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Research Article

In-vitro Antimicrobial and Antifungal Activity of Pyrimidine and Pyrazolo-[1, 5-a] Pyrimidine

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Abstract

In the present study, we have carried out the synthesis of pyrazolo-[1, 5-a] pyrimidine and pyrimidine derivatives and were investigated for their in vitro antimicrobial and antifungal activities. The results revealed that some of tested compounds possess potent antimicrobial and anti-fungal activities.

1.0 Introduction

Chalcones are 1, 3-diphenyl-2-propene-1-one, in which two aromatic rings are linked by a three carbon α, β -unsaturated carbonyl system. These are abundant in edible plants and are considered to be precursors of flavonoids and isoflavonoids[1]. Chalcones present great interest as compounds exhibiting antimalarial[2], anticancer[3,4], antimicrobial and antioxidant[5], antiinflammatory[6], antiplatelet[7], antileishmanial[8], antitrichomonal[9], antitrypanosoma cruzi[10] activities, antiangiogenic and antitumor[11] as well as hyperglycemic[12]. Chalcones are useful synthons in the synthesis of a large number of bioactive molecules, such as pyrazolines, pyrazoles and isoxazoles that are well-known nitrogen-containing heterocyclic compounds[13, 14].

From a chemical point of view, an important feature of chalcones and their heteroanalogs is the ability to act as activated unsaturated systems in conjugated addition reactions of carbanions in the presence of basic catalysts [1].

Pyrimidine derivatives have wide varieties of usages and its nucleus is also present in vitamin B_{12} and folic acid. Pyrimidine heterocycles possessing hydroxyl group has a unique place in medicinal chemistry[15], and also plays a vital role in biological processes as well as synthetic drugs[16]. Pyrimidines are associated with various therapeutic activities e.g., anticancer[18, 19] anti-, anti-tubercular[20], anti-inflammatory[21,] antibacterial[22], antihypertensive[23], and antimicrobial[24] activities. Pyrimidines are present among the three isomeric diazines. Several (mainly uracil, thymine and cytosine) Pyrimidines have been isolated from the nucleic acid hydrolyses. The nucleic acid are essential constituent of all cell and thus of all living matter cytosine is found to be present in both types of nucleic acid i.e. ribonucleic acid (RNA) and deoxyribonucleic acid (DNA) while uracil present only in RNA and thymine only in DNA [25].

In this work we have synthesized some of pyrazolo [1,5-a] pyrimidine and 4,6-dihetaryl pyrimidine.

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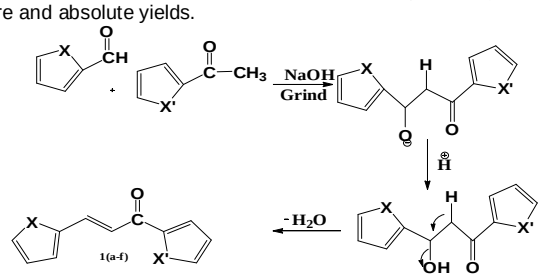
2.0 Material and Methods

2.1 Synthesis of 1, 3-di(2-hetaryl) propenone [1(a-e)]

Hetarylmethyl ketone (5 mmol), hetaryl aldehyde (5 mmol) and $NaOH_{(s)}$ (5mmol) were combined using a mortar and pestle, and the yellow medium was aggregated until a pale yellow powder was formed within 10 min. The cross- aldol product was washed with water, dried and crystallized from ethanol; the product gave very pure and absolute yields.



(E)-1,3-di(hetar-2-yl)prop-2-en-1-one

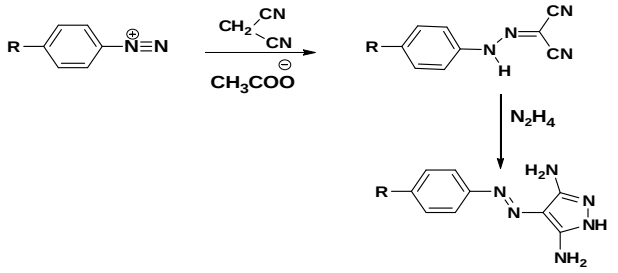
1a; X = S, X' =S
1b; X = O, X' = S
1c; X = O, X' = O
1d; X = S, X' = NH
1e; X = O, X' = NH
2f; X = S, X' = O

Scheme 1: Synthesis of 1, 3-di (het-2-aryl)propen - 1-ones.1 (a-f)

2.2 Synthesis of pyrazolo [1, 5-a] pyrimidine using heterocyclic chalcones with 4-((4-subestitutedphenyl)diazenyl)-1H-pyrazol-3,5-diamine

Step-I: Synthesis of 4-Arylazo-3, 5-diamino-1H-pyrazoles
A solution of hydrazine hydrate (0.5 g, 9 mmol) in MeOH (30 mL) was added to the hydrazone (3 mmol). The reaction mixture was

heated under reflux for 4 h and was then evaporated to dryness. The solid residue was recrystallized from appropriate solvents.



