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LETTERS TO THE EDITOR

Synthesis of 3-(4-Fluorophenyl)-3-(4-methoxyphenyl)-1-propanarylamines and Their Antibacterial Activity

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Abstract—Condensation of 3-(4-fluorophenyl)-3-(4-methoxyphenyl)-1-propanamine with aromatic aldehydes and ketones followed by the reduction of the obtained azomethines with $NaBH_4$ afforded secondary propanaryl -amines, whose oxalates and hydrochlorides possess high antibacterial activity.

Keywords: propanarylamines, azomethines, reduction, oxalates, hydrochlorides, antibacterial activity

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One of the main tasks of pharmaceutical chemistry is the search for new biologically active compounds with high efficacy and low toxicity. In this regard, the search for new highly effective drugs does not become obsolete.

In continuation of our studies in this direction [1–3], we report here the targeted synthesis of new biologically active oxalates and hydrochlorides of substituted propanarilamines, the study and analysis of their biological activity in comparison with the reference compounds and their structural analogs in order to establish the structure–activity relationship, and also to identify the most promising substances for further research.

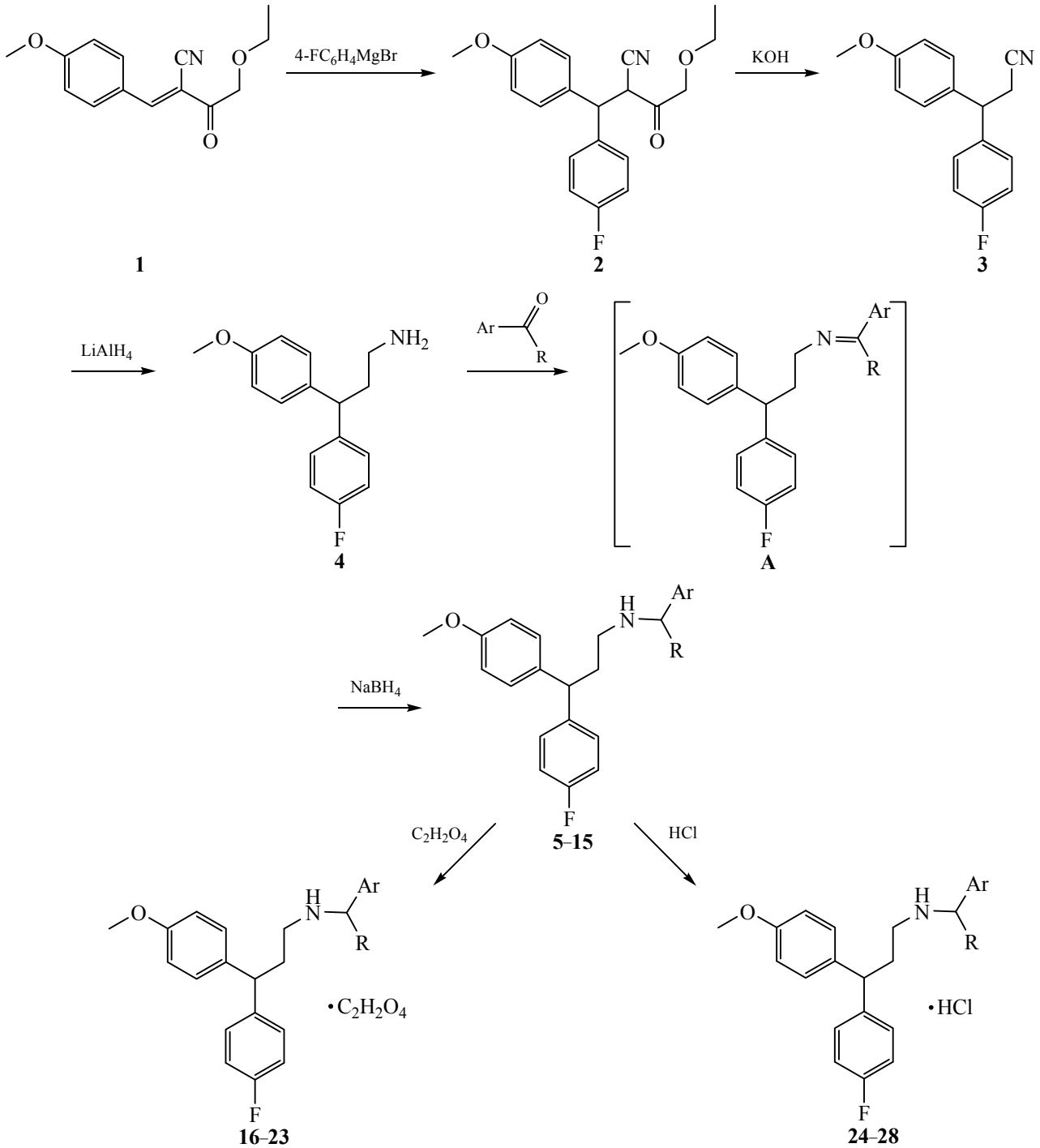
Ethyl (*E*)-2-cyano-3-(4-methoxyphenyl)-2-propenoate **1** reacted with 4-fluorophenylmagnesium bromide to give ethyl 2-cyano-3-(4-fluorophenyl)-3-(4-methoxyphenyl)propanoate **2**. The decarbethoxylation of the latter led to the formation of the corresponding nitrile **3**. The reduction of nitrile **3** with lithium aluminum hydride afforded 3-(4-fluorophenyl)-3-(4-methoxyphenyl)-1-propanamine **4**. Its condensation with various aromatic aldehydes and ketones led to the formation of the corresponding azomethines **A**, whose reduction with $NaBH_4$ afforded secondary amines **5**–**15**. For biological screening, amines **5**–**15** were converted to the corresponding oxalates **16**–**23** and hydrochlorides **24**–**28** (Scheme 1).

