Synthesis And Characterization Of Some Substituted Chromones As An Anti-infective And Antioxidant Agents

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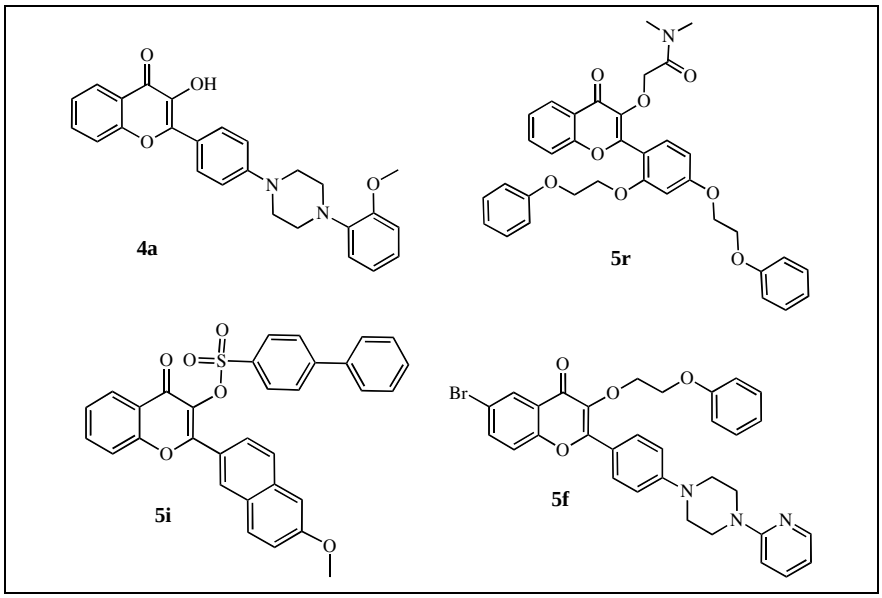

A series of substituted chromones were synthesized and characterized by spectral data. Some of the synthesized compounds were tested for *in-vitro* antibacterial, antifungal and antioxidant activity. Two compounds have shown very good antioxidant activity and some of the chromone derivatives have exhibited moderate antibacterial and antifungal activity.

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INTRODUCTION

Chromones and other related ring systems, have several interesting biological activities. In addition, chromones are also interesting structural scaffolds and have for example, been designed to be used as mimetics of short peptides. The wide range of applications observed for chromone derivatives and their potential use in drug discovery implicates the importance of access to efficient synthetic routes to such compounds.

According to the literature survey, chromone compounds are associated with various physiological and biological properties and thus, find important use in medicine. Excessive calpain activation contributes to serious cellular damage and has been found in many pathological conditions.

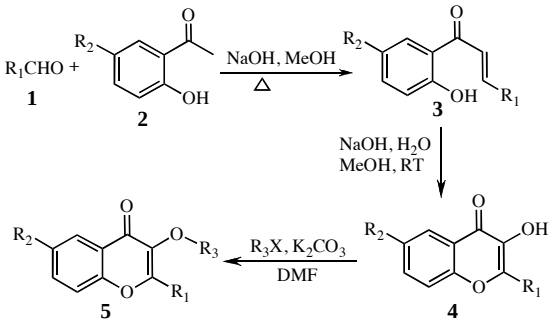
Chromones derived from ketoamides showed very good selective μ – calpain inhibition [1]. 3-(1*H*-Tetrazol-5-yl)-chromones have been found to show very good antiallergic activity [2]. Substituted chromones have been found to have coronary vasodilatory activity [3]. (Piperidinylalkoxy) chromones have been reported to show antihistamine and antagonistic activity against leukotriene-D_4 [4]. Substituted chromones have been reported to show potential anticancer activity [5]. Lockhart *et al* reported the central stimulant activity of 3-chromonanamine derivatives [6].

A series of sulfonamide derived chromones, previously reported as inhibitors of carbonic anhydrase, have been found to show *in vitro* antibacterial and antifungal activity [7]. Chromones having heterocyclic substituents at the 2-position have been reported to possess anti-bacterial and antifungal activities and also found to exhibit good phosphodiesterase-IV inhibition activity and some chromones have potential HIV-integrase inhibition activity [8]. Owing to the biological importance of chromones, we herein, report the synthesis and biological testing of some chromones.

