Research Article

A Modified and Credible Methods to Estimate Nitrofurantoin In the Standard of Substances and Pharmaceutical Dosage

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ABSTRACT

For identifying the nitrofurantoin drug, the four selective, sensitive and simple methods were developed. And these methods are then proved as well as validated in our particular research work. These methods are dependent of the nitrofurantoin reactions, performed by utilizing ZN/Cl, as well as iron mixture (II)and neutral medium is used for ferric chloride reduction through this drug along with 1, method A- 10- phenanthroline or 2, method B- bisperdyl or blue chromogen is formed when this particular drug binds with the oxidized ferric chloride and potassium ferritic cyanide reagent(method D). A colourful product is produced with the ninhydrin and nitrofurantoin reagent interaction and also method D is also dependent on this. By using method A, B, C and D the measurement of resulted red chromosomes is found to 500nm, 515nm, 735nm, and 575nmrespectively.Method A, B, C and D uses the concentration ranges of 0.20-8.0 mg/ml 0.25-40 mg/ml, 0.50-30 mg/ml and 0.50-50 mg/ml respectively and in such optimal conditionsBers law is applied along with molar's absorption values are also estimated.The statistical comparability of the suggested methods resulted with all those acquired by the reference technique which proved outstanding agreement as well as also shown there does not exist any interference through typical excipients in pharmaceutical formulations.

Keywords: Chelating agents, Ferric chloride, Nitrofurination drug.

INTRODUCTION

One of the nitrofuran's drug derivative namely nitrofurantoin (NTF) is essential during the disease of urinary area and possesses a chemical structurenamely (1-((5-nitro-2-furfurylidene)-1-amino) hydantoin) and is presented in Figure 1. Additionally, a few gram-positive organisms likecorynebacterium, viridians streptococci, group D streptococci,S. agalactiae,enterococcus faecalis,S. saprophyticus,S. epidermidis,andS. aureus induces activity in NTF.

The activity spectrum for gram negative organisms that are shigella, salmonella, Neisseria,Enterobacter, andE. coli, [1,2].Furthermore, from the bacterial resistancedevelopment this drug is highly stable and this characteristic is result of the mechanismswork multiplicity [3].

In addition to, it would once deal with bladder infections through antibiotic that is provided through theoral cavity. Therefore, it is essential for preventing as well as treatingthe infections of urinary tract infection by opposing the bacteria's growth. Although, in case of kidney infections the drug is inactive [4].

In the pure drug and pharmaceutical preparation the nitrofurantoinevaluation is registered by some of the analytical techniques. Furthermore, the drug can be estimated in the form of tablet dosage through the HPLC technique, additionally, spectrophotometric method verified that evaluation of the nitrofurantoinelectroanalytical techniquewas posted to drugdetermination [5,6].

A rotating mercury electrodes and platinum electrode is utilised by the voltammetric method that are used for the nitrofurantoin drug's determination [7,8].During the technique of drugdetermination in pharmaceutical preparations, they has reported a liquid chromatographic[9,10].

This particular drug has discovered inbiological fluids and in pharmaceuticals with the help of square–wave cathodic adsorptive stripping voltammetry [11,12].

The first phase determiner was drug reductionthrough zinc dust for transforming the nitro set within the acidic medium.

The drug oxidation in neutral medium along with the ferric ion is included in the 3 methods namely, A, B and C as well as successive complications introduced by the ferrous ion with 1, method-A aqueous solution containing 10- phenanthroline reagent, 2, method-B 2`-bipyridyl or method-D potassium ferricyanide reagent for producing the color complex.

However, for producing the colour complex by using the method D that is dependent of having a basic medium on the direct reaction ofNitrofurination drug reduction along with ninhydrin reagent [13,14].

STUDY AIM

This study aims in developing the new 4 accurate and simple techniques for determining as well as estimating the Nitrofurantoin inpharmaceuticalsandpure form.

EXPERIMENTAL

Apparatus

"Jena Model 1100, UV-Visible spectrophotometer (Germany) in pharmaceutical chemistry, University of Basra, Iraq" was used to carry out all the absorbancespectral and measurements. A 10mm path length and a quartz cell is used by the UV-Visible spectrophotometer. Also, for sample weighting a meter electrical balance is utilised.

Material and Reagents

A deionized water is used for analytical grading for preparation of all the reagents.

Nitrofurantoin solution (500 µg/ml):

This particular drug's pharmaceutical quality is accredited to be 98.98 % pure as well as 0.0500 g of Nitrofurantoin was dissolved in the 50 ml of ethanol for preparing the drug's reduction solution.

Furthermore, we transfers this solution to a beaker of capacity 125ml and after that 3.0g of zinc powder, 20ml of concentrated hydrochloric acid, and 20ml of distilled water is added to the solution. Then, at room temperature of 25 °C, for the 15 minutes beaker was allowed to stand so that reduction process is completed, afterward, solution was filtered into a volumetric flask of capacity 100ml. along with the distilled water, volume is found to diluting to the particular mark and thus, a NIT reduction solution of 500 mg/ml is obtained and finally this solution is transmitted to a brown bottle.