Scheme 2: Synthesis of 4-Arylazo-3,5-diamino-1H-pyrazole

Step-II: Synthesis of pyrazolo[1,5-a]pyrimidine using heterocyclic chalcones with 4-((4-subestitutedphenyl)diazenyl)-1H-pyrazol-3,5-diamine [2(a-q)]

A mixture of 4-((4-subestitutedphenyl) diazenyl)-1H-pyrazol-3,5-diamine (0.01mole) and hetaryl chalcones (0.01mole) was refluxed in glacial acetic acid in presence of anhydrous zinc chloride. The completion of the reaction was monitored by TLC. After cooling the precipitate was formed which could be recrystallized from ethanol/DMF.

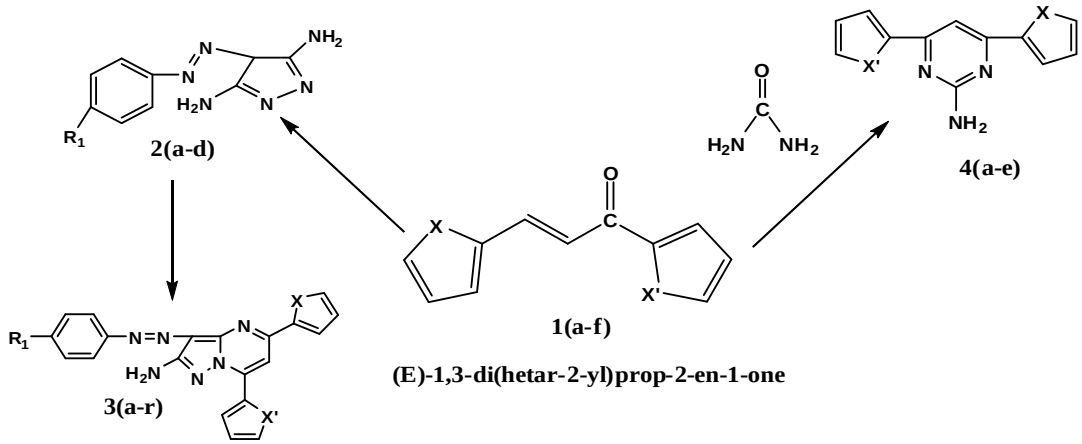
Step-III: Synthesis of 4, 6-Dihetarylpyrimidin-2-amine [3(a-e)]

A mixture of hetaryl chalcones (0.001 mol) and guanidine hydrochloride (500 mg) in absolute ethanol (10 ml) were refluxed on a water bath for 6 hours. The solvent was completely evaporated and the residue was poured into ice cold water. The precipitated solid was collected by filtration and crystallized from suitable.

3.0 Results and Discussion

Hetaryl aldehyde with hetaryl ketone by grinding gave hetaryl chalcone (2), after purification byrecrystallization from ethanol, pure compounds as shown in (scheme 1) in (90-97)% yield. Then treatment of hetaryl chalcones (1) 4-Arylazo-3,5-diamino-1H-pyrazoles and guanidine hydrochloride gave pyrazol[1,5-a]pyrmidine(3) and dihetaryl pyrimidine-2-amine(4) after purification by recrystallization from ethanol, pure compounds as shown in (scheme 3) The structures of these products were established from their elemental analysis, FT-IR, C.H.N and ^{1}H NMR spectra and screened for in *vitro* activity.

