CHAPTER I

INTRODUCTION

Literature survey of the investigated compounds

1.1. *Ciprofloxacin Hydrochloride*

The polarographic behaviour of ciprofloxacin was investigated by **Tekstor** et al[1] using differential pulse polarography. Two well–defined peaks were observed in acidic, neutral and slightly alkaline media. In 0.1 M KCl, peaks were observed at -1.54 V and -1.70 V aganist SCE. In solution of pH > 10, only one peak was observed at -1.87 V against SCE in 0.1 M LiOH. The method was applied for the determination of ciprofloxacin in human serum.

Determination of ciprofloxacin in urine by adsorptive stripping voltammetry at mercury and carbon-paste electrodes was investigatd by **O'Dea** et al[2]. Stripping curve of the prepared solution was recorded using a hanging mercury drop electrode or a carbon-paste electrode aganist Ag/AgCl. Calibration graphs were rectilinear. Detection limits were 0.258 and 0.231 μg/ml ciprofloxacin using hanging mercury drop and carbon-paste electrodes, respectively. Results were low due to the limited accumulation properties of ciprofloxacin with the reduction process selected. The coefficient of variation with the carbon–paste electrode was 4.1% (n = 5).

Study on the polarographic behaviour of ciprofloxacin, was investigated by **Zhao** et al[3]. Portions of standard ciprofloxacin solutions were treated with phosphate buffer of pH 6.8, 0.1 M H_2O_2 and diluted to 25 ml with H_2O. Oscillopolarography was performed with measurement of the

second-derivative peak height at –1.17 V. The calibration graph for the drug was linear within the range of 0.38-7.60 μg/ml. The method was applied to the analysis of ciprofloxacin tablets, with recoveries of 95.8-101.45 %.

Spectrophotometric determination of ciprofloxacin in its dosage forms was investigated by **Rao** et al[4]. The method was based on complexation reaction between the drug and ferric ion in acidic medium. The absorbance of the solution was measured at 440 nm against a reagent blank. The complex formed was stable for 4.0 hour. Beer's law was obeyed from 6.0 to 150 μg/ml of the drug. The coefficient of variation was 0.3%. Alternatively, portion of the drug solution was treated with aqueous 0.1% 3-methylbenzothiazolin-2-one hydrazone hydrochloride and 0.2% ceric ammonium sulphate in 0.5 M sulphuric acid. The absorbance of the solution was measured at 425 nm aganist a reagent blank. The formed complex was stable for 30 min. Beer's law was obeyed from 6-12 μg/ml of the drug, and the coefficient of variation was 0.5%.

Spectrophotometric determination of ciprofloxacin in pharmaceutical formulations was studied by **Mathur** et al[5]. The method was based on complexation reaction of the drug with ferric chloride in acidic medium. The absorbance was measured at 432 nm aganist a reagent blank. Beer's law was obeyed from 16-160 μg/ml of the drug, and the colour was stable for more than 24 h.

Spectrophotometric determination of ciprofloxacin in pure form and in tablets through charge-transfer complex formation was investigated by

Abdel-gawad et al[6]. The absorbance of ciprofloxacin solution and 5 mM 2,3-dichloro-5,6-dicyano-p-benzoquinone (I) or 5 mM 7,7,8,8-tetracyanoquin-odimethane (II), or 5 mM p-chlornil (III) using acetonitril as solvent was measured at 460, 834 or 550 nm using I, II, and III, respectively. Beer's law was obeyed in the concentration ranges 5-50, 1.5-15 and 20-200 μg/ml of ciprofloxacin-I, II, and III, respectively, with RSD of 1.4, 1.0 and 0.7% (n = 7).

A simple spectrophotometric method for estimation of ciprofloxacin in its dosage forms was investigated by **Shanbag** et al[7]. The procedure was based on the charge–transfer (CT) complex formation between the drug and ethanolic 0.1% p-benzoquinone in phosphate buffer of pH 7.8. The absorbance was measured at 495 nm. Recoveries of the drug were 99.53-100.5%.

Spectrophotometric determination of ciprofloxacin through charge-transfer complex formation was studied by **Mostafa** et al[8]. A Spectrophotometric method was described for the determination of the antibacterial quinolone derivative through charge transfer complexes formation with different acceptors. Chloranilic acid and tetracyanoethylene (TCNE) were used forming charge-transfer complexes with λ_{max} = 520 and 335 nm. The proposed method was applied for analysis of Ciprocin tablets with mean accuracies 99.58% ± 1.25 and 99.4% ± 1.27 for the used acceptors respectively.

Flow injection spectrophotometric method for the determination of

ciprofloxacin was investigated by **Sultan** et al[9]. The method was based on the complexation of ferric ion with the drug in 0.023 M sulfuric acid solution and the reactants were passed through a reaction coil. The brown-red complex produced was monitored at 447 nm. Calibration graphs were rectilinear from 50 to 500 μg/ml. Sample frequency was 250 /h ; coefficient of variation was < 0.9% (n = 6).

Determination of ciprofloxacin in urine samples was investigated spectrophotometrically by **Zhang** et al[10]. The method was based on the hydrolysis of the drug in basic midium (0.01M sodium hydroxide). The absorbance of the mixture was measured at 335 nm. Beer's law was obeyed for 5-10 μg/ml of ciprofloxacin with an average recovery of 100%, and relative standard deviation (RSD) of 0.76% (n = 9).

Two new spectrophotometric methods for determination of ciprofloxacin in tablets were established by **Tosunoglu** et al[11]. The method was based on the ion-pair complexation reaction of the drug with bromo-cresol purple (BCP) and bromophenol blue (BPB). The absorbance was measured at λ_{max} 410 nm. Beer's law was obyed in the concentration range from 1.5 to 16.5 μg/ml, with recovery of 100%.

Spectrophotometric determination of ciprofloxacin hydrochloride (I) in ophthalmic preparations was studied by **Su** et al[12]. Sample was diluted with 0.1 M HCl and its absorbance was measured at 277 nm against a reagent blank. The mean recovery of (I) was 99.9% and the RSD was 0.1%.

