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Comparative of chemical methods for determination ciprofloxacin hydrochloride- A Review

Amina M. Abass[1], Huda ghalib Salman[1], Hamsa Thamer Sadeq[1], Alaa Adnan Rashad[1], Jamal M. Rzaij[2], Ahmed Ahmed[1]

[1]*Department of Chemistry, College of Science, Al-Nahrain University, Al-Jaderia, Baghdad-Iraq*
[2]*Department of Physics, College of Science, University of Anbar, Ramadi, Iraq*

Abstract

Ciprofloxacin hydrochloride is a wide-spectrum antibiotic that is active against Gram-positive and Gram-negative bacteria, is now one of the most widely-distributed antibiotics in the United States and Europe. An overview is given dealing with the chemical methods used to determined ciprofloxacin hydrochloride, some of these methods including: spectrophotometric, High performance liquid chromatography, Ion selective electrodes ISEs, based on the concentration range ,detection limit ,PH, the wavelength, solvent ,correlation coefficient ,response time, relative standard deviation, recovery, slope, life time The main emphasis of this article is directed towards summarizing recent results of this drug during the past several years.

Keywords: Ciprofloxacin, Review, ISEs, Chemical Method, HPLC

1. Introduction

Chemically Ciprofloxacin Hydrochloride (CPH) is (1-cyclopropyl-6-fluoro-1, 4- dihydro-4-oxo-7-(1-piperazinyl)-3-quinolinecarboxylic acid) is fluoro quinolones and antimicrobials with potent activity against a broad spectrum of bacteria[1,2,3] Its empirical formula is $C_{17}H_{18}FN_3O_3$ and $C_{17}H_{18}FN_3O_3$,HCl with its molecular weight is 331.4 and367.8 gm mole-1.It is a faintly yellowish to light yellow crystalline substance and its chemical structures are:

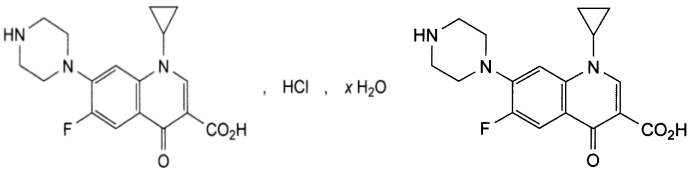

Figure1: Structure of Ciprofloxacin and Ciprofloxacin Hydrochloride

Ciprofloxacin belongs to the second group of quinolone similarities of nalidix acid that has larger influence, lesser harmfulness and a wider antibacterial variety. The highest variance amid the other antibiotics and ciprofloxacin and it can be administrated both orally and parenterally. It is good absorbed and far and wide disseminated into fluids and various body tissues. It is used in a wide-ranging variation of taints of the gastrointestinal tract and urinary tract in addition to soft tissue infections and skin [4]. A number of analytical methods for determined of ciprofloxacin in pharmaceutical dosage forms, bulk, and body fluids are described. Additionally, different analytical methods for the valuation of ciprofloxacin in pharmaceuticals as well as bulk including UV-visible HPLC, and ion selective electrodes ISEs are reported in Table 1, 2, 3.

Corresponding author: Amina M. Abass
Email Address: aminamohsen75@gmail.com
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Table 1: Spectrophotometric methods for determination Ciprofloxacin

