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Spectrophotometric Determination of Chromium (III) using 1,2-bis(4-methoxyphenyl-2(quinolone-8-ylimino)ethan-1-one(BMPQYE1), Investigating of Thermodynamic Functions and Their Analytical Uses

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Abstract:

The spectrophotometric approach was employed as an advanced technique for the measurement of Cr(III) ions. The compound integrate1,2-bis(4-methoxyphenyl)-2(quinolone-8-ylimino)ethan-1-one was employed as a chromogenic reagent under a pH of 8. Numerous variables which influence the formation of complexes, including the influences of pH, temp, duration, and reagent amount, were thoroughly examined and investigated. Under optimal circumstances, the amount of Cr(III) ranged from 5 to 80 µg/mL and followed Beer's Law. The complexes exhibited its highest level of absorption at a wavelength of 560nm, with a molar absorptivity of 0.0217 $L.mol^{-1}.cm^{-1}$. The limit of detection (LOD) (1.169×10-4µg/mL)، respectively. The chelate demonstrates a stoichiometric ratio of 1:3 (Cr:BMPQYE1).The method that was developed demonstrated successful application in the determination of Cr(III) ions in pharmaceutical samples.

Keywords: Schiff base, Chromium (III), Spectrophotometry.

التحديد الطيفي للكروم الثلاثي باستخدام 1,2 ثنائي (4-ميثوكسي فينيل -2(كوينولون-8-يليمينو)ايثان 1-.دراسة الوظائف الديناميكية الحرارية واستخداماتها التحليلية.

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الخلاصة

تضمنت الدراسة تقدير ايون الكوبلت الثلاثي بأستخدام ليكاند قواعد شف الجديد وهو

1,2-bis(4-methoxyphenyl-2(quinolone-8-ylimino)ethan-1-one(BMPQYE1)

ككاشف كروموجيني تحت درجة حامضيه 8. تمت دراسة الضروف المثلى لتفاعل الايون الثلاثي مع الكاشف ، مثل الدالة الحامضية ، وحجم الكاشف ، درجة الحرارة وزمن الاستقرار للمعقد. في ظل الظروف المثلى، تراوحت كمية الكروم حسب قانون لامبرت بير.(5µg/10mL-80µg/10mL).

أظهرت المعقدات أعلى مستوى من الامتصاص عند طول موجي 560 نانومتر، حد الكشف . (Cr:BMPQYE1يظهر المعقد نسبة الكاشف الى الايون 1:3(1.169×10^{-4}µg/mL) لأيون الكروم هو أثبتت الطريقة التي تم تطويرها تطبيقًا ناجحًا في تحديد أيونات الكروم الثلاثية على عينات صيدلانيه ووجد ان الطريقة المتبعة في التقدير ذات حساسية ودقة عالية.

Introduction:

In recent years, there has been a significant focus on coordination compounds containing biologically active ligands (1,2). The reactions between primary amines and carbonyl compounds Outcomes in the formation of Schiff bases that can form stable complexes with metallic ions (3,4). The azomethine set represents a prevalent structural characteristic detected in these compounds, characterized by a general formula of RHC=N-R1, where R and R1 represent aryl, alkyl, cycloalkyl, or heterocyclic groups that may be substituted in various ways. These compounds are commonly referred to as anils, imines, or azomethines (5,6). It has been determined that the existence of a solitary pair of electrons within a sp2 hybridized orbital of a nitrogen atom within the azomethine group holds significant chemical and biological significance. Schiff bases are commonly regarded as effective chelating agents due to their favorable attributes, including their ease of production, synthetic adaptability, and the distinctive characteristics of the C=N group (7,8). Schiff bases were first discovered by Hugo Schiff in 1864, once he documented the combination of the primary amines with carbonyl compounds (9,10).The discovery of chromium (Cr) can be attributed to the French chemist Vauquelin in 1798, who initially identified it in the Siberian red lead ore known as crocoite. The element in question is classified as a transition metal and is positioned within group VI-B of the periodic table. Its ground-state electronic configuration can be represented as Ar(3d5 4s1). The stable oxidation states of Cr are Cr (III) and Cr(VI). Chromium (Cr) is a vital dietary element necessary for the efficient metabolism of carbohydrates and lipids. Its primary mechanism of action is to enhance the efficacy of insulin. The presence of this substance is distributed during various anatomical regions of the human body, with significant concentrations observed

in the bone, liver, kidneys, and spleen (11). The objective of this investigation is to prepare and characterize a specific Schiff base derivative through the utilization of novel spectroscopic techniques. A novel spectrophotometric technique was devised to quantify trace amounts of Cr (III) ions by investigating the optimal circumstances to identify the ions using a specific reagent. The investigation also encompassed an assessment of the accuracy and precision of the technique. This technique is being employed for the analysis of certain pharmaceutical specimens.