Therefore, the solution prepared by this particular work was (100mg/ml) by day-to-day preparation with suitable dilution achieved with the help of distilled water [15,16].

Ferric chloride (0.1%)

1.0g of the chemical is dissolved in the 100ml of water and is placed in a dark bottle so as to prepare 0.1% ferric chloride hexahydrateaqueous solution (S.D. Fine Chem., Mumbai, India). After that the appropriate dilution of stock solutionwith water is used to acquire the 0.1%concentration for every method. Before the experiment, an absolute new solution was prepared.

1,10phenanthroline mono-hydrate solution, 0.1 %:

0.1g of 1,10-phenanthroline monohydrate (Fluke) was dissolved in the 100ml distilled water in a volumetric flask for preparing this solution.

2,2bipyridyl (0.1%)

In a 100ml calibrated flask, 0.1g of the chemical (Qualigens Fine Chemicals, Mumbai, India, assay 100%) was dissolved in the water to attain the acquired volume dilution.

Potassium ferricyanide reagent 0.1%

BDH fine Chemicals Ltd., India used the 0.1% of potassium ferrodehyde reagent. 100mg of reagent was dissolved in the 100mL of deionized water.

Preparation of sodium Bicarbonate (saturated solution)

For preparing this solution approximately 25g of sodium bicarbonate is dissolved in the 100ml of deionized water and 100% distilled water and them for next 20 minutes magnetic stirrer is used to stir this solution. Furthermore, quantitative filter paper is used for decantation and filtration of the solution.

Ninhydrin 2% solution

200mg of ninhydrin is dissolved in the 100ml of deionized water for preparing the 2% ninhydrin solution in distilled water.

Solution of pharmaceutical preparations

The local markercommercial sources were used to purchase the various pharmaceutical preparations such as 50mg (Bio-Active T-UK), Furantil capsules,100mg (Uvamin retard, Switzerland), and a Nitrofurantoin capsules.

For the preparation, Nitrofurantoin pharmaceutical were finelyandaccuratelypowdered. Furthermore, 50mgequivalentpowder quantity of Nitrofurantoin is used to dissolve in 30ml ethanol, after that volumetric flask of capacity 50ml is used for filtration of the solution. Then, similar solvent is used for obtaining the marked diluted volume of 1000mg/ml of NIT. Finally, the solution is moved to a beaker of capacity 125ml and the previous procedure is used for its reduction.

PROCEDURES

Method A

An alternative aliquots (0.02-0.8ml) on the standard format 100mg/ml Nitrofurantoinsolution had been suitably assessed as well as moved into various calibrated flasks of capacity of10ml using micro burette, as well as the complete volume was indicated to 5ml in every flask, 3.0ml of 1, 10 phenanthroline (0.1%) as well as 2.0ml of ferric chloride (0.1%) have been loaded consecutively, and then with the distilled water the total volume is 10ml.

Furthermore, for mixing the content, flasks were closed and shook for next 5 minutes. After that every solution was measured for the absorbance against the reagent blank at 500nm.

Method B

Different aliquots range (0.025-4.0ml) of standard100mg mlNitrofurantoinsolution had been correctly assessed into several calibrated flasks of capacity10ml through a micro burette as well as the complete volume was indicated to 5ml with the water addition. 2.5ml of 2, 2`-bipyridyl (0.1%) and 1.5ml of ferric chloride (0.1%) were added to every flask. After that contents were mixed thoroughly and then deionized water is used for diluting the solution to the marked point. After that every solution was measured for the absorbance after 30 minutes against the reagent blank at 515nm. In a spectrophotometric technique, a standard graph was plotted between values of Nitrofurantoinconcentrationversusincreasing absorbance values.

Method C

Varying aliquots range (0.05-3.0ml) of Nitrofurantoinsolution had been correctly assessed into several calibrated flasks of capacity10ml for providing absolute concentration range0.02–0.12mg/ml. 1ml of potassium ferricyanide reagent and 2.0 ml of ferric chloride is added to every flask and allowed to sit for 5 min. The required volume is attained with the help of the deionized water. After that every solution was measured for the absorbance against the reagent blank at 735nm. Furthermore, calibration graph was plotted between concentrations versus absorbanceof Nitrofurantoin. Calibration graph was used to read the unknown concentration levels and regression equation was used to compute it.

Method D

Varying aliquots range (0.05-5.0ml) of Nitrofurantoinsolution had been correctly assessed into several calibrated flasks of capacity10ml for providing absolute concentration range 0.50–50mg/ml.1.0ml saturated sodium bicarbonate solution and 2ml of 2% ninhydrin solution were

added and then required volume is attained with the help of the deionized water. A15 min boiling water bath (97 ± 1°C) is used for heating the solution. After that these solution were let to cool down at room temperature. After that every solution was measured for the absorbance against the reagent blank at 575nm. Furthermore, calibration graph was plotted between concentrations versus absorbanceof Nitrofurantoin.

