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Synthesis and Biological Studies of Some Sulfur, Selenium and Tellurium Organic Compounds Based on Diethanolamine

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Abstract— Several new and known bis(2-(arylchalcogeno)ethyl)amines (i.e. $HN(CH_2CH_2EAr)_2$; where E= S, Se and Te, Ar = C_6H_5, 4-$CH_3C_6H_4$, 4-$CH_3OC_6H_4$, 4-$CH_3CH_2OC_6H_4$, 4-BrC_6H_4, 4-ClC_6H_4 and 4-PhC_6H_4) were prepared by the reaction of bis(chloroethyl)amine with lithium arylthiolate or with the corresponding sodium arylchalcogenate (generated in *situ* by borohydride reduction of R_2Ee_2; *i.e.* ArE^-Na^+; E= Se and Te). All compounds were obtained in good yield and characterized by elemental analysis, IR, ^1H and ^{13}C NMR and mass spectroscopic data. Antibacterial activity study of these compounds showed some promising activity against *S. aureus*, *P. aeruginosa* and E. *coli*.

Key words— Diethanolamine, organotellurium, selenium, sodium arylchalcogenate, diaryl dichalcogenides, biological activity.

1 INTRODUCTION

DIETHANOLAMINE has been used as surfactants for detergents and cleaning agent formulations and as a gas purification agent to remove carbon dioxide or hydrogen sulfide gas. Furthermore, diethanolamine was also used as an anticorrosion agent in metalworking fluids, and in preparations of agricultural chemicals. In addition, diethanolamine is raw materials to synthesize drugs and it is also a cross linking agent for production of high elasticity polyurethane foam [1-3].

Selenium and tellurium compounds were considered a poison for many years, until non-toxic selenium and tellurium compounds with high biological activity were found [4–10]. A variety of organoselenium compounds with potential antioxidant activity, including ebselen analogues, benzoselenazolinones, diaryl diselenides, selenamide and related derivatives have been reported in a variety of pathological situations [8-12]. Like organoselenium compounds, a number of organotellurium compounds exhibited high glutathione peroxidase-like activity [2–5]. The literature [4–12] indicates that among organotellurium compounds, mainly telluranes (four-valent tellurium compounds), showed high biological activity. Thus, the present work describes the synthesis of some new and knows organosulfur, organoselenium and organotellurium compounds based on diethanolamine in order to study their biological activity.

2 EXPERIMENTAL

2.1 *Physical measurements*

All melting points were determined on a Gallenkamp melting point apparatus and are uncorrected. FT-IR spectra were recorded on FT-IR spectrophotometer -8400s Shimadza as KBr disc. The ^1H and ^{13}C NMR spectra were measured on a Bruker spectrometer at 400 (^1H NMR) MHz and 100 (^{13}C NMR) MHz using $CDCl_3$ solution with TMS as internal standard. Elemental analyses were determined on an MT-3 elemental analyzer within ±5 % of the theoretical values. Mass spectra were recorded on a HP-598 8A MS instrument at 70 eV.

2.2 *Synthesis*

All reactions were carried out under nitrogen or argon atmosphere and monitored by conventional TLC method. All organic solvents were dried prior to use according to standard methods. Diphenyl diselenide[13], bis(4-methylphenyl) diselenide [14] , bis(4-methoxyphenyl) diselenide [14], bis(4-ethoxyphenyl) diselenide [14], bis(4-bromophenyl) diselenide [14], bis(4-chlorophenyl) diselenide [14] and bis(4-phenlphenyl) diselenide[14] were prepared according to literature methods. Diphenyl ditelluride[15], bis(4-methoxyphenyl) ditelluride[15], bis(4-ethoxyphenyl) ditelluride[16] , bis(4-bromophenyl) ditelluride[16], bis(4-chlorophenyl) ditelluride[16] , bis(4-phenlphenyl) ditelluride[16], Bis(2-chloroethyl)amine was prepared by chlorination of diethanolamine with thionyl chloride in $CHCl_3$ as described in a literature method[17]. All the above compounds were characterized according to their mp's and IR spectra. Diphenyl) disulfide and bis(4-methoxyphenyl) disulfide were obtained from Aldrich-Sigma company and used without further purification.

