Available online at http://www.journalcra.com

International Journal of Current Research
Vol. 7, Issue, 05, pp.16074-16078, May, 2015

INTERNATIONAL JOURNAL OF CURRENT RESEARCH

ISSN: 0975-833X

RESEARCH ARTICLE

SYNTHESIS AND CHARACTERIZATION OF SOME NOVEL ISOXAZOLES AND PYRAZOLES OF CARBAZOLO AND AZACARBAZOLO FUSED QUINOXALINES

[1]Neelam K. Yadav, [1]D. Kishore and [2,*]Bhawani Singh

[1]Department of Chemistry, Banasthali Vidyapith, Banasthali (Rajasthan)-304 022, India
[2]Department of Pure and Applied Chemistry, University of Kota, Kota (Rajasthan)-324 005, India

ARTICLE INFO

Article History:
Received 24th February, 2015
Received in revised form
09th March, 2015
Accepted 17th April, 2015
Published online 31st May, 2015

Key words:

Carbazole, Azacarbazole, Chalcones, Quinoxalines, Isoxazoles, Pyrazoles.

ABSTRACT

Enol ethers 9(a-b) and chalcones 10(a-b) were synthesized from quinoxalino-oxohydrocarbazoles and oxohydroazacarbazoles 8(a-b) using Japp-Klingemaan and Fischer indole synthesis. Isoxazole derivatives of carbazolo and azacarbazolo fused quinoxalines (12a,13a) and pyrazole derivatives of carbazolo and azacarbazolo fused quinoxalines (12b,13b) were prepared by the cyclocondensation reaction of corresponding enol ethers 9(a-b) and chalcones 10(a-b) with hydroxylamine hydrochloride and hydrazine hydrate respectively. The structures of all the compounds have been established on the basis of their elemental analysis and spectral (IR, ^{1}HNMR and MS) data.

***Citation*:** Neelam K. Yadav, D. Kishore and Bhawani Singh, 2015. "Synthesis and characterization of some novel Isoxazoles and Pyrazoles of Carbazolo and Azacarbazolo fused Quinoxalines", *International Journal of Current Research,* 7, (5), 16074-16078.

INTRODUCTION

Quinoxalines have versatile pharmacogical property such as anti-tumor (Waring *et al*, 2002), anti-bacterial (Khan *et al.,* 2007), anti-fungal (Kotharkar *et al*, 2006), anti-viral (Kleim *et al.,* 1993), anti-inflammatory (Sainz *et al.,* 1999), anti-HIV (Patel *et al.*, 2000), anti-malarial activities (Guillon *et al,* 2004), *etc*. Similarly, pyrazoles and isoxazoles are the key part in numerous heterocyclic compounds and exhibit extensive pharmacological properties like anti-viral, anti-microbial, anti-tumor, anti-fungal, pesticidal, anti-convulsant, anti-histaminic, anti-toxin stimulant, CNS regulant (Solanki *et al.*, 1996), *etc*. In the synthetic point of view, enol ethers and chalcones are versatile intermediates and offer remarkable open door to scientists to synthesize a wide assortment of heterocyclic compounds. The enol ethers, chalcones, *etc.* show considerable potential as substrates for functional group manipulations and sequential carbon-carbon bond forming transformations and received considerable attention recently due to their synthetic importance in the construction of a variety of alicyclic, aromatic and heterocyclic compounds. Ever since, the enol ethers and chalcones have been developed as adaptable synthons (Martel *et al.*, 2003; Anbazhagan *et al.*, 1997; Biddle *et al.*, 2007; Ji, Shun-Jun *et al*, 2004; Potts *et al.,* 1981; Masson *et al*., 1980; Pozgan *et al.*, 2007; Dineen *et al*., 2006. The pyrazole and isoxazole moieties on the quinoxalinocarbazoles and azacarbazoles have been synthesized in the present work by using enol ethers and chalcones.

Corresponding author: Bhawani Singh,
Department of Pure and Applied Chemistry, University of Kota, Kota (Rajasthan)-324 005, India.

Experimental Work

Chemicals were purchased from Aldrich Chemical Company (USA) and solvents were used after purification by distillation. Melting points were determined in open glass capillaries and are uncorrected. The reaction completion of the compounds was checked by TLC on silica gel G plates. IR spectra were recorded on CE (SHIMADZU) FTIR-8400S. ^{1}H NMR spectra were recorded on model AC 300F (Bruker) using $CDCl_3$ and DMSO-d_6 solvents. Chemical shift is expressed in δ ppm. Before analysis, all samples were dried for one hour under reduced pressure. Mass spectra were recorded on a waters QTOF (LCMS) mass spectrometer using Argon/Xenon (6kV, 10mB) gas. Column chromatography was performed on silica gel (Merck). Anhydrous sodium sulfate was used as a drying agent for the organic phase.

