Synthesis and Screening of *in vitro* Antibacterial and Enzyme Inhibitory Activity of *N*,*N*-disubstituted 4-Chlorobenzenesulfonamides

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Summary: Sulfonamide, pharmacologically important class of compounds, is of significant interest for scientists due to increased resistance in microbes against the existing drug constituents. So the aim of following research work was to synthesize new more effective series of compounds. A facile and environmentally benign series of *N*-(substituted phenyl)-4-chlorobenzenesulfonamides, **3a-e**, were synthesized by gearing up substituted aniline, **2a-e**, with 4-chlorobenzenesulfonyl chloride (**1**) in basic aqueous media under dynamic pH control, 9-10. All these sulfonamides were treated with alkyl/aralkyl halides, **4-6** as electrophiles, in presence of NaH and DMF as aprotic solvent to yield *N*-(substituted phenyl)-*N*-alkyl/aralkyl-4-chlorobenzenesulfonamides, **7a-e** to **9a-e**. Spectroscopic analysis IR, ^{1}H-NMR and EIMS helped to corroborate the structure of all the derivatives. All the compounds were then analyzed for antibacterial analysis and enzyme inhibition potential. Most of the derivatives were found to exhibit great biological potential.

Keywords: Aryl sulfonyl chloride, Spectral analysis, Antibacterial activity, Enzyme inhibition.

Introduction

Infectious diseases are one of the most important causes of death worldwide, during the past few decades. New infectious diseases have become visible and old ones, thought to be controlled, have reappeared [1] and thus, despite of major developments in the antimicrobial therapy, many problems are still to be solved for most of the antimicrobial drugs available [2]. Compounds bearing sulfonamide moiety have been reported as HIV inhibitors and are also known as antitumor and anti depressants [2-4]. Hence, invention of novel antimicrobial agents with improved pharmacological profile is still extremely desirable.

Sulfonamides, class of organic compounds bears -SO_2NH- functional group, famous for its great therapeutic potential so are extensively used as anti-bacterial, antifungal, anti-viral and anti-inflammatory agents to cure different infectious diseases and also known as potent inhibitor of a series of enzymes [2-8]. Sulfonamides are related to para amino benzoic acid that is utilized by bacteria to synthesize folic acid.

The most recent issue of research is to explore new drug constituents exhibiting high potential against various resistant microorganisms that are responsible for disorders and malfunction. The research work under discussion is a continuation of our previous research projects on sulfonamides [6-8], it was an attempt to produce therapeutically important compounds that bear great potential as antibacterial agents. All the synthesized derivatives exhibit considerable potential that can help in drug development process for pharmaceutical industries to cure numerous diseases.

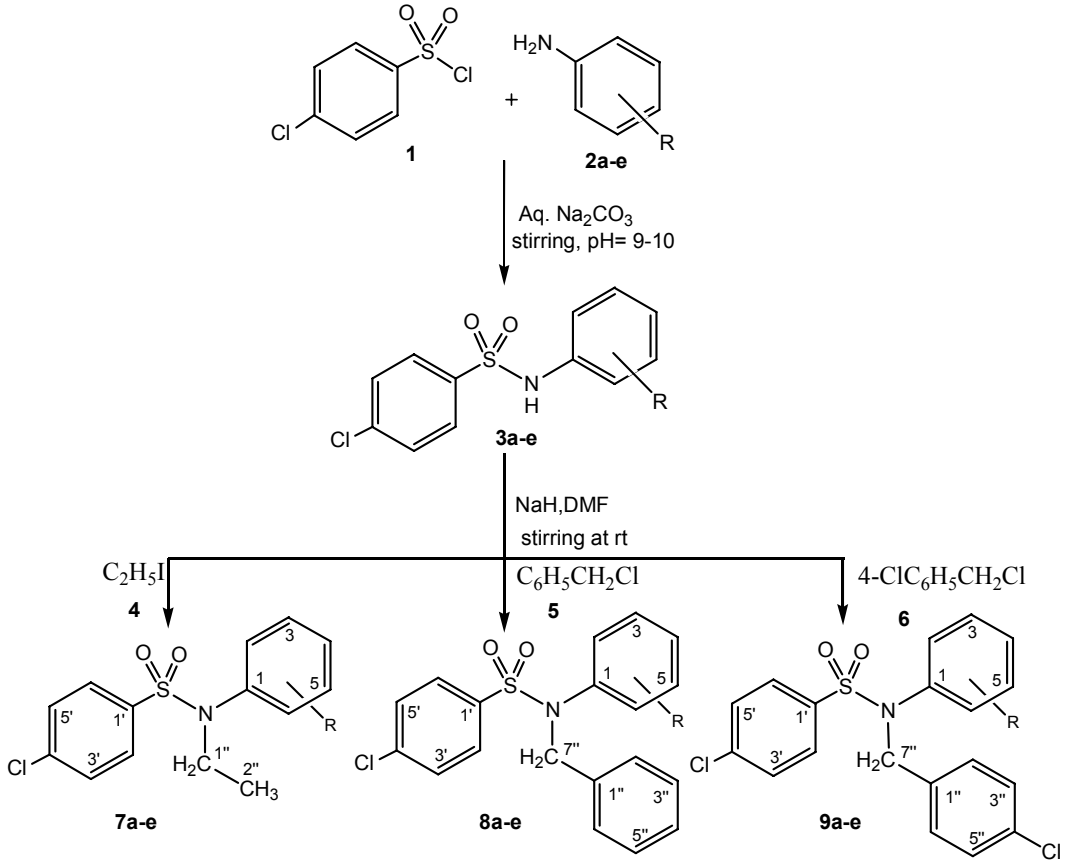
Results and Discussion

Chemistry

The presented research work illustrates the synthesis of some new *N*-(substituted phenyl)-*N*-alkyl/aralkyl-4-chlorobenzenesulfonamide molecules and are outlined in reaction scheme-1. Further, the synthesized compounds were evaluated for anti-bacterial and enzyme inhibition potential.

The parent molecules, *N*-substituted phenyl-4-chlorobenzenesulfonamide (**3a-e**) were synthesized by the reaction of 4-chlorobenzenesulfonyl chlorides (**1**) with substituted aniline (**2a-e**) in environment friendly reaction conditions, that is, basic aqueous medium with a limited range of pH. The products were obtained in considerable yields, after treating with dilute HCl slowly. Further, the compounds **3a-e** were treated with different electrophiles like ethyl iodide (**4**), benzyl chloride (**5**), and 4-chlorobenzyl chloride (**6**) to synthesize the target compounds, **7a-e, 8a-e** and **9a-e** respectively in the presence of NaH as base and a polar aprotic *N,N*-Dimethylformamide (DMF) solvent. The final products formed by the addition of cold water were obtained either by filtration or solvent extraction depending upon the

nature of the products. Structures of the new compounds were verified by IR, ^{1}H-NMR and mass spectral data as illustrated in the experimental section.



