Chemistry of Natural Compounds, Vol. 48, No. 4, September, 2012 [Russian original No. 4, July–August, 2012]

CHEMICAL TRANSFORMATIONS OF MACKINAZOLINONE AND ITS DERIVATIVES[a]

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UDC 547.944/945+547.856

*The thioanalog of mackinazolinone (2,3,4,10-tetrahydro-1*H*-pyrido[2,1-*b*]quinazolin-10-one) was synthesized for the first time by reacting it with P_2S_5. The thioanalog was reacted with aromatic aldehydes and Vilsmeier–Haack reagent (DMF + $POCl_3$) to produce 4-arylidene- and –hydroxymethylidenemackinazolinthiones, respectively. The reactions of 4-hydroxymethylidenemackinazolinone with isomeric aminophenols and aminobenzoic acids and of hydroxymethylidenemackinazolinthione with thionylchloride were studied. Subsequent reaction of the obtained 4-chloromethylidene derivative with sodium hydroselenide was synthesized a new Se-containing derivative of mackinazolinone. It was shown that 4-formylmackinazolinthione existed in the enol form whereas 4-formylmackinazolinone existed as the enaminoaldehyde tautomer.*

Keywords: mackinazolinone, mackinazolinthione, nucleophilic substitution, electrophilic addition.

Derivatives of tricyclic quinazolines, quinazolin-4-ones, and their homologs are used in medical practice as pharmacologically active compounds [1–4].

The alkaloid mackinazolinone (2,3,4,10-tetrahydro-1*H*-pyrido[2,1-*b*]quinazolin-10-one, **1**) was isolated from a species of *Mackinlaya* [5]. It was synthesized [2, 5] and its reactions with acid chlorides [6, 7], a formylating agent [7, 8], and aromatic and heterocyclic aldehydes [9] were studied. The thioanalog of **1** has not been reported although there is information on the synthesis of thiodeoxyvasicinone (1,2,3,9-tetrahydropyrrolo[2,1-*b*]quinazolin-4-thione) [10].

Herein we present results on the chemical transformation of **1** and mackinazolinthione (**2**). The latter was prepared by the reaction of **1** with P_2S_5 according to the literature method [10] that was developed for transformation of deoxyvasicinone into thiodeoxyvasicinone.

The reaction of **2** with aromatic aldehydes in glacial HOAc occurred at the α-C atom of **2** and formed 4-arylidene-**2** (**3a**–**d**). Benzaldehyde, 4-dimethylamino-, and 4-nitrobenzaldehyde (**a**–**c**) and furfurol (**d**) were used as the aldehydes. The condensation proceeded upon heating of equimolar amounts of the starting materials in glacial AcOH for 2–8 h. The corresponding 4-arylidene(furfurylidene-2′)-mackinazolinthiones (**3a**–**d**) were synthesized.

Compound **2** was formylated using Vilsmeier–Haack reagent (DMF + $POCl_3$) under the conditions for formylation of **1** [11]. This formed 4-hydroxymethylidenemackinazolinthione (**4**). The structures of the compounds were studied using physical analytical methods (IR and PMR spectra) and showed that the enol form was stable. Thus, $\nu_{C=S}$ stretching vibrations in the IR spectrum appeared at 1283 cm^{-1}; $\nu_{C=N}$, 1563; ν_{C-N}, 1488; and ν_{OH}, 3435. The PMR spectrum of **4** in $CDCl_3$ exhibited a 1H singlet for the OH at 14.7 ppm. Methylene protons in the 1-position had chemical shift (CS) 3.83 ppm (triplet); in the 3-position, 2.48 (triplet); in the 2-position, 1.91 (multiplet). Olefinic proton =CH had CS 8.76 ppm (singlet); aromatic protons of the benzene ring, 7.11–8.03.

[a]Materials presented at the 9th International Symposium on the Chemistry of Natural Compounds (SCNC, People's Republic of China, Urumqi, Oct. 16–19, 2011).

