Synthesis, spectral analysis and biological evaluation of *N*-alkyl/aralkyl/aryl-4-chlorobenzenesulfonamide derivatives

Aziz-ur-Rehman[1]*, Muhammad Athar Abbasi[1], Sabahat Zahra Siddiqui[1], Ayesha Mohyuddin[2], Sohail Nadeem[2] and Syed Adnan Ali Shah[3,4]

[1]Department of Chemistry, Government College University, Lahore, Pakistan
[2]Department of Chemistry, School of Science and Technology, University of Management & Technology, Lahore, Pakistan
[3]Atta-ur-Rahman Institute for Natural Products Discovery (AuRIns), Level 9, FF3, University Teknologi MARA, Puncak Alam Campus, 42300 Bandar Puncak Alam, Selangor Darul Ehsan, Malaysia
[4]Faculty of Pharmacy, University Technology MARA, Puncak Alam Campus, 42300 Bandar Puncak Alam, Selangor Darul Ehsan, Malaysia

Abstract: New potent organic compounds were synthesized with an aim of good biological activities such as antibacterial and anti-enzymatic. Three series of sulfonamide derivatives were synthesized by treating *N*-alkyl/aryl substituted amines (2a-f) with 4-chlorobenzensulfonyl chloride (1) to yield *N*-alkyl/aryl-4-chlorobenzenesulfonamide(3a-f)that was then derivatized by gearing up with ethyl iodide (4), benzyl chloride (5) and 4-chlorobenzyl chloride (6) using sodium hydride as base to initialize the reaction in a polar aprotic solvent (DMF) to synthesize the derivatives, 7a-f, 8a-fand 9a-f respectively. Structure elucidation was brought about by IR, ^{1}H-NMR and EIMS spectra for all the synthesized molecules which were evaluated for their antibacterial activities and inhibitory potentials for certain enzymes.

Keywords: 4-Chlorobenzenesulfonyl chloride; amines; sulfonamides; antibacterial activity; enzyme inhibition activity; ^{1}H-NMR and EIMS.

INTRODUCTION

The functional group -SO_2NH- is known as sulfamoyl linkage and the class of compounds bearing it, is called sulfonamide. Sulfonamide is recognized as pharmacologically significant class of compounds. Sulfonamides famous as sulfa drugs are utilized in vast number of biologically active compounds as a result of their antimicrobial activity (Alsughayer *et al.,* 2011; Kumar *et al.,* 2010). Most of the pharmacologically active sulfonamide derivatives are utilized as antibacterial and antiviral compounds (Baskin *et al.,* 2002; Shi F *et al.,* 2009). During the action mechanism of sulfonamide 4-aminobenzoic acid gets incorporated in folic acid pathway and inhibits the enzyme, the foliate synthetase. As a result it inhibits the synthesis of folic acid and consequently hinders purine synthesis (Alsughayer *et al.,* 2011; Thakur *et al.,* 2006). Sulfonamides exhibit a range of biological applications like antidiuretics, anticancer, anti-inflammatory, anticonvulsant, hypoglycemic and HIV protease inhibitors (Alsughayer *et al.,* 2011; Shi F *et al.,* 2009; Sondhi *et al.,* 2010; Cami *et al.,* 2006; Argyropoulou *et al.,* 2009).

The presented work demonstrates the synthesis of environment friendly sulfonamides using alkyl/aryl amines as starting material and their evaluation for antibacterial and anti-enzymatic potentials. This was the propagation of our last projects on the synthesis of a variety of sulfonamides with certain biological potentials (Aziz-ur-Rehman *et al.,* 2012; Aziz-ur-Rehman *et al.,* 2013; Khalid *et al.,* 2012 and Khalid *et al.,* 2013).

**Corresponding author:* e-mail: azizryk@yahoo.com

MATERIALS AND METHODS

General

All the chemical reagents were of Merck and Alfa Aesar brands purchased through local suppliers. The solvents utilized were of analytical grade. Purity of the synthesized compounds was verified by employing thin layer chromatography (TLC) the using EtOAc and *n*-hexane (as solvent systems) and visualized by UV lamp at 254 nm. Melting points were taken by using Griffin-George melting point apparatus in an open capillary tube and were uncorrected. The I.R. spectra were recorded on a Jasco-320-A spectrophotometer by KBr pellet method, wave number was mentioned in cm^{-1}. ^{1}H-NMR spectral data were taken in CH_3OH-$d_1$onBruker spectrometers at 500 MHz. TMS was used as internal reference. Chemical shift (δ) values are mentioned in ppm scale and coupling constant *J*-values are expressed in Hz. EI Mass spectra were taken by a JMS-HX-110 spectrometer.

Synthesis of N-Alkyl/aryl-4-chlorobenzenesulfonamide (3a-f)

N-Alkyl/aryl amine (2a-f, 20mmol) was suspended in 30 mL distilled water contained in a 100mL round bottom flask. Small amount of aq. Na_2CO_3 solution was added to set a pH of 9-10 along with shaking. 4-Chlorobenzene sulfonyl chloride (1, 0.02mol) was introduced to the reaction contents along with continuous stirring. Reaction flask was set to stir for few hr. and reaction completion

was monitored by TLC using *n*-hexane and EtOAc. On completion a few drops of conc. HCl (to make pH=4-6) were added into reaction contents and vigorously shaken by hand. The precipitates were collected after filtration and drying to get the final compounds.

Synthesis of N-alkyl/aralkylsubstituted-N-Alkyl/aryl-4-chlorobenzenesulfonamide (7a-f, 8a-f, 9a-f)

The parent compounds 3a-f (0.001 mol) was taken in 100 mL round bottom flask containing 10mL *N*, *N*-dimethyl form amide (DMF) to dissolve the compound. Sodium hydride was added as activator and allowed the reaction contents to stir at room temperature. After half an hour different electrophiles i.e., ethyl iodide (4; 0.001 mol), benzyl chloride (5; 0.001 mol) and 4-chlorobenzyl chloride (6; 0.001 mol) were introduced to the reaction mixture and allowed the contents of the flask to stir for 3-4 hours. After single spot on TLC plate, ice-cold distilled water was added to quench the precipitates by shaking and kept in freezer for 15-20min. The precipitated products, 7a-e, 8a-e and 9a-e, were filtered, washed and dried for further analysis.