Compd.	R	Compd.	R	Compd.	R_1
7a,8a,9a	2-CH_3	**7c,8c,9c**	4-CH_3	**7e,8e,9e**	4-C_2H_5
7b,8b,9b	3-CH_3	**7d,8d,9d**	2-C_2H_5		

Scheme-1: Outline for the synthesis of *N*-(substituted phenyl)-*N*-alkyl/aralkyl-4-chlorobenzene sulfonamides

Compound **7e** was obtained as white amorphous solid having molecular formula $C_{16}H_{18}ClNSO_2$. In EI-MS spectrum, molecule **7e** showed the molecular ion peak at *m/z* 323 and chlorinated phenylsulfonyl cation gave peak at *m/z* 175 while benzyne cation gave signal at *m/z* 76 after the loss of SO_2 and chlorine radical and *p*-ethylphenyl cation appeared at *m/z* 105. In IR spectrum the absorption peak for sulfamoyl group appear at 1412 cm^{-1} due to -SO_2 group while stretching of aromatic C-H bond came out at 3059 cm^{-1} (Ar-H) and stretching of C=C bond appeared at 1532 cm^{-1}. In the ^{1}H-NMR spectrum, the signals of *p*-chlorophenyl sulfonyl group resonated at 7.66 and 7.46 as two doublet with *J* coupling of 9.0 and 8.5 Hz each integrated for two protons due to symmetry of this group. The signals of *p*-ethylphenyl group appeared at 7.05 and 6.96 as two doublet with *J* coupling of 9.0 Hz each integrated for two protons for aromatic ring and; that for ethyl group resonated at 2.54 as quartet with coupling constant of 7.5 Hz for methylene protons and at 1.15 as triplet with *J* coupling of 7.0 Hz for methyl protons. Substitution of ethyl group was confirmed by two signals appearing at 3.45 (q, *J* = 7.5 Hz, 2H, H-1") and 0.93 (t, *J* = 7.5 Hz, 2H, H-2"). All the spectral data elaborated the structure of **7e** as *N*-(4-Ethylphenyl)-*N*-ethyl-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

All synthesized compounds were subjected to biological evaluation by screening against two gram-positive (*Bacillus subtilis and Staphylococcus aureus*) and four gram-negative (*Klebsiella pneumonae, Escherichia coli, Pseudomonas aeruginosa and Salmonella typhi*) bacterial strains (Table-1 and 2) and enzyme inhibition activity (Table-3). Some of the derivatives were active as antibacterial agents while some were found to exhibit enzyme inhibition activity. Compound **7c** & **7d** were found active against *Salmonella typhi* bacterial strains with MIC values 10.96±2.05 & 11.62±0.44 relative to reference standard ciprofloxacin having MIC 9.27±1.58. Similarly two compounds **7b** & **7c** were active against *Escherichia coli* bacterial strain with MIC 10.74±2.76 and 10.93±0.44 respectively. Compound **7c** & **7d** have potential against *Klebsiella pneumonae* bacterial strains having MIC values 11.27±0.05 & 12.43±0.61 relative to ciprofloxacin having MIC 8.51±0.14. Compounds that showed potential against *Pseudomonas aeroginosa* were **7b**, **7c**, **7d** and **8b** with MIC values of 10.43±1.45, 9.26±2.12, 10.38±1.44 and 10.44±1.65 as compared to ciprofloxacin 8.48±1.91. Compounds **7a** & **7d** were found to be active against *Bacillus subtilis* with MIC 12.85±0.72 & 12.03±1.80 as compared to ciprofloxacin standard 9.04±1.86. Compound **7d** & **7e** revealed potential against *S. aureus* with MIC values of 10.67±2.09 and 10.42±1.16 respectively, relative to standard 8.95±1.33. All the results showed that compound **7d** were active against five bacterial strains *Bacillus subtilis, Staphylococcus aureus*, *Klebsiella pneumonae, Pseudomonas aeruginosa and Salmonella typhi* and was the most active compound of the series relatively. Overall antibacterial screening revealed that compounds **7a-e** are promising antibacterial agents as compare to **8a-e** and **9a-e** that is attributed to the ethyl group substitution on sulfonamide. The small ethyl group bearing strong affinity for the living cell can easily penetrate and decrease the bacterial metabolism leading to cell death. All the derivatives were also analyzed for enzyme inhibition potential against lipoxygenase (LOX) and chemotrypsin enzyme. The results against these enzymes were not so significant (Table-3). Baicalein and chemostatin were taken as reference for LOX and chemotrypsin activity respectively.

Experimental

General

All the amines and 4-chlorobenzenesulfonyl chloride were of Merck, Alfa Aeser & Sigma Aldrich purchased through local suppliers. All the solvents were of analytical grade and used without further purification. Thin layer chromatography (TLC) was used to assure the purity of synthesized compounds by ethyl acetate & *n*-hexane employed as solvent systems; and UV lamp at 254 nm was used to visualize TLC and UV inactive compounds were detected by spraying TLC with ceric sulfate solution. By open capillary tube method melting points of all the derivatives were recorded on a Griffin-George melting point apparatus and were not corrected. By potassium bromide pellet method on a Jasco-320-A spectrophotometer, the I.R. spectra were taken with wave number in cm^{-1}. ^{1}H-NMR spectra were recorded in CD_3OD on a Bruker spectrometers operating at 500 MHz. The chemical shift values are mentioned in ppm units using TMS as reference, and the coupling constants (*J*) are in Hz. Mass spectra (EI-MS) were recorded on a JMS-HX-110 spectrometer.

General Procedure for the Synthesis of Different N-(Methyl/ethyl substituted phenyl)-4-chlorobenzenesulfonamide **(3a-e)**

Methyl/ethyl substituted anilines (0.01 mol, **2a-e**) were suspended in 30 mL distilled water contained in 100 mL round bottom flask. The pH of the reaction mixture was controlled around 9-10 by adding aqueous Na_2CO_3 solution during the reaction time by time. 4-chlorobenzenesulfonyl chloride (0.01 mol, **1**) was added to reaction mixture gradually in 10-15 min maintaining the pH at 9-10. The reaction contents were set to stir for 3-5 hours. On reaction completion, confirmed by TLC using *n*-hexane:EtOAc (70:30) as solvent system, small amount of dilute HCl was added drop wise till pH of 4-5 was obtained. The solid precipitates were filtered off, washed by distilled water, dried and recrystallized to get the pure products, **3a-e**.

