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CLEAN SYNTHESIS AND ANTIMICROBIAL INTERPRETATION OF AZO (DIPYRANO) AND BIS- CHALCONES DERIVATIVES FROM N-PHENYL PYRROLIDINE-2,5-DIONE AND N-PHENYL PIPERIDINE-2,6-DIONE

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ABSTRACT
The solvent-free synthesis ofAzo (Dipyrano) derivatives was carried out with the help ofPbO nanoparticles. They have been employed as an efficient catalyst (yields 81–91%) at room temperature using green chemistry and clean approach. PbO nanoparticles were established to be highly efficient,renewable and eco-friendly heterogeneous catalyst. PbO nanoparticles were prepared by hydro-thermal method.In the same mannera simple eco-friendly microwave instigated solvent free synthesis of bis-chalcones was carried out by the reaction of1-(3-chlorophenyl)ethan-1-one with different substituted N-phenylpyrrolidine-2,5-dione orN-phenyl piperidine-2,6-dione in presence of neutral corundum(yields 85–90%). All the derivatives were characterized and interpreted for antimicrobial potencies.

KEYWORDS
Solvent free, pyrrolidine-2,5-dione, piperidine-2,6-dione, PbO nanoparticles.

INTRODUCTION
Benzo-pyrans and their derivatives are of appreciableimportance because of their pharmacological activities[i], such as anti-coagulant, spasmolytic, diuretic,anti-ancaphylactia and anti-canceractivities[ii-v]. In addition, they could act as cognitive enhancers and can be useful in the treatment of neuro-degenerative disease,Alzheimer's disease andHuntington's disease.Benzo-pyrans and their derivatives are also used for treatment of amyotrophic lateral sclerosis, AIDS associated dementia and Down's syndrome as well as schizophrenia and myoclonus[vi,vii]. The several biologically active natural products contain Benzo-pyrans and their derivatives[viii]. A number of Azo (Dipyrano) derivativesand 2-amino-4H-pyrans are helpful as pigments[ix], photo-active material[x] and biodegradable agrochemicals[xi]. Hence a synthetic interest has

neededtechnological improvements for the original reaction conditions. The titled Azo (Dipyrano) derivatives are synthesized with the help ofPbO nanoparticles by the reaction of cyclic imidewithmalononitrile in the presence of an appropriate substituted aromatic aldehyde. A varietyof variousreagents such asNaBr[xii,xiii],KF-basic alumina under ultrasound irradiation[xiv],hexadecyltrimethylammonium bromide (HTMAB)[xv], amino-functionalized ionic liquid[xvi], Na_2SeO_4, $Ce(SO_4)_2.4H_2O$[xvii], the use of microwave irradiation[xviii], tetramethylammonium hydroxide (TMAH)[xix], electrolysis[xx], tetrabutylammonium bromide (TBABr)[xxi] andrare earth perfluorooctanoate $RE(PFO)_3$, (S)-proline[xxii,xxiii] were signed up to catalyse these reactions.

Chalcones are the resourcefulpioneer of heterocycle communityand showed significant cytotoxic activities against cell line, breast cancer, human hepatocellular and lung carcinoma[xxiv]. They are potent microbial agents[xxv-xxxvi]and exhibit the synergetic antifungaland antibacterial, activities. They have shown considerable pharmacological activities likeanti-mycobacterial activity against tuberculosis H37Rv[xxxvii]anti-cancer[xxxviii, xxxix] in particular anti-breast cancer[xl], anti-oxidant[xli],antipyretic[xlii], and anti-inflammatory[xliii-xlv].

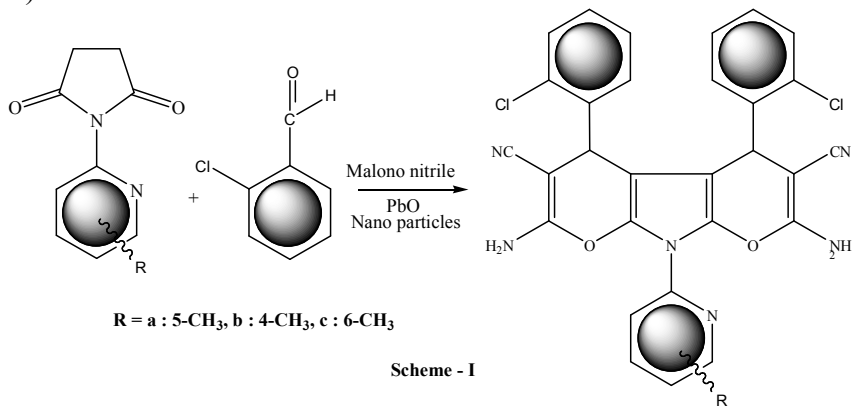
The titled bis-chalcones are synthesized with the help of catalyst $Al_2O_3$and microwave irradiation bythe reaction of N-phenylpyrrolidine-2,5-dione or N-phenyl piperidine-2,6-dionewith an appropriate substituted aromatic aldehyde. They could also besynthesized by the condensation[xlvi]of the substitutedaldehyde, ketones and cyclic imide groups[xlvii, xlviii]. They could be also synthesized with the help of various types of synthetic routes likeknoevenagelcondensation[xlix], solid phase claisen-schemdit, acid catalyst,cross aldol condensation, coupling reaction[l], and microwave assisted synthesis[li-liv].