Antibacterial activity

The antibacterial activity method was based on the principle that microbial cell number or microbial growth was directly related to the log phase of growth with increase in absorbance of broth medium (Kaspady *et al.*, 2009; Yang *et al.*, 2006). The clinically isolated two-gram +ive bacteria (*B. subtilis and S. aureus*) and four gramive (*K. pneumonae, E. coli, P. aeruginosa and S. typhi*) were stored on stock culture agar medium. 20µg test samples with dilution by suited solvents and 180µL over night maintained fresh bacterial culture with suited dilution with fresh nutrient broth were mixed. The initial absorbance was crucially between 0.12-0.19 at 540 nm. The incubation was processed at 37°C for 16-24 hrs with lid on the micro plate. The absorbance was recorded at 540 nm using micro plate reader before and after incubation and the difference was noted as an index of bacterial growth. The percent inhibition was calculated using the formula:

$$\text{Inhibition } (\%) = \frac{\text{Control} - \text{Test}}{\text{Control}} \times 100$$

Where Control = Absorbance in control with bacterial culture

Test = Absorbance in test sample

Results are mean of triplicate (n=3, ± SEM). Ciprofloxacin and Gentamycin were taken as standard. Minimum inhibitory concentration (MIC) was measured with suitable dilutions (5-30µg/well) and results were calculated using EZ-Fit Perrella Scientific Inc. Amherst USA software, and data was expressed as MIC.

Lipoxygenase assay

Lipoxygenase activity was assayed following the reported method (Clapp *et al.*, 1985; Bertaccini *et al.*, 1982; Baylac *et al.*, 2003) but with slight changes. A total volume of 200µL assay mixture consisted of 150µL Na_3PO_4 buffer (100mM) that maintain pH at 8.0, 10µL test compound and purified lipoxygenase enzyme (15µL) (Sigma, USA). All the constituents were mixed and pre absorbance was noted at 234nm and pre-incubated at 25°C for 10 min. The reaction started on addition of 25µL substrate solution. The change in absorbance was recorded after 6 min at the same wavelength. Synergy HT (BioTek, USA) 96-well plate reader was used in all experiments. All readings were recorded in triplicates. Both positive and negative controls were used in the assay. Baicalein (0.5mM $well^{-1}$) was a positive control. The percent inhibition and IC_{50} values were calculated as mentioned above.

α-Chymotrypsin assay

α-Chymotrypsin inhibition assay was performed according to the method mentioned in literature (Cannell *et al.*, 1988; Abbasi *et al.*, 2009). A total volume of 100µL reaction mixture contained 60µL of 50mM Tris-HCl buffer that control the pH at 7.6, 10µL of 0.5mM test compound and 15µL (0.9 units) of enzyme (Sigma, USA) prepared in the above buffer. The contents were mixed, preincubated at 37°C for 15 min and pre read by measuring the absorbance at 410 nm. The reaction gets started on addition of 15µL of 1.3mM substrate, *N*-succinyl phenylalanine-*p*-nitroanilide (Sigma, USA). Absorbance was recorded at 410 nm using Synergy HT micro plate reader after 30-60 min when absorbance values of uninhibited enzyme assay reached 0.7-0.9. The positive and negative controls were included. All experiments were carried out in triplicate. The percent inhibition was calculated by

$$\text{Inhibition } (\%) = \frac{\text{Control} - \text{Test}}{\text{Control}} \times 100$$

Where, Control = Absorbance in control with bacterial culture

Test = Absorbance in test sample

IC_{50} values (concentration at which enzyme inhibition is 50%) were calculated using EZ-Fit Enzyme Kinetics Software (Perrella Scientific Inc. Amherst, USA).

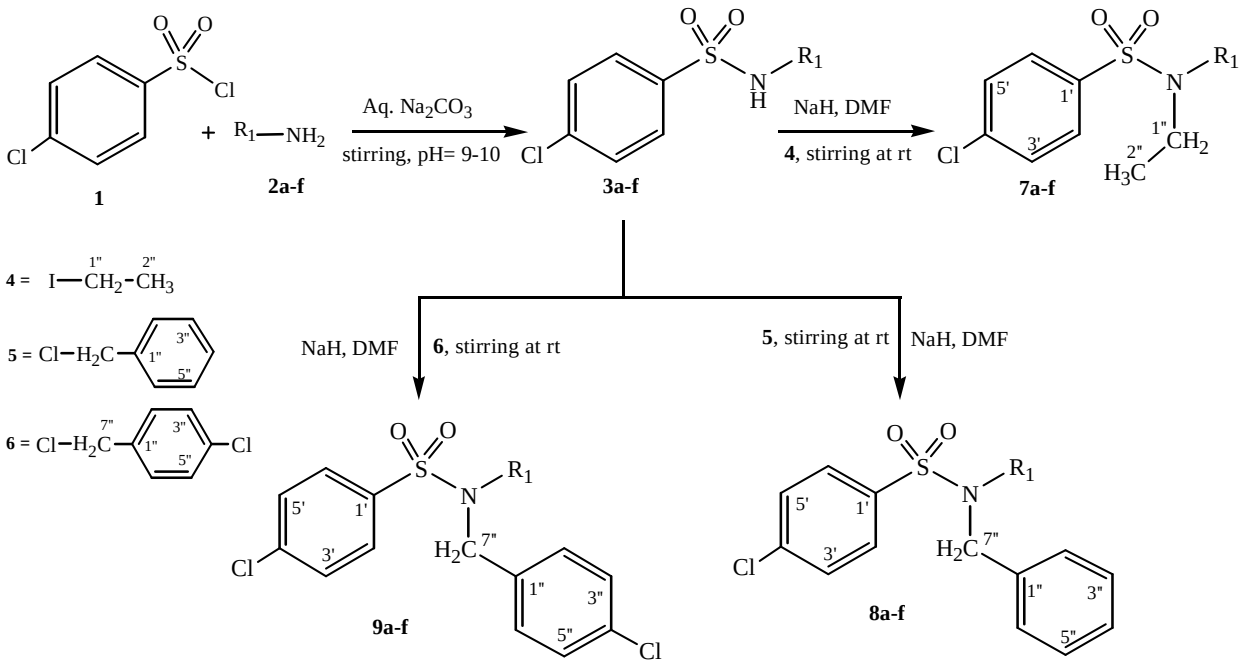
STATISTICAL ANALYSIS

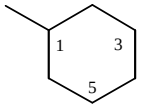
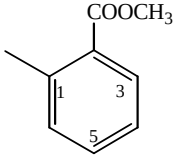
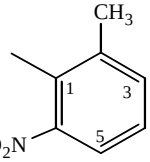
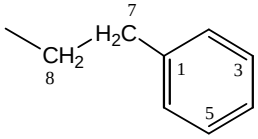
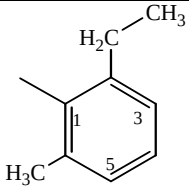
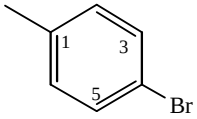
All the procedures were repeated in triplicate and statistical analysis was performed by Microsoft Excel 2010. Results are presented as mean ± SEM.

