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Synthesis and antimicrobial evaluation of 2-(2-butyl- 4-chloro-1*H*-imidazol-5-yl-methylene)-substituted-benzofuran-3-ones

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Abstract: In the present study, the oxidation of 3-(4-chloro-1H-imidazol-5-yl)-1-(2-hydroxyphenyl)prop-2-en-1-ones with mercuric(II) acetate in in polyethylene glycol (PEG-400) gave the corresponding 2-((4-chloro-1H-imidazol-5-yl)methylene)benzofuran-3(2H)-ones. Newly synthesized compounds were tested for their *in vitro* antimicrobial activity.

Keywords: PEG-400; 2'-hydroxy chalcones; benzofuran-3-ones; antimicrobial activity..

1. Introduction

Both aurones[1] and flavones,[2] which are structurally isomeric compounds, are widely distributed in nature. They play significant roles for the pigmentation of the flowers[3] in which they occur. Antifungal, antibacterial, anti-plasmodial antileishmanicidal and antiviral activities of aurones have also been reported.[4-7] On the other hand, imidazole ring has wide applications in medicinal chemistry. It is also reported that, imidazole derivatives are gained synthetic interest in recent years due to their broad spectrum of biological properties.[8-13] In view of these observations, it was devised to

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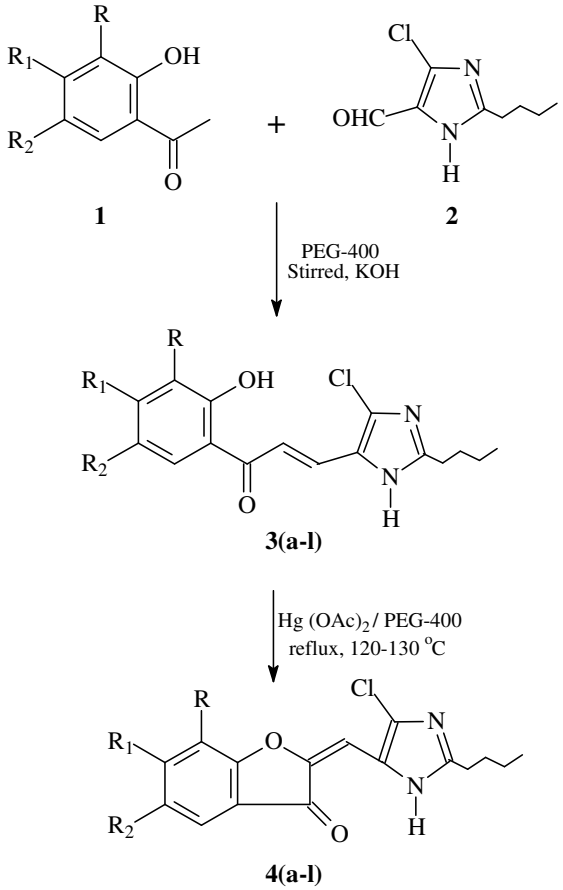
synthesize some new aurones containing imidazole moiety using mercuric acetate in polyethylene glycol (PEG-400) as green reaction solvent. Furthermore, all the synthesized compounds were screened for their antimicrobial activity.

2. Results and Discussion

Aurones has been synthesized in high boiling polar aprotic solvents like DMSO[14] and pyridine. To avoid the use of volatile organic solvents can minimize the generation of waste, which is a requirement of one of the principles of green chemistry.[15,16] Recently, PEG is found to be an interesting solvent system. The important difference between using PEG and other neoteric solvents is that all of the toxicological properties, the short and long-term hazards, and the biodegradability. Polyethylene glycol (PEG) as environmentally benign protocol prompted to have many applications, in substitution, oxidation and reduction reaction.[17]

In this present study, a series of 2-(2-butyl-4-chloro-1*H*-imidazol-5-yl-methylene)-substituted-benzofuran-3-ones were synthesized by the oxidation of 2'-hydroxy chalcones with mercuric (II) acetate in polyethylene glycol (PEG-400) as solvent under mild reaction condition is described. The reaction sequence for the preparation of title compounds is outlined in Scheme 1.



