
CHAPTER - I

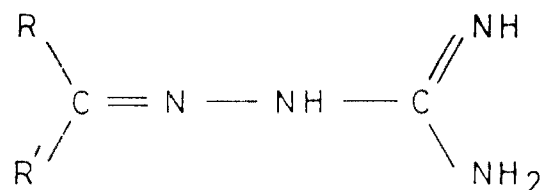
SYNTHESIS AND CHARACTERISATION OF 2-BENZOYL PYRIDINE GUANYLHYDRAZONE

1.1 INTRODUCTION

In the modern chemical knowledge, more and more analytical problems can be solved via complexation reactions. The development of instrumental methods and new analytical instruments have increased the sensitivity of analytical procedures to a very great extent and has helped in the application of highly sensitive organic reagents or reactions. Much of the research has been dedicated to the development of more discriminatory methods of estimation, such as emission spectroscopy, absorption spectroscopy, polarography, mass spectrometry, radiochemical methods, atomic absorption spectroscopy etc. Although all these methods are rapid, spectrophotometric methods are generally preferred as they involve less expensive instrumentation.

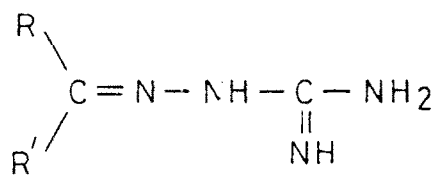
Spectrophotometry is one of the techniques used in exploiting the characteristic property of absorption of light by coordination compounds for trace analysis. Photometric determination of inorganic substances with organic reagents are most frequently based on reactions which yield products absorbing or emitting radiation within the frequency range of electronic spectra. The absorption of UV and visible radiation is thus measured in spectrophotometric applications of organic reagents. These reagents allow the development of highly sensitive, selective and rapid methods for analysis of variety of materials. Solvent extraction and simultaneous photometric determination of metals has proved to be the most useful, as it helps to improve the selectivity and sensitivity.

The ligands containing guanidine group offer an immense analytical potentialities. Schiff's bases are interesting as analytical reagents. Oximes, hydrazones and thiosemicarbazones have been the most widely studied, but guanyldiazones have not previously been studied as analytical reagents. Aldehydes and ketones give easily crystallizable guanyldiazone derivatives and this property is used for the identification of the compounds with C=O function. Guanyldiazones react as chelating ligands and form complexes with transition metal ions. Guanyldiazones were first synthesized by Thiele and Dralle¹. Their importance is due to their pharmacological properties. Their general structure is

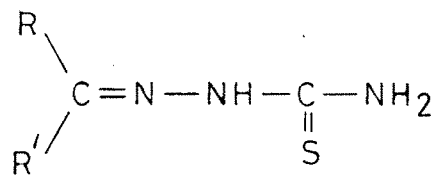


where R and R' are H or any organic radical. The analytical properties of the guanyldiazones depend on the structural features of both R and R'.

Guanyldiazone have a similar structure to that of the thiosemicarbazone.



Guanyldiazone



Thiosemicarbazone

The great affinity to sulphur for coordination of metal ions poses a serious hindrance in the use of thiosemicarbazones as analytical reagents and hence it makes selective methods difficult to establish. The replace-

ment of the sulphur atom of the thiosemicarbazones by the imine group of the guanylhydrazones can increase the selectivity and sensitivity. The reactivity of Schiff's bases is also dependent on the structural characteristics of the aldehyde or ketone which is condensed with the amine, 2-Benzoyl pyridine guanylhydrazone has been used extensively.

Four compounds² and the hydrochloride salts of benzoyl pyridine guanylhydrazones were prepared. They are useful as prolonged acting antihypertensive drugs.

Several compounds were prepared with guanylhydrazones and are useful as bactericides and insecticides³⁻⁵, in treating heart insufficiency and hypersensitivity⁶, in normal leukemia bearing mice as growth inhibitors.

