SPECTROPHOTOMETRIC DETERMINATION OF PARACETAMOL USING LIQUID ION EXCHANGE JOINED WITH CLOUD POINT EXTRACTION

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Abstract

A liquid ion exchange joined with the cloud point extraction method is studied to determine Paracetamol in pure form. The method utilizes a liquid ion exchange reaction based upon forming an ion-pair association complex for PAR with Fe(II) in the presence of HCl and non-ionic surfactant Triton X-100. The maximum wavelength was 291nm. The optimum condition effect on the separation method was studied: temperature 80°C, heating time 15min., the concentration of Fe(III) was 80µg/mL, and the best surfactant was TritonX-100. The reaction kinetics were studied by using the initial rate method. The calibration curve was linear over the concentration range of 5-600µg/mL with LOD of 3.65 µg/mL and LOQ of 11.07µg/mL.

Keywords: Paracetamol, Liquid ion exchange, Fe(III)

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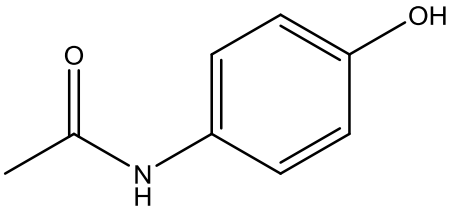
1. Introduction

Paracetamol is a chemically N-(4-hydroxyphenyl)acetamide; has formula[1] in scheme (1):



Paracetamol is a common pain reliever and fever-reduction medicine [2]. It is obtainable as a generic drug with trading names, including Tylenol and Panadol [3]. It is generally used by mouth or rectally, as well as intravenously [1,4]. Paracetamol is attainable as a tablet, drops, capsules, injections, and syrup [5]. Paracetamol is commonly safe at proposed doses. The proposed maximum daily dosage for an adult is 3 or 4 g [6,7].

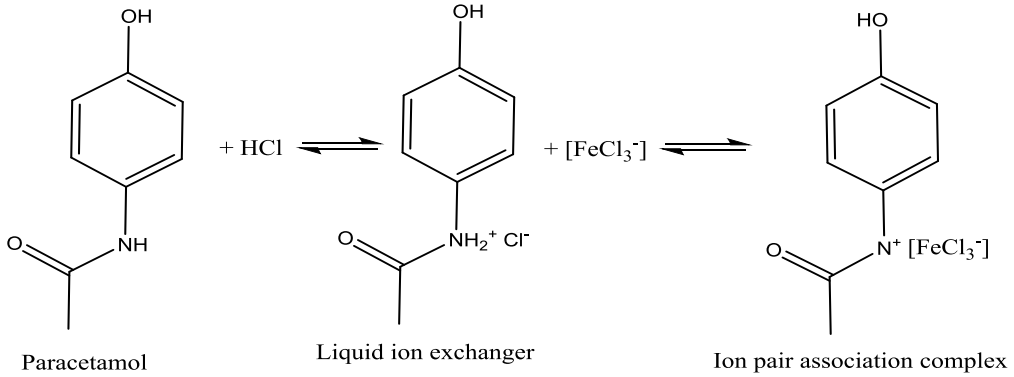
There are different methods for the determination of Paracetamol in different samples, such as titrimetric [8], Voltammetry[9], electrochemical [10], HPLC [11], and spectroscopy[12,13]. This research describes the simple spectrophotometric method for determining Paracetamol in pharmaceuticals.

Experimental

- **Chemicals and Apparatus:** All chemicals were used as received from a company without additional purification, the standard Fe(II) solution (1mg/mL) was prepared by dissolving 0.484g from $FeCl_3.6H_2O$ (Merck 99.8%) in 100 mL distilled water, and Paracetamol (100µg/mL) was prepared by dissolving 0.01g (SDI, Samarra 99.98%) in 100 mL distilled water. 1% Triton X-100 (Alpha Chemika), any other working solutions prepared by serial dilution with distilled water to an appropriate volume. A biochem double beam UV-Vis. A spectrophotometer model (Biochrom libra S60) (UK) and an Electrostatic water bath (Germany) were used.
- **General Procedure:** Prepared aqueous solutions with a volume of 10mL containing Paracetamol (100µg/mL), Ni(II) (100µg/mL) in HCl media, then add a suitable volume of 1%TritonX-100 as the non-ionic surfactant, the solution heated in the electrostatic water bath for adequate temperature and time after that separated the cloud point layer (CPL) from aqueous solution, and dissolved CPL in 5mL ethanol, after that measure the absorbance against ethanol as a blank at λmax.