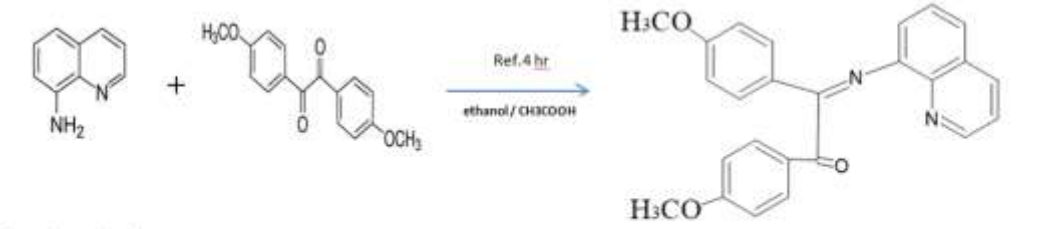
Material and methodology:

Production of Standard Solutions

- By dissolving 0.770g of [$Cr(NO_3)_3$], Cr (III) solution at a concentration of 1 mg/mL is created.100 mL of water that has been distilled with $9H_2O$.
- Solution of sodium hydroxide This solution was created by mixing 0.4 g of sodium hydroxide with 0.1M:100 mL of distilled water.
- Solution of hydrochloric acid 0.1M: To make this solution, 0.40 mL of high-concentration hydrochloric acid (38 percent, 1.19 g/mL) had been diluted in 50 mL of water that had been distilled.
- Reagent solution BMPQYE1 was created by combining 0.1g of the reagent with 100 mL of pure ethanol to create a $2.523x10^{-3}$ amount.

Synthesis of reagent 1,2-bis(4-methoxyphenyl)-2-(quinolone-8-ylimino)ethan-1-one(BMPQYE1)

This Investigating involves the synthesis of reagent 1,2-bis(4-methoxyphenyl)-2-(quinolone-8-ylimino)ethan-1-one In a round-bottomed flask, a solution of 8-aminoquinoline (1 mmol, 0.014g) in 20 mL of ethyl alcohol was combined with a solution of 4,4'-dimethoxybenzil (1 mmol, 0.027g) and 3-4 drops of glacial acetic acid. Subsequently, the concoction was subjected to reflux for a duration of 4 hours at a temp of 80 degrees Celsius with agitated. The aforementioned substance was obtained through a filtration process, followed by a thorough washing with ethyl alcohol, subsequent drying, recrystallization, and final drying at room temp(12,13). as outlined in Scheme 1



8-aminoquinolin 4,4'-dimethoxybenil

1,2-bis(4-methoxyphenyl)-2-(quinolone-8-ylimino)ethan-1-one
(BMPQYE1)

Scheme 1: Preparation of BMPQYE1 reagent

Interferences:

Cations solution of (Pb^{2+}, Hg^{2+}, Mg^{2+}, Ba^{2+}, Co^{2+}, Cu^{2+}, Fe^{3+}, Ni^{2+} and Cd^{2+}) ions (1000µg/ml) have been produced by dissolving, $Co(NO_3)_2.6H_2O$, $Pb(NO_3)_2$, $Cu(NO_3)_2.3H_2O$, $Cd(NO_3)_2.4H_2O$, $Mg(NO_3)_2.6H_2O$, $Fe(NO_3)_3.9H_2O$, $Hg(NO_3)_2.H_2O$, and $Ni(NO_3)_2.6H_2O$ with weight (0.770g, 0.159g, 0.380g,0.275g, 1.055g,0.723g, 0.170g, and 0.495g), respectively in 100 mL of water that had been distilled for each.

Preliminary Investigating

A test tube was utilized to combine 1ml of a solution containing Cr(III) at an amount of 1000 µg/ml with 1ml of a solution containing the ligand BMPQYE1 at an amount of 1000 µg/ml. The addition of the ligand solution to the test tube was carried out drop by drop, while simultaneously shaking the contents, and the resulting color creation was observed and recorded. A precipitate was formed, followed by the addition of drops of nitric acid (0.1 M) to one portion of the combination and drops of NaOH (0.1 M) or HCl (0.1 M) to the other portion, **so as to** explore the influence of the acidic component. The experiment revealed that under acidic conditions, there was a slight decrease in color intensity, whereas under basic conditions, the color created distinctly.

Results and Discussion:

Figure 1 and Figure 2 display the absorption spectra of the reagent and the Cr(III) complexes, respectively. The highest absorbance of the reagent solution was observed at a wavelength of 467 nm, whereas the Cr (III) complexes generated exhibited a max absorbance at a wavelength of 560 nm under pH conditions of 8. This suggests that the generation of the complexes occurs accompanied by a substantial rise in absorbance and a bathochromic change (red shift) that is roughly 93 nm.

