Medicinal chemistry
ISSN: 2161-0444
Rajurkar et al. Med chem 2015, 5:6
DOI: 10.4172/2161-0444.1000276
Commentary Open Access

Synthesis of Some N-(4-(Aryl)-2-Thioxo-1,3-Thiazol-3(2H)-yl)Pyridine-4-Carboxamide as Antimicrobial and Anti-inflammatory Agents

Vikas G Rajurkar*, Sujata V Lambe and Vinayak K Deshmukh

Department of Pharmaceutical Chemistry, MES`s College of Pharmacy, Sonai, Newasa Taluka, Ahmednagar Dist, Maharashtra-414105, India²University College of Pharmaceutical Sciences, Kakatiya University Warangal, India

Abstract

A series of potential bioactive compounds, N-(4-(aryl)-2-thioxo-1,3-thiazol-3(2*H*)-yl) pyridine-4-carboxamide has been synthesized and screened for antibacterial, antifungal, anti-inflammatory activity by minimum inhibitory concentration and protein denaturation method respectively. The compounds IIc and IIj were found to be broad spectrum antimicrobial agents at minimum inhibitory concentration value against *E. coli*, *K. pneumonia*, *S. aureus*, *B. subtilis*, *A. nigar*, and *S. cerevisiae* respectively. In anti-inflammatory activity, compounds IIc, IIf, IIh, and IIj at 100 mg/ml and compound III at 200 mg/ml were found significant active agent.

Keywords: Antimicrobial; Anti-inflammatory; MIC; Thiazol

Introduction

There has been a constant battle between humans and the multitude of microorganisms that cause infections and diseases; the treatment of bacterial infections remains a challenging job because of the increasing number of multidrug-resistant microbial pathogens. Despite the many chemotherapeutics available, the emergence of old and new antibiotic-resistant bacterial strains, mutations in microbial genomes, the incorrect use of antibiotics has been thoroughly demonstrated to greatly increase the development of resistant genotypes has generated a substantial need for new classes of anti-bacterial agents [1-2]. Various 2-thioxo-1,3-thiazol have been extensively investigated due to their application in different areas of biological activity such as antimicrobial [2-3], hypoglycemic [4], anti-inflammatory and analgesic agents [5], antidiabetic [6], antihyperglycemic [7]. Above mentioned facts prompted us to synthesis a series of N-(4-(aryl)-2-thioxo-1,3-thiazol-3(2H)-yl)pyridine-4-carboxamide compounds having antimicrobial and anti-inflammatory activity. The structures of the compounds were confirmed by FT-IR, ^{1}H-NMR, GC-mass spectroscopy and elemental analysis data studies; their antibacterial, antifungal, and anti-inflammatory activities were performed by MIC (Minimum Inhibitory Concentration) method.

Experimental

Material and methods

All reagents and solvents used in the present study were of analytical grade and procured from Loba Chemie (India). The progress of the reactions were monitored by TLC using Merck silica gel precoated plate, with appropriate mobile phase, visualization by iodine vapour and UV chamber and product are purified by recrystallization technique. All the melting points recorded on a Veego apparatus (Mumbai, India) and were uncorrected. All the synthesized compounds were characterized by their FT-IR, ^{1}H-NMR, GC Mass spectroscopy. FT-IR spectra were recorded in KBr on Bruker FT-IR instrument (Germany), ^{1}H-NMR spectra were recorded on Bruker Avance ^{1}H-NMR spectrometer (Germany), at 400 MHz in DMSO-d6, by using varian instrument using TMS as internal standard and chemical shift values are given in ppm downfield to TMS (tetramethylsilane), GC Mass were recorded on GCMS-QP-5050 Schimadzu (Japan), and Perkin Elmer 2400 Series II CHN Elemental Analyzer. The standard drugs norfloxacin, ketoconazole, and ibuprofen were obtained as gift sample from Wockhardt Ltd., Aurangabad, India.