2. Results And Discussion

Liquid Ion Exchange Mechanism



Paracetamol — Liquid ion exchanger — Ion pair association complex

spectrum obtained was illustrated in Fig.(1), where λ_{max}=291nm.

Determine the Maximum Wavelength

The UV-Vis spectrum of the ion pair association complex was measured; the

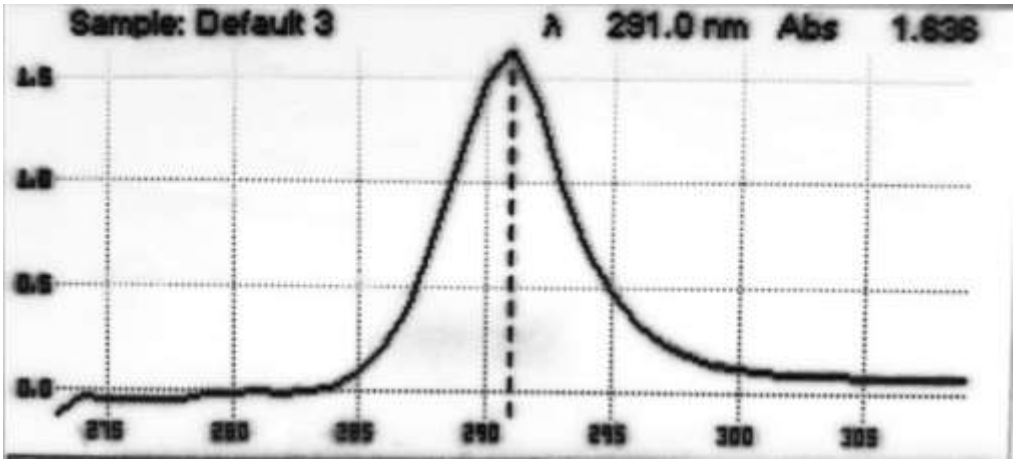


Figure 1. UV-Vis spectrum for ion pair association complex

improve the role of HCl concentration as in the general procedure; the results are represented in Fig (2):

Experimental Conditions

Effect of HCl Concentration

Different hydrochloric acid concentrations in the range (0.1-1.0M) were investigated to

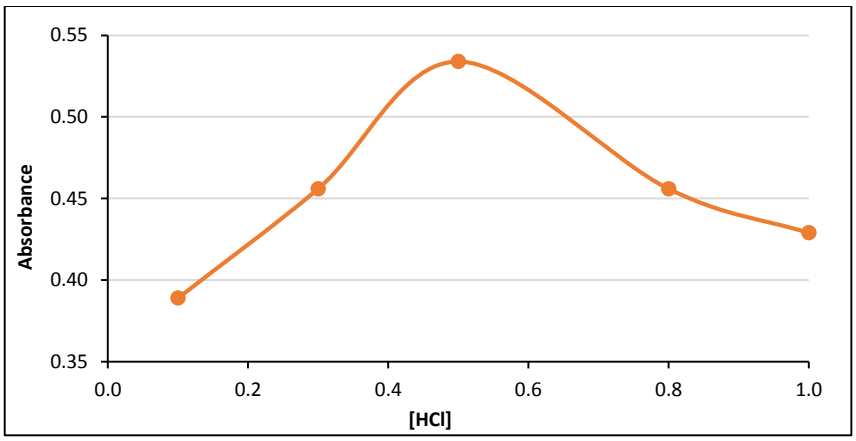


Figure 2. Effect of Hydrochloric acid concentration on absorbance

Temperature study

According to the general method extracted Paracetamol at different temperatures, the results were as in Fig (3):

The optimum concentration of HCl was (0.5M); this concentration permits to form of a liquid ion exchanger of Paracetamol and $FeCl_3^-$ as shown in scheme (1), any HCl concentration less or more than the optimum is inconvenient to reach the referable equilibrium[14].