RESULTS

Iron (II) ion is produced when iron(III) ion is activated in an oxidant agent and then reacted with the reduced Nitrofurantoin. In the neutral medium, in presense of the $FeCl_3$ the nitrofurantoin drugundergoes oxidation [17,18]. The two steps were involved when colour complexesof Fe^{2+}were formed with method A:1, 10-phenanthroline, method B: 2, 2`-bipyridyl, ormethod C:potassium ferricyanide reagent.In the first step, Nitrofurantoin is oxidized in neutral medium with excessive $FeCl_3$ whereas in the second step with the subsequent chelating the resulting Fe^{2+} is determined wither by potassium ferricyanide, 2, 2-bipyridyl, or 10-phenanthroline as well as for colour formation the complexes were measured for the absorbance against the reagent blank.

The formation mechanism of colored complexes formation is represented in the figure 1 among the Nitrofunationreduction along with excessive Fe^{3+} (ferric salt) as well as the besides the unreacted Fe^{3+} their reduced state is used. Red colored complexes can be produced by $Fe^{2+}$when treated with 1,10-phenanthroline [19-21].

The method B mechanism is represented in figure 3 that contains the red colour complex formation when Fe^{+2} is treated with the 2,2` bipyridylor figure 4 represents the formation of insoluble Prussian blue complexes with potassium ferricyanide reagent at room temperature.

For determining the some particular thiophenes, amino acids andamines, ninhydrin is considered as well-known reagent [22,23].In a basic medium the Nitrofurantoin drugandninhydrin solution undergoes a reaction which is involved in method D. Furthermore, for determining the kinetic studies and pharmaceutically important compounds ninhydrin is used [24]. Generally, the reaction is caused by a small amount of heating. In an alkaline medium, the ninhydrin was converted into O-carboxyphenylglyoxal where the ninhydrin is reduced to 2-hydroxyindan-1, 3-dione. In the present study work, it is associated with the reduced Nitrofurantoin's–NH2 group so that amino derivatives can be formed, along with the Ruhemenn's purple at 575nm with greatest absorbance.

Nitrofurantoin was able in response with ninhydrin just at higher temperatures. The optimum color was acquired by warming on a boiling water bath for fifteen minutes extended heating decreased the intensity of color, therefore the response time must be managed [25]. For the next 5 hours developed color was stable. Figure 5shows the suggested response between ninhydrin as well as nitrofurantoin.

DISCUSSION

The optimization of the reaction conditions

The proposed strategies have been optimized to attain total reaction formation, highest maximum and sensitivity color improvement in the quantitative perseverance of Nitrofurantoin as well as optimum absorbance. All the experimental parameters have been optimized by utilising 100mg/ml of this particular medication standard operating formula [26].

Absorption spectrum

In figure 6, when Nitrofurantoin is treated as per the suggested methods, the absorption spectrum exhibits an optimum absorption during 500nm, 515nm 735nm as well as 575nm to he methods A, B, C, D in a respective fashion with 4mg/ml, 20mg/ml, 15mg/ml, along with 30mg/ml of Nitrofurantoin concentration to methods A, B, C, D in respectively manner [27].

An effect of ferric chloride

The outcomes of examiningimpact of the ferric chloride oxidation agent's various quantities on the solution absorbance had been suggested that the absorbance enhances with ferric chloride's

increased concentration. Also, the reagent blank's absorbance value is increased with increase in the Fe3+ concentration.

Therefore, by considering about the reaction sensitivity with a least absorbance blank, methods A, B and C were discovered with the optimum ferric chloride's quantities such as 2ml and 1.5ml and 2ml in 10mlrespectively. And as represented in figure 7 they are utilised in the complete experiment.

Although the consequent Fe2+ chelation and nitrofurantoin oxidation by Fe3+ along with 1, 10 phenanthroline in (method A), 2, 2' bipyridyl within (method B) potassium ferricyanide inside (method C) was discovred to take place in the neutral medium [28].

An effect of reagents amounts

Many experiments have been performed to learn the impact of the quantities of the reagents within the color produce by having the Ferric chloride and nitrofurantoin drug concentration to continuous and transforming the reagent concentration.

An impact of various quantities of reagents on the absorbance of the solution was studied, the results suggested the absorbance increases with raising the reagent awareness [29, 30]. The maximum amount of 1,10 phenanthroline reagent as well as 2,2 ' bipyridyl and potassium ferricyanide for on the generation of reproducible intensity of color and maximum was founding to remain 3ml of to 1,10 phenanthroline reagent method A as well as 2.5ml of 2,2 ' bipyridyl reagent to method B plus 1ml of potassium ferricyanide reagent to method C in a complete amount of 10ml with 4mg/ml, 20mg/ml, 15mg/ml along with 30mg/ml of Nitrofurantoin concentration to method A,B,C and D respectively.

The result of ninhydrin volume on optimum color was obtaining to work with 2% ninhydrin solution. It had been discovered that by raising the volume of ninhydrin solution will boost the absorbance of the response item up to 2.0ml following that further rise in the volume of ninhydrin led to no change inside the absorbance of the response item. Hence 2ml of 2% ninhydrin was used as probably the most appropriate amount for optimum absorbance as found in Figure 8.