Fluorescence characteristics of ciprofloxacin (I) based on charge transfer reaction was studied by Du[13]. The charge-transfer complex formed between (I) as the donor and 2,3-dichloro-5,6-dicyano-1,4-benzoquinone (DDQ) as the acceptor has been studied by fluorimetry. Experiment showed that (I) reacted with (DDQ) in a mixture of acetone and methanol at 40° C for 30 min and the complex was formed in 1:1 ratio. A linear calibration graph was obtained over the concentration range from 0.1 µg/ml to 7.2 µg/ml. The method was applied to tablet form

UV-spectrophotometric studies for determination of ciprofloxacin hydrochloride (I) were done by **Liu** et al[14]. The absorbance of (I) solution in 0.1 M HCl was measured at 277 nm. The recovery was 98.2-99.6 %, with RSD of 0.21-0.54 %.

Spectrophotometric determination of ciprofloxacin using tetrachloro-benzoquinone was investigated by **Xuan** et al[15]. The method was based on the charge-transfer (CT) complexation reaction of the drug with the tetra-chlorobenzoquinone in 0.01M borax buffer of pH 9.0-9.5. The absorbance was measured at 376 nm against a reagent blank. Beer's law was obeyed in the range from 0.9 to 2.5 µg/ml of added drug with RSD of 0.62.-1.39 %.

Determination of ciprofloxacin hydrochloride in tablets by differential spectrophotometry was investigated by **Zhang** et al[16]. The method was based on hydrolysis of the drug in acid medium (diluted HCl). The absorbance was measured at 283 nm. A similar sample solution treated with sodium hydroxide was used as the reference solution. The resulting

calibration graph was linear within the range from 0.002 to 0.015 µg/ml of the drug. The recovery was 101.3%, and the RSD was 0.6%.

Flow injection method was used for the determination of ciprofloxacin by **Liang** et al[17]. Portion of the drug was mixed with 5 mM Na_2SO_4 in a flow injection chemiluminometer and flowed at 6 ml/min with a carrier /reagent stream of 0.4 mM $CeSO_4$-$2(NH_4)_2SO_4$, containing 50 mM H_2SO_4 to a flow cell for mixing and the chemiluminometer intensity was measured. The calibration graph was linear within the range 1-20 µg/ml of the drug with detection limit of 0.27 µg/ml with recovery of 96-108%.

Spectrofluorometric study of the acid–base equilibria and complexation behaviour of fluoroquinolone antibiotics ciprofloxacin (CIP), ofloxacin (OFL) and norfloxacin (NOR) in aqueous solution was investigated by **Drakopoulos** et al[18]. The acid-base properties and the complexation behaviour of the antibiotics (OFL), (CIP), and (NOR) were studied fluorometry. All the fluoroquinolones formed fluorescent complexes with Sc^{3+} at pH 4.2 (acetate buffer). The fluorescence intensity was measured at 430 nm or at 480 nm for (OFL). Calibration graphs were linear up to 0.386 µg/ml. Detection limits for (OFL), (NOR) and (CIP) were 0.424×10^{-4}, 0.231×10^{-3} and 0.192×10^{-3}, respectively. RSD (n = 3) was 5.7% at 0.002 µg/ml.

Application of Tb^{3+} ion sensitized fluorescence for the determination of antibiotics ciprofloxacin and norfloxacin in serum was investigated by **Veiopoulou** et al[19]. Serum sample was deprotinized by mixing with 200 µl acetonitrile followed by centrifugation, then mixed with 1400 µl working

solution consisting of 3 mM Tb^{3+}, 1.5 mM TOPO, 5 mM cetylpyridinium chloride and 0.1 M acetate buffer of pH 5.5. The fluorescence of the resulting solution was measured at 546 nm. The calibration graphs were linear from 0.019-3.86 μg/ml for both drugs, and their detection limits in deproteinized serum were 0.386 μg/ml and 0.077 μg/ml, respectively. The recoveries were 101-108% and 87-96% for ciprofloxacin and norfloxacin.

Fluorimetric determination of the content of ciprofloxacin hydrochloride ointment was investigated by **Zhou** et al[20]. A portion of the prepared ciprofloxacin hydrochloride solution was treated with 1.0 ml HCl / sodium citrate buffer of pH 5.0 and 1.0 ml of 10 mM $AlCl_3$. The fluorescence intensity was measured at 420 nm. The calibration graph was linear within the range 0.435-4.34 μg/ml. Average recovery was 102.2%, with RSD of 1.9%.

Atomic absorption spectrophotometric determination of ciprofloxacin hydrochloride with potassium ferricyanide was investigated by **El-Ansary** et al[21]. The method was based on ion-pair complex formation between ciprofloxacin and potassium ferricyanide. The calibration graphs were linear within the range from 69.6 to 694.4 μg/ml, with detection limit of 21.36 μg/ml. The method was applied to powders, injection solution, tablets and also to urine samples.

Atomic absorption spectrometric determination of ciprofloxacin hydrochloride with sodium cobalt nitrite was studied by **El-Ansary** et al[22]. The method was based on ion-association complexe formation of

ciprofloxacin hydrochloride with $[Co(NO_2)_6]^{3-}$. The applicability of the method for determination of the drug in pure solution, pharmaceutical preparations and urine sample was studied. The drug could be determined in the range of 23.12–231.5 μg/ml, with mean RSD of 1.05-1.53% and recovery values of 98.85±0.31 to 100.09± 0.54% indicating high precision and accuracy. The detection limit for determination of the investigated drug was 6.63 μg/ml.

Centrifugation spectrophotometric determination of ciprofloxacin hydrochlo ride was studied by **Li** et al[23]. The method was based on charge–transfer reaction between ciprofloxacin hydrochloride and phloxine. The absorbance was measured at 546 nm (ε = 27100) against a reagent blank. The method was applied to the analysis of ciprofloxacin hyrochloride in tablets.

Spectrophotometric determination of ciprofloxacin in serum using Fe(III) as chromogenic agent was studeid by **Djurdjevic** et al[24]. Fe(III) nitrate was used as chromogenic agent, sodium dodecyl sulfate (SDS) was added at pH 3.0. Absorbance was measured at 430 nm. The range of linearity was found between 0.5–20.0 μg/ml with detection limit 0.2 μg/ml.

Conductometric determination of ciprofloxacin hydrochloride, ofloxacin and norfloxacin in dosage forms was established by **Belal** et al[25]. Tablets (equivalent to 100 mg 4-quinolone antibiotics) were extracted with 3 x 30 ml methanol. The combined extract was filtered and the filtrate was diluted to 100 ml with methanol. A portion of the solution was mixed with

2 ml H_2O and the resulting solution was titrated with aqueous 5 mM NaOH, 5 mM tetrabutyl ammonium hydroxide or 5 mM $AgNO_3$ by adding 0.1 ml increments at 2 minuts intervals.