Preparation of 6-nitro quinoxaline-2,3-diol (3)

A mixture of 4-nitro-*o*-phenylenediamine (2.03 g, 0.0132 mol) was treated with diethyl oxalate (25 mL). The solid diamine

slowly became red-orange and heat was evolved but solution did not occur. The mixture was, therefore, refluxed until (after about 2 h) its color had faded. After heating about five minutes, a heavy precipitate of was separated out. After cooling, the solid was filtered, washed with alcohol and dried. After recrystallizations from boiling 50% acetic acid (using decolorizing carbon) the product 3 was obtained in fine bright yellow plates. Yield: 68%; m.p. 267^{o}C.

Preparation of 6-amino quinoxaline-2,3-diol (5)

Compound 3 (1.558 g, 0.056 mol) in methanol (25 mL) and conc. HCl (9 mL) were taken in 250 mL round bottom flask and the mixture was heated on water bath. Iron powder (1.28g, 0.022 mol) was added portion wise during one hour with its continuous stirring. The reaction mixture was further refluxed for 1 h and then filtered hot. The filtrate was neutralized with aqueous ammonia (50%) until the dark brown solid has completely separated out and the organic part was extracted with the ethyl acetate. Evaporation of the solvent under reduced pressure gave the crude mass which was recrystallized from ethanol to give fine dark brown compound **5.** Yield 65%; m.p.310°C; IR (KBr) cm^{-1}: 3010 (C-H str.), 3490 (O-H str.), 3250 (N-H str.), 1580 (C=N str.), 1247 (N-H str.), 1130 (C-N str.), 780 (C-H str.); ^{1}H NMR, (δ ppm in $CDCl_3$): 11.87 (s,2H,OH), 7.42 (d,1H,CH), 7.27 (s,1H,CH), 6.88 (d,1H,CH), 5.32 (s,2H,NH_2); MS: m/z [M^+]= 177.05.

General method for the preparation of 3-hydroxymethylidine cyclohexanone and 1-benzyl-3-hydroxymethylidine-4-piperidone (7a-b)

A mixture of NaOEt (0.6 g, 0.01 mol), dry ether (10 mL), redistilled cyclohexanone (0.9 g, 0.01 mol) or 1-benzylpiperidine-4-one (1.8 g, 0.01 mol), ethyl formate (10 mL) were placed in a two necked flask equipped with a stirrer and stopper. The reaction was initiated by the addition of 3 mL of ethanol to the stirred mixture which was then placed in an ice cold water bath. Stirring was continued for 6 h. After standing overnight, 2.5 mL of ethanol was added. The mixture was stirred for additional 1h. After the addition of 20 mL of water, the reaction mixture was extracted with ether. The aqueous layer was acidified with 5 mL of 6N HCl and the mixture was extracted twice with ether. The ether solution was washed with 5 mL saturated NaCl solution. The compound was dried by the addition of anhydrous $MgSO_4$. The ether was evaporated on the steam bath. The residue was distilled under reduced pressure to give 7a and 7b respectively**.**

Preparation of 2,3-dihydroxy-9,10-dihydro-6*H*-pyrazino[2,3-b]carbazol-7(8*H*)-one (8a-b)

(a) Preparation of hydrazone

A solution of **6** (1.6 g, 0.005 mol) in aqueous hydrochloric acid (0.5 mL conc. HCl in 1 mL water) was treated with a cold saturated solution of sodium nitrite (0.1 g in 0.2 mL water) while the temperature was kept at 0-5ºC. It was then added portion wise to an ice cooled mixture containing 7a or 7b (0.05 mol), sodium acetate trihydrate (0.3 g), methanol (1.5 mL) and water (1 mL) over a period of 30 min with stirring. The contents were allowed to stand for further 30 min and the resulting solid mass was filtered, washed with water, dried and recrystallized from ethanol to give the hydrazone. Hydrazone was used as such in the second step without further purification.

