ISSN 0973-3450 (Print)
JUC Vol. 14(2), 76-83 (2018). Periodicity 2-Monthly
ISSN 2319-8036 (Online)

JOURNAL OF ULTRA CHEMISTRY
An International Open Free Access Peer Reviewed Research Journal of Chemical Sciences and Chemical Engineering
website:- www.journalofchemistry.org
Estd. 2005

Synthesis, characterization and antimicrobial activity of benzo thiazoles and 1,3 oxazine based derivatives of s-triazine

PATEL T. V. and MALIK G. M.*

*Department of Chemistry, Navyug Science College, Surat, Gujarat (India)
Email address of Corresponding Author: gmmalik2010@gmail.com
http://dx.doi.org/10.22147/juc/140204

Acceptance Date 4th February, 2018, Online Publication Date 2nd March, 2018

Abstract

In the present study, some new substituted 1,3,5 triazine derivatives with 4-(benzo[*d*]thiazol-2-yl)aniline and 6-(4-methoxyphenyl)-4-phenyl-2*H*-1,3-oxazin-2-amine and primary amine were synthesized and evaluated for their *in vitro* antimicrobial activity against Gram positive and Gram negative strains using a micro dilution procedure. Synthesized compounds P1DH to P15DH prove to be effective with MIC (µg/mL), among them P3DH, P4DH, P5DH, P15DH and P9DH showed excellent activity against a panel of microorganisms. The newly synthesized compounds were characterized using IR, ^{1}H- NMR, ^{13}CNMR, MASS Analysis.

Key words : Cyanuric Chloride, 4-(benzo[*d*]thiazol-2-yl)aniline, 6-(4-methoxyphenyl)-4-phenyl-2*H*-1,3-oxazin-2-amine, Different primary amine and antimicrobial activity.

Introduction

After years of misuse and overuse of antibiotics, bacteria are becoming antibiotic resistant, therefore recent efforts have been directed toward exploring novel antibacterial agents.[1] In order to overcome this rapid development of drug resistance, new agents should preferably consist of chemical characteristics that clearly differ from those of existing agents. Nowadays the discovery and commercial development of numerous therapeutic agents[2] afford reliably effective treatment for many infectious diseases which had previously caused extensive mortality and morbidity. In this context, substituted s-triazine has received considerable attention due to their significant activities like antimicrobial[3], antibacterial[4], antifungal[5], antitumor[6], anti-inflammatory[7], anticancer[8], antiprotozoals[9], antimalarials[10].

Heterocycles containing the oxazine nucleus were found to possess a wide range of valuable biological properties like analgesic, anti-inflammatory, anti-leukemic, antimalarial, antipyretic, anticonvulsant and antimicrobial activities.[11-15] Drugs containing

benzothiazole moiety are reported to possess wide range of biological activities such as antimicrobial,[16-18] anticancer,[19] anthelmintic,[20] antidiabetic,[21] antituberculosis,[22] antiviral,[23] as well as antitumor.[24] Cyanuric chloride and various amines with good antibacterial properties were used. Incorporation of the derivatives gave access to a wide range of different chemical structures, showing prominent antibacterial activities. Due to rapid development of drug resistance, tolerance and side effects there is a fundamental and critical need for the development of a new generation of antimicrobial agents which would exhibit improved pharmacological properties and drug-resistance profiles. Therefore, it is predicted that chemical entities with benzothiazole, 1,3-oxazine and s-triazine moieties would result in compounds of interesting biological activities. In view of these findings, we have attempted to incorporate all these three biologically active components together to give a confined structure as describe below in reaction scheme. All synthesized compounds for evaluating their antibacterial and antifungal activities.

Previously, we were also reported synthesis, characterization and antimicrobial evaluation of 4-((4-((5-benzyl-1,3,4-thiadiazol-2-yl)amino)-6-(phenyl amino) 1,3,5-triazin-2-yl)amino)-6-(*tert*-butyl)-3-(methylthio)-1,2,4-triazin-5(4*H*)-one derivatives.[25] Keeping this in mind we have subsequently carried out the synthesis of s-triazine based 4-(benzo[*d*] thiazol-2-yl) aniline and 6-(4-methoxyphenyl)-4-phenyl-2*H*-1,3-oxazin-2-amine derivatives to explore the synthesis of more potential bioactive molecules in one framework.