3.1 Synthesis of Heterocyclic Compounds



Scheme 3

Compound	R_1	X	X'
3a	-H	S	S
3b	-Cl	S	O
3c	$-OCH_3$	S	O
3d	-H	O	O
3e	$-OCH_3$	O	O
3f	-Cl	O	O
3g	$-CH_3$	O	O
3h	$-CH_3$	O	S

Table 1: Physical properties of 3-(phenyldiazenyl)-5, 7-di (hetar-2-yl) pyrazolo [1, 5-a] pyrimidin-2-amine

Compounds	3a	3b	3c	3d	3e	3f	3g	3h	3i	3j	3k	3l	3m	3n	3o	3p	3q	3r
mp ^{0}C	240-241	260-262	243-244	223-225	260-262	266-267	227-228	247-248	257-258	278-280	220-221	270-270	236-237	280-282	228-230	254-256	285-287	238-239
Yield%	76.1	60.1	56.7	5.2	75.3	60.1	65.7	55.5	80.6	77.3	60.0	61.1	80.1	66.1	76.0	71.1	60.3	60.0

3.2 Spectral Data and its interpretation

3-(substituted-phenyldiazenyl)-5,7-di(hetar-2-yl)pyrazolo[1,5-a]pyrimidine 3-(phenyldiazenyl)-5,7-di(thiophen-2-yl)pyrazolo[1,5-a]pyrimidin-2-amine [3a]

Reddish brown; (240-241^{0}C),yield% 76.1%, ^{1}H NMR (DMSO-d_6, 300.0 MHz) δ 6.52(s, 2- amine), 7.31-7.45(m, 4H, phenyl), 7.06(d, 1H, phenyl C_3-H,C_5-H), 7.17(t, 2H,C_4-H,C_4-H,2-theiophene), 7.69-7.85(m, 4H, 2-theiophene), 7.80(s, 1H, 2-pyrimidine). FTIR (KBr, cm^{-1}), 3446.3 cm^{-1}(NH), 1595 cm^{-1}(C=N), 1635.1 cm^{-1} (C=C), 966.9 cm^{-1}(C-S), 825 cm^{-1}(C-H aromatic) MS: m/z 402(M^+)(80.4%), 403(9.1%), 404(1.3%), Analysis (calc) for: $C_{20}H_{14}N_6S_2$, C (59.68), H (3.51), N(20.88), S(15.93).

(E)-3-((4-chlorophenyl)diazenyl)-7-(furan-2-yl)-5-(thiophen-2-yl)pyrazolo[1,5-a]pyrimidin-2-amine [3b]

Reddish brown crystal; (265-266^{0}C), yield% 60.1%, ^{1}H NMR (DMSO-d_6, 300.0 MHz) δ 6.79(s, 2- amine), 7.40 (d, 2H, phenyl C_2-

H, C_6-H), 7.520 (d, 2H, phenyl C_3-H,C_5-H,), 7.54(t, 2-thiophene C_4-H), 8.03(s, 1H, C-H,4-pyrimidine), 6.98(t, furan C_4-H), 7.69-8.16(m,4H,2-theiophene, 2-furan). FTIR (KBr, cm^{-1}), 3450.3 cm^{-1}(NH), 1630.1 cm^{-1} (C=C), 1542.9 cm^{-1}(C=N), 1174.9 cm^{-1}(C-O), 819 cm^{-1}(C-H aromatic) MS:m/z 420(M^++1)(100%),422(59.16%), 309(41.47%), 282(30.74%), 254(48.44%), 228(50.21%), 110(33.71%). Analysis (calc) for: $C_{20}H_{13}ClN_6OS$, C (57.07), H (3.11), Cl (8.42), N (20.99), O (3.80), S (7.65).

7-(furan-2-yl)-3-((4-methoxyphenyl) diazenyl) - 5- (theiophen-2-yl) pyrazolo [1,5-a] pyrimidin-2-amine [3c]

Reddish brown crystal; (247-248^{0}C),Yield% 55.5%, ^{1}H NMR (DMSO-d_6,300.0 MHz) δ 6.95(s, 2-amine), 6.96(t, furanC_4-H),7.073(d, 2H, phenyl C_2-H, C_6-H), 7.103 (d, 2H, phenyl C_3-H, C_5-H) 7.28(t, thiophene C_4-H), 7.820-7.87(m,4H,2-furan, 2-thiophene), 8.21(s, 1H, C-H,4-pyrimidine), 3.84(s,3H,-OCH_3). FTIR(KBr,cm^{-1}), 3409.9 cm^{-1}(NH), 1587 cm^{-1}(C=N) 1608.5(C=C), 1245.9 cm^{-1} (C-N), 1145.2 cm^{-1} (C-O), 821.6 cm^{-1}(C-H aromaic), 1022.2 cm^{-1}(C-S). MS: m/z 416(M^++1)(100%), 388(15.95%), 282(30.41%), 107(17.84%) Analysis (calc) for: $C_{21}H_{16}N_6O_2S$,C(60.56), H(3.87), N(20.18), O(7.86), S(7.70).