Cyclisation of hydrazone

A solution of hydrazone (1.7 g, 0.005 mol) in a mixture of acetic acid (0.5 mL) and hydrochloric acid (0.2 mL) was refluxed on an oil bath preheated to 125-130ºC for 0.5 h. The content were then cooled and poured in ice cooled water with continuous stirring. The separated brown solid 8a was purified by passing through a column of silica gel using 50 % benzene in pet. ether as eluant to give 8a. Similarly compound 8b was prepared. (8a): Yield 70%; m.p. 300-02°C; IR (KBr) cm^{-1}: 3460 (O-H str.), 3309 (N-H str.), 2940 (C-H str.), 1705(C=O str.), 1635 (C=N str.), 1335 (N-H str.), 1070 (C-N str.), 945 (C-H str.); ^{1}H NMR, (δppm in $CDCl_3$): 11.96 (s,1H,NH), 11.87 (s,2H,OH), 8.07 (s,2H,CH), 3.01 (t,2H,CH_2), 2.58 (t,2H,CH_2), 2.11 (m,2H,CH_2); MS: m/z [M^+]= 269.08 (8b): Yield 50%; m.p. 312-15°C; IR (KBr) cm^{-1}: 3510 (O-H str.), 3310 (N-H str.), 2930 (C-H str.), 1730 (C=O str.), 1660 (C=N str.), 1332 (N-H str.), 930 (C-H str.); ^{1}H NMR, (δppm in $CDCl_3$): 11.87 (s,2H,OH), 11.63 (s,1H,NH), 8.07 (s,2H,CH), 7.33-7.23 (m,5H,ArH), 4.51 (s,2H,CH_2), 3.39 (t,2H,CH_2), 2.63(t,2H,CH_2); MS: m/z [M^+]= 360.12.

Preparation of 8-(ethoxymethylene)-2,3-dihydroxy-9,10-dihydro-6*H*-pyrazino[2,3-b]carbazol-7(8*H*)-one (9a-b)

To a solution of 10% sodium methoxide (10 mL) in benzene (50 mL) at 0ºC, a solution of ethyl formate (10 mmol) in dry benzene (25 mL) was added and 8a (2.25 g, 10 mmol) in benzene (25 mL) was added. The mixture was stirred for 4 h at room temperature and allowed to stand. It was then diluted with cold water, acidified with dil. HCl and extracted with ether. The solvent was evaporated and the resultant compound was recrystallised from ethanol to give pure 9a. Similarly, compound 9b was prepared. (9a):Yield 57%; m.p. 300-02°C; IR (KBr) cm^{-1}: 3550 (O-H str.), 3420 (N-H str.), 2920 (C-H str.), 1670 (C=O str.), 1490 (C=N str.), 1330 (CN str.); ^{1}H NMR, (δppm in $CDCl_3$): 11.87 (s,2H,OH), 11.19 (s,1H,NH), 8.07 (s,2H,CH), 6.09 (s,1H,CH), 4.49 (q,2H,CH_2), 3.03 (t,2H,CH_2), 2.83 (t,2H,CH_2), 1.21 (t,3H,CH_3); MS: m/z [M^+]= 325.11 (9b): Yield 60%; m.p. 288-90°C; IR (KBr) cm^{-1}: 3550 (O-H str.), 3450 (N-H str.), 3000 (C-H str.), 1590-1450 (C=C str.), 1610 (C=O str.), 1550 (C=N str.), 1330 (C-N str.); ^{1}H NMR, (δppm in $CDCl_3$): 11.87 (s,2H,OH), 11.63 (s,1H,NH), 8.07 (s,2H,CH), 7.33-7.23 (m,5H,ArH), 7.11 (s,1H,CH), 4.49 (q,2H,CH_2), 3.73 (s,1H,CH_2), 4.71 (s,1H,CH_2), 1.21 (t,3H,CH_3); MS: m/z [M^+]= 416.15

Preparation of 8-benzylidene-2,3-dihydroxy-9,10-dihydro-6*H*-pyrazino[2,3-b]carbazol-7(8*H*)-one (10a-b)

