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Original Research Paper

SYNTHESIS AND ANTIMICROBIAL ACTIVITY OF NEW INDOLYLCOUMARIN DERIVATIVES CONTAINING THIAZOLIDINONE MOIETY

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ABSTRACT

As a part of systematic investigation of synthesis and biological activity, several new 2-(2-substituted- 5-ethoxy/methoxy-1H-indol-3-yl)-3-(2-oxo-2H-chromen-3-yl) thiazolidin-4-ones (4a-4h) have been synthesi zed by the reaction of 3-(2-substituted-5-ethoxy/methoxy-1H-indol-3-yl) methyleneamino)-2H-chromen-2-ones (3a-3h) with thioglycolic acid in presence of anhydrous zinc chloride. All the synthesized products are evaluated for their antibacterial activity against *S. aureus*, *E. coli* and *K. pneumoneae* and antifungal activity against *C. albicans*, *C. albicans* ATCC and *C. krusai* and compared with reference drugs gattifloxacin and fluconazole respectively. Compounds 4g and 4h showed more potent antibacterial and antifungal activity. The structures of the newly synthesized compounds have been characterized by elemental, spectral (IR, ^{1}HNMR and Mass) analysis and the purity of these compounds has been checked by TLC method.

Keywords: Antibacterial activity, Antifungal activity, Thiazolidinones, Indoles, Coumarins.

INTRODUCTION

Coumarin or chromenone derivative are well known for their diverse biological activities such as bactericidal[1,2] fungicidal[3], anti-inflammatory[4] and antimicrobial[5-7] activity etc. Similarly indole[8-10] and thiazolidinone[11,12] heterocyclic nuclei exhibit numerous biocidal activity. Keeping these facts in mind and in continuation of our earlier work on fused heterocycles of pesticidal interest and guided by the observations that sometimes the fusion of two or more heterocyclic nuclei inhances the biological profile many fold than its parent nuclei. In the light of these observations several new coumarin derivatives possessing indole and thiazolidinone ring will be synthesized with the hope to possess better antimicrobial agents.

MATERIAL AND METHODS

Chemistry

All reagents and solvents were of analytical grade and used directly. Reactions were routinely performed in oven-dried borosil glassware. The melting points of compounds were determined in open capillaries with the help of thermonic melting point apparatus and were uncorrected. The homogeneity of all newly synthesized compounds was routinely checked by thin layer chromatography (TLC) on silica gel G plates and spots were located by using iodine chamber. Elemental analysis (C, H, N) of all the synthesized compounds were determined by perkin-Elmer 2400 elemental analyzer, and results were found within the ± 0.4% of theoretical values. The IR spectra were recorded on a Beckman Acculab-10 spectrometer (ν□ max in cm^{-1}) and the ^{1}H NMR spectra were recorded by Brucker DPX-300 MHz using $CDCl_3$ as solvent. Mass spectra were determiend on VG-70-S instrument.

Pharmacological Evaluation

Antibacterial Activity

The compounds 3a-3h and 4a-4h were tested for their in vitro growth inhibitory activity against different bacteria like *Staphyloccus aureus* 209p, *Escherischia coli* ESS 2231, and *Klebsiella pneumoniae* and compared with standard drug Gattifloxacin. The inhabitation zones of synthesized compounds were determines using cup plate methods.[13] In this methods Nutrient agar was poured onto the sterilized Petri dishes (20-25 ml each Petri dish). The poured material was allowed to set (1-1.5 h) and thereafter the "CUPS" (10 mm diameter) were made by punching into the agar surface with a sterile cork borer and scooping out the punched part of the agar. Into these cups the test compound solution was added with the help of sterile syringe. The plates were incubated at 37 ^{0}C for 48 hr and the results were noted. A solvent control (10% DMSO in methanol) was also run to note the activity of the blank (solvent). The inhibition zones produced by the various synthesized compounds on the microbial growth were measured (diameter in mm).