RESULTS AND DISCUSSION

In the present work, substituted benzaldehydes **1** were treated with 2'-Hydroxyacetophenone **2** in presence of NaOH in MeOH at reflux temperature to yield the

Scheme 1



corresponding chalcone **3**, which on treatment with H_2O_2 and NaOH in MeOH by Algar Flynn Oymanda (AFO) reaction [9,10] produced the corresponding 3-hydroxy chromone **4**.

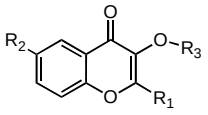
Compounds **4** were further substituted at the hydroxy position by various alkyl halide and arylsulfonyl halide derivatives using base (*viz* K_2CO_3) and DMF.

The structures of the compound **4** were confirmed by spectral techniques (ms, ir and ^{1}H nmr). In the ^{1}H nmr spectra, OH proton resonance of **4a** was observed at 9.73 δ as a singlet and its ir stretching band appeared at 3258 cm^{-1}. Compound **4a** showed a singlet at 3.80 δ due to the methoxy group and a triplet corresponding to piperazine at 3.5 δ and 3.7 δ.

Compound **4a** was treated with 3,5-dimethyl-benzenesulfonyl chloride in the presence of K_2CO_3 in DMF to get **5b**. The ^{1}H nmr spectra of **5b** showed singlet of methoxy at 3.83 δ, singlet of two methyl groups at 2.24 δ and triplet of piperazine at 3.12 δ and 3.44 δ respectively. The structural data of all chromone derivatives is shown in Table 1.

Table 1

Structure of Synthesized Chromones



Compd.	R_1	R_3	R_2	M.P. (0 °C)	Yield in %
4a		H	H	97	80
5a		4-trifluoromethoxy benzenesulfonyl	H	168	77
5b		3,5- dimethyl benzenesulfonyl	H	210	55
5c		4-*N*-acetyl benzenesulfonyl	H	142	65
4b		H	Br	174	85
5d		4'-methyl-1,1'-biphenyl-2-carbonitrile	H	187	45
5e		*N*,*N*-dimethyl acetamido	Br	176	62
5f		$-CH_2-CH_2-OPh$	Br	153	78
5g		2,4 – difluorobenzyl	H	173	48
5h		Cyclohexyl methyl	H	158	59
4c		H	H	128	88
5i		Biphenyl sulfonyl	H	125	84
5j		3,5-difluorophenyl sulfonyl	H	163	78
5k		4-*N*-acetyl benzenesulfonyl	H	243	79
4d		H	H	169	88
5l		2,4 - difluorobenzyl	H	178	55
5m		4'-methyl-1,1'-biphenyl-2-carbonitrile	H	195	48
5n		$-CH_2COOH$	Br	217	65
5o		$-CH_2-CH_2-OPh$	Br	155	75
4e		H	H	115	90
5p		Cyclohexyl methyl	H	127	74
5q		3,5 –difluorobenzyl	H	159	72
4f		H	H	185	64
5r		*N*,*N*-dimethyl acetamido	H	189	88
5s		Ethyl	H	184	78
5t		$CH(COOH)_2$	H	176	61

Antioxidant activity. The antioxidant activity of the test compounds was determined by DPPH method using L-ascorbic acid (antioxidant agent) as a positive control. Amongst the compounds screened for antioxidant activity, **4a** and **5k** show 91.7% and 89.2% antioxidant activity respectively at 200 μg/mL concentration as shown in Table **6**.

Antimicrobial. The *in vitro* antimicrobial activity of test compounds was assessed against 24 hr cultures of several selected bacteria and fungi. The bacteria used were *Escherchia coli, Staphylococcus aureus,* and *Streptococcus faecium*; the fungi used were *Candida albicans, Candida krusei* and *Aspergillus fumigatus.*

The antimicrobial activity was performed by agar diffusion method at 1 mg/mL concentration in DMSO. Nutrient agar and potato dextrose agar were used to culture the bacteria and fungi respectively. Fluconazole and Vancomycin were used as the standard for the evaluation of antibacterial and antifungal activities respectively.