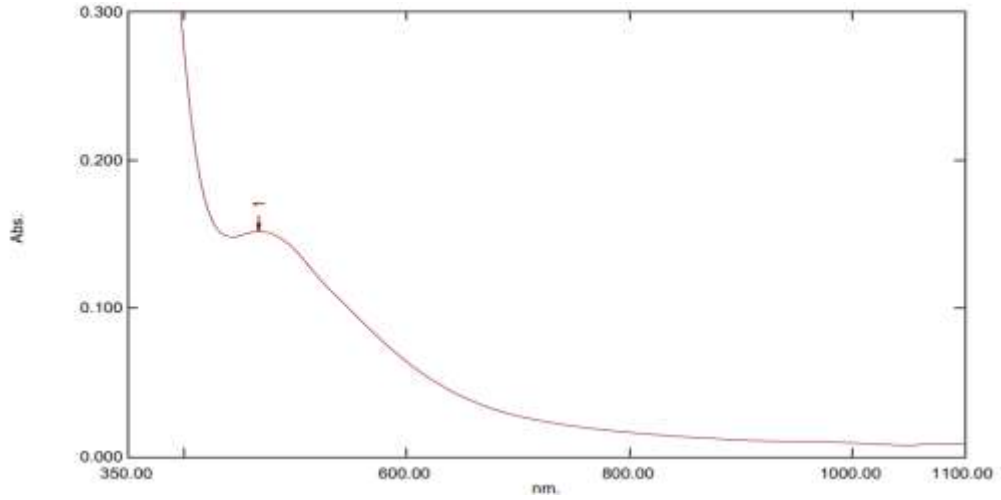


Figure 1: The electronic spectrum data of reagent (BMPQYE1)

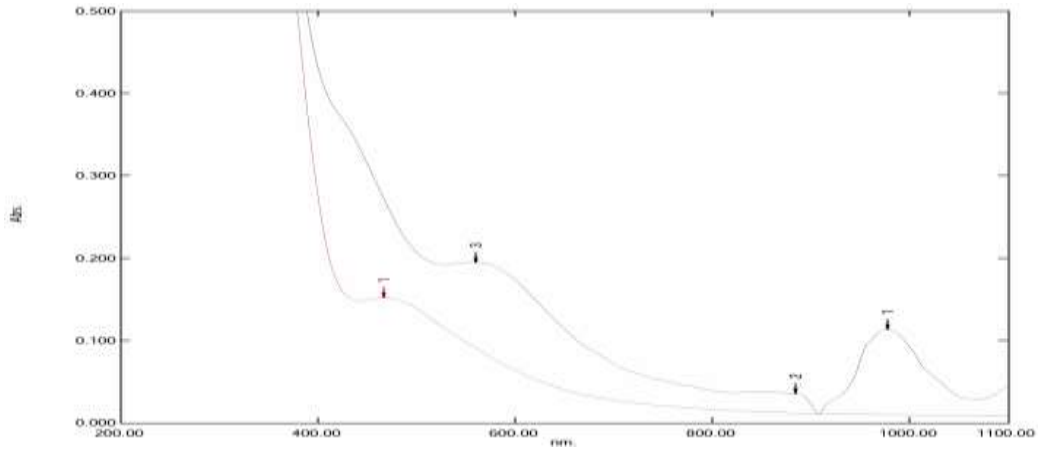


Figure 2: UV-visible spectrum of Cr (III) -BMPQYE1.

The black line represents the spectrum of the Cr (III) complexes, while the red line represents the reagent's spectrum.

Optimization of Reactions Situations:

1- Influence of optimal best of reagent.

Table 2 displays the magnitudes of absorbance of the complexes, which exhibit a gradual increase till reaching a maximum point upon the addition of the solution of the reagent to the Cr(III) complexes. The underlying factor is the interaction between the metallic ion and the reagent, which promotes the formation of the complexes and Outcomes in the highest level of color intensity. The absorption magnitudes exhibit a diminishing trend with increasing volume of the reagent, potentially attributable to the saturation or sufficiency of ion coordination within the reagent or the reagent's insolubility in the solvent.

Table 1: Influence of reagent volume on Cr(III)-BMPQYE1.

Volume of reagent(mL)	0.4	0.5	0.6	0.8	1	1.5	2
Abs.	0.275	0.281	0.286	0.325	0.391	0.376	0.362

2-The influence of pH magnitude:

The absorbance at 560nm was taken into account for solutions containing a fixed concentration of Cr(III) and the reagent BMPQYE1. The solutions were buffered at various pH magnitudes ranging from 2 to 11 utilizing a 0.1M HCl/NaOH solution. The pH of every solution was determined utilizing a pH-meter, and the Outcomes are presented in Figure 3.

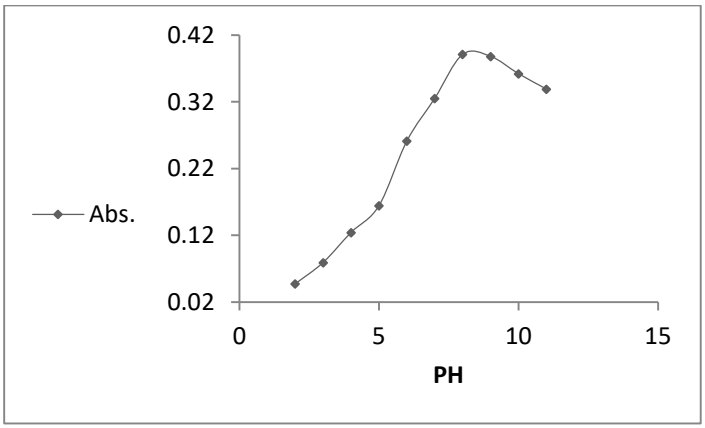


Figure 3: Influence of pH on absorptions of Cr(III) - BMPQYE1

The absorbance has been determined across a pH range of 2 to 11, and the highest absorption has been noticed at pH 8. This finding suggests that the reagent exhibits optimal sensitivity at pH 8.

