Application of Trifluoperazine Hydrochloride as a Colorimetric Reagent for Quantitative Sulfadiazine Drug Assay and Use in Various Infection Treatment Preparations

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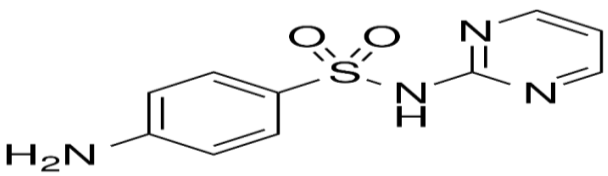
Abstract
A spectrophotometric method using direct, rapid and sensitive spectrophotometry of sulfadiazine SAD was determined by developing a stable and water-soluble product with a maximum absorption at 501nm by oxidative coupling reaction with Trifluoperazine hydrochloride TRF reagent. With sulfadiazine SAD and using potassium periodate KIO4, which acts as an oxidizing agent in an acidic medium in the presence of hydrochloric acid HCl, depending on the concentration of sulfadiazine SAD and according to Beer's law, the concentration range was 2-24 g.ml-1, and the molar absorbance was 9.74 x103, detection limit (LOD) was 1.22 quantity limit (LOQ) was 2.54 a relative standard deviation was 0.82 to 1.19 and the recovery was 100.4, method proposed has been effectively used for the determination of sulfadiazine.

Keywords: Spectrophotometric technique, Sulfadiazine, bacterial resistance, Colorimetric assay, hydrochloride of trifluoperazine

1. Introduction

Due to its low cost and effective therapeutic use, sulfadiazine (SAD), a kind of sulfonamide antibiotic, has been widely used to prevent infection in people and cattle(Zhu et al. 2022). An odorless, white or slightly yellow powder, sulfadiazine (4-amino-N-2-pyrimidinyl-benzene sulfonamide) (SAD) is the chemical name. When exposed to air, humidity, and temperatures of up to 100 °C for two weeks, it remains stable in the solid state. Upon exposure to light, it becomes darker. Due to its antibacterial properties, sulfadiazine is employed in medical therapy. It is frequently used as a sulfonamide, particularly in veterinary medicine, to control bacterial infections and stop the spread of illnesses(Huang et al. 2012). The drug's molecular formula is C10H10N4O2S, and its chemical structure is seen in figure.1 and the molar mass about 250.3g/mol, the melting point at 252 to 256C (486 to 493F)(Kobercová, Srba, and Fischer 2023)



Figer.1 The structure of Sulfadiazine

Pancreatitis, depression, fever, rash, nausea, diarrhea, and headaches are a some of the most typical adverse effects. Patients with severe renal, liver, or porphyria issues should not take it. While the manufacturer does not advise usage during nursing, it is thought to be safe if the infant is generally healthy. If used during pregnancy, it may increase the baby's chance of developing kernicterus. It belongs to the group of drugs known as sulfonamides.(Combs, Ashraf-Khorassani, and Taylor 1999). Several medicinal medications, like floumizin cream, include SAD as an active ingredient. Multiple analytical techniques have been developed and are now being used for the detection and measurement of SAD in pharmaceutical formulations or biological fluids. Direct or indirect spectrophotometric analysis based on Schiff base(Kanagavalli et al. 2023), redox(Liu et al. 2021), charge-transfer(Srinithi et al. 2023), and diazo-coupling reactions(Sagheer et al. 2022) are the main steps in the SAD assay, which is then followed by the measurement of the absorption of the colored complex compounds produced as a result of the aforementioned reactions. Other analytical methods for the SAD test are based on ion-selective electrodes(Özbek, Berkel, and Isildak 2022) and amperometric titration potentiometric (Lalmalsawmi et al. 2022)direct analysis. differential pulse polarography(Xiao et al. 2023). Differential scanning calorimetry(Michel et al. 2022). thin layer chromatography(Shahriman et al. 2023). reversed-phase high performance liquid chromatography (RPHPLC)(Saadatmandi, Sohrabi, and Kabiri Fard 2023). capillary zone electrophoresis(Yu and Quirino 2023). sequential injection chemiluminescence(Altunay 2022). Fourier transform Raman spectroscopy(Ezhil Vilian et al. 2022). spectrofluorimetric(Zhang et al. 2023) and nuclear magnetic resonance (NMR)(Woźnica, Sobiech, and Luliński 2023). In this work, we estimated the drug sulfadiazine, depending on the oxidative coupling with the TRF reagent, and in the presence of the oxidizing agent potassium periodate in an acidic medium of hydrochloric acid. The method was sensitive and fast, and a colored solution was obtained [1].