Table 2

Compound	Elemental Analysis Calcd % (Found %) C	H	N	Compound	Elemental Analysis Calcd % (Found %) C	H	N
4a	72.88 (72.86)	5.65 (5.64)	6.54 (6.52)	**5h**	75.13 (75.11)	6.71 (6.69)	8.48 (8.46)
4b	60.26 (60.24)	4.21 (4.20)	8.78 (8.76)	**5i**	71.90 (71.88)	4.15 (4.14)	
4c	75.46 (75.44)	4.43 (4.43)		**5j**	63.16 (63.14)	3.26 (3.26)	
4d	80.24 (80.22)	4.49 (4.48)		**5k**	65.23 (65.21)	4.11 (4.10)	2.72 (2.72)
4e	81.64 (81.62)	4.17 (4.18)		**5l**	76.36 (76.34)	4.12 (4.11)	
4f	72.93 (72.91)	5.13 (5.12)		**5m**	83.15 (83.14)	4.59 (4.60)	2.77 (2.77)
5a	60.73 (60.71)	4.17 (4.16)	4.29 (4.28)	**5n**	61.22 (61.20)	3.35 (3.35)	
5b	68.44 (68.43)	5.41 (5.40)	4.69 (4.68)	**5o**	67.85 (67.84)	4.12 (4.11)	
5c	65.27 (65.25)	4.99 (4.98)	6.72 (6.70)	**5p**	82.92 (82.90)	6.03 (6.01)	
5d	77.27 (77.25)	5.12 (5.10)	9.49 (9.47)	**5q**	77.58 (77.57)	3.91 (3.90)	
5e	59.69 (59.67)	4.83 (4.82)	9.94 (9.92)	**5r**	70.58 (70.56)	5.58 (5.57)	2.35 (2.35)
5f	64.22 (64.20)	4.72 (4.71)	7.02 (7.02)	**5s**	73.59 (73.57)	5.61 (5.60)	
5g	70.85 (70.84)	4.79 (4.78)	8.00 (7.98)	**5t**	66.66 (66.65)	4.61 (4.60)	

Table 3

Compound	IR (cm^{-1})	Spectral data ^{1}H nmr δ (ppm)	Mass M^+
4a	1680, 2829, 3258	δ 3.51–3.53 (t, 4H), 3.74 (t, 4H), 3.80 (s, 3H), 6.90-7.03 (m, 5H), 7.08-7.12 (d, 2H), 7.30-7.38 (t, 1H), 7.59-7.63 (s, 1H), 7.68-7.74 (d, 1H), 8.03-8.08 (d, 1H), 8.38-8.39 (d, 1H), 9.73 (s, 1H)	428
4b	1595, 1670, 3555	δ 3.44 (t, 4H), 3.65 (t, 4H), 6.65-6.68 (t, 1H), 6.73 (t, 2H), 6.87-6.91 (d, 2H), 6.96-6.99 (t, 1H), 7.55-7.58 (d, 1H), 7.72-7.75 (d, 1H), 7.91 (s, 1H), 8.14 (d, 1H), 8.62-8.65 (d, 1H), 9.73 (s, 1H).	478
4c	1596, 1680, 2829, 3255	δ 3.90-3.93 (s, 3H), 7.151-7.195 (dd, 1H), 7.34-7.38 (t, 2H), 7.67-7.74 (q, 3H), 7.85-7.89 (t, 2H), 8.05-8.09 (d, 1H), 8.52-8.54 (d, 1H), 9.04 (s, 1H)	318
4d	1596, 1670, 3560	δ 7.22-7.30 (m, 5H), 7.40-7.53 (dd, 4H), 8.11-8.25 (d, 4H), 9.07 (s, 1H)	314
4e	1340, 1596, 1670, 3564	δ 7.10-7.17 (q, 2H), 7.44- 7.48 (d,1H), 7.54-7.61 (t, 3H), 7.73-7.75 (dd, 1H), 8.15-8.16 (t, 2H), 8.22-8.27 (d, 2H), 8.45-8.49 (d, 1H), 8.69 (s, 1H), 9.09 (s, 1H) .	338
4f	1250, 1679, 3569	δ 4.23 – 4.37 (t, 4H), 4.43-4.49 (t, 4H), 6.43 -6.47 (t, 1H), 6.74-6.78 (d, 1H), 6.91-7.01 (m, 4H), 7.16-7.18 (d, 2H), 7.29-7.48 (m, 5H), 7.84-7.86 (d, 1H), 7.89-7.91 (d, 1H), 7.98-8.11 (dd, 2H), 9.73 (s, 1H)	510