Spectral characterization of all synthesized derivatives

N-Cyclohexyl-N-ethyl-4-chlorobenzenesulfonamide (7a)

White amorphous solid; Yield: 78%; M. P.: 114-116°C; Mol. formula: $C_{14}H_{20}ClNO_2S$; Mol. Wt.: 301; IR (KBr, ν_{max}/cm^{-1}): 3056 (Ar-H), 1526 (Ar C=C), 1416 (S=O), 1146 (C-N), 556 (C-Cl); ^{1}H-NMR (500 MHz, MeOD, ppm): *δ* 7.81 (d, *J*=9.0 Hz, 2H, H-2', H-6'), 7.54 (d, *J*=8.5 Hz, 2H, H-3', H-5'), 3.47 (q, *J*=7.5 Hz, 2H, H-1''), 1.68-



Compd.	R_1	Compd.	R_1	Compd.	R_1
7a, 8a,9a		7c, 8c,9c		7e, 8e,9e	
7b, 8b,9b		7d, 8d,9d		7f,8f,9f	

Scheme 1: Outline for the synthesis of *N*-substituted-*N*-alkyl/aryl-4-chlorobenzenesulfonamide.

1.52 (m, 4H, H-2, H-6), 1.28-1.14 (m, 6H, H-3 to H-5), 0.98 (t, *J*=7.5 Hz, 3H, CH_3-2"); EIMS (*m/z*): 301 $[M]^{\bullet+}$, 237 $[M\text{-}SO_2]^{\bullet+}$, 175 $[C_6H_4ClSO_2]^+$, 126 $[M\text{-}C_6H_4ClSO_2]^+$, 111 $[C_6H_4Cl]^+$, 98 $[M\text{-}C_8H_8ClSO_2]^+$, 83 $[M\text{-}C_8H_9ClNSO_2]^{\bullet+}$, 76 $[C_6H_4]^{\bullet+}$.

N-(2-Phenylethyl)-N-ethyl-4-chlorobenzenesulfonamide (7b)

Dark Yellow sticky solid; Yield: 79%; Mol. formula: $C_{16}H_{18}ClNO_2S$; Mol. Wt.: 323; IR (KBr, ν_{max}/cm^{-1}): 3057 (Ar-H), 1529 (Ar C=C), 1412 (S=O), 1141 (C-N), 567 (C-Cl); ^{1}H-NMR (500 MHz, MeOD, ppm): δ 7.74 (d, *J*=9.0 Hz, 2H, H-2', H-6'), 7.54 (d, *J*=8.5 Hz, 2H, H-3', H-5'), 7.23-7.10 (m, 5H, H-2 to H-6), 3.47 (q, *J*=7.5 Hz, 2H, H-1"), 3.08 (t, *J*=7.5 Hz, 2H, H-8), 2.72 (t, *J*=7.5 Hz, 2H, H-7), 0.98 (t, *J*=7.5 Hz, 3H, CH_3-2"); EIMS (*m/z*): 323 $[M]^{\bullet+}$, 259 $[M\text{-}SO_2]^{\bullet+}$, 175 $[C_6H_4ClSO_2]^+$, 148 $[M\text{-}C_6H_4ClSO_2]^+$, 120 $[M\text{-}C_8H_8ClSO_2]^+$, 111 $[C_6H_4Cl]^+$, 105 $[M\text{-}C_8H_9ClNSO_2]^{\bullet+}$, 77 $[C_6H_5]^{\bullet+}$.

N-(2-(Methoxycarbonyl)phenyl)-N-ethyl-4-chlorobenzenesulfonamide (7c)

Brownish yellow sticky solid; Yield: 86%; Mol. formula: $C_{16}H_{16}ClNO_4S$; Mol. Wt.: 353; IR (KBr, ν_{max}/cm^{-1}): 3054 (Ar-H), 1526 (Ar C=C), 1408 (S=O), 1139 (C-N), 554 (C-Cl); ^{1}H-NMR (500 MHz, MeOD, ppm): δ 7.93 (dd, *J*= 9.0, 2.5 Hz, 1H, H-3), 7.75 (d, *J*=9.0 Hz, 2H, H-2', H-6'), 7.65 (d, *J*=9.5 Hz, 1H, H-6), 7.53 (dt, *J*=9.0, 2.5 Hz, 1H, H-4), 7.49 (d, *J*=8.5 Hz, 2H, H-3', H-5'), 7.16 (dt, *J*=9.5, 1.5 Hz, 1H, H-5), 3.84 (s, 3H, $\underline{CH_3}$OOC-2), 3.45 (q, *J*= 7.5 Hz, 2H, H-1"), 0.95 (t, *J*=7.5 Hz, 3H, CH_3-2"); EIMS (*m/z*): 353 $[M]^{\bullet+}$, 289 $[M\text{-}SO_2]^{\bullet+}$, 178 $[M\text{-}C_6H_4ClSO_2]^+$, 175 $[C_6H_4ClSO_2]^+$, 150 $[M\text{-}C_8H_8ClSO_2]^+$, 135 $[M\text{-}C_8H_9ClNSO_2]^{\bullet+}$, 111 $[C_6H_4Cl]^+$, 76 $[C_6H_4]^{\bullet+}$.

N-(2-Ethyl-6-methylphenyl)-N-ethyl-4-chlorobenzenesulfonamide (7d)

White amorphous solid; Yield: 87%; M. P.: 94-96^{o}C; Mol. formula: $C_{17}H_{20}ClNO_2S$; Mol. Wt.: 337; IR (KBr,

ν_{max}/cm^{-1}): 3057 (Ar-H), 1527 (Ar C=C), 1407 (S=O), 1137 (C-N), 555 (C-Cl); ^{1}H-NMR (500 MHz, MeOD, ppm): δ 7.67 (d, *J*=9.0 Hz, 2H, H-2', H-6'), 7.54 (d, *J*=8.5 Hz, H-3', H-5'), 7.15-6.97 (m, 3H, H-3 to H-5), 3.43 (q, *J*=7.5 Hz, 2H, H-1''), 2.45 (q, *J*=7.5 Hz, 2H, CH_3CH_2-2), 1.96 (s, 3H, CH_3-6), 1.04 (t, *J*=7.5 Hz, 3H, CH_3CH_2-2), 0.95 (t, *J*=7.5 Hz, 3H, CH_3-2''); EIMS (*m/z*): 337 $[M]^{\bullet+}$, 273 $[M\text{-}SO_2]^{\bullet+}$, 175 $[C_6H_4ClSO_2]^+$, 162 $[M\text{-}C_6H_4ClSO_2]^+$, 134 $[M\text{-}C_8H_8ClSO_2]^+$, 119 $[M\text{-}C_8H_9ClNSO_2]^{\bullet+}$, 111 $[C_6H_4Cl]^+$, 104 $[M\text{-}C_9H_{12}ClNSO_2]^+$, 76 $[C_6H_4]^{\bullet+}$.

