Chemistry of Heterocyclic Compounds, Vol. 38, No. 3, 2002

BENZAZOLES. 1. ACYLATION OF BENZOTHIAZOLIN-2-ONES BY AROMATIC ACID CHLORIDES USING SMALL AMOUNTS OF ZINC CHLORIDE

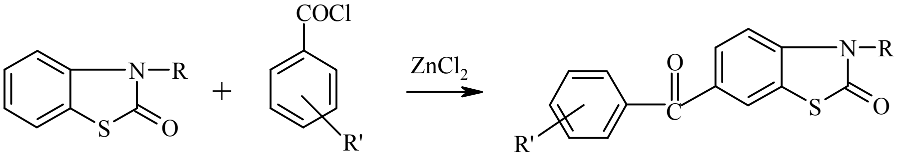
N. S. Mukhamedov, D. A. Dushamov, N. A. Aliev, Kh. M. Bobokulov, M. G. Levkovich, and N. D. Abdullaev

We show that the yield of 6-aroylbenzothiazolin-2-ones, products of acylation of benzothiazolin-2-ones by aromatic acid chlorides in the presence of $ZnCl_2$, depends on the degree of nucleophilicity of benzothiazolin-2-ones.

Keywords: 6-aroylbenzothiazolin-2-ones, aromatic acid chlorides, acylation.

Reactions of acylation of the aromatic ring in benzazolin-2-ones have been little studied. Benzimidazolin-2-ones can be condensed with anhydrides [1-4] and chlorides [5-8] of carboxylic acids in the presence of excess anhydrous $AlCl_3$ to form the corresponding C-acylbenzimidazolin-2-ones. The corresponding 6-acylbenzoxazolin-2-ones are synthesized by reaction of benzoxazolin-2-ones with aliphatic acid chlorides in the presence of excess anhydrous $AlCl_3$ [9,10], while in the case of aromatic acid chlorides, 6-aroylbenzoxazolin-2-ones are obtained by using small amounts of $ZnCl_2$ [11]. The indicated reactions have not been previously studied for benzothiazolin-2-ones.

In this work, we have studied acylation of benzothiazolin-2-ones by aromatic acid chlorides using small amounts of $ZnCl_2$. The physicochemical characteristics of 6-aroylbenzothiazolin-2-ones **3a-g** obtained are presented in Table 1.



1a,b **2a–d** **3a–g**

1 a R = H, **b** R = Me; **2 a** R'= H, **b** R'= 2-Br, **c** R'= 4-Br, **d** R'= 3-Me;
3 a R = R'= H, **b** R = H, R'= 2-Br, **c** R = H; R'= 4-Br, **d** R = H, R'= 3-Me,
e R = Me, R'= 2-Br, **f** R = Me, R'= 4-Br, **g** R = Me, R'= 3-Me

---

Institute of Plant Chemistry, Academy of Sciences of the Republic of Uzbekistan, Tashkent 700170. Translated from Khimiya Geterotsiklicheskikh Soedinenii, No. 3, pp. 380-384, March, 2002. Original article submitted December 28, 1999.

TABLE 1. Physicochemical Characteristics of the Synthesized Compounds **3a-g**

Com-pound	Empirical formula	Found, % / Calculated, %			mp, °C (ethanol)	Mass spectrum, *m/z* (I_{rel}, %)			IR spectrum, ν, cm^{-1}		Yield, %
		C	H	N		M$^+$	A$^+$	B$^+$	C=O	NH	
3a	$C_{14}H_9NO_2S$	65.48 65.88	3.14 3.52	5.82 5.49	209-211	255 (42)	178 (100)	77 (23)	1650, 1710	3200	57
3b	$C_{14}H_8BrNO_2S$	50.81 50.37	2.81 2.39	3.93 4.19	197-199	333/335 (38)	178 (100)	155/157 (27)	1655, 1705	3220	53
3c	$C_{14}H_8BrNO_2S$	49.93 50.37	2.01 2.39	4.67 4.19	266-268	333/335 (36)	178 (100)	155/157 (31)	1655, 1700	3250	67
3d	$C_{15}H_{11}NO_2S$	67.24 66.91	3.86 4.08	4.95 5.20	234-236*	269 (44)	178 (100)	91 (25)	1660, 1710	3300	45
3e	$C_{15}H_{10}BrNO_2S$	52.03 51.79	2.65 2.87	3.90 4.02	131-133	347/349 (35)	192 (100)	155/157 (23)	1650, 1710	—	81
3f	$C_{15}H_{10}BrNO_2S$	51.88 51.79	2.69 2.87	4.19 4.02	162-164	347/349 (40)	192 (100)	155/157 (26)	1650, 1710	—	84
3g	$C_{16}H_{13}NO_2S$	67.99 67.84	4.41 4.59	5.05 4.94	139-141*	283 (32)	192 (100)	91 (28)	1660, 1705	—	72

---

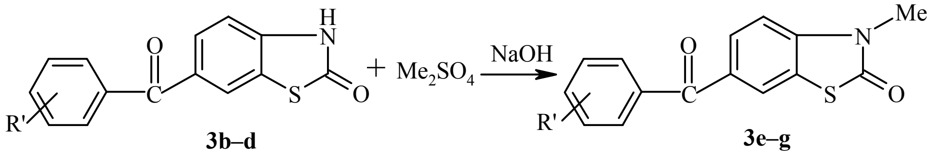
* Solvent: benzene.