Table 4

Compound	IR (cm^{-1})	Spectral data ^{1}H nmr δ (ppm)	Mass M^+
5a	1680, 2829, 1030,	3.09–3.10 (t, 4H), 3.52–3.53 (t, 4H), 3.80 (s, 3H), 6.88-6.90 (m, 4H), 6.92-6.99 (d, 3H), 7.02-7.05 (d, 2H), 7.36 (d, 1H), 7.42 – 7.44 (d, 1H), 7.52 – 7.54 (d, 1H), 7.63-7.79 (d, 1H), 7.85 – 7.92 (m, 2H), 8.06- 8.07 (d, 1H).	652
5b	1675, 1030, 2882, 2951	2.24 (s, 6H), 3.12 (s, 4H), 3.44 (s, 4H), 3.83 (s, 3H), 6.86 (d, 3H), 6.94-6.99 (m, 4H), 7.20-7.29 (t, 2H), 7.59 (m, 3H), 7.77-7.86 (dd, 2H), 8.08 (d, 1H).	596
5c	1030, 1598, 1692, 2836, 3277	3.09– 3.10 (t, 4H), 3.39 (s, 3H), 3.53 -3.60 (t, 4H), 3.80-3.82 (s, 3H), 6.85 -6.87 (d, 1H), 6.90-6.94 (t, 2H), 7.10-7.12 (d, 1H), 7.49 (s, 1H), 7.52-7.56 (t, 2H), 7.58- 7.65 (q, 3H), 7.72-7.78 (q, 3H), 7.84-7.88 (t, 2H), 8.06-8.08 (d, 1H), 9.73 (s, 1H),	625
5d	1598, 1726, 2245	δ 3.45 – 3.47 (t, 4H), 3.64-3.66 (t, 4H), 5.15-5.16 (s, 2H), 7.10-7.13 (d, 2H), 7.44-7.58 (m, 13H), 7.78-7.82 (m, 5H).	590
5e	1666, 1726 , 2844, 2924	δ 2.81–2.82 (s, 3H), 2.90 (s, 3H), 3.39-3.54 (t, 4H), 3.65-3.68 (t, 4H), 4.87 (s, 2H), 6.58-6.66 (t, 1H), 6.86-6.89 (d, 1H), 7.04-7.08 (d, 2H), 7.55-7.59 (t, 1H), 7.75-7.79 (d, 1H), 7.94-7.97 (dd, 1H), 8.12-8.15 (m, 2H), 8.20-8.24 (d, 2H).	563
5f	1604, 1705, 2960	δ 3.40–3.45 (t, 4H), 3.63-3.65 (t, 4H), 4.17-4.19 (t, 2H), 4.39- 4.41 (t, 2H), 6.66- 6.69 (t, 1H), 6.84-6.89 (m, 5H), 6.97-7.01 (d, 2H), 7.20-7.26 (t, 2H), 7.56-7.60 (t, 1H), 7.71-7.76 (d, 1H), 7.92-7.95 (dd, 1H), 8.10-8.14 (q, 3H)	598
5g	1233, 1600, 2840, 2940	δ 3.44 – 3.47 (t, 4H), 3.66-3.68 (t, 4H), 5.09-5.14 (s, 2H), 6.67-6.70 (q, 1H), 6.90-6.92 (d, 1H), 7.00-7.07 (m, 3H), 7.13-7.18 (m, 2H), 7.48-7.52 (t, 2H), 7.56-7.60 (m, 1H), 7.73-7.76 (d, 1H), 7.79-7.82 (t, 1H), 7.93-7.95 (d, 2H), 8.10-8.16 (q, 1H)	525
5h	1596, 1726, 2851, 2936	δ 0.87-.90 (m, 1H), 1.04-1.10 (t, 2H), 1.20-1.39 (m, 2H), 1.73-1.76 (d, 3H), 1.83-1.90 (d, 2H), 3.47-3.56 (t, 4H), 3.73-3.79 (t, 4H), 3.84-3.89 (d, 1H), 5.32 (s, 2H), 6.69-6.73 (m, 3H), 6.91-6.98 (m, 1H), 7.00-7.13 (d, 2H), 7.35-7.41 (t, 1H), 7.52-7.60 (t, 2H), 7.64-7.68 (t, 1H), 8.10-8.15 (d, 1H), 8.25-8.27 (m, 1H)	495
5i	1027, 1656, 2839	δ 3.73 (s, 3H), 7.03 (d, 1H), 7.08-7.11 (s, 2H), 7.24 (s, 2H), 7.27-7.36 (dd, 2H), 7.44-7.45 (t, 3H), 7.59-7.63 (d, 2H), 7.66-7.73 (s, 2H), 7.78-7.80 (d, 1H), 7.83-7.88 (d, 1H), 7.91-7.95 (t, 1H), 8.14-8.18 (d, 1H), 8.22-8.24 (s, 1H)	534
5j	1134, 1560, 1648, 2627, 2920	δ 3.88 –3.94 (s, 3H), 7.12 – 7.13 (t, 1H), 7.14-7.17 (dd, 1H), 7.33 (d, 2H), 7.58-7.62 (t, 1H), 7.75-7.77 (dd, 1H), 7.81 (s, 1H), 7.83-7.91 (q, 3H), 7.93-7.95 (t, 1H), 8.14-8.16 (dd, 1H), 8.25 (s, 1H).	494