Scheme 1. Synthesis of benzofuran-3-ones

The starting 2'-hydroxy chalcones were already reported[18] by reacting substituted 2-hydroxy acetophenones and 2-butyl-4-chloro-5-formyl-imidazole (BCFI) in presence of base

by conventional Claisen-Schmidt condensation method. The purity of the compounds was checked by thin layer chromatography and structures of the synthesized products were confirmed by their spectral and elemental analysis.

Table 1. Synthesis of benzofuran-3-ones using $Hg(OAc)_2$ in PEG-400

Entry	Product	Substituents			Yield (%)	M. P. (^{0}C)
		R	R_1	R_2		
1	**4a**	H	H	Cl	86	186
2	**4b**	I	H	Cl	85	176
3	**4c**	Br	H	Cl	88	212
4	**4d**	H	CH_3	Cl	85	164
5	**4e**	I	CH_3	Cl	86	192
6	**4f**	Br	CH_3	Cl	88	225
7	**4g**	I	H	CH_3	84	205
8	**4h**	Br	H	CH_3	88	168
9	**4i**	H	H	CH_3	88	234
10	**4j**	I	H	I	86	195
11	**4k**	Br	H	Br	89	172
12	**4l**	Cl	H	Cl	88	181

The IR spectra of all the products were showed absorption band at 1690-1710 cm^{-1} due to >C=O stretching. The ^{1}H NMR spectra of aurones (benzofuran-3-ones) showed a characteristic singlet near at δ 6.55-6.75 is due to 1H of benzylidene proton, while other aromatic and aliphatic protons were observed at excepted regions. The mass spectra of the compounds (**4a-l**) were showed molecular ion peak corresponding to their molecular formula. Besides the molecular ion peak (M^+), compounds showed appropriate isotopic abundances which confirmed the presence of halo groups in respective compounds.

All the synthesized products were evaluated for *in vitro* antimicrobial activity. The results are showed in Table 2. It has been observed that some of the compounds revealed moderate to good antimicrobial activity. In comparision with tetracycline, only the compounds **4c** and **4e** were showed relatively effective against *Bacillus subtilis*. Compounds **4c**, **4e**, and **4g** showed moderate activities against *Klebsiella penumoniae*. Compounds **4e**, **4g** and **4l** were exhibited comparable activities against *Staphylococcus aureus*. In comparision with tetracycline, all the compounds were possess weak activities except **4c** against *Proteus vulgaris*.

Antifungal screening data revealed that most of the compounds were active against *Trichoderma viridae* and *Fusarium moniliformae*. When compared to nystatin, compounds **4a** and **4f** showed good activity against *Trichoderma viridae*. On the other hand, compounds **4a, 4d, 4g** and **4l** were also exhibited good activity against *Fusarium moniliformae*. Moreover, **4b**, **4e** and **4j** displayed similar level of activity against *Fusarium moniliformae*. Only the compound **4c** was showed stronger activity as compared to standard against *Trichoderma viridae* and *Fusarium moniliformae*. In comparision with nystatin, all the compounds showed less active against *Aspergillus niger* and *Aspergillus flavus*. When structure activity relationships are concerned, the antimicrobial activity might be increased by the presence of halo (I, Br and Cl) groups as substituents at R and R_2-position on the benzene ring.

Furthermore, compounds bearing methyl groups at R_1 or R_2 position in combination with I and Br at R position, both enhanced the activity.

Table 2. Antimicrobial activity of newly synthesized compounds **4(a-l)**

Compound	Bacteria				Fungi			
	BS	**KP**	**PV**	**SA**	**AN**	**AF**	**TV**	**FM**
4a	11	10	13	10	10	10	17	12
4b	10	11	8	9	9	8	14	10
4c	19	15	16	10	12	12	19	15
4d	12	10	11	12	10	11	12	12
4e	18	14	13	15	8	9	11	10
4f	11	8	14	13	11	8	14	9
4g	14	16	13	15	10	10	16	11
4h	12	9	8	10	8	8	12	8
4i	14	10	11	11	8	9	10	5
4j	13	10	12	13	10	11	14	10
4k	10	11	13	9	8	6	12	9
4l	16	12	14	15	9	9	11	11
Tetracycline	29	22	25	30	NA	NA	NA	NA
Nystatin	NA	NA	NA	NA	14	13	18	10