3-The influence of Duration:

Table 4 presents the subsequent interaction of the reagent with the ion, as observed under ideal situations. The observed Outcomes are indicative of the constitution of the Cr(III) complexes that exhibits stability (as evidenced by absorption magnitudes) for one day subsequent to the commencement of the experiment.

Table 2: The influence of duration on Cr(III) -BMPQYE1

Time (min.)	1	10	20	30	60	120	180	240	1440
Abs.	0.391	0.388	0.387	0.385	0.381	0.279	0.276	0.274	0.270

4-Influence of Temperature:

Table 5 presents the influence of variations in temp difference on the progression of the examined complexes. The Outcomes of this investigation present that within the temp range of 10 to 30 degrees Celsius. The absorption magnitudes of the complexes exhibit their maximum magnitude, resulting in optimal color intensity. Nevertheless, subsequent to this peak, the absorption magnitudes decrease, potentially attributable to reduced stability within the complexes.

Table 3: Temp influence on Cr(III) complexes

Temperature ºC	10	20	30	40	50	60
Abs.	0.364	0.387	0.388	0.383	0.294	0.275

5-Influence of Sequence:

Table 4 presents the utilization of four various addition arrangements to manipulate the order of the reactions amount in a complexes absorbance.

Table 4: Sequence influence on Cr(III) complexes

Sequence of number	Addition Sequence	Abs. of Cr complexes
1	M+L+ pH	0.391
2	L+ M+PH	0.385
3	M+ pH +L	0.322
4	L+ pH + M	0.310

pH = hydrogen ion functions M = Ion of Cr, L = ligand

Based on the Outcomes presented in Table 4, it was observed that the initial sequence employed in this investigation yielded the most favorable outcomes. Conversely, the alternative sequence led to a reduction in the complexes absorption. This decline in absorption may be attributed to the potential influence of the base and acid ions interacting with the metallic materials.

6- Ionic Strength Influence:

So as to investigate the influence of the ion strength on the Cr(III) complexes absorption, the present Investigating aims to identify and analyze the relationship between these variables. Solutions of sodium sulfate salts and sodium nitrate have been generated at various amounts spanning from 0.0005 M to 0.5 M for every salt. Subsequently, 1 mL of these salt solutions was added to complexes Cr(III), as depicted in Table 5.

Table 5: Influence of ionic strength on Cr(III) complexes.

Adding salt	Amount of add salt	Abs.	Added salt	Amount of added salt	Added salt
Na2SO4	0.5	0.284	NaNO3	0.5	0.281
	0.05	0.326		0.05	0.319
	0.005	0.375		0.005	0.358
	0.0005	0.384		0.0005	0.376
Abs. of Cr(III)-(BMPQYE1) without addition = 0.391					

Through the Outcomes shown in Table 5, it was detected that all concentrations of solutions lead to a decrease in the absorption magnitude.

Calibration Curve

The calibration curve for the Ion of Cr was illustrated in Figure 4. Beer's low complied with in the amount range of 5 µg/mL to 80 µg/mL. The molar absorptivity magnitude has been detected to be 0.1971 L/mol.cm, and it was observed that the absorption of the Ion of Cr complicated exhibited a linear relationship with respect to the amount of the metal. Table 6 presents the analytical data pertaining to the quantification of chrome ions utilizing the reagent (BMPQYE1).

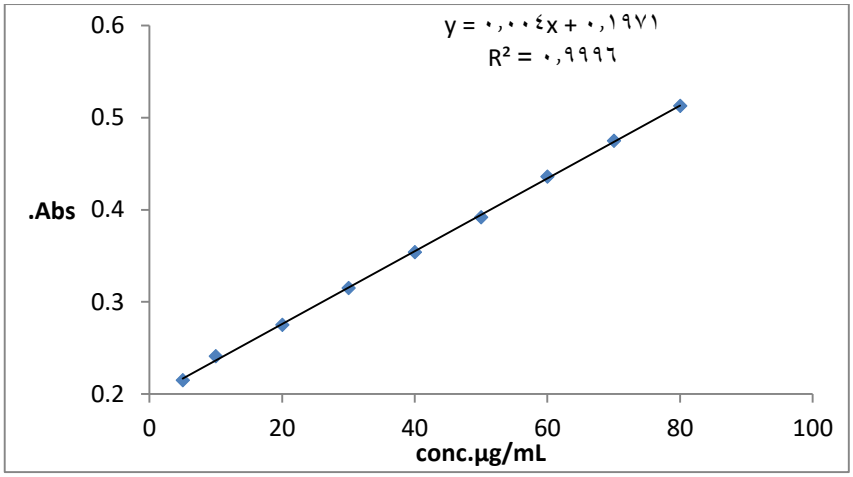


Figure 4: Calibration curve for spectrophotometric determining of Cr(III)

Table 6: Data selected for Cr (III) analyzing

Analytical Data	Magnitude
Molar Absorptivity ($L.mol^{-1}.cm^{-1}$)	0.1971
Slope	0.004
Linear formula	Y=0.004X
Linear ranging (µg/mL)	(5-80)
Sandal sensitivity(µg/cm^2)	0.25
Detection limit (µg/mL)	1.443
Quantification Limits (µg/mL)	4.81
Linearity coefficient (R^2)	0.9996
The coefficient of correlation (r)	0.9997
λ max	560 nm
The products color	dark reddish-brown

Formation Constant and Stoichiometry Estimation:

The Investigating involved the integration of the mole proportion technique with Job's technique for constant variation **so as to** examine the composition of the

resulting complexes. At a pH of 8, it was observed through both approaches that the proportion of metallic ions to reagent (M:L) was 1:3.(14).

