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The synthesis and characterization of some novel 5-chloro-2-(substituted alkoxy)-*N*-phenylbenzamide derivatives

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Abstract: To obtain biologically active compounds, the synthesis of some new derivatives with an *o*-hydroxybenzamide structure was performed. The ethyl esters **4–6** were obtained by the reaction of 5-chloro-2-hydroxy-*N*-phenylbenzamide and chloro-substituted acid ethyl esters **1–3** in ethyl methyl ketone. The obtained ethyl esters were condensed with hydrazine yielding the hydrazides **7–8**. The hydrazones **11–14** were obtained by the reaction of the hydrazides and the chloro-substituted benzaldehydes **9–10**. All the newly synthesized compounds were characterized by FTIR, ¹H-NMR, ¹³C-NMR, MS and elemental analyses.

Keywords: 5-chloro-2-(substituted alkoxy)-*N*-phenylbenzamide derivatives; ethyl esters; hydrazides; hydrazones; *O*-substituted salicylanilides.

INTRODUCTION

Searching for novel biologically active compounds with improved and highly selective effects and lower toxicity remains a challenge for pharmaceutical chemistry, while the incidence of the systemic diseases as well as the spectrum of pathogens have been steadily increasing over the past few years.

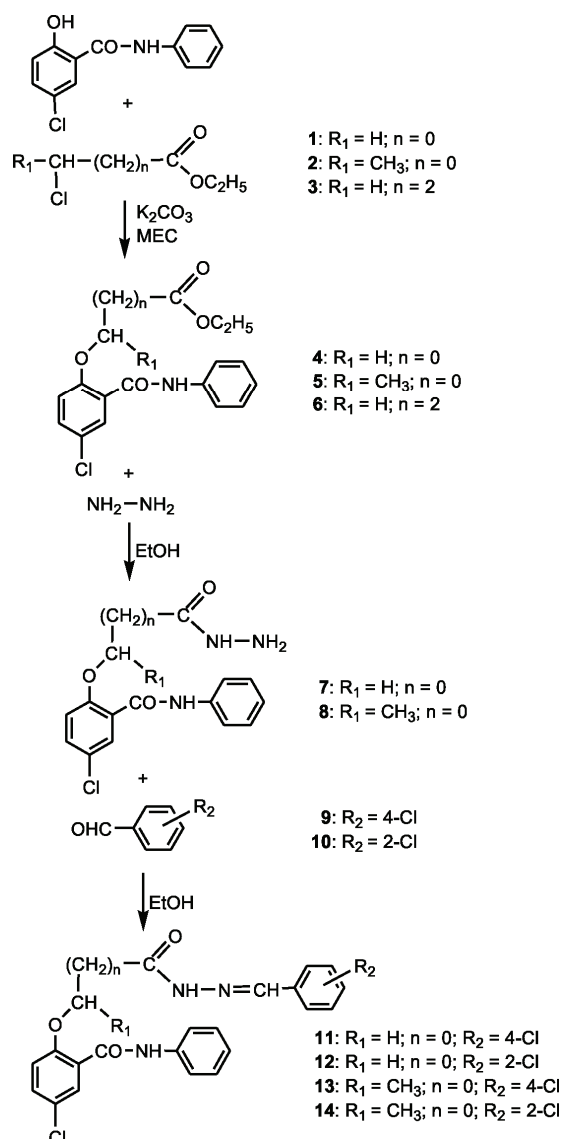
Salicylanilides, as well as *O*-substituted salicylanilides, represent a class of compounds with a broad spectrum of biological activity,^{1,2} including antimicrobial effects against a number of yeast and filamentous fungi. Substitution of phenoxyacetic acid with an electrophilic group in the *ortho* or *para* position increases their activity against human pathogenic fungi.^{3–9}

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2-(Hydrazinocarbonylmethoxy)benzamide and its hydrazones obtained with substituted benzaldehydes show anti-inflammatory and analgesic activity superior to salicylamide itself and lower ulcerogenic activity.^{10,11}

In order to obtain such active compounds, some *ortho*-substituted phenoxyalkanoic acids and their derivatives were synthesized and characterized.^{12,13}

The aim of this research was to synthesize new 5-chloro-2-(substituted alkoxy)-*N*-phenylbenzamide derivatives (Scheme 1) with potential antibacterial and antifungal activity and to characterize them.



Scheme 1. Synthesis of 5-chloro-2-(substituted alkoxy)-*N*-phenylbenzamide derivatives.

RESULTS AND DISCUSSION

The synthesized compounds are crystalline substances (needles or prisms) and were obtained with reaction yields ranging from 66 to 92 %. Their physical, chemical and spectral properties are given below.

