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## A REVIEW ON ESTIMATION OF CIPROFLOXACIN IN PHARMACEUTICALS

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### ABSTRACT

The key intend of this review is to estimate the Ciprofloxacin and its combination of drugs by various analytical techniques. Ciprofloxacin is an antibiotic agent belonging to the class Fluoroquinolones used to treat bacterial infections such as urinary tract infections and pneumonia. This review enlighten the different analytical techniques like UV Spectrophotometry, chromatographic techniques like High performance liquid chromatography(HPLC), Ultra Performance Liquid Chromatography (UPLC), High performance thin layer chromatography(HPTLC) and hyphenated techniques like Liquid chromatography-Mass spectroscopy(LC-MS), Ultra Performance Liquid Chromatography-Mass Spectroscopy (UPLC-MS)are discussed for the estimation of Ciprofloxacin and its combination of drugs by various researches. This review makes clear that the best suitable conditions favoring for the Ciprofloxacin estimation.

**Keywords: Ciprofloxacin, HPLC, HPTLC, LC-MS, UPLC-MS**

### INTRODUCTION

Ciprofloxacin is an antibiotic agent belonging to the class fluoroquinolones used to treat bacterial infections such as urinary

tract infections and pneumonia [1]. Ciprofloxacin is a 1-cyclopropyl-6-floro-1,4-dihydro-4-oxo-7-(1-piperazinyl)-3-

quinolinecarboxylic acid with empirical formula:  $C_{17}H_{18}FN_3O_3$ . Ciprofloxacin has a molecular weight of 331.35 g/mol [2]. Quinolones shows potent antibacterial effect by binding to bacterial enzymes, DNA gyrase and Topoisomerase IV. It leads to formation of Quinolone enzyme DNA complex, it undergoes conformational changes and enzyme breaks the DNA and the drug prevents replication of the broken DNA strands, thus preventing DNA replication. Ultimately, this results in the damage to bacterial DNA and thus cell death [3]. Methods were developed to determine ciprofloxacin in active pharmaceutical ingredient, dosage forms were reviewed in the present article.

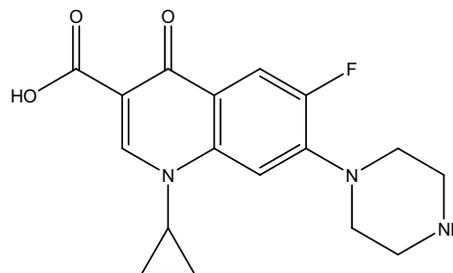


Figure 1: ciprofloxacin

## METHODS FOR ESTIMATION

### UV Spectrophotometric methods

Various UV Spectrophotometric methods for ciprofloxacin single and combination with other drugs are developed and are listed (Table 1-3).

### Hyphenation Techniques

Hyphenation technique was developed for estimation of ciprofloxacin. Methods determined for the estimation of ciprofloxacin are enlisted in Table 4.

Table 1: Methods For Estimation Of Ciprofloxacin Single And Combination With Other Drugs By UV Spectrophotometry

S. No.	Drugs	Application	Description	References
1	Ciprofloxacin	Tablet Formulation	Wavelength: 277nm and 266nm Solvent:0.1N HCl and Distilled water	(4)
2	Ciprofloxacin and Curcumin	Bulk Drug	Wave length: Ciprofloxacin: 275 nm Curcumin : 430 nm Solvent: Methanol and Water (50:50v/v) Linearity range: 1-6µg/ml	(5)
3	Ciprofloxacin and Metronidazole	Combined Dosage Form	Wave length: Ciprofloxacin:253nm Metronidazole :301nm Solvent: Methanol Linearity range: Ciprofloxacin :2-16 µg/ml Metronidazole :4-16/ µg/ml	(6)
4	Ciprofloxacin and Ornidazole	Tablet Dosage Form	Wave length: Ciprofloxacin :270nm Ornidazole:319nm Solvent: Distilled water Linearity range: Ciprofloxacin :2-12 µg /ml Ornidazole:6-16 µg /ml	(7)
5	Ciprofloxacin and	Active Pharmaceutical	Wave length:	(8)