Simultaneous estimation of ciprofloxacin in tablet dosage forms using spectrophotometric and HPLC methods, were estimated by **Tipre** et al[26]. The analysis of ciprofloxacin in tablets was done by HPLC using simultaneous equation (SE). Twenty tablets were dissolved in methanol and diluted with DMF. The absorbance of the solution was measured at 278 nm. The calibration graphs were linear within the range 2-10 µg/ml. For absorption factor (AF) spectrophotometry, the absorbance of the diluted tablet solution was measured at 272 nm. Beer's law was obeyed in the range of 2-10 µg/ml of the drug.

1.2. *Norfloxacin*

Determination of norfloxacin by differential pulse polarography was illustrated by **Veber** et al[27]. Norfloxacin in 0.1 M KCl exhibited reduction peaks at –1.56 and –1.7 V against SCE. The calibration graph was rectilinear over a wide concentration range, the coefficient of variation was 2.0 to 6.0 %.

Polarographic procedure for determination of norfloxacin (NOR) was illustrated by **Delgado** et al[28]. The polarographic behaviour of the drug was studied at a mercury electrode as a function of pH. The effect of the pH on the wave height was reported. The linear dependence between the limiting current (wave height) and the drug concentration was observed for (NOR) concentration from 3.35 to 108.2 μg/ml or from 0.619 to 7.759 μg/ml.

Polarographic behaviour of norfloxacin–Co(II) complex was studied by **Li** et al[29]. The study occurred in supporting electrolyte containing 4.15 μg/ml norfloxacin and 0.1 M NH_3/NH_4Cl of pH 7.5. The wave of norfloxacin–Co(II) complex was obtained by using single sweep polarography. The peak potential was –1.09 V. The peak current changes linearly with the concentration of Co(II) in the range of 0.016 to 0.798 μg/ml.

Polarographic behaviour for the determination of norfloxacin in tablets was investigated by **Yaber** et al[30]. The polarographic behaviour of the drug had been studied in various base electrolytes, at different pH values in the

presence of dimethylformamide. In strongly acidic medium (pH<1) only one reduction wave in the range from –0.95 to –1.05 V for 1.0 x 10^{-4} M of norfloxacin. At pH ≥7.5 two well-defined irreversible waves were observed in the range from –1.48 to –1.67 V and –1.79 to –1.93 V, respectively, for norfloxacin concentration of 1.0 x 10^{-4} M. At pH ≥10, only the second wave had been observed, but all waves disappeared completely in 0.1 M NaOH. In addition, two ill–defined waves appeared in the range –0.06 to –0.42 V. Within pH range from 6.5 to 8.5 for drug concentration > 5 x 10^{-5} M. The single differential pulse wave which appeared in 2 M HCl and the first wave showed a useful rectilinear relation between concentration and wave heights from 32 to 560 µg/ml norfloxacin. These two differential pulse waves were utilized for determination of the drug in norfloxacin tablets.

Adsorptive differential pulse stripping voltammetry of norfloxacin and its analytical application was illustrated by **Yaber** et al[31]. The study was performed at a hanging mercury electrode in various supporting electrolytes of pH < 9 (LiCl, NaCl/NaOH, sodium acetate, sodium acetate/acetic acid and NH_3/NH_4Cl) was investigated. Three waves in the ranges from –1.02 to -1.18 V, -1.28 to -1.34 V and from -1.43 to -1.54 V, were observed. The optimum experimental parameters were; accumulation potential from 0 to -0.1 V, accumulation time 60-300 second and scan rate 2-10 mV/s. The method was applied to tablets under the above conditions. The calibration graphs were linear from the detection limit 0.32 µg/ml to 900 µg/ml and from 0.32 x 10^{-3} to 65 x 10^{-3}µg/l of the drug depending on the base electrolyte and adsorptive peak used for analysis. The RSD were 2.5-6.0%, (n = 10).

Single-sweep oscillopolarographic determination of norfloxacin was studied **Luo** et al[32]. The method was performed with measurement at –1.48V against SCE in $NaOH/NaH_2PO_4$ buffer of pH 6.9. The linear relationship between wave height and concentration was obtained for 0.03-1.4 μg/ml of drug.

Determination of norfloxacin using adsorptive voltammetry was studied **Liu** et al[33]. The method was performed with measurement of the peak potential of the reduction wave of the drug in NH_3/NH_4Cl buffer of pH 7.49 at –1.52 V against SCE. A linear relationship was observed for 0.063-23.81 μg/ml norfloxacin. The method was applied to the analysis of norfloxacin eye drops.

Spectrophotometric estimation of norfloxacin in its dosage forms using 3-methylbenzolin-2-one hydrazone hydrochloride was studied by **Rao** et al[34]. The absorbance of the drug solution in 0.1 M H_2SO_4 and water after filtration and addition of 0.2% solution of 3-methylbenzothiazolin-2-one hydrazone hydrochloride and ceric ammonium sulphate was measured at 630 nm against a reagent blank. The calibration graph was rectilinear from 1.0 to 20 μg/ml of the drug. Recovery was 89.5-101%, the coefficient of variation was 0.11%.

Spectrophotometric determination of amount of Fe(III) with norfloxacin (NOR) as complexing reagent was investigated by **Issopoulos**[35]. The complexation of Fe(III) with (NOR) in acidic solution at 25°C of ionic strength 0.3 M HCl has been studied. The maximum

absorbance at 377 nm was used for spectrophotometric determination of trace amount of Fe(III). The molar absorptivity was 9.05 x 10^3 l mol^{-1} cm^{-1} and Sandell sensitivity 6.2 mg cm^{-2} of Fe(III) per 0.001 A was obtained. The calibration graph was rectilinear over the range 0.25 to 12.0 μg/ml of Fe(III). The formation constant was found to be 4 x 10^8 at 25°C.

Spectrofluorometric determination of the content of norfloxacin capsules was investigated By **Jin**[36]. The method was based on hydrolysis of the drug in acidic medium (0.05 M HCl). The fluorescence of the solution after filteration and addition of more 0.05 M HCl was measured at 440 nm. Recovery (n = 8) was 99.9 % with variation coefficient of 0.8 %. A rectilinear relationship between fluorescence and concentration was observed for 0.1 to 0.36 μg/ml of the drug.