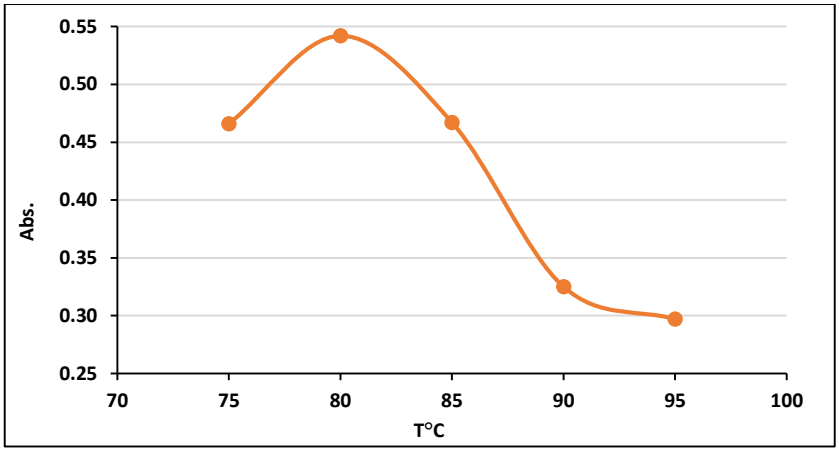


Figure 3. Effect of Temperature on the absorbance value

Heating Time Effect

As shown in the general method, extracted Paracetamol from 10mL aqueous solution at different heating times, the results were as in Fig (4):

Results show optimum temperature which gives higher extraction efficiency of Paracetamol according to join of liquid ion exchange with CPE was 80ºC; this temperature gives the necessary energy for best aggregation micelles of surfactant to formation CPL to extracted ion pair association complex[15].

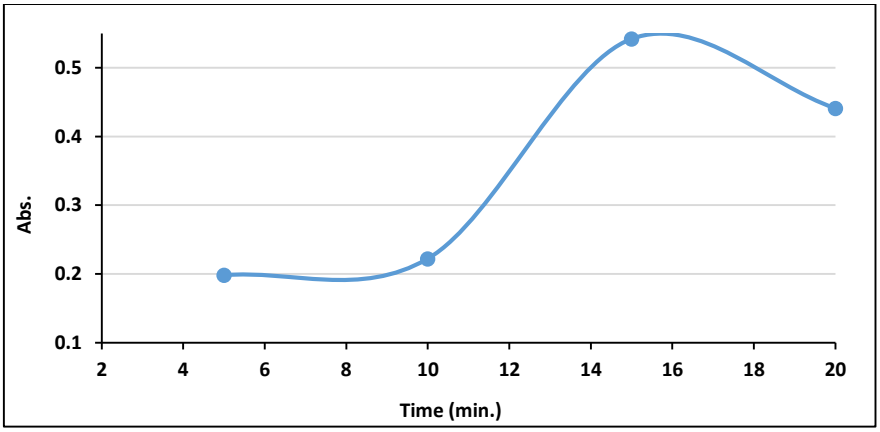


Figure 4. Heating time effect on CPL formation

Effect of Fe(III) Concentration

Extracted Paracetamol in the presence of different amounts of Fe(III) ion in 10mL aqueous solution in the presence of 0.5M HCl. According to the general extraction method, the results were as in Fig (5):

The results evidence 15min. It Was the optimum heating time to give better extraction efficiency because this time helps to form the best CPL to extract ion pair association complex quantitatively. More than optimum heating time effect drop extraction efficiency, which causes micelles diffusion[16].

