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DESIGN, SYNTHESIS AND EVALUATION OF SOME NEW ISOXAZOLES, CYANO-PYRIDINES AND 1, 5 BENZOTHIAZEPINES AS ANTIMICROBIAL AGENTS

A. Solankee* and R. Patel

Department of Chemistry, B. K. M. Science College, Valsad-396001, Gujarat, India

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Correspondence to Author:

Dr. A. Solankee

Department of Chemistry, B. K. M. Science College, Valsad-396001, Gujarat, India

E-mail: dranjani_solankee@yahoo.com

ABSTRACT: The title compounds **(7a-f)**, **(8a-f)** and **(9a-f)** have been prepared from chalcones **(6a-f)** having *s*-triazine nucleus. These chalcones on cyclisation with hydroxyl amine hydrochloride in the presence of alkali and malononitrile in the presence of ammonium acetate give isoxazoles **(7a-f)** and cyanopyridines **(8a-f)** respectively. Chalcones **(6a-f)** on condensation with 2-amino thiophenol in the presence of glacial acetic acid give benzothiazepines **(9a-f)**. Structures of newly synthesised compounds were established on the basis of their elemental analysis, IR and ^{1}H NMR. All the synthesised compounds have been screened for their antimicrobial activity.

INTRODUCTION: In recent years, the synthesis of novel isoxazole derivatives remains a main focus of medicinal research. Isoxazoles have found wide application as pharmaceutical and agrochemical agents. The synthesis of isoxazole derivatives has attracted considerable attention from organic and medicinal chemists due to their considerable bioactivity. Various biological applications have been reported for isoxazoles such as antileukemia [1], anthelmintic [2], antimicrobial [3], antitubercular [4] etc… activities. Substituted pyridine derivatives like cyanopyridines have found to possess different biological activities such as antihistaminic [5], antiproliferative [6], antitumor[7], antihypertensive [8], cardiovascular [9] etc… activities. Benzothiazepine is a benzo - annelated example of thiazepine. Thiazepine is a seven membered ring compound containing N and S as hetero atoms.

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Literature survey reveals that 1,5-benzothiazepines possess wide spectrum of pharmacological activities such as hypertensive[10] , spasmolytic[11], antiulcer[12,13] etc… activities. In continuation of our work[14-17] and the scope for further studies on chalcones and its derivatives, we herein report some novel isoxazoles **(7a-f)**, cyanopyridines **(8a-f)** and benzothiazepines **(9a-f)**.

EXPERIMENTAL SECTION: All melting points were determined in open capillary and are uncorrected. The IR spectra were recorded on Perkin-Elmer 237 spectrophotometer. ^{1}H NMR spectra were recorded on a Bruker Avance DPX 400 MHz spectrometer with $CDCl_3$ as a solvent and tetramethylsilane (TMS) as internal standard.

Thin Layer Chromatography (TLC) analytical separation was conducted with Silica Gel 60 F-254 (Merck) plates of 0.25mm thickness eluted with visualized with UV (254nm) or iodine to check the purity of the synthesised compounds.

General procedure for the compounds (3), (4), (5) and (6): Compounds (3), (4), (5) and (6) were prepared by the reported method [18].

Preparation of 2,4-bis-(tetrahydro-1',4'-oxazine)-6-[4'-{5"-(2'"-methoxyphenyl)-isoxazol-3"-yl} phenylamino]-s-triazine **(7a)** : Compound **6a** (0.01 mol) was dissolved in alcohol (25ml) and hydroxylamine hydrochloride (0.01 mol) was added to it. Then solution of KOH (5ml of 40%) was added to the reaction mixture and refluxed for 8 hours. The progress of the reaction was monitored on TLC plate. After completion, the reaction mixture was cooled and poured into crushed ice and neutralised with dilute HCl. The product separated out was filtered, washed with water, dried and recrystallised from alcohol to give **7a**.

Similarly, the remaining compounds **(7b-f)** were prepared by this method.