Synthesis of potassium-pyridine-dithiocarbazate (I)

In a 250 ml round bottom flask, isoniazide (0.075 mol, 10.28 g) was dissolved in a solution of potassium hydroxide (0.075 mol, 4.2 g) in 100 ml of absolute ethanol and carbon disulphide (0.075 mol). The reaction mixture was agitated overnight and diluted with 200 ml of dry ether. The solid obtained was filtered and washed with dry ether, yield 15.05 g (80%) [8].

General procedure for synthesis of N-(4-(aryl)-2-thioxo-1,3-thiazol-3(2*H*)-yl)pyridine-4-carboxamide (II)

In a 250 ml round bottom flask, potassium-pyridine-dithiocarbazate I (0.01 mol, 2.51 g) was dissolved in a solution of α-bromo ketone (0.01 mol) in 100 ml of absolute ethanol and was refluxed for 8 h. The resultant solution was concentrate, and the precipitate obtained filtered, washed with cold water, dried and recrystalized from ethanol to give good yield [9,10]. All the compounds were obtained in good yield, TLC mobile phase - benzene:pet. ether (6:4). Scheme 1 and Table 1.

N-(4-biphenyl-4-yl-2-thioxo-1,3-thiazol-3(2H)-yl)pyridine-4-carboxamide IIa: FT-IR ν max (KBr, cm^{-1}): 1368 (C=S), 1402(C=C), 1651 (O=C), 1661(C=N), 2235(C-N), 3150(N-H). ^{1}H-NMR (DMSO, 400 MHz) δ: 5.50(s, 1H, ethylene), 7.41-7.59 (m, 9H, aromatic), 8.1(s, 1H, sec. amide), 8.89-7.81(m, 4H, pyridine). MS: $[M]^+$ at m/z 389.

N-[4-(2-hydroxyphenyl)-2-thioxo-1,3-thiazol-3(2H)-yl] pyridine-4-carboxamide IIb: FT-IR ν max (KBr, cm^{-1}): 1000 (C-O), 1370 (C=S), 1453 (C=C), 1636 (O=C), 1665 (C=N), 2250 (C-N), 3120 (N-H), 3645 (OH). ^{1}H-NMR (DMSO, 400 MHz) δ: 5.15 (s, 1H, ethylene), 8.0 (s, 1H, sec. amide), 8.80-7.75 (m, 4H, pyridine), 6.60-7.32 (m, 4H, aromatic), 4.90 (s, 1H, OH). MS: $[M]^+$ at m/z 329.

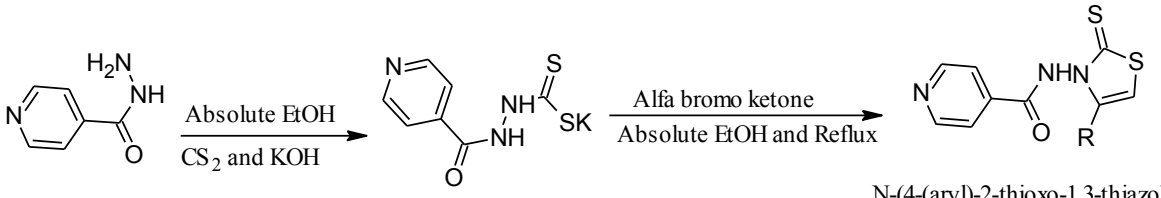
N-[4-(4-chlorophenyl)-2-thioxo-1,3-thiazol-3(2H)-yl]pyridine-4-carboxamide IIc: FT-IR ν max (KBr,

cm^{-1}): 750 (C-Cl), 1360 (C=S), 1600 (C=C), 1610 (O=C), 1709 (C=N), 2275 (C-N), 3160 (N-H). ^{1}H-NMR (DMSO, 400 MHz) δ: 5.20 (s, 1H, ethylene), 7.38-7.50 (m, 4H, aromatic), 7.90 (s, 1H, sec. amide), 8.70-7.95 (m, 4H, pyridine). MS: $[M]^+$ at m/z 347.