5,7-di(furan-2-yl)-3-(phenyldiazenyl)pyrazolo[1,5-a]pyrimidin-2-amine [3d]

Reddish brown crystal; (256-257^{0}C),^{1}H NMR (DMSO-d_6,300.0 MHz) δ 6.82(s,2- amine),6.97(t, 1H, furanC_4-H), 7.33-7.54(m,4H, phenyl C_2-H,C_3-H,C_5-H,C_6-H), 7.87(m, 2H,furanC_3-H, C_5-H), 7.84 (s,1H, C-H,4-pyrimidine); FTIR(KBr,cm^{-1}) 3433 cm^{-1} (NH), 1550 cm^{-1}(C=N)1601.59 cm^{-1}(C=C) and aromatic rings) 885 cm^{-1}(C-H aromatic). MS:m/z 371(M+2H); Analysis (calc) for :$C_{20}H_{14}N_6O_2$, C(64.86),H(3.81), N(22.69), O(8.64)%.

5,7-di(furan-2-yl)-3-((4-methoxyphenyl)diazenyl)pyrazolo[1,5-a]pyrimidin-2-amine [3e]

Reddish brown crystal; (270-271^{0}C), Yield% 80.6%, ^{1}H NMR (DMSO-d_6,300.0 MHz) δ 6.51(s, 2-amine), 6.98(t, furanC_4-H),7.50-7.81(m, 4H, 2-furanC_3-H, C_5-H) 6.99 (d,2H, phenyl C_2-H,C_6-H), 7.13 (d, 2H, C_5-H,C_6-H), 7.85(s,1H, C-H,4-pyrimidine), 3.83(s,3H, methoxy ,-OCH_3). FTIR (KBr, cm^{-1}), 3784.1 cm^{-1}(NH), 1576 cm^{-1}(C=N)1245.9 cm^{-1}(C-N), 1596.9 cm^{-1} (C=C), 10118.3 cm^{-1} (C-O),1380.9 cm^{-1}(CH_3), 829.3 cm^{-1}(=C-H) MS : m/z 401(M^++1)(100%),372.4(26.89%),237(53.40%),171(22.23%),107(53.0%),63.00(41.12%) Analysis (calc) for: C21H16N6O3, C (62.69), H (4.03), N(20.99), O(11.99)%.

3-((4-chlorophenyl)diazenyl)-5,7-di(furan-2-yl)pyrazolo[1,5-a]pyrimidin-2-amine [3f]

Reddish brown crystal; (278-280)^{0}C, Yield% 77.3%, ^{1}H NMR (DMSO-d_6,300.0 MHz) δ 6.2(s, 2-amine), 6.97(t, 2H, furanC_4-H), 7.33(d,2H, phenyl C_2-H, C_6-H), 7.57(d,2H, phenyl C_3-H,C_5-H), 7.69-7.89(m, 4H,furanC_3-H, C_5-H), 7.81(s,1H, C-H,4-pyrimidine); FTIR(KBr,cm^{-1}), 3404 cm^{-1}(NH), 1566 cm^{-1}(C=N), 1677 cm^{-1} (C=C), 860 cm^{-1} (C-H aromatic MS:m/z 405(M^++1H)(100%), 406(78.87%), Analysis (calc) for: $C_{20}H_{13}ClN_6O_2$; C(59.34), H(3.24), Cl(8.76), N(20.76).

5,7-di(furan-2-yl)-3-(p-tolydiazenyl)pyrazolo[1,5-a]pyrimidin-2-amine [3g]

Reddish brown crystal; (220-221^{0}C), Yield% 61.1%, ^{1}H NMR (DMSO-d_6, 300.0 MHz) δ 6.77(s, 2-amine), 6.95(t,1H, furanC_4-H), 7.33 (d, 2H, phenyl C_2-H,C_3-H), 7.5(d,2H, phenyl C_3-H,C_5-H), 7.74-8.01(m, 4H,2 furan), 8.23(s, 1H, C-H,4-pyrimidine), 8.01 (d,1H, furanC_5-H), 2.31 (s,3H, methyl, -CH_3). FTIR(KBr,cm^{-1}), 3425.1 cm^{-1}(NH), 1560 cm^{-1}(C=N), 1670 cm^{-1} (C=C), 875 cm^{-1} (C-H aromatic). MS:m/z 385(M^++1)(100%), 356(78.87%),293(55.67%), 238(56.32) Analysis (calc) for: $C_{21}H_{16}N_6O_2$,C(65.62), H(4.20), O(8.32)%.