Antibacterial activity of compounds **16**–**28** with respect to the gram-positive strain of *Staphylococcus aureus* 209 p, 1) and gram-negative strains of *Sh. dysenteriae flexneri* 6858 and *Escherichia coli* 0-55 was studied according to the procedure of [4]. Some of the compounds obtained were found to exhibit antibacterial activity. Thus, compounds **17**, **18**, **25**, and **27** showed high activity, suppressing the growth of microorganisms in the zone with a diameter of 22–28.6 mm. These compounds have a slightly higher activity against gram-positive microorganisms than furazolidone (d = 24.3–25 mm). The other substances (d 15–22 mm) were inferior to furazolidone (d = 24.3–25 mm).

It should be noted that any difference in the antibacterial activity between the hydrochlorides and oxalates of 3-(4-fluorophenyl)-3-(4-methoxyphenyl)propanamines had not been established.

Ethyl (*E*)-2-cyano-3-(4-methoxyphenyl)-2-propenoate (1). A mixture of 34 g (0.3 mol) of ethyl cyanoacetate, 40.8 g (0.3 mol) of anisaldehyde and 2 g of ammonium

Scheme 1.



R = H, Ar = 4-FC_6H_4 (**5**, **16**, **24**), 2-FC_6H_4 (**6**), 3,4-$(CH_3O)_2C_6H_3$ (**7**, **17**, **25**), benzo[1,3]dioxol-5-ylmethyl (**8**), C_6H_5 (**9**, **18**, **26**), 4-$CH_3OC_6H_4$ (**10**, **19**, **27**), fur-2-yl (**11**, **20**), 4-*i*-$PrOC_6H_4$ (**12**, **21**); R = CH_3, Ar = thien-2-yl (**13**, **28**), 4-ClC_6H_4 (**14**, **22**), C_6H_5 (**15**, **23**).

acetate in 100 mL of benzene was heated for 4 h with a Dean–Stark trap until the water was completely separated. After cooling, the reaction mixture was washed with water. The solvent was removed, and the residue was distilled. Yield 84%, bp 178°C (2 mmHg). IR spectrum, ν, cm^{-1}: 2244 (CN), 1715 (C=O), 1600, 1580 (C=C_{Ar}). ^1H NMR spectrum (DMSO-d_6–CCl_4), δ, ppm (*J*, Hz): 1.39 t (3H, $\underline{CH_3}CH_2$, *J* = 7.1), 3.90 s (3H,

OCH_3), 4.33 q (2H, OCH_2, J = 7.1), 7.06 m and 8.03 m (4H, C_6H_4), 8.18 s (1H, $\underline{CH}_{Ar}$). Found, %: C 67.84; H 6.00; N 6.58. $C_{13}H_{13}NO_3$. Calculated, %: C 67.52; H 5.67; N 6.06.