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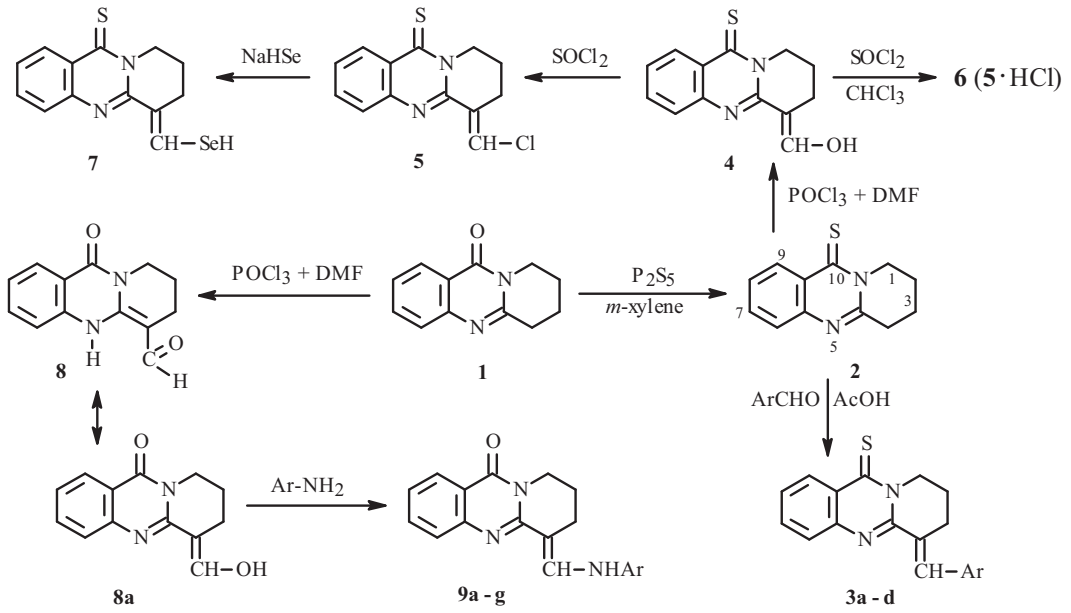

Ar = C_6H_5 (**3a**), C_6H_4-$N(CH_3)_2$-4 (**3b**), C_6H_4-NO_2-4 (**3c**), furyl-2 (**3d**)
C_6H_4-OH-2 (**9a**), C_6H_4-OH-3 (**9b**), C_6H_4-OH-4 (**9c**), C_6H_4-COOH-2 (**9d**),
C_6H_4-COOH-3 (**9e**), C_6H_4-COOH-4 (**9f**), C_6H_3-COOH-2-Br-5 (**9g**)

Compound **4** underwent nucleophilic substitution of the OH by Cl upon reacting with an excess of thionylchloride with heating on a water bath to form 4-chloromethylidenemackinazolinthione (**5**) in 98% yield. However, it was unstable and decomposed with release of HCl upon standing. We reacted equimolar amounts of **4** and $SOCl_2$ in anhydrous $CHCl_3$ in order to prepare a stable form of this compound. This produced 4-chloromethylidenemackinazolinthione hydrochloride (**6**) in 78.5% yield.

Compound **5** reacted rapidly with sodium hydroselenide to afford 4-hydroselenylmethylidenemackinazolinthione (**7**). We demonstrated that similar compounds could be synthesized using 3-chloromethylidenedeoxyvasicinone as an example [12].

It was observed earlier [2] that the reaction of **1** with Vilsmeier–Haack reagent ($POCl_3$:DMF) formed exclusively 4-formyl derivative **8**. Furthermore, **8** can exist in enol form **8a**, which reacts readily with nucleophilic reagents. We studied the reactions of the nucleophiles *o*-, *m*-, and *p*-aminophenols (**a**–**c**); *o*-, *m*-, and *p*-aminobenzoic acids (**d**–**f**); and 5-bromo-*o*-aminobenzoic acid (**g**) with **8a**. The reactions were carried out in refluxing MeOH for 3 h. Nucleophilic substitution products **9a**–**g** were obtained. The yields of products obtained from condensation of **8** with nucleophilic reagents containing an electron-donating (OH) group (**a**–**c**) were slightly greater (74–80%) than those involving an electron-acceptor group (COOH) (**d**–**f**) (67–70%). The yield was even lower (38.6%) for 5-bromo-*o*-aminobenzoic acid (**g**). This was due to the fact that the nucleophilicity of the amine in the isomeric aminobenzoic acids decreased under the influence of the electron-acceptor substituents.