Zone of inhibition are measured in mm at 25µg/mL.
BS-*Bacillus subtillis*, KP-*Klebsiella penumoniae,* PV-*Proteus vulgaris,* Sa- *Staphylococcus aureus*, AN-*Aspergillus niger*, AF-*Aspergillus flavus*, TV-*Trichoderma viridae*
FM- *Fusarium moniliformae,* NA-Not Applicable

3. Conclusion

In summary, we have described the simple and efficient synthesis of 2-(2-butyl-4-chloro-1*H*-imidazol-5-yl-methylene)-substituted-benzofuran-3-ones by the oxidation of 2'-hydroxy chalcones with mercuric (II) acetate in polyethylene glycol (PEG-400) as green reaction solvent. The present procedure has the advantages of less reaction time, improved yields and recyclability of the reaction medium. From the results of antimicrobial screening it was concluded that compounds **4c** and **4e** were showed relatively effective zone of inhibition against *Bacillus subtilis*. Compounds **4b**, **4e** and **4j** displayed similar level of activity against *Fusarium moniliformae*. Only the compound **4c** was showed comparatively stronger activity against *Trichoderma viridae* and *Fusarium moniliformae*. Considering the results obtained from antibacterial and antifungal tests together, it is possible to say that some of the tested compounds showed good zone of inhibition against fungi than bacteria.

4. Experimental

Melting points were determined by in an open capillary method and were uncorrected. IR spectra were recorded (in KBr pallets) on Shimadzu spectrophotometer. ^{1}H NMR spectra were recorded (in DMSO-d_6) on Avance 300 MHz spectrometer using TMS as an internal standard. The mass spectra were recorded on EI-Shimazdu-GC-MS spectrometer. Elemental analyses were performed on a Carlo Erba 106 Perkin-Elmer model 240 analyzer.

General procedure for the synthesis of 2'-hydroxy chalcones (3a-l)[18]: An equimolar mixture of substituted 2-hydroxy acetophenone **1** (1mmol), 2-butyl-4-chloro-5-formyl-imidazole **2** (1mmol) and KOH (2mmol) was stirred in polyethylene glycol (PEG-400) (15mL) at 40 °C for 1 hour. After

completion of the reaction (monitored by TLC), the crude mixture was worked up in ice cold water (100 mL). Product separated out was filtered and crystallized from ethanol to give pure yellow crystalline product (**3a-l**). Filtrate was evaporated to remove water leaving PEG behind.

General procedure for the synthesis of 2-(2-butyl-4-chloro-1H-imidazol-5-yl-methylene)-substituted-benzofuran-3-ones (4a-l): An equimolar mixture of substituted 2'-hydroxy chalcones **3** (1mmol), and mercuric (II) acetate (1mmol) were dissolved in polyethylene glycol (PEG-400) (15 mL). This reaction mixture was refluxed at 120-130 °C for 2 hrs. After completion of the reaction (checked by TLC), the crude mixture was worked up in ice cold water (100 mL). The solution was acidified with 2-3 drops of dilute HCl. Separated solid was filtered, dried and recrystallized from acetic acid to give the pure corresponding product **(4a-l)**.

2-(2-butyl-4-chloro-1H-imidazol-5-yl-methylene)-5-chloro-benzofuran-3-one (4a): IR (KBr): 1638 (-C=C), 1705 (>C=O), 3338 (-NH) cm^{-1}; ^1H NMR (DMSO-d_6, 300 MHz): δ 0.93 (t, 3H, $-CH_3$, J = 7.5 Hz), δ 1.33 (m, 2H, $-CH_2-$), δ 1.68 (m, 2H, $-CH_2-$), δ 2.76 (t, 2H, $-CH_2$, J = 7.5 Hz) δ 6.65 (s, 1H, benzylidene), δ 7.15 (d, 1H, J = 8.7 Hz), δ 7.81 (d, 1H, J = 9.0 Hz), δ 8.04 (dd, 1H, J = 2.1Hz), δ 8.18 (s, 1H, -NH) ppm; EIMS (*m/z*, %): 336 (M^+, 42), 256 (28), 128 (35), 64 (100%); Anal. Calcd. For $C_{16}H_{14}O_2N_2Cl_2$: C, 56.99, H, 4.18; N, 8.31%. Found: C, 56.82; H, 4.26; N, 8.22%

