ORIGINAL ARTICLE

Synthesis, characterization, antimicrobial, and pharmacological evaluation of some 2, 5-disubstituted sulfonyl amino 1,3,4-oxadiazole and 2-amino-disubstituted 1,3,4-thiadiazole derivatives

Dilipkumar Pal, Rohit Tripathi[1], Desh Deepak Pandey[1], Preety Mishra[1]

Department of Pharmaceutical Sciences, Guru Ghasidas Vishwavidyalaya, Bilaspur, Chhattisgarh, [1]Department of Pharmaceutical Chemistry, KNIMT Faculty of Pharmacy, Sultanpur, Uttar Pradesh, India

J. Adv. Pharm. Technol. Res.

ABSTRACT

The presence of heterocyclic structures in diverse types of compounds, this is strongly indicative of the profound effect like structure exerts on physiologic activity, and recognition of this is abundantly reflected in efforts to find useful synthetic drugs. The search for better pharmacological active drug and the importance of disubstituted 1,3,4-oxadiazole and 1,3,4-thiadiazole as active pharmacophores, prompted us to design, synthesize, characterize, and evaluate a series of differently substituted sulfonyl amino 1,3,4-oxadiazole and 1,3,4-thiadiazole for their potential antimicrobial, analgesic and antiinflammatory activity, respectively. New sulfonyl amino 1,3,4-oxadiazole and 1,3,4-thiadiazole derivatives were synthesized by intramolecular cyclization of thiosemicarbazide in alkaline medium. Reactions were carried out by the reaction between aromatic carbonyl halide and thiosemicarbazide.

Key words: 1,3,3,4-oxadiazole, 4-thiadiazole, semicarbazide, sulphonyl amino 1, thiosemicarbazide

INTRODUCTION

A fused aromatic ring consists of monocyclic rings that share their connecting bonds forming other aromatic compounds such as oxadiazoles and thiadiazoles with two nitrogen instead of one. These are the azoles with oxygen, or sulfur, and nitrogen separated by one carbon atom.[1] Oxadiazole and thiadiazole derivatives have been evaluated and proved for a wide range of pharmacological, biochemical, clinical uses and applications.[2] Phenyl 1,3,4-oxadiazole derivatives are known to have diverse biological activities like antifungal,[3] antibacterial,[4,5] anticonvulsant,[6-8] antiinflammatory[9] etc., moreover, 1,3,4-thiadiazole derivatives also possess diverse chemical and pharmacological applications such as, antiinflammatory,[10,11] analgesic,[12] anticonvulsant,[13] antimicrobial,[14] anticancer,[15] antifungal,[16] antiviral,[17] carbonic anhydrates inhibitor,[18] antidepressants,[19] and antioxidant.[20,21] properties. This property of 1,3,4-thiadiazole is particularly due to the presence of = N-C-S moiety.[22]

Address for correspondence:
Dr. Dilipkumar Pal,
Department of Pharmaceutical Sciences, Guru Ghasidas Vishwavidyalaya, Bilaspur, Chhattisgarh - 495 009, India.
E-mail: drdilip71@gmail.com

Access this article online

Quick Response Code:

Website: www.japtr.org

DOI: 10.4103/2231-4040.143040

MATERIALS AND METHODS

All used chemicals and glass were supplied by (Merck and S.D. Fine Chemicals, Lucknow, Uttar Pradesh, India). Melting point was determined by open capillary tube method. Progress of each step was confirmed by teens learning control (TLC). Purification of compounds was checked by column chromatography and silica gel G (60-120 MESS) and silica gel GF 254 (4:1) for preparation of the TLC plates and spots were seen under iodine vapor and U.V. light chamber (Ramtech Laboratories Product, Chennai, India). Proton nuclear magnetic resonance (^{1}HNMR) Spectra were recorded

on a BRUKER DR × 300 MHz instrument) in DMSO-d_6 using (tetramethylsilane) as an internal standard. Chemical shifts (δ) were expressed in ppm. The mass spectra were recorded on water OPLC - TQDMS in positive mode electrospray Ionization mass spectrometry spectrophotometer.