***Corresponding author:** Vikas Gopalrao Rajurkar, MES`s College of Pharmacy, Sonai, Newasa Taluka, Ahmednagar Dist, Maharashtra-414105, India, Tel: +91-9860482926; Fax: 02427-230948; E-mail: vikas_rajurkar_1973@yahoo.co.in

Received May 19, 2015; **Accepted** June 22, 2015; **Published** June 24, 2015

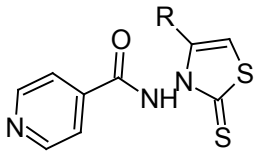
Citation: Rajurkar VG, Lambe SV, Deshmukh VK (2015) Synthesis of Some N-(4-(Aryl)-2-Thioxo-1,3-Thiazol-3(2H)-yl)Pyridine-4-Carboxamide as Antimicrobial and Anti-inflammatory Agents. Med chem 5: 285-289. doi: 10.4172/2161-0444.1000276



Isoniazide — Pottasium pyridine dithiocarbazate (I) — N-(4-(aryl)-2-thioxo-1,3-thiazol-3 (2H)-yl) pyrimidine-4-carboxamide (II)

R: Biphenyl, *o*-OH-Ph, *p*-Cl-Ph, *p*-Br-Ph, 2H-chromen-2-one, *p*-CH_3-Ph, *p*-OCH_3-Ph, *p*-NH_2-Ph, *m*-NH_2-Ph, *p*-OH-Ph, Ph, *p*-NO_2-Ph, and *m*-NO_2-Ph

Scheme 1: Scheme of synthesis for N-(4-(aryl)-2-thioxo-1,3-thiazol-3(2*H*)-yl)pyridine-4-carboxamide(II).



Comp	R	Mole. formula	M.W	M.P. (°C)	Yield (%)
IIa	*Bi*-Ph	$C_{21}H_{15}N_3OS_2$	389	240-242	60
IIb	*o*-HO-Ph	$C_{15}H_{11}N_3O_2S_2$	329	125-126	57
IIc	*p*-Cl-Ph	$C_{15}H_{10}ClN_3OS_2$	347	240-241	60
IId	*p*-Br-Ph	$C_{15}H_{10}BrN_3OS_2$	392	139-140	59
IIe	Chromen	$C_{18}H_{11}N_3O_3S_2$	381	130-131	67
IIf	*p*-CH_3-Ph	$C_{16}H_{13}N_3OS_2$	327	100-101	55
IIg	*p*-OCH_3-Ph	$C_{16}H_{13}N_3O_2S_2$	343	97-98	70
IIh	*p*-NH_2-Ph	$C_{15}H_{12}N_4OS_2$	328	180-181	53
IIi	*m*-NH_2-Ph	$C_{15}H_{12}N_4OS_2$	328	160-161	72
IIj	*p*-OH-Ph	$C_{15}H_{11}N_3O_2S_2$	329	90-91	50
IIk	Ph	$C_{15}H_{11}N_3OS_2$	313	137-138	78
IIl	*p*-NO_2-Ph	$C_{15}H_{10}N_4O_3S_2$	358	120-121	72
IIm	*m*-NO_2-Ph	$C_{15}H_{10}N_4O_3S_2$	358	132-133	45

Table 1: Physicochemical characterization of N-(4-(aryl)-2-thioxo-1,3-thiazol-3(2H)-yl)pyridine-4-carboxamide. (II).

N-[4-(4-bromophenyl)-2-thioxo-1,3-thiazol-3(2H)-yl]pyridine-4-carboxamide IId: FT-IR ν max (KBr, cm^{-1}): 995 (C-Br), 1393 (C=S), 1604 (C=C), 1677 (O=C), 1755 (C=N), 2260 (C-N), 3190 (N-H). ^{1}H-NMR (DMSO, 400 MHz) δ: 5.22 (s, 1H, ethylene), 7.22-7.54 (m, 4H, aromatic), 8.15 (s, 1H, sec. amide), 8.99-7.76 (m, 4H, pyridine). MS: $[M]^+$ at m/z 392.