Name of Method	Results	Ref. No
Hydrotropic techniques	Sample : ciprofloxacin hydrochloride	5
	λ_{max} = 272nm	
	Concentration Range= 5-50 µg/ml	
	r^2=>0.99%	
	%Re=98.62-101.27	
	%S.D=< 1.0	
	%RSD=less than 2.0	
Cloud point extraction with UV-Vis spectrophotometry	Sample : ciprofloxacin hydrochloride	6
	λ_{max} = 437nm	
	Concentration Range=2.5-120 µg/ml	
	r^2=0.9984	
	Detection Limit= 0.77 µg/ml	
	%Re=98.89±0.87	
	%Precision=1.15-2.85	
Simultaneous Spectrophotometric	Sample: ciprofloxacin hydrochloride	7
	λ_{max} = 292nm	
	Concentration Range=2.5-22.5µg/ml	
	S.D=0.006	
UV Spectroscopy	Sample :ciprofloxacin hydrochloride	8
	λ_{max} = 279nm in phosphate Buffer: Acetonitrile(80:20)	
	Concentration Range=1-13 µg/ml	
	r^2=0.998	
	Detection Limit= 0.33µg/ml	
	% Mean of Re=99.35-99.61	
UV spectrophotometric	Sample :ciprofloxacin	9
	λ_{max} = 280nm in methanol :water(50:50 %v/v)	
	Concentration Range=2-16 µg/ml	
UV-Visible Spectrophotometric	Sample :ciprofloxacin	10
	λ_{max} = 275nm	
	Concentration Range=3-7 µg/ml	
	r^2=0.9994	
	% Mean of Re=98-102	
A First-Derivative Spectrophotometric	Sample :ciprofloxacin hydrochloride	11
	λ_{max} = 360-500nm	
	Concentration Range=50.0-100.0 µg/ml	
	r^2=0.9999	
	% Mean of Re=98.0-102.0	
	%RSD=0.57	
Extractive ion-pair spectrophotometric	Sample :ciprofloxacin	12
	λ_{max} = 415 nm with Eriochrome Black T (EBT) in acidic medium provided by	
	phthalate buffer pH 2	
	Concentration Range=5-25 µg/ml	
	Detection Limit=1.09 µg/ml	
Spectrophotometric and Titrimetric	Sample :ciprofloxacin	13
	λ_{max} = 590 , 610 nm	
	Concentration Range=0.5-3.5 , 1.0-7.0 µg/ml	
	r^2=0.9971,0.9897	
	Detection Limit= 0.05 , 0.09µg/ml	
	Slope=0.18 , 0.09	
A Novel Spectrophotometric	Sample :ciprofloxacin hydrochloride	14
	Concentration Range=5-50 µg/ml	
	r^2= >0.99	
	% Re=99.42,101.2	
	%RSD= less than 2.0 %RSD= less than 2.0	
	Sample :ciprofloxacin hydrochloride	
	λ_{max} = 319 nm in distilled water	
	Concentration Range=2-12 µg/ml	

UV Spectrophotometric	r^2=0.999	15
	Detection Limit= 0.546µg/ml	
	%Re=99.573	
	%RSD= 0.452	
Solid-phase Spectrofluorimetry	Sample :ciprofloxacin	16
	λ_{max} = 272,448 nm	
	Concentration Range=0.3-10.0 ng/ml	
	Detection Limit= 0.1ng/ml	
	%Re=100	
	%RSD= 1.2	
Spectrophotometric(Binary Mixture)	Sample :ciprofloxacin hydrochloride	17
	λ_{max} = 278.6 nm	
	Concentration Range=2-14 µg/ml	
Spectrophotometric	Sample :ciprofloxacin hydrochloride	18
	λ_{max} = 275 nm	
	Concentration Range=2.0-7.0µg/ml	
	%RSD=1.55 to 2.47	

