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COMPLEXATION OF NORFLOXACIN WITH SOME TRANSITION METAL IONS - A SPECTROPHOTOMETRIC STUDY

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UV-Visible spectrophotometry technique is a new and selective method for determination of complexation of Norfloxacin with Fe, Co, Ni and Cu. The method based on the formation of stable Fe(III), Co(II), Ni(II), and Cu(II) complexes with Norfloxacin. Norfloxacin reacts with these metal ions in aqueous buffer solutions whereby a coloured complexes are formed which absorb maximally at 425, 422, 418 and 415 nm, respectively. The different experimental parameters affecting the development and stability of the colour were carefully studied and optimized. The absorbance-concentration plots of complexes are linear. No interferences were observed from excipients and the validity of the method was tested against reference methods. Key words: Complexation, Spectrophotometry, Absorbance, Norfloxacin, Stability, Antibiotics.

INTRODUCTION

Norfloxacin (Fig.1) (1-ethyl -6- fluoro -4-oxo-7- (1-piperazinyl) -1,4-dihydroquinoline- 3- carboxylic acid) is a second generation fluoroquinolone, and widely used representative member of this family (Dhaneshwar et al, 2001). It is antibiotic agent that extensively used in both human and veterinary medicine (Cui et al., 2011). Norfloxacin is active against a wide variety of aerobic Gram-negative and Gram-positive bacteria but specifically, active against aminoglycoside-resistant Pseudomonas aeruginosa and betalactamase producing organisms (Shaikh et al., 2007).

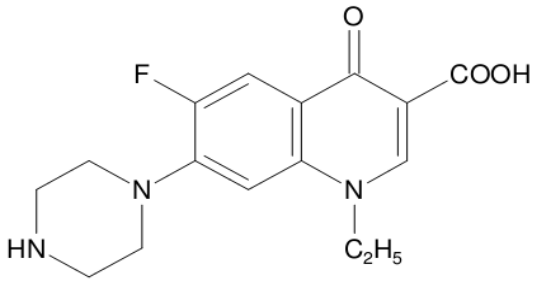

Figure 1. Structure of norfloxacin.

One of the most spectacular effects of complex formation is the change of spectral properties[3]. The reasons for light absorption by the complexes are, the excitation of the electrons of both the metal ions and the ligand due to their interaction, Owing to interaction of the central metal ion and the ligand, a charge transfer from the ligand to metal ion may occur on irradiation; this phenomenon is the reason for the so called charge transfer spectra in the visible and near ultraviolet region. The electrons of transition metal ions are easily excited and consequently absorbed in the visible region i.e. these ions give coloured compounds. In this paper, the interaction of norfloxacin with some transition metal ions is an attempt to examine the mode of norfloxacin coordination and the determination of stability constant of the resulting complexes.

MATERIAL AND METHOD

A Systronic UV/Vis spectrophotometer with 1 cm quartz cells was used to measure the absorbance. The pH measurements were made with systronic pH meter model 371 All measurements were performed at room temperature (30 ±0.01°C). Norfloxacin stock solution (2 x 10-3 M) was prepared by dissolving the accurately weighed amount in glacial acetic acid and the volume was completed to the mark with double distilled water. Metal stock solution (0.1M) was prepared by dissolving the appropriate amount of ferric chloride anhydrous (Fluka) cobalt nickel and copper(II) acetate monohydrate (Merck) in double distilled water and was standardized by the recommended method[4]. Working solutions were prepared by suitable dilutions with deionized water. The solutions used for investigation of the effect of diverse ions were prepared from sulfate or nitrate of the tested cations and sodium or potassium salts of the tested anions. The universal,

acetate, borate and phosphate buffer solutions of varying pH values were prepared as described by Britton [5].

A series of solutions containing up to 4.0 ml of buffer solution, 1 ml (0.1 M) of the metal ions and 0.2-2.8 ml (1 x 10-2 M) of norfloxacin was mixed in 10 ml measuring flask and then diluted up to the mark with water. The mixture was allowed to stand for 10 min. The absorbance was measured at the maximum wavelength (λmax) against a blank solution prepared in the same manner but not contains metal ions[6]. The calibration graphs were prepared by using the same procedure (at least seven concentration points) and were linear passing through the origin.