Antifungal Activity

The newly synthesized compounds and the standard drug, fluconazole were tested for their antifungal activity by employing the standard agar disc diffusion method.[14] The following strains of fungi have been used in this study: Candida albicans, C. albicans ATCC 10231 and Candida Krusei G03. All cultures were maintained on [Sabouraud-dextrose agar] SDA and incubated at 30 ^{0}C. To prepare homogeneous suspensions of the above mentioned fungi for the disc assays, they were grown in Sabouraud broth, centrifuged to collect the pellet, and buffered with saline. The fungal pellet was homogenized in a sterile hand-held homogenizer. This suspension was then plated onto SDA using a fungal spreader to obtain an even growth field. Sterile 6 mm Whatmann filter paper were impregnated with 250 µg/mL concentration of the various test compounds and standard drug fluconazole. These disc were then placed in the center of each quadrant of an SDA plate. Each plate had one control disc impregnated with DMSO. The plates were incubated at 30 ^{0}C. After 48 h, the plates were removed.

Experimental Section

Synthesis of N-(2-oxo-2H-chromen-3-yl) acetamide (1)

It was prepared according to the method by Tripathy and Mukerjee.[15] To the suspension of aceturic acid (0.01 mol) in dry benzene (50 ml) containing triethylamine (0.025 mol), benzenesulphonyl chloride (0.01 mol) was added and the mixture was shaken at room temperature untill the aceturic acid crystal disappeared and triethylamine salt separated out which were filtered and washed with benzene (20 ml). To the benzene filtrate salicylaldehyde (0.01 mol) was added. The mixture refluxed for 2 hr. After refluxing the solution was concentrated upto dryness and the residue obtained was treated with a groups ethanol and filtered. The seperated solid was recrytallized from aqueous ethanol. Physical, analytical and spectral data are given in table 1 and 2 respectively.

Synthesis of 3-amino-2H-chromen-2-one (2)

It was prepared according to tripathy and Mukerjee compound 1 was treated with ethanol (con. HCl/50 ml, 25 ml per g. of aceturic acid) and the mixture refluxed for 15 min. The solution was concentrated on a steam bath, diluted with water and to the clear solution $NaHCO_3$ added until it was alkaline. The resultant solid which was filtered, washed with water and recrstallized from ethanol to give compound 2. Physical, analytical and spectral data are given in table 1 and 2 respectively.

General procedure for synthesis of 3-((2-substituted-5-methoxy/ethoxy-1H-indol-3-yl)methyleneamino)-2H-chromen-2-ones (3a-3h)

To a solution of compound 2 (0.01 mol) in methanol (50 ml), 5-methoxy/ethoxy-2-substituted indolaldehyde (0.01 mol) was added in present of glacial acial acetic acid (2 ml). The reaction mixture was refluxed for about 10 hr. The excess of slolvent was distilled off at reduced pressure and the solid thus obtained was recrystallized from acetone to yield compounds 3a-3h. Physical, analytical and spectral data are given in table 1 and 2 respectively.

General procedure for synthesis of 2-(2-substituted-5-methoxy/ethoxy-1H-indol-3-yl)-3-(-oxo-2H-chromen-3-yl)thiazolidin-4-ones (4a-4h)

To a ethanolic solution (60 ml) of compound 3a-3h (0.01 mol), thioglycolic acid (0.02 mol) was added in the presence of anhydrous zinc chloride. The reaction mixture was refluxed for 15 hr. The excess of solvent was distilled off and separated from ethanol to yield compound 4a-4h. Physical, analytical and spectral data are given in table 1 and 2 respectively.

RESULT AND DISCUSSION

All the new synthesized compounds were screened for their antibacterial activities against *Staphyloccus aureus* 209p, *Escherischia coli* ESS 2231 and *Klebsiella pneumoniae* and antifungal activity against *Candida albicans*, *Candida albicans* ATCC 10231 and *Candida krusei* G03. Gattifloxacin and fluconazole were used as standard drugs for antibacterial and antifungal activity respectively. Most of the newly synthesized compounds showed good antimicrobial activities with respect to the control drugs. The results of antimicrobial activities were shown in table-3. Compounds 3a-3h showed mild to moderate antibacterial and antifungal activity. Cyclization of these compounds by thioglycolic acid in presence of anhydrous zinc chloride yielded corresponding thiazolidinones 4a-4h. Compounds 4a-4h exhibited moderate to good antibacterial as well as antifungal activities. Compounds 4g and 4h exhibited the highest potency against all tested organism with respect to reference drugs. Among the compounds 4a-4h, compounds 4c, 4d, 4e and 4f showed good antibacterial and antifungal activity.