An effect of the time and temperature

In this particular work the time impact on the stability and development period of the Nitrofurantoin determination was studied. The durationfor full-color development at room temperature were discovered as 15 minutes for methods A, B and C andit is going to be 20 minutes of blending the reactants to method D. For minimum of 120 minutes in methods A, B, and D the absorbance stayed constant.

In method D, the Nitrofurantoinreacts with ninhydrin (method D) solely at increased temperature, optimum color was acquired by warming on a boiling water bath for 5 minutes. Color intensity is decreased by the prolonged heating, therefore there is need to control the reaction time [31]. The evolved color was stabling for five hours.

The Statistical analysis

The statistical analysis was done by ANOVA single factor test and the results were expressed as mean ± SD and analysed statistically using a t-test and f-test Differences were considered significant at the 95 % confidence limit. Paired t-test was put on to evaluate the pharmaceutical preparation's mean values analysis with labeled values at ninety-five% confidence level. For calculating the confidence level for nitrofurantoindrugat 95%Student t-test were applied.

The method validation

The methods were validated based on the International Conference on Harmonization (ICH) standards for awareness andlinearity boundaries of recovery, selectivity, accuracy, precision, quantification, anddetection

To understand the Beer's law boundaries of the suggested techniques, the absorbance of a number of treatments was that contain different amounts of Nitrofurantoin (0.02-0.8 ml) to method

A, and 0.025-4.0ml to method B and 0.05-3.0ml to method C and 0.05-5.0ml to method D and then specified levels of the other as provided in the process (2.0-8mg/ml, 0.25-40mg/ml, 0.5-30mg/ml as well as 0.5-50mg/ml to methods A, B,C and D in respective technique, in a complete amount of 10ml had been computing during 500nm,515nm,725nm, 575nm to solutions A,B,C,D against a reagent blank. Calibration curve to Nitrofurantoin was producing by plotting absorbance compared to focus on mg/ml (Figure nine). Under optimum conditions, different analytical parameters were obtained as well as presented in Table one. The worth of the correlation coefficient suggests excellent linearity of the present method. a premium price of molar absorptivity with a reduced value of sandell's awareness mirrors a high and good awareness to the method [32].

The Limit of Detection (LOD) was calculated by starting the minimum amount at which quercetin might be recognized based on the equation: LOD =3.3S/a where: a slope of the calibration line; Sub-standard deviation in intercept. The following formula is used for determining the Limit of Quantification (LOQ):

$$LOQ=10\ Sb/a$$

Great linearity on the calibration curve, as well as tiny, scatter of experimental areas has led to an impressive coefficient of dedication, R^2=0.9989, 0.9987and 0.9998. The LOD was 0.05, 0.07, 0.15 as well as 0.09 LOQ was 0.10, 0.115, 0.25 as well as 0.17mg/ml for methods A, B, D and C respectively.

Interferences

The complicated development in the existence of excipients as starch, acacia as well as talc lactose had been examined. The excipients had been evaluating at concentration 10-times much higher as compared to concentration of Nitrofurantoin, based on the treatments on the calibration curve, the interference was thinking about appropriate to decrease the error than ± 2%.

Accuracy and precision

After theproposed strategies concentrations have been optimized 2.0-8mg/ml, 0.25-40mg/ml, 0.5-30-mg/ l as well as 0.5-50-mg/ml to methods A, B, C and D. The precision as well as accuracy of the methods were determining by performing 5 similar evaluation of Nitrofurantoin in natural forms during 3 concentration based on the calibration curve. The results showed the very good precision through lower values of Good accuracy and RSD percentage through error portion as well as recovery portion (99.13-101.50% to methodA, 99.90-100.35% to methodB, 99.70-100.60% to methodC along with 99.23-100.50%to methodD, the acquired results are shown as well as summarized in Table two indicate great accuracy and precision to all strategies.

The Application of the methods

The developed techniques were effectively applied to the Nitrofurantoin determination within the pharmaceutical formulation of its and also the table 3presentedthe results.

The results obtained had been statistically in contrast to the reference by using the t-test and F-test at ninety-five% confidence level. Table 3 suggested that there is not a distinction in between the suggested strategies as well as the reference technique with great accuracy and precision. The outcomes (Table3) demonstrated that the mean recoveries have been founding in the number 98.17-102.50 with RSD range 0.72-1.05% methodA, 98.95-100.40 with RSD range 0.79-1.05 to method B as well as 98.80-101.00with RSD range 0.65-1.02 to methodC and 95.90-99.80 with RSD range 0.76-1.25 to methodD.

The results obtained had been statistically in contrast to the reference. The student's t-test values gotten at the ninety-five% confidence level as well as 5 degrees of freedom didn't go over the theoretical tabulated importance of t=2.77, indicating simply no substantial distinction in between the as opposed strategies.

The F-value (19.01) even presented that there's no substantial distinction in between the accuracy of the suggested strategies as well as the reference method.