Table 5

Compound	IR (cm^{-1})	Spectral data ^{1}H nmr δ (ppm)	Mass M^+
5k	1028, 1627, 1696	δ 2.03 (s, 3H), 3.93 (s, 3H), 7.17-7.20 (dd, 1H), 7.25- 7.28 (d, 2H), 7.30- 7.30 (s, 1H), 7.44-7.46 (d, 2H), 7.57-7.61 (t, 1H), 7.70-7.78 (m, 3H), 7.81-7.83 (d, 1H), 7.89-7.93 (t, 1H), 8.13-8.14 (d, 2H)	515
5l	1233, 1600, 1726	δ 5.19 (s, 2H), 6.96 (t, 1H), 7.06-7.16 (m, 3H), 7.32-7.33 (t, 1H), 7.43-7.46 (m, 2H), 7.48-7.56 (m, 2H), 7.58 (s, 1H), 7.75-7.85 (d, 2H), 7.85-7.87 (t, 1H), 8.00-8.02 (d, 1H), 8.15-8.18 (dd, 1H), 8.31 (s, 1H)	440
5m	1233, 1600, 1726, 2245	δ 5.21 (s, 2H), 7.41-7.43 (q, 1H), 7.45-7.46 (d, 2H), 7.49-7.55 (d, 3H), 7.57-7.61 (t, 3H), 7.70-7.78 (m, 3H), 7.80-7.83 (d, 2H), 7.85-7.90 (d, 3H), 7.95-7.97 (d, 1H), 8.13-8.15 (d, 2H), 8.19-8.20 (d, 1H)	505
5n	1598, 1758, 2865, 2913	δ 4.87–4.95 (s, 2H), 7.42-7.46 (t, 1H), 7.51-7.55 (t, 2H), 7.79-7.81 (d, 2H), 7.82-7.85 (d, 1H), 7.88-7.90 (d, 2H), 8.00-8.03 (dd, 1H), 8.17-8.18 (d, 1H), 8.27-8.32 (d, 2H), 11.35 (bs, 1H)	451
5o	1605, 1807, 2865 2913	δ 4.20–4.22 (t, 2H), 4.50-4.52 (t, 2H), 6.83-6.85 (d, 2H), 6.87-6.91 (t, 1H), 7.21-7.24 (t, 2H), 7.42-7.45 (t, 1H), 7.50-7.54 (t, 2H), 7.71-7.73 (d, 2H), 7.78-7.81 (t, 2H), 7.83 (s, 1H), 8.00-8.02 (dd, 1H), 8.18-8.19 (d, 1H), 8.26-8.28 (d, 2H)	513