General procedure for the synthesis of different N-(Methyl/ethyl substituted phenyl)-N-alkyl/aralkyl-4-chlorobenzenesulfonamide **(7a-e, 8a-e, 9a-e)**

The calculated amount of **3a-e** (0.01 mol) was dissolved in 10 mL dimethylformamide (DMF) contained in 100 mL round bottom flask. Sodium hydride (0.01 mol) was added to the mixture to activate the reaction. The mixture was allowed to stir for 0.5 hour at room temperature and then alkyl/aralkyl halides in equimolar ratio (0.01 mol) was added to the mixture as electrophiles and the solution was left to stir for 3-4 hours. After the completion of reaction, assured by TLC, the product was quenched by adding cold distilled water. 2-3 mL aqueous Na_2CO_3 was added to make basic pH of 9 and to remove unreacted reactants. The product was

filtered off, washed with distilled water and re- crystallized from methanol.

Table-1: Antibacterial activity (% Inhibition) of the tested compounds.

Compound	% Inhibition					
	Gram-negative bacteria				Gram-positive bacteria	
	Salmonella typhi	*Escherichia coli*	*Klebsiella pneumonae*	*Pseudomonias aeroginosa*	*Bacillis subtilis*	*Staphylococcus aureus*
7a	70.63±0.35	67.98±0.27	68.90 ±1.50	66.55±2.64	76.16±3.31	76.43 ±2.11
7b	64.88±0.21	78.03±3.52	53.09±0.09	74.96±0.71	72.90±1.10	68.58±0.42
7c	69.82±1.67	71.83±0.76	70.60 ±0.41	79.50±3.23	66.97±4.53	76.60 ±2.28
7d	68.35±2.22	68.58±0.98	72.95±1.05	74.68±0.14	76.65±0.43	77.85 ±3.21
7e	63.20±2.02	63.11±3.96	66.65 ±1.45	72.45±0.36	72.65±1.84	72.43 ±1.77
8a	60.58±1.67	70.51±0.12	54.09±1.45	65.63±2.29	64.30±0.10	59.54 ±0.08
8b	62.29±3.84	56.99±0.98	61.15±1.85	73.77±1.77	69.95±2.05	71.86±3.71
8c	55.50±1.92	64.44±3.16	42.41±0.41	67.08±1.42	63.40±0.60	54.85±0.38
8d	47.93±2.95	39.01±2.93	46.41 ±4.11	55.18±2.36	46.97±2.32	50.46±4.32
8e	48.25±2.33	72.88±0.79	43.32±0.86	64.63±1.46	63.40±1.70	51.81±2.58
9a	55.21±3.94	48.65±2.17	62.25 ±3.21	68.05±3.42	65.41±0.11	67.58 ±3.42
9b	58.49±0.56	51.03±0.98	56.41±1.71	53.23±1.41	60.97±3.57	69.35 ±3.71
9c	40.46±0.04	48.73±1.15	27.32±2.12	49.92±1.03	44.30±0.60	39.85 ±3.62
9d	38.93±1.87	37.81±0.22	48.51 ±0.71	51.41±1.32	58.92±2.49	61.13 ±4.17
9e	39.57±1.00	58.62±1.94	35.55 ±3.41	59.42±3.11	37.55±1.06	47.65 ±0.10
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

Table-2: Antibacterial activity (MIC values) of the tested compounds.

Compound	MIC (µM)					
	Gram-negative bacteria				Gram-positive bacteria	
	Salmonella typhi	*Escherichia coli*	*Klebsiella pneumonae*	*Pseudomonias aeroginosa*	*Bacillis subtilis*	*Staphylococcus aureus*
7a	12.01±1.29	11.87±1.62	13.63 ±0.35	13.64±1.09	12.85±0.72	12.73±0.67
7b	11.94±1.51	10.74±2.76	18.32±01.95	10.43±1.45	12.59±1.11	14.11±1.13
7c	10.96±2.05	10.93±0.44	11.27 ±0.05	9.26±2.12	14.28±42.50	12.37±0.52
7d	11.62±0.44	12.98±1.11	12.43±0.61	10.38±1.44	12.03±1.80	10.67±2.09
7e	12.63±1.96	11.75±0.05	16.68 ±1.22	12.29±0.21	13.11±0.38	10.42±1.16
8a	12.16±1.42	11.39±0.42	14.38±1.62	13.32±2.24	13.59±1.23	14.82±0.33
8b	16.47±1.82	16.22±2.06	16.64±1.99	10.44±1.65	14.98±0.06	11.49±0.94
8c	14.05±0.75	13.42±0.22	-	12.07±0.54	13.40±2.43	16.36±1.09
8d	-	-	-	16.97±0.36	-	18.92±1.61
8e	-	12.11±0.11	-	15.37±1.32	12.99±0.73	18.71±1.13
9a	14.49±0.62	-	17.12 ±1.21	14.36±1.21	14.41±0.06	13.82±2.09
9b	14.01±1.83	19.51±1.81	15.93±1.12	16.74±0.99	15.27±0.57	13.94±2.13
9c						
9d	-	-	-	18.36±0.43	16.95±1.59	16.37±1.49
9e	-	12.24±2.11	-	15.55±2.22	-	-
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

Table-3: Enzyme inhibition activity of synthesized derivatives.

Compd.	Conc. (mM)	LOX		Conc. (mM)	Chemotrypsin	
		% Inhibition	IC_{50}		% Inhibition	IC_{50}
7a	0.5	9.05±1.23	-	0.5	70.84±0.11	210.45±0.09
7b	0.5	13.72±0.06	-	0.5	17.61±0.07	
7c	0.5	79.52±1.10	154.32±1.29	0.5	79.10±0.11	175.38±0.09
7d	0.5	28.62±1.27	-	0.5	11.71±0.03	-
7e	0.5	10.70±0.10	-	0.5	14.41±0.12	-
8a	0.25	20.78±1.25	-	0.5	74.28±0.02	360.20±0.08
8b	0.25	52.17±1.06	187.35±1.16	0.5	71.87±0.09	194.10±0.05
8c	0.25	58.33±1.12	152.48±1.19	0.5	69.23±0.03	361.70±0.03
8d	0.25	60.33±1.22	152.94±1.27	0.5	18.03±0.09	-
8e	0.25	61.11±1.26	144.35±1.29	0.5	26.18±0.11	-
9a	0.5	11.71±0.03	-	0.5	18.78±0.04	-
9b	0.25	69.36±1.12	173.28±1.22	0.5	70.95±0.10	225.18±0.01
9c	0.25	83.36±1.25	108.27±1.33	0.5	78.53±0.06	245.11±0.01
9d	0.25	66.43±1.06	138.26±1.26	0.5	18.37±0.10	-
9e	0.25	70.63±1.11	127.48±1.33	0.5	39.27±0.10	-
Baicalein	0.5	93.79±1.27	22.4±1.3			
Chymostatin					93.50±0.91	8.24±0.11