CONCLUSION

In general, cyclized compounds showed better activity than their parent compounds. 4-C_6H_4Cl substituted thiazolidinone moiety 4g and 4h are scem to be beneficial bactericidal as well as fungicidal compounds against all the bacterial fungal strain in comparison to clinically used drug as gattifloxacin and fluconazole respectively.

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Table 1: Physical and analytical data of the compounds 1, 2, 3a-3h and 4a-4h

Compounds	R	R'	Recrystali-zation solvent	Yield %	mp (^{0}c)	Mol. Formula	Analysis % found (calculated)		
							C	H	N
1		-	Ethanol	89	215	$C_{11}H_9NO_3$	65.05 (65.02	4.48 4.46	6.86 6.89)
2		-	Methanol	87	218	$C_9H_7NO_2$	67.04 (67.07	4.37 4.38	8.65 8.69)
3a	OCH_3	H	D.M.F.	86	207	$C_{19}H_{14}N_2O_3$	71.66 (71.69	4.46 4.43	8.82 8.80)
3b	OC_2H_5	H	Benzene	84	220	$C_{20}H_{16}N_2O_3$	72.27 (72.28	4.86 4.85	8.45 8.43)
3c	OCH_3	CH_3	Methanol	83	187	$C_{20}H_{16}N_2O_3$	72.26 (72.28	4.87 4.85	8.47 8.43)
3d	OC_2H_5	CH_3	Ethanol	84	195	$C_{21}H_{18}N_2O_3$	72.83 (72.82	5.26 5.24	8.06 8.09)
3e	OCH_3	C_6H_5	Benzene	82	210	$C_{25}H_{18}N_2O_3$	76.17 (76.13	4.62 4.60	7.13 7.10)
3f	OC_2H_5	C_6H_5	D.M.F.	81	219	$C_{26}H_{20}N_2O_3$	76.48 (76.45	4.93 4.94	6.85 6.86)

3g	OCH_3	4-C_6H_4Cl	Methanol	80	195	$C_{25}H_{17}ClN_2O_3$	70.02 (70.01	4.01 4.00	6.56 6.53)
3h	OC_2H_5	4-C_6H_4Cl	Ethanol	76	214	$C_{26}H_{19}ClN_2O_3$	70.53 (70.51	4.34 4.32	6.30 6.33)
4a	OCH_3	H	Benzene	75	198	$C_{21}H_{16}N_2O_4S$	64.28 (64.27	4.13 4.11	7.13 7.14)
4b	OC_2H_5	H	Ethanol	72	235	$C_{22}H_{18}N_2O_4S$	65.03 (65.01	4.42 4.46	6.86 6.89)
4c	OCH_3	CH_3	Methanol	69	220	$C_{22}H_{18}N_2O_4S$	65.02 (65.01	4.45 4.46	6.87 6.89)
4d	OC_2H_5	CH_3	D.M.F.	66	195	$C_{23}H_{20}N_2O_4S$	65.68 (65.70	4.80 4.79	6.63 6.66)
4e	OCH_3	C_6H_5	Ethanol	63	226	$C_{27}H_{20}N_2O_4S$	69.20 (69.22	4.32 4.30	5.97 5.98)
4f	OC_2H_5	C_6H_5	Benzene	62	211	$C_{28}H_{22}N_2O_4S$	69.70 (69.69	4.57 4.60	5.83 5.81)
4g	OCH_3	4-C_6H_4Cl	Ethanol	60	229	$C_{27}H_{19}ClN_2O_4S$	64.45 (64.47	3.80 3.81	5.53 5.57)
4h	OC_2H_5	4-C_6H_4Cl	Methanol	59	235	$C_{28}H_{21}ClN_2O_4S$	65.03 (65.05	4.07 4.09	5.43 5.42)