Methods and Materials

All reactions except those in aqueous media were carried out by standard techniques for the exclusion of moisture. Melting points were determined on an electro thermal melting point apparatus and are reported uncorrected. TLC on silica gel plates were used for purity checking and reaction monitoring. Elemental analysis (% C, H, N) was carried out by a Perkin–Elmer 2400 CHN analyzer. IR spectra of all compounds were recorded on a Perkin–Elmer FT-IR spectrophotometer in KBr. ^{1}HNMR spectra were recorded on Bruker Avance II-400 MHz and ^{13}CNMR spectra on Bruker Avance II-400, 100 MHz in DMSO-*d6* as a solvent and tetramethylsilane (TMS) as an internal standard. Mass spectra were recorded on triple quadrapole LCMS-6410 from Agilent Technology.

Preparation of 4,6-dichloro-N-phenyl-1,3,5-triazin-2-amine: (P1 to 15) :

To the stirred solution of cyanuric chloride (0.01 mol) in acetone (25 mL) at 0-5 ºC, the solution of primary amine solution (0.01 mol) in acetone (15 mL) was added and pH being maintained neutral by the addition of 10% sodium bi-carbonate solution from time to time as per requirement of reaction condition. The stirring was continued at 0-5 ºC for 2 hours. After the completion of reaction the stirring was stopped and the solution was treated with crushed ice. The solid product obtained was filtered and dried. The crude product was purified by crystallization from absolute alcohol to get title compound.

Preparation of N^2-(4-benzo[d]thiazol-2-yl)phenyl)-N^4-(4-fluorophenyl)-6-methyl-1,3,5-triazine-2,4-diamine: (P1 to 15D) :

To a stirred solution of (P1 to 15) (0.01 mol) in DMF (25 mL) the solution of 4-(benzo[*d*]thiazol-2-yl)aniline (0.01 mol) in DMF (15 mL) was added drop wise maintaining the temperature at 40 °C, the pH was maintained neutral by the addition of 10% sodium bi-carbonate solution from time to time as per requirement of reaction condition. The temperature was gradually raised to 45 ºC during three hours. After the completion of reaction, the resultant content was poured into ice-cold water. The solid product obtained was filtered and dried. The crude product was purified by crystallization from absolute alcohol to get the title compound.

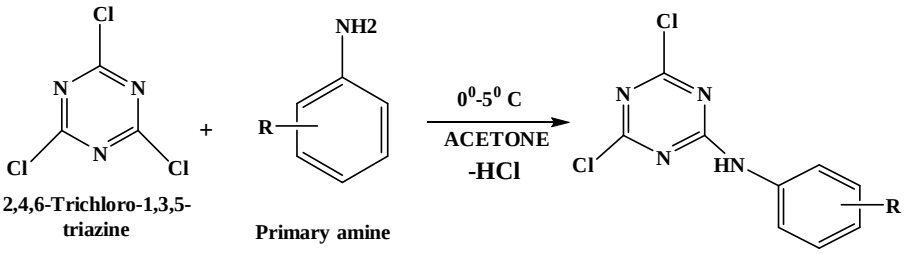
Preparation of N^2-(4-(benzo[d]thiazol-2-yl)phenyl)-N^4-(6-(4-methoxyphenyl)-4-phenyl-2H-1,3-oxazin-2-yl)-N^6-phenyl-1,3,5-triazine-2,4,6-triamine : (P1 to 15DH) :

A mixture of (P1D) (0.01 mol) and 6-(4-methoxyphenyl)-4-phenyl-2*H*-1,3-oxazin-2-amine (0.01 mol) in DMF (15mL) was refluxed in oil bath. The temperature was gradually raised to 80-100 ºC during

four hours, the pH being maintained neutral by the addition of 10% sodium bi-carbonate solution from time to time as per requirement of reaction condition. After the completion of reaction add charcoal in R.B.F. and heat and filter into cold water. The solid product obtained was filtered and dried. The crude product was purified by recrystallization from absolute alcohol.

Reaction Scheme

Step-1:

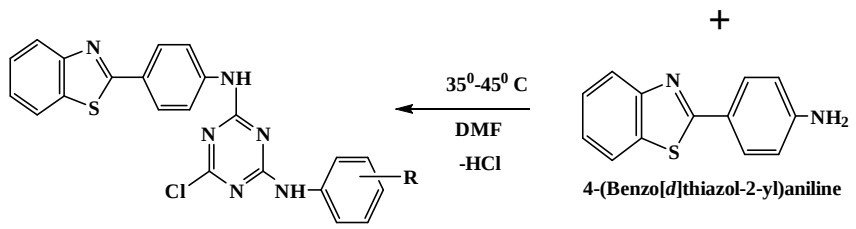


2,4,6-Trichloro-1,3,5-triazine **Primary amine**

4,6-Dichloro-*N*-phenyl-1,3,5-triazin-2-amine

(P1 to 15)