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Resources and Procedures

- Both the spectral and absorbance measurements were performed using a double-beam UV visible 160 wavelength digital recording spectrometer (Japan).
- Analytical equilibrium (Sartorius BL210S).

Resources and chemicals

The following remedy was used to force the chemicals that were used in the procedure with a high degree of purity and did not require cleaning: - 500ppm Sulfadiazine SAD

Sulfadiazine (SAD) 500 ppm

Samara-Iraq (SDI) was used to manufacture straightforward material (State of the Drug Industries as well as Medical Appliances Company). By adding 0.01g of bulk substance, the 500ppm standard concentration SMS solution was dissolved. It was dissolved in 10 ml of ethanol to increase solubility before being diluted in 20 ml of deionized and distilled water in a volumetric flask. The conventional method results in persistent working concentrations(Avcı, Oymak, and Bağda 2022).

Hydrochloric Acid Solution (HCl) 1M

Concentrated hydrochloric acid was prepared by taking a volume of 1.750 ml in a 20ml volumetric flask and diluting with distilled water to the mark. SAD has been studied as an obeys in drug compositions (Cream Dose Aspects) that contain it as the active component. Forms of cream dosage Ag. SAD 250ml of ether and 5g of cream (containing 0.05g of Ag. SAD) were combined, then the mixture was well shaken and transferred to a different funnel.

The Ag. SAD was then extracted three times with 125ml of deionized water. A volumetric flask was used to collect and filter the aqueous layer.(Ecjhao et al. 2009).

Reagents

The general medical supply and pharmacy facility in Samarra, Iraq provided SAD standard material, and all of the materials used in this experiment were analytical reagents.

TRF solution (1.5 x10^{-2}M) trifluoperazine hydrochloride:

This solution was created by dissolving 0.1442g of TRF in 20 ml of distilled water.

Potassium Periodate (pp) (KIO_4) Solution, 4 x10^{-3} M

0.0184g of (pp) were made into this solution by dissolving them in 20ml of distilled water.

Suggestions for action

Equal portions of standard solutions from Solution SAD of a concentration ranging from 2 to 24 ppm were successively added to a series of 20 ml Volatile flasks in the last volume, along with 1.5 ml of potassium periodate (4 x 10-3 M), 1.7 ml of TRF, and 1 ml of 1 M hydrochloric acid. We then allowed the solutions to stand for 10 minutes at a temperature of 15 C before adding 1 ml of SAD in The absorbance was incrementally quantified against the blank reagent at 501 nm, and a calibration graph was also constructed.(Carlo et al. 2023)[2].

Table 1. The paper and their businesses use cream dosage forms.

Forms for cream doses and composition as stated	Organization submitted an application
Hamazine cream (each 100gm of cream contain 1gm silver sulphadiazine)	Hayat drug production Co./ Baghdad /Iraq
Awasilvadin cream (each 1g contain10mg silver sulfadiazine)	Awamedica Co.,Erbil, Iraq
Silfazine cream1% (each 1g containe silver sulfadiazine10mg).	Sama Alfayhaa – Basrah-Iraq

Biological activity

The following multidrug resistant (MDR) pathogenic microbial isolates include six Gram-negative bacteria (Proteus mirabilis, Enterobacter cloacae). Two Gram +ve bacteria (Staphylococcus aureus and Enterococcus faecalis) were recovered from several clinical samples, including a wound, burns, diabetic ulcer, and Pseudomonas aeruginosa, Acinetobacter baumanii, and Klebsiella pneumonia. The isolates were identified using phenotypic and biochemical experiments, and they were afterwards recently verified using the Vitek-2 compact instrument GP and GN card automated bacterial identification instrument Both bacterial isolates were procured in glycerol-added BHI broth at (-20°C) (15 percent). Before use, the isolates were sterilized at 37°C for 24 hours and subcultured on BHIA.(Boughougal et al. 2018)[3].