2-(2-butyl-4-chloro-1H-imidazol-5-yl-methylene)-5-chloro-7-iodo-benzofuran-3-one (4b):
IR (KBr): 1641 (-C=C), 1710 (>C=O), 3332 (-NH) cm^{-1}; ^1H NMR (DMSO-d_6, 300 MHz): δ 0.91 (t, 3H, $-CH_3$, J = 7.5 Hz), δ 1.31 (m, 2H, $-CH_2-$), δ 1.65 (m, 2H, $-CH_2-$), δ 2.75 (t, 2H, $-CH_2$, J = 7.2 Hz), δ 6.68 (s, 1H, benzylidene), δ 7.78 (s, 1H, Ar-H), δ 8.06 (s, 1H, Ar-H), δ 8.21 (s, 1H, -NH) ppm; EIMS (*m/z*, %): 462 (M^+, 25), 427 (22), 370 (55), 127 (100%); Anal. Calcd. For $C_{16}H_{13}O_2N_2Cl_2I$: C, 41.50, H, 2.83; N, 6.05%. Found: C, 41.64; H, 2.91; N, 6.11%

2-(2-butyl-4-chloro-1H-imidazol-5-yl-methylene)-5-chloro-7-bromo-benzofuran-3-one (4c):
IR (KBr): 1638 (-C=C), 1706 (>C=O), 3328 (-NH) cm^{-1}; ^1H NMR (DMSO-d_6, 300 MHz): δ 0.91 (t, 3H, $-CH_3$, J = 7.2 Hz), δ 1.33 (m, 2H, $-CH_2-$), δ 1.66 (m, 2H, $-CH_2-$), δ 2.77 (t, 2H, $-CH_2$, J = 7.5 Hz), δ 6.72 (s, 1H, benzylidene), δ 7.75 (s, 1H, Ar-H), δ 7.98 (s, 1H, Ar-H), δ 8.19 (s, 1H, -NH) ppm; EIMS (*m/z*, %): 414 (M^+, 18), 335 (26), 278 (100%); Anal. Calcd. For $C_{16}H_{13}O_2N_2Cl_2Br$: C, 46.19, H, 3.15; N, 6.73%. Found: C, 46.32; H, 3.26; N, 6.62%

2-(2-butyl-4-chloro-1H-imidazol-5-yl-methylene)-5-chloro-6-methyl-benzofuran-3-one (4d):
IR (KBr): 1632 (-C=C), 1705 (>C=O), 3330 (-NH) cm^{-1}; ^1H NMR (DMSO-d_6, 300 MHz): δ 0.93 (t, 3H, $-CH_3$, J = 7.5 Hz), δ 1.31 (m, 2H, $-CH_2-$), δ 1.65 (m, 2H, $-CH_2-$), δ 2.28 (s, 3H, CH_3), δ 2.75 (t, 2H, $-CH_2$, J = 7.5 Hz), δ 6.61 (s, 1H, benzylidene), δ 7.05 (d, 1H, J = 1.5 Hz), δ 7.85 (d, 1H, J = 1.2 Hz), δ 8.15 (s, 1H, -NH) ppm; EIMS (*m/z*, %): 350 (M^+, 65), 315 (100%), 272 (72%); Anal. Calcd. For $C_{17}H_{16}O_2N_2Cl_2$: C, 58.13, H, 4.59; N, 7.98%. Found: C, 58.24; H, 4.51; N, 7.86%