N-[4-(2-oxo-2H-chromen-4-yl)-2-thioxo-1,3-thiazol-3(2H)-yl] pyridine-4-carboxamide IIe: FT-IR ν max (KBr, cm^{-1}): 1448 (C=S), 1600 (C=O), 1711 (C-O-C), 1711 (C=N), 2210 (C-N), 3105 (N-H). ^{1}H-NMR (DMSO, 400 MHz) δ: 5.21 (s, 1H, ethylene), 7.72-7.90 (m, 5H, coumarin), 7.96 (s, 1H, sec. amide), 8.68-7.94 (m, 4H, pyridine). MS: $[M]^+$ at m/z 381.

N-[4-(4-methylphenyl)-2-thioxo-1,3-thiazol-3(2H)-yl]pyridine-4-carboxamide IIf: FT-IR ν max (KBr, cm^{-1}): 1444(C=S), 1490 (C-CH_3), 1448 (C=S), 1635(O=C), 1675(C=N), 2240(C-N), 3210(N-H). ^{1}H-NMR (DMSO, 400 MHz) δ: 2.38(s, 3H, CH_3), 5.57 (s, 1H, ethylene), 7.18-7.26 (m, 4H, aromatic), 8.20(s, 1H, sec. amide), 8.95-7.61(m, 4H, pyridine). MS: $[M]^+$ at m/z 327.

N-[4-(4-methoxyphenyl)-2-thioxo-1,3-thiazol-3(2H)-yl] pyridine-4-carboxamide IIg: FT-IR ν max (KBr, cm^{-1}): 1448(C=S), 1587(C=C), 2252(C-N), 1490(C-OCH_3), 1636(O=C) 1675(C=N), 2220 (C-N), 3208 (N-H). ^{1}H-NMR (DMSO, 400 MHz) δ: 3.85 (s, 3H, OCH_3), 5.65 (s, 1H, ethylene) 7.27-7.36(m, 4H, aromatic), 7.96 (s, 1H, sec. amide), 8.79-7.69(m, 4H, pyridine). MS: $[M]^+$ at m/z 343.

N-[4-(4-aminophenyl)-2-thioxo-1,3-thiazol-3(2H)-yl]pyridine-4-carboxamide IIh: FT-IR ν max (KBr, cm^{-1}): 1452(C=S), 1556(C=C), 1597(O=C), 1733(C=N), 2354 (C-N), 2919 (N-H), 3548 (C-NH_2). ^{1}H-NMR (DMSO, 400 MHz) δ: 8.25(s, 1H, sec. amide), 5.42(d, 2H, NH_2), 5.69 (s, 1H, ethylene), 6.25-7.64(m, 4H, aromatic), 8.69-7.94(m, 4H, pyridine). MS: $[M]^+$ at m/z 328.

N-[4-(3-aminophenyl)-2-thioxo-1,3-thiazol-3(2H)-yl]pyridine-4-carboxamide IIi: FT-IR ν max (KBr, cm^{-1}): 1456(C=S), 1597(C=C), 1620(O=C), 1713(C=N), 2247(C-N), 2950 (N-H), 3565(C-NH_2). ^{1}H-NMR (DMSO, 400 MHz) δ: 5.41 (d, 2H, NH_2), 5.63 (s, 1H, ethylene), 6.41-7.35 (m, 4H, aromatic), 8.12 (s, 1H, sec. amide), 8.63-7.92 (m, 4H, pyridine). MS: $[M]^+$ at m/z 328.

N-[4-(4-hydroxyphenyl)-2-thioxo-1,3-thiazol-3(2H)-yl] pyridine-4-carboxamide IIj: FT-IR ν max (KBr, cm^{-1}): 1233(C-O), 1453(C=S), 1540(C=C), 1636(O=C), 1734(C=N), 2290(C-N), 2915(N-H), 3647(OH).^{1}H-NMR (DMSO, 400 MHz) δ: 5.37(s, 1H, ethylene), 6.74-7.59(m, 4H, aromatic), 8.16 (s, 1H, sec. amide), 8.82-7.61 (m, 4H, pyridine), 5.68(s, 1H, OH). MS: $[M]^+$ at m/z 328.