Stoichiometry of norfloxacin complexes formed in the solution was determined spectrophotometrically applying the continuous variation[7] and mole ratio[8] methods. The obtained results revealed the formation of 1:1 (M:L) norfloxacin complexes with all metal ions. The logarithmic constants (log βn) and the free energy changes (ΔG) of the formed complexes were calculated from the data of continuous variation and mole ratio methods applying equations 1 and 2 [8Harvey and Manning].

$$\beta_n = \frac{\frac{A}{A_m}}{1-[\frac{A^{n+1}}{A_m}]} \; C_1^n n^2 \quad \text{------ [1]}$$

$\Delta G = -2.303\ RT \log \beta n$ ---------- [2]

where βn is the stability constant of the metal chelate, A is the absorbance at ligand concentration CL, Am is the absorbance at full color developed, n is the order of the complex formed, T is the absolute temperature and R is the gas constant.

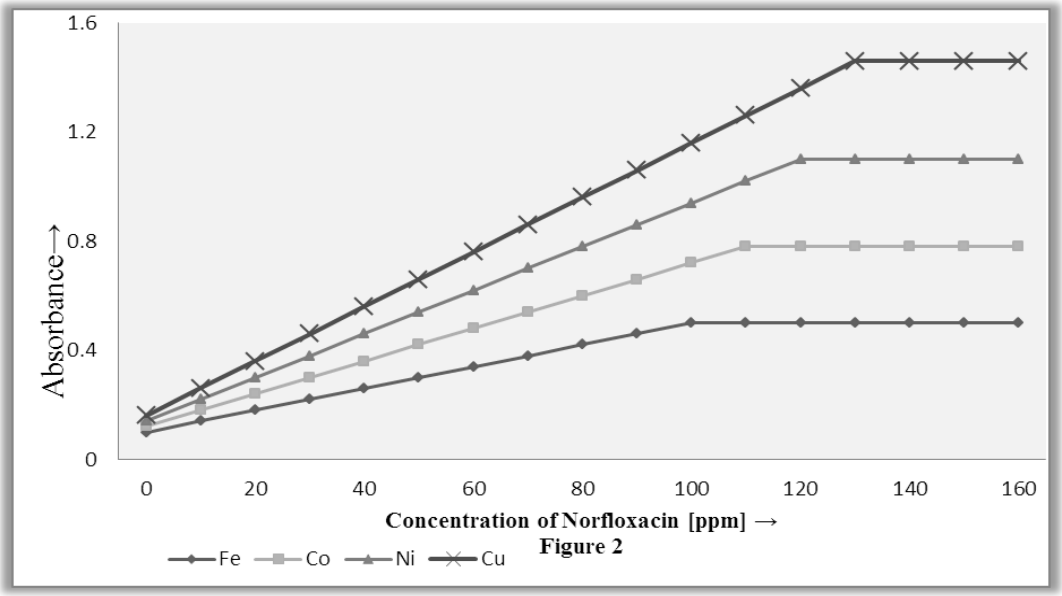

Figure 2

Figure 2. Absorbance vs concentration plots for Fe(III)-Norfloxacin Co(II)- Norfloxacin, Ni(II)- Norfloxacin and Cu(II)-norfloxacin complexes.

Table 1. Spectrophotometric analytical characteristics of Norfloxacin complexes with Fe(III), Co(II), Ni(II), and Cu(II) ions

METAL ION	λ max	M/L ratio	log βn	(- ΔG)
Fe	425	1:1	2.75	2.54
Co	422	1:1	3.20	2.86
Ni	418	1:1	3.95	3.46
Cu	415	1:1	4.80	3.95

RESULT AND DISCUSSION

The stability constant values for complexation of antibiotics Norfloxacin with Fe(III), Co(II), Ni(II), and Cu(II), ions by spectrophotometric method have been presented in Table (1) Norfloxacin complexes in the UV−Vis region exhibits maximum absorption at 425, 422, 418 and 415 nm for Fe(III) Co(II), Ni(II) and Cu(II) complexes, respectively, using the same amount of the metal ion as a blank. These longer wavelength peaks have been used in all subsequent measurements of the absorbance. At these wavelengths the absorption of both Norfloxacin and metal solution were negligible. On plotting the absorbance as a function of Norfloxacin concentration, straight lines were obtained up 101.00 and 111.10, 120.00, 130.12 µg ml^{-1} using Fe(III), Co, Ni and Cu(II), respectively, in presence of borate buffer.

The complexes of this antibiotic with all the metal ions indicate the formation of 1:1 complexes. The stability constants values for metal Norfloxacin complexes have been found to be in order Fe (III) < Co(II) < Ni(II) < Cu(II). Thus Cu complexes have the highest value of stability constants with Norfloxacin, this is found to be in good agreement with Irving and Williams[9] and Mellor and Meley [10]natural order.

CONCLUSIONS

The present research work has demonstrated that the use of UV-Vis spectroscopy is feasible in complexation reaction for determination of stability constant. The determination process based on the ability of Norfloxacin to form stable 1:1 (M:L) complexes with some transition metal ions.

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