Table 5 (continued)

Compound	IR (cm^{-1})	Spectral data ^{1}H nmr δ (ppm)	Mass M^+
5p	1196, 1250, 1604, 1696,	δ 0.44 - 0.50 (m, 1H), 0.59 – 0.77 (m, 4H), 1.07-1.10 (d, 2H), 1.18-1.21 (d, 1H), 1.44-1.46 (d, 3H), 3.82-3.84 (d, 2H), 7.10-7.17 (q, 2H), 7.44- 7.48 (d, 1H), 7.54-7.61 (t, 3H), 7.73-7.75 (dd, 1H), 8.15-8.16 (t, 2H), 8.22-8.27 (d, 2H), 8.45-8.49 (d, 1H), 8.69 (s, 1H).	434
5q	1250, 1604, 1696,	δ 5.19 (s, 2H), 6.36-6.40 (t, 1H), 6.66-6.72 (t, 1H), 7.16-7.20 (t, 1H), 7.31-7.36 (m, 2H), 7.46-7.50 (t, 2H), 7.54-7.58 (t, 2H), 7.60-7.64 (t, 1H), 7.73-7.75 (d, 1H), 8.11-8.16 (q, 3H), 8.38-8.42 (d, 1H), 8.68 (s, 1H).	464
5r	1592 1666 2874 2928	δ 2.83–2.84 (s, 3H), 2.95-2.97 (s, 3H), 4.32-4.35 (t, 4H), 4.40-4.43 (t, 4H), 4.94-4.95 (s, 2H), 6.65-6.86 (dd, 1H), 6.76-6.78 (d, 1H), 6.90-7.03 (m, 8H), 7.29-7.33 (m, 4H), 7.39-7.47 (m, 1H), 7.66-7.77 (dd, 1H), 7.82-7.86 (d,1H)	595
5s	1040, 1250, 1679	δ 1.25–1.28 (t, 3H), 4.03-4.09 (q, 2H), 4.32-4.34 (t, 4H), 4.40-4.42 (t, 4H), 6.67-6.70 (dd, 1H), 6.78-6.79 (d, 1H), 6.93-7.03 (m, 7H), 7.27-7.33 (m, 4H), 7.37-7.42 (m, 2H), 7.69-7.76 (q, 2H)	538
5t	1218, 1598, 1671, 1728, 2932	δ 4.23–4.40 (m 8H), 5.51-5.57 (s,1H), 6.50-6.51 (d, 1H), 6.63 (s, 1H), 6.73-6.99 (m, 7H), 7.09-7.11 (d, 1H), 7.19-7.23 (t, 2H), 7.26-7.30 (t, 2H), 7.34-7.36 (d, 1H), 7.42-7.44 (t, 1H), 7.97-7.99 (d, 1H), 11.30 (bs, 2H)	612

Table 6

% Antioxidant Activity of Compounds

Compound	Concentration in μg/mL		
	200	100	50
L-ascorbic acid	98.56	97.09	88.26
4a	91.86	93.77	88.26
5n	27.19	38.19	30.51
5k	89.15	74.59	53.20
5t	38.76	32.83	26.65
5j	0.71	0.51	0.11
5o	0.24	0.12	0.09