2-[4-Chloro-[(2-phenylamino)carbonyl]phenoxy]acetic acid, ethyl ester (4). Yield: 78 %; m.p. 150 °C; Anal. Calcd. for C₁₇H₁₆ClNO₄ (333.08 g/mol): C, 61.18, H, 4.83, N, 4.20 %. Found: C, 61.20, H, 4.80, N, 4.24 %; IR (KBr, cm⁻¹): 3328 *m*, 1751 *i*, 1652 *i*, 1596 *m*, 1541 *i*, 1502 *m*, 1483 *m*, 1442 *m*, 1388 *s*, 1321 *m*, 1282 *s*, 1222 *i*, 1112 *m*, 1074 *m*, 1062 *m*, 1024 *s*, 906 *s*, 823 *m*, 758 *m*, 706 *s*, 690 *s*, 547 *s*, 511 *s*; ¹H-NMR (400 MHz, DMSO-*d*₆, δ / ppm): 1.21 (3H, *t*, COOCH₂CH₃, *J* = 7.2 Hz), 4.22 (2H, *q*, COOCH₂CH₃, *J* = 7.2 Hz), 4.99 (2H, *s*, -O-CH₂-CO-), 7.13 (1H, *t*, H₁₀, *J* = 7.6 Hz), 7.22 (1H, *d*, H₃, *J* = 8.8 Hz), 7.37 (2H, *t*, H₉, H₁₁, *J* = 8.0 Hz), 7.57 (1H, *d*, H₄, *J* = 8.8 Hz), 7.78 (2H, *d*, H₈, H₁₂, *J* = 8.0 Hz), 7.83 (1H, *s*, H₆), 10.39 (1H, *s*, -CO-NH-); ¹³C-NMR (400 MHz, CDCl₃, δ / ppm): 14.14 (COOCH₂CH₃), 61.48 (COOCH₂CH₃), 66.25 (-O-CH₂-CO-), 115.91 (C₃), 120.16 (C₈, C₁₂), 124.28 (C₁), 125.12 (C₁₀), 125.81 (C₅), 129.03 (C₉, C₁₁), 130.13 (C₆), 132.43 (C₄), 138.58 (C₇), 154.05 (C₂), 162.07 (-CO-NH-), 168.80 (COOC₂H₅); (+)MS¹ (*m/z*): 356.1 ([M+Na]⁺), 334.0 ([M+H]⁺); (+)MS^{*n*} (*m/z*): 334.0, 258.9, 240.8, 212.8, 184.8, 154.9.

2-[4-Chloro-[(2-phenylamino)carbonyl]phenoxy]propionic acid, ethyl ester (5). Yield: 72 %; m.p. 69–73 °C; Anal. Calcd. for C₁₈H₁₈ClNO₄ (347.09 g/mol): C, 62.16, H, 5.22, N, 4.03 %. Found C, 62.11, H, 5.25, N, 4.05 %; IR (KBr, cm⁻¹): 3338 *m*, 2989 *s*, 1745 *i*, 1660 *i*, 1596 *m*, 1541 *i*, 1494 *m*, 1479 *m*, 1440 *m*, 1379 *s*, 1367 *m*, 1303 *s*, 1271 *m*, 1232 *i*, 1149 *m*, 1118 *m*, 1053 *s*, 1020 *s*, 910 *s*, 866 *s*, 802 *s*, 758 *m*, 719 *s*, 702 *s*, 677 *s*, 648 *s*, 515 *s*, 418 *s*; ¹H-NMR (400 MHz, DMSO-*d*₆, δ / ppm): 1.18 (3H, *t*, COOCH₂CH₃, *J* = 6.8 Hz), 1.58 (3H, *d*, -O-CH(CH₃)CO-, *J* = 6.8 Hz), 4.17 (2H, *q*, COOCH₂CH₃, *J* = 6.8 Hz), 5.23 (1H, *q*, -O-CH(CH₃)CO-, *J* = 6.8 Hz), 7.12 (1H, *t*, H₁₀, *J* = 7.6 Hz), 7.18 (1H, *d*, H₃, *J* = 8.8 Hz), 7.37 (2H, *t*, H₉, H₁₁, *J* = 8.0 Hz), 7.54 (1H, *d*, H₄, *J* = 8.8 Hz), 7.72 (2H, *d*, H₈, H₁₂, *J* = 8.0 Hz), 7.75 (1H, *s*, H₆), 10.29 (1H, *s*, -CO-NH-); ¹³C-NMR (400 MHz, CDCl₃, δ / ppm): 14.05 (COOCH₂CH₃), 18.11 (-O-CH(CH₃)CO-), 61.70 (COOCH₂CH₃), 73.60 (-O-CH(CH₃)CO-), 116.42 (C₃), 119.80 (C₈, C₁₂), 124.19 (C₁), 125.85 (C₁₀), 126.39 (C₅), 129.10 (C₉, C₁₁), 130.04 (C₆), 132.15 (C₄), 138.60 (C₇), 153.49 (C₂), 162.39 (-CO-NH-), 171.65 (COOC₂H₅); (+)MS¹ (*m/z*): 386.0 ([M+K]⁺), 370.1 ([M+Na]⁺), 348.1 ([M+H]⁺); (+)MS^{*n*} (*m/z*): 370.0, 342.0, 276.9, 268.9, 250.9.