5-(furan-2-yl)-7-(thiophen-2-yl)-3-(p-tolyldiazenyl)pyrazolo[1,5-a]pyrimidin-2-amine [3h]

Reddish brown crystal, (228-230^{0}C), yield% 76.0%, ^{1}H NMR (DMSO-d_6, 300.0 MHz) δ 6.50(s, 2- amine), 6.96(t, 1H, 2-furan C_4-H), 7.19(t,1H, 2-theiophen C_4-H), 7.23 (d, 2H,phenyl C_3-H , C_5-H,),7.76(d,2H,phenyl C_2-H, C_6-H) 7.82(s, 1H, C-H,4-pyrimidine), 2.34(s, CH_3 methyl). FTIR (KBr, cm^{-1}), 3440.3 cm^{-1}(NH), 1590 cm^{-1}(C=N), 1625.1 cm^{-1} (C=C), 1166.9 cm^{-1}(C-O), 835 cm^{-1}(C-H aromatic) MS:m/z 400(M^+)(100%), 401(25.16%), 402(5.4%), Analysis (calc) for: $C_{21}H_{16}N_6OS$, C (62.98), H (4.03), N(20.99), O(4.00), S(8.01).

Step-III: 4, 6-Dihetarylpyrimidin-2-amine

Table 2: Physical properties of 4,6-Dihetarylpyrimidin-2-amine

compounds	4a	4b	4c	4d	4e
mp ^{0}C	130-132	195-197	94-95	164-165	135-136
Yield %	73.0	70.0	60.2	68.1	64.4

4,6-di(thiophen-2-yl)pyrimidin-2-amine [4a]

Brawn needle crystal; (130-131^{0}C), Yield% 75.0%, ^{1}H NMR (CD_3Cl-D_2O, 300.0 MHz) δ 6.60(s, 2H, aromatic C-NH_2), 7.14(t, 2H,C_4-H,2-theiophene), 7.21-7.78(m, 4H, 2-theiophene), 7.96(s,2H pyrimidine). FTIR (KBr, cm^{-1}) 3326.59 cm^{-1}(NH), 1639.2 cm^{-1}(C=N), 1560.13 cm^{-1} (C=C), 1225.54 cm^{-1} (C-N), 852.88 cm^{-1} (=C-H), 634.47 cm^{-1} (C-S) MS: m/z 259(M^+) (100%), 218(48.8%), 108(28.7), 69(19.3%) Analysis (calc) for: $C_{12}H_9N_3S_2$, C (55.57), H (3.50), N (16.20), S (24.73).

4-(furan-2-yl)-6-(thiophen-2-yl)pyrimidin-2-amine [4b]

Reddish brown crystal, (195-196^{0}C), Yield % 70.0%, ^{1}H NMR (CD_3Cl-D_2O, 300.0 MHz) δ 6.59(s, 2H, aromatic C-NH_2), 6.98 (t, 1H,C_4-H,2-furan), 7.13 (t, 1H,C_4-H,2-theiophene), 7.42-7.75(m, 4H, 2-theiophene, 2-furan) 7.97(s,2H pyrimidine). FTIR (KBr, cm^{-1}) 3335.59 cm^{-1}(NH), 1645.2 cm^{-1}(C=N), 1564.13 cm^{-1} (C=C), 860.38 cm^{-1} (C-H aromatic), 660.47 cm^{-1} (C-S). MS:m/z 244(M^++H)(95.22%), Analysis (calc) for: $C_{12}H_9N_3OS$, C (59.24), H (3.73), N (17.27), O(6.58), S (13.18).