Table 7

Anti-bacterial and Anti-fungal Activity of Compounds

Sr.No.	Sample No.	Concentration (μg/mL)	Fungal Models			Bacterial Models		
			C. albicans ATCC 14503	*A. fumigatus* ATCC 16424	*C. krusei* GO3 Fluco^R	*S. aureus* MRSA E710	*E. coli* ESS 2231	*S. faecium* VRE 323
1	**4a**	100	10	12	8	10	14h	12
2	**5a**	100	10h	8	12	12	8	14
3	**5b**	100	12	10h	8	10	14	12h
4	**5c**	100	8h	12	12	12h	12	14
5	**5e**	100	16	10	12	10	12	14h
6	**5f**	100	12	10	nil	12	10	12
7	**5g**	100	16	12	10	14	12	10
8	**5i**	100	12	10	nil	12	10	10h
9	**5j**	100	10	16	12	10	8	10
10	**5k**	100	10	14	8	12h	14	10
11	**5n**	100	14	12	8	10	14h	12
12	**5o**	100	12h	10	12	14	14	10
13	**5r**	100	12	10	10	12h	12	14
14	**5s**	100	14	10	12	12	14h	12
15	**5t**	100	12h	10h	8	14vh	10	10
16	**Fluconazole**	10 μg / disc	24h	20h	18	NA	NA	NA
17	**Vancomycin**	20 μg / mL	NA	NA	NA	15	15	16

All compounds were dissolved in DMSO and tested at 1 mg/mL concentration. In each well 50 μl sample was loaded. The zone of inhibition is expressed as the diameter of zone in mm.

The activity is reported by measuring the diameter of the inhibition zone in mm. Amongst the compounds screened, **5j, 5k** and **5s** have shown good activity against some of the fungi and **5a, 5c, 5e** and **5r** have shown very good activity against some of the bacterial strains. The results are summarized in Table **7**.

Chromones with arylsulfonyl linkage at R3 and phenyl-4-pyridin-2-ylpiperazine, 1-(2-methoxyphenyl)-4-phenyl-piperazine and 2,4-bis (2-phenoxyethoxy)benzene at R1 showed good antimicrobial activity. While compounds with the anthracene group at R1 did not show any activity.

EXPERIMENTAL

All recorded melting points were determined in open capillary and are uncorrected. IR spectra were recorded on Perkin-Elmer FTIR spectrophotometer in KBr disc. The ^{1}H nmr spectra were recorded on a 400 MHz spectrophotometer in DMSO-d_6 as a solvent and TMS as an internal standard. Peak values are shown in δ ppm. Mass spectra were obtained by Waters mass spectrometer.

General procedure for the preparation of 3-hydroxy chromone (4a-f). Compound **3** (0.01 mole) was dissolved in MeOH (25 mL), with 25 mL water and NaOH (0.03 mole) and then 5 mL of H_2O_2 was slowly added to the reaction mixture. The reaction mixture was stirred at room temperature for 8 hrs, and then poured into ice water. The solid obtained was separated by filtration and crystallized with alcohol. The compounds synthesized by the above procedure are listed in Table **1** and their characterization data is given in Table **2** and **3**.

General procedure for the preparation of 5 (d-h, l-t). Equimolar amounts of (0.01 mole) 3-hydroxychromone (**4**) and the approporate alkyl halide were taken in DMF with (0.03 mole) K_2CO_3 at room temperature. The reaction mixture was heated at 80°C for 6 hours. After completion of the reaction, the contents were cooled to room temperature and poured into ice water. The solid obtained was separated by filtration and dried under vacuum. It was purified by column chromatography using 1% MeOH in DCM. The compounds synthesized by the above procedure are listed in Table **1** and their characterization data is given in Table **2**, **4** and **5**.

General procedure for the preparation of 5 (a-c, i-k). Equimolar amount of (0.01 mole) 3-hydroxychromone (**4**) and arylsulfonyl chloride were taken in DMF with (0.03 mole) K_2CO_3 at room temperature. The reaction mixture was stirred at room temperature for 8 hours. After completion of the reaction, the contents were poured into ice water. The solid obtained was separated by filtration and dried under vacuum. It was purified by column chromatography using 1% MeOH in DCM. The compounds synthesized by the above procedure are listed in Table **1** and their characterization data is given in Table **2**, **4** and **5**.

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