To determine the optimal acylation conditions and to determine the limits for use of small amounts of catalyst, we studied the effect of the amount of $ZnCl_2$, temperature, and the reaction time on the yield of benzoylation product of benzothiazolin-2-one **1a**. The best yield of 6-benzoylbenzothiazolin-2-one (**3a**) was obtained for reagent ratio **1a**:**2a**:$ZnCl_2$ of $1:1.2:1\cdot10^{-2}$ and when the reaction mass was heated for 3 h at 200°C to 210°C. Increasing the amount of catalyst did not increase the yield of the product **3a**, while decreasing the amount of catalyst down to 0.1 mmol only resulted in traces of product.

As shown by our study, the yields of the acylation products of 3-methylbenzothiazolin-2-one (**1b**) are higher than for benzothiazolin-2-one **1a**. This probably can be explained by the higher nucleophilicity of compound **1b**, similar to what was observed in acylation of benzoxazolin-2-ones [11].

The structure of the synthesized compounds **3a-g** was demonstrated by IR and ^{1}H NMR spectroscopy and mass spectrometry, and confirmed by elemental analysis and an alternate synthesis.

In methylation of 6-aroylbenzothiazolin-2-ones **3b-d** by dimethyl sulfate in alkaline medium, we obtained 6-aroyl-3-methylbenzothiazolin-2-ones **3e-g** in quantitative yields that were identical to the products of direct acylation of compound **1b**.



3b–d **3e–g**

For the IR spectra of compounds **3a-g** (Table 1), typically absorption bands appear for the stretching vibrations of the carbonyl group in the 6 position (1650-1660 cm^{-1}) and out-of-plane bending vibrations of the CH bonds of the 1,2,4-trisubstituted benzene ring (805-825 cm^{-1} and 870-885 cm^{-1}).

The mass spectra of compounds **3a-g**, independent of the nature of the substituents R and R', show the same type of fragmentation with rupture of the Ar–CO bond and formation of the fragments A (M^+-Ar) and B (Ar) (Table 1). Fragmentation directions related to elimination of the benzothiazolin-2-one ring are weakly expressed.

The ^{1}H NMR spectra of compounds **3a-g** (Table 2) also support their structure. In the part of the spectrum characteristic of the benzothiazolin-2-one ring, we observe H-4 doublet at 7.04-7.21 ppm with *ortho* coupling constant J = 8.39 Hz, H-5 doublet of doublets at 7.66-7.77 ppm with *ortho* and *meta* coupling constants J = 8.40 Hz and J = 1.68 Hz, and also H-7 doublet at 7.81-7.93 ppm with *meta* coupling constant J = 1.68 Hz. In the aromatic part of the spectrum, there are five one-proton multiplets at 7.29-7.79 ppm. Downfield, we observe a broad signal at 9.15-11.6 ppm which is characteristic of the NHCO– group. In the spectra of compounds **3e-g**, the methylation products of 6-aroyl derivatives **3b-d**, a singlet appears from protons of the methyl group at 3.44-3.46 ppm.

EXPERIMENTAL

The IR spectra of the studied compounds were recorded on an UR-20 spectrometer in KBr disks. The ^{1}H NMR spectra were taken on an UNITY 400^+ plus spectrometer (Varian) in $CDCl_3$. The mass spectra were obtained on a MS 25-RF (Kratos) with direct injection of the sample into the ion source (ionizing electron energy 70 eV, ion source temperature 250°C, temperature of the sample injection system 200°C). The course of the reactions and the purity of the synthesized compounds were monitored by TLC (Silufol UV-254, benzene–ethanol, 21:4, visualizing agent: 1 g of $KMnO_4$ + 4 ml of conc. H_2SO_4 + 96 ml of H_2O).

Benzothiazolin-2-one **1a** was obtained by the procedure [12], and its 3-methyl derivative **1b** was obtained by the method [13].