EXPERIMENTAL: Melting points were recorded in open glass capillaries and were uncorrected. The chemical structures of the obtained compounds were confirmed by spectral analyses. IR spectra in KBr pallets were obtained on Simadzu and ATR Brucker alpha FT-IR spectrophotometer. ^{1}H NMR spectra were obtained on and 500.13 MHz by Brucker spectrophotometer. The chemical shifts were reported as parts per million (ppm) with $(CH_3)_4Si$ (TMS) as an internal standard. Signal multiplicities are represented by: s (singlet), d (doublet), t (triplet), m (multiplet).The purity of compound was checked by thin layer chromatography which was performed by using pre-coated silica gel aluminium plates with mixture of diethyl ether and ethyl acetate 7:3 proportion. Anti-microbial and Anti-fungal activities were carried out by Agardiffusionassay(Diskdiffusionmethod,Disksize6mm).PbO nanoparticle were synthesized by taking a mixture of 10 ml of 0.1N sodium hydroxide and 0.025 molecitric acid in distilled water was added tomethanolic solution of 0.02 mole lead nitrate. The reaction mixture was continuously stirred with the help of magnetic stirrer for 2 hours atroom temperature. The white polycrystalline product was obtained which is filtered, washed with distilled water and dried at110^0C for 2 hours. The dried solid product was calcinized at 500^0C for 2 hours. During this process, thePbOnanoparticle which has white colour earlier turned to pale yellow colour.All the compounds (6a-f and 10a-f) were synthesized from the correspondingsuccinic and glutaric anhydride derivatives and commercially purchasedp-flurobenzaldehyde,neutralalumina(Al_2O_3)and ethanol.

General Procedure of synthesis

Preparation of Azo (Dipyrano): 2,7-diamino-4,5-bis(2-chlorophenyl)-9-(N-methylpyridin-2-yl)-5,9-dihydro-4H-dipyrano[2,3-b:3',2'-d]pyrrole-3,6-dicarbonitrile (6a-c):

A mixture of 0.01 mole N-phenylpyrrolidine-2,5-dione, 0.02 mole aromatic aldehydes, 0.02 molemalononitrileand 100 mg PbO nanoparticles were ground at a room temperature with a mortar and pestle. The reaction was monitored by thinlayer chromatography (TLC). After completion of reaction, the product was washed with distilled water. The novel developed compounds were dried and recrystallized from ethanol to afford pure compounds with high yield(Scheme – I).

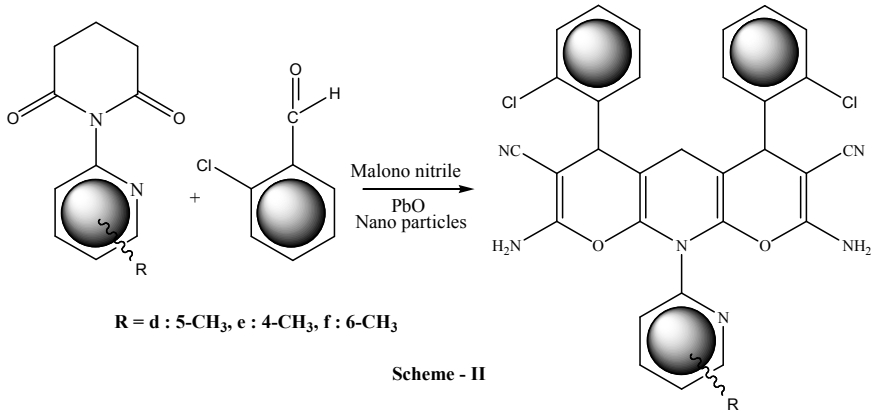


R = a : 5-CH_3, b : 4-CH_3, c : 6-CH_3

Scheme - I

Preparation of Azo (Dipyrano): 2,8-diamino-4,6-bis(2-chlorophenyl)-10-(N-methylpyridin-2-yl)-6,10-dihydro-4H,5H-dipyrano[2,3-b:3',2'-e]pyridine-3,7-dicarbonitrile (6d-f):

A mixture of 0.01 mole N-phenyl piperidine-2,6-dione, 0.02 mole aromatic aldehydes, 0.02 molemalononitrileand 100 mg PbO nanoparticles were ground at a room temperature with a mortar and pestle. The reaction was monitored by thinlayer chromatography (TLC). After completion of reaction, the product was washed with distilled water. The novel developed compounds were dried and recrystallized from ethanol to afford pure compounds with high yield(Scheme – II).



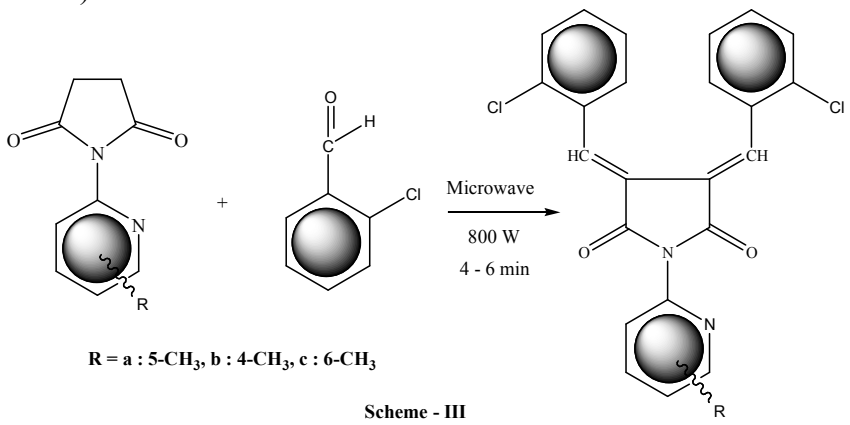
R = d : 5-CH_3, e : 4-CH_3, f : 6-CH_3

Scheme - II

General Procedure of Synthesis:

Preparation of Chalcone: 3,4-bis((E)-2-chlorobenzylidene)-1-(N-methylpyridin-2-yl)pyrrolidine-2,5-dione (10a-c):

The bis-chalcones (10a-c) derivatives were synthesized by the mixture of 0.01 mole of N-phenylpyrrolidine-2,5-dione and 0.02 mole of aromatic aldehyde in 1 gm of neutral Al_2O_3 with the help of microwave irradiations. This mixture is maintained in microwave at 800W power for 4-6 minutes in solvent free condition. The novel developed compounds were recrystallized from ethanol (Scheme – III).

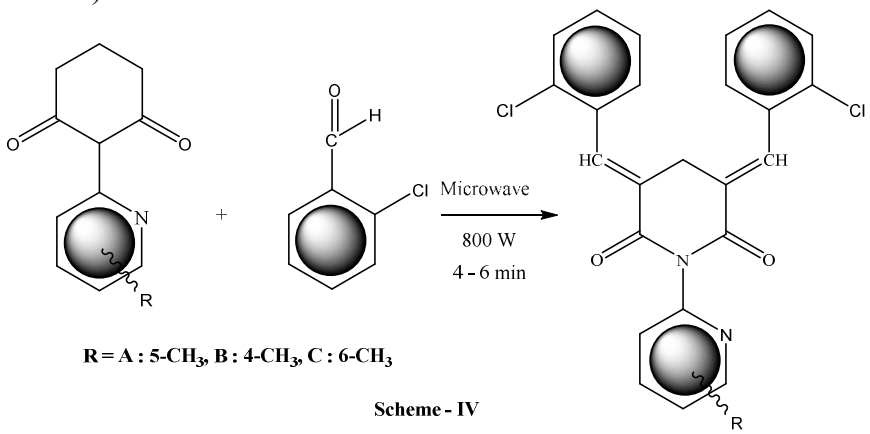


R = a : 5-CH_3, b : 4-CH_3, c : 6-CH_3

Scheme - III

Preparation of Chalcone:3,5-bis((E)-2-chlorobenzylidene)-1-(N-methylpyridin-2-yl)piperidine-2,6-dione (10d-f):

The bis-chalcones (10d-f) derivatives were synthesized by the mixture of 0.01 moles of N-phenyl piperidine-2,6-dione and 0.02 mole of aromatic aldehyde in 1 gm of neutral Al_2O_3 with the help of microwave irradiations. This mixture is maintained in microwave at 800W power for 5-8 minutes in solvent free condition. The novel developed compounds were recrystallized from ethanol (Scheme – IV).



R = A : 5-CH_3, B : 4-CH_3, C : 6-CH_3

Scheme - IV

RESULTS AND DISCUSSION:

Chemistry:

The series of Azo (Dipyrano) derivatives 6a-f were synthesized by the reaction of different substitutedN-phenylpyrrolidine-2,5-dione orN-phenyl piperidine-2,6-dione, 1-(3-chlorophenyl)ethan-1-one and malononitrile with the help ofPbO nanoparticles. The formationofAzo (Dipyrano) derivativeswas confirmed byIR, ^{13}CNMRand ^{1}HNMRandelemental analysis.Theseriesofbis-chalcones derivatives 10a-f were synthesized by the reaction of 1-(3-chlorophenyl)ethan-1-onewith different substituted N-phenylpyrrolidine-2,5-dione or N-phenyl piperidine-2,6-dione in presence of neutral Al_2O_3 with the help of microwave irradiations. The formationofbis-chalconeswas confirmed byIR, ^{13}CNMRand ^{1}HNMRandelemental analysis.

2,7-diamino-4,5-bis(2-chlorophenyl)-9-(5-methylpyridin-2-yl)-5,9-dihydro-4H-dipyrano[2,3-b:3',2'-d]pyrrole-3,6-dicarbonitrile(6a)

SulfurYellow Solid, Yield (87.96%), M. P. 186-88ºC, M.F. $C_{30}H_{20}Cl_2O_2N_6$,M.W.567.42;Composition: Cal:C(63.50%) H(3.55%)N(14.81%); Obs: C(63.70%) H(3.67%)N(14.47%); IR-(KBr):-C-Cl:613.70; C≡N:2223.99; -N-H: 3095.16; aromatic ring (2-Peaks): 3030.44, 660.79; -CH_3: 2968.20; >C=C<: 1741.26, C-O: 1091.09; C-N (Aliphatic): 1005.32; C-N (Aromatic): 1288.43;-C-C- Stretch in a ring(3-Peaks): 1579.86, 1548.05, 1406.17; -CH_3 bend: 1487.56, 1372.27 cm^{-1};^{1}H NMR (500.13 MHz, DMSO, δ ppm): 7.37 (t,4H, Ar-H,J=7.39), 7.42 (t,4H,Ar-H,J=7.34),4.77 (s, 2H, methine),6.81 (s, 4H,-NH_2), 8.53 (d, 1H, pyridine,J=7.44), 7.34 (t, 1H, pyridine,J=7.34), 7.42 (t, 1H, pyridine),2.45 (s, 3H, CH_3-pyridine).