The structures of **4**–**7** were confirmed by IR and PMR spectral data. Their IR spectra showed $\nu_{C=S}$ stretching vibrations in the range 1278–1284 cm^{-1}; $\nu_{C=N}$, 1552–1584; and ν_{C-N}, 1450–1471. CSs in PMR spectra were 4.13–4.6 and 3.90–4.13 ppm (triplets) for methylene protons in the 1-position in **3a**–**d** and **9a**–**g**; 2.78–2.90 and 2.33–2.73 (triplet) for those in the 3-position; and 1.78–2.0 (multiplet) for protons in the 2-position. The $N(CH_3)_2$ resonance in **3b** gave a 6H singlet at 2.96 ppm. The aromatic protons appeared at 6.70–8.74 ppm.

EXPERIMENTAL

Mass spectra were recorded on an MS-30 (Kratos) instrument; IR spectra, in mineral oil on a System 2000 IR-Fourier spectrometer; PMR spectra, in $CDCl_3$ (**2**, **3a**–**c**, **4**), CD_3COOD (**7**, **9e**), DMSO-d_6 (**9a**), and TFA + CD_3COOD (**3d**, **9g**, **9f**) on a Unity 400+ instrument (operating frequency 400 MHz, TMS internal standard, δ-scale). The purity of products and course of reactions were monitored by TLC on Sorbfil (Russia) and Whatman® UV-254 (Germany) plates using $CHCl_3$:MeOH (5:1, system A; 10:1, system B) and C_6H_6:MeOH (5:1, system C).

Mackinazolinone (1) was synthesized by the literature method [13]; **mackinazolinthione (2)**, by the previous method [10] with several changes.

A mixture of **1** (7.2 g, 0.036 mol) and P_2S_5 (8.3 g, 0.037 mol) in *m*-xylene (40 mL) was refluxed and stirred for 3 h and cooled to room temperature. The resulting precipitate was filtered off, worked up with NaOH (80 mL, 10%), left for 1 h, filtered off, washed with H_2O until neutral, and dried. Recrystallization from hexane afforded **2** (5.45 g, 70%), $C_{12}H_{12}N_2S$, mp 118–120°C, R_f 0.88 (system C). IR spectrum (ν, cm^{-1}): 1584 ($\nu_{C=N}$), 1471 (ν_{C-N}), 1270 ($\nu_{C=S}$).

PMR spectrum (δ, ppm, J/Hz): 8.73 (1H, dd, J = 8.2, 1.6, H-9), 7.7 (1H, t, J = 8.2, 1.6, H-7), 7.5 (1H, d, J = 8.2, H-6), 7.4 (1H, t, J = 8.2, H-8), 4.55 (2H, t, J = 6.2, H-1), 3.0 (2H, t, J = 6.9, H-4), 2.0 (2H, m, H-2), 1.92 (2H, m, H-3).

4-Benzylidenemackinazolinthione (3a). Compound **2** (0.218 g, 1 mmol) was dissolved in glacial AcOH (4 mL), treated with benzaldehyde (0.110 mL, 0.116 g, 1.1 mmol, ρ = 1.0498 g/cm^3) and refluxed for 2–8 h. The resulting precipitate was filtered off, washed with H_2O, and dried. Recrystallization from cyclohexane afforded **3a** (0.198 g, 65%), $C_{19}H_{16}N_2S$, mp 168°C, R_f 0.86 (system C). IR spectrum (ν, cm^{-1}): 1567 ($\nu_{C=N}$), 1491 (ν_{C-N}), 1268 ($\nu_{C=S}$).