N-(2-Methyl-6-nitrophenyl)-N-ethyl-4-chlorobenzenesulfonamide (7e)

White amorphous solid; Yield: 89%; M. P.: 84-86^{o}C; Mol. formula: $C_{15}H_{15}ClN_2O_4S$; Mol. Wt.: 354; IR (KBr, ν_{max}/cm^{-1}): 3053 (Ar-H), 1534 (Ar C=C), 1414 (S=O), 1145 (C-N), 565 (C-Cl); ^{1}H-NMR (500 MHz, MeOD, ppm): δ 8.07 (d, *J*=9.0 Hz, 2H, H-2', H-6'), 7.94 (d, *J*=9.5 Hz, 1H, H-5), 7.74 (d, *J*=8.5 Hz, 2H, H-3', H-5'), 7.28 (d, *J*=9.0 Hz, 1H, H-3), 6.56 (t, *J*=9.0 Hz, 1H, H-4), 2.24 (s, 3H, CH_3-2), 3.41 (q, *J*=7.5 Hz, 2H, H-1''), 0.93 (t, *J*=7.5 Hz, 3H, CH_3-2''); EIMS (*m/z*): 354 $[M]^{\bullet+}$, 290 $[M\text{-}SO_2]^{\bullet+}$, 179 $[M\text{-}C_6H_4ClSO_2]^+$, 175 $[C_6H_4ClSO_2]^+$, 151 $[M\text{-}C_8H_8ClSO_2]^+$, 136 $[M\text{-}C_8H_9ClNSO_2]^{\bullet+}$, 111 $[C_6H_4Cl]^+$, 90 $[M\text{-}C_8H_9ClN_2SO_4]^+$, 76 $[C_6H_4]^{\bullet+}$.

N-(4-Bromophenyl)-N-ethyl-4-chlorobenzenesulfonamide (7f)

White crystalline solid; Yield: 84%; M. P.: 102-104^{o}C; Mol. formula: $C_{14}H_{13}BrClNO_2S$; Mol. Wt.: 373; IR (KBr, ν_{max}/cm^{-1}): 3054 (Ar-H), 1528 (Ar C=C), 1413 (S=O), 1142 (C-N), 557 (C-Cl), 510 (C-Br); ^{1}H-NMR (500 MHz, MeOD, ppm): δ 7.71 (d, *J*=9.0 Hz, 2H, H-2', H-6'), 7.48 (d, *J* = 8.5 Hz, 2H, H-3', H-5'), 7.35 (d, *J*=9.5 Hz, 2H, H-3, H-5), 7.01 (d, *J*=9.5 Hz, 2H, H-2, H-6), 3.41 (q, *J*= 7.5 Hz, 2H, H-1''), 0.96 (t, *J*=7.5 Hz, 3H, CH_3-2''); EIMS (*m/z*): 373 $[M]^{\bullet+}$, 309 $[M\text{-}SO_2]^{\bullet+}$, 198 $[M\text{-}C_6H_4ClSO_2]^+$, 175 $[C_6H_4ClSO_2]^+$, 170 $[M\text{-}C_8H_8ClSO_2]^+$, 155 $[M\text{-}C_8H_9ClNSO_2]^{\bullet+}$, 111 $[C_6H_4Cl]^+$, 76 $[C_6H_4]^{\bullet+}$.

N-Cyclohexyl-N-benzyl-4-chlorobenzenesulfonamide (8a)

White amorphous solid; Yield: 82%; M. P. 110-112^{o}C; Mol. formula: $C_{19}H_{22}ClNO_2S$; Mol. Wt.: 363; IR (KBr, ν_{max}/cm^{-1}): 3055 (Ar-H), 1525 (Ar C=C), 1417 (S=O), 1147 (C-N), 558 (C-Cl); ^{1}H-NMR (500 MHz, MeOD, ppm): δ 7.83 (d, *J*=9.0 Hz, 2H, H-2', H-6'), 7.57 (d, *J*= 8.5 Hz, 2H, H-3', H-5'), 7.29-7.26 (m, 5H, H-2'' to H-6''), 4.84 (s, 2H, H-7''), 1.69-1.53 (m, 4H, H-2, H-6), 1.26-1.15 (m, 6H, H-3 to H-5); EIMS (*m/z*): 363 $[M]^{\bullet+}$, 299 $[M\text{-}SO_2]^{\bullet+}$, 188 $[M\text{-}C_6H_4ClSO_2]^+$, 175 $[C_6H_4ClSO_2]^+$, 111 $[C_6H_4Cl]^+$, 98 $[M\text{-}C_{13}H_{10}ClSO_2]^+$, 83 $[M\text{-}C_{13}H_{11}ClNSO_2]^{\bullet+}$, 76 $[C_6H_4]^{\bullet+}$.

N-(2-Phenylethyl)-N-benzyl-4-chlorobenzenesulfonamide (8b)

Cream white amorphous solid; Yield: 81%; M. P. 84-86^{o}C; Mol. formula: $C_{21}H_{20}ClNO_2S$; Mol. Wt.: 385; IR (KBr, ν_{max}/cm^{-1}): 3051 (Ar-H), 1523 (Ar C=C), 1417 (S=O), 1143 (C-N), 572 (C-Cl); ^{1}H-NMR (500 MHz, MeOD, ppm): δ 7.73 (d, *J*=9.0 Hz, 2H, H-2', H-6'), 7.54 (d, *J*=8.5 Hz, 2H, H-3', H-5'), 7.24-7.12 (m, 5H, H-2 to H-6), 7.31-7.28 (m, 5H, H-2'' to H-6''), 4.86 (s, 2H, H-7''), 3.08 (t, *J*=7.5 Hz, 2H, H-8), 2.72 (t, *J*=7.5, 2H, H-7); EIMS (*m/z*): 385 $[M]^{\bullet+}$, 321 $[M\text{-}SO_2]^{\bullet+}$, 210 $[M\text{-}C_6H_4ClSO_2]^+$, 175 $[C_6H_4ClSO_2]^+$, 120 $[M\text{-}C_{13}H_{10}ClSO_2]^+$, 111 $[C_6H_4Cl]^+$, 105 $[M\text{-}C_{13}H_{11}ClNSO_2]^{\bullet+}$, 77 $[C_6H_5]^{\bullet+}$.

N-(2-(Methoxycarbonyl)phenyl)-N-benzyl-4-chlorobenzenesulfonamide (8c)

White amorphous solid; Yield: 85%; M. P. 92-94^{o}C; Mol. formula: $C_{21}H_{18}ClNO_4S$; Mol. Wt.: 415; IR (KBr, ν_{max}/cm^{-1}): 3054 (Ar-H), 1528 (Ar C=C), 1406 (S=O), 1138 (C-N), 558 (C-Cl); ^{1}H-NMR (500 MHz, MeOD, ppm): δ 7.92 (dd, *J*=8.5, 2.5 Hz, 1H, H-3), 7.75 (d, *J*=9.0 Hz, 2H, H-2', H-6'), 7.64 (d, *J*=9.5 Hz, 1H, H-6), 7.56 (dt, *J* = 9.0, 2.5 Hz, 1H, H-4), 7.46 (d, *J*=8.5 Hz, 2H, H-3', H-5'), 7.27-7.21 (m, 5H, H-2'' to H-6''), 7.14 (dt, *J*=9.5, 1.5 Hz, 1H, H-5), 4.81 (s, 2H, H-7''), 3.85 (s, 3H, $\underline{CH_3}OOC$-2); EIMS (*m/z*): 415 $[M]^{\bullet+}$, 351 $[M\text{-}SO_2]^{\bullet+}$, 240 $[M\text{-}C_6H_4ClSO_2]^+$, 175 $[C_6H_4ClSO_2]^+$, 150 $[M\text{-}C_{13}H_{10}ClSO_2]^+$, 135 $[M\text{-}C_{13}H_{11}ClNSO_2]^{\bullet+}$, 120 $[M\text{-}C_{14}H_{14}ClNSO_2]^+$, 111 $[C_6H_4Cl]^+$, 76 $[C_6H_4]^{\bullet+}$.