2.2.1 Bis(2-(phenylthio)ethyl)amine **(1)**

To 0.18 mole of phenyllithium in 100 cm^3 THF was added cautiously sulfur(5.77 g; 0.18 g. atom) . The reaction was exothermic; the stirring was continued until all the sulfur had been disappeared. The resulting solution was stirred for additional 1 h at room temperature. The solution was cooled in ice-

bath and a solution of bis(2-chloroethyl)amine (12.07g; 0.085mol) in dry THF(100 cm^3) was added drop wise to the rapidly stirred solution of PhSLi. After the addition was complete, the reaction mixture was stirred for 12h at room temperature. The resulting solution was hydrolyzed with distilled water and the extracted with dichloromethane (5 x 50 cm^3). The organic layer was dried over anhydrous calcium chloride. Solvent was removed by rotary evaporator, to give a yellow solid product. Recrystallization of the product from a mixture of ethyl acetate-CH_2Cl_2gave compound **1** as a pale-yellow solid in 56% yield. M.p. 54-55^oC.

Anal. Calcd. for $C_{16}H_{19}NS_2$: C, 66.39; H, 6.62; N, 4.84%; Found: C, 66.09; H, 6.44; N 4.53%. ^1H NMR($CDCl_3$): 1.62 (s, 1H), 2.77 (d, 4H, J = 6.4 Hz), 2.98 (d, 4H, J = 6.5 Hz), 7.09 (d, 6H, J = 6.6 Hz), 7.33 (d, 4H, J= 6.4 Hz); ^{13}C NMR ($CDCl_3$), ^{13}C NMR ($CDCl_3$): 31.8, 49.6, 124.8, 128.7, 129.6, 139.7 EI MS: m/z $[M]^+$ = 289.

2.2.2 *Bis(2-(4-methoxyphenylthio)ethyl)amine(2).*

Synthesis of **2** is similar to the method used for compounds **1**, except that 4-MeOPhSLi was used instead of PhSLi. A pale yellow solid was obtained in 45% yield. M.p. 63-64^oC.

Anal. Calcd. for $C_{18}H_{23}NO_2S_2$: C, 61.86 ; H, 6.63; N, 4.01%; Found: C, 61.59; H, 6.24; N 4.13%. ^1H NMR($CDCl_3$): 1.64(sb, 1H, N*H*), 2.82(t, 4H, CH_2Se), 3.11(t, 4H, CH_2N), 3.82(s, 6H, OCH_3), 7.12(d, 4H, J= 6.4 Hz, Ar-*H*), 7.33(d, 4H, , J= 6.4 Hz, Ar-*H*); ^{13}C NMR ($CDCl_3$): 31.4, 49.8, 114.8, 124.7, 128.8, 159.1. EI MS: m/z $[M]^+$ = 349.

***Synthesis of bis(2-(arylseleno)ethyl)amine* (3-9)**

Compounds **3-9** were prepared according to the previously reported method [19] and as follow:

To a solution of diaryl diselenide (20 mmol), sodium hydroxide (8.602 g, 0.22 mol) and ethanol (150 mL) was add $NaBH_4$ (1.015 g, 27 mmol) in a small portion. The resulting solution was stirred for 4 hours at room temperature until the yellow colour disappeared. Bis(2-chloroethyl)amine (3.57g, 20 mmol) was added in small portions during 1 h. The resulted solution was stirred for 3 h at room temperature. The solvent was removed by a rotatory evaporator. The residue was dissolved in CH_2Cl_2 (50 mL) and then water (100 mL) was added to it. The organic phase was separated and the aqueous phase was extracted with CH_2Cl_2 (3 x 25 mL). The combined extracts were dried over anhydrous Na_2SO_4. The solvent was removed and the residue was purified by column chromatography (SiO_2, hexane/ethyl acetate). A white precipitate of the corresponding compound was obtained.

2.2.3 *Bis(2-(phenylseleno)ethyl)amine*(**3**)

Yield: 91% , m.p 54-55^oC.

Anal. Calcd. for $C_{16}H_{19}NSe_2$: C, 50.14; H, 5.00; N, 3.65%; Found: C, 50.09; H, 4.94; N 3.53%. ^1H NMR($CDCl_3$): 1.71 (s, 1H), 2.89 (d, 4H, J = 6.4 Hz), 3.04 (d, 4H, J = 6.5 Hz), 7.28 (d, 6H, J = 6.6 Hz), 7.53 (d, 4H, J= 6.4 Hz); ^{13}C NMR ($CDCl_3$), 133.07, 129.71, 129.17, 127.12, 48.57, 28.75. EI MS: m/z $[M]^+$ = 385.

2.2.4 *Bis(2-(4-methylphenylseleno)ethyl)amine* (**4**)

White solid. Yield: 78%, m.p.105-106^oC.

