

Synthesis of Quinoxaline Derivatives and Their Thermal Characterization

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Abstract: The synthesis and chemistry of quinoxalines have been of interest in the past few decades. Substituted quinoxaline have received considerable attention during last few decades as they are endowed with variety of biological activities and have wide range of therapeutic properties. The condensation of 1,2 diamine with 1,2 diketones yielded the quinoxaline. Formation of the compounds were confirmed by various spectral techniques viz., UV, FTIR, ¹H NMR and Mass. Thermal stability of the quinoxalines were also studied.

Keywords: Quinoxaline derivatives, 1,2-diketones, o-phenylenediamine, spectral, thermal studies.

I. INTRODUCTION

Quinoxaline and its derivatives are an important class of benzoheterocycles displaying a broad spectrum of biological activities which have made them privileged structures in pharmacologically active compounds.¹⁻⁴ They are used as dyes, pharmaceuticals and antibiotics such as echinomycin, levomycin and actinoleutin. Some studies were carried out in order to explore the antitumoral properties of quinoxaline compounds.⁵ Recently, quinoxaline and its analogues have been investigated as the catalyst's ligands.⁶ On the other hand quinoxaline constitute the basis of many insecticides, fungicides, herbicides and anthelmintics, as well as being important in human health and as receptor antagonists.^{2,3&7} In addition, quinoxaline derivatives have also found applications in efficient electron luminescent materials,⁸ organic semiconductors,⁹ chemically controllable switches,¹⁰ building blocks for the synthesis of anion receptors,¹¹ cavitands¹² and dehydroannulenes.¹³ Because of wide variety of applications associated with the quinoxaline moieties their synthesis has remained the goal of many research groups over the years. The scope of the present investigation involves to synthesis some of the quinoxaline derivatives and characterized. However, the thermal stability of these derivatives have not been investigated and therefore these compounds have been studied thermo analytically.

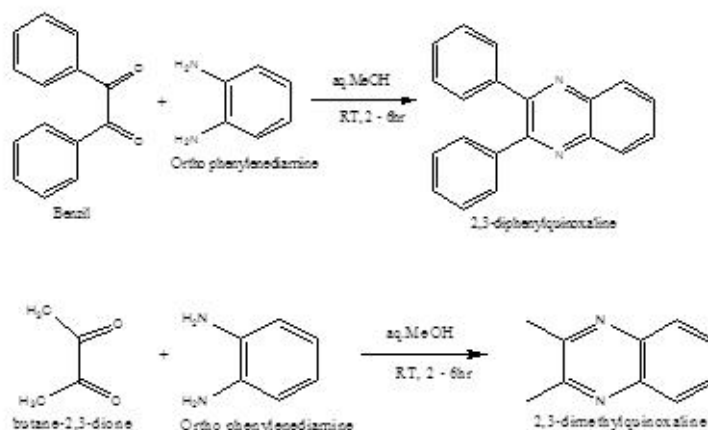
II. MATERIALS AND METHODS

The chemicals benzil, 2,3-butadiene, isatin, sodium pyruvate, ortho-phenylenediamine were purchased from Avra, Chennai, India. Silica gel (TLC and Column grade) were purchased from Merck. Methanol, ethanol, acetone, chloroform, acetic acid were purchased from S.d fine-Chem, India and solvents were purified by according to standard procedure. Melting points were determined using an X-5A melting point measurement instrument. UV spectra were also recorded using Alpha Bruker UV spectrophotometer. FTIR spectra were recorded in KBr disk on a Alpha Bruker FTIR spectrophotometer. ¹H NMR was assayed using Bruker Advanced 300MHz NMR spectrometer, TMS was used as internal standard and CDCl₃, DMSO as solvent. Mass spectroscopy was recorded on ES-FIGIEAN ionization mass spectrometer. Thermogravimetric analysis (TGA) was performed at heating rate of 10°C/min under N₂ atmosphere by using a Perkin-Elmer STA 6000 model.

III. PREPARATION OF QUINOXALINE DERIVATIVES

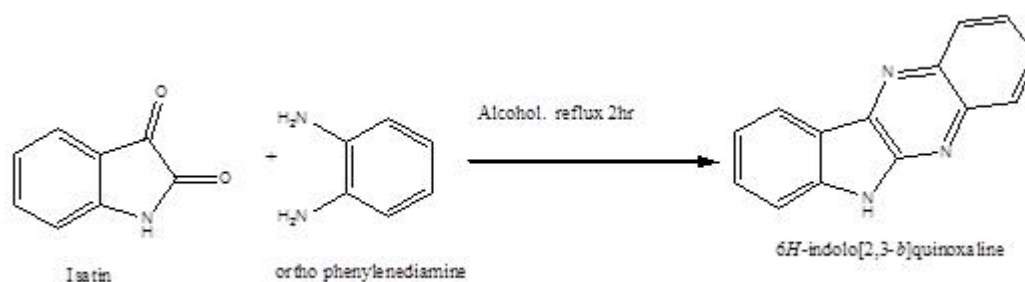
A. 2, 3-Diphenylquinoxaline & 2,3-Dimethylquinoxaline

This compound is synthesis using the method reported earlier⁷. 2mmol of benzil or 2,3-butadiene was dissolved in 3ml of methanol and was made homogeneous by vigorous stirring at room temperature. To this 2mmol of o-phenylenediamine was added in the form of powder. The progress of the reaction was monitored by TLC and stirring was continued until the reaction is completed. Methanol was evaporated under reduced pressure the solid product thus formed was recrystallized from ethanol.