N-(2-Ethyl-6-methylphenyl)-N-benzyl-4-chlorobenzenesulfonamide (8d)

Cream white amorphous solid; Yield: 84%; M. P.: 116-118^{o}C; Mol. formula: $C_{22}H_{22}ClNO_2S$; Mol. Wt.: 399; IR (KBr, ν_{max}/cm^{-1}): 3059 (Ar-H), 1527 (Ar C=C), 1408 (S=O), 1137 (C-N), 554 (C-Cl); ^{1}H-NMR (500 MHz, MeOD, ppm): δ 7.69 (d, *J*=9.0 Hz, 2H, H-2', H-6'), 7.56 (d, *J*=8.5 Hz, H-3', H-5'), 7.32-7.28 (m, 5H, H-2'' to H-6''), 7.15-6.99 (m, 3H, H-3 to H-5), 4.84 (s, 2H, H-7''), 2.47 (q, *J*=7.5 Hz, 2H, $CH_3\underline{CH_2}$-2), 1.96 (s, 3H, CH_3-6), 1.05 (t, *J*=7.5 Hz, 3H, $\underline{CH_3}CH_2$-2); EIMS (*m/z*): 399 $[M]^{\bullet+}$, 335 $[M\text{-}SO_2]^{\bullet+}$, 224 $[M\text{-}C_6H_4ClSO_2]^+$, 175 $[C_6H_4ClSO_2]^+$, 134 $[M\text{-}C_{13}H_{10}ClSO_2]^+$, 119 $[M\text{-}C_{13}H_{11}ClNSO_2]^{\bullet+}$, 111 $[C_6H_4Cl]^+$, 104 $[M\text{-}C_{14}H_{14}ClNSO_2]^+$, 76 $[C_6H_4]^{\bullet+}$.

N-(2-Methyl-6-nitrophenyl)-N-benzyl-4-chlorobenzenesulfonamide (8e)

Light pink amorphous solid; Yield: 81%; M. P.: 90-92^{o}C; Mol. formula: $C_{20}H_{17}ClN_2O_4S$; Mol. Wt.: 416; IR (KBr, ν_{max}/cm^{-1}): 3053 (Ar-H), 1534 (Ar C=C), 1412 (S=O), 1146 (C-N), 564 (C-Cl); ^{1}H-NMR (500 MHz, MeOD, ppm): δ 8.07 (d, *J*=9.0 Hz, 2H, H-2', H-6'), 7.92 (d, *J*=9.5 Hz, 1H, H-5), 7.74 (d, *J*=8.5 Hz, 2H, H-3', H-5'), 7.39-7.34 (m, 5H, H-2'' to H-6''), 7.27 (d, *J*=9.0 Hz, 1H, H-3), 6.56 (t, *J*=9.0 Hz, 1H, H-4), 4.79 (s, 2H, H-7''), 2.25 (s, 3H, CH_3-2); EIMS (*m/z*): 416 $[M]^{\bullet+}$, 352 $[M\text{-}SO_2]^{\bullet+}$, 241 $[M\text{-}C_6H_4ClSO_2]^+$, 175 $[C_6H_4ClSO_2]^+$, 151 $[M\text{-}C_{13}H_{10}ClSO_2]^+$, 136 $[M\text{-}C_{13}H_{11}ClNSO_2]^{\bullet+}$, 121 $[M\text{-}C_{14}H_{14}ClNSO_2]^+$, 111 $[C_6H_4Cl]^+$, 76 $[C_6H_4]^{\bullet+}$.

Table 1: % inhibition values of antibacterial activity of the tested compounds.

Compd.	% Inhibition					
	S. typhi (-)	*E. coli* (-)	*K. pneumonae* (-)	*P. aeroginosa* (-)	*B. subtilis* (+)	*S. aureus* (+)
7a	70.78±0.31	70.26±0.16	71.20±2.11	80.73±0.55	79.19±0.71	80.25±0.11
7b	55.25±1.75	82.40±0.12	40.86±0.95	59.79±1.46	61.85±0.55	55.88±0.81
7c	59.56 ±0.28	63.49 ±0.43	64.50±2.01	72.68±1.59	78.76±0.38	75.97±1.08
7d	39.29±0.79	82.10±0.06	50.77±1.68	73.54±0.04	73.05±2.05	69.31±1.00
7e	-	-	-	-	-	-
7f	67.95 ±0.31	69.56 ±1.08	72.25±0.74	71.49±3.05	78.16±0.65	76.21±0.17
8a	45.46±2.46	61.53 ±1.46	36.36±2.36	56.63±1.21	55.35±0.45	50.42±0.42
8b	51.50±0.42	53.82±2.55	37.18±0.55	53.38±2.13	45.80±2.21	49.08±1.11
8c	41.54±0.13	39.93±0.12	37.68±3.86	49.92± 1.12	41.45±2.25	45.23±0.38
8d	41.92±1.00	52.12±3.22	44.32±2.14	64.38±3.13	61.65±1.65	52.12±1.73
8e	-	-	-	-	-	-
8f	47.98 ±4.15	55.42 ±3.09	54.01±2.10	56.41±2.14	57.03±4.05	66.55±4.28
9a	49.95±0.33	58.13 ±3.64	42.14±0.77	64.88±0.54	53.85±1.35	59.08±0.54
9b	44.21±1.21	50.24±0.24	28.05±3.59	51.25±3.17	42.60±0.20	43.23±0.23
9c	68.50 ±1.67	81.19 ±1.09	51.32±1.05	73.92±0.08	72.90±0.10	68.54±0.23
9d	42.67±1.33	45.04±0.84	41.55±0.29	49.67±0.46	47.71±1.25	49.60±0.21
9e	-	-	-	-	-	-
9f	58.04 ±2.13	56.07±1.94	37.36±0.64	54.13±0.91	50.80±0.10	50.96 ±0.35
Ciprofloxacin	91.21±0.22	92.00±0.23	90.63±0.12	91.38±0.01	90.35±0.21	91.98±0.04

N-(4-Bromophenyl)-N-benzyl-4-chlorobenzenesulfonamide (8f)

