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Synthesis and antimicrobial activity of some new quinoxaline derivatives

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ABSTRACT

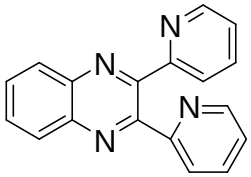
Quinoxaline derivatives have several pharmaceutical applications. Quinoxaline derivatives are benzoheterocycles, quinoxalin-2-ones and quinoxaline-2, 3-diones. Some of quinoxaline compounds are synthesized and characterized such as 8-bromo-2-methoxyquinoxaline, tert-butyl 1-(2-methoxyquinoxalin-8-yl) pyrrolidin-3-ylcarbamate, tert-butyl (R)-1-(2-methoxyquinoxalin-8-yl) pyrrolidin-3-ylcarbamate, tert-butyl (S)-1-(2-methoxyquinoxalin-8-yl)pyrrolidin-3-ylcarbamate, 1-(2-methoxyquinoxalin-8-yl) pyrrolidin-3-amine, (R)-1-(2-methoxyquinoxalin-8-yl)pyrrolidin-3-amine, (S)-1-(2-methoxyquinoxalin-8-yl)pyrrolidin-3-amine. Biological activity results were statisfactory.

Keywords: Quinoxaline derivaties, Organic synthesis, Pharmaceutical applications and Biological activity.

INTRODUCTION

Quinoxaline and its derivatives are important nitrogen containing heterocyclic compounds of various biologically interesting properties with several pharmaceutical applications. Substituted quinoxalines are an important class of benzoheterocycles, which constitute the building blocks of wide range of pharmacologically active compounds having antibacterial [1-6] antifungal [7, 8], anticancer [8-10], antitubercular [11], antileishmanial [12], antimalarial [13, 14] and antidepressant activities [15, 16]. Also, some quinoxalin-2-ones and quinoxaline-2, 3-diones have been reported to show antimicrobial [17, 18], novel, potent antithrombotic [19], anti-pain and anti-inflammatory [20, 21] activities. The quinoxaline is described as a bioisoster of quinoline, naphthalene, benzothiophene and other aromatic rings such as pyridine and pyrazine. Because of the similarity between some antitubercular drugs and quinoxaline, as well as the presence of the quinoxaline moiety in some broad spectrum antibiotics, it was hoped that quinoxaline analogs would exhibit antitubercular activity [22].

Some of quinoxaline analogues, such as 2, 3-bis (2-pyridyl)-quinoxaline (DPQ) complexed with transition metals are of current interest in view of its binding to DNA.This may suggest that conjugation of biologically active peptides with quinoxaline analogs can lead to new therapeutic agents possessing interesting anticancer properties [23].



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2,3-bis(2-pyridyl)-quinoxaline (DPQ)

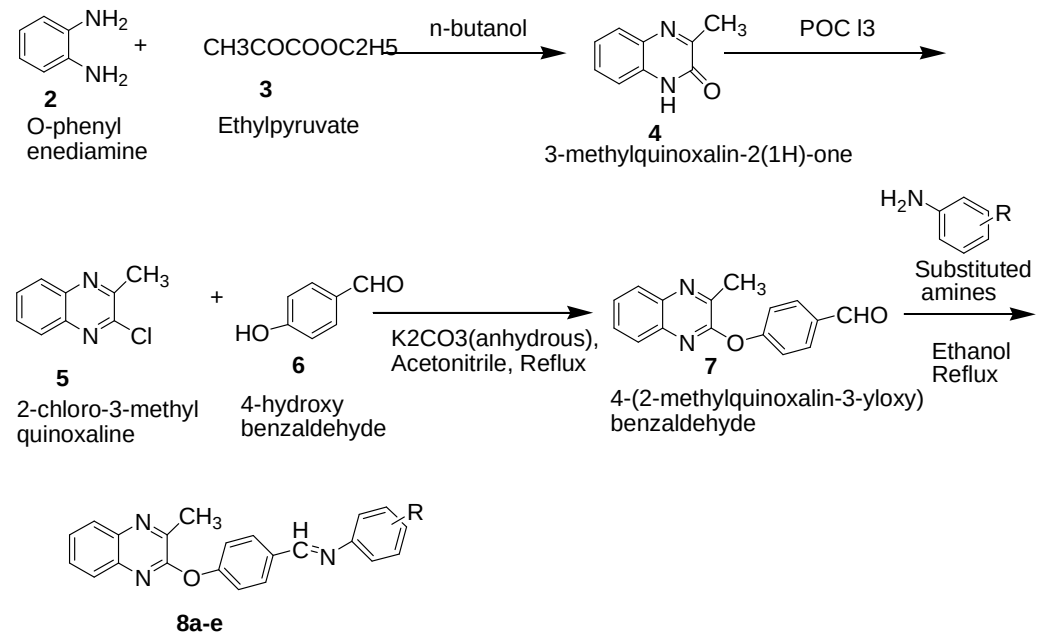
Figure-1: Chemical structure of DPQ

Quinoxaline derivatives constitute the basis of many insecticides, fungicides, herbicides, as well as being important in human health and as receptor antagonists. Although rarely described in nature, synthetic quinoxaline moiety is a part of number of antibiotics such as echinomycin, levomycin and actinomycinwhich are known to inhibit the growth of Gram positivebacteria and also active against various transplantable tumors. In addition, quinoxaline derivatives are reported for their application in dyes, efficient electroluminescent materials, organic semiconductors and DNA cleaving agents.