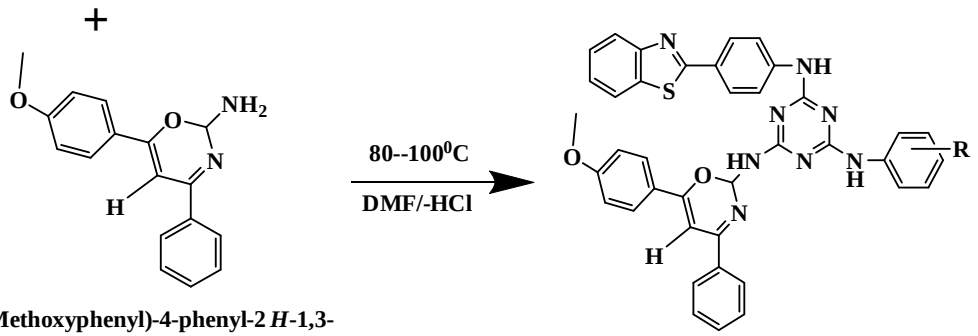
Step-2:



***N*^{2}-(4-(Benzo[*d*]thiazol-2-yl)phenyl)-6-chloro- *N*^{4}-phenyl-1,3,5-triazine-2,4-diamine**

4-(Benzo[*d*]thiazol-2-yl)aniline

Step-3: **(P1 to 15D)**



6-(4-Methoxyphenyl)-4-phenyl-2 *H*-1,3-oxazin-2-amine

***N*^{2}-(4-(Benzo[*d*]thiazol-2-yl)phenyl)- *N*^{4}-(6-(4-methoxyphenyl)-4-phenyl-2 *H*-1,3-oxazin-2-yl)- *N*^{6}-phenyl-1,3,5-triazine-2,4,6-triamine**

Table 1. Physicochemical data of the synthesized compounds P1DH to P15DH:

Sr. No.	R	M.P. ^{O}C	Yield %	Mol. Formula	Calculated (Found) %		
					C	H	N
P1DH	4-Cl	210	65.15	$C_{39}H_{29}ClN_8O_2S$	66.05(66.00)	4.12(4.09)	15.80(15.75)
P2DH	4-F	212	45.10	$C_{39}H_{29}FN_8O_2S$	67.62 (67.57)	4.22 (4.17)	16.17(16.12)
P3DH	4-Br	190	63.65	$C_{39}H_{29}BrN_8O_2S$	62.15 (62.11)	3.88 (3.85)	14.87(14.81)
P4DH	4-CH_3	186	58.25	$C_{40}H_{32}N_8O_2S$	69.75 (69.72)	4.68 (4.63)	16.27(16.22)
P5DH	2-OCH_3	170	67.35	$C_{40}H_{32}N_8O_3S$-	68.17 (68.14)	4.58 (4.55)	15.90(15.88)
P6DH	2-CH_3	155	60.60	$C_{40}H_{32}N_8O_2S$	69.75 (69.74)	4.68 (4.66)	16.27(16.23)
P7DH	H	150	60.25	$C_{39}H_{30}N_8O_2S$	69.42(69.40)	4.48(4.42)	16.61(16.57)
P8DH	4-OCH_3	145	66.55	$C_{40}H_{32}N_8O_3S$	68.17 (68.15)	4.58 (4.55)	15.90(15.87)
P9DH	4-$COCH_3$	175	50.50	$C_{41}H_{32}N_8O_3S$	68.70 (68.68)	4.50(4.47)	15.63(15.60)
P10DH	1-NH	180	64.10	$C_{39}H_{31}N_9O_2S$	67.91 (67.88)	4.53(4.50)	18.28(18.24)
P11DH	4-NO_2	190	68.35	$C_{39}H_{29}N_9O_4S$	65.08 (65.03)	4.06(4.03)	17.51(17.48)
P12DH	3-Cl	235	70.20	$C_{39}H_{29}ClN_8O_2S$	66.05(66.01)	4.12(4.08)	15.80(15.75)
P13DH	-C_6H_5	165	70.25	$C_{43}H_{32}N_8O_2S$	71.25 (71.22)	4.45(4.42)	15.46(15.43)
P14DH	2,5-Cl	195	63.65	$C_{39}H_{28}Cl_2N_8O_2S$	62.99 (62.98)	3.80(3.77)	15.07(15.03)
P15DH	4-Cl,2-NO_2	145	65.75	$C_{39}H_{28}ClN_9O_4S$	62.11 (62.09)	3.74(3.70)	16.71(16.67)

