RESEARCH ARTICLE

Spectrophotometric Assessment of Pyrocatechol Drug Employing Oxidative Coupling Reaction with 4-amino antipyrine as a Model of Pharmaceutical Compounds

Abbas Fadhil Ali[1*], Mustafa Aziz Rahi[2], Kamil K Atiyah Altameemi[3], Mohammed Kassim Al-hussainawy[4], Munthir Abdulwahid Abdulhussain[5]

[1]*Department of Medical Laboratories Technology, AL-Nisour University College, Baghdad, Iraq*
[2]*Department of Pharmacy, Al-Manara College For Medical Sciences, Maysan, Iraq*
[3]*Faculty of Pharmacy, Department of Pharmaceutics, University of Al-Ameed, Karbala, Iraq*
[4]*College of Dentist, National University of Science and Technology, Dhi Qar, Iraq*
[5]*Department of Pharmacy, Mazaya University College, Iraq*

Received: 27th February, 2024; Revised: 28th May, 2024; Accepted: 24th June, 2024; Available Online: 25th September, 2024

ABSTRACT

A rapid, simple, sensitive, and higher stability spectrophotometric method was developed the determine that it is stable Pyrocatechol drug in pure and pharmaceutical preparations. The method is based on an oxidative coupling reaction among Pyrocatechol drug and 4-amino antipyrine (4AAP) in the presence of potassium iodate (KIO_3) in an acid medium to form a color complex that stable violet dye and a maximum absorption at 505 nm. The best optimum conditions and other analytical factors have been evaluated. A calibration curve of absorbance of several concentrations that obey the law of Beer-Lambert over the range concentration of pyrocatechol drug 10 to 100 mg/L, with (LoD $=1.2*10^{-4}$ mg/L), (LoQ$=3.4*10^{-4}$ mg/L), The relative standard deviations RSD% of the proposed methods were less than 0.68%). In contrast, recovery average and determination parameters are 99.9%. The method was used successfully for the determination of drugs in a pharmaceutical preparation with the best accuracy and precision. At range about 99.1 to 100.2% with RSD less than 0.3%. The analytical result for the estimation of the pure drug is presented together with the use of the proposed process for the analysis of some commercial pharmaceuticals. The data compare favorably with those of official and reported ways.

Keyword: Spectrophotometric, Determination, Drug, pharmaceutical, pyrocatechol.

International Journal of Drug Delivery Technology (2024); DOI: 10.25258/ijddt.14.3.19

How to cite this article: Ali AF, Rahi MA, Altameemi KKA, Al-hussainawy MK, Abdulhussain MA. Spectrophotometric Assessment of Pyrocatechol Drug Employing Oxidative Coupling Reaction with 4-amino antipyrine as a Model of Pharmaceutical Compounds. International Journal of Drug Delivery Technology. 2024;14(3):1384-1388.

Source of support: Nil.

Conflict of interest: None

INTRODUCTION

Pyrocatechol, also known as 1,2-dihydroxybenzene, or catechol chemical formula C6H6O2. It is a toxic organic compound with a molar mass is 110.112 $g{\cdot}mol^{-1}$, a density of 1.344 g/cm^3, solid, a melting point of 105°C (221°F; 378 K), solubility in water 430 g/L, and very soluble in pyridine soluble in it chloroform, benzene, CCl4, ether, ethyl acetate. Pyrocatechol is colorless and, occurs naturally in very trace amounts and is mainly as used in pesticides, fragrances, and flavors.[1,2]

4-amino antipyrine is a pyrazolone (4-amino-1,5-dimethyl-2-phenyl-1,2-dihydro-3H-pyrazol-3-one) called 4-Aminoantipyrine(4AAP) is an aromatic substance a crystalline yellow powder, has analgesic, anti-inflammatory and antipyretic and properties. The chemical formula C11H13N3O, relative molecular mass is 204 g/mol, and molar volume is 168.3 L/mol.4AAP is used as a reagent chromogenic to the determination of several phenols drug.[3,4]

Oxidative coupling reactions have been long utilized for the estimation of several drugs like pyrocatechol folic acid, 4-amino antipyrine, paracetamol, phenylephrine hydrochloride, sulphonyl amide, phenol, catecholamine drugs, salbutamol, amoxicillin, spectrophotometric ways often suffer from limitations in selectivity and sensitivity but are usually utilized due to both the resulting experimental simplicity and rapidity.[4-12] These pharmaceutical compounds are harmful to animals and humans even in trace low concentrations. Hence, it is very significant to improve a highly selective and

*Author for Correspondence: abbasfadhil20204@gmail.com

sensitive analytical method for determining pharmaceuticals. Several analytical colorimetric methods have been well-known to determine spectrophotometry, Voltammetry, micellar liquid chromatographic HPLC, GC-MS, flow injection, chromatography, fluorimetry, thin layer chromatographic-densitometric, polarography, fluorimeter chemiluminescence, fluorescence, kinetic methods, electrochromatography, electrochemical oxidation, determination.[1,10,11,13-21]

This research objects to developing a simple, sensitive, and accurate spectrophotometric way to determine of Pyrocatechol drug based on oxidative coupling reactions within an acid medium to form a color complex that stable violet dye.