Compounds containing the quinoxaline nucleus exhibit a broad spectrum of biological activity such as antibacterial [40–42], antifungal [43, 44], antiviral [45], anticancer [46], antituberculosis [47], antimalarial [48] and anti-inflammatory properties [49]. Many researchers have reported the synthesis and biological activity of quinoxaline derivatives [50–53]. In the light of these facts we decided to synthesize some new quinoxaline derivatives incorporating aromatic aldehyde and aromatic amine moieties attached to a 2-hydroxy-3-methylquinoxaline nucleus with an ether linkage followed by the treatment with aromatic amines or aromatic aldehydes to afford Schiff bases in the hope of obtaining better antimicrobial agents. All the synthesized compounds were screened for their antimicrobial activity.

Synthetic schemes and Literature report:

The chemical synthesis was initiated with the reaction of *o*-phenylenediamine (**2**) with ethyl pyruvate **(3)** in *n*-butanol to yield 2-hydroxy-3-methylquinoxaline (**4**), which on treatment with POCl3 yielded 2-chloro-3-methylquinoxaline **(5)**. A mixture of compound **5** and 4-hydroxy benzaldehyde was next refluxed in acetonitrile for 30 hours to afford 2-(*p*-formylphenoxy)-3-methyl Quinoxaline **(7)** as intermediate. Mixtures of compound **7** and various substituted aromatic amines were refluxed in ethanol to afford 2-[4-(substituted benziminomethyl) phenoxy]-3-methylquinoxalines **8a–e**. In another set of reactions, compound **3** was refluxed with *p*-aminophenol in acetonitrile for 30 hours to yield 4-(2-methylquinoxalin-3-yloxy) benzamine **(10)** as a second intermediate. Compound **10** was refluxed with different substituted aromatic aldehydes in order to prepare compounds **11a–e**. The structures of all newly synthesized compounds were elucidated on the basis of their spectral and analytical data. The IR spectrum of compound **7** showed absorption bands at 3,038 cm−1 due to CH3 stretching, at1,600 cm−1 due to C=N stretching, a strong band at 1,699 cm−1 due to an aldehyde function and a band at 1,222 cm−1 due to the C-O-C aryl ether (C-O stretching). Its 1H-NMR spectrum showed a singlet (3H) at δ 2.870 due to CH3 protons, a broad set of multiplets between δ 6.6 - 8.0 (8H) due to aromatic hydrogens and a sharp singlet at δ 10.07 due to an aldehyde proton. This indicated that a free aldehyde function was present which could be reacted with substituted aromatic amines to form Schiff bases.