2,7-diamino-4,5-bis(2-chlorophenyl)-9-(4-methylpyridin-2-yl)-5,9-dihydro-4H-dipyrano[2,3-b:3',2'-d]pyrrole-3,6-dicarbonitrile(6b)

Vanilla Solid, Yield (89.88%), M. P. 196-98ºC, M.F. $C_{30}H_{20}Cl_2O_2N_6$, M.W.567.42;Composition: Cal:C(63.50%) H(3.55%)N(14.81%); Obs: C(63.67%) H(3.37%)N(14.58%); IR-(KBr): -C-Cl:610.55; C≡N:2224.85; -N-H: 3094.02; aromatic ring (2-Peaks): 3031.41, 661.25; -CH_3: 2966.72; >C=C<: 1742.51, C-O: 1092.13; C-N (Aliphatic): 1004.53; C-N (Aromatic): 1280.43;-C-C- Stretch in a ring(3-Peaks): 1580.22, 1547.19, 1405.75; -CH_3 bend: 1480.22, 1370.61 cm^{-1};^{1}H NMR (500.13 MHz, DMSO, δ ppm): 7.37 (t,4H, Ar-H,J=7.39), 7.42 (t,4H,Ar-H,J=7.34),4.77 (s, 2H, methine),6.81 (s, 4H,-NH_2), 8.53 (d, 1H, pyridine,J=7.44), 7.34 (t, 1H, pyridine,J=7.34), 7.42 (t, 1H, pyridine),2.45 (s, 3H, CH_3-pyridine).

2,7-diamino-4,5-bis(2-chlorophenyl)-9-(6-methylpyridin-2-yl)-5,9-dihydro-4H-dipyrano[2,3-b:3',2'-d]pyrrole-3,6-dicarbonitrile(6c)

Vanilla Solid, Yield (93.06%), M. P. 198-200ºC, M.F. $C_{30}H_{20}Cl_2O_2N_6$,M.W.567.42;Composition: Cal:C(63.50%) H(3.55%)N(14.81%); Obs: C(63.62%) H(3.73%)N(14.32%);IR-(KBr): -C-Cl:611.39; C≡N:2223.51; -N-H: 3096.23; aromatic ring (2-Peaks): 3031.98, 660.88; -CH_3: 2970.23; >C=C<: 1741.95, C-O: 1091.87; C-N (Aliphatic): 1007.43; C-N (Aromatic): 1289.52;-C-C- Stretch in a ring(3-Peaks): 1581.34, 1546.93, 1406.00; -CH_3 bend: 1479.08, 1369.55cm^{-1};^{1}H NMR (500.13 MHz, DMSO, δ ppm): 7.30 (t,4H,Ar-H,J=7.53), 7.40 (t,4H,Ar-H,J=7.33),4.80 (s, 2H, methine),6.73 (s, 4H,-NH_2), 7.90

(t, 1H, pyridine,J=7.44), 7.81 (t, 1H, pyridine,J=7.29), 6.98 (t, 1H, pyridine,J=7.25),2.57 (s, 3H, CH_3-pyridine).

2,8-diamino-4,6-bis(2-chlorophenyl)-10-(5-methylpyridin-2-yl)-6,10-dihydro-4H,5H-dipyrano[2,3-b:3',2'-e]pyridine-3,7-dicarbonitrile (6d)

Ivory ColorSolid, Yield (83.66%), M. P. 110-12ºC, M.F. $C_{31}H_{22}O_2N_6Cl_2$,M.W. 581.45;Composition: Cal:C(64.03%) H(3.81%)N(14.45%); Obs: C(64.36%) H(3.10%)N(14.99%); IR-(KBr): -C-Cl:616.10; C≡N:2226.52; -N-H: 3166.84; aromatic ring (2-Peaks): 3101.77, 653.55; -CH_2: 3048.95; -CH_3: 2932.79; >C=C<: 1622.05, C-O: 1043.27; C-N (Aliphatic): 1128.69; C-N (Aromatic): 1173.66;-C-C- Stretch in a ring(3-Peaks): 1581.06, 1544.83, 1497.28; -CH_3 bend: 1439.06, 1379.21; -CH_2 bend: 1462.80 cm^{-1}; ^{1}H NMR (500.13 MHz, DMSO, δ ppm): 7.60 (t,2H, Ar-H,J=7.29), 7.24 (m,2H,Ar-H,J=7.40),7.25 (m,2H,Ar-H,J=7.60),7.35 (t,2H, Ar-H,J=7.49), 3.87 (s, 2H, methine), 3.17 (s, 2H, -CH_2),6.78 (s, 4H,-NH_2), 7.88 (d, 1H, pyridine), 7.41 (t, 1H, pyridine,J=7.61), 6.90 (d, 1H, pyridine,J=7.65),2.13 (s, 3H, CH_3-pyridine).