4-[4-Chloro-[(2-phenylamino)carbonyl]phenoxy]butyric acid, ethyl ester (6). Yield: 66%; m.p. 168–172 °C; Anal. Calcd. for C₁₉H₂₀ClNO₄ (361.11 g/mol): C, 62.16, H, 5.22, N, 4.03 %. Found: C, 62.15, H, 5.20, N, 4.04 %; IR (KBr, cm⁻¹): 3323 *s*, 3020 *m*, *l*, 1720 *m*, 1630 *i*, 1596 *m*, 1558 *i*, 1498 *m*, 1488 *m*, 1417 *m*, 1365 *m*, 1278 *m*, 1224 *m*, 1190 *s*, 1074 *s*, 894 *s*, 821 *m*, 773 *s*, 754 *s*, 698 *m*, 686

m, 651 *m*, 543 *s*, 509 *s*, 418 *s*; $^1\text{H-NMR}$ (400 MHz, DMSO- d_6 , δ / ppm): 1.06 (3H, *t*, $\text{COOCH}_2\text{CH}_3$, $J = 7.2$ Hz), 1.13 (2H, *t*, $-\text{CH}_2-\text{CH}_2-\text{COO}-\text{CH}_2-$, $J = 7.2$ Hz), 2.00 (2H, *cv*, $-\text{CH}_2-\text{CH}_2-\text{CH}_2-\text{COO}-\text{CH}_2-$), 4.01 (2H, *q*, $\text{COOCH}_2\text{CH}_3$, $J = 7.2$ Hz), 4.12 (2H, *t*, $-\text{O}-\text{CH}_2-\text{CH}_2-\text{CH}_2-$, $J = 6.4$ Hz), 6.95 (1H, *d*, H_3 , $J = 8.8$ Hz), 7.11 (1H, *t*, H_{10} , $J = 7.2$ Hz), 7.34–7.38 (3H, *m*, H_4 , H_9 , H_{11}), 7.70 (2H, *d*, H_8 , H_{12} , $J = 8.4$ Hz), 7.92 (1H, *s*, H_6), 10.16 (1H, *s*, $-\text{CO}-\text{NH}-$); $^{13}\text{C-NMR}$ (400 MHz, CDCl_3 , δ / ppm): 13.98 ($\text{COOCH}_2\text{CH}_3$), 23.95 ($-\text{O}-\text{CH}_2-\text{CH}_2-\text{CH}_2-\text{CO}-$), 29.83 ($-\text{O}-\text{CH}_2-\text{CH}_2-\text{CH}_2-\text{CO}-$), 59.78 ($\text{COOCH}_2\text{CH}_3$), 67.76 ($-\text{O}-\text{CH}_2-\text{CH}_2-\text{CH}_2-\text{CO}-$), 119.68 (C_3), 119.83 (C_1), 120.31 (C_8 , C_{12}), 120.65 (C_{10}), 123.74 (C_5), 128.54 (C_6), 128.77 (C_9 , C_{11}), 132.67 (C_4), 138.50 (C_7), 159.45 (C_2), 164.65 ($-\text{CO}-\text{NH}-$), 172.40 (COOC_2H_5); (+)MS 1 (m/z): 400.1 ($[\text{M}+\text{K}]^+$), 384.1 ($[\text{M}+\text{Na}]^+$), 362.1 ($[\text{M} + \text{H}]^+$); (+)MS n (m/z): 400.0, 362.1, 316.0, 286.9, 115.1.

5-Chloro-2-(hydrazinocarbonylmethoxy)-N-phenylbenzamide (7). Yield: 92 %; m.p. 194–196 °C; Anal. Calcd. for $\text{C}_{15}\text{H}_{14}\text{ClN}_3\text{O}_3$ (319.07 g/mol): C, 56.35, H, 4.41, N, 13.14 %. Found: C, 56.33, H, 4.38, N, 13.16 %; IR (KBr, cm^{-1}): 3303 *m*, *l*, 3051 *s*, *l*, 1705 *m*, 1654 *i*, 1639 *i*, 1595 *i*, 1541 *i*, 1488 *m*, 1444 *m*, 1272 *m*, 1234 *m*, 1076 *s*, 985 *m*, 914 *s*, 815 *s*, 752 *m*, 717 *m*, 688 *m*, 542 *m*; $^1\text{H-NMR}$ (400 MHz, DMSO- d_6 , δ / ppm): 4.79 (2H, *s*, $-\text{O}-\text{CH}_2-\text{CO}$), 5.20 (2H, *s*, $-\text{NH}-\text{NH}_2$), 7.11 (1H, *t*, H_{10} , $J = 6.8$ Hz), 7.18 (1H, *d*, H_3 , $J = 8.8$ Hz), 7.37 (2H, *t*, H_9 , H_{11} , $J = 6.8$ Hz), 7.57 (1H, *d*, H_4 , $J = 8.8$ Hz), 7.75 (1H, *d*, H_8 , $J = 6.8$ Hz), 7.80 (1H, *d*, H_{12} , $J = 6.8$ Hz), 7.86 (1H, *s*, H_6), 8.96, 9.49 (2 conformers: *Z*, *E*) (1H, *s*, $-\text{CO}-\text{NH}-\text{NH}_2$), 10.72, 11.20 (2 conformers: *Z*, *E*) (1H, *s*, $-\text{CO}-\text{NH}-\text{Ar}$); $^{13}\text{C-NMR}$ (400 MHz, CDCl_3 , δ / ppm): 67.23 ($-\text{O}-\text{CH}_2-\text{CO}$), 116.14 (C_3), 120.06 (C_8 , C_{12}), 124.20 (C_1), 125.89 (C_{10}), 126.31 (C_5), 129.03 (C_9 , C_{11}), 130.01 (C_6), 132.29 (C_4), 138.75 (C_7), 154.23 (C_2), 162.66 ($-\text{CO}-\text{NH}-\text{Ar}$), 167.21 ($-\text{CO}-\text{NH}-\text{NH}_2$); (+)MS 1 (m/z): 358.0 ($[\text{M}+\text{K}]^+$), 342.1 ($[\text{M}+\text{Na}]^+$), 320.0 ($[\text{M}+\text{H}]^+$); (+)MS n (m/z): 320.0, 247.9, 226.8, 198.8, 154.8.