N-((4-(2-methylquinoxalin-3-yloxy)phenyl)methylene)-4-substituted benzenamine

R= H; Cl;CH3; 4-COOH; 2- CH3 6- CH3 Compounds

Figure-2a: Literature synthetic process of quinoxaline derivatives

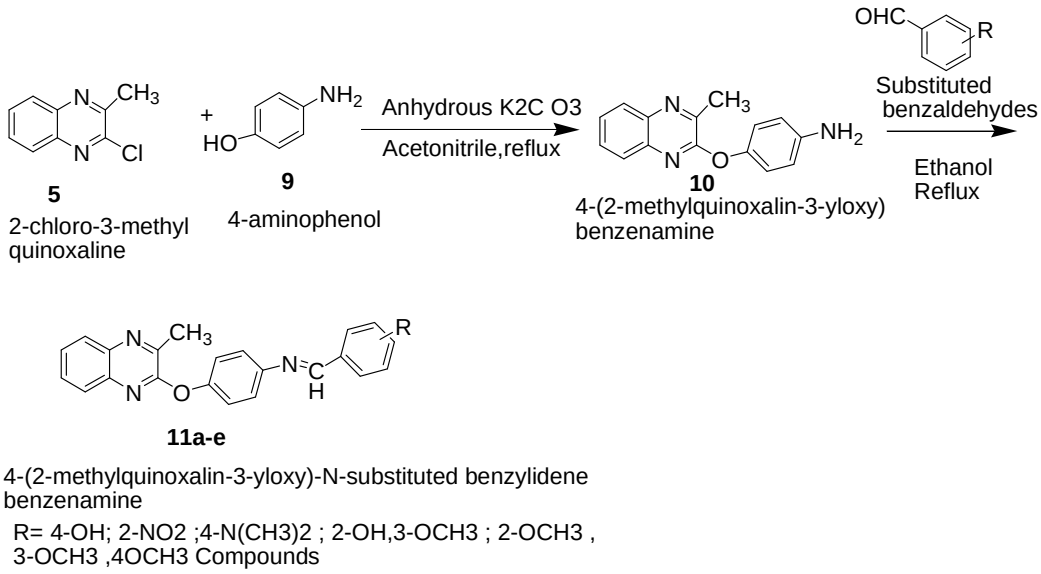


Figure-2b: Literature synthetic process of quinoxaline derivatives

Similarly the IR spectrum of compound **10** showed two bands at 3,466 cm−1 and 3,425 cm−1 due to primary amine N-H stretching, while other bands at 3,041 cm−1 due to CH3 stretching and a band at1, 220 cm−1 due to (C-O-C) aryl ether were also present. In the case of the intermediate **10**, the 1H-NMRspectrum showed a sharp singlet at δ 2.825 due to the protons of a CH3 group attached to the quinoxaline ring, a broad D2O exchangeable singlet at δ 3.742 due to NH2 protons, and a characteristic aromatic proton multiplet between δ 6.77-8.00 ppm. A singlet at around δ 8.40-9.03 due to presence of the (CH=N-) group in the compounds **8a–e** and **11a–e** clearly suggested the formation of the expected Schiff bases. IR, 1H-NMR spectra and elemental analytical data of compounds **8a–e** and **11a–e**confirmed the structures of the newly synthesized compounds.

Antimicrobial Activity:

The antibacterial activity was determined by the disc diffusion method at the concentration of 50 µg per disk. All the synthesized compounds were tested in vitro for their antibacterial activity against micro organisms such as Staphylococcus aureus, Bacillus subtilis (Gram positive), Escherichia coli, Pseudomonas aeruginosa (Gram negative), using ciprofloxacin as standard antibacterial. The results of activity, presented in the **Table 2** suggested that compounds **7**, **8a**, **8c**, **8d**, **8e**, **11a** and **11c** were highly active against both Gram positive and Gram negative bacteria, among them compounds **8c**, **8d**, **11a**, **11c**, and **11e** were specifically highly active against E. coli. Compound **8a** possessed no activity against Bacillus subtilis, Compounds **8b**, **and 8c** showed no activity against Pseudomonas aeruginosa .Compound **11d** showed no activity against Escherichia coli and Pseudomonas aeruginosa. The rest of tested compounds were found to have moderate antibacterial activity. The high activity of compounds **7**, **8a**, **36c**, **8d**, **8e** and **11c** could be explained on the basis of the contributions of incorporated aromatic ring and –CH3 groups, which we know should increase the lipophilicity of the compounds. This increase in lipophilicity would help their permeability through the microbial cell wall resulting in higher activity. Compound **8d** may be considered the analogue of benzoic acid (a known Antimicrobial) due the presence of the –COOH group.

The antibacterial activity was assayed by agar plate disc diffusion method [57] at the concentration of 50 µg per disk. All the synthesized compounds were tested in vitro for their antibacterial activity against micro organisms such as Staphylococcus aureus, Bacillus subtilis (gram positive), Escherichia coli, and Pseudomonas aerugenosa (gram negative) strains. Each test compounds were dissolved in dimethylsulphoxide (DMSO) to get a concentration of 10 mg/mL. The disc (6 mm in diameter) was impregnated with 5 µL of each test solution to get 50 µg/disc, air dried and placed onthe agar medium, previously seeded with 0.2 mL of broth culture of each organism for 18 hours. The plates were incubated at 37 °C for 24 hours and the inhibition zones measured in mm. Discs impregnated with DMSO were used as a control and ciprofloxacin discs as antibacterial reference standard.

Antifungal Activity:

The antifungal activity was tested against strain such as A. Niger and C. albicans, using fluconazoleas standard antifungal. Compounds **7**, **10**, and **11a** showed moderate activity against both strains. Compounds **8a**, **8b**, **8c**, **8d** and **8e** showed no activity against A. Niger. Compounds **11b**, **11c**, **11d** and **11e** showed moderate activity against A. Niger but no activity against C. albicans.

The antifungal activity [58] was assayed by the Sabouraud dextrose agar media plate disc diffusion method at a concentration of 50 µg per disk. All the synthesized compounds were tested in vitro for their antifungal activity against micro organisms such as Aspergillus Niger and Candida albicans. Each test compound was dissolved in dimethylsulphoxide (DMSO) to get a concentration of 10 mg/mL. The disc (6 mm in diameter) was impregnated with 5 µL of each test solution to get 50 µg/disc; air dried and placed on the Sabouraud dextrose agar media, previously seeded with 0.2 mL of broth culture of each organism for 18 hours. The plates were incubated at 22 °C for 48 hours and the inhibition zones measured in mm. Discs impregnated with DMSO were used as a negative control and fluconazole discsas antifungal reference standard. The results have already been shown are in **Table 2**.

