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Synthesis, Characterization and Antibacterial Activity of Some Schiff Bases Derived from 4-Aminobenzoic Acid

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In the present study, a series of Schiff bases were synthesized from aromatic amines (4-aminobenzoic acid and ethyl-4-aminobenzoate) and aromatic aldehydes (salicylaldehyde, 5-chloro-salicylaldehyde, 5-bromo-salicylaldehyde, 3-nitrobenzaldehyde, 2-nitrobenzaldehyde, 4-hydroxy-benzaldehyde and 4-methoxybenzaldehyde). The chemical structures of these compounds were confirmed by means of FT-IR, ^{1}H NMR and ^{13}C NMR and elemental analysis. The synthesized compounds screened for antibacterial activity against *Pseudomonas aeruginosa* ATCC 27853, *Entrococcus faecalis* ATCC 29212, *Acinetobacter calcoaceticus* ATCC 23055, *Klebsiella pneumoniae* ATCC 10031, *Vibrio cholerae* 569B, *Escherichia coli* ATCC 25922, *Staphylococcus aureus* PTCC 1112 and *Salmonella typhimurium* PTCC 1735. The bioassay was carried out *in vitro* antibacterial property of these synthesized compounds, using dimethylsulfoxide as solvent.

Key Words: Schiff bases, 4-Aminobenzoic acid, Aromatic aldehydes, Antibacterial activity, Parekh method.

INTRODUCTION

Compounds with the structure of $R_1C=NR_2$ are known as Schiff bases, in which one or both of R_1 and R_2 is aromatic group. Schiff bases are usually synthesized from the condensation of primary amines and active carbonyl groups.

The increasing microbial resistance to antibiotics in use nowadays necessitates the search for new compounds with potential effects against pathogenic bacteria. Many researchers studied the synthesis, characterization and structure-activity relationship (SAR) of Schiff bases[1-5]. Some Schiff bases were reported to possess antiinflammatory activity[6,7]. Antibacterial and antifungal activities of various Schiff bases have also been reported[8-11]. Many Schiff bases are known to be medicinally important and are used to design medicinal compounds[12-14]. In this study, the synthesis of some Schiff base derivatives of 4-aminobenzoic acid and their antibacterial properties

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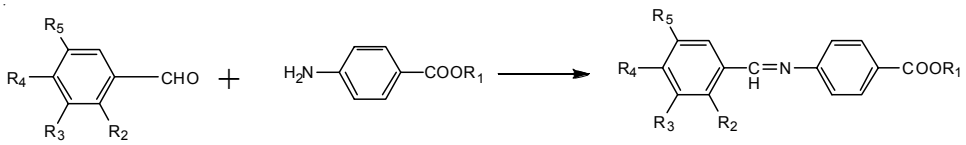
were reported (**Scheme-I**). The result of this study may be useful to researchers attempting to obtain more understanding of the antimicrobial activity of Schiff base compounds.



Scheme-I

EXPERIMENTAL

All chemicals used were commercially available. 4-Aminobenzoic acid was purchased from Merck Co. The ^{1}H NMR and ^{13}C NMR spectra were recorded on a Bruker 300 mHz model spectrometer in DMSO-d_6 and $CDCl_3$. The IR spectra of the compounds were recorded on Thermonicolet spectrometer Nexus 670 FT-IR with KBr pellets. Elemental analyses were performed on a CHN-LECO932 instrument and were within ± 0.39 % of the theoretical values. Melting points were measured on an electrothermal digital melting point apparatus (Table-1).