PMR spectrum (δ, ppm, J/Hz): 8.70 (1H, d, J = 7.7, H-9), 8.1 (1H, t, J = 2.0, =CH), 7.65–7.68 (2H, m, H-6,7), 7.34–7.42 (5H, m, H_{Ph}), 7.28 (1H, td, J = 7.7, 1.6, H-8), 4.6 (2H, t, J = 5.7, H-1), 2.9 (2H, td, J = 6.6, 2.0, H-3), 2.0 (2H, m, H-2).

4-(4-Dimethylaminobenzylidene)-mackinazolinthione (3b). By analogy with the above, **2** (0.317 g, 1.5 mmol) and 4-dimethylaminobenzaldehyde (0.224 g, 1.65 mmol) synthesized **3b** (0.312 g, 60%), mp 184°C (cyclohexane), R_f 0.87 (system C). IR spectrum (ν, cm^{-1}); 1566 ($\nu_{C=N}$), 1470 (ν_{C-N}), 1267 ($\nu_{C=S}$).

PMR spectrum (δ, ppm, J/Hz): 8.72 (1H, dd, J = 8.2, 1.1, H-9), 8.0 (1H, t, J = 2.0, =CH), 7.66 (2H, d, J = 7.1, H-2′,6′), 7.38–7.40 (3H, m, H-6,7,8), 6.7 (2H, d, J = 7.1, H-3′,5′), 4.6 (2H, t, J = 5.7, H-1), 2.96 [6H, s, $N(CH_3)_2$], 2.9 (2H, td, J = 6.0, 2.0, H-3), 2.0 (2H, m, H-2).

4-(4-Nitrobenzylidene)-mackinazolinthione (3c). By analogy with the above, **2** (0.432 g, 2 mmol) and 4-nitrobenzaldehyde (0.332 g, 2.2 mmol) afforded **3c** (0.517 g, 74%), mp 209–210°C (cyclohexane), R_f 0.88 (system C). IR spectrum (ν, cm^{-1}): 1568 ($\nu_{C=N}$), 1509 (ν_{NO_2}), 1469 (ν_{C-N}), 1223 ($\nu_{C=S}$).

PMR spectrum (δ, ppm, J/Hz): 8.74 (1H, d, J = 8.2, H-9), 8.23 (2H, d, J = 8.8, H-3′,5′), 8.2 (1H, s, =CH), 7.66–7.74 (2H, m, H-6,7), 7.56 (2H, d, J = 8.8, H-2′,6′), 7.46 (1H, t, J = 8.2, H-8), 4.62 (1H, t, J = 6.0, H-1a), 4.13 (1H, t, J = 6.0, H-1b), 2.90 (2H, t, J = 6.0, H-3), 1.98–2.11 (2H, m, H-2).

4-(Furfurylidene-2)-mackinazolinthione (3d). By analogy with the above, **2** (0.432 g, 2 mmol) and furfurol (0.18 mL, 0.21 g, 2.2 mmol, ρ = 1.1598 g/cm^3) synthesized **3d** (0.39 g, 68%), mp 170°C (cyclohexane), R_f 0.88 (system C). IR spectrum (ν, cm^{-1}): 1569 ($\nu_{C=N}$), 1469 (ν_{C-N}), 1272 ($\nu_{C=S}$).

PMR spectrum (δ, ppm, J/Hz): 8.28 (1H, d, J = 8.2, H-9), 7.5 (1H, t, J = 8.2, H-7), 7.39 (1H, d, J = 1.7, H-5′), 7.30 (1H, t, J = 1.7, =CH), 7.23–7.29 (2H, m, H-6,8), 6.68 (1H, d, J = 3.4, H-3′), 6.3 (1H, dd, J = 3.4, 1.7, H-4′), 4.36 (2H, t, J = 5.5, H-1), 2.78 (2H, td, J = 6.8, 1.7, H-3), 1.85 (2H, m, H-2).

