

INTERNATIONAL JOURNAL OF CURRENT RESEARCH IN
CHEMISTRY AND PHARMACEUTICAL SCIENCES

(p-ISSN: 2348-5213; e-ISSN: 2348-5221)

www.ijcrpps.com

DOI:10.22192/ijcrpps

Coden: IJCROO(USA)

Volume 4, Issue 4 - 2017

Research Article

DOI: <http://dx.doi.org/10.22192/ijcrpps.2017.04.04.001>

pH Scale Buffer and Solvent Effects on the UV Absorption Spectra of Cefixime Trihydrate

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Abstract

Behavior study of substances is often performed by different methods to provide a lot of information about these substances. The present study describes behavior of cefixime trihydrate (CEF-3H₂O) which was carried out by pH buffer solutions and different polarity solvents. Solutions with different pH were showed different UV absorption spectra for each pH, revealed a red shifted as compared with UV absorption spectra of drug in less pH (2) as reference. Different polarity solvents of water, methanol and ethanol were used and appeared different UV absorption spectra that showed a bathochromic shift behavior considering UV absorption spectra of water as reference, all spectra intersects at certain λ 289 nm (isosbestic point). Hypsochromic shift (blue shift) of cefixime trihydrate occur with solvents of HCl and NaOH and showed isosbestic point at 254 nm.

Keywords: Cefixime trihydrate, pH buffer solutions effect, solvents effect, UV Absorption Spectra.

1. INTRODUCTION

Cefixime is (6R, 7R)-7-[[2-(2-amino-4-thiazolyl)-2-(carboxymethoxyimino)-1-oxoethyl] amino]-3-ethenyl-8-oxo-5-thia-1-azabicyclo [4.2.0] oct-2-ene-2-carboxylic acid trihydrate white to yellowish crystalline powder with molecular formula C₁₆H₁₅N₅O₇S₂ · 3H₂O

and molecular weight 507.50 and Chemical structure (figure 1.)^{1,2,16}.

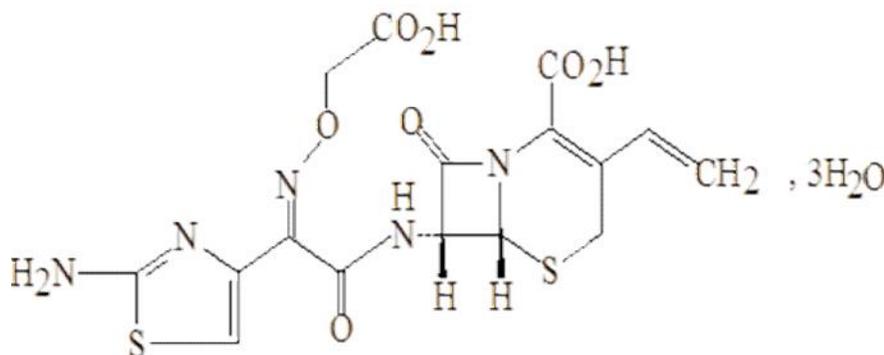


Figure 1. Chemical structure formula of cefixime trihydrate

Its broad spectrum third generation cephalosporin antibiotic that is stable to hydrolysis by beta-lactamases, active against gram positive and gram negative aerobic bacteria^{1,3,110,16}.

These studies help to provide significant information related to cefixime trihydrate which can be used to development any method to determination cefixime substance or finished product.

A solvent is a liquid that serves as the medium for a reaction. It can serve two major purposes as non-participatory to dissolve the reactants and participatory as a source of acid and base or as a nucleophile. Solvents can cause considerable confusion in reactions, because they're listed along with the reagents of a reaction but often don't actually participate in the reaction itself. And to be honest, a lot of instructors (myself included) are less than consistent about when to include solvents and when not to^{9, 11, 12}.

Solvent polarity is a commonly used term related to the capacity of a solvent for solvating dissolved charged or neutral, a polar or dipolar, species. Attempts to express it quantitatively have mainly involved physical solvent properties such as relative permittivity, dipole moment, or refractive index, but these parameters cannot effectively account for the multitude and specific interactions of solute-solvent on the molecular- microscopic level^{11, 12, 14}.

Spectroscopic Solvent polarity parameters have been derived from solvent sensitive standard compounds absorbing radiation in spectral ranges corresponding to UV/Vis, IR, ESR and NMR spectra^{9, 14, 15}. In spite of the observation that single empirical parameters may serve as good approximations of solvent polarity in the sense defined, but there are many examples of solvent-sensitive processes known, which cannot be interrelated to one empirical solvent parameter⁵⁻⁹.