Spectrophotometric determination of some recently produced antibacterial drugs [norfloxacin (I), ciprofloxacin (II)] using ferric chloride was studied by **Bhowal** et al[37]. In this method, the powderd tablets or capsules (equivalent to 100 mg) was heated and shaked with DMSO in a boiling water bath, the mixture completed to 100 ml with methanol and filtered. A portion of the filtrate was mixed with 5.0 ml methanolic 0.1% $FeCl_3$ and completed to 50 ml with methanol. The absorbances for (I) were measured at 442 nm, and for (II) at 440 nm. Beer's law was obeyed in the range of 50 to 125 μg/ml for (I) and 40 to 100 μg/ml for (II).

Spectrophotometric determination of norfloxacin was studied by **Chowdary** et al[38]. The method was based on the reaction of norfloxacin

with ferric nitrate to form a stable yellow-orange complex solution, which can be measured at 355 nm. Beer's law was obeyed in the concentration range of 5-100 μg/ml.

Determination of norfloxacin in its capsules by UV-spectrophotometry was studied by **Ye** et al[39]. The drug was dissolved in 0.1 M HCl and the absorbance was measured at 277 nm against 0.1M HCl. Beer's law was obeyed for 2×10^3 to 1×10^4 μg/ml of the drug. The mean reovery was 99.9%.

Chemometric optimization of norfloxacin in drug formulations was studied by **Sultan** et al[40]. The absorbance of the colored complex formed between the drug and 0.0271 M Fe(III) was monitored at 430 nm. The calibration graph was rectilinear form 50 to 450 μg/ml of the drug.

Charge transfer complex formation between norfloxacin and tetrachlorobenzoquinone (TCBQ) was illustrated by **Zhou** et al[41]. The absorbance of the drug solution in 0.2 M NaOH and 0.1 M borate buffer of pH 9 and 3 mM TCBQ was measured at 375.2 nm (ε = 16.8 l $ml^{-1}cm^{-1}$) against a reagent blank. Beer's law was obeyed from 1-17μg/ml and the recovery was more than 99 % with variation coefficient of 1.1 %.

Fluorimetric and derivative-spectrophotometric determination of norfloxacin was investigated by **Stankov** et al[42]. In this method, the fluorescence of 0.1 ml serum in 0.05 ml of 2 % sodium dodecyl sulphate,

and 0.1 ml of 0.1 M HCl, was measured at 455 nm. The calibration graph was linear for 20-320 μg/ml of the drug and the detection limit was 2.0 μg/ml. The method was applied to tablets.

UV-spectrophotometric analysis of norfloxacin syrup was studied by **Wu** et al[43]. A sample of the drug was dissolved in 0.04 M HCl and completed to 100 ml by HCl. The absorbance of the resulting solution was measured at 315 nm. The calibration graph was rectilinear from 4.69 to 23.45 μg/ml of the drug .The recovery was 99.9 % with an RSD of 0.25 %.

Utility of certain π-acceptors for the spectrophotometric determination of norfloxacin was investigated by **Amin** et al[44]. The method was based on the reaction of the drug as π-donor with 2,3-dichloro-5, 6-dicyano-p-benzoquinone (DDQ), 7,7,8,8,-tetracyanoquinonedimethane (TCNQ), p-chloranil (CL) or chloranilic acid (CLA) as π–acceptors to give highly colored complex species. The colored products were measured at 460, 843, 550, and 531 nm for DDQ, TCNQ, CL and CLA, respectively. Beer's law was obeyed in the concentration range 10-400 μg/ml.

Spectrophotometric determination of norfloxacin was studied by **Zhao** et al[45]. The method was based on formation of 1:1 purple red complex between norfloxacin and 2,6-dichloroquinone-4-dichloramide. The absorbance was measured at 534 nm. Beer's law was obeyed at 2×10^3- 4×10^3 μg/ml. The average recovery was 99.9 % and the RSD was 0.15 % (n = 5).

Spectrophotometric estimation of norfloxacin was studied by **Hiremath** et al[46]. The method was based on the formation of yellow compound with ceric ammonium nitrate showing an absorption maximum at 354 nm. Beer's law was obeyed in the concentration range of 0- 28 µg/ml.

A colorimetric procedure for the determination of norfloxacin in tablets by the reaction with p-benzoquinone was investigated by Al-**Khamees**[47]. The complexation between the drug and p-benzoquinone has the ratio 1:1 and showed an absorption band at 495 nm. Beer's law was obeyed over the concentration range 7.5-40 µg/ml of the drug.

Fluorescence reaction and complexation equilibrium between norfloxacin and Al^{3+} ion in chloride medium was investigated by **Predrag** et al[48]. The formed complex showed maximum emission at 440 nm with excitation at 320 nm. The fluorescence intensity was enhanced by addition of 0.5 % sodium dodecyl sulphate.

Charge–transfer reaction between electron acceptors and norfloxacin was investigated by **Zhou** et al[49]. Portions of the drug solution was mixed with 1.5 ml ethanolic 0.15 M p-benzoquinone or 2.0 ml ethanolic 3 mM 2,3-dichloro 5,6-dicyano-1,4-benzoquinone. The absorbance was measured at 490 or 470 nm against a reagent blank. For determination of norfloxacin in aqueous medium, sample solution was mixed with 1.0 ml ethanolic tetrachlorobenzoquinone or tetrabromobenzoquinone in borax buffer of pH 7 and the mixture was diluted to 10 ml with water, the absorbance was measured at 490 or 470 nm aganist a reagent blank. Calibration graphs were

linear from 5 to 15, 35 to 65 and from 1.0 to 17.0 μg/ml of the drug, respectively, with recoveries of 98.6-100%.

Determination of norfloxacin in animal drugs by fluorimetry was estimated by **Xu** et al[50]. The method was based on the reaction of the drug with β–cyclodextrin in 5.0 ml NaH_2PO_4 -citric acid buffer solution of pH 2.6. The fluorescence intensity of solution was measured at 450 nm. The calibration graph was linear from 1.0-1.5 μg/ml of the drug and the detection limit was 0.78 x 10^3 μg /ml. The RSD was 2.5 % for 0.15 μg/ml of the drug.

Spectrophotometric and spectrofluorimetric estimation of norfloxacin (NOR) and ciprofloxacin hydrochloride (CIP) by ternary complex formation with eosin and palladium(II) was studied by **El-Walily** et al[51]. In the spectrophotometric method, the absorbance of the powdered tablets solution after filtration and addition of 0.5% methylcellulose solution, 0.2 M acetate buffer of pH 4 for (CIP) and pH 4.2 for (NOR) was measured at 545 nm against a reagent blank. In the fluorimetric method the difference in the relative fluorescence intensities of the sample solution and blank was measured at 540 nm. Recoveries for both methods were > 97%.