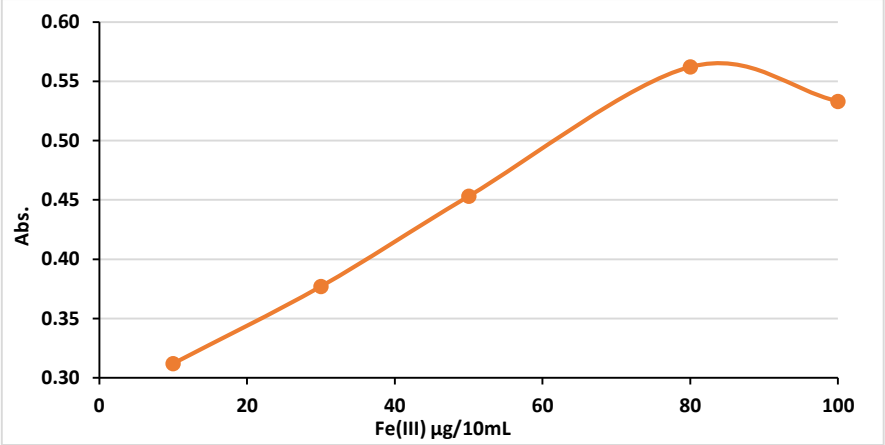


Figure 5. Relation between Fe(III) concentration and Abs

the backward direction of equilibrium and dissociation according to mass action law.

Effect of Surfactant Volume

As in general procedure, extracted Paracetamol from 10mL aqueous solutions at optimum conditions in the presence of different volumes of TritonX-100, the results were as in Fig(6):

The results show that 80µg/10mL Fe(III) was the optimum metal cation concentration, giving higher Abs. This concentration created the convenient equilibrium, a concentration less than optimum unsuitable to reach the best thermodynamic equilibrium. Hence, an increase in Fe(III) causes a reduction in extraction efficiency because increasing in

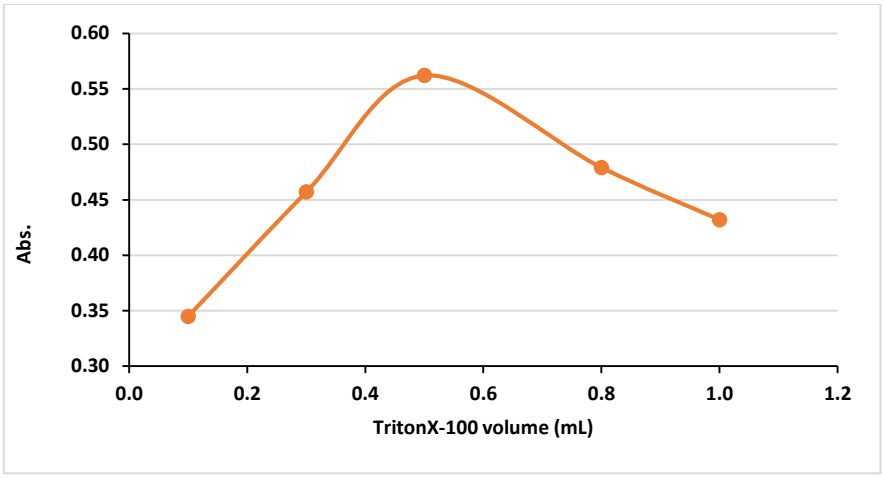


Figure 6. Surfactant volume effect

attainment decrease in extraction efficiency by the effect of diffusion micelles.

Stoichiometry

For knowledge more probable structure of ion pair association complex extracted into CPL, used slope analysis method at optimum conditions and according to the comprehensive method, the results in Figs (7 and 8) show the more probable structure of the complex extracted:

The results show 0.5mL of TritonX-100 was the optimum volume; this volume of surfactant provides the critical micelles concentration CMC which gives the best aggregation for micelles to form the best CPL; any volume of TritonX-100 less than the optimum value, not sufficient to reach CMC and give a decrease in extraction efficiency so that any volume of TritonX-100 more than optimum value and

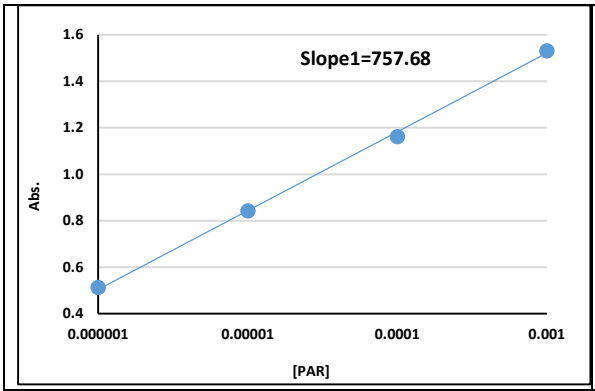


Fig 7. Abs.= f[PAR]