1- The Technique of Job

A series of solutions with varying quantities of the Cr(III) ion and the ligand, each having the same amounts, were prepared in solution with an amount of 1.5x10-4 M, as depicted in Figure 5 (15).

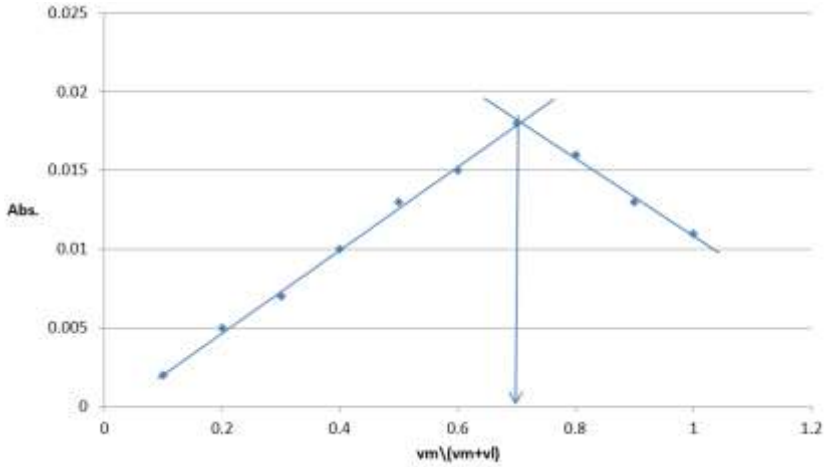


Figure 5: The Technique of Job.

2-Mole Proportion Technique

The Outcomes of this investigation demonstrate that the Ion of Cr types a 1:3 complexes (M-L) with the reagent. This complexes formation was observed by employing an existing and consistent amount of Cr(III) ion, specifically 3.786×10^{-4} M, while gradually increasing the amount of the reagent (BMPQYE1) from 0.000215 to 0.001351. This information is visually represented in Figure 6 (16).

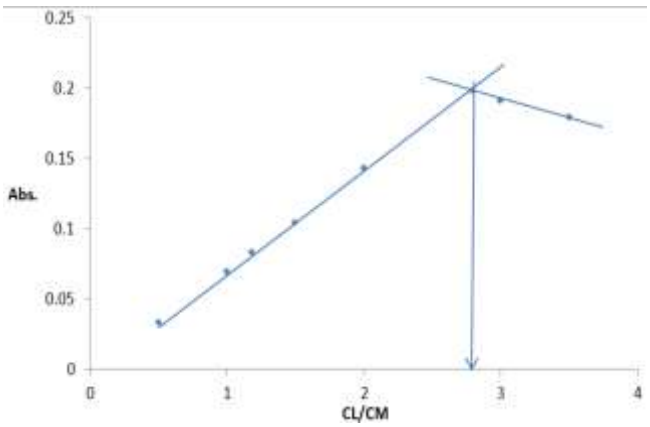


Figure 6: Mole Proportion Technique

Investigation of Stability Complexes (17)

$$M^{+n} + nL \leftrightarrow MLn$$

$$\alpha + nc\alpha \leftrightarrow (1-\alpha)\, c$$

$$K=\frac{[MLn]}{[M^{+n}][L]}$$

$$K=\frac{(1-\alpha)c}{\alpha c(n\alpha c)^n}$$

$$K=\frac{1-\alpha}{n^n\alpha^{n+1}c^n}$$

$$\alpha=\frac{Am-As}{Am}$$

The location of absorption at the stoichiometric amount is denoted as (As), while the max absorption is represented as (Am).

The stability constant has been determined through the application of the mole proportion method, utilizing the equilibrium response of the colored complexes. The Outcomes obtained have been presented in Table 7.

Table 7. The constant of stability complexes magnitudes

Complexes	(Am) magnitude	(As) magnitude	degree of dissociation (α)	Constant of Stability (K)
[Cr (BPQYE1)3]	0.312	0.280	0.103	3.332×10^{10}

The stability of the complexes is demonstrated by the Outcomes presented in Table 7, indicating that the reagent BPQYE1 can be effectively employed for the calculation of the spectrum of Ions of Cr.

The temp influence on the stability constant of the [Cr (BPQYE1)3] complexes:

The present Investigating aimed at examining the stability constant of the Cr(III) ion in the temp range of 100 degrees Celsius to 300 degrees Celsius, in the presence of the reagent BPQYE1. The Outcomes are presented in Table 8.

Table 8. The temps influence on the Cr (III)complexes stability constant.