Ethyl 2-cyano-3-(4-methoxyphenyl)-3-(4-fluorophenyl)propanoate (2). To an ether solution of the Grignard reagent (obtained from equimolar amounts of aryl halide and magnesium turnings) was added a benzene solution of **1** (0.4 mol per 0.48 mol of Grignard reagent) with gentle boiling and stirring. The reaction mixture was stirred for 3 h at 42–44°C, then cooled, acidified with 20% hydrochloric acid, extracted with diethyl ether, the extract was washed with water and dried. After removal of the solvents, the residue was distilled. Yield 83% (two stereoisomers in a ratio of 1 : 1), bp 205–210°C (2 mmHg). IR spectrum, ν, cm^{-1}: 2251 (CN), 1748 (C=O), 1600, 1580 ($C{=}C_{Ar}$). ^{1}H NMR spectrum (DMSO-d_6–CCl_4), δ, ppm (J, Hz): 1.11 t (3H, $\underline{CH_3}CH_2$, J = 7.1), 3.75 s and 3.78 s (3H, OCH_3), 4.08 q (2H, OCH_2, J = 7.1), 4.61 d (1H, $\underline{CH}_{Ar}$, J = 9.2), 4.83 d and 4.85 d (1H, CHC=O, J = 9.2); 6.77–6.88 m, 7.21 m and 7.31 m (4H, OC_6H_4); 6.96–7.08 m, 7.33 m and 7.43 m (4H, FC_6H_4). Found, %: C 69.84; H 5.12; N 4.43. $C_{19}H_{18}FNO_3$. Calculated, %: C 69.71; H 5.54; N 4.28.

2-(4-Methoxyphenyl)-2-(4-fluorophenyl)ethylcyanide (3). A solution of 37 g (0.66 mol) of KOH in 200 mL of ethylene glycol was added to 110 g (0.33 mol) of compound **2** with stirring. The mixture was refluxed for 3 h, and then cooled. Next, 200 mL of water was added, and the product was extracted with diethyl ether, washed with water, and dried. After removal of the solvent, the residue was distilled. Yield 73%, bp 186–191°C (2 mmHg). IR spectrum, ν, cm^{-1}: 2246 (CN), 1610, 1596 ($C{=}C_{Ar}$). ^{1}H NMR spectrum (DMSO-d_6–CCl_4), δ, ppm (J, Hz): 3.11 d (2H, CH_2, J = 7.8), 3.76 s (3H, OCH_3), 4.34 t (CH, J = 7.8), 6.82 m and 7.17 m (4H, OC_6H_4), 7.01 m and 7.28 m (4H, FC_6H_4). Found, %: C 75.00; H 5.13; N 4.55. $C_{16}H_{14}FNO$. Calculated, %: C 75.28; H 5.53; N 5.49.

3-(4-Methoxyphenyl)-3-(4-fluorophenyl)-1-propanamine (4). To a pre-cooled solution of 18 g (0.48 mol) of $LiAlH_4$ in 200 mL of anhydrous diethyl ether was added dropwise an ethereal solution of 60 g (0.24 mol) of compound **3** maintaining the temperature of the reaction mixture within the range of 0±2°C. The mixture was stirred at the same temperature for 1 h, and then cooled to –10°C. Next, 18 mL of water, 18 mL of 15% NaOH solution, and 54 mL of water were successively added. The reaction mixture was filtered; the inorganic precipitate was washed with diethyl ether. The organic fractions were combined, dried, and evaporated. The residue was distilled. Yield 88%, bp 158–162°C (2 mmHg). IR spectrum, ν, cm^{-1}: 3300, 3290 (NH_2), 1610, 1590 ($C{=}C_{Ar}$). ^{1}H NMR spectrum (DMSO-d_6–CCl_4), δ, ppm (J, Hz): 2.01 m (2H, NH_2), 2.07 m (2H, $CH\underline{CH_2}$), 2.54 t (2H, CH_2N, J = 6.9), 3.74 s (3H, OCH_3), 4.03 t (1H, $Ar\underline{CH}$, J = 7.8), 6.78 m and 7.12 m (4H, OC_6H_4), 6.95 m and 7.21 m (4H, C_6H_4F). Found, %: C 74.65; H 7.23; N 5.85. $C_{16}H_{18}FNO$. Calculated, %: C 74.11; H 7.00; N 5.40.