(7a): mp 165^{o}C, IR (KBr) cm^{-1}: 3410 (N-H str.), 3077 (=CH str.), 804 (C-N str., s-triazine moiety), 831 (C-H bending), 1636 (C=N str, isoxazoles moiety), 1278 (C-O-C str.); ^{1}H NMR ($CDCl_3$) δ : 3.52 (t, 8H, oxazine ring), 3.63 (t, 8H, oxazine ring), 3.81 (3H, s, o-OCH_3), 6.81 (1H, s, -CH=), 7.0 – 8.0 (9H, m, Ar-H and -NH). (Found: C, 62.89; H, 5.62; N, 19.00. Calcd. for $C_{27}H_{29}N_7O_4$: C, 62.90; H, 5.67; N, 19.02 %).

Preparation of 2,4-bis-(tetrahydro-1',4'-oxazine)-6-[4'-{5"-(2'"-nitrophenyl)-isoxazol-3"-yl} phenylamino]-s-triazine **(7b):** mp 165^{o}C, IR (KBr) cm^{-1}: 3405 (N-H str.), 3066 (=CH str.), 809 (C-N str., s-triazine moiety), 822 (C-H bending), 1625 (C=N str, isoxazoles moiety), 1566 (C-NO_2 str.), 1095; ^{1}H NMR ($CDCl_3$) δ: 3.49 (t, 8H, oxazine ring), 3.60 (t, 8H, oxazine ring), 6.78 (1H, s, -CH=), 7.1 – 8.3 (9H, m, Ar-H and -NH). (Found : C, 70.09; H, 4.60; N, 16.80. Calcd. for $C_{26}H_{26}N_8O_5$: C, 64.32; H, 5.60; N, 20.19 %).

Preparation of 2,4-bis-(tetrahydro-1',4'-oxazine)-6-[4'-{5"-(3'",4'"-methoxyphenyl)-isoxazol-3"-yl} phenylamino]-s-triazine **(7c):** mp 159^{o}C, IR (KBr) cm^{-1}: 3400 (N-H str.), 3051 (=CH str.), 801 (C-N str., s-triazine moiety), 831 (C-H bending), 1645 (C=N str, isoxazoles moiety), 1250 (C-O-C str.) ; ^{1}H NMR ($CDCl_3$) δ : ^{1}H NMR ($CDCl_3$) δ: 3.52 (t, 8H, oxazine ring), 3.63 (t, 8H, oxazine ring), 3.81 (3H, s, m-OCH_3), 3.81 (3H, s, p-OCH_3), 6.81 (1H, s, -CH=), 7.0 – 8.0 (8sH, m, Ar-H and -NH). (Found : C, 61.60; H, 5.71; N, 17.94. Calcd. for $C_{28}H_{31}N_7O_5$: C, 61.64; H, 5.73; N, 17.97 %).

Preparation of 2,4-bis-(tetrahydro-1',4'-oxazine)-6-[4'-{5"-(3'"-chlorophenyl)-isoxazol-3"-yl} phenyl amino]-s-triazine **(7d) :** mp 162 ^{o}C, IR (KBr) cm^{-1} : 3405 (N-H str.), 3066 (=CH str.), 809 (C-N str., s-triazine moiety), 822 (C-H bending), 1625 (C=N str, isoxazolemoiety), 1096 (C-Cl str); ^{1}H NMR ($CDCl_3$) δ : ^{1}H NMR ($CDCl_3$) δ : 3.46 (t, 8H, oxazine ring), 3.69 (t, 8H, oxazine ring), 6.69 (1H, s, -CH=), 7.0 – 8.5 (9H, m, Ar-H and -NH). (Found : C, 60.04; H, 5.02; N, 18.83. Calcd. for $C_{26}H_{26}ClN_7O_3$: C, 60.06; H,5.04; N, 18.86 %).

