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Comparative study of determination of acetaminophen in pharmaceutical formulations by spectrophotometric method

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Abstract

Two simple and sensitive methods were used for comparative study of determination of acetaminophen (Paracetamol), based on the formation of azodye and ferroin have been described. Both the sets of reactions can be monitored spectrophtometrically by measuring the absorbance of reaction products at 505nm.Both the methods can be well applied for the determination of Aceteminophen from 0.50 to 10µg ml^{-1} concentration.Beer's law is obeyed by both the methods within the concentration range employed for analysis.Both the methods used in the present study may be applied to the determination of trace amount of paracetamol in different formulations

Key-Words: Azodye, Paracetamol, Spectrophotometric determination, Ferroin

Introduction

Acetaminophen(Paracetamol) is official in United states[1],British[2], European[3] and Japanese[4] Pharmacopeias and is widely used as a minor analgesic and antipyretic agent[5]. Its action is similar to aspirin and is most commonly used in pedriatics.Many methods are available in literature for assay of Paracetamol including spectrophotometric[6-11], Titrimetric[12-13], Coulorimetric[14],Densitometric [15], HPLC[16-19] , Stripping Voltametric in Pharmaceutical preparations. Owing to wide spread use of paracetamol in different kinds of pharmaceutical preparations, rapid and sensitive methods for determination of Paracetamol are being investigated. The method of assaying acetaminophen was to react acetaminophen with different reagents so that a colored species was formed, the absorbance of which was measured in visible region at appropriate wavelength.

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Material and Methods

Materials- All the reagents on analytical reagent grade and doubly distilled water was used throughout the experiment. 1-napthol(Loba chemie), Sodium hydroxide(Merck), Sodium Nitrite(Loba chemie), HCl(Merck), Feric Chloride(sd-fine-chem), 1,10-Phenantroline (Loba chemie), glacial acetic acid (Merck), were used without any purification. Pure Paracetamol sample was supplied by PDPL, Indore.Acetate buffer solution (pH 4.5) was prepared by using glacial acetic acid and NaOH solutions and adjusting its pH with a pH-meter.

Apparatus- A systronics visible spectrophotometer-104 was used.

Method I – Accurately 250mg of pure sample of Paracetamol was weighed and refluxed with 20ml of 5M HCl with 30ml distilled water for about 30 minutes to prepare standard solution. The content was appropriately diluted and required aliquots of 0.5- 10µg ml^{-1} were taken for the preparation of calibration curve. Solution containing 0.5- 10µg ml^{-1} of Paracetamol was taken and to this 5M HCl and 0.1% w/v solution of sodium nitrite was added for diazotization, then 0.2%w/v solution of 1-napthol in 5M NaOH was added as coupling agent.The absorbance of this azodye was measured at 505nm.

Paracetamol $\xrightarrow[H^+, H_2O]{\text{reflux}}$ p-aminophenol

p-aminophenol $\xrightarrow{NaNO_2/HCl}$ Diazonium salt

Diazonium salt + 1-napthol ⟶ Azo dye

Method II – An aliquot containing 0.5- 10µg ml^{-1} of acetaminophen was transferred to a 10ml volumetric flask containing 1.5ml of 1.25x 10^{-2}M 1, 10-Phenantroline and 1ml of pH4.5 buffer solution. The solution was diluted with doubly distilled water and was placed in water bath at 50°C for 5 min, and then 1ml of 6.5x 10^{-3}M Fe^{3+} ion solution (ferric chloride) was added. The reaction is monitored spectrophotometrically by measuring the absorbance at 505nm.

Paracetamol + Fe^{3+} ⟶ Fe^{2+} + oxidized product

Fe^{2+} + 3Phen ⟶ $Fe(Phen)_3^{2+}$ (ferroin)

Results and Discussion

Method I – The maximum absorbance of azodye formed in the alkaline medium with acetaminophen in 1-napthol was observed at 505nm. The adherence to the Beer Lamberts law was tested by reacting aliquots of standard solution s containing 0.5- 10µg ml^{-1} of acetaminophen as shown in figure-1.

Determination of Acetaminophen in different tablets was carried out according to recommended method I. The results are given in table-1.As table-1 shows the relative error of the measurements were ≤ 4% which confirms good accuracy of the proposed method.

Method II- The maximum absorbance of ferroin formed by the reaction of acetaminophen with Fe3+ resulting in the formation of oxidized product of Acetaminophen and Fe2+, this Fe2+ forms a complex with 1,10-phenantroline i.e. ferroin and was observed at 505nm. The adherence to the Beer Lamberts law was tested by reacting aliquots of standard solution s of acetaminophen as shown in figure-2.