4-Hydroxymethylidenemackinazolinthione (4) was prepared by the literature method [11] with several changes. Freshly distilled anhydrous DMF (1.93 g, 0.027 mol) was cooled on an ice bath, stirred vigorously by a mechanical stirrer, treated dropwise with $POCl_3$ (1.54 g, 0.01 mol) and in portions with **2** (1 g, 0.046 mol), stirred for 2 h at room temperature, left overnight, heated for 2 h on a water bath (95–98°C), cooled, decomposed with ice (10 g), and neutralized with NH_4OH solution (10%) until weakly basic (pH 8). The resulting yellow solid was filtered off, washed with H_2O (3–4×), and dried to afford **4** (0.88 g, 78%), mp 206–208°C (acetone), R_f 0.74 (system C). IR spectrum (ν, cm^{-1}): 3435 (ν_{OH}), 1563 ($\nu_{C=N}$), 1488 (ν_{C-N}), 1283 ($\nu_{C=S}$).

PMR spectrum (δ, ppm, J/Hz): 14.67 (1H, s, OH), 8.54 (1H, s, =CH), 7.95 (1H, dd, J = 7.9, 1.7, H-9), 7.57 (1H, td, J = 8.3, 1.7, H-7), 7.2 (1H, d, J = 8.3, H-6), 7.16 (1H, td, J = 7.9, 0.8, H-8), 3.94 (2H, t, J = 5.8, H-1), 2.48 (2H, t, J = 6.2, H-3), 1.91 (2H, m, H-2).

4-Chloromethylidenemackinazolinthione (5). Compound **3** (0.6 g, 2.44 mmol) was heated, treated with freshly distilled $SOCl_2$ (4 mL, 56.8 mmol, ρ = 1.66 g/cm^3), heated on a water bath at 70–75°C for 1.5–2 h, cooled, and decomposed with distilled H_2O (100 mL). The resulting precipitate was filtered off, washed with H_2O, and dried to afford **5** (0.63 g, 98%), mp 120°C (dec.), R_f 0.96 (system C). IR spectrum (ν, cm^{-1}): 1563 ($\nu_{C=N}$), 1474 (ν_{C-N}), 1278 ($\nu_{C=S}$), 771 (ν_{C-Cl}).

4-Chloromethylidenemackinazolinthione Hydrochloride (6). A solution of **3** (1 g, 4.1 mmol) in anhydrous $CHCl_3$ (20 mL) was treated dropwise with $SOCl_2$ (0.4 mL, 5.6 mmol, ρ = 1.66 g/cm^3), and stirred for 30 min at room temperature. The resulting crystals were filtered off, washed with $CHCl_3$, and dried to afford **6** (0.96 g, 78.5%), mp 200–202°C, R_f 0.83 (system C). IR spectrum (ν, cm^{-1}): 1567 ($\nu_{C=N}$), 1484 (ν_{C-N}), 1284 ($\nu_{C=S}$), 757 (ν_{C-Cl}).

4-Hydroselenylmethylidenemackinazolinthione (7). A mixture of selenium (0.26 g, 3.3 mmol) in deaerated distilled H_2O (25 mL) was constantly purged with N_2, treated in portions with $NaBH_4$ (0.25 g, 6.6 mmol) over 30 min, stirred for another 15–20 min, and heated to 40–45°C for 1 h. During this time the mixture became brownish-red. The mixture was cooled under a stream of N_2, treated with **5** (0.9 g, 3 mmol), stirred for 1 h at room temperature and just as long at 95–98°C, and cooled to room temperature. The resulting precipitate was filtered off. The filtrate was acidified with conc. AcOH until the pH was 1–2. The resulting red crystals were filtered off, washed with H_2O until neutral, and dried to afford **7** (0.56 g, 52%), mp 112–114°C (cyclohexane), R_f 0.89 (system C). IR spectrum (ν, cm^{-1}): 2795 (ν_{Se-H}), 1563 ($\nu_{C=N}$), 1474 (ν_{C-N}), 1283 ($\nu_{C=S}$).