CONCLUSION

The proposed methods are discovered to be sensitive,selective and simple than the majority of the spectrophotometric techniques found. Therecovery study data, as well as statistical parameterscertainly specify the methods' precision as well as reproducibility. The suggested techniques are ideal for the bulk Nitrofurantoin as well as pharmaceutical products determinationas well not having the excipients interference. For determining this drug in the quality control laboratoriesthe above approach can be used.

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Table 1: analytical parameters

Parameter	Method A	Method B	Method C	Method D
Beer's law limits (µg/ml)	*0.20-8.0*	*0.25-40*	*0.5-30*	*0.5-50*
λ max / nm	*500*	*515*	*725*	*575*
Molar absorptivity(L/mol cm^{-1})	*2.1785x104*	*0.5942x104*	*1.0939x104*	*4.6704x103*
Sandell sensitivitya µg/cm2)	*0.0771x10-3*	*1.4133x10-3*	*0.5757x10-3*	*0.0269x10-3*
Detection limit (µg/mL)	*0.05*	*0.07*	*0.15*	*0.09*
Quantification limit (µg/ml)	*0.10*	*0.15*	*0.25*	*0.17*
Correlation coefficient (R^2)	*0.9988*	*0.9989*	*0.9987*	*0.9998*
Intercept of Correlation coefficient (R)	*0.012*	*0.019*	*0.006*	*0.011*
Slope (b)	*0.090*	*0.023*	*0.043*	*0.019*

Table 2: Accuracy and precision of the proposed method

Method	Amount taken (µg/mL)	Amount Found* (µg/mL)	%Relative error*	%(Recovery ± SD)*	%RSD*
A	*2*	*2.03*	*1.50*	*101.50±0.04*	*0.53*
	4	*4.04*	*1.00*	*101.0±0.05*	*0.98*
	8	*7.93*	*0.875*	*99.13±0.08*	*0.99*
B	*10*	*10.03*	*0.30*	*100.30±0.09*	*0.76*
	20	*20.07*	*0.35*	*100.35±0.06*	*0.87*
	30	*29.97*	*0.10*	*99.90±0.03*	*0.89*
C	*5*	*5.03*	*0.60*	*100.60±0.07*	*0.77*
	10	*9.87*	*1.30*	*98.70±0.14*	*1.02*
	15	*14.96*	*0.27*	*99.73±0.13*	*1.05*
D	*10*	*10.05*	*0.50*	*100.50±0.09*	*0.96*
	20	*20.06*	*0.30*	*100.30±0.12*	*1.01*
	30	*29.77*	*0.77*	*99.23±0.25*	*1.09*

Table 3: Application of the proposed method to determination of Nitrofuration in pharmaceutical preparations

Proposed methods	Conc.(µg/ml)	Drugs brand name					
		Nitrofurantoin (Cap.100 mg)			Furantil(Cap.50mg),		
Method A	Taken conc. (µg/ml)	2	4	6	2	4	6
	Found conc. (µg/ml)	2.03	4.04	5.97	2.05	3.99	5.89
	Recovery (%) n=3	101.50	101.00	99.50	102.50	99.75	98.17
	RSD(%),n=3	0.95	0.72	0.90	1.01	0.95	1.05
Reference method	(%Recovery ± SD)n=5	105.27±0.12			102.05±0.06		
Method B	Taken conc. (µg/ml)	5	10	20	5	10	20
	Found conc. (µg/ml)	5.02	10.03	19.88	4.98	9.99	19.79
	Recovery (%) n=3	100.40	100.30	99.4	99.60	99.90	98.95
	RSD(%),n=3	0.92	0.89	0.67	0.99	0.79	1.05
Reference method	(%Recovery ± SD)n=5	104.33±0.09			101.03±0.07		
Method C	Taken conc. (µg/ml)	5	10	15	5	10	15
	Found conc. (µg/ml)	5.05	9.98	15.01	4.97	9.88	14.99
	Recovery (%) n=3	101.00	99.80	100.07	99.40	98.80	99.93
	RSD(%),n=3	0.68	0.77	0.88	0.92	0.65	1.02
Reference method	(%Recovery ± SD)n=5	102.45±0.06			101.08±0.12		
Method D	Taken conc. (µg/ml)	5	10	20	5	10	20
	Found conc. (µg/ml)	4.98	9.59	19.94	4.99	9.97	19.88
	Recovery (%) n=3	99.60	95.90	99.70	99.80	99.70	99.40
	RSD(%),n=3	1.25	0.89	0.97	0.76	0.91	1.01
Reference method	(%Recovery ± SD)n=5	103.11±0.07			104.04±0.10		