	Naproxen	Ingredient	Ciprofloxacin: 278nm Naproxen :228nm Ciprofloxacin: 277nm(0.1NHCl),278nm(D.W),270nm and 278nm(PH 7.4,2.5) Naproxen: 288nm(D.W,0.1N HCl, PH 7.4) and 190nm(PH 2.5) Solvent: 0.1N HCl, Distilled Water, Phosphate Buffer(7.4,2.5) Linearity range: 1-5 µg/ ml	
6	Ciprofloxacin and Tinidazole	Tablet Formulation	Wave length: Method A: 271nm and 318nm Method B: 292nm and 271nm Solvent: Methanol Linearity range: 10-35 µg /ml	(9)
7	Ciprofloxacin and Esomeprazole	Pure and Dosage Form	Wave length:525nm Solvent: Distilled Water Linearity range: 0.4-2µg /ml	(10)

Table 2: Methods For Estimation Of Ciprofloxacin Single And Combination With Other Drugs By HPLC, UPLC

8	Ciprofloxacin	Active Pharmaceutical Ingredient	Detection wavelength:278nm Mobile phase: Distilled Water Column: C18column (5S, ODS 25 cm × 4.6 mm, 5µm) Flow rate: 1.5 ml/min	(11)
9	Ciprofloxacin and Ornidazole	Biological Sample	Detection wavelength:300 nm Mobile phase: Acetonitrile : Methanol: Water: Triethylamine (40:20:40: 1% v/v/v) Column: Eurosphere 100 C18 (250 mm × 4.6 mm × 5 µ) Flow rate:1 ml/min Retention time:2.13min, 4.91min, 6.86 min	(12)
10	Ciprofloxacin and Norfloxacin	Pharmaceutical Preparation	Detection wavelength:279 nm Mobile phase: water: Acetonitrile:Triethylamine (80:20:0.3 v/v/v). Column:LiChrospher®100 RP-18 column(5 µm, 125 x 4 mm) Flow rate:1.0 ml/min	(13)
11	Ciprofloxacin and Fluocinolone acetoneide	Synthetic Mixture	Detection wavelength: 255nm Mobile phase: Buffer (0.05M Potassium Dihydrogen Phosphate having pH 6.5): Methanol - 50:50 Column: Hypersil BDS (250 x 4.6mm C18) column Flow rate:1 ml/min Retention time: Fluocinolone: 3.330min Ciprofloxacin:4.773min	(14)
12	Ciprofloxacin and Dexamethasone	Pharmaceutical Preparation	Detection wavelength:254 nm. Mobile phase: Methanol-Water- Triethylamine (55:45:0.6 v/v/v) Column:250 mm × 4.6 mm i.d Grace Smart reversed- phase C18 column Flow rate:0.8 ml/min Retention time: Ciprofloxacin:4.123 ± 0.014min Dexamethasone :9.688 ± 0.049min	(15)