TABLE-1
MELTING POINT AND YIELD OF 11 SYNTHETIC COMPOUNDS

Compd.	R_1	R_2	R_3	R_4	R_5	m.p. (ºC)	Yield (%)
1a	H	OH	H	H	H	247	58
1b	Et	OH	H	H	H	85	85
2a	H	OH	H	H	Br	>250*	53
2b	Et	OH	H	H	Br	141	89
3a	H	OH	H	H	Cl	>200*	52
3b	Et	OH	H	H	Cl	136	57
4a	H	H	NO_2	H	H	200	50
4b	Et	H	NO_2	H	H	152	52
5a	H	NO_2	H	H	H	>220*	76
5b	Et	H	H	OH	H	157	30
6a	H	H	H	OMe	H	183	40

Ethyl *p*-aminobenzoate: Absolute ethanol (80 mL) was placed in a 250 mL two-necked flask equipped with a double surface reflux condenser and gas inlet tube. Dry hydrogen chloride was passed through the alcohol until saturated and the gas inlet tube was removed. *p*-Aminobenzoic acid (12 g, 0.088 mol) was added and the mixture was refluxed for 2 h. The hot solution was poured in water (300 mL) and solid sodium carbonate was added carefully to the clear solution until it became neutral to litmus. The precipitated ester was filtered at pump and dried in air[15]. m.p. 86 ºC; Yield: 69 %; ^{1}H NMR ($CDCl_3$), δ (ppm): 1.373 (t, J = 7.2 Hz, 3H, CH_3), 4.065 (s, 2H, NH_2), 4.329 (q, J = 7.1 Hz, 2H, CH_2), 6.644 (d, 2H, ArH), 7.866 (d,

2H, ArH) FT-IR (KBr, ν_{max}, cm^{-1}): 1172, 1280 (C-O), 1311 (CH_3), 1367 (CH_2), 1683 (C=O), 3343, 3422 (NH_2).

General method for the synthesis of compounds 1a, 1b and 4b: To the requisite amount of aldehyde dissolved in absolute ethanol (30 mL), amine (3.65 mmol) and few drops of glacial acetic acid were added and the solution was refluxed. After a few minutes yellow crystals appeared in the solution. The refluxing was continued for 5-6 h, then the resulting mixture was cooled to room temperature. The precipitate was filtered and recrystallized from hot ethanol.

(E)-4-(2-Hydroxybenzylidenamino)benzoic acid (1a): m.p. 247 °C; Yield: 58 %; ^{1}H NMR (DMSO-d_6), δ (ppm): 6.992 (t, 2H, ArH), 7.455 (m, 3H, ArH), 7.694 (d, *J* = 7.8 Hz, 1H, ArH), 8.01 (d, *J* = 8.4 Hz, 2H, ArH), 8.989 (s, 1H, CH=N), 12.714 (s, 2H, -OH + -COOH); ^{13}C NMR (DMSO-d_6), δ (ppm): 117.144, 119.776, 121.99, 129.246, 131.187, 133.066, 134.302, 152.613 (C-N), 160.747 (C-OH), 165.263 (C=N), 167.331(C=O); FT-IR (KBr, ν_{max}, cm^{-1}): 1319 (C-O), 1598 (C=N), 1678 (C=O), 3200-2200 (OH). Anal. (%) Calcd. for $C_{14}H_{11}NO_3$: C, 69.70; H, 4.60; N, 5.81. Found: C, 69.80; H, 4.62; N, 5.84.

(E)-Ethyl-4-(2-hydroxybenzylidenamino)benzoate (1b): m.p. 85 °C; Yield: 85 %; ^{1}H NMR ($CDCl_3$), δ (ppm): 1.426 (t, *J* = 7.05 Hz, 3H, CH_3), 4.408 (q, *J* = 7.1 Hz, 2H, CH_2), 6.974 (t, *J* = 7.35 Hz, 1H, ArH), 7.05 (d, *J* = 8.7 Hz, 1H, ArH), 7.314 (d, *J* = 8.4 Hz, 2H, ArH), 7.423 (t, 2H, ArH), 8.122 (d, *J* = 8.1 Hz, 2H, ArH), 8.642 (s, 1H, CH=N); ^{13}C NMR ($CDCl_3$), δ(ppm): 14.355 (CH_3), 61.074 (CH_2), 117.393, 118.977, 119.283, 121.105, 128.711, 131.008, 132.644, 133.795, 152.414 (C-N), 161.253 (C-OH), 164.106 (C=N), 166.097 (C=O); FT-IR (KBr, ν_{max}, cm^{-1}): 1705 (C=O), 1598 (C=N), 1165, 1283 (C-O), 1365 (CH_3), 1458 (CH_2), 2975 (C-H, sp^3), 3065 (C-H, sp^2). Anal. (%) Calcd. for $C_{16}H_{15}NO_3$: C, 71.36; H, 5.61; N, 5.20. Found: C, 71.42; H, 5.65; N, 5.18.