Some such compounds have extremely high bacterial activity and are suitable as internal, external and oral disinfectants⁷, and are used as antiseptics for foods⁸. Several guanylhydrazone complexes have antifungal activity⁹ and act as anticancer and antiinflammatory agents¹⁰. Some compounds possess antileukemic activity, antihistamine activity¹¹, antiviral activity¹² and also antimalarial activity.

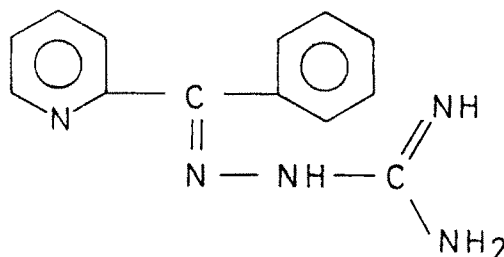
Several steroid guanylhydrazones were prepared^{13,14}. Inhibitory effects of these compounds are shown on *in vitro* growth of some dermatophytes. They are also useful in waste water purification, precipitation of organic anions especially dyes from waste water.

Some aminoguanidine derivatives are used in photographic materials and for paper treatment¹⁵, useful as cationic agents for retention of dyes

and pigments on cellulose fibres and provide dry and wet strength in paper. Guanylhydrazone compounds are cardioactive substances^{16,17} and also used as new pharmaceuticals¹⁸.

These studies have created increased interest in the chemistry of complexes of guanylhydrazones. Because of the several applications of guanylhydrazone to pharmacology, there has been almost a unidirectional growth in the field of physiological activity of the ligands and their ability to form chelates with trace metals. Most of the chemical research is directed towards the structure and bonding in complexes in the solid state. No significant investigation is made about the properties of complexes in solutions and virtually nothing is known of the reactions of the ligands and complexes. It is with this view, that the present authors have chosen this topic.

This chapter deals with the synthesis and characterisation of 2-benzoyl pyridine guanylhydrazone (BPG). The structure of BPG is



The reagent, BPG is used for the photometric determinations of gold, palladium, ruthenium and osmium. The reagent is also useful for the photometric simultaneous determinations of ruthenium and osmium.

1.2 EXPERIMENTAL

1.2.1 Apparatus :

The absorbance measurements were done on a spectronic-20 Bausch and Lomb equipped with matched pair of glass test tubes.

The spectrophotometric work was also done on a Carl Zeiss grating spectrophotometer, Spekol equipped with ZV booster amplifier and EGS and EG photocells. A matched pair of glass cuvettes (10.01 mm) was used.

For pH measurements, Digital pH-meter ELICO, model L1-120 having glass-calomel combination electrode was used. The pH-meter was standardized by using 0.05 M potassium hydrogen phthalate (pH=4.01) and 0.01M borax (pH=9.18) buffers.

All the measurements were done at room temperature $\sim 25^{\circ}$ to 30°C .

1.2.2 Reagents :

All solvents and reagents were of analytical reagent grade.

Glass distilled conductivity water was used throughout the work.