PMR spectrum (δ, ppm, J/Hz): 8.77 (1H, t, J = 1.9, =CH), 8.1 (1H, dd, J = 8.0, 1.6, H-9), 7.99 (1H, d, J = 8.0, H-6), 7.77 (1H, td, J = 8.0, 1.6, H-7), 7.5 (1H, td, J = 8.0, 1.3, H-8), 4.13 (2H, t, J = 6.4, H-1), 2.73 (2H, td, J = 6.8, 1.9, H-3), 1.98 (2H, m, H-2).

4-Formylmackinazolinone (8) was prepared by the literature method [11].

4-(*o*-Hydroxyphenylamino)methylidenemackinazolinone (9a). Compound **8** (0.228 g, 1 mmol) was dissolved in MeOH (10 mL), treated with *o*-aminophenol (0.109 g, 1 mmol), and refluxed for 3 h. When the reaction was finished, the solvent was vacuum distilled. The solid was recrystallized from MeOH to afford **9a** (0.248 g, 78%), $C_{19}H_{17}N_3O_2$, mp 224–226°C, R_f 0.63 (system A). Mass spectrum (*m*/*z*, %): 319 (100) $[M]^+$, 302 (16) $[M - OH]^+$, 226 (8.4) $[M - C_6H_4 - OH]^+$, 199 (77) $[M - CH{=}N - C_6H_4 - OH]^+$, 185 (20), 145 (5), 119 (29). IR spectrum (ν, cm^{-1}): 3273 (ν_{OH}), 2934 (ν_{NH}), 1639 ($\nu_{C=O}$), 1523 ($\nu_{C=N}$), 1474 (ν_{C-N}).

PMR spectrum (δ, ppm, J/Hz): 10.14 (1H, s, OH), 7.98 (1H, dd, J = 8.0, 1.5, H-9), 7.68 (1H, td, J = 7.1, 1.5, H-7), 7.63 (1H, d, J = 12.2, =CH), 7.55 (1H, d, J = 7.8, H-3′), 7.27 (2H, m, H-8,6′), 6.83 (1H, dd, J = 7.1, 2.1, H-6), 6.73 (2H, m, H-4′,5′), 3.90 (2H, t, J = 5.6, H-1), 2.56 (2H, t, J = 5.6, H-3), 1.88 (2H, m, H-2).

4-(*m*-Hydroxyphenylamino)methylidenemackinazolinone (9b). By analogy to the above, **8** (0.228 g, 1 mmol) and *m*-aminophenol (0.109 g, 1 mmol) afforded **9b** (0.236 g, 74%), $C_{19}H_{17}N_3O_2$, mp 180–182°C (MeOH), R_f 0.48 (system A). Mass spectrum (*m*/*z*, %): 319 (100) $[M]^+$, 226 (16) $[M - C_6H_4 - OH]^+$, 199 (26) $[M - CH{=}N - C_6H_4 - OH]^+$, 184 (9.1), 146 (7), 119 (15.4). IR spectrum (ν, cm^{-1}): 3367 (ν_{OH}), 3014 (ν_{NH}), 1647 ($\nu_{C=O}$), 1518 ($\nu_{C=N}$), 1473 (ν_{C-N}).

4-(*p*-Hydroxyphenylamino)methylidenemackinazolinone (9c). By analogy to the above, **8** (0.228 g, 1 mmol) and *p*-aminophenol (0.109 g, 1 mmol) afforded **9c** (0.255 g, 80%), $C_{19}H_{17}N_3O_2$, mp 240–242°C (MeOH), R_f 0.56 (system A). Mass spectrum (*m*/*z*, %): 319 (100) $[M]^+$, 302 (7) $[M - OH]^+$, 226 (8.4) $[M - C_6H_4 - OH]^+$, 199 (16.8), 184 (6.3), 119 (14). IR spectrum (ν, cm^{-1}): 3231 (ν_{OH}), 2939 (ν_{NH}), 1628 ($\nu_{C=O}$), 1523 ($\nu_{C=N}$), 1474 (ν_{C-N}).