Determination of Acetaminophen in different tablets was carried out according to recommended method II. The results are given in table-2.As table-2 shows the relative error of the measurements were ≤ 4.0% which confirms good accuracy of the proposed method.

Conclusion

Determination of Acetaminophen in various tablets by the two proposed methods is based on the formation of Azo dye in method I and formation of ferroin in method II. Inboth the sets the reactions can be monitored at 505nm.These methods offer good selectivity,accuracy and precision.To evaluate the applicability of the proposed methods it was applied to commercially available preparations of acetaminophen in the form of tablets. The quantitative results of this analysis show good agreement between the obtained results and certified amounts.These methods were found suitable for simple and precise routine analysis of pharmaceutical formulations.

Acknowledgement

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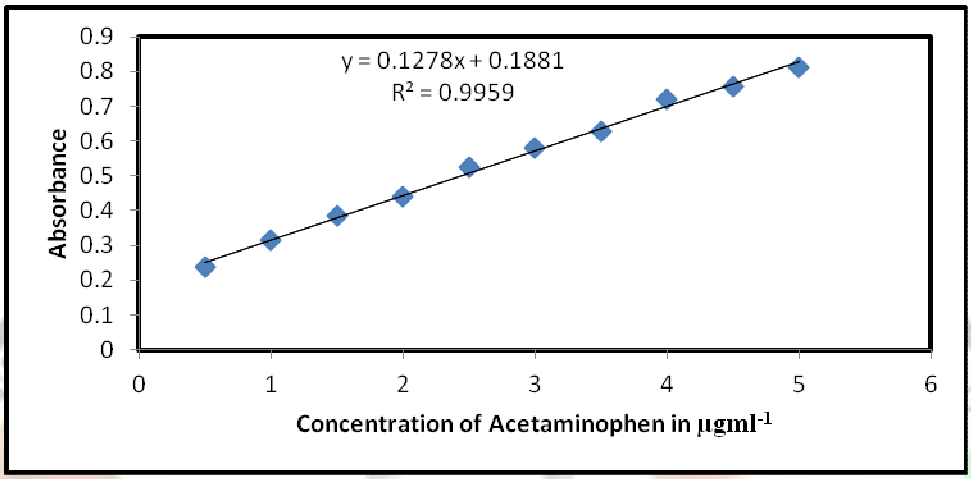

Fig. 1: Adherence of Beer Lamberts law using 1-napthol as coupling agent

Table 1: Analyses of different tablets of Acetaminophen by method I

Brand name of tablet	Acetaminophen(µg ml^{-1}) Taken	Found	Relative error(%)
Paracip	2.5	2.6	+4.0%
	5.0	5.2	+4.0%
Crocin	2.5	2.4	-4.0%
	5.0	5.1	+2.0%
Calpol	2.5	2.4	-4.0%
	5.0	5.1	+2.0%

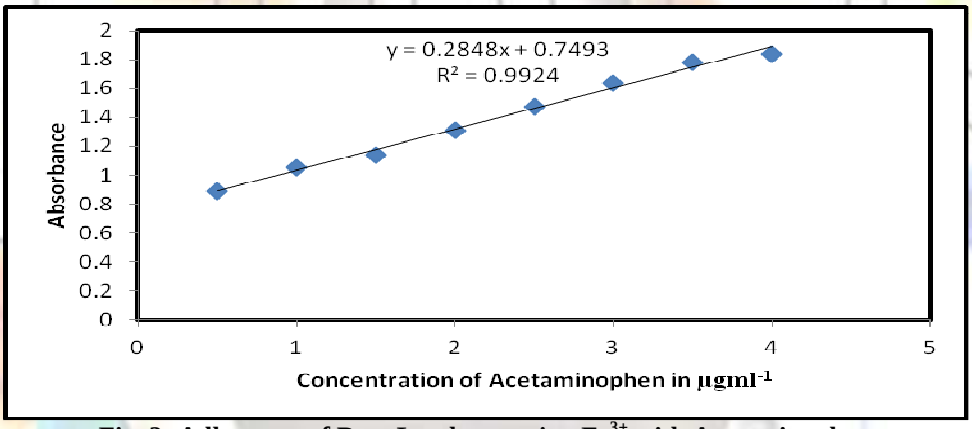

Fig. 2: Adherence of Beer Lamberts using Fe^{3+} with Acetaminophen

Table 2: Analyses of different tablets of Acetaminophen by method II

Brand name of tablet	Acetaminophen(µg ml^{-1}) Taken	Found	Relative error(%)
Paracip	2.5	2.4	-4.0%
	5.0	5.0	0.0%
Crocin	2.5	2.6	+4.0%
	5.0	5.1	+2.0%
Calpol	2.5	2.6	+4.0%
	5.0	5.2	+4.0%