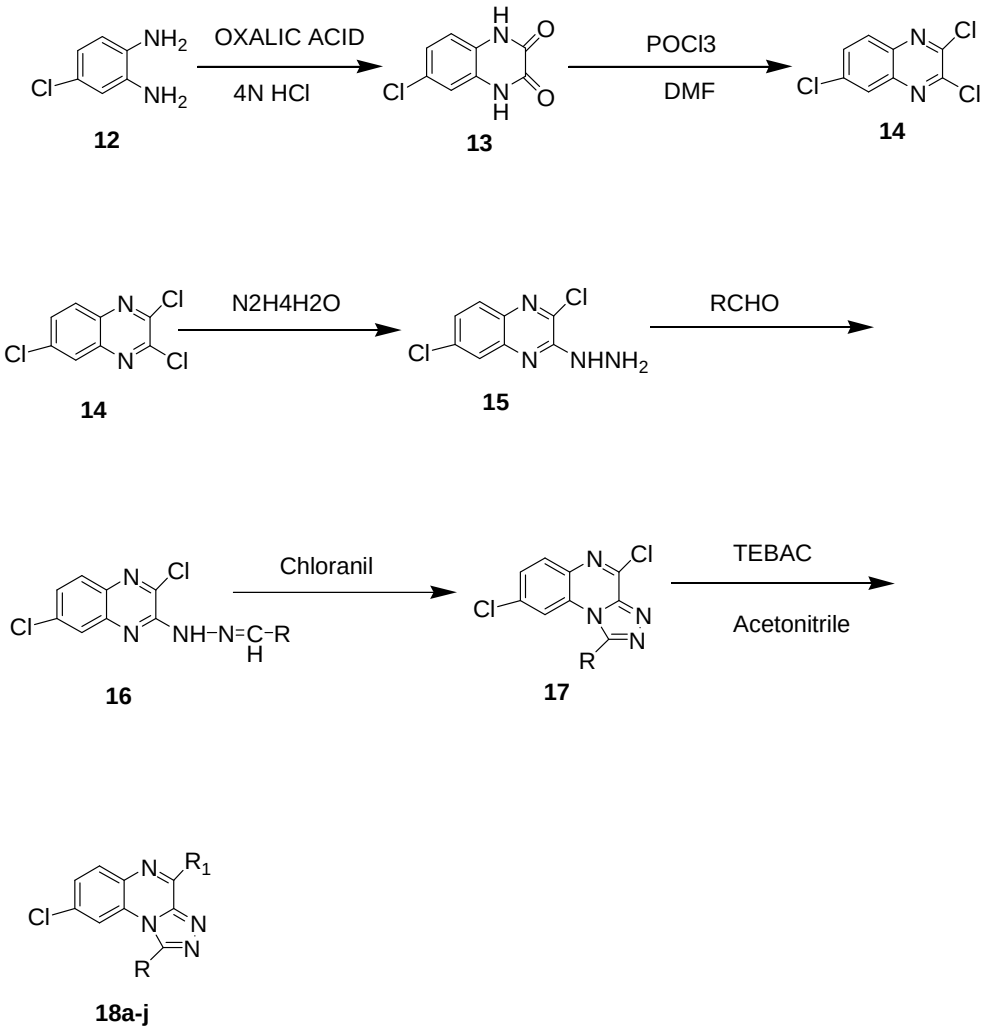
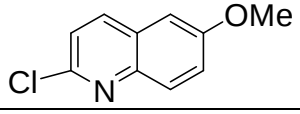
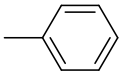
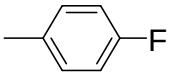
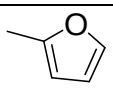
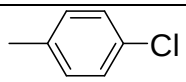
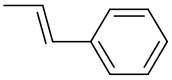
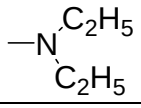
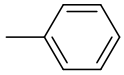
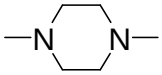
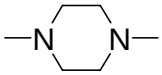
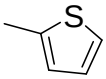
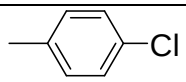
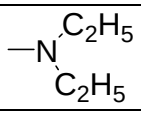


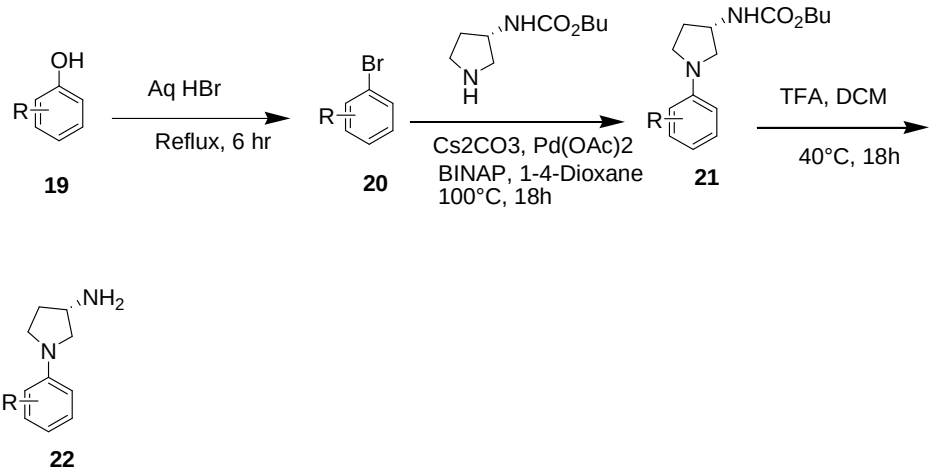
Figure-3: Literature synthetic process of quinoxaline derivatives