(E)-Ethyl-4-(3-nitrobenzylidenamino)benzoate (4b): m.p. 152 °C; Yield: 52 %; ^{1}H NMR ($CDCl_3$), δ (ppm): 1.419 (t, *J* = 7.05 Hz, 3H, CH_3), 4.4 (q, *J* = 7.1 Hz, 2H, CH_2), 7.25 (d, *J* = 8.4 Hz, 2H, ArH), 7.69 (t, *J* = 7.95 Hz, 1H, ArH), 8.11 (d, *J* = 8.1 Hz, 2H, ArH), 8.26 (*t*, *J* = 7.8 Hz, 2H, ArH), 8.356 (dt, *J* = 8.4, 1.2 Hz, 1H, ArH), 8.537 (s, 1H, ArH), 8.762 (s, 1H, CH=N); ^{13}C NMR ($CDCl_3$), δ (ppm): 14.351 (CH_3), 61.029 (CH_2), 120.65, 123.683, 126.012, 128.569, 129.922, 130.92, 134.298, 137.428, 148.713 (C-NO_2), 154.863 (C-N), 158.662 (C=N), 166.158 (C=O); FT-IR (KBr, ν_{max}, cm^{-1}): 1312 (CH_3), 1168, 128 (C-O), 1365, 1529 (NO_2), 1413 (CH_2), 1599 (C=N), 1701 (C=O), 2989 (C-H, sp^3), 3067 (C-H, sp^2). Anal. (%) Calcd. for $C_{16}H_{14}N_2O_4$: C, 64.42; H, 4.73; N, 9.39. Found: C, 64.50; H, 4.70; N, 9.45.

General method for the synthesis of compounds 2a, 3a, 2b, 3b and 5a: To the requisite amount of aldehyde dissolved in absolute methanol (30 mL), a few drops of glacial acetic acid were added. While the solution was stirred, amine (3.65 mmol) slowly was added at room temperature. The stirring was continued for 4-5 h. The precipitate was filtered and crystallized from hot methanol and minimum amount of DMF and then washed with ethanol and water for three times.

(E)-4-(5-Bromo-2-hydroxybenzylidenamino)benzoic acid (2a): m.p. > 250 °C decomp.; Yield: 53 %; ^{1}H NMR (DMSO-d_6), δ (ppm): 6.96 (d, *J* = 8.7 Hz, 1H, ArH), 7.459 (d, *J* = 8.4 Hz, 2H, ArH), 7.57 (dd, *J* = 8.7, 2.4 Hz, 1H, ArH), 7.9 (d, *J* = 2.4 Hz, 1H, ArH), 8.011 (d, *J* = 8.4 Hz, 2H, ArH), 8.941 (s, 1H, CH=N), 12.724 (s, 2H, -OH + -COOH); ^{13}C NMR (DMSO-d_6), δ (ppm): 110.562 (C-Br), 119.61, 121.774, 121.997, 129.509, 131.194, 134.248, 136.443, 152.516 (C-N), 159.726 (C-OH), 163.424 (C=N), 167.299 (COOH); FT-IR (KBr, ν_{max}, cm^{-1}): 1318 (C-O), 1596 (C=N), 1680 (C=O), 3300-2400 (OH). Anal. (%) Calcd. for $C_{14}H_{10}NO_3Br$: C, 52.52; H, 3.15; N, 4.38. Found: C, 52.61; H, 3.17; N, 4.40.