2-(2-butyl-4-chloro-1H-imidazol-5-yl-methylene)-5-chloro-6-methyl-7-iodo-benzofuran-3-one (4e):
IR (KBr): 1646 (-C=C), 1708 (>C=O), 3326 (-NH) cm^{-1}; ^1H NMR (DMSO-d_6, 300 MHz): δ 0.93 (t, 3H, $-CH_3$, J = 7.2 Hz), δ 1.35 (m, 2H, $-CH_2-$), δ 1.66 (m, 2H, $-CH_2-$), δ 2.35 (s, 3H, CH_3), δ 2.76 (t, 2H, $-CH_2$, J = 7.5 Hz), δ 6.75 (s, 1H, benzylidene), δ 7.98 (s, 1H, Ar-H), δ 8.22 (s, 1H, -NH) ppm; EIMS (*m/z*, %): 476 (M^+, 60), 441 (28), 384 (100%), 369 (15), 127 (46); Anal. Calcd. For $C_{17}H_{15}O_2N_2Cl_2I$: C, 42.80, H, 3.17; N, 5.87%. Found: C, 42.66; H, 3.26; N, 5.81%

2-(2-butyl-4-chloro-1H-imidazol-5-yl-methylene)-5-chloro-6-methyl-7-bromo-benzofuran-3-one (4f): IR (KBr): 1642 (-C=C), 1705 (>C=O), 3331 (-NH) cm^{-1}; ^1H NMR (DMSO-d_6, 300 MHz): δ 0.91 (t, 3H, $-CH_3$, J = 7.2 Hz), δ 1.33 (m, 2H, $-CH_2-$), δ 1.66 (m, 2H, $-CH_2-$), δ 2.31 (s, 3H, CH_3), δ 2.75 (t, 2H, $-CH_2$, J = 7.2 Hz), δ 6.68 (s, 1H, benzylidene), δ 7.92 (s, 1H, Ar-H), δ 8.18 (s, 1H, -NH) ppm; EIMS (*m/z*, %): 428 (M^+, 34), 349 (100%), 298 (41); Anal. Calcd. For $C_{17}H_{15}O_2N_2Cl_2Br$: C, 47.46, H, 3.52; N, 6.51%. Found: C, 47.58; H, 3.64; N, 6.45%

2-(2-butyl-4-chloro-1H-imidazol-5-yl-methylene)-5-methyl-7-iodo-benzofuran-3-one (4g): IR (KBr): 1630 (-C=C), 1710 (>C=O), 3325 (-NH) cm^{-1}; ^1H NMR (DMSO-d_6, 300 MHz): δ 0.91 (t, 3H, -CH_3, *J* = 7.5 Hz), δ 1.32 (m, 2H, -CH_2-), δ 1.68 (m, 2H, -CH_2-), δ 2.26 (s, 3H, CH_3), δ 2.78 (t, 2H, -CH_2, *J* = 7.5 Hz), δ 6.56 (s, 1H, benzylidene), δ 7.12 (d, 1H, *J* = 2.4 Hz), δ 7.86 (d, 1H, *J* = 2.1 Hz), δ 8.22 (s, 1H, -NH) ppm; EIMS (*m/z*, %): 442 (M^+, 15), 385 (51), 127 (100%); Anal. Calcd. For $C_{17}H_{16}O_2N_2Cl_2I$: C, 46.13, H, 3.64; N, 6.33%. Found: C, 46.26; H, 3.52; N, 6.39%

2-(2-butyl-4-chloro-1H-imidazol-5-yl-methylene)-5-methyl-7-bromo-benzofuran-3-one (4h):
IR (KBr): 1645 (-C=C), 1708 (>C=O), 3323 (-NH) cm^{-1}; ^1H NMR (DMSO-d_6, 300 MHz): δ 0.93 (t, 3H, -CH_3, *J* = 7.2 Hz), δ 1.35 (m, 2H, -CH_2-), δ 1.65 (m, 2H, -CH_2-), δ 2.21 (s, 3H, CH_3), δ 2.75 (t, 2H, -CH_2, *J* = 7.2 Hz), δ 6.68 (s, 1H, benzylidene), δ 7.11 (d, 1H, *J* = 2.4 Hz), δ 7.71 (d, 1H, *J* = 2.4 Hz), δ 8.25 (s, 1H, -NH) ppm; EIMS (*m/z*, %): 394 (M^+, 28), 337 (42), 258 (18), 43 (100%); Anal. Calcd. For $C_{17}H_{16}O_2N_2Cl_2Br$: C, 51.60, H, 4.08; N, 7.08%. Found: C, 51.46; H, 4.16; N, 6.91%