13	Ciprofloxacin and Bromohexine	Tablet Dosage Form	Detection wavelength:217 nm Mobile phase: Methanol: 0.05 M Phosphate buffer: 0.5 ml Triethylamine and 0.5 ml Tetrahydrofuran (80:20 v/v) Column: Hypersil C18 column (5µm × 250 mm × 4.6 mm) Flow rate:0.8 ml/min Retention time: ciprofloxacin:3.01 min Bromohexine:4.78 min	(16)
14	Ciprofloxacin and Tinidazole	Tablet Dosage Form	Detection wavelength: Ciprofloxacin: 278 nm Tinidazole: 317 nm Mobile phase: Mobile phase –A:Potassium Dihydrogen Phosphate Buffer, pH 4.5 mobile phase–B: Buffer and Acetonitrile 50:50 v/v Column: X-terra C18 column (4.5 x150 mm ID, 5µm particle size) Flow rate:1ml/min Retention time:21.98min, 18.56 min and 11.02 min	(17)
15	Ciprofloxacin and Ofloxacin	Combined Dosage Form	Detection wavelength:289 nm Mobile phase: Phosphate Buffer (15 mm): Methanol: Acetonitrile: Triethylamine (66:24:10:1 % v/v) Column:(SIL 100Å, 125×4.6 mm ID) C18-RP, 5 µm Flow rate:1 ml/min Retention time: Ciprofloxacin:3.01 min Ofloxacin: 6.03min	(18)
16	Ciprofloxacin and Metronidazole	Combined Dosage Form	Detection wavelength: 280nm Mobile phase:0.5% Aqueous Phosphoric acid and Acetonitrile (90:10, v/v) and (80:20 v/v) Acetonitrile Column: Kromasil 100-5C 18 (150 mm x 4.6 mm) Flow rate:1 ml/min Retention time: Ciprofloxacin:4.00 min Metronidazole:2.03 min	(19)
17	Ciprofloxacin and Phenylephrine	Pharmaceutical Dosage Form	Detection wavelength: 272nm Mobile phase: Water: Acetonitrile: Triethylamine (85: 15: 0.1, v/v/v), pH 3 adjusted with Orthophosphoric acid Column: Zorbax Bonus RP C18 Flow rate: 1 ml/min Retention time: Ciprofloxacin: 3.71min Phenylephrine hydrochloride: 2.71min	(20)
18	Ciprofloxacin and Hydrocortisone	Pharmaceutical Formulation	Detection wavelength: Ciprofloxacin:278nm Hydrocortisone: 244nm Mobile phase: 0.025 M phosphoric acid in water(solvent A) and Acetonitrile(solvent B). Column: Grace Smart RP 18 column(150 × 4.6 mm, 5 m, WITKO, USA), Flow rate:1.5 ml/ min	(21)
19	Ciprofloxacin and Moxifloxacin	Biological Samples	Detection wavelength:280 nm Mobile phase:0.1% Trifluoroacetic acid in water for chromatography - Methanol (66:34 v/v) Column: Zorbax SB-C18 (150 mm x 4.6 mm i.d., particle size 3.5 µm) Flow rate:1 ml/min	(22)

20	Ciprofloxacin, Tinidazole and Dicyclomine	Bulk and Tablet Dosage Form	Detection wavelength:218nm Mobile phase: Buffer pH 4.0: Methanol (60:40 v/v) Column: HiQ Sil C18 column (250 x 4.6 mm, i.d., 5 μ m) Flow rate:1 ml/min Retention time: Ciprofloxacin:8.04 min Tinidazole:5.642 min Dicyclomine:6.96 min	(23)
21	Ciprofloxacin, Ofloxacin, Tinidazole and Ornidazole	Tablet Formulation	Detection wavelength:300nm Column:C-18 column (RP-18, 5μ) Mobile phase: Acetonitrile: Water: Tri ethylamine (25:75:1). Flow rate:1.0 ml/min- Retention Time: Ciprofloxacin :2.7min Ofloxacin :3.5min Tinidazole : 4.5 min Ornidazole : 5.8 min	(24)
22	Ciprofloxacin and Chloramphenicol	Combined Dosage Form	Detection wavelength: 280nm Column: Reversed-phase Shim-pack XR-ODS (100 × 3.0 mm, 1.7 μm) Mobile phase: Methanol and 5 mM sodium Dihydrogen Phosphate Flow rate:0.20 ml/ min Retention time: Ciprofloxacin :2.46 Chloramphenicol :13.80	(25)
23	Ciprofloxacin, Levofloxacin, Moxifloxacin and Pefloxacin	Biological Samples	Column: Kinetex XB-C <sub>18</sub> column Mobile phase: Orthophosphoric acid 0.4% (v/v), Acetonitrile and Methanol Flow rate: 1.2 ml/min Concentration range: Levofloxacin: 0.125–25 mg/L Moxifloxacin: 0.1–20mg/L Peofloxacin and ciprofloxacin :0.05-10 mg/L	(26)

Table 3: Methods For Estimation Of Ciprofloxacin Single And Combination With Other Drugs By HPLTC