T (ºC)	T (K)	α	K×10^{10}
10	283.15	0.118	3.242
15	288.15	0.119	3.132
20	293.15	0.120	3.025
25	298.15	0.121	2.923
30	303.15	0.131	2.641

The Outcomes presented in Table 8 present that the influence of temp on the stability of the complexes was minimal.

Thermodynamic Function of Complexes:

The thermodynamic functions ΔG, ΔH, and ΔS were calculated and the corresponding Outcomes are presented in Figure 7 and Table 9.

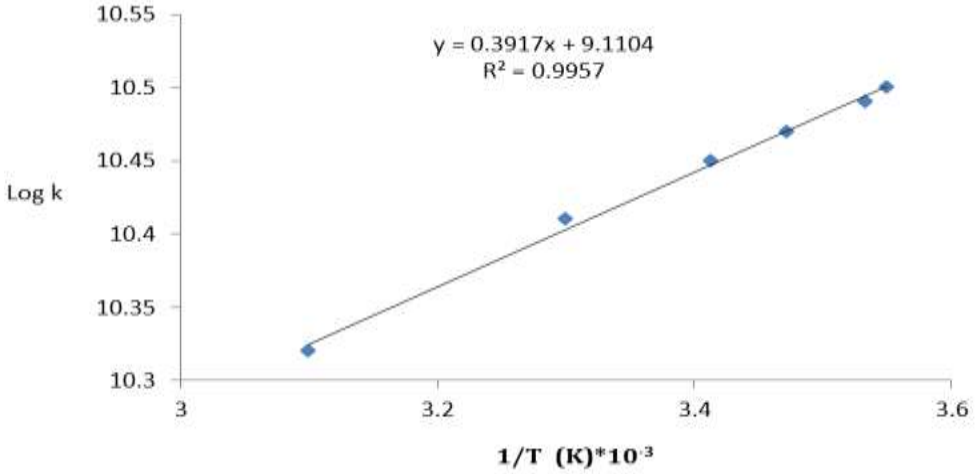


Figure 7: Connection between 1/T and Log K magnitudes of Cr (III) complexes.

Table 9: The temp influence of on Cr (III) complexes thermodynamic function.

T(K)	1/T×10-3(K-1)	log K	ΔH	ΔG (K.J/mole)	ΔS (K.J/mole .K)
283.15	3.532	10.49	-7.499	-56.974	0.1747
288.15	3.470	10.47		-57.897	0.1749

293.15	3.411	10.45		-58.817	0.1750
298.15	3.354	10.5		-59.735	0.1752
303.15	3.298	10.41		-60.481	0.1747

In instances where the temp reduces and the magnitude of enthalpy exhibits negativity, it can be inferred that the response was exothermic. The reduction in complexes generation and the spontaneous nature of the response can be attributed to the free energy negative sign.

Influence of Foreign Ions:

To determine the interference influence, several anion and cation solutions with known concentrations—shown in Tables 10, 11—that served as foreign ions were combined with Cr solution.

Table 10: The influence of cations

Foreign/ ions	**Cations formula structure**	**(50µg/10mL) Abs. post addition of Cations**	**E%**	**(100µg/10mL) Abs. post addition of Cations**	**Error%**
Cd^{2+}	Cd(NO3)2.4H2O	0.235	39.89	0.146	62.65
Ni^{2+}	Ni(NO3)2.6H2O	0.207	47.05	0.188	51.91
Ba^{2+}	Ba(NO3)2	0.287	26.59	0.133	65.98
Fe^{3+}	Fe(NO3)3.9H2O	0.153	60.86	0.124	68.28
Hg^{2+}	Hg(NO3)2.H2O	0.332	30.25	0.332	30.25
Pb^{2+}	Pb(NO3)2	0.235	39.89	0.214	45.26
Mg^{2+}	Mg(N03)2.6H2O	0.252	35.54	0.197	49.61
Ag^{+}	AgNO3	0.308	21.22	0.156	60.10
Cu^{2+}	Cu(NO3)2.3H2O	0.251	35.80	0.132	66.24
Absorbance without interferences = 0.391					

Table 11: The influence of inions

Foreign Ions	Formula structure of Anions	(50µg/10mL) Absorption post addition of Anions	E%	(100µg/10mL) Absorption post addition of Anions	E%
SO_4^{2-}	K_2SO_4	0.188	52.16	0.137	65.13
Br^{1-}	KBr	0.224	43.01	0.148	62.34
SCN^{1-}	KSCN	0.346	11.95	0.327	16.79
Cl^{1-}	KCL	0.214	45.54	0.141	64.12
CrO_7^{2-}	K_2CrO_7	0.267	32.06	0.179	54.45
CO_3^{2-}	K_2CO_3	0.385	2.03	0.381	3.05
CN^{1-}	KCN	0.293	25.44	0.253	35.62
Absorbance without interferences = 0.393					

The majority of ions exhibit an influence on the absorption characteristics of the Cr(III) complexes. The influence of these ions on absorbance can vary based on their specific properties, with certain ions leading to an increase in absorbance while others result in a reduction. The observed outcomes, as depicted in tables 10 and 11, can be attributed to the competitive nature of these ions with Cr(III) in the formation of a complexes with the ligand. This competition leads to a reduction in competition and an enhancement in the sensitivity of this technique towards the Cr(III) ion. The reactions exhibited selectivity and sensitivity for Cr(III). The confirmation of reactions selectivity might be achieved through the utilization of appropriate masking agents.