Determination of norfloxacin in capsules by UV-spectrophotometry was studied by **Tang** et al[52]. The drug was dissolved in 0.4% NaOH, and the absorbance was measured at 273 nm against a solvent as blank. The calibration graph was linear for 1-13 μg/ml of norfloxacin. The average recovery was 100.2%, with RSD (n = 5) of 0.21%.

Extractive spectrophotometric method for the determination of norfloxacin in pharmaceutical preparations was studied by **Bharat** et al[53]. The solution of the powdered tablets in 0.1 M H_2SO_4 was filtrated and completed by 0.1 M H_2SO_4 to 100 ml, in 1.5 ml ceric ammonium sulphate was added. The resultant yellow chromogen was extracted with 10.5 and 5.0 ml $CHCl_3$ with shaking. The separated $CHCl_3$ extract was passed through a layer of anhydrous sodium sulphate then washed with $CHCl_3$. The absorbance was measured at 350 nm. Beer's law was obeyed form 10 to 100 µg/ml of the drug.

Simultaneous spectrophotometric estimation of norfloxacin from tablets was estimated by **Srinivasa** et al[54]. Two spectrophotometric methods were discussed. In the first method standards of 4-20 µg/ml of norfloxacin (I) and 6-30 µg/ml of tinidazole (II) were used. Two kinds of commercially available tablets were analysed. A spectrophotometer in multicomponent mode scanned was used in the range from 200 to 400 nm with absorbance maxima at 275.6 and 317.8 nm for II and I, respectively. In the second method; the difference in absorbance from 275.6 to 353.6 nm for I and from 317.8 to 254.2 nm for II were determined.

Determination of norfloxacin in real samples by different spectrofluorimetric techniques was investigated by **Perez** et al[55]. The method was based on the reaction of the drug with Al(III) at pH 4 in SDS medium and measurement of the fluorescence intensity. Under the optimum conditions, the calibration graph was 0.4 µg/ml and the RSD (n = 11) was 0.2-2.4%. The method was applied to pharmaceutical preparations of the

drug, by measuring the fluorescence intensity of the Al(III)-norfloxacin complex at 423 nm. The recoveries were 95-103 %. The method was also applied to determine the drug in urine, using $\Delta\lambda = 93$ nm, and the recoveries were 96-108 %.

Micelle enhanced spectrofluorimetric determination of norfloxacin using terbium as fluorescent props was studied by **Huang** et al[56]. Norfloxacin was treated with Tb^{3+}, 0.01 M surfactant and 0.2 M trishydrochloride buffer at pH 8.0. The relative fluorescence intensity of the prepared solution was measured at 545 nm. This intensity increased three fold in the presence of surfactant. This method was applied to the determination of the drug in serum.

The determination of tinidazole-norfloxacin in combined tablet preparations by derivative spectroscopy was investigated by **Prasad** et al[57]. Tablets were dissolved in DMF to a total volume of 50 ml and diluted in 0.01 M NaOH. The absorbances were scanned from 250 to 360 nm and first–derivative spectrum was recorded ($\varepsilon = 20$ L mol^{-1} cm^{-1}). The detection limit was 0.06, 0.101 µg /ml for the tinidazol and norfloxacin, respectively.

Studies on the fluorescence characteristics and liposolubilities of complexes of norfloxacin with Al(III), Zn(II) and Mg(II) was studied by **Xu** et al[58]. Standard solution containing 16 mg of the drug, was mixed with 2 ml $NaHPO_4$, citric acid buffer of pH 3.0 and 5.0 ml of 10 mM Al(III), diluted to 25 ml with H_2O. The fluorescence was measured at 403 nm. The calibration graph for the drug was linear from $4.7 \times 10^{+3}$- $630 \times 10^{+3}$ µg/ml.

calibration graph for the drug was linear from $4.7 \times 10^{+3}$- $630 \times 10^{+3}$ µg/ml. the detection limit was $4.7 \times 10^{+3}$ µg/ml. Zn(II) and Mg(III) produced such specific fluorescence characteristics at pH 6.6.

Spectrophotometric estimation of norfloxacin (I) and tinadazole (II) from combined dosage forms was investigated by **Dahibhate** et al[59]. The method was based on the hydrolysis of both drugs in acidic medium. The absorbance was measured at 277 and 316 nm for (II) and (I) respectively. Beer's law was obeyed over the concentration range employed for the method. The RSD values were low and the recoveries were 100 %.

Fluorescence characteristics of Fe(III)–norfloxacin–guanylic acid ternary complex was studied by **Xu** et al[60]. A mixture of 16 µg/ml norfloxacin and Fe(III) or Cu(II), 1.0 ml aqueous 1.0 mM guanylic acid sodium salt (I) and 0.5 M ammonium acetate buffer of pH 7.0 was prepared. The fluorescence of the drug could be quenched by Fe(III) and Cu(II) due to formation of complexes 1:1 with the drug.

Zhao et al[61] studied of the fluorescent system of norfloxacin–terbium and its application to the determination of norfloxacin. The fluorescence intensity of the prepared drug solution and 1.0 mM Tb (III), was measured at 545 nm against a reagent reference. The calibration graph was linear up to 0.45 µg/ml norfloxacin. The detection limit was 0.016 µg/ml. The recoveries were 98.5-105 %. The method was used for the analysis of the drug in blood serum.

Spectrophotometric determination of some antibacterial drugs using p-nitrophenol was studied by **Xuan** et al[62]. Sample of norfloxacin was treated with 2.5 ml p-nitrophenol and completed to 10 ml with water. The absorbance was measured at 407 nm for the drug. Beer's law was obeyed in the ranges from 0.3 to 16 μg/ml norfloxacin.

Charge transfer complexation reaction study on norfloxacin was investigated by **Song** et al[63]. A sample of norfloxacin was treated with 1.5 ml of 6 mM 2,4-dinitrophenol, the absorbance was measured at 397.4 (ε = 13-400 l mol^{-1} cm^{-1}). The calibration graphs for the drug were linear from 0.25 to 15 μg/ml. The recoveries were > 99% with RSD 1.43–3.65 %. The method was applied to tablets of the drug.