*Compound P1DH :*IR(KBr, cm^{-1}): -C=N str. in s-triazine (782.1),-C-S-C str. in thiazole (825.1), -C-Cl str. (754.5), -C-O-C str. in aromatic ring (1263.8), C=C- str. in aromatic ring(1480.5),-N-H deformation in -2^0 NH(1660.1),C-H str. in -OCH_3 (2770.9), -C-H str. in aromatic (3172.6), N-H str. in -2^0NH(3324.5).^{1}H NMR (400.0MHz, DMSO-d6, $\delta_H$ppm): 6.56-8.15 (m, 21H, Ar), 6.22 (s, 1H,-O-CH-N), 5.29(s, 1H,-C-CH=C), 4.25 (s, 3H, -NH), 3.85 (s, 3H, -OCH_3). ^{13}C NMR (100 MHz, DMSO-d_6, δ_C ppm):55.24,74.21,115.4(trp), 122.4(2db), 124.1 (db), 127.13,127.01(db), 129.1 (db),130,130.1(qrt),131.3 (qrt),135.5,137.8(db),147.5(db),153.5,157.6(db), 161.2 (trp),165.2, 171.1,174.2.MS (EI): m/z: 708.1 (M+), 709.3(M+1).

*Compound P2DH :*IR(KBr, cm^{-1}): -C=N str. in s-triazine (783.1),-C-S-C str. in thiazole (827.1), -C-F str. (1095.4), -C-O-C str. in aromatic ring (1267.8), C=C- str. in aromatic ring(1487.7),-N-H deformation in -2^0 NH(1665.5),C-H str. in -OCH_3 (2771.1), -C-H str. in aromatic (3176.6), N-H str. in -2^0NH(3320.5). ^{1}H NMR (400.0MHz, DMSO-d6, δ_H ppm): 6.59-8.23 (m, 21H, Ar), 6.27 (s, 1H,-O-CH-N), 5.27(s, 1H,-C-CH=C), 4.27 (s, 3H, -NH), 3.84 (s, 3H, -OCH_3).^{13}C NMR (100 MHz, DMSO-d_6, δ_C ppm):55.26,74.22,115.8(trp),122.5 (qrt),124.7(db),127.08,127.17(db), 129.42 (db), 130.08,130.6(qrt),131.25 (qrt), 135.49, 137.50 (db), 147.1(db), 152.5, 156.6(db), 160.7 (trp), 166.17, 170.4, 173.5.MS (EI): m/z: 692.5 (M+), 693.5(M+1).

Compound P3DH : IR(KBr, cm^{-1}): -C=N str. in s-triazine (780.1),-C-S-C str. in thiazole (828.1), -C-Br str. (1011.4), -C-O-C str. in aromatic ring (1262.4), C=C- str. in aromatic ring(1482.1),-N-H deformation in -2^0 NH(1666.4),C-H str. in -OCH_3 (2773.4), -C-H str. in aromatic (3175.9), N-H str. in -2^0NH(3314.7). ^{1}H NMR (400.0MHz, DMSO-d_6, $\delta_H$ppm): 6.65-8.65 (m, 21H, Ar), 6.22 (s, 1H,-O-CH-N), 5.21(s, 1H,-C-CH=C), 4.35 (s, 3H, -NH), 3.90 (s, 3H, -OCH_3). MS (EI): m/z: 752.1 (M+), 754.2(M+2).

*Compound P4DH :*IR(KBr, cm^{-1}): -C=N str. in s-triazine (785.1),-C-S-C str. in thiazole (835.1), -C-O-C str. in aromatic ring (1270.8), C=C- str. in aromatic ring (1491.7),-N-H deformation in -2^0NH(1656.5),C-H

str. in -OCH_3 (2765.1), -C-H str. in aromatic (3170.6), N-H str. in -2^0 NH (3323.5). ^{1}H NMR (400.0MHz, DMSO-d6, $\delta_H$ppm): 6.43-8.22 (m, 21H, Ar), 6.35 (s, 1H,-O-CH-N), 5.43(s, 1H,-C-CH=C), 4.32 (s, 3H, -NH), 3.81 (s, 3H, -OCH_3), 2.32 (s, 3H,-CH_3). MS (EI): m/z: 688.3 (M+).

