذو لون بنفسجي يمتص عند λ_{max} 532 nm. مدى الخطية (مطاوعة قانون بير) كان من 5-40 مايكرو غرام/مل ل SDZ بمعامل تحديد 0,9980 ومعامل امتصاص مولاري 5581,6 لترا مول سم وخطاً نسبي بمدى من -0,06-2,3 % وانحراف قياسي نسبي ليس اكثر من 0,31 % . تمت دراسة نسبة الاتحاد بين العقار والكاشف و وجدت انها 1:1 وتم تطبيق الطريقة بنجاح لتقدير SDZ بحالته النقية وفي المستحضر الصيدلاني باسترجاعية لا تقل عن 101,1 % .