A mixture of 8a (2.3 g, 0.01 mol), benzaldehyde (1.2 g, 0.01 mol) and fused sodium acetate (1.2 g, 0.015 mol) in glacial acetic acid was refluxed for 5 h. The reaction mixture was cooled in an ice water. The resulting solid was filtered, washed with water and recrystalised from aqueous ethanol to give pure

compound 10a. Same procedure was followed in the preparation of compound 10b. (10a): Yield 68%; m.p. 298-99°C; IR (KBr) cm^{-1}: 3530 (O-H str.), 3460 (N-H str.), 2980 (C-H str.), 1670 (C=O str.), 1350 (C-N str.),730 (C-H str.); ^1H NMR, (δppm in $CDCl_3$): 11.87 (s,2H,OH), 11.18 (s,1H,NH), 8.07 (s,2H,CH), 7.60-7.33 (m,5H,ArH), 7.25 (s,1H,CH), 3.03 (t,2H,CH_2), 2.83 (t,2H,CH_2); MS: m/z [M^+]= 357.11 (10b): Yield 70%; m.p. 260-61°C; IR (KBr) cm^{-1}: 3530 (O-H str.), 3430 (N-H str.), 2950 (C-H str.), 1600 (C=O str.), 1530 (C-N str.),770 (C-H str.); ^1H NMR, (δppm in $CDCl_3$): 11.87 (s,2H,OH), 11.63 (s,1H,NH), 8.07 (s,2H,CH), 7.60-7.23 (m,10H,ArH), 7.45 (s,1H,CH), 4.71 (s,2H,CH_2), 3.73 (s,2H,CH_2); MS: m/z [M^+]= 448.47

Preparation of 5,12-dihydro-4*H*-isoxazolo[3,4-a]pyrazino[2,3-h]carbazole-8,9-diol (12a)

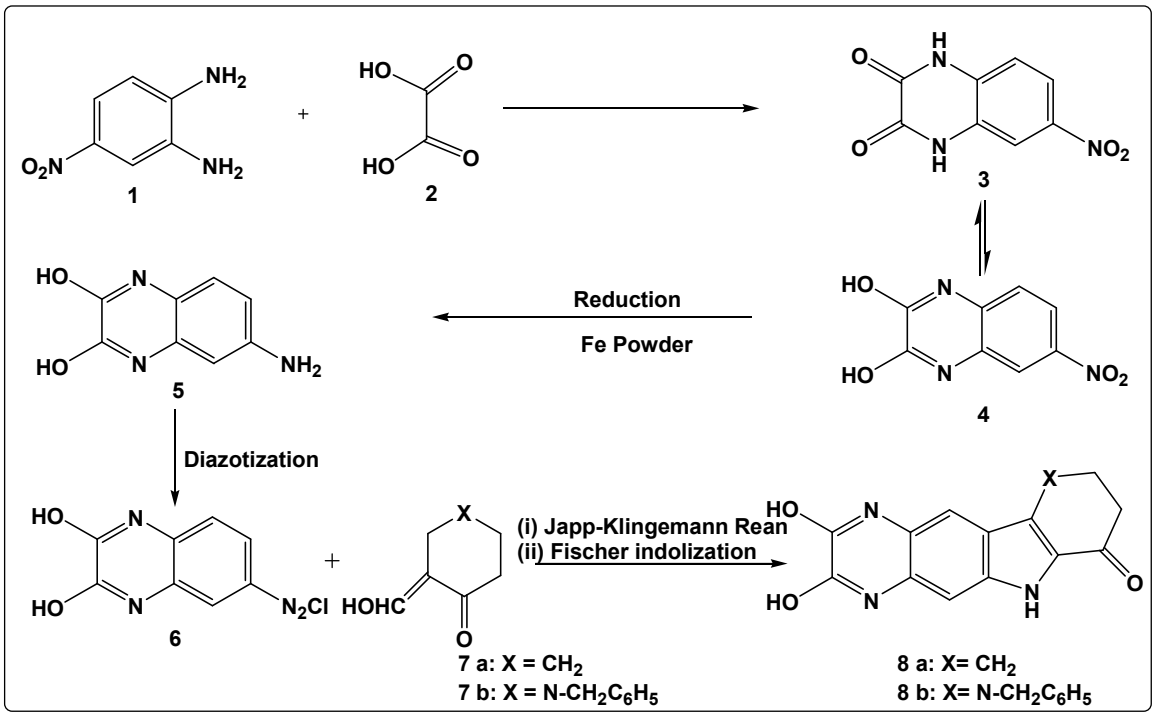
A solution of 9a (2.8 g, 10 mmol) in glacial acetic acid (25 mL) was stirred with hydroxylamine hydrochloride (1.3 g, 15 mmol) for 6-8 h at 70-80ºC. The solvent was removed under reduced pressure and the residue was diluted with water. It was extracted with ethyl acetate, washed with saturated $NaHCO_3$ solution, water, brine solution and dried over Na_2SO_4. The solvent was removed and the crude product was purified by recrystallization from ethanol to give 12a. Same procedure was followed in the preparation of compound 12b by using of hydrazine hydrate at place of hydroxylamine hydrochloride. (12a): Yield 52%; m.p. 230-32°C; IR (KBr) cm^{-1}: 3490 (O-H str.), 2950 (C-H str.), 1690 (C=N str.),770 (C-H bending), 1310 (C-N str.); ^1H NMR, (δppm in $CDCl_3$): 11.87 (s,2H,OH), 11.63 (s,1H,NH), 8.07 (s,2H,CH), 7.60-7.23 (m,10H,ArH), 7.45 (s,1H,CH), 4.71 (s,2H,CH_2), 3.73 (s,2H,CH_2); MS: m/z [M^+]= 294.08. (12b): Yield 52%; m.p. 230-32°C; IR (KBr) cm^{-1}: 3490 (O-H str.), 3430 (N-H str.), 2950, (C-H str.), 1600 (C=O str.), 1530 (C-N str.),770 (C-H str.); ^1H NMR, (δppm in $CDCl_3$): 11.87 (s,2H,OH), 11.34 (s,1H,NH), 8.07 (s,2H,CH), 8.1 (s,1H,CH), 2.93 (t,2H,CH_2), 2.87 (t,2H,CH_2); MS: m/z [M^+]= 448.47.