1.2.3 Synthesis of reagent (BPG) :

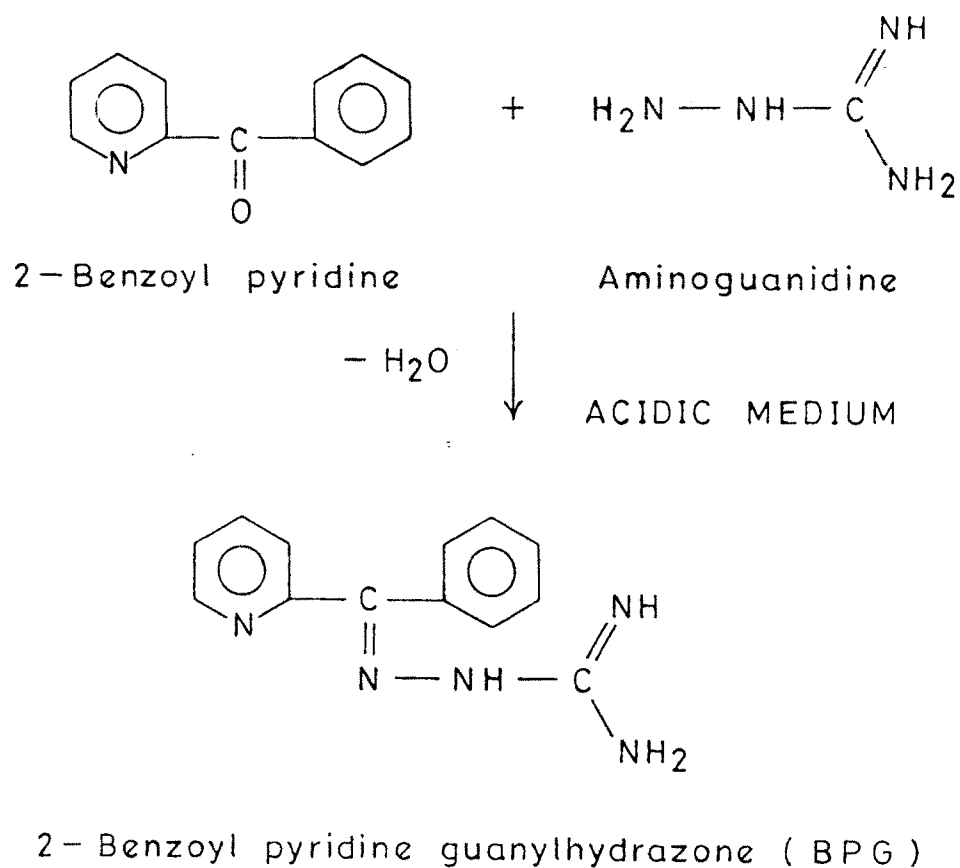
For the synthesis of 2-benzoyl pyridine guanyldiazone (BPG) aminoguanidine bicarbonate was used instead of aminoguanidine dihydrochloride, which simplified the synthesis and gave much better yield.

Aminoguanidine bicarbonate, 2.0 g was completely dissolved in 60% nitric acid (till evolution of carbon dioxide was completely stopped).

2-Benzoyl pyridine, 2.68 g was dissolved in methyl alcohol and the two solutions were mixed together. The pH of the solution was adjusted to 2.0 to 3.0 with dilute hydrochloric acid. The mixture was kept as such for about 24 hours.

To this mixture, concentrated ammonia solution was added to adjust the pH of the solution to 8.0 to 9.0. The yellowish coloured product was formed which was filtered and crystallised from ethanol-water mixture twice to give yellow needles of 2-benzoyl pyridine guanylhydrazone (~ 3.5 g). M.P. = $148^{\circ} - 150^{\circ}\text{C}$. The compound is quite stable for months.

The reaction is



1.2.4 Solubility :

The reagent is sparingly soluble in cold water. It is soluble in methyl alcohol and ethyl alcohol. It is also soluble in acetone, n-butanol, n-propanol and methyl ethyl ketone, but insoluble in chloroform and carbon tetrachloride.

The solution of the reagent in ethanol was stable for months without any deterioration.

1.2.5 Characterisation of BPG :

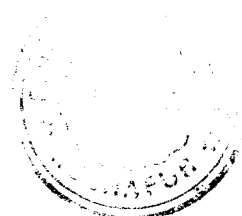
BPG is stable in air. There is no action of light on the reagent. So no special care is required to protect it from light.

The microelemental analysis of the chromatographically purified reagent confirmed the formula to be $C_{13}H_{13}N_5$.

$C_{13}H_{13}N_5$ (BPG)	Carbon	Hydrogen	Nitrogen
Calculated % of elements	65.27	5.44	29.29
Experimentally found % of elements	64.80	5.40	29.80

1.2.6 Ultraviolet Spectra of the Reagent (BPG) :

Figure 1.1 shows the ultraviolet absorption spectra of the reagent (BPG) in ethyl alcohol ($1.255 \times 10^{-5} M$) at different pH values. Absorption maxima and molar extinction coefficients of the reagent at different pH values are given in table 1.1.