The present work aimed to study the effect of solvents and buffer solution on the UV absorption spectra of cefixime trihydrate to understanding these effect and assessment its behavior.

2-CHEMICALS AND REAGENTS:

All chemicals and reagents used were of a HPLC grade. Methanol was obtained from AppliChem, Germany. Ethanol absolute, gradient HPLC grade and Hydrochloric acid 37 %, extra pure were obtained from Scharlab S.L., Spain. Chloroform was obtained from BDH laboratory, England. Sodium hydroxide pellets 98% extra pure and ammonium solution 30%, extra pure, LOBA Chem, INDIA. Cefixime trihydrate was kindly supplied from AUROBINNDO PHARMA LTD – INDIA. Boric acid, citric acid and trisodium orthophosphate -12H₂O were supplied from BDH, England.

3-EQUIPMENT:

1. V-630 Series UV-VIS Spectrophotometer, JASCO International Co., Ltd., JAPAN
2. Sartorius balance model cp224s
3. Mi 180 Bench pH meter, MARTINI instruments.

4-EXPERIMENTAL:-

4.1-Preparation of stock solution of cefixime

Solution was prepared by dissolved 10 mg of drug in 100 ml of deionized water.

4.2-Preparation of the approximately universal buffer solutions

The following solutions were prepared with pH 2,3,4,5,6,7,8,9,10,11 and 12, Table (1).

Table 1. Preparation of the approximately universal buffer solutions .Carmody⁴:

pH	Xml	pH	Xml	pH	Xml
2.0	195	5.5	126	9.0	69
2.5	184	6.0	118	9.5	60
3.0	176	6.5	109	10.0	54
3.5	166	7.0	99	10.5	49
4.0	155	7.5	92	11.0	44
4.5	144	8.0	85	11.5	33
5.0	134	8.5	78	12.0	17

Note:

1. X ml, contains 0.2M boric acid in 0.05M citric acid
2. Total volume is completed to 200 ml with 0.1M trisodium orthophosphate -12H₂O.

4.3-Preparation of solution to study the effect of pH on the UV spectrum of cefixime trihydrate:

1 ml of stock solution was separately transferred to (11) volumetric flask 100 ml. The volume was

completed to the mark with one of the universal buffer solutions given in Table (1), and its UV spectrum was recorded between 200 – 400 nm, Table (2) and Figure (2).

Table 2. UV spectral data of cefixime trihydrate in various pH

pH	Wave length max nm	Absorbance
2	285.0	0.315
3	285.4	0.381
4	287.1	0.380
5	287.7	0.355
6	287.9	0.388
7	287.9	0.362
8	288.0	0.370
9	288.2	0.366
10	288.2	0.344
11	287.1	0.326
12	286.9	0.256

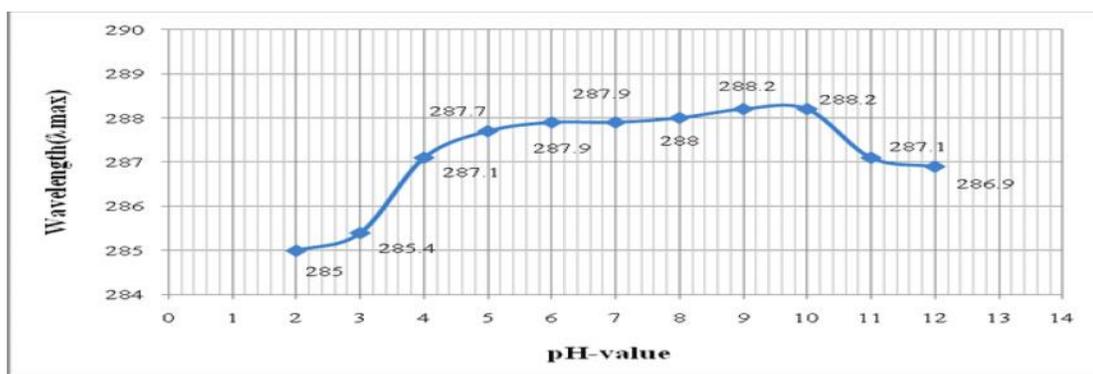


Figure 2. pH values vs. wavelength to illustrate the effect of pH - values on the UV absorption spectra of cefixime trihydrate

4.4-The effect of solvent on the UV spectra of cefixime trihydrate

The following solutions were prepared:

- i. 10 µg/ml cefixime trihydrate in water.
- ii. 10 µg/ml cefixime trihydrate in methanol.

- iii. 10 µg/ml cefixime trihydrate in ethanol.
- iv. 10 µg/ml cefixime trihydrate in 0.1M HCl.
- v. 10 µg/ml cefixime trihydrate in 0.1M NaOH.