Experimental section

Synthesis

General method of synthesis of acid halides I (a-d)

A mixture of substituted carboxylic acid (0.01 mole) and phosphorus pentachloride was taken in a renal blood flow connected with the condenser by means of the adapter. The mixture was heated gently to melt with vigorous shaking at around 50°C, after 30 min excess $POCl_3$ was distilled out, and the residue (I a-d) was dried well and used for the next reaction.

Synthesis of compound (II a-d)

Added semicarbazide to the respected acid chloride and reflux for 5 h. These programs of the reaction were monitoring by checking the TLC. The excess benzene was distilled out neutralizing with aq.$NaHCO_3$.

Synthesis of compound (III a-d)

Then hydrolyze it in the basic medium. Product was dried well and recrystallized from methanol.

Synthesis of compound (IV a-d)

The product was heated with 4-toluene-sulfonyl chloride in dry pyridine keeping the temperature 150°C-160°C for 3 h on a heating mantle to obtained respective oxadiazole. Progress of the reaction was checked by TLC using solvent system (a-c) chloroform: N-Hexane (2:3). Yield 72%, 77%, 70%, and solvent system for (d) was chloroform: Ethyl acetate: Petroleum ether: Methanol (2:1:3:2). Yield 70%.

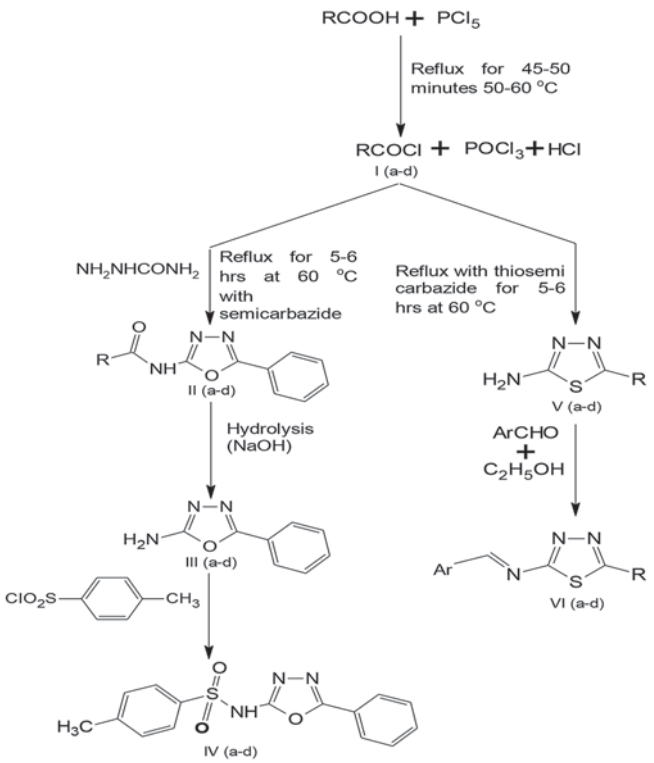
Synthesis of compound (V a-d)

The mixture of thiosemicarbazide and aromatic substituted carbonyl chloride in the presence of benzene was refluxed for 3-4 h and added to crushed ice. Recrystallized with ethanol.

Synthesis of compound (VI a-d)

A mixture of 2-amino-5-phenyl-1,3,4-thiadiazole and aromatic substituted aldehyde was irradiated in a microwave oven for 20 min with 40% power and interval of 30s. After the completion of reaction, ice cold water was added to separate the solid, recrystallized with ethanol. Progress of the reaction was checked by TLC using the solvent system (a-d) ethyl acetate: Chloroform (3:8). Yield 72%, 74%, 78%, 70%.

Synthetic scheme



Derivatives

I-IV {R= (a=-C_6H_5; b=-2-ClC_6H_4; c=-3-ClC_6H_4; d=-3-$NO_2C_6H_4$)

V-VI {R= (a=-C_6H_5; b=-2-ClC_6H_4; c=4-$NO_2C_6H_4$; d=4-ClC_6H_4); Ar= (a=-C_6H_5; b=-2-ClC_6H_4; c=-4-$NO_2C_6H_4$; d=-4-ClC_6H_4)}.