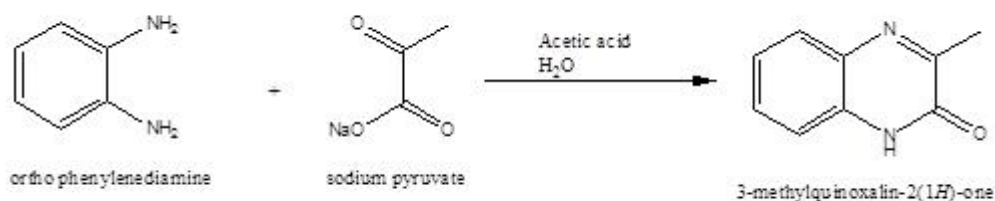
B. Preparation of 2,3-Indoloquinoxaline

Equimolar quantities of Isatin and o-phenylenediamine were refluxed in alcohol for 2hr. The contents were cooled down to separate out the solid. The compound was filtered out and recrystallized from a mixture of ethanol and chloroform (1:1).



C. Preparation of 3-Methylquinoxalin-2-one

To the solution of o-phenylenediamine (3.996g, 37.0mmol) in acetic acid (150ml) and water (200ml), which was heated upto 80°C, to this sodium pyruvate (4.07g, 37.0mmol) was added with intensive stirring. On the next day, the solvents was evaporated under reduced pressure and the crude product was purified by chromatography using silica gel. Hexane-Ethyl acetate (9:1) mixtures were used as eluent.



RESULT AND DISCUSSION

2,3-Diphenylquinoxaline M.P :124-126°C; UV (max, nm) : 244.50, 341.00, 268.50; FTIR (KBr,cm⁻¹): 3051(C-H), 1550(C=N), 1336(C-N), 765(C-H, b); ¹H NMR (CDCl₃, 300MHz) (ppm) : 7.79(2H,dd); 8.2(2H, dd); 7.53(4H,m); 7.35(6H,m); Mass (m/z) : Calculated M.W 282.3, Observed M.W 283.1 (M⁺+1), **2,3-Dimethylquinoxaline** M.P: 94-96°C; UV(max, nm): 245.50, 316.00, 308.50; FTIR(KBr, cm⁻¹): 3003.47(C-H);

1566.69(C=N); 1324.67(C-N); 759.78(C-H, b); ¹H NMR (CDCl₃, 300 MHz) (ppm):7.98(2H, q); 7.67(2H, q); 2.74(6H,s); Mass(m/z): Calculated M.W 158.2, Observed M.W 159.2 (M⁺+1), 2,3-Indoloquinoxaline M.P: 298-300°C; UV(max, nm): 265.50, 351.50, 336.50, 387.00; FTIR(KBr, cm⁻¹): 3059.01(C-H); 1605.21(C=N); 1368.59(C-N); 744.71(C-H, b); ¹H NMR(DMSO, 300MHz) (ppm):12.05(1H,s); 7.75(4H,m); 7.84(2H,m); 8.38(2H, m); Mass(m/z): Calculated M.W 219.3, Observed M.W 220.0 (M⁺+1), 3-Methylquinoxalin-2-one M.P: 235-237°C; UV(max, nm): 229.50, 279.50, 338.50, 207.00; FTIR (KBr, cm⁻¹): 3419.79(N-H), 3008.95(C-H), 1664.57(C=O), 1381.03(C-N), 754.17(C-H, b); ¹H NMR(CDCl₃, 300MHz), (ppm): 7.80(2H,dd); 7.31(2H,m); 2.63(3H,s); Mass(m/z): Calculated M.W 160.1, Observed M.W 160.1(M⁺)

IV. THERMAL STUDIES

Figure 1-4 summarised the thermogravimetric analysis of synthesized quinoxaline derivatives in nitrogen atmosphere at heating of 10⁰C/min in the temperature range of ambient to 800⁰C. The synthesized quinoxaline derivatives were labelled as P1, P5, P11 and P16. Single stage decomposition were observed for all synthesized quinoxaline derivatives of present investigation. 10 % weight loss of P1,P5,P11 and P16 were absorbed at 202 °C, 118°C, 155 °C and 125 °C respectively. Similarly 20% weight loss were absorbed for P1, P11 and P16 in the range of 218 °C - 240 °C. However, the 20% weight loss was absorbed for P5 at around 140 °C. Further 80 % weight loss was notice at 180 °C for P5, 270 °C, 285 °C in respect of P1 and P11, whereas the maximum weight loss (80 %) was absorbed P16 at 560°C. The results of thermal analysis revealed that P5 quinoxaline has considered to be thermally less stable compound than that of others. The gradual weight loss was absorbed for P1 might be due to the presence of two phenyl rings plays a vital role in gradual distortion of weight . Hence the thermal stability in the decreasing order as P16> P11> P1> P5.