Anal. Calcd. for $C_{18}H_{23}NSe_2$: C, 52.56; H, 5.64; N, 3.41%; Found: C, 52.39; H, 5.24; N 3.33%. ^1H NMR($CDCl_3$): 1.70 (sb, 1H, NH), 2.01 (t, 4H, J = 6.4 Hz), 3.32 (t, 4H, J = 6.6 Hz), 7.08 (d, 6H, J = 5.6 Hz),7.22 (d, 4H, J= 6.4 Hz) ; ^{13}C NMR ($CDCl_3$): 21.3, 28.4, 38.8, 127.5, 131.2, 134.7, 138.2. EI MS: m/z $[M]^+$ = 413

2.2.5 *Bis(2-(4-methoxyphenylseleno)ethyl)amine* (**5**)

White solid. Yield: 88%, m.p.65-67^oC.

Anal. Calcd. for $C_{18}H_{23}NO_2Se_2$: C, 48.77 ; H, 5.23; N, 3.16%; Found: C, 48.49; H, 5.24; N 3.13%. ^1H NMR($CDCl_3$): 1.72(sb, 1H, N*H*), 1.92(t, 4H, CH_2Se), 2.03(t, 4H, CH_2N), 4.30(s, 6H, OCH_3), 6.62(d, 4H, J= 6.4 Hz, Ar-*H*), 7.21(d, 4H, , J= 6.4 Hz, Ar-*H*); ^{13}C NMR ($CDCl_3$):28.3, 27.5, 55.4. 112.4, 121.7, 131.6, 159.7. EI MS: m/z $[M]^+$ = 445.

2.2.6 *Bis(2-(4-ethoxyphenylseleno)ethyl)amine*(**6**)

White solid. Yield: 84%, m.p.95-96^oC.

Anal. Calcd. for $C_{20}H_{27}NO_2Se_2$: C, 50.96 ; H, 5.77; N, 2.97%; Found: C, 50.78; H, 5.64; N 2.73%. ^1H NMR($CDCl_3$): 1.68(sb, 1H, N*H*), 1.81-1.95(m, 10H, CH_3 + CH_2Se), 2.11(t, 4H, CH_2N), 4.82(q, 4H, OCH_2), 6.82(d, 4H, J= 6.8 Hz, Ar-*H*), 7.21(d, 4H, , J= 6.6 Hz, Ar-*H*); ^{13}C NMR ($CDCl_3$): 13.7, 26.2, 38.2, 63.8, 113.5, 120.9, 132.1, 160.2 . EI MS: m/z $[M]^+$ = 473.

2.2.7 *Bis(2-(4-bromophenylseleno)ethyl)amine*(**7**)

White solid. Yield: 89%, m.p.70-72^oC

Anal. Calcd. for $C_{16}H_{17}NBr_2Se_2$: C, 35.52 ; H, 3.17; N, 2.59%; Found: C, 34.98; H, 2.96; N 2.33%. ^1H NMR($CDCl_3$): 1.61(sb, 1H, N*H*), 1.82 (t, 4H, CH_2Se), 2.11(t, 4H, CH_2N), 7.18(d, 4H, J= 6.6 Hz, Ar-*H*), 7.51(d, 4H, , J= 6.6 Hz, Ar-*H*); ^{13}C NMR ($CDCl_3$): 32.6, 49.7, 119.2, 128.6, 131.6, 134.8. EI MS: m/z $[M]^+$ = 545.

2.2.8 *Bis(2-(4-chlorophenylseleno)ethyl)amine* (**8**)

White solid. Yield: 75%, m.p.100-102^oC

Anal. Calcd. for $C_{16}H_{17}NCl_2Se_2$: C, 42.50 ; H, 3.79; N, 3.10%; Found: C, 42.47; H, 2.97; N 2.86%. ^1H NMR($CDCl_3$): 1.69(sb, 1H, N*H*), 2.33 (t, 4H, CH_2Se), 3.18(t, 4H, CH_2N), 7.21(s, 8H, Ar-*H*); ^{13}C NMR ($CDCl_3$): 32.7, 50.1, 128.8, 130.7, 131.0, 133.9.

2.2.9 *Bis(2-(4-phenylphenylseleno)ethyl)amine* (**9**)

White solid. Yield: 81%, m.p.121-123^oC.