N-(4-phenyl-2-thioxo-1,3-thiazol-3(2H)-yl)pyridine-4-carboxamide IIk: FT-IR ν max (KBr, cm^{-1}): 1402 (C=S), 1539 (C=C), 1651 (O=C), 1754 (C=N), 2408 (C-N), 3023 (N-H). ^{1}H-NMR (DMSO, 400 MHz) δ: 5.33 (s, 1H, ethylene), 7.32-7.74 (m, 5H, aromatic), 8.13 (s, 1H, sec. amide), 8.69-7.75 (m, 4H, pyridine). MS: $[M]^+$ at m/z 313.

N-[4-(4-nitrophenyl)-2-thioxo-1,3-thiazol-3(2H)-yl]pyridine-4-carboxamide IIl: FT-IR ν max (KBr, cm^{-1}): 1342 (C-NO_2), 1449 (C=S), 1596 (C=C), 1635 (O=C), 1682 (C=N), 2357 (C-N), 2914 (N-H). ^{1}H-NMR (DMSO, 400 MHz) δ: 5.61 (s, 1H, ethylene), 7.29-7.86 (m, 4H, aromatic), 7.96 (s, 1H, sec. amide), 8.68-7.82 (m, 4H, pyridine). MS: $[M]^+$ at m/z 358.

N-[4-(3-nitrophenyl)-2-thioxo-1,3-thiazol-3(2H)-yl]pyridine-4-carboxamide IIm: FT-IR ν max (KBr, cm^{-1}): 1344 (C-NO_2), 1456 (C=S), 1607 (C=C), 1637 (O=C), 1681 (C=N), 2282 (C-N), 2913 (N-H). ^{1}H-NMR (DMSO, 400 MHz) δ: 5.67 (s, 1H, ethylene), 7.66-8.24 (m, 4H, aromatic), 8.13 (s, 1H, sec. amide), 8.66-7.91 (m, 4H, pyridine). MS: $[M]^+$ at m/z 358.

Biological evaluation

Antimicrobial activity [11]: All the synthesized derivatives were screened for *in vitro* antimicrobial activity against two gram positive strains *S .aureus* (*S. aureus*, NCIM 2079), *B. subtilis* (*B. subtilis*, NCIM 2711) and two gram negative strains *E. coli* (*E. coli*, NCIM 2685), *K. pneumonia* (*K. pneumoniae,* NCIM 2957*)* and two fungal strains *A. nigar* (*A. nigar*, NCIM 596), *S. cerevisiae* (*S. cerevisiae*, NCIM 3102), using the broth micro dilution method. Minimum inhibitory concentration (MIC) was determined and compared with standard drugs norfloxacin for antibacterial and ketoconazole for antifungal activity and statistical analysis was performed using ANOVA to find the significance of the test, dimethyl sulfoxide used as inert solvent (Table 2).

***In vitro* anti-inflammatory activity by inhibition of protein denaturation [12]:** The standard drug and synthesized derivative were dissolved in minimum quantity of dimethyl formamide (DMF) and diluted with phosphate buffer ((0.2M, pH 7.4). Final concentration of DMF in all solution was less than 2.5%. Test solution (1ml) containing different concentrations of drug was mixed with 1 ml of 1mM albumin solution in phosphate buffer and incubated at 27° ± 1°C in BOD incubator for 15 min. Denaturation was induced by keeping the reaction mixture at 60° ± 1°C in water bath for 10 min. After cooling, the turbidity was measured at 660 nm (UV-Visible Spectrophotometer). Percentage inhibition of denaturation was calculated from control where no drug was added and the ibuprofen was used as standard drug.