White amorphous solid; Yield: 89%; M. P.: 108-110^{o}C; Mol. formula: $C_{19}H_{15}BrClNO_2S$; Mol. Wt.: 435; IR (KBr, ν_{max}/cm^{-1}): 3053 (Ar-H), 1525 (Ar C=C), 1417 (S=O), 1148 (C-N), 551 (C-Cl), 512 (C-Br); ^{1}H-NMR (500 MHz, MeOD, ppm): δ 7.70 (d, *J*=9.0 Hz, 2H, H-2', H-6'), 7.49 (d, *J*=8.5 Hz, 2H, H-3', H-5'), 7.36 (d, *J*=9.5 Hz, 2H, H-3, H-5), 7.33-7.29 (m, 5H, H-2" to H-6"), 7.00 (d, *J*=9.5 Hz, 2H, H-2, H-6), 4.84 (s, 2H, H-7"); EIMS (*m/z*): 435 $[M]^{\bullet+}$, 371 $[M\text{-}SO_2]^{\bullet+}$, 260 $[M\text{-}C_6H_4ClSO_2]^{+}$, 175 $[C_6H_4ClSO_2]^{+}$, 170 $[M\text{-}C_{13}H_{10}ClSO_2]^{+}$, 155 $[M\text{-}C_{13}H_{11}ClNSO_2]^{\bullet+}$, 111 $[C_6H_4Cl]^{+}$, 76 $[C_6H_4]^{\bullet+}$.

N-Cyclohexyl-N-(4-chlorobenzyl)-4-chlorobenzenesulfonamide (9a)

Light yellow amorphous solid; Yield: 81%; M. P.: 126-128^{o}C; Mol. formula: $C_{19}H_{21}Cl_2NO_2S$; Mol. Wt.: 397; IR (KBr, ν_{max}/cm^{-1}): 3055 (Ar-H), 1525 (Ar C=C), 1415 (S=O), 1145 (C-N), 556 (C-Cl); ^{1}H-NMR (500 MHz, MeOD, ppm): δ 7.84 (d, *J*=9.0 Hz, 2H, H-2', H-6'), 7.57 (d, *J*=8.5 Hz, 2H, H-3', H-5'), 7.12 (d, *J*=8.5 Hz, 2H, H-3", H-5"), 6.96 (d, *J*=8.5 Hz, 2H, H-2", H-6"), 4.83 (s, 2H, H-7"), 1.68-1.52 (m, 4H, H-2, H-6), 1.29-1.15 (m, 6H, H-3 to H-5); EIMS (*m/z*): 397 $[M]^{\bullet+}$, 333 $[M\text{-}SO_2]^{\bullet+}$, 222 $[M\text{-}C_6H_4ClSO_2]^{+}$, 175 $[C_6H_4ClSO_2]^{+}$, 111 $[C_6H_4Cl]^{+}$, 97 $[M\text{-}C_{13}H_9Cl_2SO_2]^{+}$, 82 $[M\text{-}C_{13}H_{10}Cl_2NSO_2]^{\bullet+}$, 76 $[C_6H_4]^{\bullet+}$.

N-(2-Phenylethyl)-N-(4-chlorobenzyl)-4-chlorobenzenesulfonamide (9b)

White amorphous solid; Yield: 83%; M. P.: 88-90^{o}C; Mol. formula: $C_{21}H_{19}Cl_2NO_2S$; Mol. Wt.: 419; IR (KBr, ν_{max}/cm^{-1}): 3057 (Ar-H), 1529 (Ar C=C), 1412 (S=O), 1141 (C-N), 603 (C-Cl); ^{1}H-NMR (500 MHz, MeOD, ppm): δ 7.75 (d, *J*=9.0 Hz, 2H, H-2', H-6'), 7.52 (d, *J*= 8.5 Hz, 2H, H-3', H-5'), 7.22 (d, *J*=8.5 Hz, 2H, H-3", H-5"), 7.19 (d, *J*=8.5 Hz, 2H, H-2", H-6"), 7.18-7.08 (m, 5H, H-2 to H-6), 4.82 (s, 2H, H-7"), 3.09 (t, *J*=7.5 Hz, 2H, H-8), 2.71 (t, *J*=7.5 Hz, 2H, H-7); EIMS (*m/z*): 419 $[M]^{\bullet+}$, 355 $[M\text{-}SO_2]^{\bullet+}$, 244 $[M\text{-}C_6H_4ClSO_2]^{+}$, 175 $[C_6H_4ClSO_2]^{+}$, 119 $[M\text{-}C_{13}H_9Cl_2SO_2]^{+}$, 111 $[C_6H_4Cl]^{+}$, 104 $[M\text{-}C_{13}H_{10}Cl_2NSO_2]^{\bullet+}$, 77 $[C_6H_5]^{\bullet+}$.

N-(2-(Methoxycarbonyl)phenyl)-N-(4-chlorobenzyl)-4-chlorobenzenesulfonamide (9c)

White crystalline solid; Yield: 85%; M. P.: 98-100^{o}C; Mol. formula: $C_{21}H_{17}Cl_2NO_4S$; Mol. Wt.: 449; IR (KBr, ν_{max}/cm^{-1}): 3053 (Ar-H), 1527 (Ar C=C), 1407 (S=O), 1137 (C-N), 557 (C-Cl); ^{1}H-NMR (500 MHz, MeOD, ppm): δ 7.91 (dd, *J*=9.0, 2.5 Hz, 1H, H-3), 7.74 (d, *J* = 9.0 Hz, 2H, H-2', H-6'), 7.66 (d, *J*=9.5 Hz, 1H, H-6), 7.54 (dt, *J*=9.5, 2.5 Hz, 1H, H-4), 7.48 (d, *J*=8.5 Hz, 2H, H-3', H-5'), 7.23 (d, *J*=8.5 Hz, 2H, H-3", H-5"), 7.15 (dt, *J* = 9.5, 1.5 Hz, 1H, H-5), 7.03 (d, *J*=8.5 Hz, 2H, H-2", H-6"), 4.97 (s, 2H, H-7"), 3.85 (s, 3H, $\underline{CH_3}OOC$-2); EIMS (*m/z*): 449 $[M]^{\bullet+}$, 385 $[M\text{-}SO_2]^{\bullet+}$, 274 $[M\text{-}C_6H_4ClSO_2]^{+}$, 175 $[C_6H_4ClSO_2]^{+}$, 149 $[M\text{-}C_{13}H_9Cl_2SO_2]^{+}$, 134 [M-

Table 2: MIC values of antibacterial activity of the tested compounds.