2,8-diamino-4,6-bis(2-chlorophenyl)-10-(4-methylpyridin-2-yl)-6,10-dihydro-4H,5H-dipyrano[2,3-b:3',2'-e]pyridine-3,7-dicarbonitrile (6e)

Saffron Yellow ColorSolid, Yield (89.43%), M. P. 158-60ºC, M.F. $C_{31}H_{22}O_2N_6Cl_2$ M.W. 581.45; Composition: C(64.03%) H(3.81%)N(14.45%); Obs: C(64.45%) H(3.03%)N(14.85%); IR-(KBr): -C-Cl:616.78; C≡N:2226.02; -N-H: 3164.22; aromatic ring (2-Peaks): 3100.36, 652.81; -CH_2: 3048.18; -CH_3: 2934.50; >C=C<: 1628.09, C-O: 1045.58; C-N (Aliphatic): 1130.13; C-N (Aromatic): 1153.81;-C-C- Stretch in a ring(3-Peaks): 1580.73, 1516.34, 1490.42; -CH_3 bend: 1402.48, 1372.11; -CH_2 bend: 1438.54cm^{-1};^{1}H NMR (500.13 MHz, DMSO, δ ppm): 7.58 (t,2H, Ar-H,J=7.33), 7.27 (m,2H,Ar-H,J=7.44),7.16 (m,2H,Ar-H,J=7.50),7.31 (t,2H, Ar-H,J=7.42), 3.91 (s, 2H, methine), 3.11 (s, 2H, -CH_2),6.85 (s, 4H,-NH_2), 7.79 (d, 1H, pyridine,J=7.56), 7.01 (t, 1H, pyridine,J=7.51), 6.88 (d, 1H, pyridine),2.27 (s, 3H, CH_3-pyridine).

2,8-diamino-4,6-bis(2-chlorophenyl)-10-(6-methylpyridin-2-yl)-6,10-dihydro-4H,5H-dipyrano[2,3-b:3',2'-e]pyridine-3,7-dicarbonitrile (6f)

Luminous Bright Orange ColorSolid, Yield (86.54%), M. P. 90-92 ºC, M.F. $C_{31}H_{22}O_2N_6Cl_2$,M.W.581.45; Composition: C(64.03%) H(3.81%)N(14.45%); Obs: C(64.71%) H(3.19%)N(14.83%); IR-(KBr): -C-Cl:616.47; C≡N:2225.69; -N-H: 3163.15; aromatic ring (2-Peaks): 3098.59, 651.92; -CH_2: 3048.32; -CH_3: 2932.76; >C=C<: 1694.30, C-O: 1045.28; C-N (Aliphatic): 1131.31; C-N (Aromatic): 1162.77;-C-C- Stretch in a ring(3-Peaks): 1580.57, 1509.74, 1489.57; -CH_3 bend: 1404.02, 1372.81; -CH_2 bend: 1438.93 cm^{-1};^{1}H NMR (500.13 MHz, DMSO, δ ppm): 7.70 (t,2H, Ar-H,J=7.47), 7.32 (m,2H,Ar-H,J=7.61),7.15 (m,2H,Ar-H,J=7.65),7.37 (t,2H, Ar-H,J=7.55), 3.89 (s, 2H, methine), 3.09 (s, 2H, -CH_2),6.87 (s, 4H,-NH_2), 6.80 (t, 1H, pyridine,J=7.67), 7.57 (t, 1H, pyridine,J=7.63), 6.61 (t, 1H, pyridine,J=7.70),2.50 (s, 3H, CH_3-pyridine).

3,4-bis((E)-2-chlorobenzylidene)-1-(5-methylpyridin-2-yl)pyrrolidine-2,5-dione(10a)

Red Brown Solid, Yield (83.35%), M. P. 282-84 ºC, M.F. $C_{24}H_{16}O_2N_2Cl_2$,M.W. 435.30; Composition: Cal:C(67.41%) H(3.77%)N(15.72%); Obs: C(67.82%) H(3.43%)N(15.33%); IR-(KBr): -C-Cl: 638.81; >C=C<: 1591.22;>C=O:1711.64; aromatic ring (3-Peaks): 3021.88,

997.57, 829.29; -CH_3: 2940.87; C-N (Aliphatic): 1185.37; C-N (Aromatic): 1298.82;-C-C- Stretch in a ring: 1591.22; -CH_3 bend: 1456.35, 1384.27 cm^{-1};^{1}H NMR (500.13 MHz, DMSO, δ ppm): 7.48 (t,2H, Ar-H,J=7.40), 6.98 (m,2H,Ar-H,J=7.28), 7.18 (m,2H, Ar-H,J=7.40), 7.22 (t,2H,Ar-H,J=7.36),8.04 (s, 2H, ethylene),7.90 (d, 1H, pyridine), 7.54 (t, 1H, pyridine,J=7.51), 7.40 (d, 1H, pyridine),2.19 (s, 3H, CH_3-pyridine).