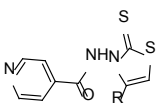
The percentage inhibition of denaturation was calculated by using following formula and statistical analysis was performed using ANOVA to find the significance of the test (Table 3).

$$\% \text{ of Inhibition} = 100 \times [1 - Vt / Vc]$$

Where, Vt=Mean absorbance of test sample, Vc=Mean absorbance of control

Structure Activity Relationship

The general structural formula of basic compound can be written as follows:



The relationship between chemical structure and antimicrobial, anti-inflammatory activity is summarized as follows.

The aryl ring should contain one substituent. Some substituent's that seem to enhance antimicrobial, anti-inflammatory activity are chloro, methyl, methoxy, hydroxyl, amino and nitro groups. Compounds containing the *p*-Cl or -OH substituent are orders of broad spectrum than the original (first generation) compounds. It is believed that the high activity of these compounds is a function of the electron withdrawing group's substitution on aryl ring at position no. 4 on thiazol ring. Among these compounds, it is thought that the spatial relationship between the electron donating groups contain compounds are less or inactive.

Results and Discussion

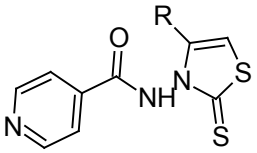
The synthesis of N-(4-(aryl)-2-thioxo-1,3-thiazol-3(2H)-yl) pyridine-4-carboxamide derivatives are depicted in Scheme 1. The IR spectra, reveals that functional groups present in the molecule appeared at their characteristic frequency characteristic frequency C=S, str. between 1360-1456 cm^{-1}, C-N, str. between 2408-2210 cm^{-1}, C-NH, str. between 3210-2913 cm^{-1}, C=N, str. between 1661-1755 cm^{-1}, C=C, str. between1402-1607 cm^{-1}, O-H, str. between 3645-3647 cm^{-1}, C-Cl, str. at 750 cm^{-1}, C-Br, str. between 995 cm^{-1}, C-CH_3, str. 1490 cm^{-1}, C-NH_2, str. between 3548-3565 cm^{-1}, C-NO_2, str. between 1342-1344 cm^{-1}, C=O, str. between 1597-1677 cm^{-1}, C-O-C, str. at 1711 cm^{-1}, C-CH_3, str. at 1490 cm^{-1} etc. The chemical shift (δ) for sec. amide hydrogen was observed in the range of 7.90-8.25 ppm, δ value for methyl hydrogen was observed at 2.38 ppm, δ value for methoxy hydrogen was observed at 3.85 ppm, δ value for ethylene hydrogen was observed in the range of 5.15-5.69 ppm, δ value for hydroxyl hydrogen was observed in the range of 4.90-5.68 ppm, δ value for amino hydrogen was observed in the range of 5.41-5.42 ppm, δ value for aromatic hydrogen was observed in the range of 6.25-8.24 ppm, δ value for pyridine hydrogen was observed in the range of 7.61-8.99 ppm. The m/e value was observed, e.g., in case of IIa-IIm at 313-392 $(M)^+$. So, from the physical and spectral data, we can conclude that the desired compounds synthesized successfully.

Antimicrobial and anti-inflammatory activity

From *in vitro* antibacterial activity, In case of *E. coli*, *K. pneumonia*, *S. aureus* and *B. subtilis* compounds IIc, IIg, IIj and IIm (*p*-Cl-Ph, *p*-OCH_3-Ph, *p*-OH, and *m*-NO_2-Ph) were found to have significant activity which is 1 folds less than the standard drug norfloxacin, while *in vitro* antifungal activity, In case of *A. nigar* and *S. cerevisiae* compounds IIc, IIf, and IIj (*p*-Cl-Ph, *p*-CH_3-Ph, and *p*-OH) were found to have significant activity which is 1 folds less than the standard drug ketoconazole. In anti-inflammatory activity, compounds IIc, IIf, IIh, and IIj at 100 mg/mL (*p*-Cl-Ph, *p*-CH_3-Ph, *p*-NH_2-Ph, and *p*-OH) were found to have significant activity which is $1/10^{th}$ less than the standard drug ibuprofen and at 200 mg/mL compound IIl (*p*-NO_2-Ph) found significant active which is $1/10^{th}$ less than standard drug ibuprofen (Tables 2 and 3). Thus from the obtained antibacterial, antifungal and anti-inflammatory activity data we could conclude that the electron-withdrawing groups substituted at specific position on phenyl ring i.e., (*p*-Cl-Ph, *p*-OCH_3-Ph, *p*-OH, *m*-NO_2-Ph, *p*-CH_3-Ph, *p*-NH_2-Ph and *p*-NO_2-Ph) are contributing positively for antibacterial and anti-inflammatory activity.