Table-1: Functional grops for 18a-j derivatives

Compound	R	R^1
18a		-Cl
18b		-SCH2COOH
18c		-OMe
18d		-SCH2COOH

18e		-Cl
18f		
18g		
18h	-C3H7	
18i		-SCH2COOH
18j		

Preparation of analogues **19–22** was readily achieved as outlined in generic figure-4. Palladium-assisted coupling of an appropriately Substituted bromobenzene with the 3-amino Bocprotected pyrrolidine derivative afforded the 3-amino Boc-protected N-arylpyrrolidine. Deprotection under acidic conditions afforded analogues 19–22 in good overall yield. [70-71].

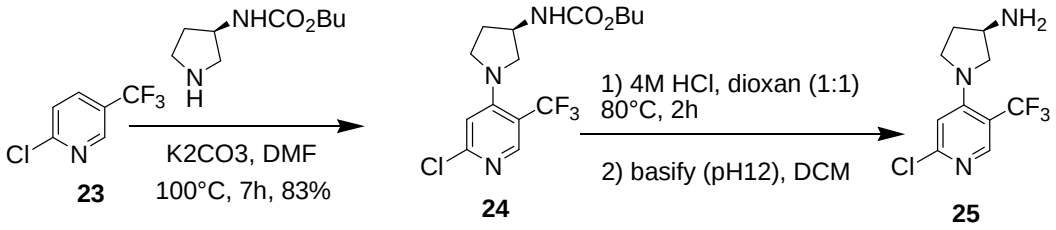


19 **20** **21** **22**

Figure-4: Literature synthetic process of quinoxaline derivatives

Preparation of analogues **23–25** was readily achieved as outlined in generic **figure-5**. Palladium-assisted coupling of an appropriately

Substituted bromobenzene with the 3-amino Bocprotected pyrrolidine derivative afforded the 3-amino Boc-protected N-arylpyrrolidine. Deprotection under acidic conditions afforded analogues 23-25 in good overall yield. [70-71]



23 **24** **25**

Figure-5: Literature synthetic process of quinoxaline derivatives

Objective:

Quinoxaline derivatives are a class of substances possessing a broad spectrum of pharmacological activities, such as antibacterial and antifungical. The objective of this research is to synthesize below Quinoxaline compounds.

i. 8-bromo-2-methoxyquinoxaline **27:**

ii. tert-butyl 1-(2-methoxyquinoxalin-8-yl) pyrrolidin-3-ylcarbamate **28:**
iii. tert-butyl (R)-1-(2-methoxyquinoxalin-8-yl) pyrrolidin-3-ylcarbamate **28a:**
iv. tert-butyl (S)-1-(2-methoxyquinoxalin-8-yl)pyrrolidin-3-ylcarbamate **28b:**
v. 1-(2-methoxyquinoxalin-8-yl) pyrrolidin-3-amine **29:**
vi. (R)-1-(2-methoxyquinoxalin-8-yl)pyrrolidin-3-amine **29a:**
vii. (S)-1-(2-methoxyquinoxalin-8-yl)pyrrolidin-3-amine **29b:**

EXPERIMENTS AND SYNTHETIC PROCESS

1. Synthesis of 8-bromo-2-methoxyquinoxaline 27:

To a stirred solution of 3-methoxyquinoxalin-5-ol **26** (4 g, 22.727 mmoles) in 40 mL of Dimethyl formamide (DMF), cooled to the O°C and slowly added PBr_3 (7.36 g, 27.272 mmoles) at 0°C. The reaction mixture was stirred at room temperature for 5 hours; reaction was monitored by TLC, after complection of reaction quenched with saturated Na_2CO_3 solution and extracted with ethyl acetate (100 mL) and separate the layers, taken organic layer and washed with water (50 mL). Taken organic layer and dried with anhydrous Na_2SO_4 filtered and concentrated under vacuum to get 8-bromo-2-methoxyquinoxaline **27** as a brown solid.

2. Synthesis of tert-butyl 1-(2-methoxyquinoxalin-8-yl) pyrrolidin-3-ylcarbamate 28:

To a stirred solution of 8-bromo-2-methoxyquinoxaline **27** (4 g, 16.086 mmole) in 1, 4- dioxane (150 mL) was added Cs_2CO_3 (16.38 g, 50.42 mmoles), Pd_2dba_3 (1.23 g, 1.344 mmoles), Xantphos (2.42 g, 4.201 mmoles) and tert-butyl pyrrolidin-3-ylcarbamate (3.43 g, 18.44 mmoles) at room temperature and then heated to 100°C for 5 hours. Cooled to the room temperature and filtered with celite. Taken filtered mls and distilled out completely to get crude product.