3,4-bis((E)-2-chlorobenzylidene)-1-(4-methylpyridin-2-yl)pyrrolidine-2,5-dione(10b)

Pearl Copper Solid, Yield (82.41%), M. P. 260-62 ºC, M.F. $C_{24}H_{16}O_2N_2Cl_2$,M.W. 435.30; Composition: Cal:C(67.41%) H(3.77%)N(15.72%); Obs: C(67.65%) H(3.57%)N(15.39%); IR-(KBr): -C-Cl: 630.12; >C=C<: 1593.53;>C=O:1715.27; aromatic ring (3-Peaks): 3022.62, 990.34, 820.17; -CH_3: 2931.79; C-N (Aliphatic): 1170.14; C-N (Aromatic): 1270.26;-C-C- Stretch in a ring: 1594.08; -CH_3 bend: 1455.87, 1380.65 cm^{-1};^{1}H NMR (500.13 MHz, DMSO, δ ppm): 7.48 (t,2H, Ar-H,J=7.40), 7.01 (m,2H,Ar-H,J=7.30), 7.19 (m,2H, Ar-H,J=7.43), 7.24 (t,2H,Ar-H,J=7.39),8.01 (s, 2H, ethylene), 7.89 (d, 1H, pyridine), 7.37 (d, 1H, pyridine), 7.26 (t, 1H, pyridine,J=7.45),2.24 (s, 3H, CH_3-pyridine).

3,4-bis((E)-2-chlorobenzylidene)-1-(6-methylpyridin-2-yl)pyrrolidine-2,5-dione(10c)

Fawn Brown Solid, Yield (79.01%), M. P. 304-06 ºC, M.F. $C_{24}H_{16}O_2N_2Cl_2$,M.W. 435.30; Composition: Cal:C(67.41%) H(3.77%)N(15.72%); Obs: C(67.31%) H(3.55%)N(15.37%); IR-(KBr): -C-Cl: 632.23; >C=C<: 1590.05;>C=O:1709.32; aromatic ring (3-Peaks): 3025.16, 925.09, 815.51; -CH_3: 2928.13; C-N (Aliphatic): 1176.66; C-N (Aromatic): 1225.73;-C-C- Stretch in a ring: 1611.28; -CH_3 bend: 1458.29, 1379.43 cm^{-1};^{1}H NMR (500.13 MHz, DMSO, δ ppm): 7.47 (t,2H, Ar-H,J=7.47), 7.02 (m,2H,Ar-H,J=7.32), 7.20 (m,2H, Ar-H,J=7.41), 7.26 (t,2H,Ar-H,J=7.39),8.05 (s, 2H, ethylene), 6.83 (t, 1H, pyridine,J=7.34), 7.59 (t, 1H, pyridine,J=7.38), 7.35 (t, 1H, pyridine,J=7.34),2.41 (s, 3H, CH_3-pyridine).

3,5-bis((E)-2-chlorobenzylidene)-1-(5-methylpyridin-2-yl)piperidine-2,6-dione (10d)

Khaki Grey Solid, Yield (83.17%), M. P. 308-10 ºC, M.F. $C_{25}H_{18}O_2N_2Cl_2$,M.W. 449.32; Composition: Cal:C(66.83%) H(4.04%)N(6.23%); Obs: C(67.02%) H(3.93%)N(6.89%); IR-(KBr): -C-Cl: 652.36; >C=C<: 1595.07;>C=O:1704.07; aromatic ring (3-Peaks): 3027.09, 835.44, 749.26; -CH_3: 2968.07; -CH_2: 2930.11;C-N (Aliphatic): 1175.55; C-N (Aromatic): 1272.19;-C-C- Stretch in a ring: 1595.07, 1545.30; -CH_3 bend: 1425.29, 1386.12; -CH_2 bend: 1466.66 cm^{-1};^{1}H NMR (500.13 MHz, DMSO, δ ppm): 7.43 (t,2H, Ar-H,J=7.38), 6.99 (m,2H,Ar-H,J=7.27), 7.21 (m,2H, Ar-H,J=7.35), 7.27 (t,2H,Ar-H,J=7.40),7.45 (d, 2H, ethylene), 2.60 (t, 2H, methylene),7.92 (d, 1H, pyridine), 7.51 (t, 1H, pyridine,J=7.54), 7.43 (d, 1H, pyridine),2.20 (s, 3H, CH_3-pyridine).

3,5-bis((E)-2-chlorobenzylidene)-1-(4-methylpyridin-2-yl)piperidine-2,6-dione (10e)

Clay Brown Solid, Yield (76.73%), M. P. 262-64 ºC, M.F. $C_{25}H_{18}O_2N_2Cl_2$,M.W. 449.32; Composition: Cal:C(66.83%) H(4.04%)N(6.23%); Obs: C(66.29%) H(4.66%)N(6.91%); IR-(KBr): -C-Cl: 662.33; >C=C<: 1571.06;>C=O:1739.10; aromatic ring (3-Peaks): 3025.45, 793.37, 688.37; -CH_3: 2944.95; -CH_2: 2931.27;C-N (Aliphatic): 1044.84; C-N (Aromatic): 1224.37;-C-C- Stretch in a ring: 1618.68, 1571.06; -CH_3 bend: 1416.61, 1372.61; -CH_2 bend: 1461.01 cm^{-1};^{1}H NMR (500.13 MHz, DMSO, δ ppm): 7.44 (t,2H, Ar-H,J=7.42), 7.03 (m,2H,Ar-H,J=7.27), 7.22 (m,2H, Ar-H,J=7.47), 7.29 (t,2H,Ar-H,J=7.33),7.47 (d, 2H, ethylene), 2.59 (t,

2H, methylene), 7.88 (d, 1H, pyridine), 7.38 (d, 1H, pyridine), 7.22 (t, 1H, pyridine,J=7.48),2.25 (s, 3H, CH_3-pyridine).