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 [9, 11]. The clinically isolated two gram-positive bacteria (*Bacillus subtilis and Staphylococcus aureus*) and four gram-negative (*Klebsiella pneumonae, Escherichia coli, Pseudomonas aeruginosa and Salmonella typhi*) were stored on stock culture agar medium. 20 µg test samples with dilution by suited solvents and 180 µL overnight maintained fresh bacterial cultures 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 ^{o}C for 16-24 hrs with lid on the micro plate. The absorbance was measured 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 were taken as standard. Minimum inhibitory concentration (MIC) was measured with suitable dilutions (5-30 µg/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 according to the reported method [11-13] but with slight modifications. A total volume of 200 µL assay mixture contained 150 µL sodium phosphate buffer (100 mM, pH 8.0), 10 µL test compound and 15 µL purified lipoxygenase enzyme (Sigma, USA). The contents were mixed and pre-read at 234 nm and pre-incubated for 10 min at 25 ^{0}C. The reaction was initiated by the addition of 25 µL substrate solution. The change in absorbance was observed after 6 min at 234 nm. Synergy HT (BioTek, USA) 96-well plate reader was used in all experiments. All reactions were performed in triplicates. The positive and negative controls were included in the assay. Baicalein (0.5 mM well^{-1}) was used as a positive control. The percentage inhibition and IC_{50} values were calculated as mentioned above.

α-Chymotrypsin Assay

α-Chymotrypsin inhibition assay was carried out according to the reported method [14, 15]. A total volume of 100 µL reaction mixture contained 60 µL of 50 mM Tris-HCl buffer (pH 7.6), 10 µL of 0.5 mM test compound and 15 µL (0.9 units) of enzyme (Sigma, USA) prepared in the above buffer. The contents were mixed, pre-incubated for 15 min at 37 ^{o}C and pre-read at 410 nm. The reaction was initiated by the addition of 15 µL of 1.3 mM substrate, N-succinyl phenylalanine-*p*-nitroanilide (Sigma,USA). Absorbance was measured at 410 nm using Synergy HT microplate 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 following equation.

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

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 measurements were done in triplicate and statistical analysis was performed by Microsoft Excel 2010. Results are presented as mean ± sem.

Spectral Characterization

N-(2-Methylphenyl)-N-ethyl-4-chlorobenzenesul fonamide **(7a)**

White amorphous solid; Yield: 81%; M. P. 118-120 ^{o}C; Molecular formula: $C_{15}H_{16}ClNSO_2$; Mol. Weight: 309; IR (KBr, υ_{max}/cm^{-1}): 3057 (Ar-H), 1534 (Ar C=C), 1414 (-SO_2-), 1144 (C-N), 564 (C-Cl); ^{1}H-NMR (500 MHz, CD_3OD, ppm): δ 7.63 (d, J = 9.0 Hz, 2H, H-2', H-6'), 7.48 (d, J = 8.5 Hz, 2H, H-3', H-5'), 7.00-7.11 (m, 4H, H-3 to H-6), 3.43 (q, J = 7.5 Hz, 2H, H-1"), 2.01 (s, 3H, CH_3-2), 0.93 (t, J = 7.5 Hz, 2H, H-2"); HR-MS: $[M]^+$ 309.8171 (Cacld. for $C_{15}H_{16}ClNSO_2$; 309.8645); EIMS (*m/z*): 311 $[M+2]^{\bullet+}$

(1%), 309 $[M]^{\bullet+}$ (6%), 245 $[M\text{-}SO_2]^{\bullet+}$ (5%), 175 $[C_6H_4ClSO_2]^+$ (3%), 134 $[M\text{-}C_6H_4ClSO_2]^+$ (100%), 111 $[C_6H_4Cl]^+$ (65%), 106 $[M\text{-}C_8H_8ClSO_2]^+$ (50%), 91 $[M\text{-}C_8H_9ClNSO_2]^{\bullet+}$ (80%), 76 $[C_6H_4]^{\bullet+}$ (47%), 65 $[C_5H_5]^{\bullet+}$ (23%).

N-(3-Methylphenyl)-N-ethyl-4-chlorobenzene sulfonamide **(7b)**

Light pink amorphous solid; Yield: 82%; M. P. 114-116 ^oC; Molecular formula: $C_{15}H_{16}ClNSO_2$; Mol. Weight: 309; IR (KBr, υ_{max}/cm^{-1}): 3053 (Ar-H), 1533 (Ar C=C), 1413 (-SO_2-), 1143 (C-N), 563 (C-Cl); ^{1}H-NMR (500 MHz, CD_3OD, ppm): δ 7.68 (d, J = 9.0 Hz, 2H, H-2', H-6'), 7.47 (d, J = 8.5 Hz, 2H, H-3', H-5'), 7.09 (d, J = 7.5 Hz, 1H, H-6), 7.05 (s, 1H, H-2), 6.85-6.89 (m, 2H, H-4, H-5), 3.41 (q, J = 7.5 Hz, 2H, H-1"), 2.22 (s, 3H, CH_3-3), 0.92 (t, J = 7.5 Hz, 2H, H-2"); HR-MS: $[M]^+$ 309.8171 (Cacld. for $C_{15}H_{16}ClNSO_2$; 309.8645); EIMS (*m/z*): 309 $[M]^{\bullet+}$ (5.5%), 245 $[M\text{-}SO_2]^{\bullet+}$ (4%), 175 $[C_6H_4ClSO_2]^+$ (3.5%), 134 $[M\text{-}C_6H_4ClSO_2]^+$ (100%), 111 $[C_6H_4Cl]^+$ (63%), 106 $[M\text{-}C_8H_8ClSO_2]^+$ (50%), 91 $[M\text{-}C_8H_9ClNSO_2]^{\bullet+}$ (83%), 76 $[C_6H_4]^{\bullet+}$ (9%), 65 $[C_5H_5]$ (17%).