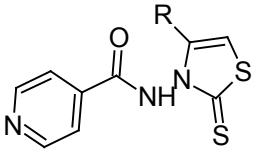
Conclusion

A series of N-(4-(aryl)-2-thioxo-1,3-thiazol-3(2H)-yl)pyridine-4-carboxamide had been synthesized in quantitative yields with the use of conventional method and evaluated for their *in vitro* antimicrobial and anti-inflammatory activity result are shown in Tables 2 and 3. On



Comp	*E.Coli*	*K. pneumoniae*	*S. aureus*	*B. subtilis*	*A. niger*	*S. cerevisiae*
IIa	45	68	49	33	59	57
IIb	48	45	38	36	32	36
IIc	27	39	31	27	36	25
IId	52	62	74	37	61	51
IIe	67	69	49	45	52	77
IIf	58	68	77	43	31	27
IIg	24	38	30	25	56	57
IIh	76	88	82	67	72	72
IIi	60	70	55	62	61	46
IIj	22	36	28	23	29	23
IIk	63	69	58	41	90	58
III	51	88	79	52	47	68
IIm	36	51	47	34	60	48
Norfloxacin	15	29	24	16	--	--
Ketoconazole	--	--	--	--	21	13

Table 2: Minimum inhibitory concentration values (µg/ml) of derivatives (IIa-IIm) against microbes.



Comp	Anti-inflammatory effect (%)		Inhibition (%)	
	100 µg/ml	200 µg/ml	100 µg/ml	200 µg/ml
IIa	0.042 ± 0.00108	0.0487 ± 0.00039	55.78	48.73
IIb	0.031 ± 0.00083	0.0423 ± 0.00080	66.63	55.47
IIc	0.021 ± 0.00082	0.0321 ± 0.00193	77.15	66.21
IId	0.033 ± 0.00086	0.0473 ± 0.00102	64.73	50.21
IIe	0.028 ± 0.00100	0.0382 ± 0.00095	69.89	59.78
IIf	0.025 ± 0.00097	0.0332 ± 0.00116	72.94	65.05
IIg	0.048 ± 0.00047	0.0528 ± 0.00140	49.26	44.42
IIh	0.017 ± 0.00396	0.0495 ± 0.00285	80	48.21
IIi	0.049 ± 0.00030	0.0558 ± 0.00186	48.42	41.26
IIj	0.023 ± 0.00045	0.0318 ± 0.00017	75.78	66.52
IIk	0.036 ± 0.00023	0.0481 ± 0.00039	62.1	49.36
III	0.037 ± 0.00029	0.0216 ± 0.00084	60.42	70.26
IIm	0.029 ± 0.00037	0.0317 ± 0.00062	69.26	66.63
Ibuprofen	0.018 ± 0.00039	0.0225 ± 0.00010	80.42	76.31
Control	0.095 ± 0.00023	0.0950 ± 0.00023	----	----

The results are expressed as mean ± SDM (n=6). Significance was calculated by using one-way ANOVA with Dunnet's t-test.

Table 3: Anti-inflammatory activity by % inhibition of protein denaturation for derivatives (IIa-IIm).

the basis of observed results, we concluded that additions of different functional groups have varying effects. In addition, the greater biological profiles were observed when the electron-withdrawing groups were incorporated at *o*-, *m*- and *p*- position of the phenyl ring.