Anal. Calcd. for $C_{28}H_{27}NSe_2$: C, 62.81 ; H, 5.08; N, 2.62%; Found: C, 62.74; H, 4.95; N 2.38%. ^1H NMR($CDCl_3$): 2.01(sb, 1H, N*H*), 2.23(t, 4H, CH_2Se), 3.15(t, 4H, CH_2N), 7.35-7.49(m, 10H, Ar-*H*), 7.54(d, 4H, J= 7.3Hz, Ar-*H*), 7.64(d, 4H, J= 7.5Hz, Ar-*H*).

***Synthesis of bis(2-(aryltelluro)ethyl)amine* (10-16)**

Compounds **10-16** were prepared by the following general method:

Diary ditelluride (2.0 mmol) was dissolved in 30 cm^3 of ethanol and the solution set to reflux under nitrogen atmosphere. A solution of sodium borohydride in NaOH (10%) was added dropwise to the refluxing solution of the ditelluride under nitrogen atmosphere until it became colourless. Bis(2-choroethyl)amine hydrochloride (0.357 g, 2.0 mmol) dissolved in 10 cm^3 of ethanol was added to this solution with constant stirring. The reaction mixture was refluxed for 3h, cooled to room temperature and poured into ice cold water (100 cm^3) in which 0.2 g of $NaHCO_3$ was dissolved. The compound was extracted into chloroform (200 cm^3) from this aqueous mixture. The extract was washed with water and dried over anhydrous sodium sulphate. The solvent was removed under reduced pressure by a rotary evaporator, resulting in a white solid, which was extracted into hexane. Recrystallization from

chloroform gave a white solid.

The melting points and spectroscopic data of all prepared compounds follow

***2.2.10 Bis(2-(phenyltelluro)ethyl)amine*(10)**

Yield: 91% , m.p 70-72°C.

Anal. Calcd. for $C_{16}H_{19}NTe_2$: C, 39.99; H, 3.99; N, 2.91%; Found: C, 40.11; H, 3.84; N 3.23%. ^{1}H NMR($CDCl_3$): 1.30 (s, 1H), 2.82 (t, 4H, CH_2Te, J = 6.4 Hz), 3.39 (t, 4H, CH_2N, J = 6.5 Hz), 7.31-7.33 (m, 6H, Ar-H), 7.42-7.46 (m, 4H, Ar-H); ^{13}C NMR ($CDCl_3$): 43.7, 48.2, 117.0, 127.1, 129.3, 131.3.

***2.2.11 Bis(2-(4-methylphenyltelluro)ethyl)amine* (11)**

White solid. Yield: 72%, m.p.56-58°C.

Anal. Calcd. for $C_{18}H_{23}NTe_2$: C, 42.51; H, 4.56; N, 2.75%; Found: C, 42.39; H, 4.24; N 2.52%. ^{1}H NMR($CDCl_3$): 1.70 (sb, 1H, NH), 2.01 (t, 4H, CH_2Te , J = 6.4 Hz), 3.32 (t, 4H, CH_2N, J = 6.6 Hz), 7.08 (d, 6H, J = 5.6 Hz, Ar-H),7.22 (d, 4H, J= 6.4 Hz, Ar-H) ; ^{13}C NMR ($CDCl_3$): 21.3, 28.4, 38.8, 127.5, 131.2, 134.7, 138.2. EI MS: m/z $[M]^+$ = 513.

***2.2.12 Bis(2-(4-methoxyphenyltelluro)ethyl)amine* (12)**

White solid. Yield: 79%, m.p.62-64°C.

Anal. Calcd. for $C_{18}H_{23}NO_2Te_2$: C, 39.99 ; H, 4.29; N, 2.59%; Found: C, 40.12; H, 4.24; N 2.55%. ^{1}H NMR($CDCl_3$): 1.08(sb, 1H, N*H*), 2.57(t, 4H, CH_2Te), 3.38-3.45(m, 4H, CH_2N), 3.77(s, 6H, OCH_3), 7.11 (d, 4H, J= 6.4 Hz, Ar-*H*), 7.23(d, 4H, , J= 6.4 Hz, Ar-*H*); ^{13}C NMR ($CDCl_3$): 38.8, 48.5, 56.0, 115.3, 127.5, 134.4, 158.4. EI MS: m/z $[M]^+$ = 545.

***2.2.13 Bis(2-(4-ethoxyphenyltelluro)ethyl)amine*(13)**

White solid. Yield: 81%, m.p.93-95°C.