General procedure for the synthesis of secondary amines 5–15. A mixture of equimolar amounts of aromatic aldehyde (or ketone) and amine **4** in benzene was refluxed for 4 h with a Dean–Stark trap until the water was completely separated. The benzene was removed, and the residue was dissolved in methanol (60 mL of methanol per 0.01 mol of azomethine **A**). An equimolar amount of $NaBH_4$ was added in portions to the solution with stirring and cooling so that the temperature of the reaction mixture did not exceed 20°C. The reaction mixture was stirred for 1 h at room temperature. After removal of methanol, the mixture was alkalinized with 20% NaOH solution, extracted with diethyl ether, and dried. After the solvent was removed the residue was distilled.

General procedure for the synthesis of amine oxalates 16–23. To a solution of amine **5**, **7**, **9**–**12**, **14** or **15** (1.5 mmol) in diethyl ether was added dropwise a solution of oxalic acid (2.0 mmol) in diethyl ether. The precipitate was filtered off and recrystallized from ethanol.

General procedure for the synthesis of amine hydrochlorides 24–28. To a solution of amine **5**, **7**, **9**, **10** or **13** (1.5 mmol) in diethyl ether was added a saturated solution of hydrogen chloride (2.0 mmol) in diethyl ether. The precipitate was filtered off and recrystallized from ethanol.

3-(4-Methoxyphenyl)-3-(4-fluorophenyl)-*N*-(4-fluorobenzyl)-1-propanamine (5). Yield 74%, bp 228–230°C (2 mmHg). IR spectrum, ν, cm^{-1}: 3225 (NH). ^{1}H NMR spectrum (DMSO-d_6–CCl_4), δ, ppm (J, Hz): 1.97 br.s (1H, NH), 2.12 m (2H, $\underline{CH_2}CHAr$), 2.46 t (2H, $N\underline{CH_2}CH_2$, J = 6.8), 3.64 s (2H, $\underline{CH_2}Ar$), 3.74 s (3H, OCH_3), 4.03 t (1H, $\underline{CH}CH_2$, J = 7.8), 6.76 m and 7.09 m (4H, OC_6H_4), 6.90–7.00 m and 7.16–7.29 m (4H, FC_6H_4). Found, %: C 75.45; H 6.58; N 3.97. $C_{23}H_{23}F_2NO$. Calculated, %: C 75.18; H 6.31; N 3.81.

Oxalate 16. mp 210–212°C. **Hydrochloride 24**. mp 148–149°C.

3-(4-Methoxyphenyl)-3-(4-fluorophenyl)-*N*-(2-fluorobenzyl)-1-propanamine (6). Yield 73%, bp 205–207°C (1 mmHg). IR spectrum, ν, cm^{-1}: 3230 (NH). ^1H NMR spectrum (DMSO-d_6–CCl_4), δ, ppm (*J*, Hz): 1.85 br.s (1H, NH), 2.13 m (2H, $\underline{CH_2}CHAr$), 2.48 t (2H, $N\underline{CH_2}CH_2$, *J* = 6.8), 3.72 s (2H, $N\underline{CH_2}Ar$), 3.74 s (3H, OCH_3), 4.04 t (1H, $\underline{CH}Ar$, *J* = 7.7), 6.76 m and 7.10 m (4H, OC_6H_4), 6.93 m and 7.19 m (4H, C_6H_4F); 7.00 m, 7.08 m, 7.19 m and 7.34 t.d (4H, $C_6H_4NH_2$, *J* = 7.6, *J* = 1.6). Found, %: C 75.50; H 6.55; N 4.00. $C_{23}H_{23}F_2NO$. Calculated, %: C 75.18; H 6.31; N 3.81.

***N*-(3,4-Dimethoxybenzyl)-3-(4-methoxyphenyl)-3-(4-fluorophenyl)-1-propanamine (7).** Yield 74%, bp 250–255°C (2 mmHg). IR spectrum, ν, cm^{-1}: 3233 (NH). ^1H NMR spectrum (DMSO-d_6–CCl_4), δ, ppm (*J*, Hz): 2.12 m (2H, $\underline{CH_2}CHAr$), 2.45 t (2H, $N\underline{CH_2}CH_2$, *J* = 6.9), 2.75 m (1H, NH), 3.57 s (2H, $N\underline{CH_2}Ar$); 3.74 s, 3.77 s and 3.78 s (9H, CH_3O), 4.01 t (1H, $\underline{CH}Ar$, *J* = 7.8), 6.68–6.74 m (2H, $H^{5,6}$, C_6H_3), 6.83 d (1H, H^2, C_6H_3), 6.75 m and 7.09 m (4H, OC_6H_4), 6.93 m and 7.18 m (4H, C_6H_4F). Found, %: C 73.54; H 7.05; N 3.75. $C_{25}H_{28}FNO_3$. Calculated, %: C 73.33; H 6.89; N 3.42. **Oxalate 17.** mp 115–117°C. **Hydrochloride 25.** mp 130–132°C.