MATERIALS AND METHODS

Reagents

All chemical reagents utilized were of analytical grade supplied by companies (BDH). The stock solution of pyrocatechol drug (100 mg/L) was prepared by dissolving about 0.01 g of the drug in 100 mL of distilled water. Standard solution (100 mg/L) of 4-amino antipyrine by dissolving 0.01 g in 100 mL of distilled water. A potassium iodate solution of 3.5 g of potassium Iodate (0.01 M) by dissolved in 250 mL of distilled water. Hydrochloric acid solution(0.5M) was prepared by 4.24 mL of (11.8N) concentrated HCl in a volumetric flask of 100 mL and competed with distilled water.

Methods

An aliquot of samples having 10 to 100 mg/L of Pyrocatechol drug was transferred into several series of 10 mL volumetric flasks. A 3 mL volume of solution 4-amino antipyrine, 2 mL of solution potassium iodate 0.01 M and volume 0.5 mL of hydrochloric acid all added in the solution Pyrocatechol drug and complete with distilled water, then mixed well for 5 min. The absorbance was measured at 505 nm against reagent blanks having all materials except the drug for determination of the pyrocatechol drug.

Mechanism of the Reaction method

Pyrocatechol drug to form a complex color with reagent 4-amino antipyrine in an acidic medium with the presence of potassium iodate(KIO3). Under the best optimum conditions of the reaction, 4-amino antipyrine oxidation with potassium iodate, which is an oxidative coupling reaction method species. The intermediate undergoes electrophilic substitution with the phenolic moieties of the pyrocatechol drug to result in a complex color.

Calibration carves

The calibration curves were constructed at their respective absorption best maxima linear Pyrocatechol drug solution 100 mL series (10–100 mL) was pipetted in volumetric flasks 10 mL. A 4-amino antipyrine 2 mL, potassium periodate 1-mL and hydrochloric acid 1 mL were added all in 10 mL volumetric flask and the content was diluted with distilled water measured the absorbance at 527 nm at optimum conditions as listed in Table 1 and Figure 1.

RESULTS AND DISCUSSION

Effect of Volume of Reagent (4-amino antipyrine)

The impact of the amount of 4-amino antipyrine as a reagent was carried out on the best absorption of the result color. The volume in use reagent from (1–5 mL) was given the absorbance of (0.13–0.422) in addition to the raised volume of reagent 4-amino antipyrine increased the absorption and increased intensity of the color product. From the results, it was found that increasing the volume of the reagent above 3 mL had no effect on improving the absorbance or increasing the color intensity and stability of the complex formed.[22,23] Thus, found 3 mL was the best selective and sensitivity and measured the absorption at a wavelength of 505 nm, as shown in Figure 2.

Effect of Volume potassium iodate (KIO_3) and Hydrochloric acid solution

The impact of the potassium periodate KIO_3 (0.01M) as an oxidative agent in absorption was investigated. In adding several volumes of KIO_3 solution (0.5–3) mL. When volume increases gives higher intensity and absorption. It was noted that the increase in the volume of KIO_3 has a low effect on the absorbance or increases slightly (almost constant). Therefore, the volume of KIO_3 (2 mL) was chosen as the better volume to give the best absorbance and best selective and sensitivity and

Table 1: Statistical data for the regression equation of the proposed methods

Parameters	*Proposed way*
Regression equation	(Y = m X- C)
R^2	0.9958
Slope (m)	0.0046
Intercept (C)	-0.0485
λmax (nm)	505
law lambert Beer limit (μg.mL^{-1})	2–20
LoD mg/L	$1.2*10^{-4}$
LoQ mg/L	$3.4*10^{-4}$
RSD%	0.68
Color	violet