*Compound P5DH :*IR(KBr, cm^{-1}): -C=N str. in s-triazine (782.1),-C-S-C str. in thiazole (834.1), -C-O-C str. in aromatic ring (1272.8), C=C- str. in aromatic ring (1493.7),-N-H deformation in -2^0NH(1666.5),C-H str. in -OCH_3 (2771.9), -C-H str. in aromatic (3173.4), N-H str. in -2^0 NH (3324.4). ^{1}H NMR (400.0MHz, DMSO-d_6, δ_H ppm): 6.67-8.21 (m, 21H, Ar), 6.21 (s, 1H,-O-CH-N), 5.34(s, 1H,-C-CH=C), 4.34 (s, 3H, -NH), 3.81-3.92 (s, 6H, -OCH_3). MS (EI): m/z: 704.5(M+).

*Compound P6DH :*IR(KBr, cm^{-1}): -C=N str. in s-triazine (773.1),-C-S-C str. in thiazole (835.1), -C-O-C str. in aromatic ring (1265.8), C=C- str. in aromatic ring (1498.7),-N-H deformation in -2^0NH(1675.5),C-H str. in -OCH_3 (2777.1), -C-H str. in aromatic (3175.6), N-H str. in -2^0 NH (3329.5). ^{1}H NMR (400.0MHz, DMSO-d_6, δ_H ppm): 6.39-8.29 (m, 21H, Ar), 6.32 (s, 1H,-O-CH-N), 5.35(s, 1H,-C-CH=C), 4.43 (s, 3H, -NH), 3.90 (s, 3H, -OCH_3), 2.30 (s, 3H,-CH_3). MS (EI): m/z: 688.5 (M+).

*Compound P7DH :*IR(KBr, cm^{-1}): -C=N str. in s-triazine (781.1),-C-S-C str. in thiazole (821.1), -C-O-C str. in aromatic ring (1257.8), C=C- str. in aromatic ring (1477.7),-N-H deformation in -2^0NH(1655.5),C-H str. in -OCH_3 (2761.1), -C-H str. in aromatic (3166.6), N-H str. in -2^0NH (3328.5).^{1}H NMR (400.0MHz, DMSO-d_6, $\delta_H$ppm): 6.49-8.13 (m, 22H, Ar), 6.34 (s, 1H,-O-CH-N), 5.41 (s, 1H,-C-CH=C), 4.36 (s, 3H, -NH), 3.76 (s, 3H, -OCH_3). MS (EI): m/z: 674.4 (M+).

*Compound P8DH :*IR(KBr, cm^{-1}): -C=N str. in s-triazine (784.1),-C-S-C str. in thiazole (830.1), -C-O-C str. in aromatic ring (1269.8), C=C- str. in aromatic ring (1488.7),-N-H deformation in -2^0NH(1667.5), C-H str. in -OCH_3 (2778.1), -C-H str. in aromatic (3180.6), N-H str. in -2^0 NH (3325.5). ^{1}H NMR (400.0MHz, DMSO-d_6, δ_H ppm): 6.66-8.234 (m, 21H, Ar), 6.45 (s, 1H,-O-CH-N), 5.65 (s, 1H,-C-CH=C), 4.35 (s, 3H, -NH), 3.80-3.90 (s, 6H, -OCH_3). MS (EI): m/z: 704.6 (M+).

*Compound P9DH :*IR(KBr, cm^{-1}): -C=N str. in s-triazine (788.1),-C-S-C str. in thiazole (832.1), -C-O-C str. in aromatic ring (1268.8), C=C- str. in aromatic ring (1488.7),-N-H deformation in -2^0NH(1671.5),C-H str. in -OCH_3 (2788.1), -C-H str. in aromatic (3178.6), N-H str. in -2^0NH (3320.5).^{1}H NMR (400.0MHz, DMSO-d6, $\delta_H$ppm): 6.55-8.35 (m, 21H, Ar), 6.34 (s, 1H,-O-CH-N), 5.30 (s, 1H,-C-CH=C), 4.31 (s, 3H, -NH), 3.87 (s, 3H, -OCH_3), 2.51 (s, 3H, -CH_3).MS (EI): m/z: 716.6 (M+).

*Compound P10DH :*IR(KBr, cm^{-1}): -C=N str. in s-triazine (789.1), -C-S-C str. in thiazole (822.1) , -C-O-C str. in aromatic ring (1272.8), C=C- str. in aromatic ring (1496.7),-N-H deformation in -2^0NH(1676.5),C-H str. in -OCH_3 (2770.1), -C-H str. in aromatic (3170.6), N-H str. in -2^0NH (3322.5). ^{1}H NMR (400.0MHz, DMSO-d6, $\delta_H$ppm): 9.21 (s, 1H, -NH-NH), 6.50-8.22 (m, 21H, Ar), 6.23 (s, 1H,-O-CH-N), 5.21(s, 1H,-C-CH=C), 4.21 (s, 3H, -NH), 3.80 (s, 3H, -OCH_3). MS (EI): m/z: 688.1 (M+).