2-(2-butyl-4-chloro-1H-imidazol-5-yl-methylene)-5-methyl-benzofuran-3-one (4i): IR (KBr): 1641 (-C=C), 1705 (>C=O), 3338 (-NH) cm^{-1}; ^1H NMR (DMSO-d_6, 300 MHz): δ 0.91 (t, 3H, -CH_3, *J* = 7.5 Hz), δ 1.31 (m, 2H, -CH_2-), δ 1.68 (m, 2H, -CH_2-), δ 2.24 (s, 3H, CH_3), δ 2.78 (t, 2H, -CH_2, *J* = 7.2 Hz), δ 6.61 (s, 1H, benzylidene), δ 7.15 (d, 1H, *J* = 8.7 Hz), δ 7.62 (d, 1H, *J* = 8.8 Hz), δ 8.11 (dd, 1H, *J* = 1.8 Hz), δ 8.22 (s, 1H, -NH) ppm; EIMS (*m/z*, %): 316 (M^+, 32), 258 (68), 91 (100%); Anal. Calcd. For $C_{17}H_{17}O_2N_2Cl_2$: C, 64.62, H, 5.41; N, 8.84%. Found: C, 64.53; H, 5.53; N, 8.75%

2-(2-butyl-4-chloro-1H-imidazol-5-yl-methylene)-5,7-diiodo-benzofuran-3-one (4j):
IR (KBr): 1635 (-C=C), 1698 (>C=O), 3321 (-NH) cm^{-1}; ^1H NMR (DMSO-d_6, 300 MHz): δ 0.93 (t, 3H, -CH_3, *J* = 7.5 Hz), δ 1.35 (m, 2H, -CH_2-), δ 1.65 (m, 2H, -CH_2-), δ 2.78 (t, 2H, -CH_2, *J* = 7.5 Hz), δ 6.58 (s, 1H, benzylidene), δ 7.21 (m, 1H, *J* = 2.1 Hz), δ 7.81 (m, 1H, *J* = 1.8 Hz), δ 8.21 (s, 1H, -NH) ppm; EIMS (*m/z*, %): 554 (M^+, 36), 519 (100%), 462 (35), 127 (41); Anal. Calcd. For $C_{16}H_{13}O_2N_2Cl_2I_2$: C, 34.65, H, 2.36; N, 5.05%. Found: C, 34.52; H, 2.23; N, 5.14%

2-(2-butyl-4-chloro-1H-imidazol-5-yl-methylene)-5,7-dibromo-benzofuran-3-one (4k): IR (KBr): 1641 (-C=C), 1702 (>C=O), 3318 (-NH) cm^{-1}; ^1H NMR (DMSO-d_6, 300 MHz): δ 0.91 (t, 3H, -CH_3, *J* = 7.2 Hz), δ 1.33 (m, 2H, -CH_2-), δ 1.66 (m, 2H, -CH_2-), δ 2.72 (t, 2H, -CH_2, *J* = 7.5 Hz), δ 6.64 (s, 1H, benzylidene), δ 6.96 (d, 1H, *J* = 2.4 Hz), δ 7.85 (d, 1H, *J* = 2.1 Hz), δ 8.16 (s, 1H, -NH) ppm; EIMS (*m/z*, %): 458 (M^+, 41), 379 (26), 322 (55), 43 (100%); Anal. Calcd. For $C_{16}H_{13}O_2N_2Cl_2Br_2$: C, 41.73, H, 2.86; N, 6.08%. Found: C, 41.62; H, 2.97; N, 6.15%