Antibacterial activity

Antibacterial activity of all synthesized derivatives was determined by disc diffusion method (Kirby Baeur method) against two gram positive bacteria namely *Staphylococcus aureus* and *Bacillus subtilis* and two gram negative bacteria namely *Salmonella* sp. and *Pseudomonas* sp. minimum inhibitory concentration. Those compounds were determined which are showing activity in primary screening standard antibiotics namely ofloxacin was used for comparison.

Pharmacological evaluations

Antiinflammatory activity of 2-amino-disubstituted-1,3,4-thiadiazole compounds was done by carrageenan-induced rat paw edema method using diclofenac sodium-30 as a standard drug, and analgesic activity of 2-amino 5-disubstituted-1,3,4-thiadiazole derivatives was done by tail flick method using aspirin as a standard drug.

Statistical analysis

One-way ANOVA using Dunnett's *t*-test was applied for statistical analysis; treatment groups were compared with the control group and the standard drug(s). $P < 0.05$

and $P < 0.001$ value was considered significant and highly significant, respectively.

RESULTS AND DISCUSSION

Physical data of the synthesized compounds are presented in Tables 1 and 2. The titled compounds 2, 5-disubstituted sulfonyl amino-1,3,4-oxadiazole (IV a-d) and 2-amino-disubstituted-1,3,4-thiadiazole derivatives were obtained in good yields (VI a-d). The structures were confirmed on the basis of spectral data.