Table 2: HPLC for determination of Ciprofloxacin

Method	Column	Mobil Phase	Elution	Flow Rate	Results.	t_R	λ (nm)	Ref.
HPLC–UV	5C18(250mm× 4.6mm,5µm)	Phosphate Buffer (PH)=2.7 and Acetonitrile	(77:23v/v%) Isocratic	-	Conc. range=0.05-8µg/ml DOL=0.01µg/ml %Re=90.0-96.11 %RSD=0.05-8.94	5 min	277	19
High Performance Thin Layer Chromatography	Methanol:Formic acid(5.5:0.5v/v)on silica gel 60 F_{254} plates using Camag Linomat V auto sampler	Chloroform:methanol:triethyl amine	(9.0:0.8:0.4 v/v/v)	-	Conc. Range=100-700µg/ml %Re=81.02-86.26	-	291	20
Ultra performance liquid chromatography-tandem mass spectroscopy	Zorbax C18(100× 4.6mm,3.5µm)	0.1%Formic acid in water and acetonitrile	(70:30.v/v)	0.5ml/min	Conc. Range=10-4000ng/ml Mean of r^2=0.999	6min	-	21
Reverse phase -high performance liquid chromatography	C18(5S.ODS 25 cm×4.6mm,5µm)	0.025Morthophosphoric acid(adjusted of PH=3.0 with trietheylamine):acetonitrile	(87:13v/v)	1.5ml/min	r^2=0.999	-	278	22
Reverse Phase High Performance Liquid Chromatography	Agilent XDB C18,250×4.60mm,5µm	Comprising acetonitrile water containing 0.1%orthophosphoric	(20:80)	1 ml/min	Conc. Range=50-100µg/ml %Re=100.19-100.92 %RSD= < 2	3.036 min	316	23
RP-HPLC	C18 (250 mm x 4.6 mm, 5 µm)	0.3% orto-phosphoric acid and acetonitril	(65:35)	0.8ml/min	Conc. Range= 12.5 – 100 µg/ml, %Re= 98.96±2.14 r^2=0.9999	3.10 min	290	24
Ruggedness testing of an HPLC	Lichrosorb RP-18,10 µm,250 µm×4mm)	PH=3.0,Acetonitrile with agues solution	(14:86v/v)		Range of r^2=0.9993-0.9990 Range of LOD=0.04-0.06µM %RSD= < 3	-	-	25
Liquid Chromatographic	Inertsil C18 (150×4.6×5µ)	Water pH 2.4 adjusted with ortho phosphoric acid: aceto nitrile	(850: 150, v/v)	1 ml/min	%Re= 97-103	2.419min	275	26
High performance liquid chromatography	100 RP-18 (5 µm, 125 x 4 mm)	water:acetonitrile:triethylamine with pH of final mixture was adjusted to 3.3 with phosphoric acid	(80:20:0.3 v/v/v)	1 ml/min	Conc. Range= 4.0 -24.0 µg/ml %Mean of Re= 101.85 %RSD= < 2 r^2= > 0.9999	5 min	279	27
High Performance Liquid Chromatographic	Eurosphere 100 C18 (250 mm × 4.6 mm × 5 µ)	Acetonitrile: methanol: water: triethylamine	(40:20:40: 1% v/v/v)		Conc. Range=100-400 ng/ml DOL=0.0501g/ml %Re= 71.49-75.68 Slope=0.038 % Range of RSD=1.03-0.35 r^2=0.9995	-	300	28

HPLC and UV/VIS Spectroscopy	-	-	-	-	%Limit of Effectiveness= 90-110	-	276-278	29
HPLC and UV spectrophotometric	-	-	-	-	Conc. Range=14.0-56.0 µg/ml %Re= 99.71 % Range of RSD=2.06-2.30 r^2=0.9995		530	30
HPLC	C18 (250 mmx4.6 mm i.d, 5µ particle size)	Phosphate buffer (pH 4) and acetonitrile	(65:35, v/v)	1ml/min	Conc.Rane=3-18 µg/ml r^2=0.9986 Slope=36.23	2.4 min	254	31
High performance liquid chromatography and derivative spectrophotometry	C18 (250 mm x 4.6 mm, 5 µm)	Sodium octane sulfonate buffer (pH 3.8) and acetonitrile	(65:35, v/v)	1 ml/min	%Re=101.12,102.34 r^2=0.9997,0.9996 LOD=0.18,0.08 µg/ml %RSD= < 0.81,< 0.77	12 min	240	32
High Pressure Liquid Chromatography	C18, 250 mm × 4.0 mm, 5 µm	0.15% Orthophosphoric acid adjusted pH to 3.0 with triethylamine and acetonitrile	0.7 ml/min	-	%Conc. Range=50-150 %Re= 98.0 , 102.0 r^2=0.999, 0.998	-	278	33
High Performance Liquid Chromatography	Xterra RP-18 (4.6 x 150 mm, 5-µm) steel	0.025 M of sodium phosphate monobasic (pH = 3.0, adjusted with phosphoric acid) and acetonitrile	(85:15, v:v).	1 ml/min	Conc. Range= 0.1 – 12.0 µg/ml, DOL= 0.05 µg/ml r^2=0.9997	10min	276	34
RP-UPLC	Phenomenex Kinetex C18 (50x4.6 mm, 2.6 µm)	triethylamine (TEA), pH 4.5	(0.5 % v/v)	0.6 ml/min	-	-	320	35
Reversed-Phase Ion-Pair HPLC and TLC-Densitometric	C18 column (250 mm 9 4.6 mm, 10 lm)	monobasic potassium phosphate (50 mM, pH 3, adjusted with phosphoric acid) and acetonitrile	(65:35 v/v)	1.2 ml/min	Conc. Range= 3–180 µg/ml DOL= 0.08 µg/ml r^2= 0.9988 %RSD= 0.01–0.2	-	280	36
High performance thin-layer chromatographic	silica gel 60F_{254} HPTLC aluminium sheets	dichloromethane: methanol: ammonia	(30:60:10, v/v/v)	-	%Re=99.68,100.59,99.77,100.26, %RSD=0.82,1.27,0.79,0.65	-	279	37
RP-UPLC	Phenomenex Kinetex C18 (50x4.6 mm, 2.6 µm)	Triethylamine (TEA), pH 4.5) and acetonitrile	(0.5 % v/v,	0.6 ml/min	Conc. Range= 1.25-75 µg/ml DOL= 0.18 µg/ml r^2= 0.9994 Slope=10	-	-	38
Stability-indicating HPLC-DAD	Kinetex C18	acetronitrile–water, pH 3.0	50 : 50 v/v)	-	Conc. Range= 2.5 - 25.0 µg/ml, DOL= µg/ml %Re=100 ± 2, r^2= 0.9993	-	-	39