Anal. Calcd. for $C_{20}H_{27}NO_2Te_2$: C, 42.24 ; H, 4.79; N, 2.46%; Found: C, 42.17; H, 4.66; N 2.32%. ^{1}H NMR($CDCl_3$): 1.41(t, 6H, CH_3), 1.81(sb, 1H, *NH*), 2.93(t, 4H, CH_2Te), 3.01(t, 4H, CH_2N), 4.04(q, 4H, OCH_2), 6.87(d, 4H, J= 6.6 Hz, Ar-*H*), 7.25(d, 4H, , *J*= 6.6 Hz, Ar-*H*); ^{13}C NMR ($CDCl_3$): 13.8, 44.9, 48.6, 63.99, 116.9, 127.5, 135.2, 157.9.

***2.2.14 Bis(2-(4-bromophenyltelluro)ethyl)amine*(14)**

White solid. Yield: 79%, m.p.77-78°C

Anal. Calcd. for $C_{16}H_{17}NBr_2Te_2$: C, 30.11 ; H, 2.68; N, 2.19%; Found: C, 29.92; H, 2.47; N 2.03%. ^{1}H NMR($CDCl_3$): 1.44(sb, 1H, N*H*), 2.72 (t, 4H, CH_2Te), 3.31(t, 4H, CH_2N), 7.26(d, 4H, J= 7.3 Hz, Ar-*H*), 7.65(d, 4H, , J= 6.6 Hz, Ar-*H*); ^{13}C NMR ($CDCl_3$): 32.6, 48.6, 109.2, 128.5, 131.6, 137.2. EI MS: m/z $[M]^+$ = 645.

***2.2.15 Bis(2-(4-chlorophenyltelluro)ethyl)amine* (15)**

White solid. Yield: 69%, m.p.88-89°C

Anal. Calcd. for $C_{16}H_{17}NCl_2Te_2$: C, 34.98 ; H, 3.12; N, 2.55%; Found: C, 35.03; H, 2.96; N 2.36%. ^{1}H NMR($CDCl_3$): 1.67(sb, 1H, N*H*), 2.99 (t, 4H, CH_2Te), 3.42(t, 4H, CH_2N), 7.39(d, 4H, Ar-*H*), 7.64(d, 4H, Ar-*H*). ; ^{13}C NMR ($CDCl_3$): 44.9, 48.6, 127.5, 130.1, 133.4, 1339.

***2.2.16 Bis(2-(4-phenylphenyltelluro)ethyl)amine* (16)**

White solid. Yield: 75%, m.p.112-113°C.

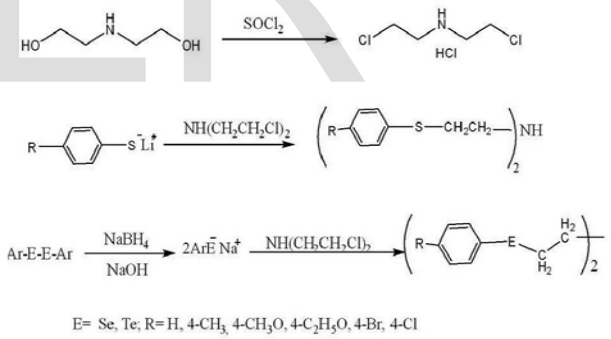
Anal. Calcd. for $C_{28}H_{27}NTe_2$: C, 53.15 ; H, 4.30; N, 2.21%; Found: C, 53.11.74; H, 4.05; N 2.31%. ^{1}H NMR($CDCl_3$): 1.95(sb, 1H, N*H*), 2.78(t, 4H, CH_2Te), 3.21(t, 4H, CH_2N), 7.37-7.46 (m, 6H, Ar-*H*), 7.61-7.64(m, 4H, Ar-*H*), 7.80(d, 4H, , Ar-*H*), 7.88(d, 4H, J= 7.5Hz, Ar-*H*).; ^{13}C NMR ($CDCl_3$): 44.8, 48.5, 127.3, 127.5, 128.3, 128.8, 128.9, 133.0, 140.9.

3 ANTIBACTERIAL ACTIVITY

Compounds **1-16** were tested for their antibacterial activity by using cup plate agar diffusion method [18] and the inhibition zones were measured in millimeter (mm). The nutrient agar broth prepared by the usual method, was inoculated aseptically with 0.5 mL of 24 h old subculture of *S. aureus*, *P. aeruginosa* and *E. coli* in separate conical flasks at 40-50°C and mixed well by gentle shaking. About 25 mL of the contents of the flask were poured and evenly spread in petridish (90 mm in diameter) and allowed to set for 2h. The cups (10 mm in diameter) were formed by the help of borer in agar medium and filled with 0.04 mL (40 µg/ mL) solution of sample in DMF. The plates were incubated at 37°C for 24 h and the control was also maintained with 0.04 mL of DMF in similar manner and the zones of inhibition of the bacterial growth were measured in millimeter and recorded in Table 1.