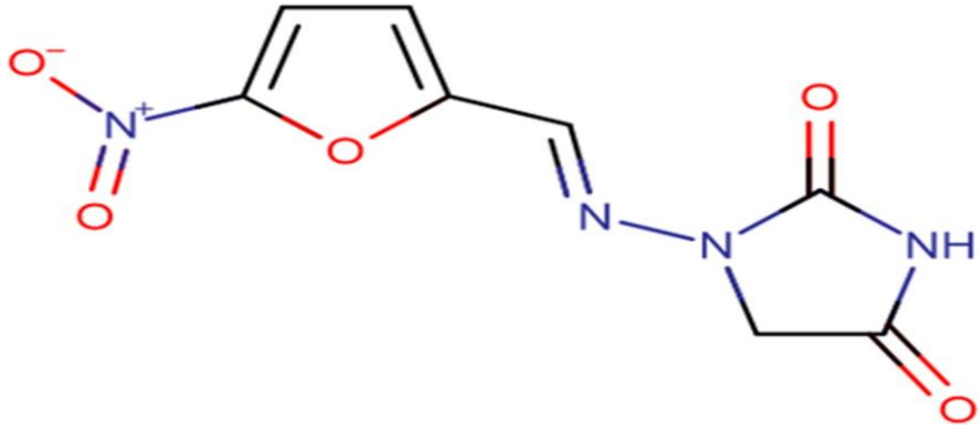

Fig.1: The chemical structure of Nitrofurantion drug

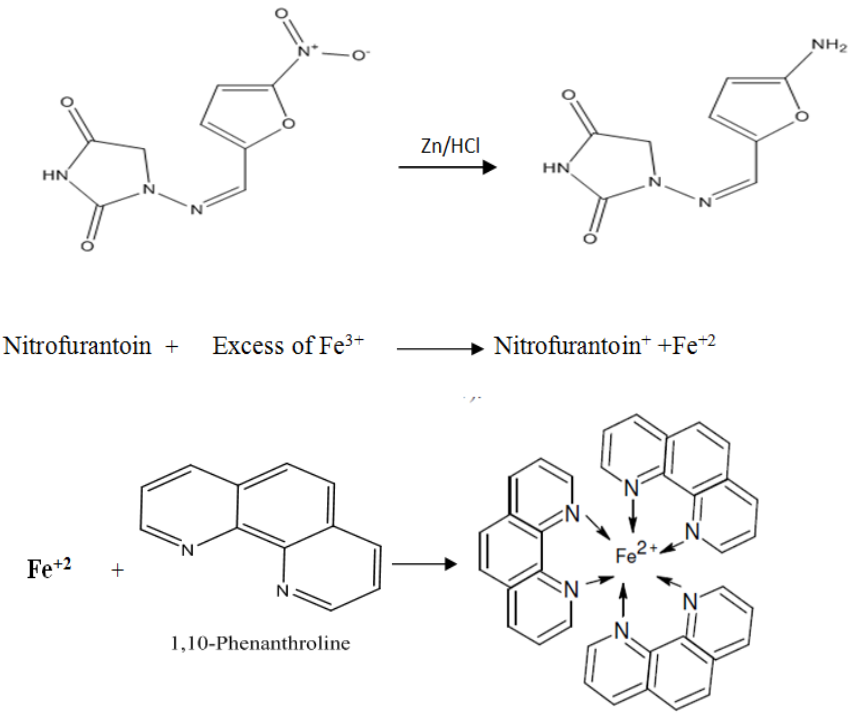

Fig.2: The suggested reaction pathway (Method A) between Fe^{+2} and 1,10-phenanthroline