Masking agents Influence:

Various masking agents were employed in the identification of the Cr compound, with the selection of the optimal masking agent being constrained. The method of detection involved the addition of 1mL of each masking agent, as presented in Table 12, **so as to** assess the competitive interaction between the masking agents and the reagent in relation to the interfering ions and their retention.

Table 12: The masking agent influence on Cr(III) complexes absorption

Masking agent (0.1M)	Abs of Cr(III)complexes

Without Masking agent	0.392
Thiourea	0.219
Ascorbic acid	0.386
Na2EDTA	0.267
Citric Acid	0.260
KCl	0.119
Na2HPO4.12H2O	0.241
Formal dehyde	0.258

The data presented in Table 12 demonstrates that the presence of ascorbic acid does not have a significant influence on the absorption of the generated complexes. This suggests that ascorbic acid has the potential to be employed as a masking agent.

The utilization of an optimal masking agent for the purpose of identifying the Cr(III) complexes in the existence of interference from cations:

The most effective masking agent, as presented in table 12, was utilized to achieve the most accurate determination of the Cr(III) complexes in the existence of cationic ions that may cause interference.

Table 13: The masking agent influences the existence of cations on Cr (III) complexes absorption.

Foreign ions	**Absorption post addition cation (50µg/10mL) and addition masking agent (0.1M)**	**(E%)**
Cd^{2+}	0.470	1.26
Ni^{2+}	0.477	-0.21
Ba^{2+}	0.440	7.56
Fe^{3+}	0.473	0.63
Hg^{2+}	0.480	-0.840
Pb^{2+}	0.475	0.210
Mg^{2+}	0.462	2.940
Ag^{+}	0.491	-3.150
Cu^{2+}	0.453	4.830

Table 13 displays the absorption magnitudes of the Cr(III) complexes in the existence of interfering cations, wherein the addition of a more effective masking agent Outcomes in absorbance magnitudes that closely resemble the absorbance magnitudes observed prior to the introduction of the interference.

Statistical treatment of the Outcomes:

To determine the magnitude of (% RSD), three solutions of Ion of Cr with various amounts were made and the absorbance was measured five times for each amount, as demonstrated in Table14, the relative standard deviation (RSD) has been recognized as a measurement of precision.

Table 14: Computation the magnitude of RSD

Amount of Cr^{+3}present [M]	Amount of Cr^{+3} detected [M]	RSD%	Recovery%	Error%
5.042×10^{-7}	4.807×10^{-7}	0.661	95.33	4.66
2.653×10^{-5}	2.596×10^{-5}	0.759	90.01	2.15
4.807×10^{-5}	5.000×10^{-5}	0.887	104.01	-4.02

Investigation of FT-IR Spectra for reagent and Complexes

The generated reagent and its corresponding complexes were analyzed using Fourier Transform Infrared Spectroscopy (FT-IR). The reagent and Cr(III) complexes were analyzed using FT-IR spectroscopy, as depicted in Figures 8 and 9.

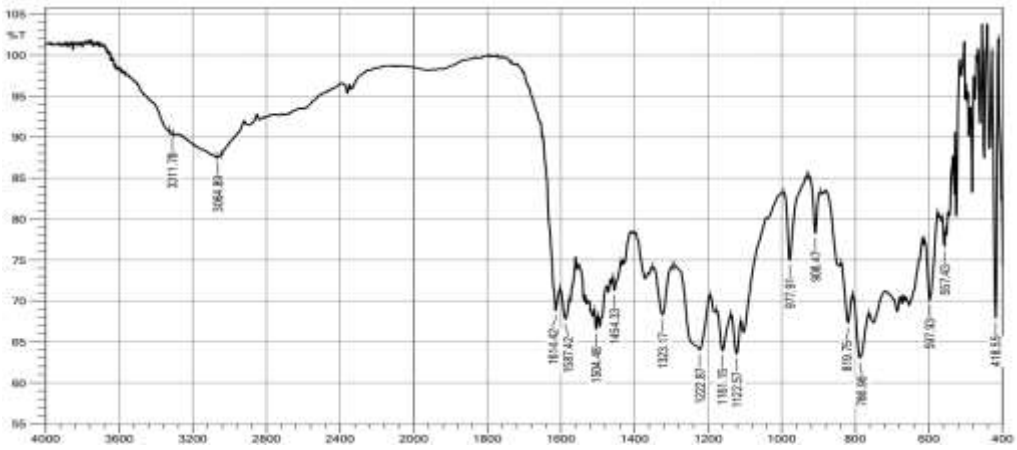


Figure 8: Spectrum-ATR-FTIR of the Reagent (BMPQYE1)