Table 3: Ion –Selective Electrodes for Determination Ciprofloxacin hydrochloride

Type of Ion –pair for Electrodes	Slope mV/decade	Conc. Range	Detection Limit	R	Response Time	PH	Life Time	Ref.
ciprofloxacin hydrochloride - phosphotungstic acid (CFH-PT)	57.21	1.5×10^{-5}-1.0×10^{-1} mole/L	1.5×10^{-6} mole/L	0.9990	11 to 23 sec	3.0-6.0 3.5-7.5 5.5-9.5	93 days	40
ciprofloxacin hydrochloride(CFH)–Molybdophosphoric acid (MPA)	53.30 50.10	4.0×10^{-6} - 1.0×10^{-1} and 5.1×10^{-6} -1.0×10^{-1}	1.2×10^{-6} and 2.3×10^{-6}	0.9998 and 0.9998	-	3.5-6.0 and 3.0-7.5	8 and 2 days	41
Ciprofloxacin-tetraphenyl borate	56.8, 58.7	1.0×10^{-5}- 1.0×10^{-2} and 1.0×10^{-6} -1.0×10^{-1}	1.0×10^{-5} and 1.0×10^{-6}	0.995 and 0.996	20 and 15 sec	4.0 -8.0	6 and 8 weeks	42
Ciprofloxacin- sodium tetraphenyl borate (TPB), phosphomolybdate (PMA) and phosphotungstate (PTA)	51.7,50.7,58.3, 57.7,44,41.8	1.0×10^{-6}- 1.0×10^{-2} and 1.0×10^{-5} -1.0×10^{-2} and 1.0×10^{-7} -1.0×10^{-2}	-	-	10 and 15 sec	5.0-9 .0 and 5.0-7.0	-	43
Carbon paste based potentiometric sensors with cirprofloxacinium-phosphotungstate, sodium tetrakis (trifluoromethyl) phenyl borate	55.7 and 66.6	1.0×10^{-2} -1.0×10^{-5}	1.0×10^{-5} and 7.9×10^{-6}	-	-	2.0 to 4.1	-	44

2. Conclusion

A set of antibiotics named fluoroquinolones, is ciprofloxacin is used for prevent certain infections or treat caused by bacteria. Many of the analytical techniques are time destroying methods, less accurate, less sensitive. It is very imperative to improve an appropriate analytical technique to determined ciprofloxacin, which can be simply adjusted for in-process quality controller analysis and unchanging Complex materials analysis such as pharmaceuticals, the work of analytical chemist turn out to be dull as it includes separation of the components prior to their confirmation which are costlier and time consuming . The objective of the current work is to make a note an accurate, rapid, precise, and simple spectrophotometric, ultra performance liquid chromatographic (UPLC) and ion selective electrodes (ISEs) methods for the determination of ciprofloxacin current in pharmaceutical formulations and substances. Spectrophotometry is one of the most suitable methods of measurable analysis in several fields such as clinical applications, physics, biochemistry, chemistry and chemical engineering. It was used to determine ciprofloxacin at different wavelength with accurate and high concentration range of ciprofloxacin with excellent recovery, in addition high liquid performance chromatography was used to evaluated the concentration of ciprofloxacin in very less time with many types of column and mobile phase, the results were gave wide range of range response for ciprofloxacin with excellent values of recovery, relative standard deviation, correlation coefficient. At the end ,ion selective electrodes(ISEs) was used to calculate the slope, concentration response, life time, detection limit ,response time, effect of PH, and correlation coefficient. They are have a varied range of usage, well to use, also low-cost. More of prevailing values for the formation of membrane's electrode is the adding up of a lipophilic ion-pair complex into a to a great extent plasticized membrane. We can say the three method which recorded above in Table 1, 2, 3 were more suitable methods for determination ciprofloxacin.

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