Purification: The crude product was purified by silica gel (100-200 mesh) column chromatography. The product was eluated with 2% Methanol in DCM, collected fractions and concentrated under vacuum to give tert-butyl 1-(2-methoxyquinoxalin-8-yl) pyrrolidin-3-ylcarbamate **28** as a yellow solid.

3. Synthesis of tert-butyl (R)-1-(2-methoxyquinoxalin-8-yl) pyrrolidin-3-ylcarbamate 28a:

According to the same procedure (Preparation of 28) tert-butyl (R)-1-(2-methoxyquinoxalin-8-yl) pyrrolidin-3-ylcarbamate **28a** was prepared.

4. Synthesis of tert-butyl (S)-1-(2-methoxyquinoxalin-8-yl)pyrrolidin-3-ylcarbamate 28b:

According to the same procedure (Preparation of 28) tert-butyl (S)-1-(2-methoxyquinoxalin-8-yl) pyrrolidin-3-ylcarbamate **28b** was prepared.

5. Synthesis of 1-(2-methoxyquinoxalin-8-yl) pyrrolidin-3-amine 29:

To a stirred solution of tert-butyl 1-(2-methoxyquinoxalin-8-yl) pyrrolidin-3-ylcarbamate **28** (2g, 5.813 mmoles) in Dichloromethane (40 mL) was added Trifluoro acetic acid (2.65 g, 23.255 mmoles) at 0°C and then allowed to stir at rt for 2 hours. The complection of the reaction was monitared by TLC. The reaction mixture was diluated with water 950 mL) and DCM (100 mL) separate the layers. Taken aqueous layer and adjucted the pH to 7.0 with aq. $NaHCO_3$ solution and extracted with 10% Methanol in DCM (2 X 400 mL). The combined organic layers were dried over Na_2SO_4, filtered and concentrated in vacuo to obtain the 1-(2-methoxyquinoxalin-8-yl) pyrrolidin-3-amine **29** as a yellow solid.

6. Synthesis of (R)-1-(2-methoxyquinoxalin-8-yl)pyrrolidin-3-amine 29a:

According to the same procedure (Preparation of 29) (R)-1-(2-methoxyquinoxalin-8-yl) pyrrolidin-3-amine **29a** was prepared.

7. Synthesis of (S)-1-(2-methoxyquinoxalin-8-yl)pyrrolidin-3-amine 29b:

According to the same procedure (Preparation of 29) (S)-1-(2-methoxyquinoxalin-8-yl) pyrrolidin-3-amine **29b** was prepared.