N-(4-Methylphenyl)-N-ethyl-4-chlorobenzenesul fonamide **(7c)**

White crystalline solid; Yield: 83%; M. P. 120-122 ^oC; Molecular formula: $C_{15}H_{16}ClNSO_2$; Mol. Weight: 309; IR (KBr, υ_{max}/cm^{-1}): 3054 (Ar-H), 1532 (Ar C=C), 1412 (-SO_2-), 1142 (C-N), 562 (C-Cl); ^{1}H-NMR (500 MHz, CD_3OD, ppm): δ 7.65 (d, J = 9.0 Hz, 2H, H-2', H-6'), 7.46 (d, J = 8.5 Hz, 2H, H-3', H-5'), 7.02 (d, J = 8.0 Hz, 2H, H-2, H-6), 6.93 (d, J = 8.5 Hz, 2H, H-3, H-5), 3.42 (q, J = 7.5 Hz, 2H, H-1"), 2.23 (s, 3H, CH_3-4), 0.94 (t, J = 7.5 Hz, 2H, H-2"); HR-MS: $[M]^+$ 309.8171 (Cacld. for $C_{15}H_{16}ClNSO_2$; 309.8645); EIMS (*m/z*): 311 $[M+2]^{\bullet+}$, 309 $[M]^{\bullet+}$ (7.6%), 245 $[M\text{-}SO_2]^{\bullet+}$ (4.8%), 175 $[C_6H_4ClSO_2]^+$ (2.5%), 134 $[M\text{-}C_6H_4ClSO_2]^+$ (100%), 111 $[C_6H_4Cl]^+$ (67%), 106 $[M\text{-}C_8H_8ClSO_2]^+$ (47%), 91 $[M\text{-}C_8H_9ClNSO_2]^{\bullet+}$ (89%), 76 $[C_6H_4]^{\bullet+}$ (8.6%), 65 $[C_5H_5]^{\bullet+}$(21%).

N-(2-Ethylphenyl)-N-ethyl-4-chlorobenzene sulfonamide **(7d)**

Light purple amorphous solid; Yield: 84%; M. P. 116-118 ^oC; Molecular formula: $C_{16}H_{18}ClNSO_2$; Mol. Weight: 323; IR (KBr, υ_{max}/cm^{-1}): 3057 (Ar-H), 1531 (Ar C=C), 1411 (-SO_2-), 1141 (C-N), 561 (C-Cl); ^{1}H-NMR (500 MHz, CD_3OD, ppm): δ 7.64 (d, J = 9.0 Hz, 2H, H-2', H-6'), 7.50 (d, J = 8.5 Hz, 2H, H-3', H-5'), 7.18 (dd, J = 9.0, 3.0 Hz, 1H, H-6), 7.14 (dt, J = 8.5, 2.0 Hz, 1H, H-5), 7.04 (dt, J = 11.5, 3.0 Hz, 1H, H-4), 6.95 (dd, J = 13.0, 3.0 Hz, 1H, H-3), 3.41 (q, J = 7.5 Hz, 2H, H-1"), 2.48 (q, J = 7.5 Hz, 2H, $\underline{CH_2}$-2), 1.01 (t, J = 7.5 Hz, 3H, $\underline{CH_3}CH_2$-2), 0.91 (t, J = 7.5 Hz, 2H, H-2"); HR-MS: $[M]^+$ 323.8335 (Cacld. for $C_{16}H_{18}ClNSO_2$; 324.9586); EIMS (*m/z*): 325 $[M+2]^{\bullet+}$ (2%), 323 $[M]^{\bullet+}$ (7%), 259 $[M\text{-}SO_2]^{\bullet+}$ (3.9%), 175 $[C_6H_4ClSO_2]^+$ (2.6%), 148 $[M\text{-}C_6H_4ClSO_2]^+$ (100%), 120 $[M\text{-}C_8H_8ClSO_2]^+$ (3.4%), 111 $[C_6H_4Cl]^+$ (2.3%), 105 $[M\text{-}C_8H_9ClNSO_2]^{\bullet+}$ (22.3%), 76 $[C_6H_4]^{\bullet+}$ (5.4%).

N-(4-Ethylphenyl)-N-ethyl-4-chlorobenzene sulfonamide **(7e)**

White amorphous solid; Yield: 85%; M. P. 120-122 ^oC; Molecular formula: $C_{16}H_{18}ClNSO_2$; Mol. Weight: 323; IR (KBr, υ_{max}/cm^{-1}): 3059 (Ar-H), 1532 (Ar C=C), 1412 (-SO_2-), 1142 (C-N), 562 (C-Cl); ^{1}H-NMR (500 MHz, CD_3OD, ppm): δ 7.66 (d, J = 9.0 Hz, 2H, H-2', H-6'), 7.46 (d, J = 8.5 Hz, H-3', H-5'), 7.05 (d, J = 9.0 Hz, 2H, H-2, H-6), 6.96 (d, J = 9.0 Hz, 2H, H-3, H-5), 3.45 (q, J = 7.5 Hz, 2H, H-1"), 2.54 (q, J = 7.5 Hz, 2H, $\underline{CH_2}$-4), 1.15 (t, J= 7.0 Hz, 3H, $\underline{CH_3}CH_2$-4), 0.93 (t, J = 7.5 Hz, 2H, H-2"); HR-MS: $[M]^+$ 323.8335 (Cacld. for $C_{16}H_{18}ClNSO_2$; 324.9586); EIMS (*m/z*): 325 $[M+2]^{\bullet+}$ (1.5%), 323 $[M]^{\bullet+}$ (6.5%), 259 $[M\text{-}SO_2]^{\bullet+}$ (3.6%), 175 $[C_6H_4ClSO_2]^+$ (2.1%), 148 $[M\text{-}C_6H_4ClSO_2]^+$ (100%), 120 $[M\text{-}C_8H_8ClSO_2]^+$ (3.9%), 111 $[C_6H_4Cl]^+$ (2.7%), 105 $[M\text{-}C_8H_9ClNSO_2]^{\bullet+}$ (25.3%), 76 $[C_6H_4]^{\bullet+}$ (6.7%).