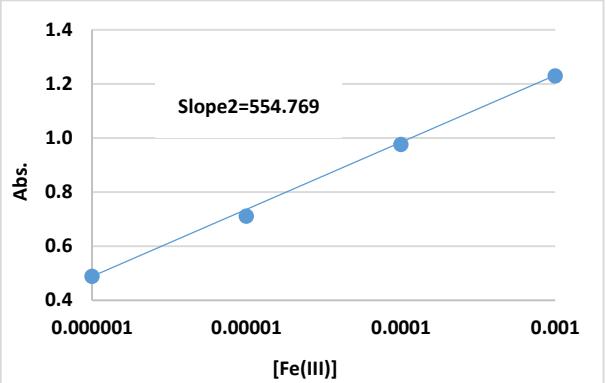


Fig 8. Abs.= f[Fe(III)]

$$\textbf{\textit{Slope ratio}} = \frac{\textbf{\textit{Slope1}}(\textbf{\textit{PAR}})}{\textbf{\textit{Slope2}}(\textbf{\textit{Fe(III)}})} = \frac{\mathbf{575.687}}{\mathbf{554.769}} = \mathbf{1.366}$$

Paracetamol was extracted from 10mL aqueous solutions at optimum conditions as in general procedure in the presence of different electrolyte salts; the results were as in Table (1):

The slope ratio values of the two straight lines in Figs(7 and 8) demonstrate more the probable structure of the ion pair association complex extracted into CPL of PAR and Fe(III) was 1:1.

Electrolyte effect

Electrolyte Salt	Abs. at λmax=291nm
Without	0.562
NaCl	1.125
KCl	1.067
KI	0.931
NH_4Cl	0.826
$MgCl_2$	0.634

Solvent Effect

Extracted Paracetamol from 10mL aqueous solutions at optimum conditions as in the general procedure, then the CPL dissolved in different organic solvents; the results were as in Figs. (9-12):

Electrolyte salts cause enhancement in absorption value because this salt is highly soluble in water. Hence, withdrawing water molecules from the hydration shell of Fe(III) gives a chance to form a complex with PAR.