Table 2: Spectral data of compounds 1, 2, 3a-3h and 4a-4h

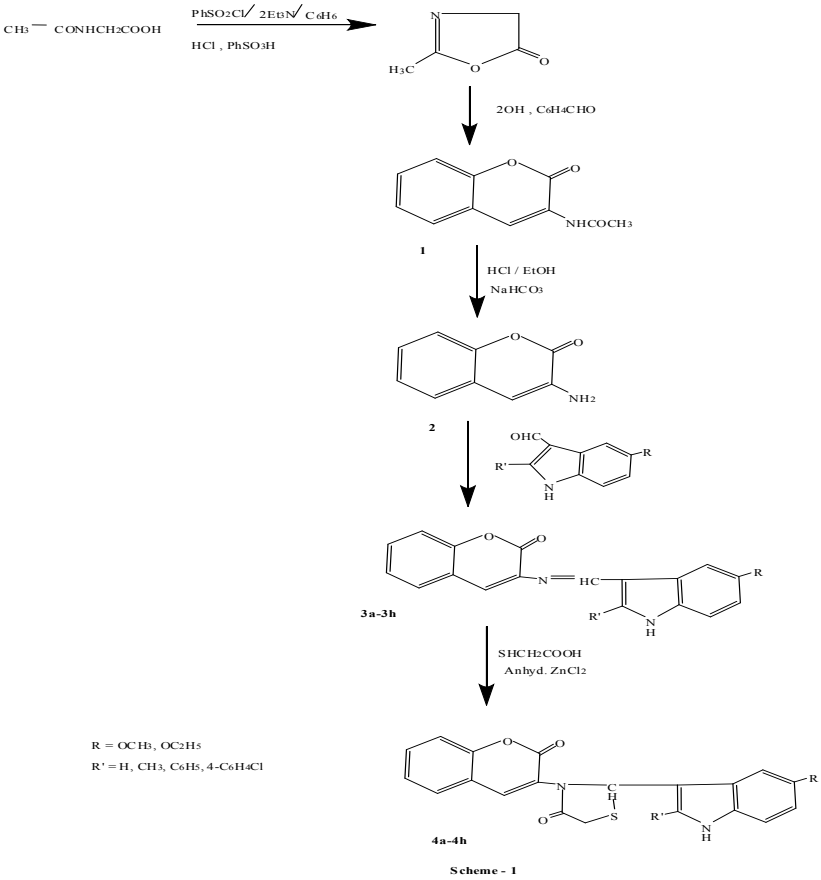
Comp. No.	$[M]^+$ m/z	IR (KBr) ν max in Cm^{-1}	^{1}H-NMR ($CDCl_3$+$DMSOd_6$)δ in ppm
1	203.19	3245 (NH), 3032 (C-H aromatic), 2910 (C-H aliphatic), 1670 (C=O), 1531 (C-C of aromatic ring), 1510 (C-N-C), 1180 (C-N)	7.13-8.12 (m, 4H, ArH), 6.40 (s, 1H, C-4H of coumarin), 5.85 (s, 1H. NH, exchangeable with D_2O), 3.65 (s, 3H, $COCH_3$)
2	161.16	3372 (NH_2), 3035 (C-H aromatic), 2913 (C-H aliphatic), 1672 (C=O), 1534 (C-C of aromatic ring), 1182 (C-N), 1071 (C-O-C)	8.46 (s, 2H, NH_2 exchangeable with D_2O), 7.14-8.10 (m, 4H, ArH), 6.43 (s, 1H, C-4H of coumarin).
3a	318.33	3032 (C-H aromatic), 2911 (C-H aliphatic), 1673 (C=O), 1613 (C=N), 1530 (C-C of aromatic ring), 1185 (C-N), 1070 (C-O-C)	8.35 (s, 1H, CH-indole), 6.56 (s, 1H, NH of indole), 7.18-8.11 (m, 4H, Ar-H), 6.89 (s, 4H, Indole), 6.43 (s, 1H, C-4H of coumarin), 3.62 (s, 3H, OCH_3)
3b	332.35	3037 (C-H aromatic), 2915 (C-H aliphatic), 1672 (C=O), 1617 (C=N), 1533 (C-C of aromatic ring), 1184 (C-N), 1074 (C-O-C)	8.32 (s, 1H, CH-indole), 6.58 (s, 1H, NH of indole), 7.16-8.51 (m, 4H, Ar-H), 6.86 (s, 4H, Indole), 6.40 (s, 1H, C-4H of coumarin), 3.10 (s, 5H, OC_2H_5)
3c	332.35	3036 (C-H aromatic), 2916 (C-H aliphatic), 1677 (C=O), 1615 (C=N), 1531 (C-C of aromatic ring), 1510 (C-N-C), 1186 (C-N), 1071 (C-O-C)	8.35 (s, 1H, CH-indole), 6.59 (s, 1H, NH of indole), 7.15-8.10 (m, 4H, Ar-H), 6.87 (s, 3H, Indole), 6.43 (s, 1H, C-4H of coumarin), 3.70 (s, 3H, OCH_3), 3.55 (s, 3H of indole)
3d	346.38	3032 (C-H aromatic), 2917 (C-H aliphatic), 1670 (C=O), 1616 (C=N), 1535 (C-C of aromatic ring), 1180 (C-N), 1079 (C-O-C)	8.30 (s, 1H, CH-indole), 6.56 (s, 1H, NH of indole), 6.89 (s, 3H, Indole), 6.47 (s, 1H, C-4H of coumarin), 7.18-8.11 (m, 4H, Ar-H), 3.16 (s, 5H, OC_2H_5), 2.35 (s, 3H , CH_3)
3e	394.42	3038 (C-H aromatic), 2910 (C-H aliphatic), 1675 (C=O), 1612 (C=N),	8.35 (s, 1H, CH-indole), 7.14-8.13 (m, 4H, Ar-H), 6.58 (s, 1H, NH of indole),6.85 (s,