Acknowledgement

The authors thank Shri. Prashant Patil Gadakh, President, Mula Education Society and Dr. V.K. Deshmukh, Principal, MES`s College of Pharmacy, Sonai for providing all laboratory facilities, UDCT Dr. BAMU, Aurangabad for recording FT-IR Spectra , ^{1}H-NMR spectra at SAIF Punjab University, Chandigarh, GC-MS spectra at Savitribai Phule Pune University, Pune for recording spectra.

References

1. Yurttas L, Ozkay Y, Kaplancikli ZA, Tunali Y, Karaca H (2013) Synthesis and antimicrobial activity of some new hydrazone-bridged thiazole-pyrrole derivatives. J Enzyme Inhib Med Chem 28: 830-835.
2. Parkhomenko O, Kovalenko SM, Chernykh VP, Osolodchenko TP (2005) Synthesis and antimicrobial activity of 5-oxo-1-thioxo-4,5-dihydro[1,3] thiazolo[3,4-a]quinazolines. ARKIVOC 8: 82-88.
3. Patel KH, Mehta AG (2012) Synthesis and antifungal activity of [(4-(2-naphthalenyl) thiazol-2-yl)-2-(substituted phenyl)-6-phenyl- 4-thioxo-1,3,5-oxadiazine] derivatives. Der Chemica Sinica 3: 1410-1414.

4. Hui-peng S, Kang T, Lei L, Zhu-fang S, Shou-xin L, et al. (2011) Novel N-(pyrimidin-4-yl) thiazol-2-aminederivatives as dual-action hypoglycemic agents that activate GK and PPARc. Acta Pharmaceutica Sinica B 1: 166-171.

5. Baheti KG, Thore SN, Gupta SV (2012) Synthesis and pharmacological evaluation of 5-methyl-2-phenylthiazole-4-substituted heteroazoles as a potential anti-inflammatory and analgesic agent. J Saudi Chem Soc (in press).

6. Tegginamath G, Kamble RR, Kattimani PP, Margankop SB (2011) Synthesis of 3-aryl-4-({2-[4-(6-substituted-coumarin-3-yl)-1,3-thiazol-2-yl]hydrazinylidene} methyl/ethyl)-sydnones using silica sulfuric acid and their antidiabetic, DNA cleavage activity. Arabian J Chem (in press).

7. Khan SA, Lamba HS, Alam O, Mohd I (2008) Synthesis and antihyperglycemic activity of [2-(substituted phenyl)-3-[{4-(1-naphthyl)- 1,3-thiazol-2-yl}amino]-4-oxo-1,3-thiazolidin-5-yl] Acetic Acid. Asian J Chem 20: 4987-4993.

8. Bhanojirao ME, Rajurkar VG (2009) Synthesis and biological evaluation of 5-pyridine-4- arylidine amino)-3-mercapto-4(H)-1,2,4-triazole. Asian J Chem 21: 4733-4736.

9. Reza S, Yasin MS, Tahereh Y, Maryam K (2012) Synthesis, NMR, Vibrational and Mass Spectroscopy with DFT/HF Studies of 4-(4/-Bromophenyl) -2-Mercaptothiazole Structure. Oriental J Chem 28: 627-638.

10. Abolfath A, Reza S, Milad T, Halimeh R, Mehdi D (2013) Synthesis and Studies of Potential Antifungal and Antibacterial Agents New Aryl Thiazolyl Mercury (II) Derivatives Compounds. J Chem 186531: 6.

11. Khloya P, Kumar P, Mittal A, Aggarwal NK, Sharma PK (2013) Synthesis of some novel 4-arylidene pyrazoles as potential antimicrobial agents. Org Med Chem Lett 3: 9.

12. Geronikaki A, Hadjipavlou-Litina D, Zablotskaya A, Segal I (2007) Organosilicon-containing thiazole derivatives as potential lipoxygenase inhibitors and anti-inflammatory agents. Bioinorg Chem Appl 2007: 92145.