24	Ciprofloxacin	Tablets Dosage Form	Detection wavelength:279 nm Mobile phase: Dichloromethane: Methanol: Ammonia (30:60:10, v/v/v). Stationary phase: Precoated silica gel 60F254 Retardation factor:0.62 ± 0.03 Linearity range:100 – 600 ng /band	(27)
25	Ciprofloxacin and Enrofloxacin	Biological Sample	Detection wavelength :366 nm Mobile phase: Dichloromethane/Methanol/Aqueous Ammonia/Acetonitrile (2:3:2:3) Stationary phase: silica gel 60F254, aluminum sheets (10 × 10 cm) Retardation factor: Enrofloxacin 0.60 Ciprofloxacin 0.44 Linearity range: Enrofloxacin: 2 to 110 ng/band Ciprofloxacin: 3 to 110 ng/band	(28)
26	Ciprofloxacin and Ornidazole	Combined Dosage Form	Mobile phase: Acetonitrile: Toluene: Water and Triethylamine (5.5:1.8:1.5:1.6 V/V) Retardation factor: Ciprofloxacin: 0.16 Ornidazole: 0.84 Linearity range: Ciprofloxacin:0.4 to 0.8 μg/ml Ornidazole: 0.4 to 0.8 μg/ml	(29)

Table 4: Methods For Estimation Of Ciprofloxacin Single And In Combination With Other Drugs By LC-MS (Liquid Chromatography-Mass Spectroscopy) And UPLC-MS

27	ciprofloxacin	Biological Sample	Column:C18 Ionizer: Multiple Reaction-Monitoring mode (MRM) Flow rate:0.6ml/min Mobile phase: 5 mM Ammonium Formate (0.1% formic acid)-Acetonitrile Concentration range: 100-5000 ng/ml coefficient of determination :0.99	(30)
28	Ciprofloxacin, Norfloxacin Moxifloxacin and Ofloxacin	Tablet Dosage Form	Column: UPLC BEH C18 column; (2.1 × 100 mm, 1.7 μm particle size). Ionizer: Electron spray Flow rate: 0.3 ml/ min Analyzer: Triple Quadruple Mobile phase: Eluent A: 0.1% (v/v) Formic acid in Water; Eluent B: 0.1% (v/v) Formic acid in Acetonitrile.	(31)
29	Ciprofloxacin, Levofloxacin, Moxifloxacin and Rifampicine	Biological Sample	Column: BEH C18 column (4.6 x 150 mm, 3.5 μm particle size) Ionizer: Electron spray Flow rate: 0.3 ml/min Analyzer: Triple Quadruple Mobile phase: Eluent A Water-Formic acid (100:0.1v/v)- Ammonium Acetate 2 mM Eluent B Methanol-Formic acid (100:0.1, v/v)- Ammonium Acetate 2 mM Concentration range: 0.5–30 μg/mL coefficient of determination :0.995	(32)
30	Ciprofloxacin and Metronidazole	Biological Sample	Column : Zorbax C18, 100 × 4.6mm, 3.5 μm Ionizer: Positive Ion Mode Analyzer :Triple Quadruple Mobile phase: 0.1% Formic acid in water and Acetonitrile (70:30 v/v ) Flow rate: 0.5 ml/min Concentration range: Ciprofloxacin : 10-4000 ng/ml Metformin :30-12000 ng/ml Coefficient of determination:0.999.	(33)

## CONCLUSION

Finally, we conclude that the reported spectroscopic technique like UV Spectroscopy and Chromatographic techniques like HPLC, HPTLC and hyphenated techniques developed and validated for the estimation of ciprofloxacin in single or in combination with other

pharmaceutical drugs. It was reviewed that majorly HPLC with UV detection was extensively used technique by using different mobile phases such as Methanol, Distilled Water, Acetonitrile, Triethylethamine were used for better elution with a flow rate of 1.0ml/min for improved separations. In the spectroscopic technique methods discussed

mostly used solvent was Methanol and achieved the correlation coefficient of 0.99. Hence all these methods discussed were simple, precise, accurate, and offers reproducibility with reliability and low in cost even with advanced techniques.

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