Preparation of 3-phenyl-3a, 4, 5, 12-tetrahydro-4*H*-isoxazolo [3,4-a]pyrazino[2,3-h] carbazole-8,9-diol (13a)

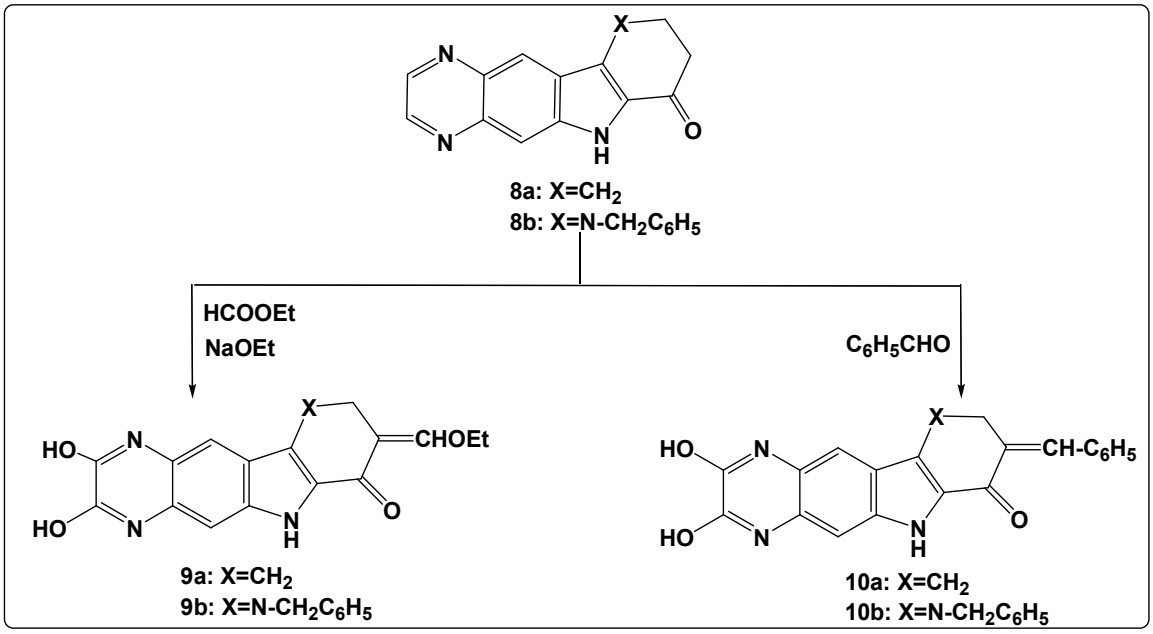
Anhydrous sodium acetate (1.0 g, 0.001 mol) dissolved in a minimum amount of acetic acid was added to a solution of hydroxylamine hydrochloride (0.5 mL, 0.01mol) in ethanol. This was added to a solution of 10a (3 g, 0.01 mol) in ethanol (15mL). The mixture was refluxed on a sand-bath for 2-3 h. The contents were poured into crushed ice, filtered and recrystallised from ethanol to give 13a. Same procedure was followed in the preparation of compound 13b by using of hydrazine hydrate at place of hydroxylamine hydrochloride. (13a): Yield 62%; m.p. 251-52°C; IR (KBr) cm^{-1}: 3520 (O-H str.), 3132 (N-H str.), 3010 (C-H str.), 2983, 2854 (C-H str.), 1728 (C=N), 1604-1450 (C=C), 1337 (C-N str.), 1342 (C-H str.); ^1H NMR, (δppm in $CDCl_3$): 11.87 (s,2H,OH), 11.63 (s,1H,NH), 7.38-7.36 (m,5H,ArH), 4.5 (d,1H,CH), 2.68 (t,2H,CH_2), 2.0 (q,1H,CH), 1.74 (q,2H,CH_2); MS: m/z [M^+]= 370.11 (13b): Yield 70%; m.p. 248-50°C; IR (KBr) cm^{-1}: 3510 (O-H str.), 2980 (C-H str.), 1620 (C=N str.), 1510-1400 (C=C), 1310 (C-N str.), 780 (C-H str.); ^1H NMR, (δppm in $CDCl_3$): 11.87 (s,2H,OH), 7.0 (s,1H,NH), 7.40-7.27 (m,5H,ArH), 3.9 (d,1H,CH), 2.68 (t,2H,CH_2), 2.1 (q,1H,CH), 1.6 (q,2H,CH_2); MS: m/z [M^+]=369.12.