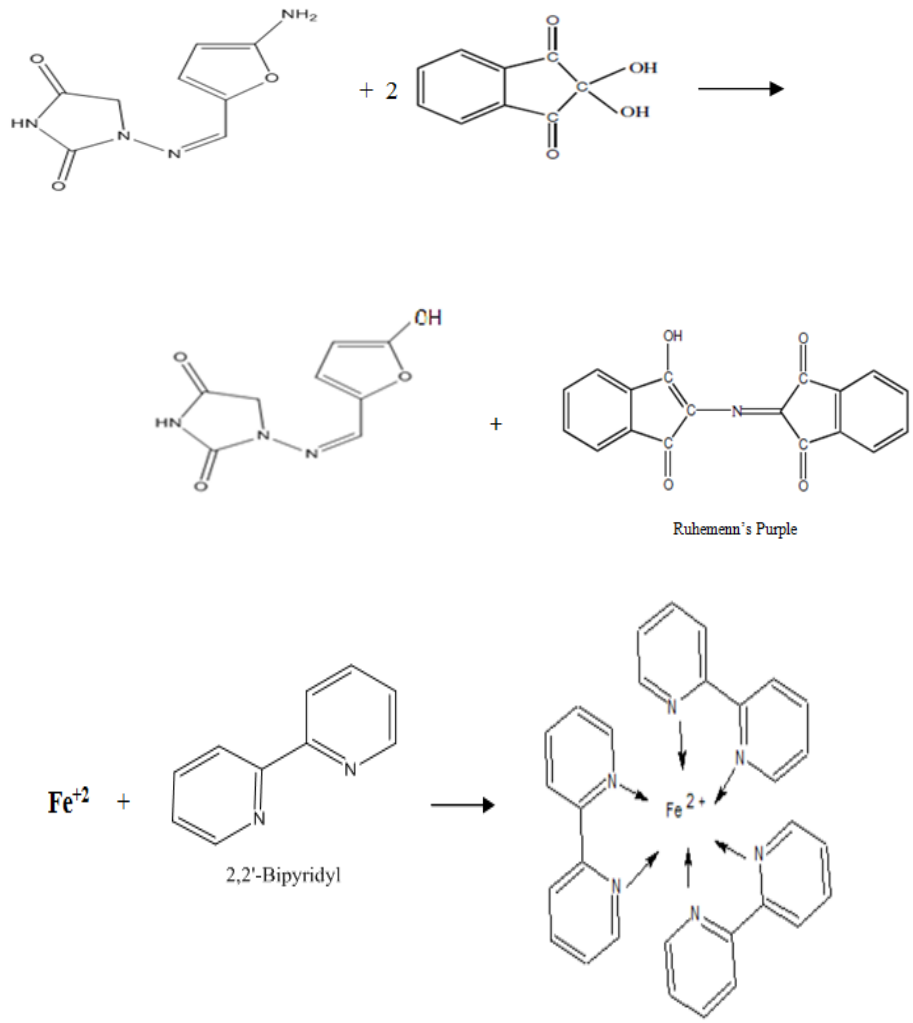

Fig.3: The suggested reaction pathway (method B) between Fe2+ and 2, 2' bipyridyl

$$3\,Fe^{2+} + 2\,[Fe(CN)_6]^{3-} \longrightarrow Fe_3[Fe(CN)_6]_2$$

Potassium ferricyanide — colored complex

Fig.4: The suggested reaction pathway (Method C) between Fe2+and potassium ferricyanide

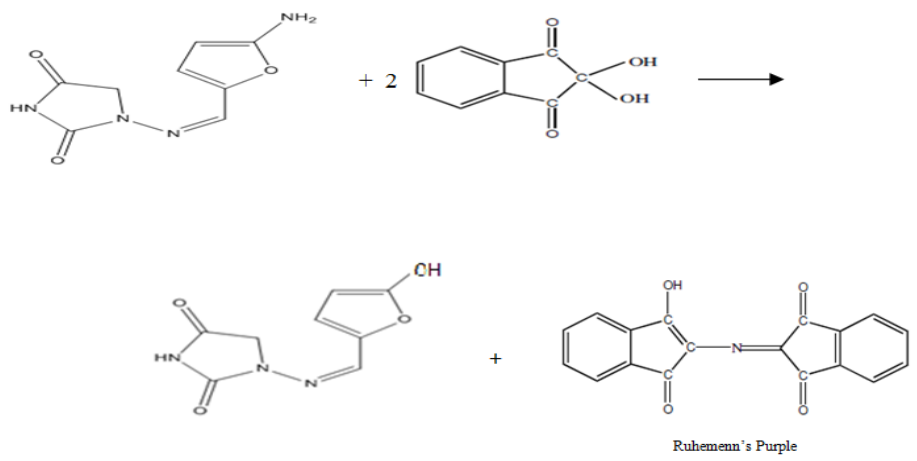

Fig.5: Suggested reaction pathway between Nitrofurination and ninhydrin

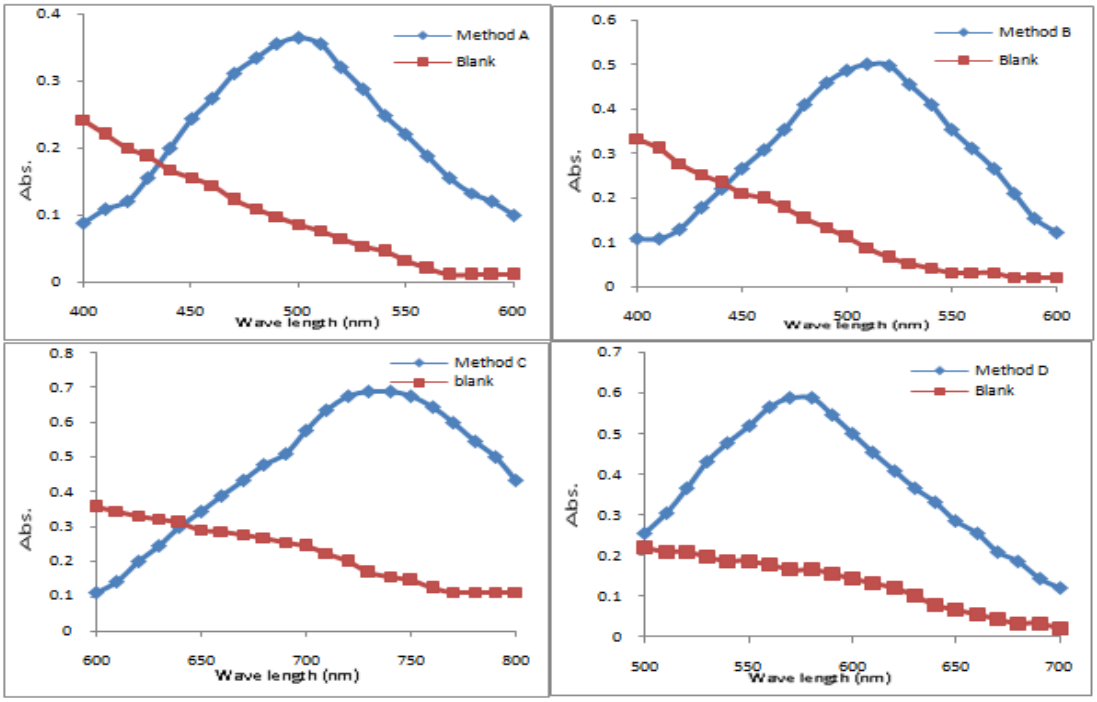

Fig.6: The absorption spectra of Nitrofurantoin complexes with methods A,B,C and D against the reagent blank