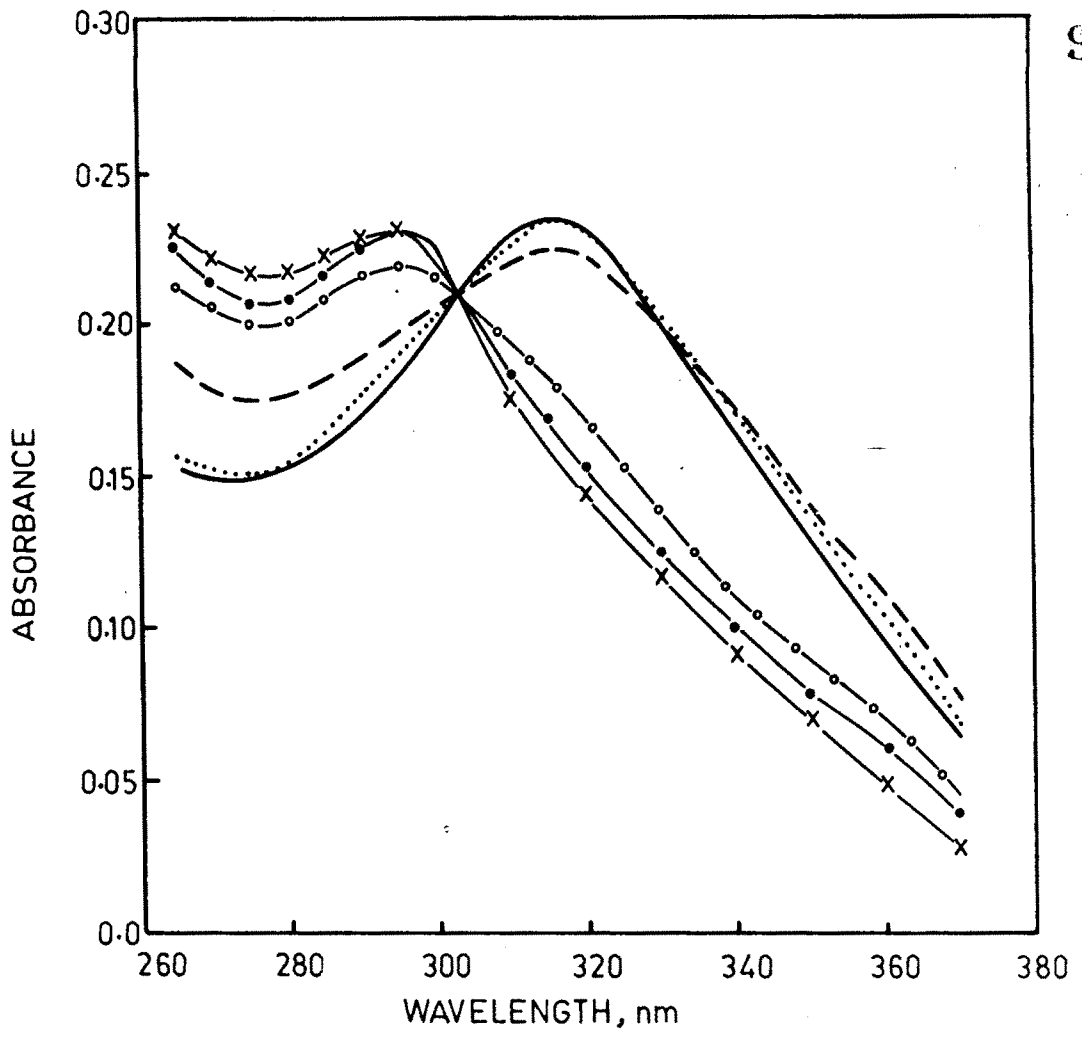


FIG.1.1 ULTRAVIOLET SPECTRA OF REAGENT (BPG).

x—x—x	pH = 7.5	-----	pH = 10.0
●—●—●	pH = 8.0	pH = 11.0
○—○—○	pH = 9.0	————	pH = 12.0