(E)-4-(5-Chloro-2-hydroxybenzylidenamino)benzoic acid (3a): m.p. >200 °C Decomp.; Yield: 52 %; ^{1}H NMR (DMSO-d_6), δ (ppm): 6.7 (d, *J* = 8.7 Hz, 1H, ArH), 7.44 (m, 3H, ArH), 7.759 (d, *J* = 2.7 Hz, 1H, ArH), 8.00 (d, *J* = 8.7 Hz, 2H, ArH), 8.93 (s, 1H, CH=N), 12.646 (s, 2H, OH + COOH); ^{13}C NMR (DMSO-d_6), δ (ppm): 119.174,121.15, 121.96, 123.2 (C-Cl), 129.497, 131.176, 131.275, 133.659, 152.517 (C-N), 159.32 (C-OH), 163.47 (C=N), 167.269 (COOH); FT-IR (KBr, ν_{max}, cm^{-1}): 1317 (C-O), 1598 (C=N), 1679 (C=O), 3300-2200 (OH). Anal. (%) Calcd. for $C_{14}H_{10}ClNO_3$: C, 60.19; H, 3.66; N, 5.08. Found: C, 60.26; H, 3.68; N, 5.06.

(E)-Ethyl-4-(5-bromo-2-hydroxybenzylidenamino)benzoate (2b): m.p. 141 °C; Yield: 89 %; ^{1}H NMR (DMSO-d_6), δ (ppm): 1.304 (t, *J* = 6.9 Hz, 3H, CH_3), 4.293 (q, *J* = 6.9 Hz, 2H, CH_2), 6.93 (d, *J* = 8.7 Hz, 1H, ArH), 7.446 (d, *J* = 8.4 Hz, 2H, ArH), 7.54 (dd, *J* = 8.7, 2.1 Hz, 1H, ArH), 7.874 (d, *J* = 2.1 Hz, 1H, ArH), 7.997 (d, *J* = 8.1 Hz, 2H, ArH), 8.907 (s, 1H, CH=N), 12.513 (s, 1H, -OH); ^{13}C NMR (DMSO-d_6), δ (ppm): 14.599 (CH_3), 61.197 (CH_2), 110.551 (C-Br), 119.596, 121.783, 122.102, 128.489, 130.984, 134.165, 136.465, 152.85 (C-N), 159.708 (C-OH), 163.412 (C=N), 165.68 (C=O); FT-IR (KBr, ν_{max}, cm^{-1}): 1169, 1284 (C-O), 1355 (CH_3), 1474 (CH_2), 1596 (C=N), 1699 (C=N), 2975 (C-H, sp^3), 3055 (C-H, sp^2). Anal. (%) Calcd. for $C_{16}H_{14}NO_3Br$: C, 55.19; H, 4.05; N, 4.02. Found: C, 55.25; H, 4.07; N, 4.04.

(E)-Ethyl-4-(5-chloro-2-hydroxybenzylidenamino)benzoate (3b): m.p. 136 °C Yield: 57 %; ^{1}H NMR (DMSO-d_6), δ (ppm): 1.315 (t, *J* = 6.9 Hz, 3H, CH_3), 4.304 (q, *J* = 6.9 Hz, 2H, CH_2), 6.995 (d, *J* = 8.7 Hz, 1H, ArH), 7.44 (m, 3H, ArH), 7.756 (d, *J* = 2.7 Hz, 1H, ArH), 8.01 (d, *J* = 8.7 Hz, 2H, ArH), 8.919 (s, 1H, CH=N), 12.513 (s, 1H, OH); ^{13}C NMR (DMSO-d_6), δ (ppm): 14.607 (CH_3), 61.207 (CH_2), 119.182, 121.167, 122.098, 123.215 (C-Cl), 128.507, 130.992, 131.21, 133.711, 152.845 (C-N), 159.845 (C-OH), 163.488 (C=N), 165.689 (C=O); FT-IR (KBr, ν_{max}, cm^{-1}): 1167, 1285 (C-O), 1355 (CH_3), 1483 (CH_2), 1598 (C=N), 1700 (C=O), 2979 (C-H, sp^3), 3058 (C-H, sp^2). Anal. (%) Calcd. for $C_{16}H_{14}NO_3Cl$: C, 63.27; H, 4.65; N, 4.61. Found: C, 63.35; H, 4.68; N, 4.59.