2-(2-butyl-4-chloro-1H-imidazol-5-yl-methylene)-5,7-dichloro-benzofuran-3-one (4l): IR (KBr): 1646 (-C=C), 1705 (>C=O), 3331 (-NH) cm^{-1}; ^1H NMR (DMSO-d_6, 300 MHz): δ 0.91 (t, 3H, -CH_3, *J* = 7.2 Hz), δ 1.35 (m, 2H, -CH_2-), δ 1.68 (m, 2H, -CH_2-), δ 2.78 (t, 2H, -CH_2, *J* = 7.2 Hz), δ 6.59 (s, 1H, benzylidene), δ 7.18 (d, 1H, *J* = 1.8 Hz), δ 7.91 (d, 1H, *J* = 2.1 Hz), δ 8.21 (s, 1H, -NH) ppm; EIMS (*m/z*, %): 370 (M^+, 18), 335 (100%), 278 (38); Anal. Calcd. For $C_{16}H_{13}O_2N_2Cl_3$: C, 51.71, H, 3.53; N, 7.54%. Found: C, 51.89; H, 3.41; N, 7.46%

Antimicrobial activity

The antimicrobial activities of the synthesized compounds **(4a-l)** were determined by agar diffusion method.[19,20] The compounds were evaluated for antibacterial activity against *Bacillus subtilis* MTCC 1789, *Klebsiella penumoniae* NCIM 2957, *Proteus vulgaris* MTCC 1771, *Staphylococcus aureus* MTCC 96 and antifungal activity against various fungi *viz. Aspergillus niger* MTCC 1781, *Aspergillus flavus* MTCC 2501, *Trichoderma viridae* MTCC 167, *Fusarium moniliformae* MTCC 156, were procured from Institute of Microbial technology (IMTech), Chandigarh, India. The antibiotic Tetracycline (25 µg/mL) and Nystatin (25 µg/mL) are used as reference antibacterial and

antifungal substances, respectively for comparison. Dimethyl sulphoxide (1%, DMSO) was used a control.

The culture strains of bacteria were maintained on nutrient agar slant at 37±0.5 °C for 24 h. The antibacterial activity was evaluated using nutrient agar plate seeded with 0.1 mL of respective bacterial culture strain suspension prepared in sterile saline (0.85%) of 10^5 CFU/mL dilutions. The wells of 6 mm diameter were filled with 0.1 mL of compound solution at fixed concentration 25 µg/mL separately for each bacterial strain. All the plates were incubated at 37±0.5 °C for 24 h. Zone of inhibition of compounds in mm were noted.

For antifungal activity, all the culture strains of fungi maintained on potato dextrose agar (PDA) slant at 27±0.2 °C for 24-48 hrs, till sporulation. Spore of strains were transferred in to 5 mL of sterile distilled water containing 1% Tween-80 (to suspend the spore properly). The spores were counted by haemocytometer (10^6 CFU/mL). Sterile PDA plate was prepared containing 2% agar; 0.1 mL of each fungal spore suspension was spread on each plate and incubated at 27±0.2 °C for 12 hrs. After incubation well prepared using sterile cork borer and each agar well was filled with 0.1 mL of compound solution at fixed concentration 25 µg/mL. The plates were kept in refrigerator for 20 minutes for diffusion and then incubated at 27±0.2 °C for 24-28 hrs. After incubation, zone of inhibition of compounds were measured in mm, along with standard.

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References:

[1] Geissman, T. A.; Harborne, J. B. Anthochlor pigments. XIII. The ultraviolet absorption spectra of phenolic plant pigments. Polyhydroxyaurones. *J. Am. Chem. Soc*. **1956**, *78*, 832-837.

[2] Harborne, J. B. Introduction to Ecological Biochemistry, 4th ed. Acedamic Press, London, 1993, 318.

[3] Harborne, J. B. The hand book of natural flavonoids: advances in Research Since 1986. Chapman and Hall, London, 1993, 565

[4] Kayser, O. Kiderlen, A. F.; Brun, R. In vitro activity of aurones against plasmodium falciparum strains K1 and NF54. *Planta Med.* **2001**, *67*, 718-721.

[5] Kayser, O. Kiderlen, A. F.; Folkens, U., Kolodziej, H.; In vitro leishmanicidal activity of aurones. *Planta Med.* **1999**, *65*, 316-319.