RESULTS AND DISCUSSION

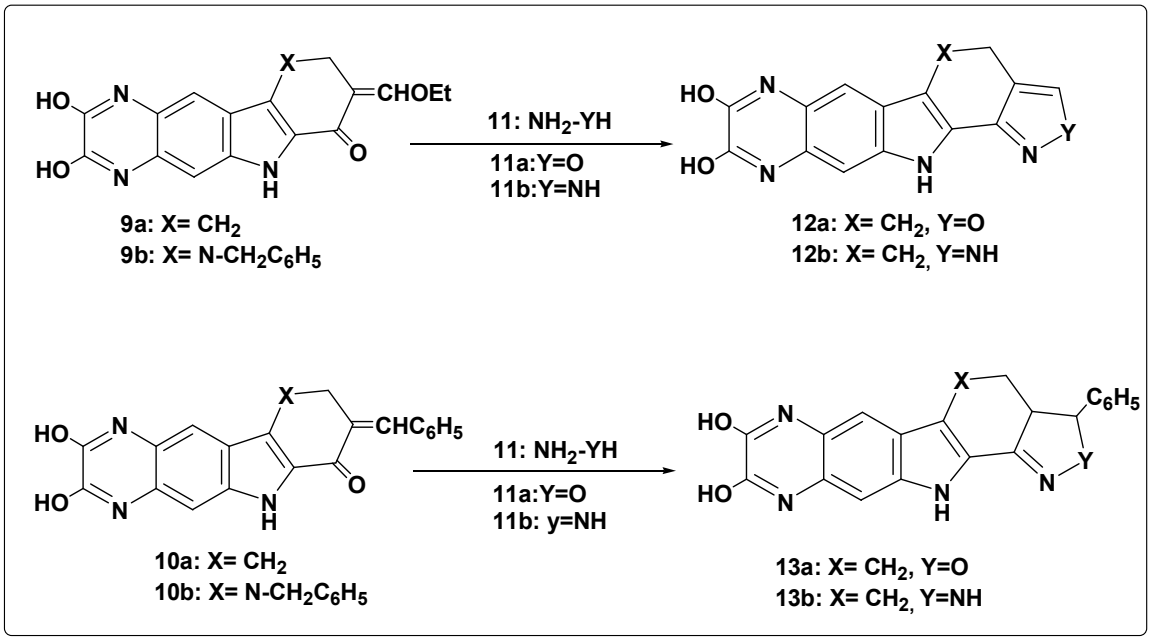
In the present work, the condensation of 4-nitro-*o*-phenylenediamine (1) with oxalic acid (2) followed by reduction of the nitro group of 4 with iron powder in the subsequent step to give corresponding amine 4 (Thakuria *et al.,* 2006). Formation of the compound 5 from 4 was confirmed by chemical tests as well as by IR spectra in which peaks of nitro group of compound 4 at 1560 and 1346 cm^{-1} disappeared and peaks of amino group of compound 5 at 3472 and 3368 cm^{-1} appeared. Compound 5 was diazotized with $NaNO_2$ and HCl at temperature 0-5°C which was allowed to undergo Japp-