		1536 (C-C of aromatic ring), 1188 (C-N), 1073 (C-O-C)	3H, Indole), 6.43 (s, 1H, C-4H of coumarin), 3.42 (s, 3H, OCH_3)
3f	408.45	3039 (C-H aromatic), 2919 (C-H aliphatic), 1674 (C=O), 1615 (C=N), 1530 (C-C of aromatic ring), 1514 (C-N-C), 1185 (C-N), 1070 (C-O-C)	8.38 (s, 1H, CH-indole), 6.58 (s, 1H, NH of indole), 7.18-8.11 (m, 9H, Ar-H), 6.89 (s, 3H, Indole), 6.45 (s, 1H, C-4H of coumarin), 3.12 (s, 5H, OC_2H_5)
3g	428.87	3034 (C-H aromatic), 2915 (C-H aliphatic), 1670 (C=O), 1618 (C=N), 1531 (C-C of aromatic ring), 1187 (C-N),1071 (C-O-C), 713 (C-Cl)	8.33 (s, 1H, CH-indole), 6.54 (s, 1H, NH of indole), 7.17-8.14 (m, 8H, Ar-H), 6.85 (s, 3H, Indole), 6.40 (s, 1H, C-4H of coumarin), 3.42 (s, 3H, OCH_3)
3h	442.89	3030 (C-H aromatic), 2918 (C-H aliphatic), 1674 (C=O), 1615 (C=N), 1533 (C-C of aromatic ring), 1517 (C-N-C), 1188 (C-N), 711 (C-Cl)	8.32 (s, 1H, CH-indole), 6.56 (s, 1H, NH of indole), 7.16-8.12 (m, 8H, Ar-H), 6.89 (s, 3H, Indole), 6.43 (s, 1H, C-4H of coumarin), 3.12 (s, 5H, OC_2H_5)
4a	392.43	3039 (C-H aromatic), 2913 (C-H aliphatic), 1670 (C=O), 1531 (C-C of aromatic ring), 1513 (C-N-C), 1180 (C-N), 1077 (C-O-C), 654 (C-S-C)	8.36 (s, 1H, CH-indole), 6.58 (s, 1H, NH of indole), 7.18-8.11 (m, 4H, Ar-H), 6.85 (s, 4H, Indole), 6.47 (s, 1H, C-4H of coumarin), 3.83 (s, 2H, CH_2 thiazolidine), 3.10 (s, 3H, OCH_3)
4b	406.45	3032 (C-H aromatic), 2910 (C-H aliphatic), 1670 (C=O), 1531 (C-C of aromatic ring), 1510 (C-N-C), 1180 (C-N), 1072 (C-O-C), 659 (C-S-C)	8.37 (s, 1H, CH-indole), 6.59 (s, 1H, NH of indole), 7.16-8.15 (m, 4H, Ar-H), 6.89 (s, 4H, Indole), 6.43 (s, 1H, C-4H of coumarin), 3.85 (s, 2H, CH_2 thiazolidine), 3.12 (s, 5H, OC_2H_5)
4c	406.45	3035 (C-H aromatic), 2912 (C-H aliphatic), 1677 (C=O), 1535 (C-C of aromatic ring), 1518 (C-N-C), 1187 (C-N), 1070 (C-O-C), 655 (C-S-C)	8.36 (s, 1H, CH-indole), 6.58 (s, 1H, NH of indole), 7.14-8.11 (m, 4H, Ar-H), 6.84 (s, 3H, Indole), 6.40 (s, 1H, C-4H of coumarin), 3.80 (s, 2H, CH_2 thiazolidine), 3.10 (s, 3H, OCH_3) 2.35 (s, 3H, CH_3)
4d	420.48	3032 (C-H aromatic), 2910 (C-H aliphatic), 1670 (C=O), 1531 (C-C of aromatic ring), 1510 (C-N-C), 1180 (C-N), 1076 (C-O-C), 659 (C-S-C)	8.30 (s, 1H, CH-indole), 6.55 (s, 1H, NH of indole), 7.19-8.13 (m, 4H, Ar-H), 6.87 (s, 3H, Indole), 6.45 (s, 1H, C-4H of coumarin), 3.83 (s, 2H, CH_2 thiazolidine), 3.16 (s, 5H, OC_2H_5) 2.33 (s, 3H, CH_3)
4e	468.52	3037 (C-H aromatic), 2917 (C-H aliphatic), 1675 (C=O), 1530 (C-C of aromatic ring), 1516 (C-N-C), 1186 (C-N), 1073 (C-O-C), 650 (C-S-C)	8.32 (s, 1H, CH-indole), 6.53 (s, 1H, NH of indole), 7.16-8.12 (m, 9H, Ar-H), 6.86 (s, 3H, Indole), 6.44 (s, 1H, C-4H of coumarin), 3.80 (s, 2H, CH_2 thiazolidine), 3.12 (s, 3H, OCH_3)
4f	482.55	3033 (C-H aromatic), 2919 (C-H aliphatic), 1670 (C=O), 1534 (C-C of aromatic ring), 1513 (C-N-C), 1183 (C-N), 1070 (C-O-C), 657 (C-S-C)	8.35 (s, 1H, CH-indole), 6.58 (s, 1H, NH of indole), 7.15-8.16 (m, 9H, Ar-H), 6.89 (s, 3H, Indole), 6.43 (s, 1H, C-4H of coumarin), 3.84 (s, 2H, CH_2 thiazolidine), 3.15 (s, 5H, OC_2H_5)
4g	502.97	3039 (C-H aromatic), 2913 (C-H aliphatic), 1673(C=O), 1534 (C-C of aromatic ring), 1513 (C-N-C), 1183 (C-N), 1071 (C-O-C), 714 (C-Cl), 659 (C-S-C)	8.31 (s, 1H, CH-indole), 6.59 (s, 1H, NH of indole), 7.18-8.10 (m, 8H, Ar-H), 6.88 (s, 3H, Indole), 6.45 (s, 1H, C-4H of coumarin), 3.81 (s, 2H, CH_2 thiazolidine), 3.16 (s, 3H, OCH_3)
4h	517.00	3035 (C-H aromatic), 2915 (C-H aliphatic), 1671 (C=O), 1534 (C-C of aromatic ring), 1513 (C-N-C), 1183 (C-N), 1075 (C-O-C), 715 (C-Cl), 655 (C-S-C)	8.32 (s, 1H, CH-indole), 6.56 (s, 1H, NH of indole), 7.15-8.12 (m, 8H, Ar-H), 6.87 (s, 3H, Indole), 6.40 (s, 1H, C-4H of coumarin), 3.83 (s, 2H, CH_2 thiazolidine), 3.14 (s, 5H, OC_2H_5)