TABLE 2. ^{1}H NMR Spectral Characteristics of Compounds **3a-g**

Compound	^{1}H NMR spectrum ($CDCl_3$), δ, ppm, (spin–spin coupling constant, *J*, Hz)								
	H-4	H-5	H-7	α	β	γ	α'	β'	3-H/3-Me	Ar–Me
3a	7.21 (1H, d, $J_{45} = 8.42$)	7.77 (1H, dd, $J_{45} = 8.42$, $J_{57} = 1.58$)	7.93 (1H, d, $J_{75} = 1.58$)	7.79 (1H, dd, $J_{\alpha\beta} = 8.40$; $J_{\alpha\gamma} = 1.71$)	7.51 (1H, br. t, $J_{\beta\alpha} = 8.40$, $J_{\beta\gamma} = 7.69$)	7.61 (1H, tt, $J_{\gamma\beta} = J_{\gamma\beta'} = 7.69$, $J_{\gamma\alpha} = J_{\gamma\alpha'} = 1.71$)	7.79 (1H, dd, $J_{\alpha'\beta} = 8.40$, $J_{\alpha'\gamma} = 1.71$)	7.51 (1H, br. t, $J_{\beta'\alpha} = 8.40$, $J_{\beta'\gamma} = 7.69$)	9.15 (1H, br. s)	—
3b	7.14 (1H, d, $J_{45} = 8.39$)	7.68 (1H, dd, $J_{54} = 8.39$, $J_{57} = 1.68$)	7.83 (1H, d, $J_{75} = 1.68$)	7.60 (1H, dd, $J_{\alpha\beta} = 7.93$, $J_{\alpha\gamma} = 1.22$)	7.32 (1H, td, $J_{\beta\alpha} = 7.93$, $J_{\beta\gamma} = 7.48$, $J_{\beta\beta'} = 1.91$)	7.38 (1H, td, $J_{\gamma\beta} = J_{\gamma\beta'} = 7.48$, $J_{\gamma\alpha} = 1.22$)	—	7.29 (1H, dd, $J_{\beta'\gamma} = 7.48$, $J_{\beta\beta'} = 1.91$)	9.91 (1H, br. s)	—
3c	7.10 (1H, d, $J_{45} = 8.39$)	7.66 (1H, dd, $J_{54} = 8.39$, $J_{57} = 1.68$)	7.81 (1H, d, $J_{75} = 1.68$)	7.58 (1H, s)	7.58 (1H, s)	—	7.58 (1H, s)	7.58 (1H, s)	10.44 (1H, br. s)	—
3d	7.13 (1H, dd, $J_{45} = 8.39$, $J_{47} = 0.46$)	7.69 (1H, dd, $J_{54} = 8.39$, $J_{57} = 1.68$)	7.82 (1H, dd, $J_{75} = 1.67$, $J_{74} = 0.46$)	7.46 (1H, dtd, $J_{\alpha\beta} =7.32$, $J_{\alpha\gamma} = J_{\alpha'\alpha} = 1.68$, $J_{\alpha Me} = 0.61$)	7.31 (1H, t, $J_{\beta\gamma} = 7.79$, $J_{\beta\alpha} = 7.32$)	7.35 (1H, dtd, $J_{\gamma\beta} = 7.79$, $J_{\gamma\alpha} = J_{\gamma\alpha'} = 1.68$, $J_{\gamma Me} = 0.61$)	7.51 (1H, br. s, $J_{\alpha'\gamma} = J_{\alpha'\alpha} = 1.68$, $J_{\alpha'\beta} = 0.91$, $J_{\alpha' Me} = 0.61$)		11.16 (1H, br. s)	2.37 (3H, s)
3e	7.04 (1H, d, $J_{45} = 8.40$)	7.75 (1H, dd, $J_{54} = 8.40$, $J_{57} = 1.68$)	7,82 (1H, dd, $J_{75} = 1.68$, $J_{74} = 0.39$)	7.60 (1H, dd, $J_{\alpha\beta} = 7.79$, $J_{\alpha\gamma} = 1.22$)	7.32 (1H, td, $J_{\beta\alpha} = 7.79$, $J_{\beta\gamma} = 7.48$, $J_{\beta\beta'} = 1.91$)	7.38 (1H, td, $J_{\gamma\beta} = J_{\gamma\beta'} = 7.48$, $J_{\gamma\alpha} = 1.22$)	—	7.29 (1H, dd, $J_{\beta'\gamma} = 7.48$, $J_{\beta'\beta} = 1.91$)	3.44 (3H, s)	—
3f	7.06 (1H, d, $J_{45} = 8.39$)	7.73 (1H, dd, $J_{54} = 8.39$, $J_{57} = 1.84$)	7.84 (1H, d, $J_{75} = 1.84$)	7.57 (1H, s)	7.57 (1H, s)	—	7.57 (1H, s)	7.57 (1H, s)	3.46 (3H, s)	—
3g	7.06 (1H, dd, $J_{45} = 8.39$, $J_{47} = 0.46$)	7.77 (1H, dd, $J_{54} = 8.39$, $J_{57} = 1.67$)	7,88 (1H, dd, $J_{75} = 1.67$, $J_{74} = 0.46$)	7.46 (1H, dtd, $J_{\alpha\beta} =7.32$, $J_{\alpha\gamma} = J_{\alpha'\alpha} = 1.68$, $J_{\alpha Me} = 0.61$)	7.31 (1H, t, $J_{\beta\gamma} = 7.63$, $J_{\beta\alpha} = 7.32$)	7.35 (1H, dtd, $J_{\gamma\beta} = 7.63$, $J_{\gamma\alpha} = J_{\gamma\alpha'} = 1.68$, $J_{\gamma Me}= 0.61$)	7.52 (1H, br. s, $J_{\alpha'\gamma} = J_{\alpha'\alpha} = 1.68$, $J_{\alpha'\beta} = 0.91$, $J_{\alpha' Me} = 0.61$)	—	3.45 (3H, s)	2.37 (3H, s, $J_{Me\alpha} = J_{Me\gamma}$ $= J_{Me\alpha'} =$ $= 0.61$)