Preparation of 2,4-bis-(tetrahydro-1',4'-oxazine)-6-[4'-{5"-(3'",4'"-methylphenyl)-isoxazol-3"-yl} phenylamino]-s-triazine **(7e) :** mp 132 ^{o}C, IR (KBr) cm^{-1}: 3405 (N-H str.), 3066 (=CH str.), 809 (C-N str., s-triazine moiety), 822 (C-H bending), 1625 (C=N str, isoxazolemoiety), 1266 (C-O-C str.); ^{1}H NMR ($CDCl_3$) δ: ^{1}H NMR ($CDCl_3$) δ : 3.21 (3H, s, o-CH_3), 3.41 (3H, s, m-CH_3), 3.52 (t, 8H, oxazine ring), 3.63 (t, 8H, oxazine ring), 6.81 (1H, s, -CH=), 7.0 – 8.0 (8H, m, Ar-H and -NH). (Found: C, 65.45; H, 6.06; N, 19.07. Calcd. for $C_{28}H_{31}N_7O_3$: C, 65.48; H, 6.08; N, 19.09 %).

Preparation of 2,4-bis-(tetrahydro-1',4'-oxazine)-6-[4'-{5"-(4'"- N,N-diethylphenyl)-isoxazol-3"-yl} phenylamino]-s-triazine **(7f) :** mp 215^{o}C, IR (KBr) cm^{-1}: 3405 (N-H str.), 3066 (=CH str.), 809 (C-N str., s-triazine moiety), 822 (C-H bending), 1625 (C=N str, isoxazolemoiety); ^{1}H NMR ($CDCl_3$) δ: 3.32 (4H, q, N-CH_2), 3.32 (6H, t, -CH_3), 3.50 (t, 8H, oxazine ring), 3.61 (t, 8H, oxazine ring), 6.81 (1H, s, -CH=), 7.0 – 8.0 (9H, m, Ar-H and -NH). (Found: C, 64.35; H, 6.50; N, 20.11. Calcd. for $C_{30}H_{36}N_8O_3$: C, 64.37; H, 6.52; N, 20.13 %).

Preparation of 2, 4-bis-(tetrahydro-1', 4'-oxazine)-6-[4′-{2″-amino-3″-cyano-4″- (2‴-methoxyphenyl) – pyridin-6"-yl} phenyl amino]-s-triazine **(8a).**

Compound **6a** (0.01 mol) was dissolved in ethyl alcohol (25ml) malononitrile (0.01 mol) and ammonium acetate were added to it and Refluxed for 10 hours. The progress of the reaction was monitored on TLC plate. After completion, the reaction mixture was cooled and poured into crushed ice and neutralised with dilute HCl. The product separated out was filtered, washed with water, dried and recrystallized from alcohol to give **8a**.

Similarly, the remaining compounds **(8b-f)** were prepared by this method.

(8a): mp 105^{o}C, IR (KBr) cm^{-1}: 3410 (N-H str.), 3062 (=CH str.), 809 (C-N str, s-triazine moiety), 1618 (C=N str, cyanopyridine moiety), 1250 (C-O-C str.); ^{1}H NMR ($CDCl_3$) δ: 3.53 (t, 8H, oxazine ring), 3.67 (t, 8H, oxazine ring), 3.87 (3H, s , o-OCH_3), 6.8 (2H, s, -NH_2), 7.0 – 8.0 (10H, m, Ar-H and -NH); (Found : C, 63.67; H, 5.50; N, 22.25. Calcd. for $C_{30}H_{31}N_9O_3$: C, 63.70; H, 5.52; N, 22.29 %).