[6] Malhotra, B.; Onyillagha, J. C.; Bohm, B. A.; Towers, G. H. N.; James, D.; Harborne,J. B.; French, C.J. Inhibition of tomato ring-spot virus by flavonoids. *Phytochemistry* **1996**, *43*, 1271-1276.

[7] Hadj-esfandiari, N.; Navidpour, L.; Shadnia, H.; Amini, M.; Samadi, N.; Faramarzi M. A.; Shafiee, A.; Synthesis, antibacterial activity, and quantitative structure-activity relationships of new (Z)-2-(nitroimidazolylmethlene)-3(2H)-bezofuranone derivatives. *Bioorg. Med. Chem. Lett*. **2007**, *17*, 6354-6363.

[8] Slee, D. H.; Romano, S. J.; Yu, J.; Nguyen, T. N.; John, J. K.; Raheja, N. K.; Axe, F. U.; Jones, T. K.; Ripka, W. C. Development of potent non-carbohydrate imidazole-based small molecule selectin inhibitors with antiinflammatory activity. *J. Med. Chem*. **2001**, *44*, 2094-2107.

[9] Khabnadideh, S.; Rezaei, Z.; Khalafi-Nezhad, A.; Bahrinajafi, R.; Mohamadi, R.; Farrokhroz, A. A. Synthesis of *N*-alkylated derivatives of imidazole as antibacterial agents. *Bioorg. Med. Chem. Lett.* **2003**, *13*, 2863-2865.

[10] Davood, A.; Khodarahmi, Gh.; Alipour, E.; Dehpour, A. R.; Amini, M.; Shafiee, A. Synthesis and calcium channel antagonist activity of nifedipine analogues containing 2- methyl-4(5)-chloro-5(4)-imidazolyl substituent. *Boll. Chim. Farm*. **2001**, 140, 381-386.

[11] Miri, R.; Dehpour, A. R.; Azimi M.; Shafiee, A. Synthesis and smooth muscle calcium channel antagonist effect of alkyl, aminoalkyl 1,4-dihydro-2,6-dimethyl-4-nitroimidazole-3,5-pyridine dicarboxylates, *DARU*, **2001**, *9*, 40-45.
[12] Miri, R.; Niknahad, H.; Vazin, A.; Azarpira, A.; Shafiee, A. Synthesis and smooth muscle calcium channel antagonist effects of new derivatives of 1,4- dihydropyridine containing nitroimidzolyl substituent, *DARU,* **2002**, *10*, 130-136.
[13] Shafiee, A.; Rastkary N.; Jorjani, M. Synthesis and calcium channel antagonist activity of 1,4-dihydropyridine derivatives containing 4-nitroimidazolyl substituents, *Arzneim Forsch. Drug Res.* **2002**, *52*, 537-542.
[14] Agrawal, N. N.; Soni, P. A. A new process for the synthesis of aurones by using mercuric (II) acetate in pyridine and cupric bromide in dimethyl sulfoxide. *Ind. J. Chem.* **2006**, *45B*, 1301-1303.
[15] Lankey, R. L.; Anastas, P. T. Life-cycle approaches for assessing green chemistry technologies**.** *Ind. Eng. Chem. Res*. 2002, 41, 4498-4502.
[16] Anastas, P. T.; Warner, J. C. Green chemistry: Theory and Practice. Oxford University Press, New York, 1998.
[17] Chen, J.; Spear, S. K.; Huddleston, J. G.; Rogers, R. D. Polyethylene glycol and solutions of polyethylene glycol as green reaction media. *Green Chem.* **2005**, *7*, 64-82.
[18] Dawane, B. S.; Konda, S. G.; Shaikh, B. M.; Bhosale, R. B. An improved procedure for synthesis of some new 1, 3-diaryl-2-propen-1-ones using PEG-400 as a recyclable solvent and their antimicrobial evaluation. *Acta Pharm*. **2009**, *59*, 473-482.
[19] Fairbrother, R. W.; Martyn, G. The disc technique for determining sensitivity to the antibiotics. *J. Clin. Patho.* **1951**, *4*, 374-377.
[20] Gould, J. C.; Bowie, J. H. The determination of bacterial sensitivity to antibiotics. *J. Edinb. Med.* **1952**, *59***,** 178-199.