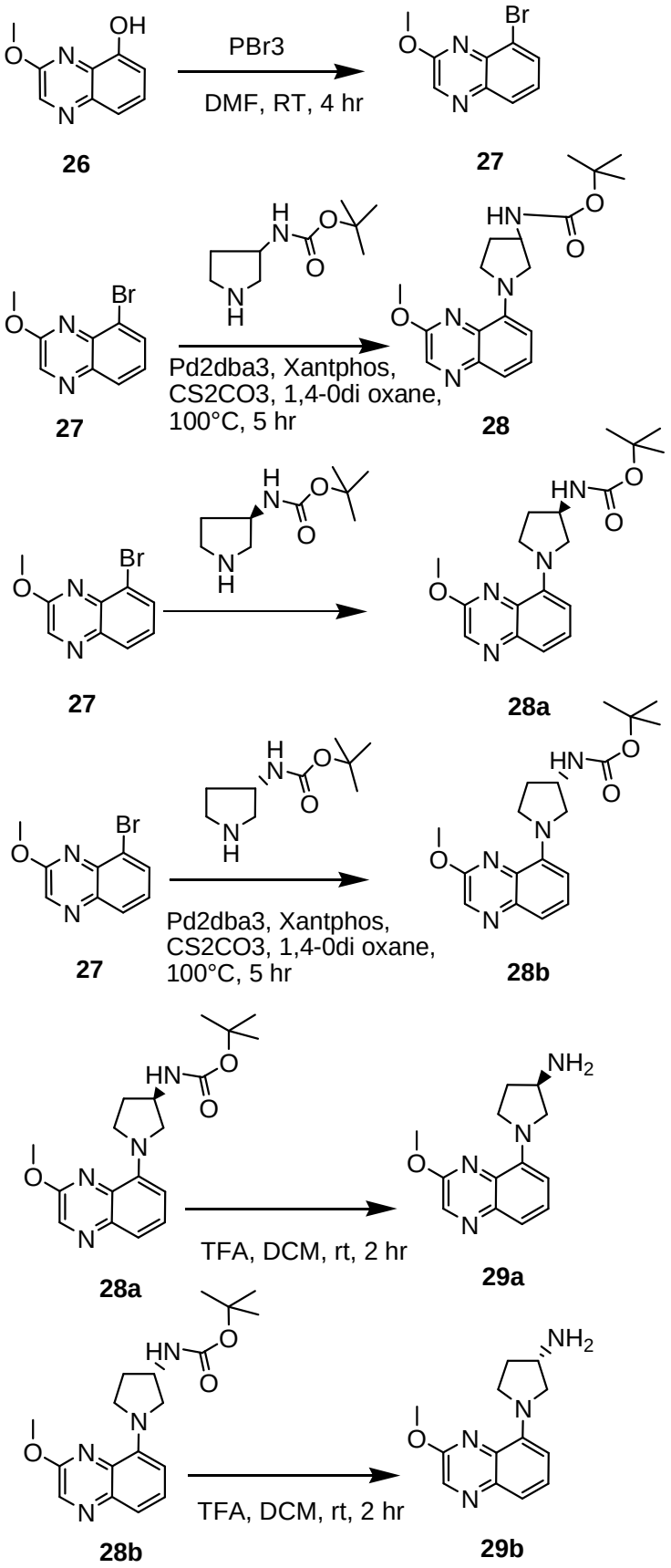


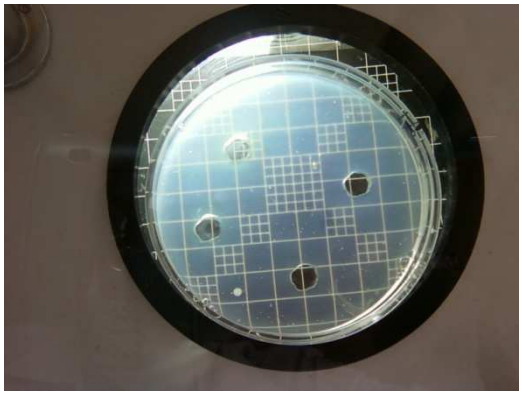
Figure-6: Synthetic process flow

RESULTS AND DICSUSSION

All Quinoxaline compounds are synthesized and well characterized. All steps compounds yields are satisfactory. Table-2 represents complete characterization and synthesis results. Table-3 shows antimicrobial results with growth rate.