Spectral data

- Compound (IVa): [2-(p-toluene sulfonyl amino–N-(5-phenyl)-[1, 3, 4]-oxadiazole]
  Proton nuclear magnetic resonance (D_2O, δ, ppm): 2.1 (s, 3H, *J* = 2.385), 7.3 (s, 2H, *J* = 7.44), 7.6 (s, 3H, *J* = 7.699), 8.0 (s, 1H, *J* = 7.968), 8.5 (d, 1H, *J* = 8.688). MASS m/z (%): 424.2 (6), 372.1 (8), 380.9 (8), and 291.3 (10), 263.0 (14), 224.2 (16), 481.9 (30), 444.6 (32), 380.2 (34), 490.8 (48), 223.2 (100)
- Compound (IVb): [2-(p-toluene sulfonyl amino)-N-[5-(2-chloro-phenyl)]-[1, 3, 4]-oxadiazole]
  Proton nuclear magnetic resonance (D_2O, δ, ppm): 2.3 (s, 2H, *J* = 2.369), 7.28 (d, 2H, *J* = 7.375), 7.44 (s, 2H, *J* = 7.4855), 7.61 (d, 1H, *J* = 7.675), 7.98 (s, 1H, *J* = 8.017), 8.54 (s, 1H, *J* = 8.567), 8.68 (d, 1H, *J* = 8.6465). MASS m/z (%): 80.1 (6), 228.6 (6), 468.7 (6), 473.3 (6), and 372.8 (12), 436.7 (16), 471.3 (16), 313.0 (24), 410.9 (26), 330.9 (44), 344.6 (46), 371.8 (46) 293.1 (54), 369.8 (72), 291.2 (100)
- Compound (IVc): [2-(p-toluene sulfonyl amino)-N-[5-(4-chloro-phenyl) -[1, 3, 4]-oxadiazole]
  Proton nuclear magnetic resonance (D_2O, δ, ppm) 2.3 (s, 4H, *J* = 2.378), 7.3 (d, 4H, *J* = 7.344) 7.64 (d, 2H, *J* = 7.672), 8.0 (*t*, 2H, *J* = 8.062), 8.57 (t, 1H, *J* = 8.6106), 8.72 (d, 2H, *J* = 8.763), MASS m/z (%): 318.7 (8), 378.8 (10), 470.1 (10), 436.6 (14), 248.6 (15), 414.4 (18), 344.4 (21), 331.0 (24), 274.8 (26), 410.9 (26), 80.1 (28), 332.7 (34), 291.0 (100)
- Compound (IVd): [2-(p-toluene sulfonyl amino)-N-[5-(3-nitro-phenyl)] -[1, 3, 4]-oxadiazole]
  Proton nuclear magnetic resonance (D2O, d6, δ, ppm) 2.1(s, 2H, J = 2.359), 7.23 (s, 2H, J = 7.322), 7.55 (s, 1H, J = 7.6704), 7.93 (s, 2H, J = 8.059), 8.52 (s, 2H, J = 8.587), 8.67 (s, 1H, J = 8.647), MASS m/z (%): 194.7 (6), 301.7 (6), 497.8 (7), 274.8 (8), 419.0 (8), and 387.8 (10), 348.6 (12), 378.8 (12), 448.5 (13), 248.5 (14), 332.6 (14), 306.6 (16), 468.3 (19), 410.9 (38), 80.1 (100)
- Compound (VIa): [2-aminobenzyl-5-phenyl-1,3, 4-thiadiazole]
  Proton nuclear magnetic resonance (DMSO, d_6, δ, ppm): 0.42(m, 1H, *J* = 7.5), 0.93 (m, 1H, *J* = 7.5), 1.00 (t, 1H, *J* = 7.4); mass m/z (%): 166.1 (08), 179.2 (10), 237.5 (10), 338.0 (10), 279.0 (14), 500.1 (14), 610.9 (14), 301.2 (18), 372.1 (18), 413.3 (18), 561.0 (18), 586.4 (18), 661.2 (18), 453.1 (22), 378.8 (24), 569.1 (26), 712.6 (26), 178.2 (30), 428.1 (34), 523.0 (38), 685.4 (38), 664.3 (48), 452.1 (94), 663.3 (100)
- Compound (VIb): [2-amino (2-chlorobenzyl)-5(2-chlorophenyl)-1,3,4-thiadiazole]
  Proton nuclear magnetic resonance (DMSO, d_6, δ, ppm): 1.0 (d, 1H, *J* = 7.680), 2.0 (d, 2H, *J* = 7.637), 2.44 (m, 2H, *J* = 7.520), 2.56 (m, 2H, *J* = 7.52), 3.06 (m, 3H, *J* = 7.60), 4.27 (m, 4H, *J* = 7.549), 4.36 (m, 4H, *J* = 7.594), 5.64 (m, 5H, *J* = 7.575), 6.33 (d, 6H, *J* = 7.807), 7.61 (m, 7H, *J* = 7.599); mass m/z (%): 458.6 (10), 356.7 (14), 633.6 (14), 178.2 (20), 335.5 (22), 631.6 (24), 354.7 (100)
- Compound (VIc): [2-amino-(4-nitrobenzyl)-5-(4-nitropheny)-1,3,4-thiadiazole]
  Proton nuclear magnetic resonance (DMSO-d_6, δ, ppm): 0.33 (s, 1H, *J* = 6.152), 0.46 (d, 1H, *J* = 7.999), 1.00 (d, 1H, *J* = 7.739), 1.44 (d, 1H, *J* = 8.283),

Table 1: Physical data of the synthesized compounds of 2,5-disubstituted sulfonyl amino 1,3,4-oxadiazole

Compounds (IV)	-R	Yield %	M.P. (°C)	R^f value	Molecular formula	Molecular weight
a	$-C_6H_5$	72	200-210	0.60	$C_{15}H_{13}N_3O_3S$	315.0
b	$-2\text{-}ClC_6H_4$	77	200-215	0.42	$C_{15}H_{12}N_3O_3ClS$	349.5
c	$-3\text{-}ClC_6H_4$	70	260-270	0.56	$C_{15}H_{12}N_3O_3ClS$	349.5
d	$-3\text{-}NO_2C_6H_4$	70	260-270	0.54	$C_{15}H_{12}N_4O_5S$	360.0