A Discussion of the Results

The effect of a number of variables on the emergence of color was examined in order to establish the perfect conditions. By employing spectrophotometric analysis, the results revealed that the interaction between SAD and (TRF) in the results in a vividly colored product that may be used to treat burns and skin ulcers. At a wavelength of 501 nm, the orange product absorbs the majority of light (Fig.2)

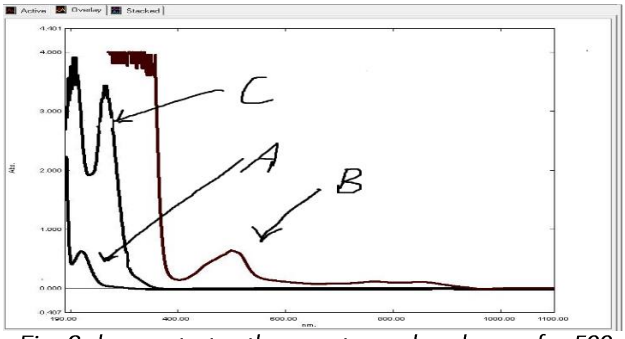


Fig. 2 demonstrates the spectrum absorbance for 500 ppm SAD treated using the advised approach, in comparison to (A) pure medicine SAD and (B) colored solution. (C) all-natural ingredients; no drugs. 20 ml of the finished amount, comprising 500 ppm of SAD (20 ppm), was used for optimization.

Acidic effects

A few acids, including HCl, CH_3COOH, H_2SO4, HNO_3, and H_3PO_4, are then tested at 1M concentrations; the findings demonstrate that all of the tested acids achieved the product's color absorption, with hydrochloric acid being the best acid that achieves the highest absorption. The optimal amount of acid was 1 ml, which resulted in a significant absorption and a high absorbance product.(Majeed, Taha, and Mutaq 2020).

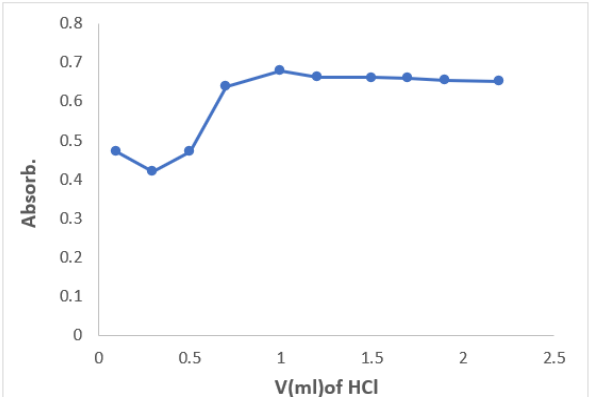


Fig.3. The volume Influence of acid (1M)

Impact of the reagent concentration

To examine how reagent concentration affects the trifluoperazine hydrochloride absorbance (TRF). It was created by transferring 1 ml of a 500 ppm Sulfadiazine SAD medication into a succession of 25 ml volumetric flasks. A range of quantities, from 0.1 to 2.2 ml, were taken for the reagent 1.5 x 10^{-2}M, and the volumes were completed to (25 ml) by distilled water. The optimum volume for the formation was 1.7ml (TRF), which results in a highly absorbent material that was used in the subsequent experiments and can be seen in Fig. 4.(Gaballah et al. 2023)

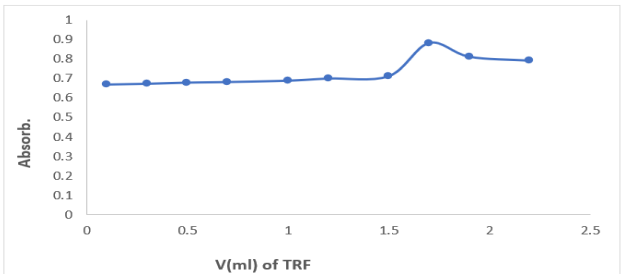


Fig.4. The volume of reagent effect on the reaction

Response time has an impact.

The product's color intensity was maximum after reacting to the SAD medicine with a solution of TRF, potassium periodate, and hydrochloric acid and stabilizing it for 10 minutes. This way, the suggested method showed that the optimal progress window was a 10-minute window. Within a day, the color had stabilized(Hu et al. 2022). This is shown in Fig 5.