6-Benzoylbenzothiazolin-2-one (3a). Mixture of compound **1a** (1.51 g, 10 mmol), benzoyl chloride **2a** (1.68 g, 12 mmol), and $ZnCl_2$ (13.6 mg, 0.1 mmol) in nitrobenzene (15 ml) was heated for 3 h at 200°C to 210°C. The solvent was distilled off with steam and the residue was filtered out, washed with water, and dried. Yield of compound **3a** 1.45 g (57%).

Compounds 3b-g were obtained similarly.

6-(2'-Bromobenzoyl)-3-methylbenzothiazolin-2-one (3e). Solution of dimethyl sulfate (1.51 g, 12 mmol) in 5% solution of NaOH (10 ml) was added with stirring to solution of compound **3b** (3.33 g, 10 mmol) in 5% solution of NaOH (10 ml). The mixture was stirred for 2 h at room temperature and then the precipitate was filtered out, washed with water, and dried. Obtained 3.3 g (95%) of compound **3e**.

Compounds 3f,g were obtained similarly.

REFERENCES

1. L. S. Efros, B. A. Porai-Koshits, and S. G. Farbenshtein, *Zh. Obshch. Khim.*, **23**, 1691 (1953).
2. M. N. Kosyakovskaya, A. V. Gordeeva, and Ch. Sh. Kadyrov, *Khim. Geterotsikl. Soedin.*, 386 (1972).
3. M. N. Kosyakovskaya, A. V. Gordeeva, Ch. Sh. Kadyrov, V. N. Balikhina, and V. V. Filippov, *Dokl. Akad. Nauk UzSSR*, 34 (1975).
4. Ch. Sh. Kadyrov, S. S. Khalikov, A. U. Kariev, A. A. Rakhimov, and E. V. Imamdzhanova, in: *Chemicals for Plant Protection, Abstracts of the All-Union Conference* [in Russian], Ufa (1982), Vol. 1, p. 70.
5. J. R. Vaugan and J. Blogenger, *J. Am. Chem. Soc.*, **77**, 5757 (1955).
6. R. L. Clark and A. A. Pessolano, *J. Am. Chem. Soc.*, **80**, 1657 (1958).
7. Yu. A. Rozin, E. D. Darienko, and Z. V. Pushkareva, *Khim. Geterotsikl. Soedin.*, 698 (1968).
8. Ch. Sh. Kadyrov and S. S. Khalikov, *Khim. Geterotsikl. Soedin.*, 808 (1984).
9. N. V. Savitskaya, T. V. Gortyanskaya, G. V. Nyrkova, I. N. Fedorova, A. N. Polezhaeva, M. D. Mashkovskii, N. M. Shchukina, and T. V. Vlasova, *Khim.-Farm. Zh.*, **11**, No. 1, 60 (1977).
10. N. S. Mukhamedov, K. Giyasov, N. A. Aliev, and Ch. Sh. Kadyrov, Dep. in VINITI 26 December 1984, No. 8343-84, Moscow (1984), 9.
11. N. S. Mukhamedov, E. L. Kristallovich, V. N. Plugar', K. Giyasov, N. A. Aliev, and N. D. Abdullaev, *Khim. Geterotsikl. Soedin.*, 1136 (1994).
12. L. S. Efros and L. R. Davidenkov, *Zh. Obshch. Khim.*, **21**, 2046 (1951).
13. K. Giyasov, N. A. Aliev, and Ch. Sh. Kadyrov, *Uzb. Khim. Zh.*, No. 5, 32 (1978).