***N*-(1,3-Benzodioxol-5-ylmethyl)-3-(4-methoxyphenyl)-3-(4-fluorophenyl)-1-propanamine (8).** Yield 68%, bp 225–230°C (1 mmHg). IR spectrum, ν, cm^{-1}: 3228 (NH). ^1H NMR spectrum (DMSO-d_6–CCl_4), δ, ppm (*J*, Hz): 2.05–2.16 m (2H, $\underline{CH_2}CHAr$), 2.44 t (2H, $N\underline{CH_2}CH_2$, *J* = 6.8), 2.24 br.s (1H, NH), 3.57 s (2H, $N\underline{CH_2}Ar$), 3.74 s (3H, OCH_3), 4.02 t (1H, $\underline{CH}Ar$, *J* = 7.7), 5.92 s (2H, OCH_2), 6.67 br.s (2H, H^5, C_6H_3), 6.79 br.s (1H, H^6, C_6H_3), 6.73–6.78 m (2H, $H^{3,5}$, $CH_3OC_6H_4$), 7.06–7.12 m (2H, $H^{2,6}$, $CH_3OC_6H_4$), 6.89–6.97 m (2H, $H^{3,5}$, C_6H_4F), 7.15–7.22 m (2H, $H^{2,6}$, C_6H_4F). Found, %: C 73.44; H 6.52; N 3.85. $C_{24}H_{24}FNO_3$. Calculated, %: C 73.26; H 6.15; N 3.56.

***N*-Benzyl-3-(4-methoxyphenyl)-3-(4-fluorophenyl)-1-propanamine (9).** Yield 75%, bp 225–227°C (2 mmHg). IR spectrum, ν, cm^{-1}: 3225 (NH). ^1H NMR spectrum (DMSO-d_6–CCl_4), δ, ppm (*J*, Hz): 2.13 m (2H, $\underline{CH_2}CHAr$), 2.14 br.s (1H, NH), 2.48 t (2H, $N\underline{CH_2}CH_2$, *J* = 6.8), 3.67 s (2H, $\underline{CH_2}Ar$), 3.74 s (3H, OCH_3), 4.04 t (1H, $\underline{CH}Ar$, *J* = 7.8), 6.76 m (2H, $H^{3,5}$, OC_6H_4), 7.10 m (2H, $H^{2,6}$, OC_6H_4), 6.93 m and 7.18 m (4H, FC_6H_4), 7.14–7.27 m (5H, C_6H_5). Found, %: C 79.54; H 7.15; N 3.78. $C_{23}H_{24}FNO$. Calculated, %: C 79.05; H 6.92; N 4.01. **Oxalate 18.** mp 194–195°C. **Hydrochloride 26.** mp 118–120°C.

***N*-(4-Methoxybenzyl)-3-(4-methoxyphenyl)-3-(4-fluorophenyl)-1-propanamine (10).** Yield 70%, bp 240–245°C (2 mmHg). IR spectrum, ν, cm^{-1}: 3220 (NH). ^1H NMR spectrum (DMSO-d_6–CCl_4), δ, ppm (*J*, Hz): 1.81 br.s (1H, NH), 2.12 m (2H, $\underline{CH_2}CHAr$), 2.46 t (2H, $N\underline{CH_2}CH_2$, *J* = 6.8), 3.59 s (2H, $\underline{CH_2}Ar$), 3.74 s (3H, OCH_3), 3.76 s (3H, OCH_3), 4.02 t (1H, $\underline{CH}Ar$, *J* = 7.8), 6.73–6.79 m and 7.07–7.17 m (4H, OC_6H_4), 6.93 m and 7.18 m (4H, FC_6H_4). Found, %: C 75.55; H 7.25; N 3.88. $C_{24}H_{26}FNO_2$. Calculated, %: C 75.96; H 6.91; N 3.69. **Oxalate 19.** mp 215–217°C. **Hydrochloride 27.** mp 178–180°C.