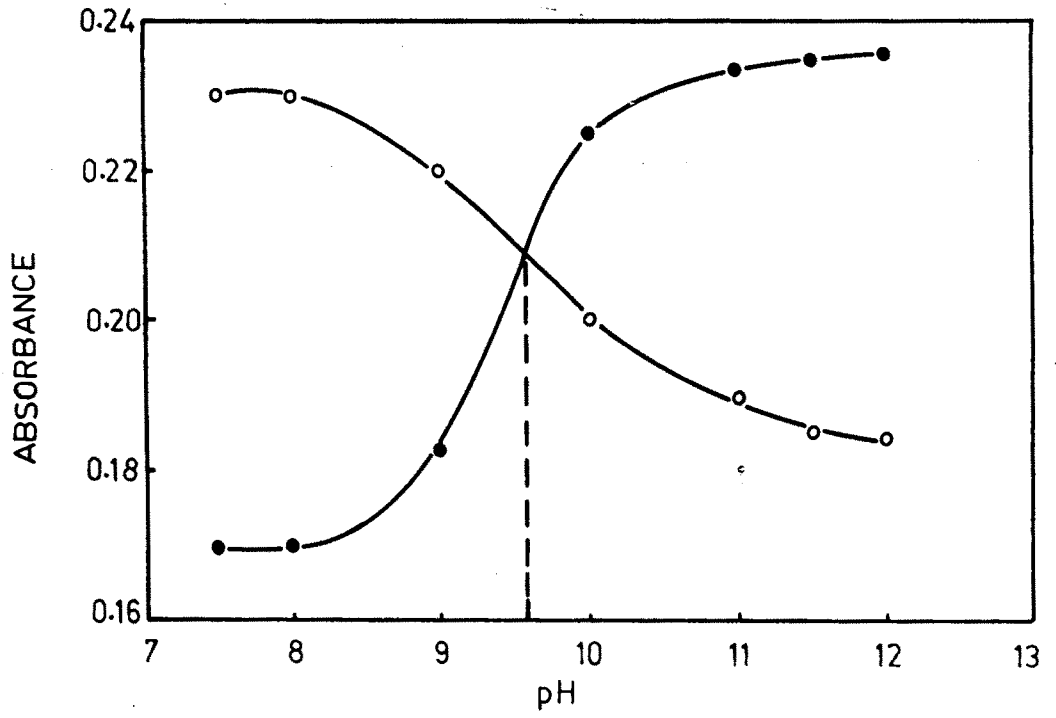


FIG.1.2 DETERMINATION OF pK

○—○—○	295 nm ;	●—●—●	315 nm
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Table 1.1 : Spectral characteristics of the reagent in ultraviolet region.

pH	Absorbance at λ		Molar extinction coefficient, ϵ 1 mol ⁻¹ cm ⁻¹ at λ	
	295 nm	315 nm	295 nm	315 nm
7.5	0.23	0.16	1.832 x 10 ⁴	1.274 x 10 ⁴
8.0	0.23	0.165	1.832 x 10 ⁴	1.321 x 10 ⁴
9.0	0.22	0.185	1.752 x 10 ⁴	1.474 x 10 ⁴
10.0	0.20	0.225	1.593 x 10 ⁴	1.792 x 10 ⁴
11.0	0.19	0.23	1.513 x 10 ⁴	1.832 x 10 ⁴
11.5	0.185	0.235	1.474 x 10 ⁴	1.872 x 10 ⁴
12.0	0.18	0.235	1.434 x 10 ⁴	1.872 x 10 ⁴

1.2.7 Infrared Spectrum of the Reagent (BPG) :

Infrared absorption spectrum of the reagent (BPG) (Figure 1.3) in the range 4000 to 500 cm⁻¹ was run on Perkin Elmer 221 IR spectrophotometer in Nujol mull. The characteristic absorption bands were observed as follows :