*Compound P11DH :*IR(KBr, cm^{-1}): -C=N str. in s-triazine (773.1),-C-S-C str. in thiazole (825.1) , -C-O-C str. in aromatic ring (1273.8), C=C- str. in aromatic ring (1477.7),-N-H deformation in -2^0NH(1660.5),C-H str. in -OCH_3 (2775.1), -C-H str. in aromatic (3172.6), N-H str. in -2^0NH (3325.5). ^{1}H NMR (400.0MHz, DMSO-d6, $\delta_H$ppm): 6.65-8.33 (m, 21H, Ar), 6.45 (s, 1H,-O-CH-N), 5.42 (s, 1H,-C-CH=C), 4.32 (s, 3H, -NH), 3.81 (s, 3H, -OCH_3). MS (EI): m/z: 719.3 (M+).

*Compound P12DH :*IR(KBr, cm^{-1}): -C=N str. in s-triazine (780.1),-C-S-C str. in thiazole (821.1) , -C-Cl str. (755), -C-O-C str. in aromatic ring (1260.8), C=C- str. in aromatic ring (1492.7),-N-H deformation in -2^0 NH(1611.5),C-H str. in -OCH_3 (2751.1), -C-H str. in aromatic (3166.6), N-H str. in -2^0NH(3334.5). ^{1}H NMR (400.0MHz, DMSO-d6, $\delta_H$ppm): 6.71-8.41 (m, 21H, Ar), 6.31 (s, 1H,-O-CH-N), 5.32 (s, 1H,-C-CH=C), 4.30 (s, 3H, -NH), 3.89 (s, 3H, -OCH_3).MS (EI): m/z: 708.3 (M+), 709.6 (M+1).

*Compound P13DH :*IR(KBr, cm^{-1}): -C=N str. in s-triazine (780.1),-C-S-C str. in thiazole (821.1) , -C-O-C str. in aromatic ring (1263.8), C=C- str. in aromatic ring (1498.7),-N-H deformation in -2^0NH(1676.5),C-H str. in -OCH_3 (2779.1), -C-H str. in aromatic (3171.6), N-H str. in -2^0NH (3330.5). ^{1}H NMR (400.0MHz, DMSO-

Table 2. Antibacterial activity (MIC) of compound P1DH to P15DH:

NO	Compound	Functional group R=	Minimum Inhibitory Concentration (μg/mL)			
			Gram Negative Bacteria		Gram Positive Bacteria	
			E. coli MTCC25922	*P. aeruginosa* MTCC 27853	*S. aureus* MTCC 25923	*S. pyogenes* MTCC 6633
1.	P1DH	4-Cl	500	1000	250	125
2.	P2DH	4-F	1000	500	125	500
3.	P3DH	4-Br	125	250	125	62.5
4.	P4DH	4-CH_3	250	62.5	500	125
5.	P5DH	2-OCH_3	250	31.25	62.5	500
6.	P6DH	2-CH_3	500	62.5	250	250
7.	P7DH	H	1000	250	500	>1000
8.	P8DH	4-OCH_3	125	500	500	500
9.	P9DH	4-$COCH_3$	250	1000	500	250
10.	P10DH	1-NH	250	1000	500	125
11.	P11DH	4-NO_2	62.5	500	1000	250
12.	P12DH	3-Cl	125	500	250	125
13.	P13DH	-Phenyl	250	125	500	500
14.	P14DH	2,5-Cl	500	125	250	250
15.	P15DH	4-Cl,2-NO_2	62.5	125	250	125
16.	Ampicillin		100	100	100	250
17.	Chloramphenicol		50	50	50	50

Table 3. Antifungal activity (MIC) of compound P1DH to P15DH:

NO	Compound	Functional group R=	FUNGAL SPECIES		
			C. albicans MTCC 10231	*A. niger* MTCC 2821	*A. clavatus* MTCC 1323
1.	P1DH	4-Cl	500	125	1000
2.	P2DH	4-F	250	500	125
3.	P3DH	4-Br	1000	1000	>1000
4.	P4DH	4-CH_3	>1000	500	>1000
5.	P5DH	2-OCH_3	>1000	500	500
6.	P6DH	2-CH_3	500	250	500
7.	P7DH	H	250	125	1000
8.	P8DH	4-OCH_3	125	500	1000
9.	P9DH	4-$COCH_3$	125	1000	250
10.	P10DH	1-NH	1000	>1000	500
11.	P11DH	4-NO_2	1000	500	500
12.	P12DH	3-Cl	125	500	1000
13.	P13DH	-C_6H_5	500	1000	1000
14.	P14DH	2,5-Cl	500	1000	>1000
15.	P15DH	4-Cl,2-NO_2	250	>1000	500
16.	Griseofulvin		500	100	100