4-(1H-pyrrol-2-yl)-6-(thiophen-2-yl)pyrimidin-2-amine [4c]

Yellow crystal, (164-165^{0}C), Yield % 76.7%, ^{1}H NMR (CD_3Cl-D_2O, 300.0 MHz) δ 5.01(s, 1H, 2-pyrrol), (6.02,6.94)(m,2H,C_3-H, C_5-H,2-pyrrol), 6.15(t, 1H,C_4-H,2-pyrrol), 6.61(s, 2H, aromatic C-NH_2), 6.94(m, 1H,C_2-H, 2-pyrrol),), 7.15(t, 1H,C_4-H,2-thiophene), 7.68-7.88(m, 2H, 2-theiophene) 7.97(s,2H pyrimidine). FTIR (KBr, cm^{-1}) 3356.59 cm^{-1}(NH), 1601.2 cm^{-1}(C=N), 1555.13 cm^{-1} (C=C), 1235.54 cm^{-1} (C-N), 877.38 cm^{-1} (C-H aromatic), 660.47 cm^{-1} (C-S). MS:m/z 242(M^+)(97%), 243(13.9), Analysis (calc) for: $C_{12}H_{10}N_4S$, C (59.48), H (4.16), N (23.21), S (13.23).

4-(furan-2-yl)-6-(1H-pyrrol-2-yl)pyrimidin-2-amine [4d]

Yellow crystal, (135-136)^{0}C, Yield % 75.4%, ^{1}H NMR (CD_3Cl-D_2O, 300.0 MHz) δ 5.01(s, 1H, 2-pyrrol), 6.15(t,1H,C_4-H,2-pyrrol), 6.97(m, 1H,C_3-H,2-pyrrol), 6.61(s, 2H, aromatic C-NH_2), 6.98(m, 1H,C_5-H, 2-pyrrol),), 7.09(t,1H, C4-H,2-furan), 7.21-7.88(m, 3H, 2-furan) 7.97(s,2H pyrimidine). FTIR (KBr, cm^{-1}) 3392.55 cm^{-1}(NH), 1653.2 cm^{-1}(C=N), 1580.13 cm^{-1} (C=C), 1240.54 cm^{-1} (C-N), 878.38 cm^{-1} (C-H aromatic), 777.47 cm^{-1} (C-O). MS:m/z 227(M^++H)(97.1%), Analysis (calc) for: $C_{12}H_{10}N_4O$, C (63.71), H (4.46), N (24.76), O (7.07).

4, 6-di (furan-2-yl) pyrimidin-2-amine [4e]

Yellow crystal, (94-95^{0}C), Yield % 71.1%, ^{1}H NMR (CD_3Cl-D_2O, 300.0 MHz) δ 6.59(s, 1H, aromatic C-NH), 7.12(t, 2H,C3-H,2-furan), 7.55-7.85(m, 4H, 2-furan), 6.60(s, 2H, aromatic C-NH_2), 7.78(s, 1H, 2-pyrimidine).). FTIR (KBr, cm^{-1}) 3414.55 cm^{-1}(NH), 1658.2 cm^{-1}(C=N), 1588.13 cm^{-1} (C=C), 888.38 cm^{-1} (C-H aromatic), 787.47 cm^{-1} (C-O). . MS:m/z 227(M+)(100.00%), Analysis (calc) for: $C_{12}H_{10}N_4O$, C (63.43), H (3.99), N (18.49), O (14.08).

3.3 Antimicrobial and antifungal Activity

3.3.1 Antibacterial activity

Antibacterial activities of all the compounds were studied against Gram-positive bacteria [*Staphylococcus aureus* (RCMB000108),

Bacillis subtilis (RCMB000109)] and Gram negative bacteria [*Pseudomonas aeruginosa* (RCMB000103), *Escherichia coli* (RCMB000106)].
The newly synthesized compounds (3-(phenyldiazenyl)-5,7-di(hetar-2-yl)pyrazolo[1,5-a]pyrimidin-2-amine and 2,4-dihetaryl pyrazolo pyrimidine), 3a to 3g excepted 3b and 3c, and 3a, 3b were screened for their antibacterial activity against human pathogenic bacteria *Staphylococcus aureus, Bacillis subtilis*, *Pseudomonas aeruginosa* and *Escherichia coli*. An examination of the data revealed that all the compounds showed antibacterial activity 6.1 to 23.3 µg/ml the compound 3g was highly activity against all organism employed. Compounds 3d, 3f, 4a and 4b were highly activity against Gram positive Bacterial *Staphylococcus aureus* and *Bacillis subtilis*. 3f and 4b were most against gram negative Bacterial *Pseudomonas aeruginosa* and *Escherichia coli*. 3a, 3d, 3e, 3g and 3h were effect against *Escherichia coli,* 3d, 3e, 3g, 3h and 4a did not show any activity against *Pseudomonas aeruginosa*.