Preparation of 2,4-bis-(tetrahydro-1',4'-oxazine)-6-[4′-{2″-amino-3″-cyano-4″- (2‴-nitrophenyl) – pyridin-6"-yl} phenyl amino]-s-triazine **(8b) :** mp 168^{o}C, IR (KBr) cm^{-1}: 3409 (N-H str.), 3065 (=CH str.), 811 (C-N str, s-triazine moiety), 1575 (C=N str., cyanopyridine moiety), 692 (C-NO_2 str.); ^{1}H NMR ($CDCl_3$) δ: ^{1}H NMR ($CDCl_3$) δ : 3.55 (t, 8H, oxazine ring), 3.69 (t, 8H, oxazine ring), 6.91 (2H, s, -NH_2), 7.2 – 8.3 (10H, m, Ar-H and -NH) ; (Found: C, 59.96; H, 4.84; N, 24.08 Calcd. For $C_{29}H_{28}N_{10}O_4$: C, 59.99; H, 4.86; N, 24.12 %).

Preparation of 2,4-bis-(tetrahydro-1',4'-oxazine)-6-[4′-{2″-amino-3″-cyano-4″- (3″,′4‴-methoxy phenyl) – pyridin-6"-yl} phenyl amino]-s-triazine **(8c):** mp 162^{o}C, IR (KBr) cm^{-1}: 3407 (N-H str.), 3069 (=CH str.), 844 (C-N str, s-triazine moiety), 1590 (C=N str, cyanopyridine moiety), 1257 (C-O-C str.); ^{1}H NMR ($CDCl_3$, δ, ppm): ^{1}H NMR ($CDCl_3$) δ: 3.53 (t, 8H, oxazine ring), 3.67 (t, 8H, oxazine ring), 3.71 (3H, s , m-OCH), 3.86 (3H, s , p-OCH_3), 6.8 (2H, s, -NH_2), 7.0 – 8.0 (9H, m, Ar-H and -NH); (Found: C, 62.48; H, 5.55; N, 21.13 Calcd. For $C_{31}H_{33}N_9O_4$: C, 62.51; H, 5.58; N, 21.16%.)

Preparation of 2,4-bis-(tetrahydro-1',4'-oxazine)-6-[4′-{2″-amino-3″-cyano-4″- (3‴-chlorophenyl) – pyridin-6"-yl} phenyl amino]-s-triazine **(8d):** mp 190^{o}C, IR (KBr) cm^{-1}: 3432 (N-H str.), 3070 (=CH str.), 813 (C-N str, s-triazine moiety), 1580 (C=N str, cyanopyridine moiety), 798 (C-Cl str.) ; ^{1}H NMR ($CDCl_3$) δ: ^{1}H NMR ($CDCl_3$) δ : 3.55 (t, 8H, oxazine ring), 3.69 (t, 8H, oxazine ring), 6.91 (2H, s, -NH_2), 7.2 – 8.3 (10H, m, Ar-H and -NH) ; (Found: C, 61.10; H, 4.92; N, 22.11 Calcd. For $C_{29}H_{28}ClN_9O_2$: C, 61.11; H, 4.95; N, 22.12%.)

Preparation of 2,4-bis-(tetrahydro-1',4'-oxazine)-6-[4′-{2″-amino-3″-cyano-4″- (3″,′4‴-methylphenyl) – pyridin-6"-yl} phenyl amino]-s-triazine **(8e):** mp 187^{o}C, IR (KBr) cm^{-1}: 3488 (N-H str.), 3067 (=CH str.), 888 (C-N str, s-triazine moiety), 1578 (C=N str, cyanopyridine moiety) ; ^{1}H NMR ($CDCl_3$) ^{1}H NMR ($CDCl_3$) δ : 3.29 (3H, s, o-CH_3), 3.47 (3H, s, m-CH_3), 3.55 (t, 8H, oxazine ring), 3.69 (t, 8H, oxazine ring), 6.91 (2H, s, -NH_2), 7.2 – 8.3 (9H, m, Ar-H and -NH) ; (Found: C: 66.04; H, 5.65; N, 22.34 Calcd. For $C_{31}H_{33}N_9O_2$: C, 66.06; H, 5.68; N, 22.36%.)