N-(2-Methylphenyl)-N-benzyl-4-chlorobenzene sulfonamide **(8a)**

White amorphous solid; Yield: 90%; M. P. 124-126 ^oC; Molecular formula: $C_{20}H_{18}ClNSO_2$; Mol. Weight: 371; IR (KBr, υ_{max}/cm^{-1}): 3057 (Ar-H), 1534 (Ar C=C), 1414 (-SO_2-), 1144 (C-N), 564 (C-Cl); ^{1}H-NMR (500 MHz, CD_3OD, ppm): δ 7.63 (d, J = 9.0 Hz, 2H, H-2', H-6'), 7.48 (d, J = 8.5 Hz, 2H, H-3', H-5'), 7.25-7.22 (m, 5H, H-2" to H-6"), 7.00-7.11 (m, 4H, H-3 to H-6), 4.79 (s, 2H, H-7"), 2.01 (s, 3H, CH_3-2); HR-MS: $[M]^+$ 371.8808 (Cacld. for $C_{20}H_{18}ClNSO_2$; 371.9895); EIMS (*m/z*): 373 $[M+2]^{\bullet+}$ (8.3%), 371 $[M]^{\bullet+}$ (20.5%), 307 $[M\text{-}SO_2]^{\bullet+}$ (1.9%), 196 $[M\text{-}C_6H_4ClSO_2]^+$ (36%), 175 $[C_6H_4ClSO_2]^+$ (15%), 106 $[M\text{-}C_{13}H_{10}ClSO_2]^+$ (13%), 111 $[C_6H_4Cl]^+$ (39%), 91 $[M\text{-}C_{13}H_{11}ClNSO_2]^{\bullet+}$ (100%), 76 $[C_6H_4]^{\bullet+}$ (30%), 65 $[C_5H_5]^{\bullet+}$(41%).

N-(3-Methylphenyl)-N-benzyl-4-chlorobenzene sulfonamide **(8b)**

White amorphous solid; Yield: 89%; M. P. 110-112 ^oC; Molecular formula: $C_{20}H_{18}ClNSO_2$; Mol.

Weight: 371; IR (KBr, υ_{max}/cm^{-1}): 3053 (Ar-H), 1533 (Ar C=C), 1413 (-SO_2-), 1143 (C-N), 563 (C-Cl); ^{1}H-NMR (500 MHz, CD_3OD, ppm): δ 7.68 (d, J = 9.0 Hz, 2H, H-2', H-6'), 7.47 (d, J = 8.5 Hz, 2H, H-3', H-5'), 7.27-7.23 (m, 5H, H-2" to H-6"), 7.09 (d, J = 7.5 Hz, 1H, H-6), 7.05 (s, 1H, H-2), 6.89-6.83 (m, 2H, H-4, H-5), 4.76 (s, 2H, H-7"), 2.21 (s, 3H, CH_3-3); HR-MS: $[M]^+$ 371.8808 (Cacld. for $C_{20}H_{18}ClNSO_2$; 371.9895); EIMS (*m/z*): 373 $[M+2]^{\bullet+}$ (1%), 371 $[M]^{\bullet+}$ (12%), 307 $[M\text{-}SO_2]^{\bullet+}$ (1.2%), 196 $[M\text{-}C_6H_4ClSO_2]^+$ (21%), 175 $[C_6H_4ClSO_2]^+$ (14%), 111 $[C_6H_4Cl]^+$ (33%), 106 $[M\text{-}C_{13}H_{10}ClSO_2]^+$ (32%), 91 $[M\text{-}C_{13}H_{11}ClNSO_2]^{\bullet+}$ (100%), 76 $[C_6H_4]^{\bullet+}$ (8.3%), 65 $[C_5H_5]^{\bullet+}$(39%).

N-(4-Methylphenyl)-N-benzyl-4-chlorobenzene sulfonamide **(8c)**

White amorphous solid; Yield: 88%; M. P. 126-128 ^{o}C; Molecular formula: $C_{20}H_{18}ClNSO_2$; Mol. Weight: 371; IR (KBr, υ_{max}/cm^{-1}): 3054 (Ar-H), 1532 (Ar C=C), 1412 (-SO_2-), 1142 (C-N), 562 (C-Cl); ^{1}H-NMR (500 MHz, CD_3OD, ppm): δ 7.65 (d, J = 9.0 Hz, 2H, H-2', H-6'), 7.46 (d, J = 8.5 Hz, 2H, H-3', H-5'), 7.23-7.20 (m, 5H, H-2" to H-6"), 7.02 (d, J = 8.5 Hz, 2H, H-2, H-6), 6.93 (d, J = 8.0 Hz, 2H, H-3, H-5), 4.77 (s, 2H, H-7"), 2.23 (s, 3H, CH_3-4); HR-MS: $[M]^+$ 371.8808 (Cacld. for $C_{20}H_{18}ClNSO_2$; 371.9895); EIMS (*m/z*): 373 $[M+2]^{\bullet+}$ (0.7%), 371 $[M]^{\bullet+}$ (10.2%), 307 $[M\text{-}SO_2]^{\bullet+}$ (1.1%), 196 $[M\text{-}C_6H_4ClSO_2]^+$ (19%), 175 $[C_6H_4ClSO_2]^+$ (13%), 111 $[C_6H_4Cl]^+$ (31%), 106 $[M\text{-}C_{13}H_{10}ClSO_2]^+$ (29.3%), 91 $[M\text{-}C_{13}H_{11}ClNSO_2]^{\bullet+}$ (100%), 76 $[C_6H_4]^{\bullet+}$ (7.7%), 65$[C_5H_5]^{\bullet+}$(36.4%).

N-(2-Ethylphenyl)-N-benzyl-4-chlorobenzene sulfonamide **(8d)**

Light pink amorphous solid; Yield: 87%; M. P. 120-122 ^{o}C; Molecular formula: $C_{21}H_{20}ClNSO_2$; Mol. Weight: 385; IR (KBr, υ_{max}/cm^{-1}): 3057 (Ar-H), 1531 (Ar C=C), 1411 (-SO_2-), 1141 (C-N), 561 (C-Cl); ^{1}H-NMR (500 MHz, CD_3OD, ppm): δ 7.64 (d, J = 9.0 Hz, 2H, H-2', H-6'), 7.50 (d, J = 8.5 Hz, 2H, H-3', H-5'), 7.31-7.27 (m, 5H, H-2" to H-6"), 7.18 (dd, J = 9.0, 3.0 Hz, 1H, H-6), 7.14 (dt, J = 9.5, 2.0 Hz, 1H, H-5), 7.04 (dt, J = 9.5, 3.0 Hz, 1H, H-4), 6.95 (dd, J = 8.0, 3.0 Hz, 1H, H-3), 4.76 (s, 2H, H-7"), 2.48 (q, J = 7.5 Hz, 2H, CH_2-2), 1.01 (t, J = 7.5 Hz, 3H, $\underline{CH_3}CH_2$-2); HR-MS: $[M]^+$ 385.9108 (Cacld. for $C_{21}H_{20}ClNSO_2$; 385.9867); EIMS (*m/z*): 387 $[M+2]^{\bullet+}$ (8.3%), 385 $[M]^{\bullet+}$ (22.1%), 321 $[M\text{-}SO_2]^{\bullet+}$ (1.3%), 210 $[M\text{-}C_6H_4ClSO_2]^+$ (43.3%), 175 $[C_6H_4ClSO_2]^+$ (6.1%), 120 $[M\text{-}C_{13}H_{10}ClSO_2]^+$ (1%), 111 $[C_6H_4Cl]^+$ (35.9%), 105 $[M\text{-}C_{13}H_{11}ClNSO_2]^{\bullet+}$ (34.1%), 76 $[C_6H_4]^{\bullet+}$ (9.3%).