5-Chloro-2-[1-(hydrazinocarbonyl)ethoxy]-N-phenylbenzamide (8). Yield: 90 %; m.p. 208–210 °C; Anal. Calcd. for $\text{C}_{16}\text{H}_{16}\text{ClN}_3\text{O}_3$ (333.09 g/mol) C, 57.58, H, 4.83, N, 12.59 %. Found: C, 57.60, H, 4.81, N, 12.54 %; IR (KBr, cm^{-1}): 3355 *m*, 3300 *m*, 1660 *i*, 1598 *m*, 1548 *m*, 1494 *m*, 1473 *m*, 1446 *m*, 1398 *s*, 1323 *m*, 1267 *m*, 1228 *i*, 1110 *s*, 1076 *s*, 1041 *s*, 970 *s*, 893 *s*, 808 *s*, 750 *s*, 677 *s*, 650 *s*; $^1\text{H-NMR}$ (400 MHz, DMSO- d_6 , δ / ppm): 1.50 (3H, *d*, $-\text{O}-\text{CH}(\text{CH}_3)\text{CO}-$, $J = 6.8$ Hz), 4.43 (2H, *s*, $-\text{NH}-\text{NH}_2$), 5.10 (1H, *q*, $-\text{O}-\text{CH}(\text{CH}_3)\text{CO}-$, $J = 6.8$ Hz), 7.12 (1H, *t*, H_{10} , $J = 7.2$ Hz), 7.18 (1H, *d*, H_3 , $J = 8.8$ Hz), 7.37 (2H, *t*, H_9 , H_{11} , $J = 8.4$ Hz), 7.57 (1H, *d*, H_4 , $J = 8.8$ Hz), 7.68 (1H, *s*, H_6), 7.78 (2H, *d*, H_8 , H_{12} , $J = 8.4$ Hz), 9.67 (1H, *s*, $-\text{CO}-\text{NH}-\text{NH}_2$), 10.84 (1H, *s*, $-\text{CONH}-\text{Ar}$); $^{13}\text{C-NMR}$ (400 MHz, CDCl_3 , δ / ppm): 19.01 ($-\text{O}-\text{CH}(\text{CH}_3)\text{CO}-$), 73.88 ($-\text{O}-\text{CH}(\text{CH}_3)\text{CO}-$), 116.88 (C_3), 119.33 (C_8 , C_{12}), 123.72 (C_1), 125.85 (C_{10}), 127.35 (C_5), 128.86 (C_9 , C_{11}), 129.81 (C_6), 131.80 (C_4), 138.85 (C_7), 153.15

(C₂), 162.57 (–CO–NH–Ar), 170.29 (–CO–NH–NH₂); (+)MS¹ (*m/z*): 356.1 ([M+Na]⁺), 334.1 ([M+H]⁺); (+)MSⁿ (*m/z*): 334.0, 247.9.

5-Chloro-2-[(4-chlorobenzylidene)hydrazinocarbonylmethoxy]-N-phenylbenzamide (11). Yield: 83 %; m.p. 205–208 °C; Anal. Calcd. for C₂₂H₁₇Cl₂N₃O₃ (441.06 g/mol): C, 59.74, H, 3.87, N, 9.50 %. Found: C, 59.80, H, 3.85, N, 9.46 %; IR (KBr, cm⁻¹): 3303 *m*, 3240 *m*, *l*, 1701 *i*, 1651 *i*, 1596 *i*, 1541 *i*, 1481 *i*, 1444 *i*, 1263 *m*, 1230 *m*, 1087 *m*, 806 *s*, 758 *m*, 731 *s*, 692 *s*, 542 *m*, 511 *s*, 459 *s*; ¹H-NMR (400 MHz, DMSO-*d*₆, δ / ppm): 4.97 (2H, *s*, –O–CH₂–CO–), 7.12 (1H, *t*, H₁₀, *J* = 7.6 Hz), 7.24 (1H, *d*, H₃, *J* = 8.0 Hz), 7.38 (2H, *t*, H₉, H₁₁, *J* = 8.4 Hz), 7.52 (1H, *d*, H₄, *J* = 8.0 Hz), 7.62 (2H, *d*, H₁₅, H₁₇, *J* = 8.8 Hz), 7.81 (2H, *d*, H₈, H₁₂, *J* = 8.4 Hz), 7.93 (2H, *d*, H₁₄, H₁₈, *J* = 8.8 Hz), 8.04 (1H, *s*, H₆), 8.19 (1H, *s*, –N=CH–), 10.64 (1H, *s*, –CO–NH–Ar), 10.96, 11.96 (2 conformers: *Z*, *E*) (1H, *s*, –CO–NH–N=CH–); ¹³C-NMR (400 MHz, CDCl₃, δ / ppm): 66.86 (–O–CH₂–CO–), 116.28 (C₃), 120.06 (C₈, C₁₂), 123.82 (C₁), 124.33 (C₁₀), 125.54 (C₅), 128.68 (C₉, C₁₁), 128.79 (C₁₅, C₁₇), 128.83 (C₁₄, C₁₈), 130.34 (C₆), 132.50 (C₁₃), 132.75 (C₄), 134.64 (C₁₆), 138.82 (C₇), 143.66 (–N=CH–), 154.52 (C₂), 161.62 (–CO–NH–Ar), 169.45 (–CO–NH–N=CH–); (+)MS¹ (*m/z*): 464.1 ([M+Na]⁺), 442.1 ([M+H]⁺); (+)MSⁿ (*m/z*): 442.0, 348.9, 320.9, 287.9, 259.9, 211.8, 166.9, 137.95.