And its UV spectrum was recorded between 200 – 400 nm, Table (3) and Figures (3, 4 and 5).

Table 3. UV spectral data of cefixime trihydrate in various solvents

Solution	Wavelength nm	Absorbance
i. CEF-3H ₂ O in water	287.40	0.336
ii. CEF-3H ₂ O in methanol	289.60	0.329
iii. CEF-3H ₂ O in Ethanol	291.00	0.330
iv. CEF-3H ₂ O in 0.1M HCl	284.80	0.373
v. CEF-3H ₂ O in 0.1M NaOH	236.20	0.389

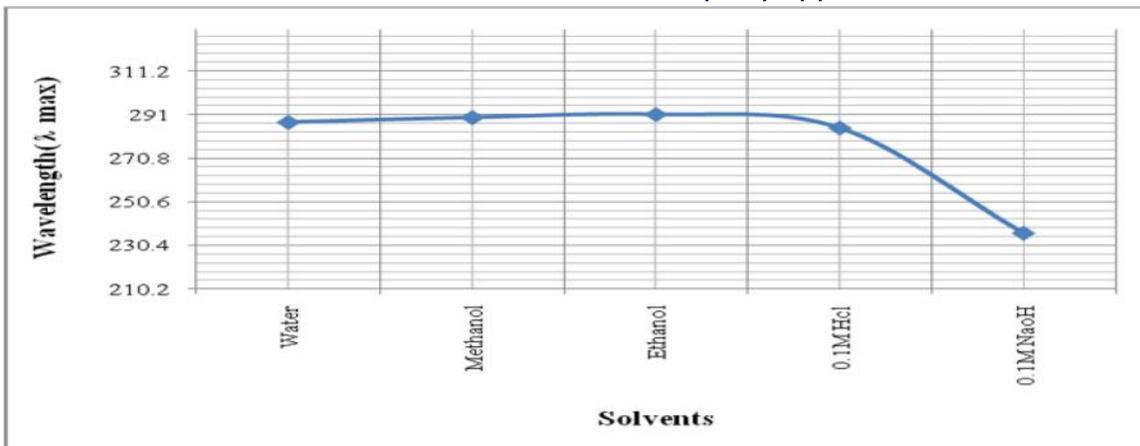


Figure 3. Solvents vs. wavelength to illustrate the effect of solvents on the UV spectrum of cefixime trihydrate