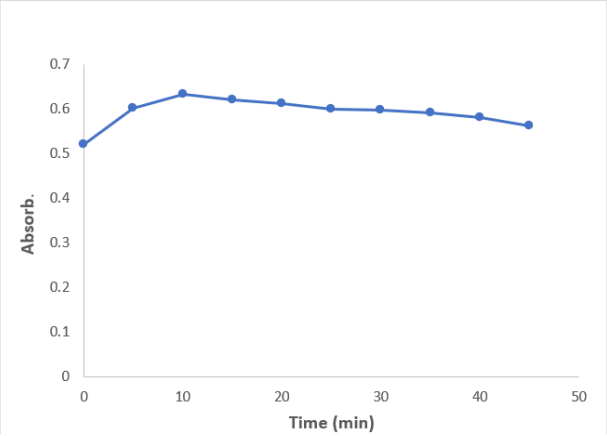


Fig. 5. The time effect of reaction

Graph of calibration

Figure 6 depicts the calibration diagram for SAD detection under controlled circumstances. The graph is linear with a correlation coefficient of 0.9984, a slope of 0.0389, and an intercept of 0.311 over the concentration range of 2 to 24 ppm. Calculations revealed that the orange product's molar absorbance is 9.74 x10^3 L. mol^{-1} cm^{-1} and its Sandall's sensitivity is 0.0257 g cm^{-1}. The LOD and LOQ, meanwhile, were 1.22 g ml^{-1} and 2.54 g ml^{-1}, respectively.

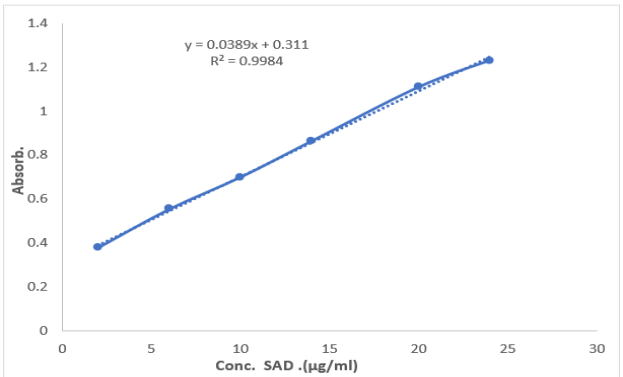


Fig. 6. The calibration curves of SAD

Table 2. Analytical Data for the studied procedure	
Parameter	Value
ƛ max, nm	501
R^2, the correlation coefficient	0.9984
(b) Slope	0.0389
Molecular of the absorptivity ($L.mol^{-1}.cm^{-1}$)	9.74x10^3
Limitations of Beer Law (ppm)	2 - 24
Sensitivity of Sandell ($g.cm^{-1}$)	0.0257
Intercept (a)	0.311
The quantification limit (LOQ) (ppm)	2.54
The detection limit (LOD) (ppm)	1.22

The average of the three recovery techniques is 100.48%, and the RSD is 0.92%.

Statistical analysis and the mechanism

The observed SAD, the reagent specified, and, in

each case, the (drug / TRF) ratio, were all evaluated as having a 1:1 stoichiometry for the reaction (i.e., 1 mole of the drug and 1 mole of the reagent reacted). This reaction produced a brand-new ligand that reacted with to produce a new complex absorbance at 501 nm. The molar ratio and the continuous variation approach both revealed a 1:1 ratio for the reaction between the produced ligand and also. These results led to the assumption that the SAD responses with (TRF), as well as, moved in the direction suggested.(Shi et al. 2022)

Table 3. The researched method's accuracy and precision				
SAD Conc. (ppm)		% Error	%Recovery	% RSD
Present	Found			
6	6.11	1.83	101.83	0.82
20	19.76	-1.2	98.8	0.75
24	24.2	0.83	100.83	1.19