TABLE I COMPARATIVE THERMAL STUDIES ON QUINOXALINE DERIVATIVES

Weight loss %	Temperature °C			
	P1	P5	P11	P16
10	202	118	155	125
20	230	140	240	218
30	244	152	255	240
40	252	160	265	258
50	259	165	270	295
60	262	170	275	330
70	265	175	280	410
80	270	180	285	560
90	275	210	-	-
100	-	-	-	-

P1 2,3-diphenylquinoxaline
P11 2,3-indolylquinoxaline

P5 2,3-dimethylquinoxaline
P16 3-methylquinoxaline-2-one

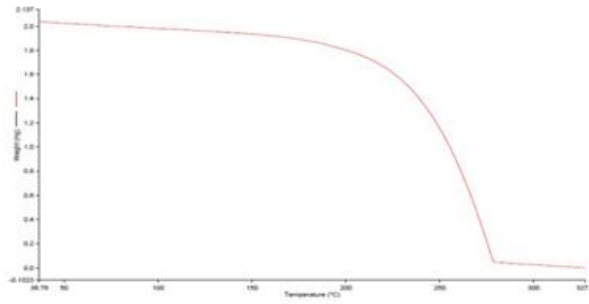


Figure 1: TGA of 2,3-Diphenylquinoxaline

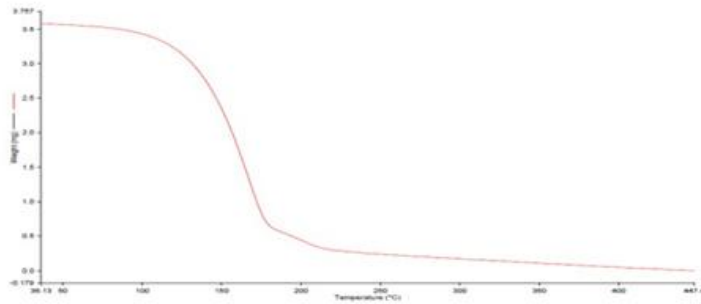


Figure 2: TGA of 2,3-Dimethylquinoxaline

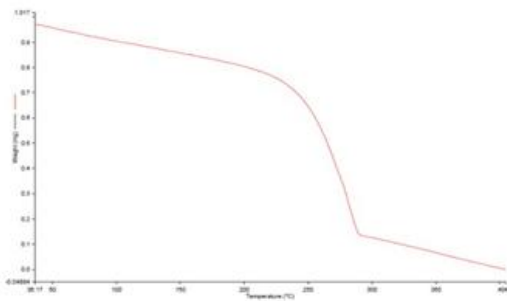


Figure 3: TGA of 2,3-Indoloquinoxaline

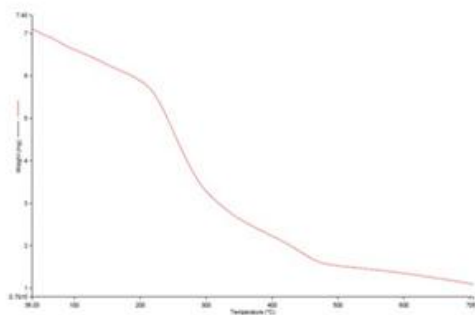


Figure 4: TGA of 3-Methylquinoxalin-2-one

V. CONCLUSIONS

Quinoxaline derivatives were synthesized using 1,2-diketone and ortho phenylenediamine via condensation reaction. Synthesised compounds were characterized by using various spectral techniques viz., UV, FTIR, ¹H NMR, MASS & TGA. The TG curves of compounds in nitrogen atmosphere were recorded at a heating rate of 10°C/min in the temperature range 40-750°C. From TGA weight loss of diphenyl derivatives commenced at 178°C, the weight loss of dimethyl derivatives proceeded at 124°C, the weight loss of 2,3 indoloquinoxaline commenced at 155°C, the weight loss of 3-methyquinoxalin-2-one progressed at 136°C showed that the aromatic compounds are more stable than aliphatic compounds. The stability of the aromatic compounds might be due to +I effect.

VI. ACKNOWLEDGEMENT

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VII. REFERENCES

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