Table-2: Chemical molecules 27 to 29 results

Compound	Synthetic Results	
8-bromo-2-methoxyquinoxaline **27**	**Yield**	4.0 gm, (74.07%)
	HPLC purity	90.79%
	IR (In KBr)	3436, 3025, 2989, 2923, 1739, 1667, 1602, 1578, 1562, 1470, 1437, 1392, 1360, 1320, 1306, 1255, 1207, 1189, 1171, 1056, 1012, 982, 910, 812, 752, 718, 641, 536, 465 cm^{-1}.
	^{1}H NMR ($CDCl_3$/TMS)	δ 4.20 (s, 3H), 7.4-7.5 (m, 1H), 7.95-8.0 (d, 2H), 8.4-8.5 (s, 1H).
	Mass (m/z)	240.90 (M+2).
tert-butyl 1-(2-methoxyquinoxalin-8-yl) pyrrolidin-3-ylcarbamate **28**	**Yield**	2.0 gm, (34.72%)
	LCMS purity	95.99%
	^{1}H NMR ($CDCl_3$/TMS)	δ 1.4-1.5 (s, 9H), 2.0 (broad, 1H), 2.2-2.3 (m, 1H), 3.8-3.9 (m, 2H), 4.0 (s, 3H), 4.2 (m, 1H), 4.3-4.4 (broad, 1H), 4.8 (broad, 1H), 7.4-7.5 (m, 1H), 7.95-8.0 (d, 2H), 8.4-8.5 (s, 1H).
	Mass (m/z)	345.37 (M+H).
tert-butyl (R)-1-(2-methoxyquinoxalin-8-yl) pyrrolidin-3-ylcarbamate **28a**	**Yield**	36% yield
	LCMS purity	93.08%
	^{1}H NMR ($CDCl_3$/TMS)	δ 1.4-1.5 (s, 9H), 2.0 (broad, 1H), 2.2-2.3 (m, 1H), 3.8-3.9 (m, 2H), 4.0 (s, 3H), 4.2 (m, 1H), 4.3-4.4 (broad, 1H), 4.8 (broad, 1H), 7.4-7.5 (m, 1H), 7.95-8.0 (d, 2H), 8.4-8.5 (s, 1H).
	Mass (m/z)	345.35 (M+H).
tert-butyl (S)-1-(2-methoxyquinoxalin-8-yl)pyrrolidin-3-ylcarbamate **28b**	**Yield**	38% yield
	LCMS purity	95.99%
	^{1}H NMR ($CDCl_3$/TMS)	δ 1.4-1.5 (s, 9H), 2.0 (broad, 1H), 2.2-2.3 (m, 1H), 3.8-3.9 (m, 2H), 4.0 (s, 3H), 4.2 (m, 1H), 4.3-4.4 (broad, 1H), 4.8 (broad, 1H), 7.4-7.5 (m, 1H), 7.95-8.0 (d, 2H), 8.4-8.5 (s, 1H).
	Mass (m/z)	345.37 (M+H).
1-(2-methoxyquinoxalin-8-yl) pyrrolidin-3-amine **29**	**Yield**	1.2 gm, (85.71%)
	LCMS purity	99.77%
	HPLC purity	98.44%
	Optical rotation $[\alpha]_D^{25}$	–1.05° [C= 1.22% in $CHCl_3$]
	IR (In KBr)	3371, 3285, 3181, 3048, 2930, 2855, 1616, 1599, 1574, 1508, 1471, 1455, 1417, 1376, 1342, 1311, 1289, 1254, 1212, 1172, 1129, 1085, 1044, 1010, 945, 895, 834, 807, 775, 738, 703, 642, 607, 580 cm^{-1}.
	^{1}H NMR (DMSO-d6/TMS)	δ 1.6-1.8 (m, 3H), 2.0 (m, 1H), 3.6 (broad, 2H), 3.8-3.85 (broad, 1H), 3.85-4.1 (s, 5H), 7.4-7.5 (m, 1H), 7.95-8.0 (d, 2H), 8.4-8.5 (s, 1H).
	Mass (m/z)	245.22 (M+H).
(R)-1-(2-methoxyquinoxalin-8-yl)pyrrolidin-3-amine 29a	**Yield**	86% yield
	LCMS purity	98.99%
	HPLC purity	99.51%
	Optical rotation $[\alpha]_D^{25}$	76.25° [C= 1.24% in $CHCl_3$]
	IR (In KBr)	3371, 3285, 3181, 3048, 2930, 2855, 1616, 1599, 1574, 1508, 1471, 1455, 1417, 1376, 1342, 1311, 1289, 1254, 1212, 1172, 1129, 1085, 1044, 1010, 945, 895, 834, 807, 775, 738, 703, 642, 607, 580 cm^{-1}.
	^{1}H NMR (DMSO-d6/TMS)	δ 1.6-1.8 (m, 3H), 2.0 (m, 1H), 3.6 (broad, 2H), 3.8-3.85 (broad, 1H), 3.85-4.1 (s, 5H), 7.4-7.5 (m, 1H), 7.95-8.0 (d, 2H), 8.4-8.5 (s, 1H).
	Mass (m/z)	245.22 (M+H).
(S)-1-(2-methoxyquinoxalin-8-yl)pyrrolidin-3-amine 29b	**Yield**	88% yield
	LCMS purity	99.77%
	HPLC purity	98.44%
	Optical rotation $[\alpha]_D^{25}$	–59.9° [C= 1.23% in $CHCl_3$]
	IR (In KBr)	3371, 3285, 3181, 3048, 2930, 2855, 1616, 1599, 1574, 1508, 1471, 1455, 1417, 1376, 1342, 1311, 1289, 1254, 1212, 1172, 1129, 1085, 1044, 1010, 945, 895, 834, 807, 775, 738, 703, 642, 607, 580 cm^{-1}.
	^{1}H NMR (DMSO-d6/TMS)	δ 1.6-1.8 (m, 3H), 2.0 (m, 1H), 3.6 (broad, 2H), 3.8-3.85 (broad, 1H), 3.85-4.1 (s, 5H), 7.4-7.5 (m, 1H), 7.95-8.0 (d, 2H), 8.4-8.5 (s, 1H).
	Mass (m/z)	245.22 (M+H).



29, 29a and 29b Aspergillus
Figure–7: Antifungal activity by disc diffusion method for 29, 29a and 29b

Table–3: Antifungal activity results (29, 29a and 29b)

S.No	Compd	Zone of inhibition (mm)		
		Aspergillus Niger		
		50µg	100µg	150µg
1	29	3mm	4mm	4mm
2	29a	3mm	5mm	4mm
3	29b	3mm	4mm	5mm

Zone of inhibition for standard samples: Aspergillus Niger (08mm); Abbreviation: NS= Not significant.

CONCLUSION

Quinoxaline derivatives are pharmacologically active compounds having antibacterial, antifungal, anticancer, antitubercular, antileishmanial, antimalarial and antidepressant activities. Quinoxaline derivatives are benzoheterocycles, quinoxalin-2-ones and quinoxaline-2, 3-diones. Some of quinoxaline compounds are synthesized and characterized such as 8-bromo-2-methoxyquinoxaline, tert-butyl 1-(2-methoxyquinoxalin-8-yl) pyrrolidin-3-ylcarbamate, tert-butyl (R)-1-(2-methoxyquinoxalin-8-yl) pyrrolidin-3-ylcarbamate, tert-butyl (S)-1-(2-methoxyquinoxalin-8-yl)pyrrolidin-3-ylcarbamate, 1-(2-methoxyquinoxalin-8-yl) pyrrolidin-3-amine, (R)-1-(2-methoxyquinoxalin-8-yl)pyrrolidin-3-amine, (S)-1-(2-methoxyquinoxalin-8-yl)pyrrolidin-3-amine. Biological activity results were statisfactory.

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