Spectrophotometric estimation of norfloxacin and other certain fluoroquinolone drugs in their pharmaceutical dosage forms using ammonium reineckate reagent, was studied by **Avadhanulu** et al[64]. The fluoroquinolones were acidified with HCl or H_2SO_4 and treated with ammonium reineckate reagent solution, after preparation of the drug solution. The absorbance was measured at 524 nm. RSD for norfloxacin was 0.02-0.70 % and for ciprofloxacin was 0.30-0.55 %.

Study on the charge–transfer reaction between 7,7,8,8-tetracyan-oquinodimethane (TCNQ) and norfloxacin was studied by **Zhao** et al[65]. The charge–transfer reaction between (TCNQ) as an π-electron acceptor and norfloxacin as electron donor have been studied using spectrophotometric method. The complex formed had stable blue color. After optimization of

the experimented conditions, the results showed that Beer's law was obeyed in the range 4-32 μg/ml of drug, ($\varepsilon = 8.91 \times 10^{+3}$ l $mol^{-1}cm^{-1}$). RSD (n = 10) was < 3 %. This method has been applied to determine the pharmaceutical dosage forms.

Determination of norfloxacin spesctrophotometrically using 2,4-dinitrofluorobenzene (DNFB) was studied by **El-Walily** et al[66]. Two experimental conditions used, for the first method, a standard solution of diluted to 10 ml with H_2O after adding 0.6 ml of 1.3 % DNFB in aceton add. The absorbance of the prepared solution was mesaered at 365 nm (ε = 71900 l mlo^{-1} cm^{-1}) against a DNFB blank. For the second method, a standard solution of the drug in DMSO was mixed with 0.5 ml 0.2% DNFB in DMSO, the absorbance was measuerd at 410 nm (ε = 36400 l mol^{-1} cm^{-1}) against a DMSO blank. Calibration graphs were linear from 10 to 40 and 2 to 8 μg/ml, respectively for the first and the second methods. The detection limits were 0.47 and 0.27 μg/ml. The method was applied to pharmaceutical preparations of the drug.

1.3. Ofloxacin

Adsorptive stripping volammetric determination of ofloxacin was studied by **Tamer**[67]. The determination of ofloxacin was investigated on static mercury electrode. A well defined stripping peak was obserbed in Britton-Robinson buffer of pH 6.0 and with a peak potentioal of –1.675 V against Ag/AgCl for 0.08 to 197.5 μg/ml when using a pre-concentration time 60 second. The detection limit was 1 x 10^3 μg/ml, with coefficient of variation 0.75% for 0.848 μg/ml (n = 6). The method was applied for Girasid tablets.

Polarographic and voltammetric behaviour of ofloxacin and its analytical application was studied by **Zhou** et al[68]. In this study ofloxacin exihibited a well-defined linear sweep voltammetric peak at –1.34 V against SCE at mercury-drop as working electrode in a Britton Robenson buffer of pH 4.0. Calibration graphs were linear for 65.8-263.2 μg/ml ofloxacin and the detection limit was 1.316 μg/ml. A voltammetric method was developed for the determination of ofloxacin in pharmaceutical formulations. The voltammogram was recorded by scanning the potential from -1.0 to -1.5 V at scan rate 250 mV/s. The RSD for 0.013 μg/ml ofloxacin was 2.2% (n = 8). The mean recovery of ofloxacin from tablets was 101%.

Polarographic investigation of ofloxacin–cu(II) complex was investigated by **Kapetanovic** et al[69]. The complex was investigated by differential pulse polarography at a dropping mercury electrode, the drop time 25 second, modulation amplitude of 25 mV, scan rate of 2 mV/s and mercury–column height of 81 cm.

Single sweep polarography of ofloxacin was studied by **Zhang** et al[70]. The polarograms were recorded in 0.2 M KH_2PO_4 / Na_2HPO_4 buffer of pH 6.0. The reduction peak was observed at –1.55 V against SCE. The calibration graph was linear from 0.15 to 3.29 μg/ml ofloxacin, the detection limit was 0.079 μg/ml. The method was applied to tablets, with recovery of 97.3–104.9% and RSD of 0.3-0.6%.

Differential pulse polarographic determination of ofloxacin in pharmaceutical and biological fluids was illustrated by **Rizk** et al[71]. A cathodic wave was produced by ofloxacin in Britton-Robinson buffer of pH 4.1-10.3 at dropping mercury electrode and the best definde wave were at pH 8.36. The current–concentration relationship was linear in the range of 3.6×10^{-3}– 0.18 μg/ml, the detection limit was 0.099 μg/ml. The method was applied to tablets in buffer of pH 8.36. The recoveries were > 99% (n = 9). The method was applied to urine in phosphate buffer of pH 7.0, the mean recovery was > 96% with RSD 1.68% (n = 4).

Determination of ofloxacin by alternating current oscillographic titration was illustrated by **Zhang** et al[72,73]. The mean recovery of 8.61 mg ofloxacin was 100.02% with an RSD (n = 6) of 0.17% - 0.56%. Results were comparable with those obtained by spectrophotometry.

Spectrofluorometric determination of ofloxacin in tablets was investigated by **Tamer** et al[74]. The method was based on measuring the fluorosence of the drug in acetic acid medium. A fluorscence was measured at 505 nm. Detection limit was 5 μg/ml of the drug. The coefficient of

variation was 0.5% (n = 6) and the calibration graphs were rectilinear from 0.1-5.0 µg/ml.

Spectrofluorometric estimation of ofloxacin in tablets was studied by **Mathur** et al[75]. The method was based on measuring the fluoroscence intensity in acetate buffer solution of pH 3.9 and in 0.1 M HCl. The fluorescence was measured at 500 nm. The recovery of added ofloxacin was 98.7 to 99.5%. Beer's law was obeyed from 0.3 to 6.0 µg/ml of the drug on using acetate buffer solution and from 0.6 to 5.0 µg/ml of the drug in 0.1 M HCl.

Simultaneous estimation of ofloxacin in tablet dosage form was studied by **Panzade** et al[76]. Solution of 10 µg/ml of ofloxacin was determined at absorbance 294 nm. Beer's law was obeyed up to 20 µg/ml. The method was applied to two different brands of tablets with recoveries 99.98-100.21 and 100.02-100.14%.