Preparation of 2,4-bis-(tetrahydro-1',4'-oxazine)-6-[4′-{2″-amino-3″-cyano-4″- (4‴-N,N-diethyl phenyl) – pyridin-6"-yl} phenyl amino]-s-triazine **(8f):** mp 155^{o}C, IR (KBr) cm^{-1}: 3407 (N-H str.), 3070 (=CH str.), 813 (C-N str, *s*-triazine moiety), 1580 (C=N str, cyanopyridine moiety) ; ^{1}H NMR ($CDCl_3$) δ: ^{1}H NMR ($CDCl_3$) δ: 3.32 (4H, *q*, N-CH_2), 3.32 (6H, *t*, -CH_3), 3.55 (t, 8H, oxazine ring), 3.69 (t, 8H, oxazine ring), 6.91 (2H, *s*, -NH_2), 7.2 – 8.3 (10H, *m*, Ar-H and -NH) ; (Found: C: 64.32; H, 5.59; N, 24.19 Calcd. For $C_{33}H_{38}N_{10}O_2$: C, 64.34; H, 5.92; N, 24.21%.)

Preparation of 2,4-bis-(tetrahydro-1',4'-oxazine)-6-[4′-{2″-(2‴ -methoxy phenyl) -2″,3″ –dihydro -1″,5''-benzothiazepine-4″-yl} phenyl amino]-s-triazine **(9a):** Compound (**6a)** (0.01mol) and 2-amino thiophenol (0.01mol) in alcohol (30 mL) were refluxed for 12 hours in the presence of glacial acetic acid (5 mL).The progress of reaction was monitored on TLC plate. The reaction mixture was then cooled and poured into crushed ice. The product separated out was filtered, washed with water, dried and crystallised from alcohol to give (**9a)**.

Similarly, the remaining compounds (**9b-f)** were prepared by this method.

(9a): mp 60^{o}C, IR (KBr) cm^{-1}: 3025 (=CH str), 1556 (C=C str), 1573 (C=N str), 802 (C-N, *s*-triazine); ^{1}H NMR ($CDCl_3$) δ: 3.10 (dd, 1H, C_3-H_a benzothiazepine moiety), 3.35 (dd, 1H, C_3-H_b benzothiazepine moiety), 3.55 (t, 8H, oxazine ring), 3.69 (t, 8H, oxazine ring), 3.81 (3H, *s*, o-OCH_3), 5.00 (dd, 1H, -CH- benzothiazepine moiety), 6.90- 8.10 (m, 13H, 12 Ar-H and 1 NH) ; (Found: C, 64.98; H, 5.76; N, 16.04. Calcd. for $C_{33}H_{35}N_7O_3S$: C, 65.00; H, 5.79; N, 16.08 %).

Preparation of 2,4-bis-(tetrahydro-1',4'-oxazine)-6-[4′-{2″-(2‴ -nitrophenyl) -2″,3″ –dihydro - 1″,5''-benzothiazepine-4″-yl} phenyl amino]-s-triazine **(9b):** mp 66^{o}C, IR (KBr) cm^{-1}: 3022 (=CH str), 1550 (C=C str), 1570 (C=N str), 810 (C-N, *s*-triazine) 695 (C-NO_2 str.) ; ^{1}H NMR ($CDCl_3$) δ : 3.12 (dd, 1H, C_3-H_a benzothiazepine moiety), 3.32 (dd, 1H, C_3-H_b benzothiazepine moiety), 3.51 (t, 8H, oxazine ring), 3.71 (t, 8H, oxazine ring), 5.12 (dd, 1H, -CH- benzothiazepine moiety), 7.0- 8.0 (m, 13H, 12 Ar-H and 1 NH) ; (Found : C, 61.49; H, 5.13; N, 17.91. Calcd. for $C_{32}H_{32}N_8O_4S$: C, 61.52; H, 5.16; N, 17.94%).