Table 3: Antibacterial and antifungal activity of synthesized compounds 3a-3h and 4a-4h

Comp. No.	R	R'	Bacterial growth inhibition (diameter in mm)			Fungal growth inhibition(diameter in mm)		
			S. aureus	*E. coli*	*K. pneumoniae*	*C. albicans*	*C. albicans ATCC*	*C. krusei*
3a	OCH_3	H	9	-	11	8	9	10
3b	OC_2H_5	H	11	12	-	10	-	12
3c	OCH_3	CH_3	-	10	13	11	12	11
3d	OC_2H_5	CH_3	10	13	11	13	11	-
3e	OCH_3	C_6H_5	11	12	14	12	11	13
3f	OC_2H_5	C_6H_5	13	-	15	-	16	12
3g	OCH_3	4-C_6H_4Cl	15	14	13	14	13	14
3h	OC_2H_5	4-C_6H_4Cl	16	12	16	16	-	13
4a	OCH_3	H	17	18	-	19	18	17
4b	OC_2H_5	H	20	17	18	20	17	18
4c	OCH_3	CH_3	24	19	17	23	19	17
4d	OC_2H_5	CH_3	23	21	20	26	22	19
4e	OCH_3	C_6H_5	22	20	19	28	23	18
4f	OC_2H_5	C_6H_5	24	21	20	27	25	17
4g	OCH_3	4-C_6H_4Cl	27	23	22	32	28	21
4h	OC_2H_5	4-C_6H_{4Cl}	28	25	21	30	26	23
Gattifloxacin			25	22	20			
Fluconazole						29	25	19