5-Chloro-2-[(2-chlorobenzylidene)hydrazinocarbonylmethoxy]-N-phenylbenzamide (12). Yield: 90 %; m.p. 222–223 °C; Anal. Calcd. for C₂₂H₁₇Cl₂N₃O₃ (441.06 g/mol): C, 59.74, H, 3.87, N, 9.50 %. Found: C, 59.76, H, 3.85, N, 9.47 %; IR (KBr, cm⁻¹): 3336 *m*, 3224 *m*, *l*, 1720 *i*, 1703 *m*, 1645 *i*, 1593 *m*, 1552 *i*, 1473 *m*, 1446 *m*, 1257 *i*, 1238 *i*, 1062 *m*, 800 *m*, 752 *i*, 727 *m*, 715 *m*, 688 *s*, 542 *m*, 507 *s*, 418 *s*; ¹H-NMR (400 MHz, DMSO-*d*₆, δ / ppm): 4.97 (2H, *s*, –O–CH₂–CO–), 7.12 (1H, *t*, H₁₀, *J* = 7.2 Hz), 7.35–7.48 (4H, *m*, H₃, H₉, H₁₁, H₁₇), 7.54 (1H, *d*, H₄, *J* = 8.8 Hz), 7.62 (1H, *d*, H₁₅, *J* = 8.6 Hz), 7.81–7.93 (3H, *m*, H₁₆, H₈, H₁₂), 8.13 (1H, *d*, H₁₈, *J* = 8.8 Hz), 8.43 (1H, *s*, H₆), 8.67 (1H, *s*, –N=CH–), 10.34, 10.64 (2 conformers: *Z*, *E*) (1H, *s*, –CO–NH–Ar), 10.92, 12.08 (2 conformers: *Z*, *E*) (1H, *s*, –CO–NH–N=CH–); ¹³C-NMR (400 MHz, CDCl₃, δ / ppm): 66.87 (–O–CH₂–CO–), 116.30 (C₃), 120.01 (C₈, C₁₂), 123.81 (C₁), 124.40 (C₁₀), 125.49 (C₅), 127.22 (C₁₇), 127.52 (C₆), 128.68 (C₉, C₁₁), 129.84 (C₁₅), 130.26 (C₁₈), 130.96 (C₁₃), 131.58 (C₁₆), 132.45 (C₄), 134.05 (C₁₄), 138.77 (C₇), 140.83 (–N=CH–), 154.48 (C₂), 161.62 (–CO–NH–Ar), 169.56 (–CO–NH–N=CH–); (+)MS¹ (*m/z*): 464.1 ([M+Na]⁺), 442.1 ([M+H]⁺); (+)MSⁿ (*m/z*): 442.0, 348.9, 321.0, 287.9, 259.9, 211.8, 166.9, 154.9, 137.9.

5-Chloro-2-[1-[(4-chlorobenzylidene)hydrazinocarbonyl]ethoxy]-N-phenylbenzamide (13). Yield: 81 %; m.p. 197–198 °C; Anal. Calcd. for C₂₃H₁₉Cl₂N₃O₃ (455.08 g/mol): C, 60.54, H, 4.20, N, 9.21 %. Found: C, 60.54, H, 4.26, N, 9.18 %; IR (KBr, cm⁻¹): 3178 *m*, *l*, 1652 *i*, 1622 *i*, 1595 *i*, 1560 *i*, 1498 *m*, 1456 *i*, 1315 *i*, 1269 *m*, 1238 *i*, 1103 *i*, 1062 *s*, 1035 *m*, 950 *s*, 898 *s*, 765 *m*, 756 *m*, 677