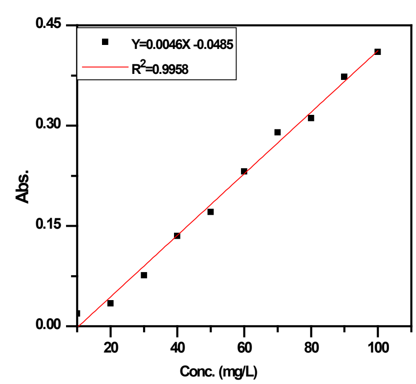

Figure 1: Calibration curve of pyrocatechol drug

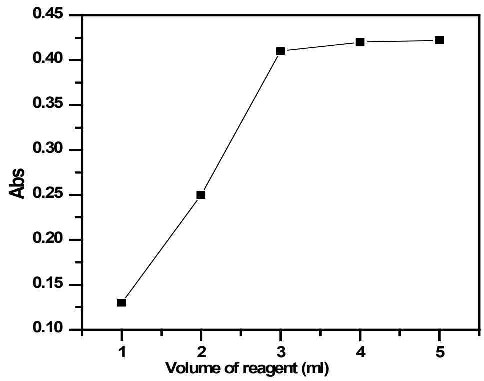

Figure 2: Effect of volume of reagent (4-amino antipyrine)

measure the absorption at a wavelength of 505 nm, as shown in Figure 3. Also, different volumes of the hydrochloric acid (0.1–2) mL utilized were working in the formation of the color reaction. It was found experimentally that the color result was only formed in an acidic medium. It was found that 1-mL of the HCl (value pH:2.1) exhibited the best absorption.[24,25] The influence of the quantity of hydrochloric acid was too tested and of (0.5M) 1-mL for pyrocatechol drug was selected and utilized in the determination of pyrocatechol drug, as shown in Table 2.

Stability Time on the Color Product

The impact of the stability time of the colored result was investigated on the best conditions of reaction obtained from previous experiments, using 10 mL of a volumetric flask and completing the solution with distilled water. From the results

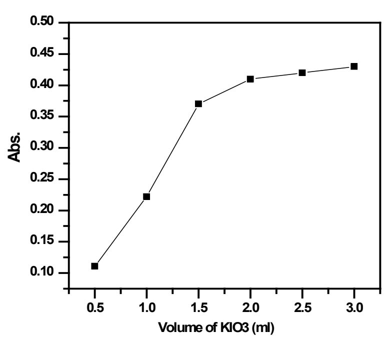

Figure 3: Effect of volume potassium periodate (KIO_3)

Table 2: Effect of different volume of the hydrochloric acid

Volume of the HCl (mL)	*Absorbance*
0.1	0.322
0.3	0.389
0.5	0.422
1	0.277
1.5	0.211
2	0.111

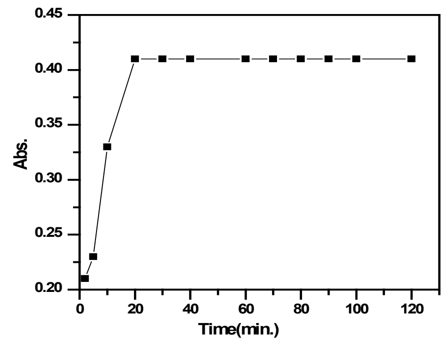

Figure 4: Effect of stability time on the complex formation

shown in Figure 4, the color of the complex is unstable for the first 10 minutes, but after shaking for a few seconds of time, the color of the complex stabilizes for two hours. Thus, the time of reaction increases, the intensity of color increases to reach stable with increased time of the reaction, and the absorption at a wavelength of 505 nm.[26]

The Effect of Temperature Solution

The difference in solution temperature of the complex reaction was used at a variety (10–30°C). Invariable and best maximum absorbance of the resulting colored solution were noted at temperatures (30°C). In the cold solution (ice), the complex formed is unstable, and the color intensity and stability are low, but in the hot solution at a high temperature of the solution to give stability, the complex formed and color and accordingly, the temperature 30°C was chosen to be the optimum temperature[11,27] as shown in Figure 5.

Order of Addition of Reagents

Observed that the order addition sequence of reagents affects the absorbance value of the colored result of the reaction; thus, the order of addition of reagents: To obtain the best data, the sequence of addition of all reagents in the solution should be followed as given via the procedures in Table 3, otherwise, a remove of color intensity and loss of stability of the reaction. It was noted that adding the reagent after the drug is considered an essential step in the formation and stabilization of the formed complex, and an increase in the intensity of the color.[19,20,28]

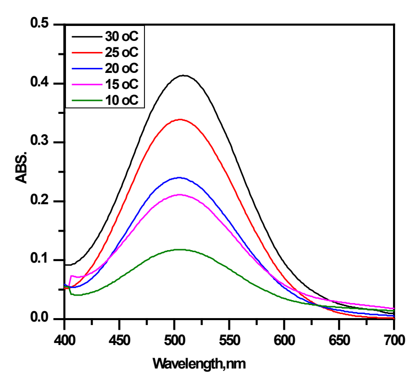

Figure 5: Effect of solution temperature stability time on the color product

Table 3: Effect of order of addition of reagents

No.	*Order of addition*	*Abs*
1	Drug+reagent+KIO3+HCL+H2O	0.422
2	Drug+ reagent+ HCL+ KIO3+ H2O	0.387
3	Drug+ KIO3+ HCL reagent++H2O	0.122
4	Reagent+KIO3+HCL+ Drug+H2O	0.087
5	Reagent+KIO3+HCL+ Drug+H2O	0.085