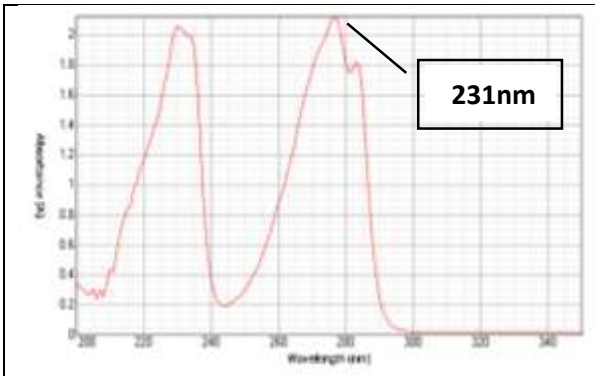


Fig. 9. Uv-Vis. Spectrum of PAR-Fe(III) in butanol

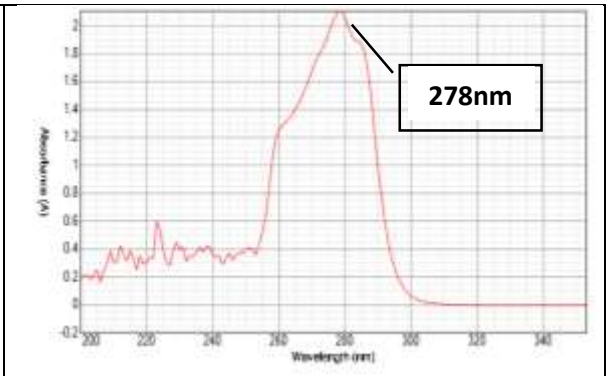


Fig. 10. Uv-Vis. Spectrum of PAR-Fe(III) in CCl_4

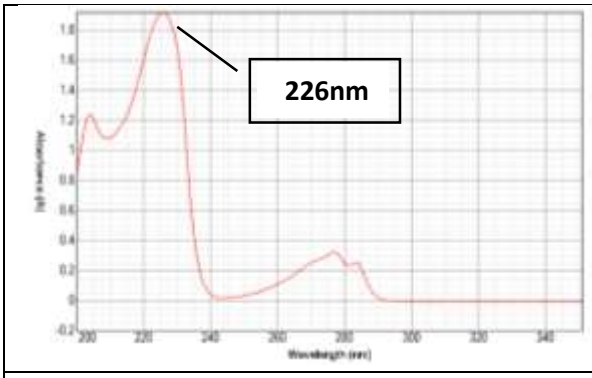


Fig. 11. Uv-Vis. The spectrum of PAR-Fe(III) in Hexane

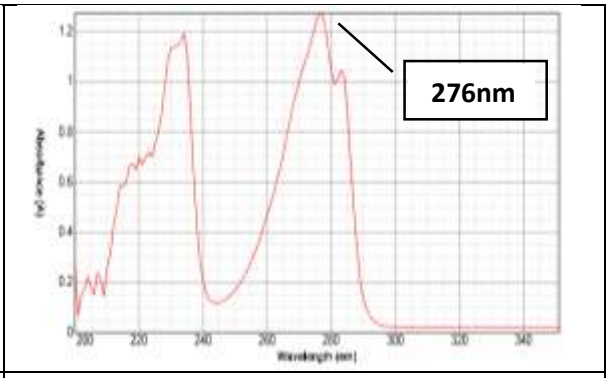


Fig. 12. Uv-Vis. Spectrum of PAR-Fe(III) in Propanol

calibration graph at λmax=291nm as in general procedure and optimum conditions Figure (13).

Calibration Graph Instruction

Spectrophotometric determination of Paracetamol with Fe(III) according to Liquid ion exchange method. Prepared

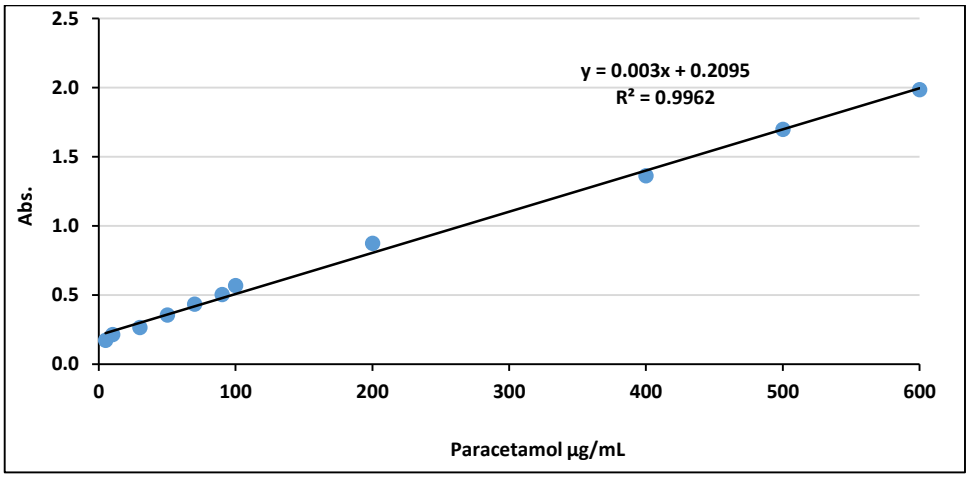


Fig. 13. Calibration graph for ion pair association complex of Paracetamol and Fe(III)

Table (2): Analytical parameters for calibration curve of Paracetamol

linearity (µgmL^{-1})	5-600
Limit of Detection (µgmL^{-1})	3.65
Limit of Quantity (µgmL^{-1})	11.07
Molar absorptivity (L.mol^{-1}.cm^{-1})	0.449×10^{3}

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