(E)-4-(2-Nitrobenzylidenamino)benzoic acid (5a): m.p. >220 °C; Yield: 76 %; ^{1}H NMR (DMSO-d_6), δ (ppm): 7.318 (d, *J* = 8.4 Hz, 2H, ArH), 7.775 (t, *J* = 7.35 Hz, 1H, ArH), 7.866 (t, *J* = 7.5Hz, 1H, ArH), 8.004 (d, *J* = 8.4 Hz, 2H, ArH), 8.135 (q, 2H, ArH), 8.873 (s, 1H, CH=N), 12.896 (s, 1H, COOH); ^{13}C NMR (DMSO-d_6),

δ (ppm): 121.512, 124.997, 129.134, 130.135, 130.249, 131.159, 132.663, 134.269, 149.73(C-NO_2), 155.081 (C-N), 159.116 (C=N), 167.352 (C=O); FT-IR (KBr, ν_{max}, cm^{-1}): 1519, 1348 (NO_2), 1600 (C=N), 1703 (C=O), 3000-2200 (OH). Anal. (%) Calcd. for $C_{14}H_{10}N_2O_4$: C, 62.22; H, 3.73; N, 10.37. Found: C, 62.30; H, 3.71; N, 10.42.

General method for the synthesis of compounds 5b and 6a: To the requisite amount of aldehyde, dissolved in absolute ethanol (30 mL), amine (3.65 mmol) and few drops of glacial acetic acid were added and the mixture was refluxed for 24 h. The resulting solution was cooled to room temperature and then poured over crushed ice with constant stirring. The precipitate was filtered and washed with sodium bisulfite solution to remove excess of aldehyde. The product was crystallized from hot ethanol and dried.

(E)-Ethyl-4-(4-hydroxybenzylidenamino)benzoate (5b): m.p. 157 °C; Yield: 30 %; ^{1}H NMR ($CDCl_3$), δ (ppm): 1.311 (t, *J* = 7.05 Hz, 3H, CH_3), 4.293 (q, *J* = 7Hz, 2H, CH_2), 6.891 (d, *J* = 8.4 Hz, 2H, ArH), 7.262 (d, *J* = 8.4 Hz, 2H, ArH), 7.79 (d, *J* = 8.4 Hz, 2H, ArH), 7.955 (d, *J* = 8.4 Hz, 2H, ArH), 8.458 (s, 1H, CH=N), 10.227 (s, 1H,OH); FT-IR (KBr, ν_{max}, cm^{-1}): 1102 (C-OH), 1288, 1168 (C-O), 1367 (CH_3), 1573 (C=N), 1718 (C=O), 3200-2200 (OH). Anal. (%) Calcd. for $C_{14}H_{10}NO_3$: C, 71.36; H, 5.61; N, 5.2. Found: C, 71.44; H, 5.64; N, 5.5.

(E)-4-(4-Methoxybenzylidenamino)benzoic acid (6a): m.p. 183 °C; Yield: 40 %; ^{1}H NMR (DMSO-d_6), δ (ppm): 3.824 (s, 3H, CH_3), 7.066 (d, *J* = 8.4 Hz, 2H, ArH), 7.263 (d, *J* = 8.4 Hz, 2H, ArH), 7.891 (d, *J* = 8.4 Hz, 2H, ArH), 7.952 (d, *J* = 8.4 Hz, 2H, ArH), 8.528 (s, 1H, CH=N), 12.818 (s, 1H, COOH); ^{13}C NMR (DMSO-d_6), δ (ppm): 55.899 (CH_3), 114.798, 121.419, 127.983, 129.071, 131.035, 131.286, 156.222 (C-N), 161.923 (C=N), 162.728 (C-OMe), 167.508 (C=O); FT-IR (KBr, ν_{max}, cm^{-1}): 1162 (C-OMe), 1314 (CH_3), 1594 (C=N), 1683 (C=O), 3200-2200 (OH), 2838 (C-H, sp^3). Anal. (%) Calcd. for $C_{15}H_{13}NO_3$: C, 70.58 %; H, 5.13; N, 5.49. Found: C, 70.68; H, 5.16; N, 5.52.