3-(4-Methoxyphenyl)-3-(4-fluorophenyl)-*N*-(2-furylmethyl)-1-propanamine (11). Yield 72%, bp 205–208°C (1 mmHg). IR spectrum, ν, cm^{-1}: 3320 (NH). ^1H NMR spectrum (DMSO-d_6–CCl_4), δ, ppm (*J*, Hz): 2.10 m (2H, $\underline{CH_2}CHAr$), 2.15 br.s (1H, NH), 2.46 t (2H, $N\underline{CH_2}CH_2$, *J* = 6.8), 3.64 s (2H, CH_2-furyl), 3.74 s (3H, OCH_3), 4.02 t (1H, $\underline{CH}Ar$, *J* = 7.8), 6.08 d (1H-furyl, *J* = 3.1), 6.26 d.d (1H-furyl, *J* = 3.1, 1.9), 7.33 d (1H-furyl, *J* = 1.9), 6.76 m (2H, $H^{3,5}$, OC_6H_4), 7.10 m (2H, $H^{2,6}$, OC_6H_4), 6.94 m and 7.19 m (4H, C_6H_4F). Found, %: C 74.85; H 6.93; N 4.62. $C_{21}H_{22}FNO_2$. Calculated, %: C 74.31; H 6.53; N 4.13. **Oxalate 20.** mp 202–204°C.

***N*-(4-Isopropoxybenzyl)-3-(4-methoxyphenyl)-3-(4-fluorophenyl)-1-propanamine (12).** Yield 73%, bp 225–230°C (2 mmHg). IR spectrum, ν, cm^{-1}: 3325 (NH). ^1H NMR spectrum (DMSO-d_6–CCl_4), δ, ppm (*J*, Hz): 1.31 d (6H, $\underline{CH_3}CH\underline{CH_3}$, *J* = 6.1), 1.95 br.s (1H, NH), 2.11 m (2H, $\underline{CH_2}CHAr$), 2.46 t (2H, $N\underline{CH_2}CH_2$, *J* = 6.8), 3.58 s (2H, $\underline{CH_2}Ar$), 3.74 s (3H, OCH_3), 4.03 t (1H, $\underline{CH}Ar$, *J* = 7.8), 4.51 septet (1H, OCH, *J* = 6.1); 6.71–6.78 m ($4H_{Ar}$), 6.93 m ($2H_{Ar}$), 7.07–7.14 m ($4H_{Ar}$), 7.18 m (2H, H_{Ar}). Found, %: C 76.85; H 7.72; N 3.82. $C_{26}H_{30}FNO_2$. Calculated, %: C 76.63; H 7.42; N 3.44. **Oxalate 21.** mp 196–198°C.

3-(4-Methoxyphenyl)-*N*-[1-(2-thienyl)ethyl]-3-(4-fluorophenyl)-1-propanamine (13). Yield 65% (two stereoisomers in a ratio of 1 : 1), bp 213°C (1 mmHg). IR spectrum, ν, cm^{-1}: 3328 (NH). ^1H NMR spectrum (DMSO-d_6–CCl_4), δ, ppm (*J*, Hz): 1.36 d (3H, $\underline{CH_3}CH$, *J* = 6.6), 1.56 br.s (1H, NH), 2.00–2.17 m (2H, $\underline{CH_2}CH$), 2.30–2.58 m (2H, NCH_2), 3.73 s and 3.74 s (3H, OCH_3), 3.93 q (1H, NCH, *J* = 6.6), 4.00 q and 4.00 q (1H, $\underline{CH}CH_2$, *J* = 7.8), 6.71–6.80 m ($1H_{Ar}$), 6.88–6.97 m ($2H_{Ar}$), 7.04–7.22 m (H_{Ar}). Found, %: C

71.84; H 6.83; N 4.02. $C_{22}H_{24}FNOS$. Calculated, %: C 71.51; H 6.55; N 3.79. **Hydrochloride 28.** mp 132–134°C.