Scheme-1



Scheme-2



Scheme-3

Klingemann reaction (Prasad *et al.*, 1994) with 2-hydroxymethylidine cyclohexanone (7a) and 3-hydroxymethylidine piperidone (7b) generated *in situ* from the reaction of cyclohexanone and piperidone with ethyl formate in presence of NaOEt. This underwent concomitant ring closure with acid under the conditions of Fischer indolization furnished the compounds 8(a-b) [Scheme-1] which in the subsequent step was treated separately with (i) ethyl formate + sodium ethoxide (Padmawati *et al*., 2000) and (ii) benzaldehyde (Singh *et al.*, 2004) to give (9a-b) and (10a-b) respectively [Scheme-2]. Formation of the enol ethers and chacones was confirmed by the ^{1}H NMR signals in which signals of CH_2 around 4.51-2.58δppm of compounds 8a-b were disappeared in the enol ethers (9a-b) and chalcones (10a-b). The synthesis of pyrazole and isoxazole derivatives was carried out by the cyclocondensation of enol ethers and chalcones with hydrazine hydrate and hydroxylamine hydrochloride respectively. Thus, when 9(a-b) and 10(a-b) were allowed to react with hydroxylamine hydrochloride in presence of a base, the corresponding isoxazole derivatives 12a and 13a were obtained in good yield. In a likewise manner, 9(a-b) and 10(a-b) reacted smoothly with hydrazine hydrate to yield the corresponding pyrazole derivatives 12b and 13b respectively [Scheme-3]. Cyclization of the compounds (9a-b and 10a-b) to the compounds (12a-b and 13a-b) was confirmed by the IR spectra in which peaks of the carbonyl group around 1670 cm^{-1} of the

compounds (9a-b and 10a-b) disappeared in the compounds (12a-b and 13a-b).

Conclusions

A practical and efficient synthesis isoxazole derivatives of carbazolo and azacarbazolo fused quinoxalines (12a,13a) and pyrazole derivatives of carbazolo and azacarbazolo fused quinoxalines (12b,13b) by the cyclocondensation reaction of corresponding enol ethers 9(a-b) and chalcones 10(a-b) with hydroxylamine hydrochloride and hydrazine hydrate respectively has been reported.

Acknowledgement

The authors are thankful to SAIF, Punjab University Chandigarh for providing the ^{1}H-NMR, and MASS data of the compounds. They are thankful to the department of pharmacy Banasthali University. Authors are highly thankful for financial support provided by Department of Science and Technology (DST), New Delhi for the project, "Banasthali Center for Education and Research in Basic Sciences" under their CURIE (Consolidation of University Research for Innovation and Excellence in Women Universities) program.

REFERENCES

Anbazhagan, M., Dixit, A.N. and Rajappa, S. 1997. Reaction of lactim ethers and lactim sulfides with electrophiles: Attack at nitrogen followed by ring-opening under neutral conditions. *Journal of Chemical Society,* 1, 2421-2424.

Biddle, M.M., Lin, M. and Scheidt, K.A. 2007. Catalytic enantioselective synthesis of flavanones and chromanones. *Journal of American Chemical Society*, 129(13), 3830-3831.

Dineen, T.A., Zajac, M.A. and Myers, A.G. 2006. Efficient transamidation of primary carboxamides by in situ activation with N, N-dialkylformamide dimethyl acetals. *Journal of American Chemical Society*, 128, 16406-16409.

Doshi, R., Kathara, P. and Parekh, H. 1999. Synthesis and biological evaluation of some novel isoxazoles and cyanopyridines, a new class of potential anti-tubercular agents. *Indian Journal of Chemistry,* 38B, 348-352.

Guillon, J., Grellier, P., Labaied, M., Sonnet, P., Léger, J.M., Déprez-Poulain, R., Forfar-Bares, I., Dallemagne, P., Lemaître, N., Péhourcq, F., Rochette, J., Sergheraert, C., and Jarry, C. 2004. Synthesis, antimalarial activity, and molecular modeling of new pyrrolo[1,2-a]quinoxalines, bispyrrolo[1,2-a]quinoxalines, bispyrido[3,2-e]pyrrolo[1,2-a]pyrazines, and bispyrrolo[1,2-a]thieno[3,2-e]pyrazine. *Journal of Medicinal Chemistry*, 47(8), 1997–2009.

Ji, Shun-Jun, S., Zhi-Lian, Da-Gond, G. and Shun-Yi, W. 2004. An efficient synthesis of ferrocenyl substituted 1, 5-diketone and cyclic α, β-unsaturated ketones under ultrasound irradiation. *Journal of Organometallic Chemistry*, 689, 1843-1848.