(E)-4-(3-Nitrobenzylidenamino)benzoic acid (4a): 3-Nitrobenzaldehyde (1 g) and 4-aminobenzoic acid (0.9 g) were dissolved in acetonitrile (20 mL) and few drops of glacial acetic acid was added. The mixture stirred at room temperature for 24 h to give a white precipitate. The product was separated by filtration and recrystallized from ethanol. m.p. 125 °C; ^{1}H NMR (DMSO-d_6), δ (ppm): 7.50 (d, *J* = 8.4 Hz, 2H, ArH), 7.95 (t, *J* = 7.97 Hz, 1H, ArH), 8.36 (d, *J* = 8.2 Hz, 2H, ArH), 8.51 (t, *J* = 7.9 Hz, 2H, ArH), 8.61 (dt, *J* = 8.4, 1.3 Hz, 1H, ArH), 8.78 (s, 1H, ArH), 8.98 (s, 1H, CH=N); ^{13}C NMR (DMSO-d_6), δ (ppm): 120.68, 123.711, 126.033, 128.569, 129.951, 130.96, 134.312, 137.431, 148.742 (C-NO_2), 156.521. FT-IR (KBr, ν_{max}, cm^{-1}): 1288 (C-O), 1597 (C=N), 1688 (C=O), 3100-2200 (OH). Anal. (%) Calcd. for $C_{14}H_{10}N_2O_4$: C, 62.22; H, 3.73; N, 10.37. Found: C, 62.31; H, 3.75; N, 10.42.

Antimicrobial activity: Bacterial strains: The antibacterial activity of synthesized compounds was tested against *Pseudomonas aeruginosa* ATCC 27853, *Entrococcus faecalis* ATCC 29212, *Acinetobacter calcoaceticus* ATCC 23055, *Klebsiella*

pneumoniae ATCC 10031, *Vibrio cholerae* 569B, *Escherichia coli* ATCC 25922, *Staphylococcus aureus* PTCC 1112 and *Salmonella typhimurium* PTCC 1735.

Preparation of test compound and antibacterial activity assays: The antibacterial activity of drugs was assayed with the method of Parekh *et al.*[11] with some modifications. The compounds were dissolved at an initial concentration of 10 mg/mL in DMSO (Merck) and serially diluted in two stages. In all three different concentrations of the compounds were prepared (10, 1 and 0.1 mg/mL) for antibacterial activity assays. A loop full of defined strain was inoculated in 25 mL of Nutrient Broth medium (BBL) and was incubated foe 24 h in 37 °C. Mueller Hinton Agar (MHA) (Merck) plates were prepared according to the manufacturer's recommendations by dissolving 34 g of the medium in 1000 mL of distilled water. 30 mL of autoclaved media were added into a 10 cm plate. Inoculation of each strain was done by the pour-plate method. 200 µL of the activated strain was added into the MHA medium in 45 °C and after proper homogenization were distributed into a Petri-dish. The complete microbiological procedures were performed in a laminar airflow to maintain aseptic conditions. After solidification of the media, a well was made in the MHA with a sterile glass tube (6 mm) and 70 µL of drug compound was added into the well. For each drug the antibacterial effects of three concentrations were investigated. 70 µL of DMSO was inoculated into another well as negative control. The antibacterial activities of drug compounds were determined by measuring the inhibition zone formed around each well against defined bacterial strain.

The *in vitro* antibacterial activity of 11 Schiff bases derived from 4-aminobenzoic acid in DMSO against some of most important gram positive and gram negative infectious agents were shown in Table-2.

RESULTS AND DISCUSSION

In 4-aminobenzoic acid, the carboxylic acid functional group has electron withdrawing activity. Therefore it can decrease the nucleophilic property of amino functional group. Thus, the 4-aminobenzoic acid can only react with active aldehydes, like salicylaldehyde, halo salicylaldehyde or nitrobenzaldehyde.