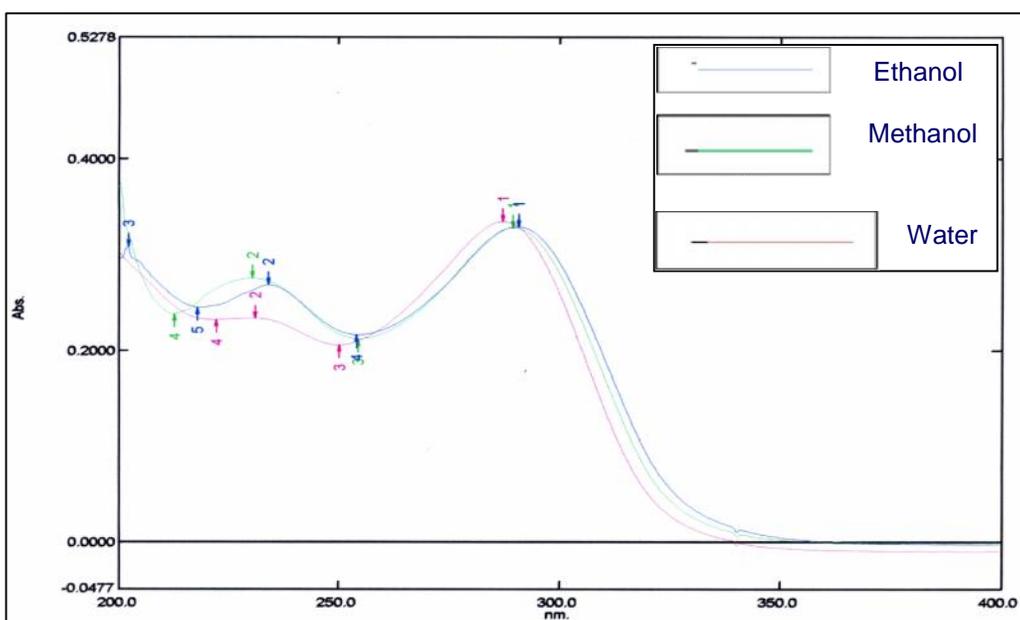


Figure 4. UV absorption spectra of Cefixime trihydrate in different solvents

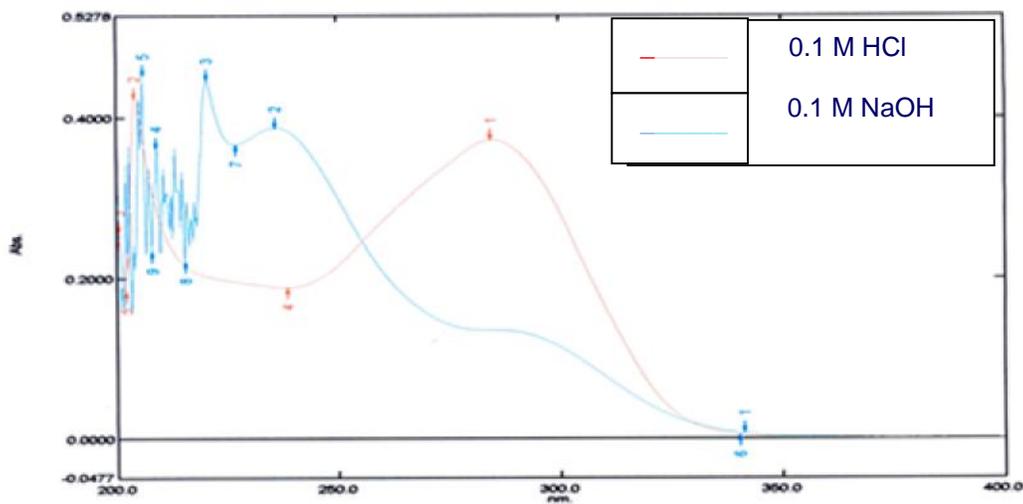


Figure 5. UV Absorption spectra of cefixime trihydrate in solvents of 0.1 M HCl and 0.1M NaOH

4.5- RESULTS AND DISCUSSION

Using the different pH solution and polarity solvent revealed different UV absorption spectra of cefixime trihydrate. The buffer solution behavior of cefixime trihydrate is the shift of absorption wavelength depends to the presence of pH of solution (Table 2), which is due to interaction between the cefixime trihydrate and buffer molecules. The UV absorption spectra of cefixime trihydrate showed gradually bathochromic shift (red shifted) from less pH (2) to the top pH (12) (Figure 2).

The different polarity solvents of water, methanol and ethanol used affected into the behavior on the absorption spectra of cefixime trihydrate. The spectra of cefixime trihydrate in water used as reference. It can be seen the absorption spectra of cefixime trihydrate in methanol and ethanol are bathochromic shift (red shifted) as compared to spectra in water from λ_{\max} 287.4 to λ_{\max} 289.6 and 291 respectively indicating to strong interaction between cefixime trihydrate molecule and ethanol solvent (Table 3), all spectra intersects at certain λ 289 nm (isosbestic point) (figure 4).

Solutions of 0.1M HCl and 0.1M NaOH shown UV absorption spectra at maximum wavelengths 284.8 and 236.20 nm respectively which appeared hypsochromic shift (blue shifted) as compared to absorption spectra of other solvents (table 3). Absorption spectra of cefixime trihydrate in 0.1M HCl and 0.1M NaOH intersects at λ 254 nm (figure 5).

It is obvious that pH scale buffer expressed an individual physical quantity that means many parameters for pH scale buffer correlate different buffer solutions.

Data obtained from this work illustrated that polarity solvents (dielectric constant) often predicted to measurement quantitatively of solvent polarity, not adequate composed for individual solvent molecules with their own solvent-solvent interactions and they do not take into account specific solute – solvent interaction.

4.6- CONCLUSION

Results obtained from this work show that pH scale buffer and different solvents their effect on the UV absorption spectra of cefixime trihydrate depends on the degree of pH and extent of solvent polarity and chemical structure of drug which contain substituent on the amino groups. These factors caused the difference in the susceptibility to nitrogen atoms electrons pair coupling with solvent composition so we got the UV absorption spectra are different and intersects at specific wavelengths depending on the nature of the solvents. This is in addition to the electronic behavior of nitrogen atoms in the compound and its association with different solvent molecules.

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	Subject: Pharmaceutical Chemistry
Quick Response Code	
DOI: 10.22192/ijrcps.2017.04.04.001	

How to cite this article:

Elsadig H. Kh. Adam. (2017). pH Scale Buffer and Solvent Effects on the UV Absorption Spectra of Cefixime Trihydrate. Int. J. Curr. Res. Chem. Pharm. Sci. 4(4): 1-6.
DOI: <http://dx.doi.org/10.22192/ijrcps.2017.04.04.001>