Preparation of 2,4-bis-(tetrahydro-1',4'-oxazine)-6-[4′-{2″-(3‴,4‴ -methoxyphenyl) -2″,3″ –dihydro - 1″,5''-benzothiazepine-4″-yl} phenyl amino]-s-triazine **(9c):** mp 188 ^{o}C, IR (KBr) cm^{-1}: 3015 (=CH str), 1567 (C=C str), 1589 (C=N str), 821 (C-N, *s*-triazine) ; ^{1}H NMR ($CDCl_3$) δ: 3.18 (dd, 1H, C_3-H_a benzothiazepine moiety), 3.41 (dd, 1H, C_3-H_b benzothiazepine moiety), 3.61 (t, 8H, oxazine ring), 3.71 (t, 8H, oxazine ring), 3.82 (3H, *s*, m-OCH_3), 3.98 (3H, *s*, p-OCH_3), 5.21 (dd, 1H, -CH- benzothiazepine moiety), 6.80- 8.0 (m, 12H, 11 Ar-H and 1 NH). (Found : C, 63.81; H, 5.80; N, 15.31. Calcd. for $C_{34}H_{37}N_7O_4S$: C, 63.83; H, 5.83; N, 15.33 %).

Preparation of 2,4-bis-(tetrahydro-1',4'-oxazine)-6-[4′-{2″-(3‴ -chlorophenyl) -2″,3″ –dihydro - 1″,5''-benzothiazepine-4″-yl} phenyl amino]-s-triazine **(9d):** mp 79 ^{o}C, IR (KBr) cm^{-1}: 3034 (=CH str), 1542 (C=C str), 1562 (C=N str), 766 (C- Cl str.), 821 (C-N, *s*-triazine) ; ^{1}H NMR ($CDCl_3$) δ : 3.14 (dd, 1H, C_3-H_a benzothiazepine moiety), 3.37 (dd, 1H, C_3-H_b benzothiazepine moiety), 3.55 (t, 8H, oxazine ring), 3.73 (t, 8H, oxazine ring), 5.14 (dd, 1H, -CH- benzothiazepine moiety), 7.2- 8.3 (m, 13H, 12 Ar-H and 1 NH); (Found : C, 64.27; H, 5.36; N, 16.38. Calcd. for $C_{32}H_{32}ClN_7O_2S$: C, 62.58; H, 5.25; N, 15.97 %).

Preparation of 2,4-bis-(tetrahydro-1',4'-oxazine)-6-[4′-{2″-(3‴,4‴ -dimethylphenyl) -2″,3″ –dihydro - 1″,5''-benzothiazepine-4″-yl} phenyl amino]-s-triazine **(9e):** mp 95 ^{o}C, IR (KBr) cm^{-1}: 3022 (=CH str), 1550 (C=C str), 1570 (C=N str), 810 (C-N, *s*-triazine), 790 ; ^{1}H NMR ($CDCl_3$) δ : 3.22 (3H, *s*, o-CH_3), 3.39 (3H, *s*, m-CH_3), 3.24 (dd, 1H, C_3-H_a benzothiazepine moiety), 3.34 (dd, 1H, C_3-H_b benzothiazepine moiety), 3.60 (t, 8H, oxazine ring), 3.74 (t, 8H, oxazine ring), 5.19 (dd, 1H, -CH- benzothiazepine moiety), 7.3- 8.1 (m, 12H, 11 Ar-H and 1 NH); (Found: C, 67.17; H, 6.11; N, 16.12. Calcd. for $C_{34}H_{37}Cl_2N_7O_2S$: C, 67.19; H, 6.14; N, 16.13 %).

Preparation of 2,4-bis-(tetrahydro-1',4'-oxazine)-6-[4′-{2″-(4‴ -N,N-diethylphenyl) -2″,3″ –dihydro - 1″,5''-benzothiazepine-4″-yl} phenyl amino]-s-triazine **(9f):** mp 108^{o}C, IR (KBr) cm^{-1}: 3022 (=CH str), 1550 (C=C str), 1570 (C=N str), 810 (C-N, *s*-triazine); ^{1}H NMR ($CDCl_3$) δ: 3.32 (4H, *q*, N-CH_2), 3.32 (6H, *t*, -CH_3), 3.21 (dd, 1H, C_3-H_a benzothiazepine moiety), 3.40 (dd, 1H, C_3-H_b benzothiazepine moiety), 3.57 (t, 8H, oxazine ring), 3.67 (t, 8H, oxazine ring), 5.18 (dd, 1H, -CH- benzothiazepine moiety), 7.1- 8.5 (m, 13H, 12 Ar-H and 1 NH) ; (Found : C, 66.41; H, 6.47; N, 17.19. Calcd. for $C_{36}H_{42}N_8O_2S$: C, 66.44; H, 6.50; N, 17.22%).