d6, $\delta_H$ppm): 6.61-8.11 (m, 24H, Ar), 6.21 (s, 1H,-O-CH-N), 5.22 (s, 1H,-C-CH=C), 4.31 (s, 3H, -NH), 3.74 (s, 3H, -OCH_3). MS (EI): m/z: 750.1 (M+).

*Compound P14DH :*IR(KBr, cm^{-1}): -C=N str. in s-triazine (784.1),-C-S-C str. in thiazole (827.1) -C=N str. in s-triazine (783109, -C-Cl str. (752.4), -C-O-C str. in aromatic ring (1267.8), C=C- str. in aromatic ring (1487.7),-N-H deformation in -2^0NH(1665.5),C-H str. in -OCH_3(2771.1), -C-H str. in aromatic (3176.6), N-H str. in -2^0NH(3320.5).^{1}H NMR (400.0MHz, DMSO-d6, δ_H ppm): 6.59-8.23 (m, 20H, Ar), 6.27 (s, 1H,-O-CH-N), 5.27(s, 1H,-C-CH=C), 4.27 (s, 3H, -NH), 3.84 (s, 3H, -OCH_3). MS (EI): m/z: 742.3 (M+), 743.1 (M+1), 744.6 (M+2).

*Compound P15DH :*IR(KBr, cm^{-1}): -C=N str. in s-triazine (780.1),-C-S-C str. in thiazole (821.1) , -C-Cl str. (765.2), -C-O-C str. in aromatic ring (1261.8), C=C- str. in aromatic ring(1481.7),-N-H deformation in -2^0NH (1674.5), C-H str. in -OCH_3(2751.1), -C-H str. in aromatic (3146.6), N-H str. in -2^0NH(3310.5). ^{1}H NMR (400.0MHz, DMSO-d6, $\delta_H$ppm): 6.52-8.20 (m, 20H, Ar), 6.21 (s, 1H,-O-CH-N), 5.20(s, 1H,-C-CH=C), 4.36 (s, 3H, -NH), 3.74 (s, 3H, -OCH_3). MS (EI): m/z: 753.2 (M+),754.5(M+1).

Result and Discussion

All the 15 compounds which were tested, exhibited considerable activities against four bacterial species, *Escherichia coli*, *Pseudomonas aeruginosa*, *Staphylococcus aureus* and *Streptococcus pyogenes*. Compounds P3DH and P8DH, P12DH showed good activity at 100-125µg/mL and compound P11DH showed excellent activity at 62.5µg/mL against *Escherichia coli* as compared to Ampicillin (MIC= 100 µg/mL). Compounds P13DH, P14DH, P15BF exhibited good activity at 100-125µg/mL and compound P4DH, P6DH showed good activity at 62.5µg/mL and compound P5DH exhibited excellent activity at 31.25-62.5µg/mL against *Pseudomonas aeruginosa* as compared to Ampicillin (MIC= 100 µg/mL). Compounds P2DH and P3DH exhibited good activity at 100-125µg/mL and P5DH compound exhibited excellent activity at 62.5 µg/mL against *Staphylococcus aureus* as compared to Ampicillin (MIC= 250 µg/mL). Compounds P1DH, P4DH, P10DH, P12DH and P15DH exhibited good activity at 100-125µg/mL against *Streptococcus pyogenes* as compared to Ampicillin (MIC= 100µg/mL) whereas P3DH compound exhibited excellent activity at 62.5 µg/mL.

Most of the compounds showed very good antifungal activity against *Candida albicans*, their MIC values were in the range between (100-500µg/mL). As far as the antifungal activity is concerned for dihydrobenzothiazole and 1,3-oxazine derivatives of s-triazine compounds P8DH, P9DH, P12DH showed good activity at 125µg/mL and P2DH and P7DH showed good activity at 250µg/mL against *Candida albicans* as compared to Griseofulvin (MIC= 500µg/mL). Compounds P1DH and P7DH showed excellent activity at 125µg/mL against *Aspergillus niger* and P6DH showed very good antifungal activity at 250µg/mL. Compounds P2DH and P9DH showed good antifungal activity against *Aspergillus clavatus*. The other compounds tested showed less activity against the fungal species.