Spectrophotometric and spectrofluorometric determination of ofloxacin was studied by **El-Yazbi**[77]. In the spectrophotometric method the absorbance of two equal portions of ofloxacin solution in 0.1 M NaOH were made to 100 ml with 0.1 M HCl (A) and 0.1 M NaOH (B), and recorded against 0.1 M HCl from 200 to 370 nm. The absorption difference spectrum was also recorded with solution A and B in the sample and reference cells, respectively. Ofloxacin was determined from measurement of the peak height at 298 nm in the absorption difference spectrum and from absorbance and derivative maximum ratio, the latter being preferable if

interference was present. The method was applied for the determination of ofloxacin in urine. In spectrofluorometric method, a rectilinear relationship being obtained from 0.658 to 3.29 μg/ml ofloxacin. The fluoresence was recorded at 512 nm. The calibration graph was rectilinear from 0.2 to 1.0 μg/ml of the drug. Both of the above methods were applied to the determination of the drug in powdered tablets .

Determination of ofloxacin in pharmaceutical forms by HPLC and derivative UV-spectrophotometry was illustrated by **Carlucci** et al[78]. The drug solution in 0.1 M NaOH was analysed by second-derivative spectrophotometry with $\Delta\lambda$ of 6 nm and measurement of the peak through amplitude between 303 and 315 nm. The detection limit was 20 μg/ml and RSD was 2.0% and that of HPLC method was 10 μg/ml and RSD was 1.2%.

Dissociation and complexation behaviour of fluoroquinolone, ciprofloxacin, norfloxacin and ofloxacin were studied by **Lee** et al[79]. The formula of the drug-Fe(III) complexe were determined spectrophotometrically by the continuous variation and molar ratio methods. The formation constant of the 1:1 complex was determined spectrophotometrically using Bjerrum's method and Scatchard plots; at pH 3.8. Also, acid dissociation constants were determined by standard potentiometric or conductimetric techniques. Also, the absorption fluorescence and IR spectra of the drugs and their iron(III)-complex were recorded .

Determination of ofloxacin in ointment by UV spectrophotometry was estimated by **Shao**[80]. The method was based on hydrolysis of ofloxacin in

acidic medium. The absorbance of the solution of ofloxacin in 0.1 M HCl was measured at 293 nm. The average recovery of the drug (n = 3) was 98.2% with RSD of 0.9%.

Spectrophotometric determination of ofloxacin in pharmaceutical formulations was investigated by **Sastry** et al[81]. The method was based on the reaction of the drug with 3-methyl–2-benzothiazolinone hydrazone hydrochloride. The absorbance of the drug solution in 0.1 M HCl and 3-methyl-2-benzothiazolinone hydrazone hydrochloride in the presence of ceric ammonium sulphate was measured at 630 nm. Beer's law was obeyed in the concentration range of 1-10 μg/ml.

Spectrophotometric investigation of the ofloxacin–Cu(II) complexes was investigated by **Kapetanovic** et al[82]. The method was based on treatment of the drug with copper nitrate reagent in Britton-Robinson buffer solution of pH 4.5 and 1.0 ml of 2.0 M Na_2CO_3. The absorbance was measured at 360 nm. Beer's law was obeyed from 0.018-0.180 μg/ml of the drug. The recovery was 98.59% with a RSD (n = 6) of 0.072%. The effects of pH on spectra in the rang 350-450 nm were investigated. Maxima were observed at pH 4 (360 nm), pH 7.02 (363 nm) and pH 8.3 (365 nm) corresponding to the formilation of 1:1, 1:2, and 1:3 Cu(II) complexes, respectively.

Determination of ofloxacin granules by UV-spectrophotometry was investigated by **Zhang** et al[83]. The method was based on the hydrolysis of the drug in 0.1 M HCl and completed to 50 ml with HCl and filtrated, 3 ml

the drug in 0.1 M HCl and completed to 50 ml with HCl and filtrated, 3 ml of the filtrated solution was diluted to 50 ml with HCl. The absorbance of the solution was measured at 293 nm against a reagent blank. The calibration graph was linear from 1.195-8.363 μg/ml of the drug. The average recovery was 98.7 % with RSD (n = 6) of the 1.01 %.

UV spectrophotometric determination of ofloxacin was investigated by **Ivankiv** et al[84]. The method was based on hydrolysis of the drug in 250 ml of 0.1 M NaOH and the solution was filtrated. A portion of the filtrate was diluted to 100 ml with 0.1 M NaOH and the absorbance of the solution was measured at 287 nm. Beer's law was obeyed up to 50 μg/ml with the relative error of ≈ 1.2 %.

Spectrophotometric determination of ofloxacin with some sulphonphthalin was investigated by **Issa** et al[85]. Powdered tablets dissolved in 0.05 M NaOH, the solution was filtered and the filtrate was diluted with water. Portions of the prepared solution were mixed with 0.05% dye [bromophenol blue (BPB), bromothymol blue (BTB), bromocresol purple (BCP)] in 0.1 M NaOH and acetate buffer of pH 4.0, when BPB or BCP were used or phosphate buffer of pH 5.7 when BTB was used. The mixtures were diluted with water, extracted with 5.0 ml $CHCl_3$ and the absorbance of the $CHCl_3$ extracts was measured at 410, 415 and 410 nm for BPB, BTB and BCP, respectively. The calibration graphs were linear within the range 5.25 2.15 and 2.20 μg/ml, using BPB, BTB and BCP as the reagents, respectively. The RSD (n = 5) less than 1.0 %.

Spectrophotometric determination of ofloxacin based on a charge–transfer complexation reaction was investigated by **Zhao** et al[86]. Portions of a methanolic solution of ofloxacin were mixed with 2.0 ml 7,7,8,8,-tetracyanoquinodimethane (1.5 μg/L) in acetone and the mixture was diluted with methanol to 5.0 ml. The methanolic solution was heated to 30°C for 30 min.The absorbance was measured at 743 nm against a reagent blank. Beer's law was obeyed up to 15 μg/ml. The recovery was 102.2% with RSD (n = 4) of 3.0%.

Study of solution equilibria between AL(III) and ofloxacin was investigated by **Djurdjevic** et al[87]. The complex formation equilibria between Al(III) and ofloxacin in 0.1 M LiCl at 298 K were studied by potentiometry using a pH meter and by spectrophotometry .

Simultaneous determination of trace ofloxacin by TLC-fluorescence spectrophotometry was studied by **Wang** et al[88]. Portion of drug solution was applied to the plates prepared with silica gel and was impregnated with 0.27 M EDTA of pH 7.0. The spots were detected fluorimetrically with excitation at 335 nm. The calibration graphs were linear up to 75 mg. RSD was 6.9 % and the recoveries from serum and urine were 95.4 - 105.2 %.