3,5-bis((E)-2-chlorobenzylidene)-1-(6-methylpyridin-2-yl)piperidine-2,6-dione (10f)

Olive Brown Solid, Yield (91.58%), M. P. 258-60 ºC, M.F. $C_{25}H_{18}O_2N_2Cl_2$,M.W.449.32; Composition: Cal:C(66.83%) H(4.04%)N(6.23%); Obs: C(66.57%) H(4.30%)N(6.80%); IR (KBr): -C-Cl: 660.47; >C=C<: 1596.51;>C=O:1728.19; aromatic ring (3-Peaks): 3026.32, 790.35, 743.67; -CH_3: 2947.83; -CH_2: 2933.43;C-N (Aliphatic): 1170.67; C-N (Aromatic): 1270.80;-C-C- Stretch in a ring: 1609.23, 1565.56; -CH_3 bend: 1425.82, 1380.16; -CH_2 bend: 1467.73 cm^{-1};^{1}H NMR (500.13 MHz, DMSO, δ ppm): 7.45 (t,2H, Ar-H,J=7.41), 7.04 (m,2H,Ar-H,J=7.30), 7.23 (m,2H, Ar-H,J=7.45), 7.30 (t,2H,Ar-H,J=7.50),7.46 (d, 2H, ethylene), 2.61 (t, 2H, methylene), 6.85 (t, 1H, pyridine,J=7.36), 7.61 (t, 1H, pyridine,J=7.40), 7.33 (t, 1H, pyridine,J=7.33),2.43 (s, 3H, CH_3-pyridine).

Antimicrobial Activities:

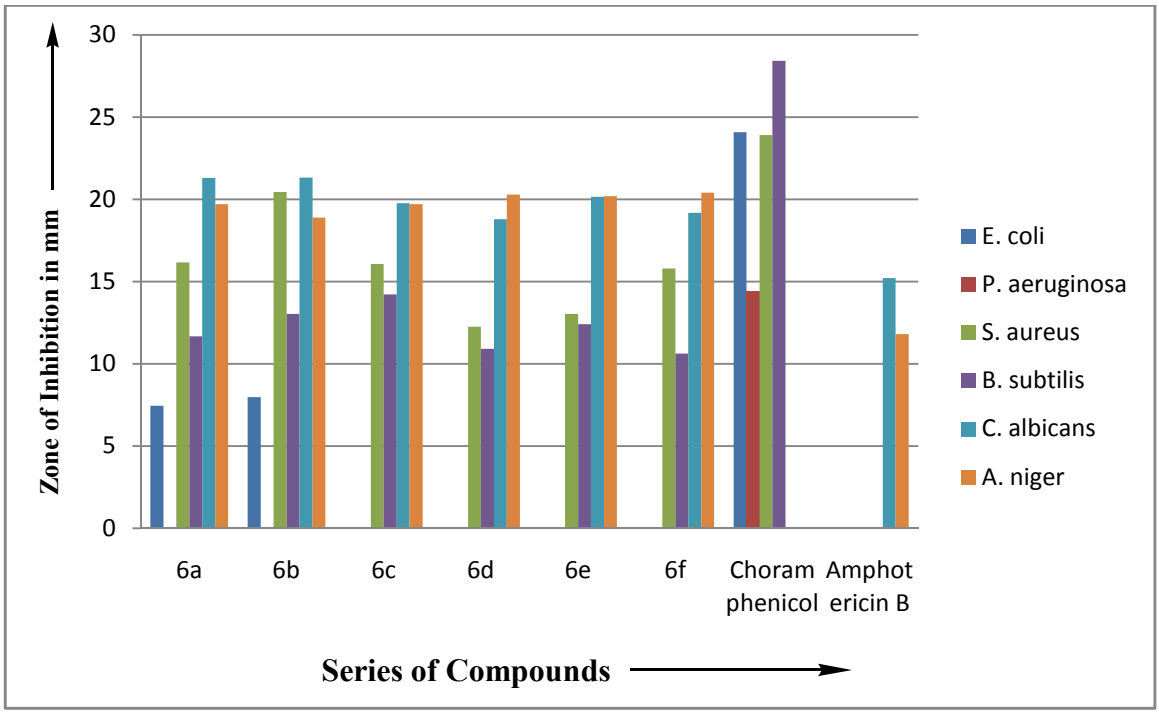
AllthesynthesizedAzo (Dipyrano) derivatives 6a-f and bis-chalcones derivatives 10a-fwerescreenedfor theirantibacterialactivityagainst gram positivebacteriaStaphylococcus aureus (NCIM 2079), Bacillus subtilis (NCIM 2250) andgramnegativebacteriaEscherichia coli(NCIM 2109), Pseudomonas aeruginosa (NCIM 2036)usingDMSOsolvent.All these novel synthesized compounds were screened against Fungi (Yeast) Candida albicans (NCIM 3471) and Aspergillus niger (NCIM 545).Thebacterialcultureswerepurchasedfrom NCIM: National Collection of Industrial Microorganisms, National Chemical Laboratory (NCL), Pune 411008 [India]. Someof thecompoundshowedmoderatetogoodactivitiesagainstgram positivebacteriaS. aureus, B. subtilis and synergetic activities against Fungi C. albicansand A. nigerasshownintheTable–I,II and Graph–I,II;