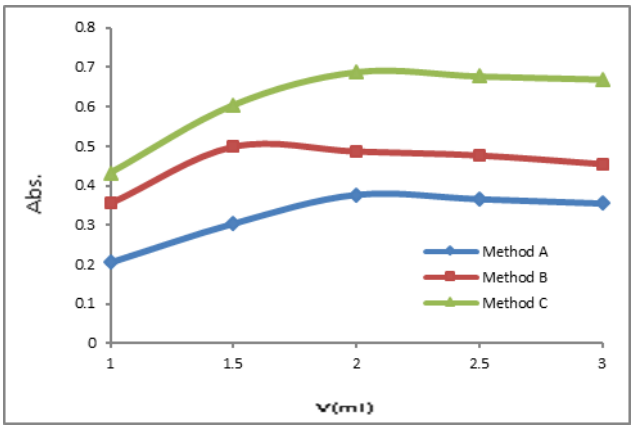

Fig.7: The effected of ferric chloride oxidation agent(0.1%) on the absorbance

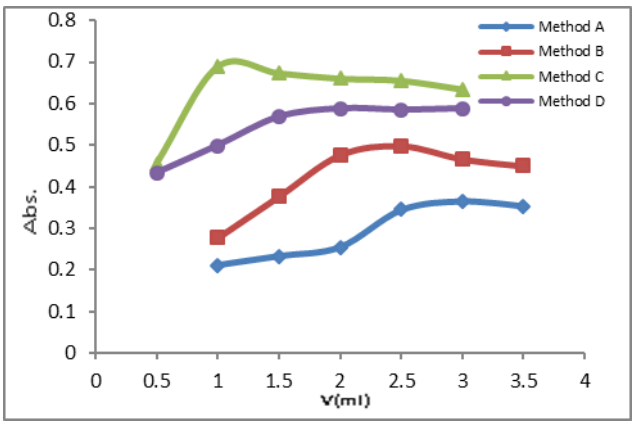

Fig.8: The effect of reagent volume on absorbance intensity for methods A,B,C and D

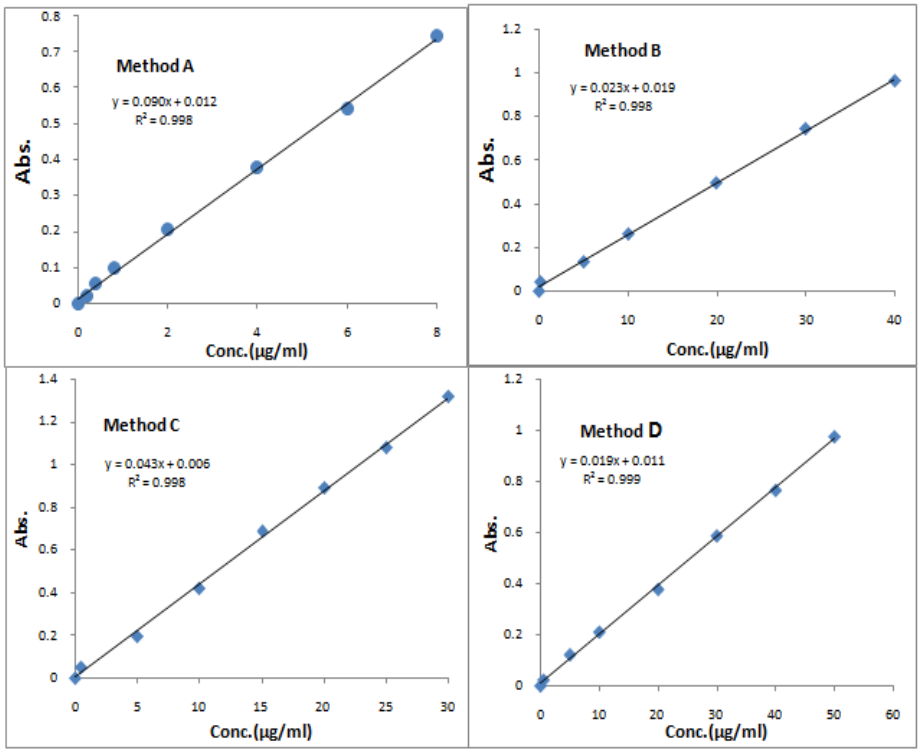

Fig.9: Calibration curve for Nitrofurantoin with differences methods A, B, C and D