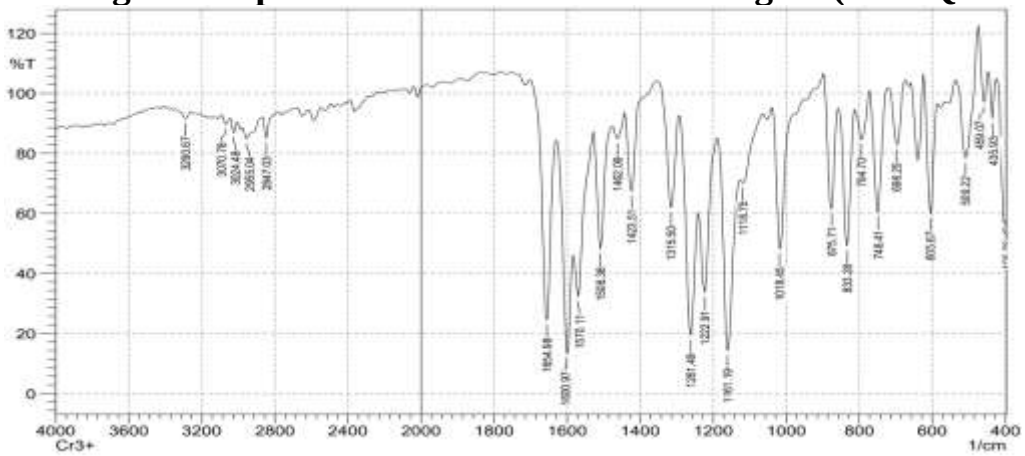


Figure 9: Spectrum-ATR-FTIR of Cr(III) - BMPQYE1

Table 15 presents the ATIR-FTIR Spectra data.

Table 15. Normal frequencies of ATIR-FTIR absorption for reagent and Cr (III) complexes (cm^{-1}).

Bonds	Reagents	Cr (III) complexes
St.(N-H)	3311.78	3290.67
St(C=O)	1614.42	1654.98
St.(C-H)Aromatic	3064.89	3024.48
St.(C=N)	1504.48	1600.97
St.(C=C)	1614.42	1508

The Suggested Figure for the Complexes

In the provided illustration, denoted as Figure 10, The proposal of the intricate arrangement is attributed to the analysis of FT-IR spectra and the determination of stoichiometry through the Job and Mole proportion techniques.

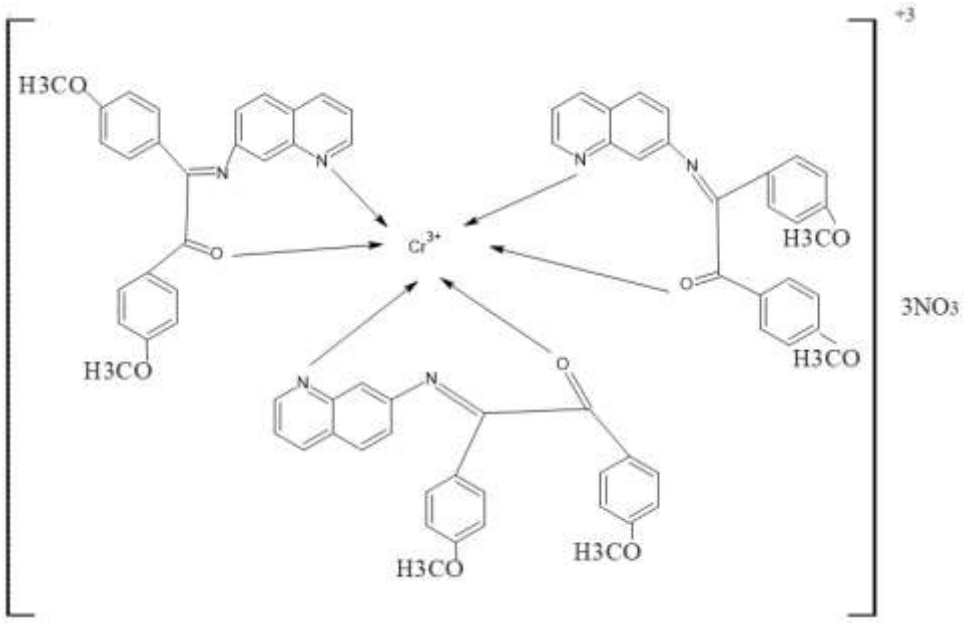


Figure 10: The Cr(III) complexes proposed structure.

Application:

The pharmaceutical specimen, known as AZ-Multiway, was employed for the purpose of quantifying the quantity of Cr(III) present. The specimen underwent digestion with acids utilizing a hydrochloric acid (HCl) (18), process prior to being subjected to a reagent ((BMPQYE1) for the purpose of assessing the Cr amount in the specimen. The Outcomes obtained are presented in table 16.

Table 16: Finding of application for Cr (III) in a drug

Drug	Amount present (µg/mL)	Abs.	Amount detected (µg/mL)	Recovery %	E%
AZ-Multiway	25	0.296	24.725	98.9	1.1

Conclusion:

A cost-effective, efficient, and precise analytical technique was devised for the quantification of Cr(III) in diverse specimen types. Based on the Outcomes obtained, it has been determined that the reagent exhibits the capability to detect Cr (III) in a diverse range of substances. The technique's limit of recovery, accuracy, and detection demonstrate its potential for successful application in the identification of Cr(III).

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