M.P.: Melting point

Table 2: Physical data of the synthesized compounds of 2-amino-disubstituted-1,3,4-thiadiazole

Compounds (VI)	-R	-Ar	Yield (%)	M.P. (°C)	R^f value	Molecular formula	Molecular weight
a	$-C_6H_5$	$-C_6H_5$	72	80-90	0.62	$C_{15}H_{11}N_3S$	265.2
b	$-2\text{-}ClC_6H_4$	$-2\text{-}ClC_6H_4$	74	100-110	0.85	$C_{15}H_9N_3SCl_2$	334.1
c	$-4\text{-}NO_2C_6H_4$	$-4\text{-}NO_2C_6H_4$	78	100-110	0.50	$C_{15}H_9N_5SO_4$	355.1
d	$-4\text{-}ClC_6H_4$	$-4\text{-}ClC_6H_4$	70	100-110	0.7	$C_{15}H_9N_3SCl_2$	334.1

M.P.: Melting point

1.83 (s, 1H, J = 10.112), 3.67 (d, 3H, J = 8.446), 3.95 (d, 3H, J = 8.177); mass m/z (%): 365.9 (10), 407.1 (10), 446.2 (10), 505.0 (10), 701.2 (12), 741.2 (12), 407.9 (14), 576.3 (14), 212.1 (16), 426.7 (20), 544.4 (22), 515.0 (24), 530.0 (34), 424.7 (70), 422.7 (100)

- Compound (VId): [2-amino- (4-chlorobenzyl) -5-(4-chlorophenyl)-1,3,4-thiadiazole]

  Proton nuclear magnetic resonance (DMSO-d_6, δ, ppm): 0.03(s, 1H, J = 8.340), 0.18 (s, 1H, J = 9.873), 0.76 (m, 1H, J = 7.898), 1.00 (d, 1H, J = 7.710), 1.78 (m, 1H, J = 7.540); mass m/z (%): 458.6 (10), 356.7 (14), 633.6 (14), 178.2 (20), 335.5 (22), 631.6 (24), 354.7 (100).

Evaluation of antibacterial activity

Antibacterial activities of all synthesized compounds were determined by disc diffusion method. Results are exhibited in Table 3 and Figure 1. Compounds IVa and IVb exhibited good activity, and IVc and IVd showed moderate activity as compared with standard drug Ofloxacin.

Pharmacological evaluation

Results are represented in Tables 4 and 5. Compounds VIb and VIc exhibited good antiinflammatory activity as compared with standard drug diclofenac-30, while VIc shows good analgesic activity as compared with standard drug aspirin.

CONCLUSION

A series of 2-amino-disubstituted-1,3,4-thiadiazoles ando2, 5-disubstituted-phenyl 1,3,4-oxadiazoles was synthesized with good yields, and their structures were elucidated by spectral data. All the compounds show good pharmacological activities. Compounds IVa and IVb exhibited good antimicrobial activity and IVc, IVd showed moderate microbial activity as compared with a standard drug ofloxacin. Compounds VIb and VIc exhibited good antiinflammatory activity as compared with standard drug diclofenac-30, while VIc shows good analgesic activity in comparison to aspirin used as standard drug.