N-(4-Ethylphenyl)-N-benzyl-4-chlorobenzene sulfonamide **(8e)**

Light pink amorphous solid; Yield: 88%; M. P. 118-120 ^{o}C; Molecular formula: $C_{21}H_{20}ClNSO_2$; Mol. Weight: 385; IR (KBr, υ_{max}/cm^{-1}): 3059 (Ar-H), 1532 (Ar C=C), 1412 (-SO_2-), 1142 (C-N), 562 (C-Cl); ^{1}H-NMR (500 MHz, CD_3OD, ppm): δ 7.66 (d, J = 9.0 Hz, 2H, H-2', H-6'), 7.46 (d, J = 8.5 Hz, H-3', H-5'), 7.25-7.22 (m, 5H, H-2" to H-6"), 7.05 (d, J = 8.0 Hz, 2H, H-2, H-6), 6.96 (d, J = 8.0 Hz, 2H, H-3, H-5), 4.75 (s, 2H, H-7"), 2.54 (q, J = 7.5 Hz, 2H, CH_2-4), 1.15 (t, J= 7.5 Hz, 3H, $\underline{CH_3}CH_2$-4); HR-MS: $[M]^+$ 385.9123 (Cacld. for $C_{21}H_{20}ClNSO_2$; 385.9867); EIMS (*m/z*): 387 $[M+2]^{\bullet+}$ (7.9%), 385 $[M]^{\bullet+}$ (21.5%), 321 $[M\text{-}SO_2]^{\bullet+}$ (1.7%), 210 $[M\text{-}C_6H_4ClSO_2]^+$ (41.3%), 175 $[C_6H_4ClSO_2]^+$ (5.7%), 120 $[M\text{-}C_{13}H_{10}ClSO_2]^+$ (1.6%), 111 $[C_6H_4Cl]^+$ (31.6%), 105 $[M\text{-}C_{13}H_{11}ClNSO_2]^{\bullet+}$ (32.6%), 76 $[C_6H_4]^{\bullet+}$ (9.2%).

N-(2-Methylphenyl)-N-[(4-chlorophenyl)methyl]-4-chlorobenzenesulfonamide **(9a)**

Yellow amorphous solid; Yield: 77%; M. P. 126-128 ^{o}C; Molecular formula: $C_{20}H_{17}Cl_2NSO_2$; Mol. Weight: 406; IR (KBr, υ_{max}/cm^{-1}): 3057 (Ar-H), 1534 (Ar C=C), 1414 (-SO_2-), 1144 (C-N), 564 (C-Cl); ^{1}H-NMR (500 MHz, CD_3OD, ppm): δ 7.63 (d, J = 9.0 Hz, 2H, H-2', H-6'), 7.48 (d, J = 8.5 Hz, 2H, H-3', H-5'), 7.34 (d, J = 8.5 Hz, 2H, H-2", H-6"), 7.14 (d, J = 8.5 Hz, 2H, H-3", H-5"), 7.11-7.00 (m, 4H, H-3 to H-6), 4.53 (s, 2H, H-7"), 2.01 (s, 3H, CH_3-2); HR-MS: $[M]^+$ 406.3259 (Cacld. for $C_{20}H_{17}Cl_2NSO_2$; 406.3867); EIMS (*m/z*): 408 $[M+2]^{\bullet+}$ (0.9%), 406 $[M]^{\bullet+}$ (1.5%), 342 $[M\text{-}SO_2]^{\bullet+}$ (1.1%), 231 $[M\text{-}C_6H_4ClSO_2]^+$ (2.9%), 175 $[C_6H_4ClSO_2]^+$ (4.1%), 125 $[C_7H_6Cl]^+$ (100%), 111 $[C_6H_4Cl]^+$ (38.7%), 106 $[M\text{-}C_{13}H_9Cl_2SO_2]^+$ (20.7%), 91 $[M\text{-}C_{13}H_{10}Cl_2NSO_2]^{\bullet+}$ (57.7%), 76 $[C_6H_4]^{\bullet+}$ (31.7%).

N-(3-Methylphenyl)-N-[(4-chlorophenyl)methyl]-4-chlorobenzenesulfonamide **(9b)**

Yellowish brown sticky solid; Yield: 79%; Molecular formula: $C_{20}H_{17}Cl_2NSO_2$; Mol. Weight: 406; IR (KBr, υ_{max}/cm^{-1}): 3053 (Ar-H), 1533 (Ar C=C), 1413 (-SO_2-), 1143 (C-N), 563 (C-Cl); ^{1}H-NMR (500 MHz, CD_3OD, ppm): δ 7.68 (d, J = 9.0 Hz, 2H, H-2', H-6'), 7.47 (d, J = 8.5 Hz, 2H, H-3', H-5'), 7.32 (d, J = 8.5 Hz, 2H, H-2", H-6"), 7.16 (d, J = 8.5 Hz, 2H, H-3", H-5"), 7.09 (d, J = 7.5 Hz, 1H, H-6), 7.05 (s, 1H, H-2), 6.85-6.89 (m, 2H, H-4, H-5), 4.51 (s, 2H, H-7"), 2.22 (s, 3H, CH_3-3); HR-MS: $[M]^+$ 406.3259 (Cacld. for $C_{20}H_{17}Cl_2NSO_2$; 406.3867); EIMS (*m/z*): 408 $[M+2]^{\bullet+}$ (1.1%), 406

$[M]^{\bullet+}$ (2.7%), 342 $[M\text{-}SO_2]^{\bullet+}$ (1.7%), 231 $[M\text{-}C_6H_4ClSO_2]^+$ (3.4%), 175 $[C_6H_4ClSO_2]^+$ (5.7%), 125 $[C_7H_6Cl]^+$ (100%), 111 $[C_6H_4Cl]^+$ (36.3%),106 $[M\text{-}C_{13}H_9Cl_2SO_2]^+$ (19.4%), 91 $[M\text{-}C_{13}H_{10}Cl_2NSO_2]^{\bullet+}$ (57.3%), 76 $[C_6H_4]^{\bullet+}$ (29.8%).