Compd.	MIC					
	S. typhi (-)	*E. coli* (-)	*K. pneumonae* (-)	*P. aeroginosa* (-)	*B. subtilis* (+)	*S. aureus* (+)
7a	11.62±2.17	11.70±0.07	11.23±1.02	9.34±1.65	11.24±1.42	9.3±0.13
7b	15.22±2.57	9.81±0.98	-	12.80±1.09	15.60±0.07	17.31±1.27
7c	14.87 ±1.63	11.05±2.45	15.46±1.26	14.57±0.32	11.31±1.02	10.41±0.52
7d	-	9.61±0.82	19.57±1.80	10.45±0.74	12.46±1.95	10.51±0.70
7e	-	-	-	-	-	-
7f	12.81 ±1.86	11.75±2.21	15.84±1.89	9.39±1.17	11.20±1.25	10.97±1.62
8a	-	14.41 ±1.12	-	17.27±0.48	17.69±0.86	18.40±1.62
8b	17.09±0.16	18.16±0.56	-	17.36±0.98	-	-
8c	-	-	-	-	-	-
8d	-	18.62±0.43	-	13.51±1.19	13.98±1.77	18.60±0.03
8e	-	-	-	-	-	-
8f	-	17.35±1.10	18.99±1.21	17.94±2.01	15.83±1.08	14.90±0.08
9a	-	14.22±2.65	-	14.68±0.74	15.16±1.77	14.89±0.55
9b	-	18.72±0.76	-	18.48±1.98	-	-
9c	11.62 ±0.77	10.28 ±0.92	18.84±1.45	11.24±2.41	10.42±0.11	10.65±0.53
9d	-	-	-	-	-	-
9e	-	-	-	-	-	-
9f	12.12 ±0.35	16.90±1.23	-	17.73±0.66	17.08±1.19	19.24±0.41
Ciprofloxacin	9.27±1.58	8.06±1.07	8.51±0.14	8.48±1.91	9.04±1.86	8.95±1.33

$C_{13}H_{10}Cl_2NSO_2]^{\bullet+}$, 119 $[M\text{-}C_{14}H_{13}ClNSO_2]^+$, 111 $[C_6H_4Cl]^+$, 76 $[C_6H_4]^{\bullet+}$.

N-(2-Ethyl-6-methylphenyl)-N-(4-chlorobenzyl)-4-chlorobenzenesulfonamide (9d)

White amorphous solid; Yield: 87%; M. P.: 142-144°C; Mol. formula: $C_{22}H_{21}Cl_2NO_2S$; Mol. Wt.: 433; IR (KBr, ν_{max}/cm^{-1}): 3058 (Ar-H), 1526 (Ar C=C), 1406 (S=O), 1136 (C-N), 556 (C-Cl); ^{1}H-NMR (500 MHz, MeOD, ppm): δ 7.68 (d, *J*=9.0 Hz, 2H, H-2', H-6'), 7.53 (d, *J*=8.5 Hz, H-3', H-5'), 7.25 (d, *J*=8.5 Hz, 2H, H-3", H-5"), 7.14-6.98 (m, 3H, H-3 to H-5), 7.09 (d, *J*=8.5 Hz, 2H, H-2", H-6"), 4.79 (s, 2H, H-7"), 2.46 (q, *J*=7.5 Hz, 2H, CH_3CH_2-2), 1.97 (s, 3H, CH_3-6), 1.02 (t, *J*=7.5 Hz, 3H, CH_3CH_2-2); EIMS (*m/z*): 433 $[M]^{\bullet+}$, 369 $[M\text{-}SO_2]^{\bullet+}$, 258 $[M\text{-}C_6H_4ClSO_2]^+$, 175 $[C_6H_4ClSO_2]^+$, 133 $[M\text{-}C_{13}H_9Cl_2SO_2]^+$, 118 $[M\text{-}C_{13}H_{10}Cl_2NSO_2]^{\bullet+}$, 111 $[C_6H_4Cl]^+$, 103 $[M\text{-}C_{14}H_{13}ClNSO_2]^+$, 76 $[C_6H_4]^{\bullet+}$.

N-(2-Methyl-6-nitrophenyl)-N-(4-chlorobenzyl)-4-chlorobenzenesulfonamide (9e)

Cream white amorphous solid; Yield: 86%; MP: 94-96°C; Mol. formula: $C_{20}H_{16}Cl_2N_2O_4S$; Mol. Wt.: 450; IR (KBr, ν_{max}/cm^{-1}): 3052 (Ar-H), 1533 (Ar C=C), 1413 (S=O), 1143 (C-N), 563 (C-Cl); ^{1}H-NMR (500 MHz, MeOD, ppm): δ 8.06 (d, *J*=9.0 Hz, 2H, H-2', H-6'), 7.93 (d, *J*=9.5 Hz, 1H, H-5), 7.73 (d, *J*=8.5 Hz, 2H, H-3', H-5'), 7.29 (d, *J*=9.0 Hz, 1H, H-3), 7.16 (d, *J*=8.5 Hz, 2H, H-3", H-5"), 7.07 (d, *J*=8.5 Hz, 2H, H-2", H-6"), 6.57 (t, *J*=9.0 Hz, 1H, H-4), 4.85 (s, 2H, H-7"), 2.23 (s, 3H, CH_3-2); EIMS (*m/z*): 450 $[M]^{\bullet+}$, 386 $[M\text{-}SO_2]^{\bullet+}$, 275 $[M\text{-}C_6H_4ClSO_2]^+$, 175 $[C_6H_4ClSO_2]^+$, 150 $[M\text{-}C_{13}H_9Cl_2SO_2]^+$, 135 $[M\text{-}C_{13}H_{10}Cl_2NSO_2]^{\bullet+}$, 120 $[M\text{-}C_{14}H_{13}ClNSO_2]^+$, 111 $[C_6H_4Cl]^+$, 76 $[C_6H_4]^{\bullet+}$.

N-(4-Bromophenyl)-N-(4-chlorobenzyl)-4-chlorobenzenesulfonamide (9f)

Cream white amorphous solid; Yield: 89%; M. P.: 106-108°C; Mol. formula: $C_{19}H_{14}BrCl_2NO_2S$; Mol. Wt.: 469; IR (KBr, ν_{max}/cm^{-1}): 3057 (Ar-H), 1529 (Ar C=C), 1412 (S=O), 1141 (C-N), 559 (C-Cl), 510 (C-Br); ^{1}H-NMR (500 MHz, MeOD, ppm): δ 7.70 (d, *J*=9.0 Hz, 2H, H-2', H-6'), 7.49 (d, *J*=8.5 Hz, 2H, H-3', H-5'), 7.36 (d, *J*=9.5 Hz, 2H, H-3, H-5), 7.22 (d, *J*=8.5 Hz, 2H, H-3", H-5"), 7.10 (d, *J*=8.5 Hz, 2H, H-2", H-6"), 7.00 (d, *J*=9.5 Hz, 2H, H-2, H-6), 4.97 (s, 2H, H-7"); EIMS (*m/z*): 469 $[M]^{\bullet+}$, 405 $[M\text{-}SO_2]^{\bullet+}$, 294 $[M\text{-}C_6H_4ClSO_2]^+$, 175 $[C_6H_4ClSO_2]^+$, 169 $[M\text{-}C_{13}H_9Cl_2SO_2]^+$, 154 $[M\text{-}C_{13}H_{10}Cl_2NSO_2]^{\bullet+}$, 111 $[C_6H_4Cl]^+$, 76 $[C_6H_4]^{\bullet+}$.