1.4. Chloramine–T

Electrochemical investigation of chloramine-T was studied by **Hahn** et al[89]. The hydrolysis and reactivity of chloramine-T were investigated using a number of analytical techniques. Capillary electrophoresis was performed for the hydrolysis of chloramine-T in alkaline, acidic and neutral solution; the hydrolysis products were toluene sulfonamide and toluene sulfonic acid. Voltammograms of chloramine-T in 50 mM borax buffer of pH 9.2 prepared with a potential scan rate of 13 mV/s against Ag/AgCl showed that chloramine-T had a lower reactivity than liquor solution. The active chlorine in chloramine-T solution was determined by stripping free chlorine with an Ar stream followed by detection in an electrolysis chamber by coulometric titration. Free chlorine was more difficult to separate from chloramine-T solution than from chlorine or hypochlorite solutions.

Spectrophotometric assay for chlorine-containing compounds was studied by **Chesney** et al[90]. The sample containing HClO was mixed with sodium ascorbate in phosphate buffer saline of pH 7.2 containing 50 μM EDTA, and the change in absorbance at 265.5 nm was measured. The limit of detection was < 1 nM of HClO and the calibration graph was rectilinear for ≤ 60 nM. The method could also be used to determine chloramines by using the same method at pH 5.0 and measuring the absorbance after 5 min.

Flow-injection methods for monitoring the environment were studied by **Mahadevappa**[91]. The method was used for the determination of S^{2-} in solution, residual Cl in solution and aromatic sulphonyl haloamine (e.g., chloramine-T) and Fe(III) was based on the reported spectrophotometric methods. The detection limits were 0.14 to 1.4 μg/ml and maximum

sampling rates were >200 samples per hour. The method was used for the determination of chlorine in seawater samples.

Online monitoring of chloramine reactions by membrane introduction mass spectrophotometry was studied by **Kotiaho** et al[92]. Formation of di- and tri-chloramine by the reaction of monochloramine (I) with HCl was monitored online by membrane-introduction mass spectra, with use of a sheet direct-insertion membrane probe was studied by **Bier** et al[93], and the system described by Brodbelt and **Cooks**[94]. The method has potential application in the water industry.

1.5. Sildenafil citrate

Reversed-phase HPLC determination of sildenafil citrate tablts was investegated by **Liu** et al[95]. Twenty tablets were ground and powderd, an aportion equivalent to 20 mg sildenafil citrate (I), was dissolved in and diluted with 0.1 M HCl to 100 ml. Portions (20 ml) of the solution were analysed for I by HPLC on a silane-bonded silica gel column, with H_3PO_4/methanol, acetonitrile (45 : 33: 22) as mobile phase at 1ml/min and detection at 29/nm. Quantitation was by the external-standard method. The calibration graph for I was linear from 66.4-332 µg/ml. The solution was stable for 24 h. The average recovery of I from tablets was 100.6 % with an RSD of 0.52 %. Results were comparable with those obtained by UV soectrophotometry.

Extraction spectrophotometric determination of sildenafil citrate in pharmaceutical forms was studied by **Reddy** et al[96]. The method was based on formation of the ion pair of sildenafil citrate with bromothymol blue (BTB), bromocresol green or bromophenol blue in 0.2 M potassium hydrogen phthalate/HCl buffer, extraction with $CHCl_3$ and spectrophotometric detection. Beer's law was obeyed from 2.5 to 12.5 µg/ml of silsenafil citrate, RSD were 0.4913-0.7114% (n=8). The method was applied to tablet form.

Voltammetric behaviour of sildenafil citrate using square wave and adsorptive stripping square wave techniques was investegated by **Berzas** et al[97]. Determination in pharmaceutical products. The behaviour of sildenafil citrate (SC) was studied by square wave technique, leading to two method for its determination in aqueous samples pH 2.0 and pharmaceutical

formulations. The application of the square wave (SW) without the adsorptive accumulation shows the maximum response at –1.03V . Besides, SC gave two adsorptive stripping voltammetric (AdSV) peaks at –1.03 V and –1.15 V using an accumulation potential of –0.8 V the effect of experimental parametrs that affect this determination were discussed. For the stripping technique, SC proved to be more sensitive, yielding signals three or four times larger than those obtanined by applying a square wave scan without the pervious accumulation. The calibration graph to determination SC was linear in the range 5 x 10^{-9} to 9 x 10^{-7} M by stripping mode with a time of accumulation tacc of 10 s. The RSD obtained for concentration levels of SC as low as 1 x 10^{-7} M with (SW) was 3.1 % (n = 10) in the same day. The two proposed methods SW and SWAdSV were applied to the determination of SC in the three pharmaceutical product (Viagra 25, Viagra 50 and Viagra 100) with very good recoveries with respect to the labelled values.

Reversed-phased HPLC determination of sildenafil citrate in the presence of its oxidative - induced degradation products was studied by **Segall** et al[98]. The determination of sildenafil citrate in the presence of its oxidative - induced degradation products by reversed - phased as stability - indicating by forced decomposition of sildenafil citrate in acid, base, oxidative, thermal, and photochemical media. The peak area versus sildenafil citrate concentration proved linear over the 10 - 160 % range of the working analytical concentration of 0.5 mg/ml. The mean absoluterecovery of sildenafil citrate using the described method was 100.9 - 1.1 % (mean SD, n = 9). The precision, expresed as relative standered diviation of ten replicate injections of sildenafil citrate reference solution remained below 0.5 %.

Utility of certain δ and π–acceptors for the spectrophotometric determination of sildenafil citrate was investegated by **Amin** et al[99]. The molecular interaction between sildenafil citrate as electron donor and each of iodine; 7,7,8,8-tetracyanoquinodimethane (TCNO); 2,3-dichloro-5,6-dicyano-1,4-benzoquinone (DDQ); tetracyanoethylene (TCNE); 2,4,7-trinitro-9-fluorenon (TNF); chloranilic acid (CCLA); chloranil (CL) and bromanil (BL) as acceptors have been investegated spectrophotometrically. Beer;s law was obeyed in a concentration limit of 10-260 g/ml. The limits of detection and determination were calculated and found to be 1.5 and 5.2 μg/ml, respectively. The standered deviations were calculated for different concentrations of sildenafil citrated using various acceptors. The methode was applied for determination of sildenafil citrate in pharmaceutical dosage forms (viagra).