N-(4-Methylphenyl)-N-[(4-chlorophenyl)methyl]-4-chlorobenzenesulfonamide **(9c)**

Yellow amorphous solid; Yield: 80%; M. P. 124-126 ^oC; Molecular formula: $C_{20}H_{17}Cl_2NSO_2$; Mol. Weight: 406; IR (KBr, υ_{max}/cm^{-1}): 3054 (Ar-H), 1532 (Ar C=C), 1412 (-SO_2-), 1142 (C-N), 562 (C-Cl); ^{1}H-NMR (500 MHz, CD_3OD, ppm): δ 7.65 (d, J = 9.0 Hz, 2H, H-2', H-6'), 7.46 (d, J = 8.5 Hz, 2H, H-3', H-5'), 7.31 (d, J = 8.5 Hz, 2H, H-2", H-6"), 7.17 (d, J = 8.5 Hz, 2H, H-3", H-5"), 7.02 (d, J = 8.5 Hz, 2H, H-2, H-6), 6.93 (d, J = 9.0 Hz, 2H, H-3, H-5), 4.55 (s, 2H, H-7"), 2.23 (s, 3H, CH_3-4); HR-MS: $[M]^+$ 406.3259 (Cacld. for $C_{20}H_{17}Cl_2NSO_2$; 406.3867); EIMS (*m/z*): 408 $[M+2]^{\bullet+}$ (1.3%), 406 $[M]^{\bullet+}$ (2.5%), 342 $[M\text{-}SO_2]^{\bullet+}$ (2.1%), 231 $[M\text{-}C_6H_4ClSO_2]^+$ (3.9%), 175 $[C_6H_4ClSO_2]^+$ (5.9%), 125 $[C_7H_6Cl]^+$ (100%), 111 $[C_6H_4Cl]^+$ (37.6%),106 $[M\text{-}C_{13}H_9Cl_2SO_2]^+$ (21.4%), 91 $[M\text{-}C_{13}H_{10}Cl_2NSO_2]^{\bullet+}$ (59.7%), 76 $[C_6H_4]^{\bullet+}$ (28.7%).

N-(2-Ethylphenyl)-N-[(4-chlorophenyl)methyl]-4-chlorobenzenesulfonamide **(9d)**

Light purple amorphous solid; Yield: 81%; M. P. 124-126 ^oC; Molecular formula: $C_{21}H_{19}Cl_2NSO_2$; Mol. Weight: 420; IR (KBr, υ_{max}/cm^{-1}): 3057 (Ar-H), 1531 (Ar C=C), 1411 (-SO_2-), 1141 (C-N), 561 (C-Cl); ^{1}H-NMR (500 MHz, CD_3OD, ppm): δ 7.64 (d, J = 9.0 Hz, 2H, H-2', H-6'), 7.50 (d, J = 8.5 Hz, 2H, H-3', H-5'), 7.34 (d, J = 8.5 Hz, 2H, H-2", H-6"), 7.21 (d, J = 8.5 Hz, 2H, H-3", H-5"), 7.18 (dd, J = 8.0, 3.0 Hz, 1H, H-6), 7.14 (dt, J = 9.5, 2.0 Hz, 1H, H-5), 7.04 (dt, J = 9.5, 2.5 Hz, 1H, H-4), 6.95 (dd, J = 9.0, 3.0 Hz, 1H, H-3), 4.53 (s, 2H, H-7"), 2.48 (q, J = 7.5 Hz, 2H, $\underline{CH_2}$-2), 1.01 (t, J = 7.5 Hz, 3H, $\underline{CH_3}CH_2$-2); HR-MS: $[M]^+$ 420.3525 (Cacld. for $C_{21}H_{19}Cl_2NSO_2$; 420.3892); EIMS (*m/z*): 422 $[M+2]^{\bullet+}$ (1.1%), 420 $[M]^{\bullet+}$ (2.5%), 356 $[M\text{-}SO_2]^{\bullet+}$ (3.2%), 245 $[M\text{-}C_6H_4ClSO_2]^+$ (17.9%), 175 $[C_6H_4ClSO_2]^+$ (4.5%), 125 $[C_7H_6Cl]^+$ (100%), 120 $[M\text{-}C_{13}H_9Cl_2SO_2]^+$ (38%), 111 $[C_6H_4Cl]^+$ (42%), 105 $[M\text{-}C_{13}H_{10}Cl_2NSO_2]^{\bullet+}$ (27%), 76 $[C_6H_4]^{\bullet+}$ (39.3%).

N-(4-Ethylphenyl)-N-[(4-chlorophenyl)methyl]-4-chlorobenzenesulfonamide **(9e)**

Light pink amorphous solid; Yield: 84%; M. P. 126-128 ^oC; Molecular formula: $C_{21}H_{19}Cl_2NSO_2$; Mol. Weight: 420; IR (KBr, υ_{max}/cm^{-1}): 3059 (Ar-H), 1532 (Ar C=C), 1412 (-SO_2-), 1142 (C-N), 562 (C-Cl); ^{1}H-NMR (500 MHz, CD_3OD, ppm): δ 7.66 (d, J = 9.0 Hz, 2H, H-2', H-6'), 7.46 (d, J = 8.5 Hz, H-3', H-5'), 7.36 (d, J = 8.5 Hz, 2H, H-2", H-6"), 7.19 (d, J = 8.5 Hz, 2H, H-3", H-5"), 7.05 (d, J = 9.0 Hz, 2H, H-2, H-6), 6.96 (d, J = 9.5 Hz, 2H, H-3, H-5), 4.49 (s, 2H, H-7"), 2.54 (q, J = 7.5 Hz, 2H, H-1"), 1.15 (t, J= 7.5 Hz, 3H, CH_3-2"); HR-MS: $[M]^+$ 420.3525 (Cacld. for $C_{21}H_{19}Cl_2NSO_2$; 420.3892); EIMS (*m/z*): 422 $[M+2]^{\bullet+}$ (1%), 420 $[M]^{\bullet+}$ (2.1%), 356 $[M\text{-}SO_2]^{\bullet+}$ (3.8%), 245 $[M\text{-}C_6H_4ClSO_2]^+$ (21.9%), 175 $[C_6H_4ClSO_2]^+$ (6.5%), 125 $[C_7H_6Cl]^+$ (100%), 120 $[M\text{-}C_{13}H_9Cl_2SO_2]^+$ (43.5%), 111 $[C_6H_4Cl]^+$ (43.5%), 105 $[M\text{-}C_{13}H_{10}Cl_2NSO_2]^{\bullet+}$ (29.3%), 76 $[C_6H_4]^{\bullet+}$ (37.9%).

Conclusion

All derivatives were obtained in good yield. ^{1}H-NMR, IR and EIMS techniques helped to elucidate the structures of all the compounds and screened them for biological activity. The results of biological activities and their potential assured that these compounds can be utilized as biologically active agents

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