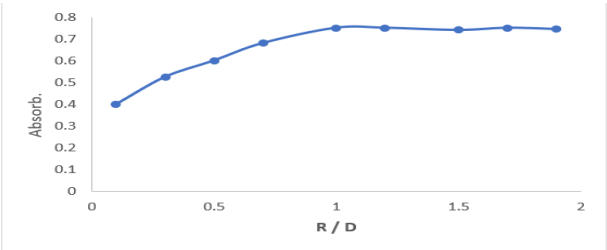
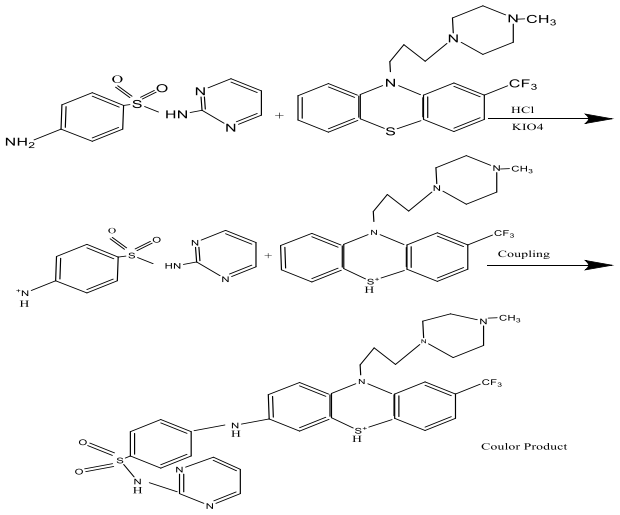


Fig. 7. The SAD mole ratio

Effects of excipients

Starch, Talc, Lactose, Sucrose, Calcium chloride, Sodium Disulfate, PVP, Sodium Sulfite, Lactose, Benzoic acid, Trimethoprim, and Fructose were the excipients that were being looked at. Although these ingredients are contained in the dosage forms of the cream, they have no impact on the measures. SAD was a component of the study's solution, and each element was brought separately and tested under identical circumstances at concentrations ten times higher than those of SAD. operation on the caliper graph of the medication for interference investigation and mark dilution, 1ml at 500ppm of the solution and 1ml from each 5000ppm excipient were brought. No interference was observed in an assessment for SAD in which an interference level was regarded acceptable provided the mistake was not more than 2% compared to the expected.(Patel et al. 2022)

Table 4 shows that there is no influence from common excipients or other chemicals with the procedure.



SAD + TRF ----------► Color Product

Scheme 1: Possible mechanism of action for the formation of SAD drug complexes with TRF through the discovery of hydrochloric acid and potassium periodate

Table 4. The effect of excipients on the evaluation of medications			
Interference	Conce. Of SAD	% Error	% Recovery
	Found (ppm)		
Calcium Chloride	19.82	-0.9	99.1
Sodium Disulfide	19.92	-0.4	99.6
Starch	20.01	0.05	100.05
Talc	19.8	-1	99
Lactose	19.89	-0.55	99.45
Fructose	19.93	-0.35	99.65
Sodium Sulfite	19.88	-0.6	99.4
PVP	20.1	0.5	100.5
Benzoic acid	19.97	-0.15	99.85
Sucrose	19.94	-0.3	99.7

Average Recovery% and Average RSD% for Current and Common Methods

Table 5. Assessment of SAD using the investigated technique and compared to the strategy for Cream dose forms dosage types.						
NO.	Composition	Present methods		Standard methods		Values (T), (F)
		% Recovery	% RSD	% Recovery	%RSD	(F) calculated Values =1.221
1-	Pure SAD	100.48	0.92	101.29	1.87	Theoretical Values = 6.39
2-	Hamazine1%	99.1	0.91	99.36	0.08	(t) calculated Values =0.682
3-	Awasilvadin1%	99.75	1.02	99.6	1.01	Theoretical Values = 2.31
4-	Silfazine1%	99.17	1. 29	97.55	1.97	

Table 6. shows the antibacterial activity of pure sulfadiazine (inhibition region, mm) against multidrug-resistant bacteria using three different sulfadiazine cream does forms

E. faecalis	E. Cloacae	S. Aureus	P. mirabilis	Compounds
20	18	22	19	Pure SAD
16	16	14	15	Hamazine cream
14	16	20	18	Awasilvadin
14	12	14	13	Silfazine

2. Conclusion

The spectrophotometry technique was used in the presence of very low concentrations of sulfadiazine, which dissolves in ethanol. The method is sensitive and fast, based on a oxidative coupling reaction in the presence of hydrochloric acid and an oxidizing agent of potassium periodate and in the presence of the colorimetric reagent of trifluoperazine hydrochloride. The test was performed in an optimal time within ten minutes and at a temperature of A temperature of 15 degrees Celsius without the need for an extraction process, and it was used well to detect burns that affect the skin.

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