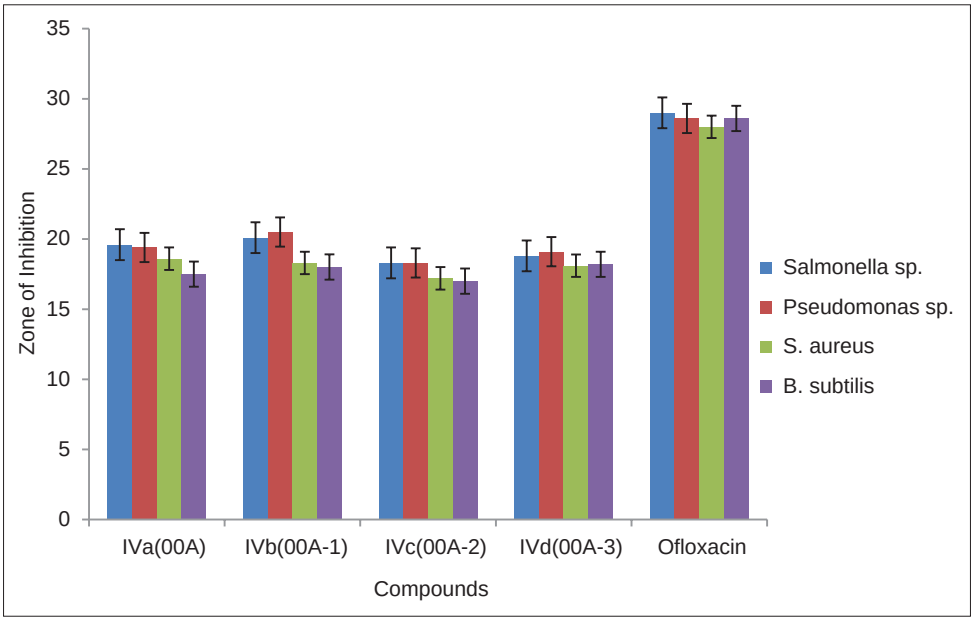


Figure 1: Zone of inhibition by different compounds against different bacteria

Table 3: Antibacterial activity of synthesized compounds (00A-00A-3)

Zone of inhibition in mm					
Compounds	**IVa (00A)**	**IVb (00A-1)**	**IVc (00A-2)**	**IVd (00A-3)**	**Ofloxacin**
Salmonella sp.	19.6±1.1	19.4±1.1	18.6±1.1	17.5±1.1	29.0±1.1
% inhibition	67.5	66.89	64.13	59.31	100
Pseudomonas sp.	20.1±1.04	20.5±1.04	18.3±1.04	18.01±1.04	28.6±1.04
% inhibition	70.27	71.67	63.98	62.97	100
Staphylococcus aureus	18.3±0.8	18.3±0.8	17.2±0.8	17.0±0.8	28.0±0.8
% inhibition	65.35	65.35	61.42	60.71	100
Bacillus subtilis	18.8±0.9	19.1±0.9	18.1±0.9	18.2±0.9	28.6±0.9
% inhibition	65.73	66.78	63.28	63.63	100

Data presented in mean±SD (n=3), concentration of derivatives=25 μg/dish, concentration of ofloxacin=25 μg/ml. In comparison to control, % inhibition by synthesized compound (s) is significant and potent, but not showing better activity than the standard drug (ofloxacin) used in this experiment. SD: Standard deviation

Table 4: Antiinflammatory activity of the synthesized compound (2-amino-5-disubstituted-1,3,4-thiadiazole derivatives) by carrageen an induced rat paw edema method showing percentage of inhibition

Treatment	Paw volume					
Time interval (h)	**0**	**1**	**2**	**3**	**6**	**24**
Control	0.19±0.03	0.20±0.02	0.28±0.01	0.34±0.04	0.30±0.04	0.28±0.01
Diclofenac-30 (% inhibition)	0.07±0.01 (63)	0.09±0.01* (55)	0.11±0.07* (60)	0.20±0.04** (41)	0.12±0.02** (60)	0.11±0.01** (60)
VIa (% inhibition)	0.10±0.01 (47)	0.14±0.02$^{\#}$ (30)	0.11±0.04 (60)	0.21±0.01 (38)	0.19±0.02$^{\#}$ (36)	0.15±0.01$^{\#}$ (46)
VIb (% inhibition)	0.12±0.01*,$^{\#}$ (36)	0.14±0.02$^{\#}$ (30)	0.14±0.01 (50)	0.25±0.04** (26)	0.16±0.04 (46)	0.12±0.01 (57)
VIc (% inhibition)	0.09±0.01$^{\#}$ (52)	0.11±0.01 (45)	0.13±0.06* (53)	0.23±0.04** (32)	0.19±0.02$^{\#}$ (37)	0.12±0.01** (57)
VId (% inhibition)	0.11±0.02*,$^{\#}$ (42)	0.13±0.01$^{\#}$ (35)	0.16±0.01* (42)	0.24±0.01 (29)	0.19±0.02$^{\#}$ (37)	0.15±0.01$^{\#}$ (46)

