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LETTERS TO THE EDITOR

Synthesis of *N*-Substituted Thioamides of Benzoic Acids under Microwave Activation

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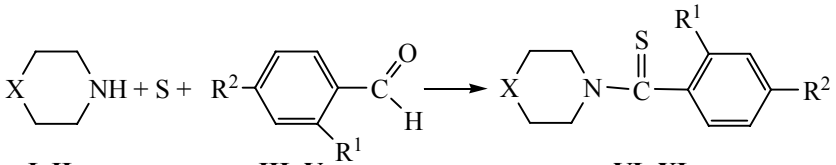
Thioamide derivatives are of particular interest since they are reactive compounds successfully used in organic synthesis of biologically active compounds. There are various synthetic approaches to thioamides. One of the most common is the Willgerodt–Kindler reac-tion [1, 2], which includes a prolonged reflux (2–4 h) of reaction mixture in DMF. In order to reduce the reaction time, we studied the reaction of substituted benzaldehydes with heterocyclic secondary amines, morpholine **I** and 1-benzylpiperazine **II**, in the presence of sulfur [3] under microwave irradiation. The reactions were carried out in DMF medium to get the comparative data.



I, II **III–V** **VI–XI**

X = O (**I, VI–VIII**), $NCH_2C_6H_5$ (**II, IX–XI**); $R^1 = R^2 = H$ (**III, VI, IX**); $R^1 = R^2 = CH_3O$ (**IV, VII, X**); $R^1 = H$, $R^2 = F$ (**V, VIII, XI**).

It was established that methane thiones **VI–XI** can be synthesized in 2 min at 750 W with breaks every 10 s. The structure and identity of compounds **VI–XI** was confirmed by the authentic synthesis under convective heating in DMF medium. Thus, the behavior of the reaction components under microwave activation does not differ from that occurring at the convective heating, and some synthetic features can be attributed to the behavior of the reaction substrates in a microwave field [4].

The ^1H NMR spectra of compounds **VI–XI** were recorded on a Bruker AM-400 spectrometer in DMSO-d_6 relative to the residual proton signals (2.50 δ_H and δ_C 39.50). TLC analysis was performed on Silufol UV-254 plates eluting with $CHC1_3$–EtOH. The melting points were determined on a Boëtius instrument.

General procedure for the synthesis of thioamides VI–XI under convection heating conditions. To a mixture of 3.61 g of aromatic aldehyde, 3 g of amine, and 1.09 g of sulfur powder was added 10 ml of DMF, and it was heated for 2 h at 100°C to complete release of hydrogen sulfide. The reaction progress was monitored by TLC. The cooled reaction mixture was diluted with water (50 ml), the precipitate formed was filtered off and recrystallized from isopropyl alcohol.

General method for synthesis of thioamides VI–XI under microwave irradiation conditions. Into a 100 ml flat-bottomed flask of heat-resistant glass was placed a mixture of 3.61 g of aromatic aldehyde, 3 g of 1-benzylpiperazine, and 1.09 g of sulfur powder in 10 ml of DMF. The reaction mixture was subjected to microwave irradiation for 2 min at 750 W with breaks every 10 s. The reaction progress was monitored by TLC. The product was isolated and purified as described above.

(4-Benzylpiperazin-1-yl)(phenyl)methane thione (VI). Yield 3.11 g (66%) under convection heating conditions and 3.53 g (75%) under microwave irradia-

tion, white powder, mp 110°C. Found, %: C 73.03; H 7.74; N 9.07; S 10.01. $C_{19}H_{24}N_2S$. Calculated, %: C 72.13; H 7.70; N 8.97; S 10.26.

(4-Benzylpiperazin-1-yl)(4-methoxyphenyl)methane thione (VII). Yield 3.29 g (50%) under convection heating conditions and 4.07 g (62%) under microwave irradiation, white powder, mp 140°C. Found, %: C 67.79; H 7.58; N 8.95; S 8.25. $C_{19}H_{22}N_2OS$. Calculated, %: C 67.68; H 7.51; N 8.05; S 7.65.

(4-Benzylpiperazine-1-yl)(4-fluorophenyl)methane thione (VIII). Yield 3.09 g (65%) under convection heating conditions and 3.75 g (79%) under microwave irradiation, white powder, mp 150°C. Found, %: C 69.12; H 7.02; N 8.58; S 9.76. $C_{19}H_{23}FN_2S$. Calculated, %: C 69.01; H 6.98; N 8.45; S 9.65.

Morpholino(phenyl)methane thione (IX). Yield 4.05 g (56%) under convection heating conditions and 6.15 g (85%) under microwave irradiation, needle-like yellow crystals, mp 130°C. Found, %: C 63.74; H 6.32; N 6.76; O 7.72; S 15.47. $C_{11}H_{13}NOS$. Calculated, %: C 63.69; H 6.28; N 6.71; O 7.68; S 15.44.

(4-Methoxyphenyl)(morpholino)methane thione (X). Yield 2.9 g (65%) under convection heating conditions and 3.53 g (79%) under microwave irradiation, yellow crystals, mp 100°C. Found, %: C 60.73; H 6.37; N 5.90; O 13.48; S 13.51. $C_{12}H_{15}NO_2S$. Calculated, %: C 60.69; H 6.34; N 5.5; O 13.41; S 13.47.

(4-Fluorophenyl)(morpholino)methane thione (XI). Yield 2.91 g (62%) under convection heating conditions and 3.75 g (80%) under microwave irradiation, white powder, mp 110°C. Found, %: C 58.70; H 5.40; N 6.28; S 14.23. $C_{11}H_{12}FNOS$. Calculated, %: C 58.63; H 5.34; N 6.17; S 14.18.

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