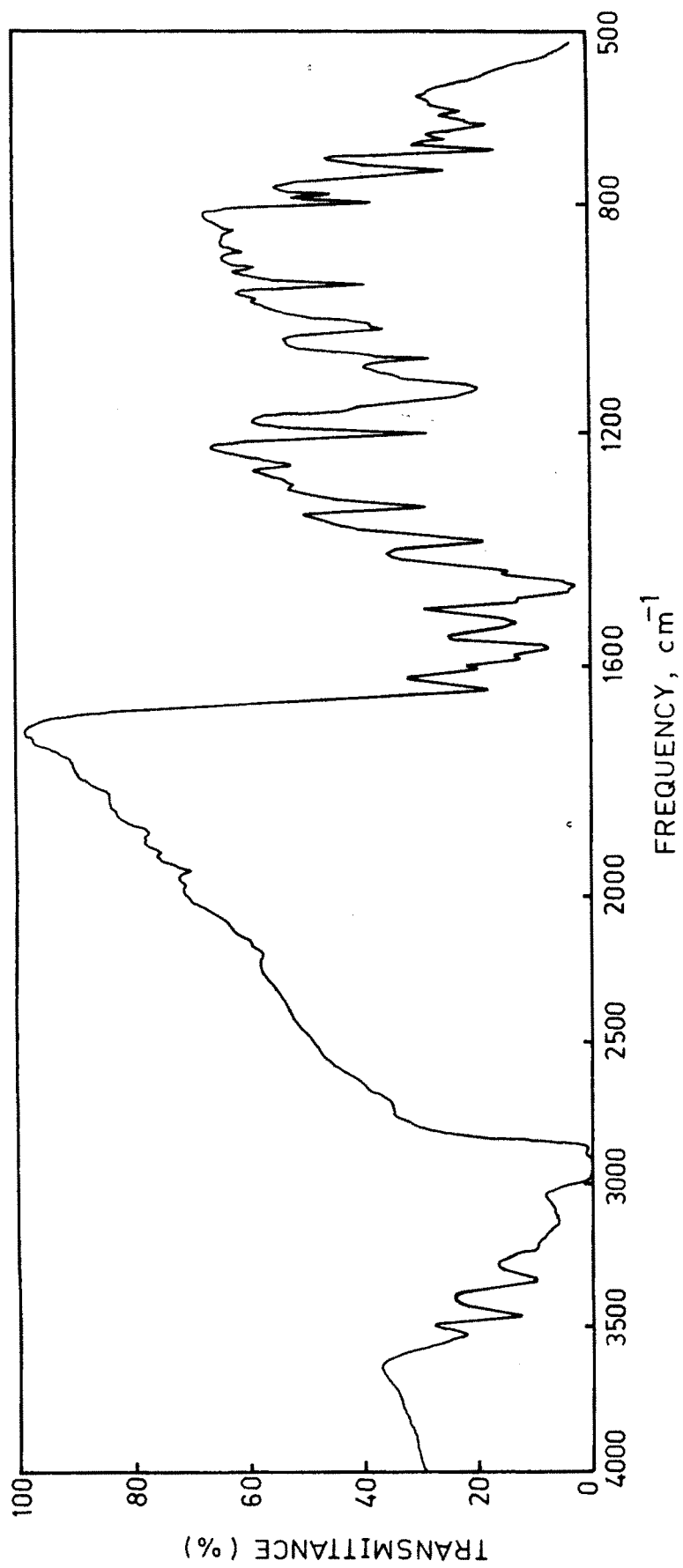


FIG. 1-3 INFRARED SPECTRUM OF REAGENT (BPG).