Each data suggests mean±SEM (n=6), one-way ANOVA using Dunnett's t-test is applied for statistical analysis. Treatment groups compared with the control group: *Significant at P<0.05, **Highly significant at P<0.01. Treatment groups compared with standard drug: $^{\#}$Significant at P<0.05. % inhibition, $(1-V_t/V_c)\times100$, V_t=Increase in paw volume of test, V_c=Increase in paw volume of the control group of rats. SEM: Standard error of the mean

Table 5: Analgesic activity of the synthesized compound (2-amino5-disubstituted-1,3,4-thiadiazole derivatives) by tail flick method (values obtained)

Treatment	Reaction time			
Time interval (min)	**15**	**30**	**45**	**60**
Control	2.90±0.21	3.10±0.19	2.80±0.15	3.07±0.06
Aspirin	4.17±0.30*	5.50±0.40**	6.93±0.72**	8.25±0.13**
VIa	3.95±0.34	5.28±0.44	5.96±0.75	2.64±0.48$^{\#}$
VIb	4.12±0.33	5.94±0.63	5.45±0.56	1.58±0.28$^{\#}$
VIc	3.90±0.33*	4.50±0.50*	6.20±0.17**	1.75±0.56**,$^{\#}$
VId	3.84±0.40	4.11±0.40$^{\#}$	6.12±0.24	1.46±0.17$^{\#}$

Each datum suggests mean±SEM (n=6), one-way ANOVA using Dunnett's t-test is applied for statistical analysis. Treatment groups compared with the control group: *Significant at P<0.05, **Moderate significant at P<0.01. Treatment groups compared with the standard drug: $^{\#}$Significant at P<0.05. SEM: Standard error of the mean

ACKNOWLEDGMENTS

One of the authors is thankful to the head of the department (Pharmaceutical Chemistry), Faculty of Pharmacy, K.N I M T, Sultanpur for necessary support. We also acknowledge our regard to SAIF Laboratory of Central Drug Research Institute (CDRI), Lucknow for providing spectra of compounds prepared.