RESULTS AND DISCUSSION: Minimum inhibitory concentration (MIC) of all the synthesised compounds have been screened by Broth dilution method against four different strains, viz. two Gram positive bacteria (*S. aureus* MTCC 96 and *S. pyogenes* MTCC 442) and two Gram negative bacteria (*E. coli* MTCC 443 and *P. aeruginosa* MTCC 1688) and compared with standard drug: Ampicillin. Antifungal activity against *C. albicans* MTCC 227, *A. niger* MTCC 282 and *A. clavatus* MTCC 1323 organisms was determined by same method and compared with standard drug: Griseofulvin.

Antibacterial Activity: From the screening results **(Table 1)**, In Gram positive bacterial strains compounds **7e, 7f, 8f** and **9f** showed good activity (25 – 150 µg/ml) against *S. aureus* ; whereas compounds **7e, 9c** and **9f** showed good to very good activity (62.5 – 100 µg/ml) against *S. pyogenes* compared with Ampicillin.

In Gram negative bacterial strains, compounds **7c, 7f, 8c** and **9b** exhibited good activity (25 – 125 µg/ml) against *E. coli*; compound **9b** exhibited good activity (50 – 100 µg/ml) against *P. aeruginosa*.

All others compound show moderately active or less active against all bacterial strains.

Antifungal Activity: From the screening results **(Table 1)**, compounds **7b, 7f, 8b, 8d** and **9c** showed very good activity against *C. albicans*, while compounds **7c, 7d, 8c, 8e** and **9b** showed good activity against *C. albicans* compared with Griseofulvin.

TABLE 1: ANTIBACTERIAL AND ANTIFUNGAL ACTIVITY DATA OF COMPOUNDS 7(A-F), 8(A-F) AND 9(A-F)

Compound	Minimal bactericidal concentration µg/ml				Minimal fungicidal concentration µg/ml		
	Gram positive		Gram negative				
	S. aureus MTCC 96	*S. pyogenus* MTCC 442	*E. coli* MTCC443	*P. aeruginosa* MTCC1688	*C. albicans* MTCC 227	*A. niger MTCC282*	*A. clavatus MTCC1323*
7a	500	500	500	500	1000	1000	1000
7b	200	200	200	250	250	1000	1000
7c	250	250	125	125	500	500	500
7d	200	500	250	500	500	>1000	>1000
7e	62.5	100	200	200	1000	>1000	>1000
7f	100	200	100	125	250	>1000	>1000
8a	250	250	200	200	1000	1000	1000
8b	500	250	500	500	200	>1000	>1000
8c	125	125	100	125	500	1000	1000
8d	250	250	200	500	250	500	500
8e	250	250	125	125	500	500	500
8f	62.5	200	250	250	1000	>1000	>1000
9a	250	500	250	250	1000	>1000	>1000
9b	500	500	100	100	500	1000	1000
9c	200	100	250	250	250	1000	1000
9d	250	500	200	250	>1000	>1000	>1000
9e	200	250	200	200	1000	1000	1000
9f	100	62.5	250	250	>1000	250	500
Ampicillin	100	100	250	100	-	-	-
Griseofulvin	-	-	-		500	100	100

CONCLUSION: Compound having ethyl group have exhibited more antimicrobial activity. These results suggest that the chalcone derivatives have excellent scope for further development as commercial antimicrobial agents.

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