Optimization of Oxidizing Agent

Using several oxidizing agents like (KIO3, $K_2S_2O_8$., $NH_4Fe(SO_4)_2$, $(NH_4)_2S_2O_8$), found KIO3 best oxidizing agent of the reaction, therefore an increase of absorbance and give higher sensitivity, time stability of intensity color complex as shown in Table 4, and Figure 6. It was observed when using different oxidation agents that no change or displacement occurred in the wavelength, but a decrease in the intensity of absorption was observed.

Effect of Solvent

Different solvents, like acetonitrile, acetone, and distilled water, were studied. Between these solvents, the utmost intense absorption was found via utilizing DW (Table 4).This is attributed to the top absorbance and greater selectivity when utilizing distilled water as a solvent for drugs. Because H_2O is a suitable solvent for the utmost oxidation coupling method, some kinds of solvents lead to an alteration in wavelength and color complex and this leads to the formation of a new complex.[7,21]

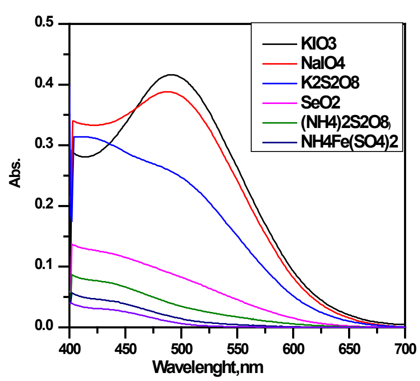

Figure 6: Effect of optimization of oxidizing agent on to stability of complex color

Table 3: Effect of several oxidizing agents

No.	*Type oxidizing agent*	*ABS*
1	KIO_4	0.41
2	$NaIO_4$	0.399
3	$K_2S_2O_8$	0.24
4	SeO2	0.008
5	$(NH_4)_2S_2O_8$)	0.012
6	$NH_4Fe(SO_4)_2$	0.006

Table 4: Influence of several of solvents on the absorbance of drug

Kind of solvent	*Absorbance (PHE)*
DW	0.41
Acetone	0.233
Acetonitrile	0.005

Table 5: Effects of several pharmaceuticals on the determination of pyrocatechol drug

Excipients	*Taken, mg/L*	*Found, mg/L*	*%Eerr*	*%Recovery*
starch	60	61.1	1.83	101.8
glucose	60	59	-1.66	98.3
Lactose	60	59.5	-0.83	99.1

Table 6: Estimation of pyrocatechol in some formulations using the official and proposed way

Pharmaceutical preparation	*Conc. Of drug(mg L^{-1})*		*E%*	*Rec%*
	present	*Found*		
Pyrocatechol syrup 5 mg, Iran	40	39.7	-0.75	99.24
Pyrocatechol syrup 5 mg Iraq	40	40.1	0.24	100.2
Pyrocatechol syrup 10 mg Iran	40	41	2.43	102.4

Interference

The effects of several pharmaceuticals on the determination of these compound phenols as pyrocatechol was studied i. The tests of several pharmaceuticals was determined via the general procedure in the presence of their respective foreign drug. Determination of pyrocatechol with several interferences in the presence of excess more than 10 fold of drug,[7,26] as shown in Tables 5.

Applications of the Pharmaceutical Commercial

The method was valuable on different pharmaceuticals (syrup) by using 20 mg/L concentration of the l pharmaceuticals. The result is in Table 6. The greatest E% error and recovery and the result of this method compared with the official way as shown in Table 4 showed there is no significant change between the official method and the proposed method.[29]

CONCLUSION

The suggested oxidative coupling reaction method offers the advantages of being fast, simple, economical with reasonable accuracy and precision and higher sensitivity, and selective more than the other methods. The applicability of the new method for some pure and pharmaceutical formulations to determination by pyrocatechol drug at the concentration level of trace (mg/L). Furthermore, these methods that no have any interference with the new procedures for routine amount control were well established via Pyrocatechol drugs in pure and pharmaceutical formulations. The proposed way is found to be more sensitive, simple, and highly selective than any reported way. The statistical factors and the recovery study result clearly indicate the reproducibility and accuracy of the method. Thus, the way can be adopted as an alternative to the existing processes.

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