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REVIEW

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Quantitative Determination of Sulfamethoxazole using various Spectroscopic Methods

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Abstract

Sulfamethoxazole is one of the important pharmaceutical preparations for which researchers have been trying to find sensitive and applicable spectroscopic methods for its estimation. The estimation methods were divided into five types: the standard method, which relied on the use of the protocol followed in the US pharmacopeia (USP), in addition to Titrimetic methods, spectroscopic methods, and voltammetry methods, the last of which used high-performance chromatography (HPLC) technology. The aim of this study is The process of counting the various spectroscopic methods used in estimating the pharmaceutical preparation sulfamethoxazole for the purpose of facilitating the research process for researchers.

Keywords: Sulfamethoxazole, Determination, Titrimetic methods, Spectroscopic methods, Voltammetry methods, HPLC

1. Introduction

Sulfamethoxazole belongs to the family of antibacterial sulfonamides and is described as one of the most prominent types of sulfa drugs. All types of sulfonamide drugs share the general formula, but the difference lies in the functional group R in (SO_2NHR) and changing the R substituents leads to differences in physical, chemical, and therapeutic properties [1].

The scientific name of sulfamethoxazole is 4-Amino-N-(5-methyl-3-isoxozoyl) benzene sulphonamide.

Its common names include Gontonol, Radonil, and Sinomin. It is a white crystalline powder, insoluble in water, slightly soluble in benzene, chloroform, and isopropanol, and highly soluble in acetone, methanol, and ethanol. Its molecular formula is $C_{10}H_{11}N_3O_3S$ [1]. Its molecular weight is 253.28 g.mol^{-1}, its melting point is 167°C [2].

A new series of Sulfamethoxazole derivatives was prepared and examined for antifibrinolytic and antimicrobial activities. Sulfamethoxazole derivatives bear heterocyclic moieties such as 1,3,4-thiadiazine [3] pyrazolidine-3,5-diol [4] 6-hydroxy-1,3,4-thiadiazinane-2-thione [5] and [(3-methyl-5-oxo-4,5-dihydro-1H-pyrazol-4-yl) diazenyl] [6]. Their structures were elucidated by spectral methods (FT-IR, H1-NMR). Physical properties are also determined for all compound derivatives. Recently prepared compounds were tested for their antimicrobial activity in the laboratory. Each screened compound showed good tendency towards moderate antimicrobial activity.

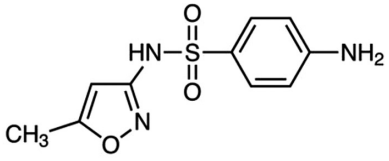

Fig. 1. Structure of Sulfamethoxazole.

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Table 1. Different spectroscopic methods for determining sulfamethoxazole.

Type of reaction	Reagent used	λ max, nm.	Linearity, μgml^{-1}	ε L.mo1^{-1}, cm^{-1}
Charge transfer complexes [9, 10]	SNP	512	5–150	1.139—103
	Chloranilic acid	520	2–10	2.7929×10^4
	NQS	460	5-50	6.7878×10^4
Condensation [11, 12]	P-N,N-dimethyl amino benzaldehyde	450.5	0.1–10	5.7950×10^4
Oxidation [13]	Phenoxazine	520	0.1–6	6.105×10^4
Diazotization-Coupling [14]	2,4,6-Trihydroxybenzoic acid	416	0.2–16	1.8×10^4
Schiff base [15]	Vanillin	399.09	5–80	1.1×10^3
Oxidative Coupling [16]	4-Aminobenzene sulfonic acid	490	2–32	9.118×10^3
Diazotization-Coupling [17]	DMP	402	1–15	1.494×10^4

By following the literature, it was noted that there are multiple methods for determining sulfamethoxazole in its pure form and in its pharmaceutical preparations. There are methods that include the simultaneous determination of sulfamethoxazole in its pharmaceutical preparations that usually contain trimethoprim. Below are some of these methods.