Table-I
Antimicrobialactivities ofAzo (Dipyrano) derivatives 6a-f

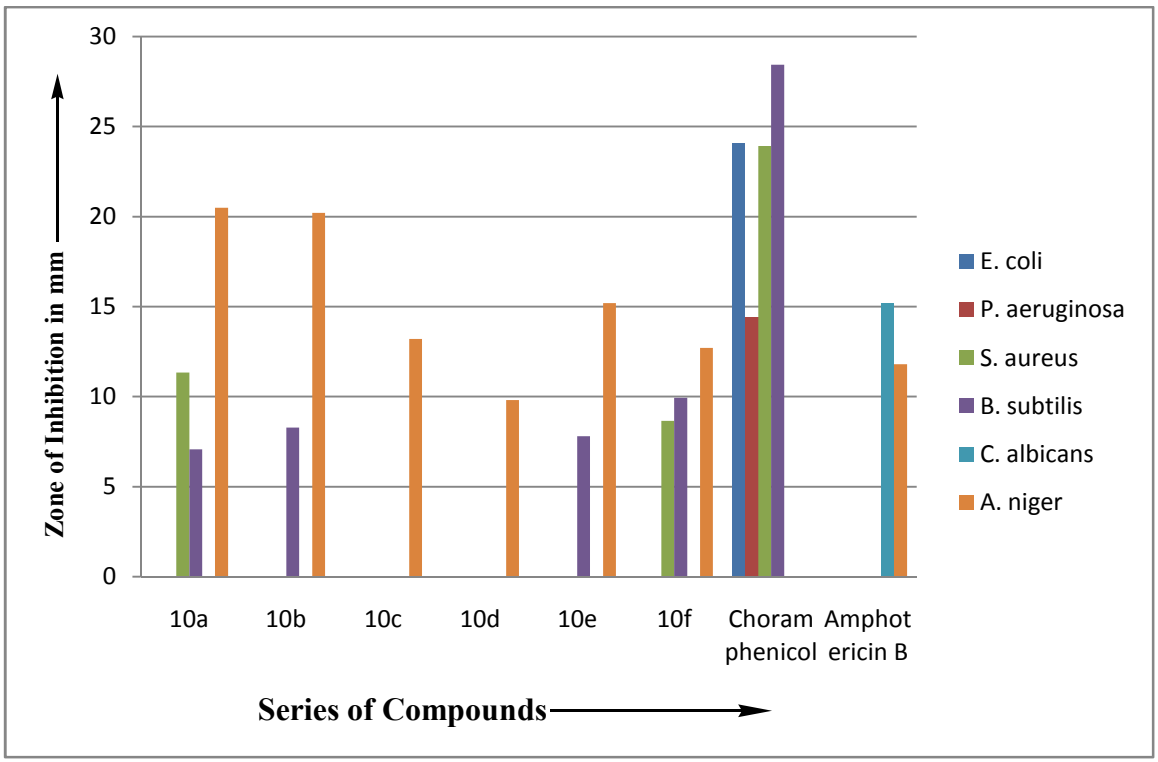
Sr. No.	Sample	E. coli	P. aeruginosa	S. aureus	B. subtilis	C. albicans	A. niger
		Mean±SD	Mean ±SD	Mean ±SD	Mean ±SD	Mean ±SD	Mean ±SD
1	6a	7.45±0.07	- - -	16.16±0.06	11.67±0.17	21.31±0.08	19.7±0.17
2	6b	7.98±0.17	- - -	20.45±0.08	13.04±0.08	21.32±0.11	18.9±0.07
3	6c	- - -	- - -	16.07±0.13	14.23±0.09	19.76±0.18	19.7±0.04
4	6d	- - -	- - -	12.26±0.06	10.92±0.10	18.79±0.13	20.3±0.17
5	6e	- - -	- - -	13.03±0.18	12.42±0.14	20.16±0.07	20.2±0.10
6	6f	- - -	- - -	15.8±0.13	10.63±0.16	19.19±0.33	20.4±0.21
	Chloramphenicol	**24.09±0.1**	**14.39±0.07**	**23.92±0.17**	**28.43±0.29**	NA	NA
	Amphotericin B	NA	NA	NA	NA	**15.21±0.15**	**11.8±0.08**

Table-II
Antimicrobialactivities ofbischalcone derivatives 10a-f

Sr. No.	Sample	E. coli	P. aeruginosa	S. aureus	B. subtilis	C. albicans	A. niger
		Mean±SD	Mean ±SD	Mean ±SD	Mean ±SD	Mean ±SD	Mean±SD
1	10a	- - -	- - -	11.34±0.31	7.07±0.06	- - -	20.5±0.09
2	10b	- - -	- - -	- - -	8.28±0.04	- - -	20.2±0.07
3	10c	- - -	- - -	- - -	- - -	- - -	13.2±0.07
4	10d	- - -	- - -	- - -	- - -	- - -	9.81±0.11
5	10e	- - -	- - -	- - -	7.80±0.10	- - -	15.2±0.02
6	10f	- - -	- - -	8.66±0.22	9.93±0.22	- - -	12.7±0.22
	Chloramphenicol	**24.09±0.1**	**14.39±0.07**	**23.92±0.17**	**28.43±0.29**	NA	NA
	Amphotericin B	NA	NA	NA	NA	**15.21±0.15**	**11.8±0.08**



Graph-I:AntimicrobialactivitiesofAzo (Dipyrano) derivatives 6a-f.



Graph-II:Antimicrobialactivitiesofbischalcone derivatives 10a-f.

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