m, 648 *s*, 524 *s*; $^1\text{H-NMR}$ (400 MHz, $\text{DMSO-}d_6$, δ / ppm): 1.65 (3H, *d*, $-\text{O}-\text{CH}(\text{CH}_3)\text{CO}-$, $J = 6.8$ Hz), 6.09 (1H, *q*, $-\text{O}-\text{CH}(\text{CH}_3)\text{CO}-$, $J = 6.8$ Hz), 7.12 (1H, *t*, H_{10} , $J = 7.2$ Hz), 7.25 (1H, *d*, H_3 , $J = 8.8$ Hz), 7.33–7.40 (2H, *m*, H_9 , H_{11}), 7.57 (1H, *d*, H_4 , $J = 8.8$ Hz), 7.60 (2H, *d*, H_{15} , H_{17} , $J = 8.8$ Hz), 7.73 (2H, *d*, H_8 , H_{12} , $J = 8.4$ Hz), 7.78–7.81 (2H, *m*, H_{14} , H_{18}), 8.08 (1H, *s*, H_6), 8.28 (1H, *s*, $-\text{N}=\text{CH}-$), 10.65, 10.89 (2 conformers: *Z*, *E*) (1H, *s*, $-\text{CO}-\text{NH}-\text{Ar}$), 11.97 (1H, *s*, $-\text{CO}-\text{NH}-\text{N}=\text{CH}-$); $^{13}\text{C-NMR}$ (400 MHz, CDCl_3 , δ / ppm): 19.01 ($-\text{O}-\text{CH}(\text{CH}_3)\text{CO}-$), 73.51 ($-\text{O}-\text{CH}(\text{CH}_3)\text{CO}-$), 117.02 (C_3), 119.32 (C_8 , C_{12}), 123.34 (C_1), 124.29 (C_{10}), 126.57 (C_5), 128.51 (C_9 , C_{11}), 128.62 (C_{15} , C_{17}), 128.66 (C_{14} , C_{18}), 130.14 (C_6), 132.30 (C_{13}), 132.56 (C_4), 134.25 (C_{16}), 138.92 (C_7), 142.58 ($-\text{N}=\text{CH}-$), 153.45 (C_2), 161.33 ($-\text{CO}-\text{NH}-\text{Ar}$), 169.46 ($-\text{CO}-\text{NH}-\text{N}=\text{CH}-$); (+)MS¹ (*m/z*): 478.1 ([M+Na]⁺), 456.1 ([M+H]⁺); (+)MS^{*n*} (*m/z*): 456.1, 363.0, 335.0, 274.0, 247.9, 225.9, 180.9, 154.8.

5-Chloro-2-[1-[(2-chlorobenzylidene)hydrazinocarbonyl]ethoxy]-N-phenylbenzamide (14). Yield: 82 %; m.p. 187–189 °C; Anal. Calcd. for $\text{C}_{23}\text{H}_{19}\text{Cl}_2\text{N}_3\text{O}_3$ (455.08 g/mol) C, 60.54, H, 4.20, N, 9.21 %. Found: C, 60.55, H, 4.24, N, 9.20 %; IR (KBr, cm^{-1}): 3394 *m*, 3178 *m*, *l*, 3099 *s*, 2979 *s*, 1681 *i*, 1598 *m*, 1548 *m*, 1483 *s*, 1446 *i*, 1398 *m*, 1269 *m*, 1226 *m*, 1093 *s*, 819 *s*, 750 *s*, 686 *s*, 542 *s*, 505 *s*, 462 *s*. $^1\text{H-NMR}$ (400 MHz, $\text{DMSO-}d_6$, δ / ppm): 1.65 (3H, *d*, $-\text{O}-\text{CH}(\text{CH}_3)\text{CO}-$, $J = 6.8$ Hz), 6.09 (1H, *q*, $-\text{O}-\text{CH}(\text{CH}_3)\text{CO}-$, $J = 6.8$ Hz), 7.13 (1H, *t*, H_{10} , $J = 7.2$ Hz), 7.27–7.61 (5H, *m*, H_3 , H_9 , H_{11} , H_{16} , H_{17}), 7.75 (1H, *d*, H_4 , $J = 8.8$ Hz), 7.79 (2H, *d*, H_8 , H_{15} , $J = 8.6$ Hz), 7.97 (1H, *d*, H_{12} , $J = 8.4$ Hz), 8.12 (1H, *d*, H_{18} , $J = 8.8$ Hz), 8.48 (1H, *s*, H_6), 8.74 (1H, *s*, $-\text{N}=\text{CH}-$), 10.65, 10.83 (2 conformers: *Z*, *E*) (1H, *s*, $-\text{CO}-\text{NH}-\text{Ar}$), 12.05, 12.17 (2 conformers: *Z*, *E*) (1H, *s*, $-\text{CO}-\text{NH}-\text{N}=\text{CH}-$); $^{13}\text{C-NMR}$ (400 MHz, CDCl_3 , δ / ppm): 19.00 ($-\text{O}-\text{CH}(\text{CH}_3)\text{CO}-$), 73.53 ($-\text{O}-\text{CH}(\text{CH}_3)\text{CO}-$), 117.04 (C_3), 119.28 (C_8 , C_{12}), 123.32 (C_1), 124.35 (C_{10}), 126.52 (C_5), 127.25 (C_{17}), 127.32 (C_6), 128.50 (C_9 , C_{11}), 129.68 (C_{15}), 130.09 (C_{18}), 130.76 (C_{13}), 131.75 (C_{16}), 132.25 (C_4), 133.88 (C_{14}), 138.87 (C_7), 140.11 ($-\text{N}=\text{CH}-$), 153.40 (C_2), 161.34 ($-\text{CO}-\text{NH}-\text{Ar}$), 169.58 ($-\text{CO}-\text{NH}-\text{N}=\text{CH}-$); (+)MS¹ (*m/z*): 478.2 ([M+Na]⁺), 456.1 ([M+H]⁺); (+)MS^{*n*} (*m/z*): 456.1, 381.0, 363.0, 335.0, 274.0, 247.9, 180.9.