3-(4-Methoxyphenyl)-3-(4-fluorophenyl)-*N*-[(4-chlorophenyl)ethyl)]-1-propanamine (14). Yield 72%, bp 225–230°C (1 mmHg). IR spectrum, ν, cm^{-1}: 3323 (NH). ^{1}H NMR spectrum (DMSO-d_6–CCl_4), δ, ppm (*J*, Hz): 1.23 d (3H, CH$\underline{CH_3}$), 1.48 br.s (1H, NH), 1.96–2.15 m (2H, $\underline{CH_2}$CH), 2.19–2.38 m (2H, NCH_2), 3.61 q (1H, NCH, *J* = 6.6), 3.73 s (3H, OCH_3), 3.97 t (1H, $\underline{CH}CH_2$, *J* = 7.8), 6.70–6.76 m and 7.10–7.18 m (4H, OC_6H_4), 6.86–6.96 m and 7.01–7.09 m (4H, C_6H_4F), 7.19 s and 7.20 s (4H, C_6H_4Cl). Found, %: C 72.65; H 6.63; N 3.84. $C_{24}H_{25}ClFNO$. Calculated, %: C 72.44; H 6.33; N 3.52. **Oxalate 22.** mp 166–168°C.

3-(4-Methoxyphenyl)-3-(4-fluorophenyl)-*N*-(1-phenylethyl)-1-propanamine (15). Yield 68% (two stereoisomers in a ratio of 1 : 1), bp 205°C (1 mmHg). IR spectrum, ν, cm^{-1}: 3222 (NH). ^{1}H NMR spectrum (DMSO-d_6–CCl_4), δ, ppm (*J*, Hz): 1.26 d (3H, CH$\underline{CH_3}$, *J* = 6.6), 1.58 br.s (1H, NH), 1.98–2.16 m (2H, $CH_2\underline{CH}$), 2.24–2.40 m (2H, NCH_2), 3.62 q (1H, NCH, *J* = 6.6), 3.73 s and 3.73 s (3H, OCH_3), 3.99 t and 3.99 t (1H, CH$\underline{CH_2}$, *J* = 7.7), 6.70–6.77 m and 7.10–7.19 m (4H, OC_6H_4), 6.86–6.96 m and 7.02–7.10 m (4H, C_6H_4F), 7.21 s and 7.22 s (4H, C_6H_4Cl). Found, %: C 79.82; H 7.00; N 4.12. $C_{24}H_{26}FNO$. Calculated, %: C 79.31; H 7.21; N 3.85. **Oxalate 23.** mp 115–116°C.

IR spectra were recorded on a Nicolet Avatar 330 FT-IR spectrophotometer. ^{1}H NMR spectra were registered on a Varian Mercury-VX-300 (300 MHz) spectrometer in DMSO-d_6–CCl_4 (1 : 3), internal reference TMS. Melting points were measured on a Boetius apparatus.

Antibacterial activity of compounds **16**–**28** was studied according to the procedure [4] with a bacterial load of 20 million microbial units per 1 mL of medium. Gram-positive strains of *Staphylococcus aureus* 209 p, 1 and gram-negative strains of *Sh. Dysenteriae flexneri* 6858 and *E. coli* 0-55 were used in the experiments. Solutions of tested compounds and control compound were prepared in DMSO at a dilution of 1 : 20. Into Petri dishes with agar medium with the above-mentioned strains of microorganisms were added the solutions (0.1 mL). Bacterial growth was monitored. The statistical treatment was carried out using the Student–Fisher method. The experiments were repeated at least 3 times. Furazolidone (Borisov Plant of Medical Preparations, Belarus) [5] was used as a positive control.

REFERENCES

1. Arutyunyan, N.S., Akopyan, L.A., Nazaryan, R.L., Gevorgyan, G.A., *Nekotorye uspekhi organicheskoi i farmatsevticheskoi khimii*, Yerevan, 2012.
2. Arutyunyan, N.S., Akopyan, L.A., Nazaryan, R.L., Gevorgyan, G.A., Stepanyan, G.M., Paronikyan, R.V., and Panosyan, G.A., *Pharm. Chem. J.*, 2013, vol. 47, p. 490. doi 10.1007/s11094-013-0987-1
3. Arutyunyan, N.S., Akopyan, L.A., Akopyan, N.Z., Gevorgyan, G.A., Stepanyan, G.M., Paronikyan, R.V., Malakyan, M.H., Agdzhoyan, R.L., Badzhinyan, S.A., and Shakhatuni, A.A., *Pharm. Chem. J.*, 2012, vol. 46, p. 351. doi 10.1007/s11094-012-0796-y
4. Pershin, G.N., *Metody eksperimental'noi khimioterapii* (Methods of Experimental Chemotherapy), Moscow: Meditsyna, 1971.
5. Mashkovskii, M.D., *Lekarstvennye sredstva* (Drugs), Moscow: Meditsyna, 2010.