3.3.2 Antifungal activity

The synthesized compounds were also screened for their antifungal activity against [*Candida albicans* (RCMB0005003), *Aspergillus fumigates* (RCMB002006), *Geotrichum candidum* (052008), *Syncephlastrum racemosum* (005004)].
The compounds 3f and 4b highly active against [*Candida albicans, Aspergillus fumigates, Geotrichum candidum, and Syncephlastrum racemosum*] Mean zone inhibition in mm ± standard deviation beyond well diameter (6mm) produced on a range of environmental and clinically pathogenic microorganisms using (10mg/ml) concentration of tested samples.
The results of Antimicrobial and antifungal Activity are summarized in Table no. 3 and 4.

Table 3: Antibacterial Activity for 3-(phenyldiazenyl)-5, 7-di(hetar-2-yl)pyrazolo[1,5-a] pyrimidin-2-amine and 4,6-di(hetar-2-yl)pyrimidin-2-amine

Test Organism	***Staphylococcus aureus***		***Bacillis subtilis***		***Pseudomonas aeruginosa***		***Escherichia coli***	
Standard used	Penicillin G	Streptomycin	Penicillin G	Streptomycin	Penicillin G	Streptomycin	Penicillin G	Streptomycin
Zone of Inhibition (mm)	30.1±0.06	28.1±0.07	31.6±0.05	29.7±0.06	28.3±0.08	25.2±0.09	33.1±0.09	29.7±0.07
Zone of Inhibition (mm) for Test Compounds								
3a	15.3±0.03		17.9±0.09		9.3±0.05		14.9±0.07	
3d	16.7±0.05		15.7±0.3		NA		15.2±0.2	
3e	14.9±0.1		15.8±0.2		NA		10.9±0.05	
3f	12.9±0.09		14.1±0.2		NA		11.8±0.2	
3g	22.2±0.09		23.3±0.2		18.5±0.08		21.9±0.1	
3h	13.4±0.09		14.7±0.3		NA		12.3±0.06	
4a	14.2±0.09		15.3±0.3		NA		10.2±0.06	
4b	17.2±0.07		18.4±0.2		9.4±0.2		11.2± 0.09	

Table 4: Antifungal Activity for 3-(phenyldiazenyl)-5, 7-di (hetar-2-yl)pyrazolo [1,5-a]pyrimidin-2-amine and 4,6-di(hetar-2-yl)pyrimidin-2-amine

Test Organism	***Aspergilluss fumigates***		***Geotrichum candidum***		***Candida albicans***		***Syncephlastrum racemosum***	
Standard used	Itraconazole	Clotrimazole	Itraconazole	Clotrimazole	Itraconazole	Clotrimazole	Itraconazole	Clotrimazole
Zone of Inhibition (mm)	27.4±0.05	26.3±0.08	24.2±0.09	23.2±0.03	25.2±0.07	20.8±0.02	23.9±0.04	21.4±0.05
Zone of Inhibition (mm) for Test Compounds								
3a	15.2±0.08		11.3±0.05		10±0.04		8.2±0.06	
3d	14.2±0.09		15.3±0.3		NA		10.2±0.06	
3f	11.2±0.1		10.2±0.09		7.3±0.3		NA	
3g	21.8±0.2		19.5±0.08		18.1±0. 3		14.8±0.09	
3h	13.2±0.07		12.9±0.1		10.7±0.2		NA	
4a	10.1±0.2		9.1±0.09		6.1±0.03		NA	
4b	17.9±0.07		14.3±0.2		11.2±0.09		10.8±0.05	

*NA: No Activity, data are expressed in the form of mean ± SD.
Inhibition zones in mm for some of the synthesized compounds at a concentration level of 30 µg/ml

4.0 Conclusion

New series of pyrazolo-[1, 5-a] pyrimidines and pyrimidine amine as antimicrobial agents have been successfully synthesized. All the synthesized pyrazolo-[1, 5-a] pyrimidines and pyrimidine amine exhibited promising antibacterial and antifungal. The compound 5,7-di(furan-2-yl)-3-(p-tolydiazenyl)pyrazolo[1,5-a]pyrimidin-2-amine showed better antimicrobial activity than 5-(furan-2-yl)-7-(thiophen-2-yl)-3-(p-tolyldiazenyl) pyrazolo [1,5-a] pyrimidin-2-amine.

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