The experimental results suggested that the 5-chloro-2-(substituted alkoxy)-*N*-phenylbenzamide derivatives were readily purified.

The IR spectral data of the ethyl esters **4–6** indicate the presence of an ether bond between the phenolic hydroxyl group and the alkyl α - or γ -C atom of the ester by signals in the range 1222–1232 and 1053–1074 cm^{-1} . The carbonyl groups from the esters appear in the range 1720–1751 cm^{-1} ; however, in the IR spectra of the hydrazides, this band is missing, which indicates the conversion of the esters into hydrazides. The signals corresponding to the vibrations of the amide and hydrazide group appear between 3178–3394 and 1630–1720 cm^{-1} , respectively.

The synthesized compounds were also analysed by $^1\text{H-NMR}$ spectroscopy in $\text{DMSO-}d_6$ and $^{13}\text{C-NMR}$ spectroscopy in CDCl_3 . In order to facilitate the NMR data interpretation, the numbering of the aromatic rings is presented in Fig. 1. The $^1\text{H-NMR}$ shifts of the ethyl group from the esters appear between 1.0 and 4.3 ppm, that of the amide group between 10.2 and 11.2 ppm, that of the hydrazide group, from both hydrazides and hydrazones, between 8.9 and 12.1 ppm and that of the imine group between 8.1 and 8.8 ppm. The $^{13}\text{C-NMR}$ signals corresponding to the carbons from the hydrazide and amide groups appear in the range 162–171 ppm and those of the aromatic carbons between 115 and 160 ppm.

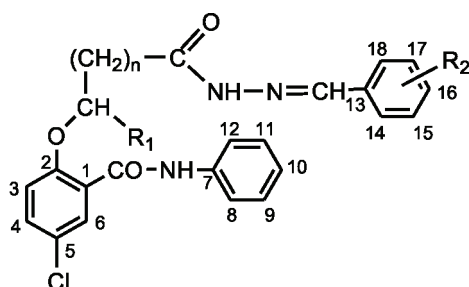


Fig. 1. Numbering of the aromatic rings used for the identification of the NMR signals.

Compound characterization was further realised by high performance mass spectrometry using an advanced methodology based on positive electrospray ionization ((+)ESI) high capacity ion trap multistage collision-induced dissociations (CID) at low energies. For the MS investigation, the samples were dissolved in pure methanol and both (+) ESI MS^1 and tandem mass spectra (+) ESI MS^n ($n = 2-6$) were acquired. MS^1 and mass calculation revealed only the presence of the molecular ions corresponding to monoprotonated molecules, $[\text{M}+\text{H}]^+$, and/or species exhibiting sodiated and potassiated adducts $[\text{M}+\text{Na}]^+$ and $[\text{M}+\text{K}]^+$. Fine and detailed structural analyses were performed by multistage mass spectrometry from MS^2 to MS^6 , which was for the first time employed here for accurate determination of compounds belonging to this particular class. Multistage MS was performed by application of an ion isolation width of 1 Da followed by He-assisted CID at low and variable energies. Unlike classical tandem MS in a single dissociation phase, the consecutive fragmentation episodes of up to MS^6 applied to the precursor ion and its derived fragments, provided not only a strict control of the dissociation process but also the unique possibility to re-sequence small fragment ions of the same precursor until unequivocal structure elucidation. Interpretation of the MS^2 – MS^6 spectra showed that the obtained multistage sequencing data unambiguously corroborated the structure of the synthesized compounds.

EXPERIMENTAL

Materials

Reagents: ethyl chloroacetate, ethyl 2-chloropropionate, ethyl 4-chlorobutyrate, 5-chloro-2-hydroxy-*N*-phenylbenzamide (Aldrich, for synthesis); hydrazine monohydrate (N₂H₄·H₂O) (Merck, for synthesis); 4-chlorobenzaldehyde, 2-chlorobenzaldehyde (Merck, for synthesis); solvents: absolute ethanol, ethyl methyl ketone, dimethylformamide (Merck, analytical purity).

*Synthesis of the ethyl esters 4–6*¹⁴

Ethyl esters were obtained by the reaction of 5-chloro-2-hydroxy-*N*-phenylbenzamide with chloro-substituted acid ethyl esters **1–3** in ethyl methyl ketone. A mixture of 5-chloro-2-hydroxy-*N*-phenylbenzamide (0.010 mol) and anhydrous K₂CO₃ (0.010 mol) was refluxed in 50 mL ethyl methylketone. The halogenated acid ethyl ester (0.010 mol) was added dropwise. The optimum molar ratio was amide:ester:K₂CO₃ = 1:1:1. The mixture was stirred and heated on a steam bath for 5 h. After cooling to room temperature, the mixture was poured onto water and shaken intensively. The organic phase was separated and dried over MgSO₄. After filtration and evaporation of the solvent under vacuum, the esters crystallized. The solid esters were re-crystallized from ethanol.

*Synthesis of the hydrazides 7 and 8*¹⁰

A mixture of ethyl ester **4** or **5** (0.010 mol) and hydrazine hydrate (2.2 mL, 0.010 mol) was refluxed in 25 mL ethanol for 3 h. The reaction mixture was cooled, the separated solid filtered off and then re-crystallized from ethanol.