Conclusion

In this article we have report a series of 4-(benzo[*d*]thiazol-2-yl)aniline and 6-(4-methoxyphenyl)-4-phenyl-2*H*-1,3-oxazin-2-amine linked s-triazine *i.e.* *N^2-(4-(benzo[d]thiazol-2-yl)phenyl)-N^4-(6-(4-methoxyphenyl)-4-phenyl-2H-1,3-oxazin-2-yl)-N^6-phenyl-1,3,5-triazine-2,4,6-triamine* showing better activity against gram positive bacteria, *S. aureus* and *S. pyogenes* with compare to standards and while P9DH showed better antifungal activity compared to standard. All the synthesized compounds have been established by elemental analysis, IR, ^{1}H NMR and mass spectral data. So, there is a future in doing more work on the synthesized compounds as some of them showed good activity against standard drugs.

Acknowledgement

The authors thankful to Principal Dr. A. S. Patel, Navyug Science College, Surat for providing necessary research facility, SAIF Chandigarh for NMR data and Central Kashiba laboratory for providing antimicrobial activity.

References

1. Moustafa M. A., Gineinah M. M., Nasr M. N., *Arch. Pharm. 337,* pp 427-433, (2004).
2. Krchnak V., Holladay M. W., *Solid phase het. Che., Chem. Rev., 102* pp 61-92, (2002).
3. Basedia D., Dubey B. K., *Am. J. PharmTech Res.* 1, pp 174-193, (2011).
4. Henke B. R., Consler T. G., *J. Med. Chem., 45,* pp 5492-5505, (2002).
5. Sarmah K. N., Patel T. V., *Arch. Appl. Sci. Res., 3,* pp 428-436, (2011).
6. Patel R. V., Kumari P., Rajani D. P., *Med.Chem. 4,* pp 1053-1065, (2012).
7. Parikh K. S., Vyas S. P., *J. Chem. Pharma. Res., 4,* pp 2684-2686, (2012).
8. Sarmah K. N., Patel T. V., *Adv. Appl. Sci. Res., 3,* pp 1459-1462, (2012).
9. Sekar N., Padalkar V. S., Phatangare K. R., *Res. J. Pharm. Biol. Chem. Sci., 2,* pp 908-917, (2011).
10. Melato D. S., Prosperi D. D., Nicoletta D. B., *ChemMedChem., 3,* pp 873-876, (2008).
11. Sheikh I. S. *et al., Chem. Soc. Ethiop, 24(2),* pp 283-287, (2010).
12. Dhanya S. *et al., Research Journal of Pharmaceutical Sciences, 2(2),* pp 15-19, (2013).
13. Beena K. *et al., Scholar Research Library, 5 (4),* pp 257-260, (2013).
14. Sayaji S. *et al., Journal of Chemical and Pharmaceutical Research, 5(5),* pp 271-274, (2013).
15. Firoz Nemati and Beyzai A., *Journal of Chemistry*, http://dx.doi.org/10.1155 /2013/365281, (2013).
16. Gupta S., Ajmera N., Gautam N., Sharma R., Gauatam D., *Indian J. Chem. 48B,* pp 853-856 (2009).
17. Kumbhare R. M., Ingle V. N., *Indian J. Chem. 48B,* pp 996-1002, (2009).
18. Rajeeva B., Srinivasulu N., Shantakumar S., *Eur. J. Chem. 6,* pp775-779, (2009).
19. Stanton H. L. K., Gambari R., Chung H. C., Johny C., Filly C., Albert S. C. C., *Bioorg. Med. Chem. Lett. 16,* 3626, (2008).
20. Sreenivasa M., Jaychand E., Shivakumar B., Jayrajkumar K.,Vijaykumar S., *J. Arch. Pharm. Sci. Res. 1,* 150, (2009).
21. Hermenegilda M. D., Rafael V. M., Rolffy O. A., Daniel D. C., Jose L. M. F., Scott P. W., *Bioorg. Med. Chem. Lett., 18,* 2871, (2008).
22. Abdel-Rahman H. M., Morsy M. A., *J. Enzyme Inhib., 22,* 57, (2007).
23. Mane D. V., Shinde D. B., Bhawsar S. B., Thore S. N., Shingare M. S., *Asian J. Chem., 8,* 222, (1996).
24. Cedric J. L., Charles S. M., Geoffrey W., Tracey D. B., Malcolm S., Andrew D. W., *Bioorg. Med. Chem. Lett., 6,* 5005, (2006).
25. Malik G. M., Patel T. V., *Journal of Asian Scientific Research, 7(6),* pp 214-223 (2017).