The 11 synthetic compounds showed different inhibition zones against tested bacterial strains. Of three concentrations evaluated, the highest concentration (*i.e.*, 10 mg/mL) was more effective against different strains. However, the lowest concentrations (0.1 mg/mL) were also effective against some of the gram negative bacteria (*i.e., Klebsiella pneumoniae, Vibrio cholerae, Acinetobacter calcoaceticus* and *Salmonella typhimurium*). In *Pseudomonas aeruginosa* none of the compounds showed any antibacterial activity with the exception of **4a** and **2b** (10 mg/mL), so *Pseudomonas aeruginosa* was the most resistant strain to all the synthetic compounds, however *Pseudomonas aeruginosa* strains always show high resistance to different antibacterial agent and the resistance of this strain to another derivatives of 4-aminobenzoic acid has been reported[11]. Among the gram negative bacterial strains, *Vibrio cholerae* was the most sensitive strain to all tested drugs, however

TABLE-2
in vivo ANTIBACTERIAL ACTIVITY OF THE SYNTHESIZED DRUG COMPOUNDS (A = 10 mg/mL, B = 1mg/mL and C= 0.1mg/mL)

Synthesized Schiff bases	Inhibition zone (70 µL)																	
	1a			**2a**			**3a**			**4a**			**5a**			**6a**		
Bacterial strains	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C
Pseudomonas aeruginosa	-	-	-	-	-	-	-	-	-	8	-	-	-	-	-	-	-	-
Entrococcus faecalis	-	-	-	15	-	-	15	-	-	30	-	-	32	-	-	-	-	-
Acinetobacter calcoaceticus	24	12	10	30	15	10	30	12	-	29	10	-	20	11	-	-	-	-
Klebsiella pneumoniae	21	15	13	20	13	12	24	15	12	20	14	12	16	12	-	15	13	10
Vibrio cholerae	34	30	-	40	35	24	42	10	-	30	-	-	40	40	20	30	24	20
Escherichia coli	17	12	11	16	-	-	16	11	-	15	-	-	15	10	-	13	-	-
Staphylococcus aureus	10	-	-	16	8	-	16	10	-	22	12	-	23	-	-	13	-	-
Salmonella typhimurium	21	15	11	27	17	12	33	14	-	28	13	10	24	16	10	20	-	-

	1b			2b			3b			4b			5b		
	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C
Pseudomonas aeruginosa	-	-	-	8	-	-	-	-	-	-	-	-	-	-	-
Entrococcus faecalis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Acinetobacter calcoaceticus	24	12	11	24	15	10	28	13	10	12	10	10	13	12	10
Klebsiella pneumoniae	15	12	-	29	18	16	15	10	8	14	10	7	16	12	10
Vibrio cholerae	38	34	32	39	38	34	38	36	32	42	40	34	40	38	33
Escherichia coli	-	-	-	20	10	-	15	9	-	15	8	-	16	11	-
Staphylococcus aureus	8	-	-	12	10	8	-	-	-	9	-	-	-	-	
Salmonella typhimurium	29	20	12	27	16	-	20	13	-	18	14	12	19	16	12

the antibacterial effect of 4-aminobenzoic acid derivatives on *V. cholerae* has not been reported elsewhere yet. Among the gram positive bacteria more antibacterial effect on *Staphylococcus aureus* was seen than *Entrococcus faecalis*. This different effect of the synthetic compounds may be because of the structure of the drug and inherent characteristics of each bacterial strain. On the average; compound **4a** had highest activity and compounds **2a**, **3a**, **5a** and **2b** showed considerable inhibitory activity. But antibacterial activity of compound **6a** was less. Compounds **1a**, **1b**, **3b**, **4b** and **5b** exhibited moderate activity. In this study, it was shown that antibacterial activity of carboxylic acid derivatives (**1a**, **2a**, **3a** and **4a**) is more than ester derivatives (**1b**, **2b**, **3b** and **4b**). It was also shown that halo and nitro groups are effective in antibacterial activity of compounds.

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