*Synthesis of the hydrazones 11–14*¹⁰

To a solution of hydrazide **7** or **8** (0.0030 mol) in 25 mL ethanol, the appropriate benzaldehyde **9** or **10** (0.0030 mol) was added. The reaction mixture was refluxed for 5 h. The solid obtained after cooling was filtered off, washed with water and re-crystallized from dimethylformamide.

Melting points were determined with a Böetius Carl-Zeiss Jena apparatus. The IR spectra, as KBr pellet, were recorded on a Jaskow FT/IR-430 instrument and the NMR spectra were recorded in DMSO-*d*₆ and CDCl₃ on a Bruker Avance DRX 400 instrument. Mass spectra were recorded in methanol on a high capacity ion trap, HCT Ultra PTM instrument (Bruker, Daltonics, Bremen), interfaced to a PC running the Compass™ integrated software package, version 1.2, which includes the Hystar™ module, version 3.2.37, for instrument controlling and spectrum acquisition, and Esquire Control™, version 6.1.512, and Data Analysis™, version 3.4.179, modules for storing the ion chromatograms and processing the MS data. Elemental analysis was performed on a Vario EL analyzer.

CONCLUSIONS

Nine novel compounds with the *ortho*-hydroxybenzamide structure were synthesized and characterized.

The 1:1 molar ratio of reagents gave good yields (>66 %) after the final purification. The purity of the synthesized compounds was higher than 95 %.

The employed analytical methods confirmed the identity and provided the elemental composition of all the investigated compounds.

Some of these compounds were found to be active against a series of bacterial and fungal strains.^{15,16} Therefore they can be considered as a group of potentially antimicrobial compounds.

ИЗВОД

СИНТЕЗА И КАРАКТЕРИЗАЦИЈА НЕКИХ НОВИХ 5-ХЛОРО-2-(СУПСТИТУИСАНИ АЛКОКСИ)-N-ФЕНИЛБЕНЗАМИДНИХ ДЕРИВАТА

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У циљу добијања биолошки активних једињења извршена је синтеза неких нових деривата *o*-хидроксибензамида. Етил-естри су добијени реакцијом *N*-фенил-2-хидрокси-5-хлоро-бензамида и хлоро-супституисаних етил-естара **1–3** у етил-метил-кетону. Добијени етил-естри кондензовани су са хидразином градећи хидразиде **7** и **8**. Хидразони **11–14** су затим добијени реакцијом хидразида са хлоро-супституисаним бензалдехидима **9** и **10**. Нова једињења су окарактерисана помоћу FTIR, ¹H-NMR, ¹³C-NMR, MS и елементалном анализом.

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REFERENCES

1. J. Matyk, K. Waisser, K. Drazkova, J. Kunes, V. Klimenova, K. Palat Jr., J. Kaustova, *Farmaco* **60** (2005) 399
2. K. Waisser, J. Matyk, H. Divisova, P. Husakova, J. Kunes, V. Klimenova, J. Kaustova, U. Mollmann, H. M. Dahse, M. Miko, *Arch Pharm.* **339** (2006) 616
3. I. Zawadowska, *Acta Polon. Pharmacol.* **20** (1963) 25
4. A. X. Lupea, RO 98000 (C14: E04, B1/72), 1989
5. K. Waisser, O. Bures, P. Holy, J. Kunes, R. Oswald, L. Jiraskova, M. Pour, V. Klimesova, L. Kubicova, J. Kaustova, *Arch. Pharm. Pharm. Med. Chem.* **336** (2003) 53
6. K. Waisser, M. Pesina, O. Bures, P. Holy, M. Pour, J. Kunes, V. Klimesova, V. Buchta, P. Kubanova, J. Kaustova, *Arch. Pharm. Pharm. Med. Chem.* **336** (2003) 322
7. P. Kubanova, V. Buchta, M. Perina, K. Waisser, M. Pour, *Folia Microbiol.* **48** (2003) 346
8. K. Waisser, M. Pesina, V. Klimesova, J. Kaustova, *Collect. Czech. Chem. Commun.* **68** (2003) 1275
9. A. X. Lupea, C. Tărăbășanu, M. Pădure, *Rev. Chim.* **54** (2003) 752
10. H. H. Fahmy, W. El-Eraky, *Arch. Pharm. Res.* **24** (2001) 171
11. H. H. Fahmy, G. A. Soliman, *Arch. Pharm. Res.* **24** (2001) 180
12. A. X. Lupea, I. Popescu, C. Tărăbășanu, I. Ienașcu, V. Badea, *J. Serb. Chem. Soc.* **71** (2006) 1247
13. A. X. Lupea, I. Popescu, C. Tărăbășanu, I. Ienașcu, M. Pădure, *Rev. Roum. Chem.* **51** (2006) 517
14. H. Kwiecien, *Pol. J. Chem.* **70** (1996) 733
15. I. Ienașcu, I. Popescu, A. Borozan, A. X. Lupea, *Ann. West Univer. Timisoara* **16** (2007) 49 (in Romanian)
16. I. Ienașcu, A. X. Lupea, D. Hădărugă, N. Hădărugă, I. Popescu, *Rev. Chim.* **59** (2008) 247.