RESULTS

Differently substituted sulfonamides have been prepared by the reaction sequence outlined in **Scheme 1**. All the synthesized derivatives were analyzed for antibacterial activity against four gram-negative and two gram-positive bacterial strains and also for enzyme inhibition study against lipoxygenase and α-chymotrypsin enzymes. The aim to synthesize the target compounds was to develop new potential sulfonamide molecules that can be utilized

Table 3: Enzyme inhibition activity of the synthesized derivatives.

Compd.	Conc. (mM)	LOX		*α*-Chymotrypsin	
		% Inhibition	IC_{50}	% Inhibition	IC_{50}
7a	0.5	9.05±1.23	-	68.20±0.02	370.72±0.08
7b	0.5	90.65±1.25	103.56±1.34	64.87±0.11	378.26±0.10
7c	0.5	35.01±1.16	-	15.38±0.09	-
7d	0.5	34.35±1.15	-	26.06±0.07	-
7e	-	-	-	-	-
7f	0.5	88.98±1.32	123.55±1.17		
8a	0.25	55.28±1.27	176.62±1.26	57.18±0.09	>400
8b	0.25	53.22±1.11	189.62±1.34	29.28±0.12	-
8c	0.25	18.94±1.09	-	25.14±0.03	-
8d	0.25	52.22±1.03	207.26±1.34	27.90±0.10	-
8e	-	-	-	-	-
8f	0.25	34.22±1.16	-		
9a	0.25	80.08±1.27	111.62±1.25	67.85±0.10	390.27±0.04
9b	0.25	65.75±1.16	153.82±1.29	48.68±0.05	-
9c	0.25	11.32±1.03	-	14.01±0.06	-
9d	0.25	76.86±1.22	132.73±1.27	16.65±0.11	-
9e	-	-	-	-	-
9f	0.25	38.54±1.22	-		
Baicalein	0.5	93.79±1.27	22.4±1.3		
Chymostatin				93.50±0.91	8.24±0.11

in the drug development program for the pharmaceutical companies.

The parent molecules, *N*-alkyl/aryl/substituted-4-chlorobenzenesulfonamide (3a-f) were synthesized by gearing up alkyl/aryl amines (2a-f) with 4-chlorobenzenesulfonyl chloride (1) in basic aqueous medium under dynamic pH control. The products were collected by acidifying with concentrated HCl slowly. Use of large amount of acid can decrease the yield. Compounds, 3a-f, were derivatized by reacting with different electrophiles, ethyl iodide (4), benzyl chloride (5) and 4-chlorobenzyl chloride (6) to synthesize the target compounds, 7a-f, 8a-f and 9a-f respectively. NaH was used as an activator in a polar ap rotic solvent, DMF. All the synthesized derivatives were either quenched by cold distilled water or extracted by solvent extraction method. The structures of all the synthesized molecules were confirmed by spectral analysis.

DISCUSSION

Compound 8a was obtained as white amorphous solid having molecular formula, $C_{19}H_{22}ClNO_2S$ and molecular mass of 363 $gmol^{-1}$. In EI-MS spectrum molecule 8a revealed the $[M]^+$ peak at *m/z* 363 and the characteristic peaks at *m/z* 175 for chlorinated phenylsulfonyl cation, at *m/z* 76 for benzyne cation after the loss of SO_2 and chlorine radical and at *m/z* 83 for cyclohexyl cation. In IR spectrum, the absorption peak for sulfamoyl group appeared at 1417 cm^{-1} due to stretching of S=O bond. The stretching of aromatic C-H bond appeared at 3055 (Ar-H) while stretching of C=C double bond revealed at 1525 cm^{-1}. In the ^{1}H-NMR spectrum, the signals resonating at *δ*7.83 as doublet with coupling constant of 9.0 Hz and 7.57 as doublet with coupling constant of 8.5 Hz each integrated for two protons, confirmed the presence of 4-chlorobenzenesulfonyl group. Signals appearing at *δ* 7.29-7.26 as multiplet integrated for five protons indicated the presence of benzyl group and the methylene of benzyl group revealed at *δ* 4.84 as singlet. Signals appearing at *δ* 1.69-1.53 (m, 4H, H-2, H-6) and 1.26-1.15 (m, 6H, H-3 to H-5) affirmed the presence of cyclohexyl group attached at nitrogen of sulfamoyl group. The discussed spectral data corroborated the structure of 8a as *N*-Cyclohexyl-*N*-benzyl-4-chlorobenzenesulfonamide.In the same way, the structures of all the synthesized compounds were corroborated by ^{1}H-NMR, IR and mass spectral data.

Antibacterial and enzyme inhibition activity

The results of antibacterial study of the synthesized compounds with %age inhibition and MIC values are tabulated in table-1. The member of series, 8a-f, were found relatively more active against two gram positive (*B. subtilis* and *S. aureus*) and four gram negative (*K. pneumonae, E. coli, P. aeroginosa* and *S. typhi*) bacterial strains as compared to enzyme inhibition activity while members of 9a-f series were relatively good inhibitors of LOX enzyme. Compound 7a was found to be active against five bacterial strains (*S. typhi, K. pneumonae, P. aeroginosa, B. subtilis* and *S. aureus)* with IC_{50} values of 11.62±2.17, 11.23±1.02, 9.34±1.65, 11.24±1.42 and

9.3±0.13 respectively, as compared to ciprofloxacin standard 9.27±1.58, 8.51±0.14, 8.48±1.91, 9.04±1.86 and 8.95±1.33. Compound 7b was found to be active against *E. coli* with IC_{50} 9.81±0.98 as compared to ciprofloxacin standard 8.06±1.07. Compound 7c was found to be active against three bacterial strains i.e., *P. aeroginosa*, *B. subtilis*and *S. aureus* with IC_{50} values of 14.57±0.32, 11.31±1.02 and 10.41±0.52 respectively, as compared to ciprofloxacin standard 8.48±1.91, 9.04±1.86 and 8.95±1.33 respectively. Compound 7f was found to be active against *K. pneumonae*, *P. aeroginosa*, *B. subtilis* and *S. aureus*. Compound 9c was found to be active against four bacterial strains *S. typhi*, *E. coli*, *P. aeroginosa* and *B. subtilis*. All these calculations were relative to ciprofloxacin taken as reference standard. All the derivatives were also screened against enzyme inhibition potential and the results are mentioned in table-3 but the results were not so significant. Because of better antibacterial activity, these compounds can be utilized in drug development procedure.

CONCLUSION

All the compounds were synthesized in good yield and purity. Their structures were elucidated through spectral data and all the compounds were subjected to biological screening. The results of biological activities were demonstrated as MIC and IC_{50} values insisting the use of the moiety for therapeutic purposes.

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