3530 cm^{-1}	→	NH_2 asymmetric stretch
3460 cm^{-1}	→	NH stretch
3340 cm^{-1}	→	NH_2 stretch symmetric
2960 cm^{-1}	→	CH stretch for methyl group-Nujol band
2930 cm^{-1}	→	CH stretch for methylene groups-Nujol band
2720 cm^{-1}	→	} Overtone Pattern
2200 cm^{-1}	→	
1950 cm^{-1}	→	
1920 cm^{-1}	→	
1890 cm^{-1}	→	
1820 cm^{-1}	→	
1760 cm^{-1}	→	
1650-1590 cm^{-1}	→	NH_2 deformation
1610 cm^{-1}	→	Aromatic ring frequency
1590 cm^{-1}	→	Guanidines - $\text{N}_2\text{C}=\text{N}$ absorption 1500-1670 cm^{-1} due to NH deformation.
1570 cm^{-1}	→	2-substituted pyridine ring
1520 cm^{-1}	→	CN-H bending of secondary aromatic amine
1490 cm^{-1}	→	Aromatic band
1460 cm^{-1}	→	Nujol scissoring band, H-C-H
1390 cm^{-1}	→	Nujol symmetric deformation of terminal methyl group
1120 cm^{-1}	→	Aromatic band-monosubstituted benzene
780 cm^{-1}	→	5 adjacent H wag
740 cm^{-1}	→	4 adjacent H wag for pyridine ring.

1.2.8 Determination of Ionization Constant of BPG :

The ionization constant of the reagent (BPG) was obtained both by spectrophotometric method and by pH-metric method.

(a) By spectrophotometric method :

The ultraviolet spectra of the reagent at different pH values are shown in figure 1.1. At pH 7.5, the ligand base, L is studied spectrophotometrically, which shows the absorption band with λ_{\max} at 295 nm, which lowers in intensity as pH increases. With increasing value of pH, the absorbance at longer wavelength increases, and at pH 12.0, highest intensity band with λ_{\max} at 315 nm appears. All spectral curves pass through the isosbestic point at 303 nm, thereby indicating a dynamic equilibrium between L and its deprotonated species, assuming that at pH 7.5, the molecular form of the ligand is exclusively present and the deprotonated species is absent and that at pH 12.0, the deprotonated species is present exclusively and the molecular form is absent. By using Hinderson equation and also from the half height¹⁹ of the sigmoid curve (Figure 1.2), the pK value for the deprotonation of the ligand is found to be 9.60.

(b) By pH-metric method :

The reagent (BPG), 10.0 ml of 0.01 M was taken in a thermostated titration vessel at $30 \pm 1^\circ\text{C}$ containing 40.0 ml distilled water. The solution was titrated with 0.1M NaOH. An ELICO Digital pH-meter with pH readable to ± 0.01 was used. The ionization constants were calculated from the pH values. The pK was determined by using the formula

$$\text{pK} = \text{pH} + \log \frac{[\text{HA}]}{[\text{A}^-]}$$

HA represents the reagent, BPG. The $\log [H^+]$ values were read from pH-meter.

The titration was repeated until two sets of values differing within ± 0.01 pH units were obtained. The results are given in table 1.2 which show that the pK is 9.60 for 2-benzoyl pyridine guanylhydrazone (BPG).

Table 1.2 : Determination of ionization constant of BPG at $30 \pm 1^\circ\text{C}$
 $[BPG] = 0.01\text{M}; \text{NaOH} = 0.1\text{M} .$

NaOH ml	pH	Stoichiometric concentration		$\log \frac{[HA]}{[A^-]}$	pK
		HA	A ⁻		
0.5	8.04	0.009	0.001	0.954	8.99
1.0	9.03	0.008	0.002	0.602	9.63
1.5	9.53	0.007	0.003	0.368	9.89
2.0	9.74	0.006	0.004	0.176	9.91
2.5	9.88	0.005	0.005	0.000	9.88
3.0	9.97	0.004	0.006	- 0.176	9.79
3.5	10.04	0.003	0.007	- 0.368	9.67
4.0	10.12	0.002	0.008	- 0.602	9.51
4.5	10.17	0.001	0.009	- 0.954	9.21
Mean pK =					9.60

1.2.9 Complex Formation :

The reagent, BPG forms complexes with Au(III), Pd(II), Ru(III) and Os(VIII). A detailed account of the complex formation with these four metals is discussed in the following chapters. Simultaneous determination of Ru(III) and Os(VIII) is also discussed in this dissertation.

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