Scheme



Scheme - 1

REFERENCES

1. Govori, S; Spahiu, S; Haziri, A and Ibrahimi, H (2013), "Antibacterial activity of some coumarin derivatives", ***European Journal of Experimental Biology***, 3 (2), 515-519.
2. Mulwad, VV and Pawar, RB (2003), "Synthesis of some antibacterial compounds from 4-hydroxy coumarin", ***Indian J. Chem.***, 42B, 2091-2096.
3. Rajanarendar, E; Karunakar, D and Srinivas, M (2004), "Synthesis and bioactivity of isoxazolyl thiazoles, isoxazolyl thiazolyl chromen-2-ones, isoxazolyl thiazinanes and isoxazolyl thiazolidinones", ***Indian J. Chem.***, 43B, 643-648.
4. Sahoo, SS; Shukla, S; Nandy, S and Sahoo, HB (2012), "Synthesis of novel coumarin derivatives and its biological evaluations", ***European Journal of Experimental Biology***, 2(4), 899-908.
5. Patel, HJ; Patel, MG; Patel, AK; Patel, KH and Patel, RM (2008), "Synthesis, characterization and antimicrobial activity of important heterocyclic acrylic copolymers", ***Express Polymer Letters***, 2(10), 727-734.
6. Kumar, PS; Ghash, G; Rout, SK and Paul, D (2013), "Synthesis and antimicrobial evaluation of some novel 4-hydroxy coumarin derivatives bearing azo moiety", ***RASAYAN J. Chem.***, 6 (2), 147-152.
7. Jaiswal, S; Sachan, N and Chawla, P (2013), "Synthesis and evaluation of novel heterocyclic chromene derivatives as antimicrobial and antioxidant agents", ***Journal of Chemical and Pharmaceutical Sciences***, 6(3), 175-180.
8. Deokar, H; Chaskar, J and Chaskar, A (2014), "Synthesis and antimicrobial activity evaluation of novel oxadiazino/thiadiazino-indole and oxadiazole/thiadiazole derivatives of 2-oxa-2H-benzopyran", ***Journal of Heterocyclic Chemistry,*** 51(3), 719-725.
9. Mohamed, MS; Awad, SM and Ahmed, NM (2011), "Synthesis and microbial activity of new indolyl pyrimidine derivatives", ***Journal of Applied Pharmaceutical Science,*** 01 (05), 76-80.
10. Yuksek, D; Algul, O; Dogen, A; Tari, O; Kucuk, E; Otag, ZF and Serin, MS (2013), "Synthesis and antimicrobial activity evaluation of some benzimidazole and indole derivatives", ***African Journal of Microbiology Research***, 7(17), 1708-1715.
11. Shrivastava, SP; Seelam, NV and Rai, R (2012), "Synthesis and antimicrobial activity of new thiazolidinone derivatives with the use of γ-ferrite catalyst", ***E. Journal of Chemistry***, 9(2), 825-831.
12. Saleh, NA-K; Saltani, HE-a; Al-Issa, F and Melad, A-SG (2013), "Evaluation of antimicrobial activity of some newly synthesized 4-thiazolidinones", ***Journal of the Chinese Chemica Society***, 60(10), 1234-1240.
13. Chuinckshank, R; Dugid, JP and Swain, RHA (1975), ***Medical Microbiology***.
14. Pai, ST and Platt, MW (1995),"Antifungal effect of Allium sativum extract against the Aspergillus species involved in otomycosis", ***Letters in Applied Microbiology***, 20, 14-18.
15. Tripathy, KP and Mukerjee, KA (1987), "A Facile synthesis of 3-acylaminocoumarins", ***Indian J. Chem.,*** 26 B, 61-62.

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