REFERENCES

1. Geeta M, Arvind KS, Kshtiz J. Review article on 1, 3, 4-Thiadiazole derivaties and it's pharmacological activities. Int J Chem Tech Res 2011;3:1380-93.
2. Tawfeeq FR, Al-Auqbi NT, Al-Khalidy T. Inhibitory effect of oxadiazooles and thiadiazoles *in vitro* on serum alkaline phosphates' enzyme of pregnant woman. Am J Plant Sci 2012;11:1.
3. Maslat AO, Abussaud M, Tashtoush H, Al-Talib M. Synthesis, antibacterial, antifungal and genotoxic activity of bis-1,3,4-oxadiazole derivatives. Pol J Pharmacol 2002;54:55-9.
4. Chawla R, Arora A, Parameswaran MK, Chan P, Sharma D, Michael S, *et al*. Synthesis of novel 1,3,4-oxadiazole derivatives as potential antimicrobial agents. Acta Pol Pharm 2010;67:247-53.
5. Mehta AN, Yadav J, Desai KR. Eco-Friendly synthesis of novel fluorine containing 1, 3, 4-oxadiazole as antibacterial and antifungal agents. Asian J Res Chem 2013;6:486-9.
6. Sudha BS, Shashikanth S, Khanum SA, Sriharsha SN. Synthesis and pharmacological screening of 5– (4-Aroyl)-aryl oxy methyl-2-thio -1, 3, 4-oxadiazole. Indian J Pharm Sci 2003; 65; 5: 465-70.
7. Bhatnacar S, Kamthan D, Mehra SC, Tandan SK. Synthesis of some new N3-substituted hydantoins as potential anticonvulsant agents. Indian J Pharm 1986;18:35-238.
8. Singh A, Rana AC. Synthesis and anticonvulsant activity of 1-[(4, 5-dihydro-5-phenyl-3-(phenylamine) pyrazol-1-yl)] ethanone derivatives. J Chem Pharm Res 2010;2:05-511.
9. Sahoo BM, Ravi Kumar BV, Prasanna KB. Synthesis, characterization and biological evaluation of novel oxadiazole derivatives. Int J Pharm Sci Res 2011;2:344-50.
10. Schenone S, Brullo C, Bruno O, Bondavalli F, Ranise A, Filippelli W, *et al*. New 1,3,4-thiadiazole derivatives endowed with analgesic and anti-inflammatory activities. Bioorg Med Chem 2006;14:1698-705.
11. Rostom SA, el-Ashmawy IM, Abd el Razik HA, Badr MH, Ashour HM. Design and synthesis of some thiazolyl and thiadiazolyl derivatives of antipyrine as potential non-acidic anti-inflammatory, analgesic and antimicrobial agents. Bioorg Med Chem 2009;17:882-95.
12. Singh AK, Bose S, Singh UP, Jana S, Shukla R, Singh V. Synthesis and biological activity of some new thiadiazole derivative. Technol Pharm Res 2009;2:133-7.
13. Chapleo CB, Myers PL, Alan CB. Smith IF. Tulloch DS. Walter. Substituted 1, 3, 4-thiadiazoles with anticonvulsant activity. Guanidine's. J Med Chem 1987;30:951-4.
14. Mulay A, Mangesh G, Nikalje AP. Exploring potential of 4-thiazolidinone: A brief review. Int J Pharm Sci 2009;1:47-64.
15. Kumar D, Maruthi Kumar N, Chang KH, Shah K. Synthesis and anticancer activity of 5-(3-indolyl)-1,3,4-thiadiazoles. Eur J Med Chem 2010;45:4664-8.
16. Matysiak J, Malinski Z. 2-(2,4-Dihydroxyphenyl)-1,3,4-thiadiazole analogues: Antifungal activity *in vitro* against *Candida* species. Bioorg Khim 2007;33:640-7.
17. Chen Z, Xu W, Liu K, Yang S, Fan H, Bhadury PS, *et al*. Synthesis

and antiviral activity of 5-(4-chlorophenyl)-1,3,4-thiadiazole sulfonamides. Molecules 2010;15:9046-56.

18. Bülbül M, Saraçoglu N, Küfrevioglu OI, Ciftçi M. Bile acid derivatives of 5-amino-1,3,4-thiadiazole-2-sulfonamide as new carbonic anhydrase inhibitors: Synthesis and investigation of inhibition effects. Bioorg Med Chem 2002;10:2561-7.
19. Clerici F, Pocar D, Guido M, Loche A, Perlini V, Brufani M. Synthesis of 2-amino-5-sulfanyl-1,3,4-thiadiazole derivatives and evaluation of their antidepressant and anxiolytic activity. J Med Chem 2001;44:931-6.
20. Pal D, Mitra S. A preliminary study on the *in vitro* antioxidant activity of the stems of opuntia vulgaris. J Adv Pharm Technol Res 2010;1:268-72.
21. Nayak AK, Pal D, Pany DR, Mohanty B. Evaluation of *Spinacia oleracea* L. leaves mucilage as an innovative suspending agent. J Adv Pharm Technol Res 2010;1:338-41.
22. Oruç EE, Rollas S, Kandemirli F, Shvets N, Dimoglo AS 1,3,4-thiadiazole derivatives. Synthesis, structure elucidation, and structure-antituberculosis activity relationship investigation. J Med Chem 2004;47:6760-7.

How to cite this article: Pal D, Tripathi R, Pandey DD, Mishra P. Synthesis, characterization, antimicrobial, and pharmacological evaluation of some 2, 5-disubstituted sulfonyl amino 1,3,4-oxadiazole and 2-amino-disubstituted 1,3,4-thiadiazole derivatives. J Adv Pharm Technol Res 2014;5:196-201.

Source of Support: Nil, **Conflict of Interest:** Nil.