4 RESULTS AND DISCUSSION

Chlorination of diethanolamine with thionyl chloride in $CHCl_3$ gave 2-(chloroethyl)amine hydrochloride as a white solid in 77% yield. The latter compound reacted with lithium arylthiolate and with sodium arylchalcogenolates (*i.e.* NaEAr (E=Se/Te)), generated *in situ* by $NaBH_4$ reduction of the corresponding diaryldichalcogenides (Ar_2E_2) in alkaline ethanol to give compounds **1-2** and **3 – 16**, respectively in good yields, Scheme 1. Compounds **3**, **11**, and **13** were previously reported [19, 20]. All compounds are fairly soluble in organic solvents such as chloroform and dichloromethane.



Scheme 1. Preparative methods of compoubds **1-16**.

The IR spectra of all compounds displayed common features in certain regions and characteristic bands in the finger print and other regions. They showed a broad band at the range 3300-3400 cm^{-1} and a fairly broad band at 735-740 cm^{-1} region due to ν(N-H) stretching and N-H deformation, respectively[21,22]. The IR spectra showed the asymmetrical stretching ($\nu_{as}CH_2$) bands between 2920-2940 cm^{-1} while symmetrical stretching bands (ν_sCH_2) appeared between 2855-2880 cm^{-1}. The C-H stretching bands between 3040 -3060 cm^{-1} are due to the aromatic group. The IR spectra showed bands in the regions 710-725cm^{-1}, 630-650 cm^{-1} and 500-530 cm^{-1} due to ν(S-C_{aliph}), ν(Se-C_{aliph}) and ν(Te-C_{aliph}), respectively which agrees

well with previous works[23].

The ^{1}H NMR spectra of compounds **1** - **16** are as expected and show two triplets for CH_2-E , CH_2-N and a broad signal for NH protons. For example, the ^{1}H NMR spectrum of **3** exhibited two triplets, arising from the methylene groups (δ1.92 SeCH_2 and 2.03 NCH_2). The aromatic protons of the phenyl ring showed two doublets at 6.62 and 7.21ppm (Experimental Section).

^{13}C NMR spectra of all compounds gave further support for the formation of these compounds. The signal from the C-Te in compounds **10-16** is 10-20 ppm further upfield than that for **1-9** owing to the polarity of Te-C bond[24].

The mass spectra of the studied compounds show a peak(along with the parent ion peak) corresponding to SCH_2CHNH^+ or $SeCH_2CHNH^+$ or $TeCH_2CHNH^+$ suggesting that the S/Se/Te-C(alkyl) bond is cleaved in preference to the S/Se/Te-C(ary1) bond.

4.1 *ANTIBACTERIAL ACTIVITY*

The antimicrobial activity of tested compounds against different strains of bacteria is shown in Table 1.

TABLE 1. Microbiological evaluation of compounds **1 – 16**.

Compounds/ Standard drugs	Organism		
	E. coli	*S. aureus*	*P. aeruginosa*
1	18	17	21
2	19	18	21
3	17	17	17
4	18	21	21
5	20	22	22
6	19	20	19
7	16	18	18
8	17	19	20
9	14	16	16
10	15	16	17
11	17	14	20
12	19	17	21
13	18	29	19
14	14	21	18
15	15	18	19
16	13	16	16
Ampicillin	20	25	20
Amoxicillin	19	21	25

From Table 1 it can be concluded that all the compounds have displayed biological activity against these bacteria. In general compounds containing sulfur and selenium (*i.e.* compounds **1 – 9**) are more active against the bacteria than analogous tellurium derivatives (*i.e.* compounds **10 – 16**), Table 1. Remarkable inhibition was observed in compounds containing methoxy, ethoxy and methyl substituents, Table 1. It seems that the methyl, methoxy and ethoxy group at *para* position are very significant for activity against bacterial. Compounds **9** and **16** showed minimum activity against all strains. This may be due to the presence of a phenyl substituent, which makes slow diffusion through the cell membrane. In general, all compound showed good antibacterial activity.

5 ACKNOWLEDGMENTS

The financial support of this work by Ministry of Higher Education and Scientific Research/ Research and Development (Grant No. 593) is hereby gratefully acknowledged.

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