2. Standard method

The standard USP method for determining sulfamethoxazole involves dissolving 0.5 g of sulfamethoxazole in a mixture of 20 mL of glacial acetic acid and 40 mL of water, then adding 15 mL of hydrochloric acid to the sample solution, cooling the mixture to 15°C, and immediately flushing with 0.1 molar solution of sodium nitrite ($NaNO_2$). The endpoint of the reaction is determined by stress analysis and using the Calomel-platinum electrode system [7] The amount of sulfamethoxazole can be calculated from the relationship below:

1 ml of 0.1 M $NaNO_2 = 25.33$ mg of $C_{10}H_{11}N_3O_3S$

3. Titrimetric methods

A simple, rapid, and indirect method (based on stress analysis) for the determination of sulfamethoxazole in the presence of trimethoprim in co-trimoxazol tablets has been described. The method was based on the formation of a complex of sulfamethoxazole with a known excess of silver ions, and then the unreacted silver ions were flushed with a standard solution of ammonium thiocyanate, using a copper electrode covered with a thin mercury film (CBMFE). The method was highly accurate. The average recovery rate was 99.88% and the relative standard deviation was 1.32%. The method was successfully applied to pharmaceutical preparations (tablets) with approved results [8].

4. Spectrophotometric methods

Sulfamethoxazole was determined using various spectroscopic methods and different reagents. Table 1 shows a summary of these methods.

5. Electrical methods (voltammetric methods)

Table 2 shows a summary of the use of different Electroanalytical methods for the determination of sulfamethoxazole in its pharmaceutical preparations.

6. Chromatographic methods

Table 3 summarizes some of the chromatographic methods used for the determination of sulfamethoxazole in its pure state and in its pharmaceutical preparations (in the presence of trimethoprim or in the presence of one of the sulfonamide preparations). It has also been estimated in human biological fluids such as blood, plasma, serum, urine, or in animal tissues.

7. Other methods

A sensitive and selective method was developed for the determination of sulfamethoxazole and sulfathiozole in different models (in milk, urine, and pharmaceutical preparations). The method was based on the chemically induced fluorescence (IF) technique, as the value of the detection limit for sulfamethoxazole was 8.1 ng/ml for sulfathiazole 2.9 ng/ml, while the recovery value for sulfamethoxazole in pharmaceutical preparations was 102%, and for sulfathiazole, the recovery value in milk and lactation models ranged from 95% to 107.5% [29]

A method was also developed to separate and estimate three antibacterial components (sulfamethoxazole, trimethoprim, and sulfadiazine) in sulfamethoxazole combination tablets. The method was based on the use of capillary electrophoresis technology and current measurement. A 70 cm long capillary

Table 2. Electroanalytical methods for the determination of sulfamethoxazole.

Type of electro analysis method	Type of electrode	Linearity, M
Square Wave Voltammetry [18]	GCE	5.5×10^{-5}–3.95×10^{-4}
Deferential Puls Voltammetry [19]	MoO_2/GCE	7.04×10^{-7}-1×10^{-3}
Voltammetry [20]	g-C3N4/ZnO-GCE	20 nM–1.1 mM
Electrochemical sensor [21]	Screen-printed Electrode	1–100 ng/ml
Deferential Puls Voltammetry and Amperometry [22]	GO/ZnO-GCE	0.10×10^{-6}-1.5×10^{-6}

Table 3. Chromatographic methods used for the determination of sulfamethoxazole.

Type of chromatographic method	Type of column	λ max, nm.	Linearity, $\mu g.ml^{-1}$
LC–MS [23]	Aligent Extend-C_8	—	20–40000 ng/ml
HPLC [24]	C_{18}	235	0.12–2.53
		250	
		260	
		270	
RP-LC [25]	C_{18}	213	5-70
RP-HPLC [26]	X Bridge RP-C_{18}	225	5-100
HPLC [27, 28]	Column of HALO 2.7	280	0.05–5
	Aligent 5TC-C_{18}	295	—

tube with a separation voltage of 18 kV was used, and it was possible to separate the three components within 14 minutes. It was found that the relationship was observed between the peak current and the concentration of the three analytes within the ranges of (5×10^{-2}-5×10^{-4}), (1×10^{-1}-5×10^{-4}) and (5×10^{-2}-5×10^{-4}) $\mu g.mL^{-1}$, respectively, and the detection limits ranged from 8×10^{-5} to 5.1×10^{-5} $\mu g.mL^{-1}$ for all components. The method was successfully applied to determine the main active ingredients in sulfamethoxazole tablets [30, 31].

The aim of this study is The process of counting the various spectroscopic methods used in estimating the pharmaceutical preparation sulfamethoxazole for the purpose of facilitating the research process for researchers.

8. Conclusion

Many scientific studies have been conducted in the fields of quantitative determination of the pharmaceutical preparation Sulfamethoxazole. The reason is attributed to the importance of that preparation, as researchers discovered that the effective groups of the preparation facilitated its entry through several color reactions. In addition to the easy physical characteristics, it was possible to provide diversity in its quantitative determination processes.

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