Khan, S.A., Saleem, K. and Khan, Z. 2007. Synthesis, characterization and *in vitro* antibacterial activity of new steroidal thiazolo quinoxalines. *European Journal of Medicinal Chemistry,* 42(1), 103-108.

Kleim, J., Bender, R., Billhardt, U., Meichsner, C., Riess, G., Rosner, M., Winkler, I. and Paessens, A. 1993. Activity of a novel quinoxaline derivative against human immunodeficiency virus type-1 reverse transcriptase and viral replication. *Antimicrobial Agents & Chemotherapy,* 37, 1659-1664.

Kotharkar, S.A. and Shinde, D.B. 2006. Synthesis of antimicrobial 2,9,10-trisubstituted-6-oxo-7,12-dihydrochromeno[3,4-b]quinoxalines. *Bioorganic Medicinal Chemistry Letters*, 16(24), 6181-6184.

Martel, A., Chewchanwuttiwong, S., Dujardin, G. and Brown, E. 2003. Low temperature synthesis of thioketals from enol ethers and carbonyl compounds. *Tetrahedron Letters*, 44, 1491-1494.

Masson, S. and Thuiller, A. 1980. Preparation of α-ethylenic ketene dithioacetals from oxoketenedithioacetals. *Tetrahedron Letters,* 21, 4085-4086.

Padmawati, V., Reddy, B.J.M., Balaiah, A., Reddy, V.K. and Reddy, D.B. 2000. Synthesis of some fused pyrazoles and isoxazoles. *Molecules*, 5, 1281-1286.

Patel, M., Mchughjr, R.J., Cordova, B.C., Klabe, R.M., Erickson-viitanen, S., Trainor, G.L. and Rodgers, J.D. 2000. Synthesis and evaluation of quinoxalinones as HIV-1 reverse transcriptase inhibitors. *Bioorganic Medicinal Chemistry Letters*, 10, 1729-1731.

Potts, K. T., Cipullo, M. J., Ralli, P. and Thiodorodis, G. 1981. Ketene dithio acetals as synthetic intermediates. Synthesis of unsaturated 1,5-dikletones, *Journal of American Chemical Society*, 103(12), 3584-3585.

Pozgan, F., Kranjc, K., Kepe, V., Polanc, S. and Kocevar, M. 2007. Synthesis of 2H- pyran-2-ones and fused pyran-2-ones as useful building blocks. *ARKIVOC*, (iii), 97-111.

Prasad, K.J. and Vijayalakshmi, C.S. 1994. Synthesis of 4-methyl-1-oxotetrahydrocarbazoles. *Indian Journal of Chemistry*, 33B, 481-482

Sainz, Y., Montoya, M. E., Martinez-Crespo, F. J., Ortega, M. A., Lopez De Cerain, A. and Monge, A. 1999. New quinoxaline 1,4-di-*N*-oxides for treatment of tuberculosis. Arzneimittel-Forschung, 49(1), 55.

Singh, B., Mehta, D., Baregama, L.K. and Talesara, G.L. 2004. Synthesis and biological evaluation of7-(*n*-alkoxypthalimido)-2-hydroxy-4-aryl-6-aryliminothiazolidino[2,3-b]pyrimidine and related compounds. *Indian Journal of Chemistry*, 43B, 1313-1306.

Solanki, P.K., Burton, G., Clarke, G.J., Douglas, J.D. and Etonglin A.J. 1996. Novel C-2 substituted carbapenm derivatives. Part II. Synthesis and structure-activity relationships of isoxazolin-2-yl, isoxazolidin-2-yl and 2-pyrazolin-2-yl carbapenems generated using1, 3-dipolar cycloaddition chemistry. *Journal of Antibiotics,* 49, 1266-1274.

Thakuria, H.J. and Das, G. 2006. One-pot green synthesis of 1,4-dihydro-quinoxaline-2,3-dione derivatives. *Journal of Chemical Sciences*, 118, 425-428.

Waring, M. J., Hadda , T.B., Kotchevar, A.T., Ramdani, A., Touzani, R., Elkadiri, S., Hakkou, A., Bouakka, M. and Tom, 2002. E.*T.* 2,3-Bifunctionalized Quinoxalines: Synthesis, DNA interactions and evaluation of anticancer, anti-tuberculosis and antifungal activity. Molecules, 7(8), 641-656.

****