4-(*o*-Hydroxycarbonylphenylamino)methylidenemackinazolinone (9d). Compound **8** (0.228 g, 1 mmol) was dissolved in MeOH (10 mL), treated with *o*-aminobenzoic acid (0.137 g, 1 mmol), and refluxed for 3 h. When the reaction was finished, the solvent was vacuum distilled. The solid was recrystallized from MeOH to afford **9d** (0.244 g, 70%), $C_{20}H_{17}N_3O_3$, mp 178–180°C, R_f 0.53 (system A). Mass spectrum (*m*/*z*, %): 347 (100) $[M]^+$, 302 (54) $[M - COOH]^+$, 226 (12.6) $[M - C_6H_4 - COOH]^+$, 211 (8.4) $[M - NH - C_6H_4 - COOH]^+$, 200 (24.5), 198 (7) $[M - CHNH - C_6H_4 - COOH]^+$, 184 (17.5), 186 (13), 143 (5), 119 (52.5). IR spectrum (ν, cm^{-1}): 3413 (ν_{OH}), 3215 (ν_{NH}), 1681 ($\nu_{O-C=O}$), 1635 ($\nu_{C=O}$), 1533 ($\nu_{C=N}$), 1472 (ν_{C-N}).

4-(*m*-Hydroxycarbonylphenylamino)methylidenemackinazolinone (9e). By analogy with the above, **8** (0.228 g, 1 mmol) and *m*-aminobenzoic acid (0.137 g, 1 mmol) afforded **9e** (0.232 g, 67%), $C_{20}H_{17}N_3O_3$, mp 276–278°C (MeOH), R_f 0.58 (system A). Mass spectrum (*m*/*z*, %): 347 (100) $[M]^+$, 330 (41) $[M - OH]^+$, 302 (4.2) $[M - COOH]^+$, 226 (17.5) $[M - C_6H_4 - COOH]^+$, 211 (8.4) $[M - NH - C_6H_4 - COOH]^+$, 199 (16.8), 198 (8.4) $[M - CHNH - C_6H_4 - COOH]^+$, 185 (7.7), 144 (3.5), 119 (10.5). IR spectrum (ν, cm^{-1}): 3450 (ν_{OH}), 2924 (ν_{NH}), 1686 ($\nu_{O-C=O-}$), 1646 ($\nu_{C=O}$), 1527 ($\nu_{C=N}$), 1474 (ν_{C-N}).

PMR spectrum (δ, ppm, J/Hz): 8.15 (1H, d, J = 13.7, NH), 8.02 (1H, d, J = 13.7, =CH), 7.87 (1H, d, J = 8.1, H-9), 7.69 (1H, s, H-2′), 7.63 (1H, d, J = 7.2, H-6), 7.5 (1H, t, J = 7.5, H-8), 7.12-7.20 (4H, m, H-7,4′,5′,6′), 3.9 (2H, t, J = 6.0, H-1), 2.33 (2H, t, J = 6.0, H-3), 1.78 (2H, m, H-2).

4-(*p*-Hydroxycarbonylphenylamino)methylidenemackinazolinone (9f). By analogy with the above, **8** (0.228 g, 1 mmol) and *p*-aminobenzoic acid (0.137 g, 1 mmol) afforded **9f** (0.235 g, 68%), $C_{20}H_{17}N_3O_3$, mp 296–298°C (MeOH), R_f 0.46 (system A). Mass spectrum (*m*/*z*, %): 347 (100) $[M]^+$, 330 (39.8) $[M - OH]^+$, 302 (4.9) $[M - COOH]^+$, 226 (17.5) $[M - C_6H_4 - COOH]^+$, 211 (9.1) $[M - NH - C_6H_4 - COOH]^+$, 199 (17.5), 198 (7.7) $[M - CHNH - C_6H_4 - COOH]^+$, 185 (8.4), 144 (2.8), 119 (11.2). IR spectrum (ν, cm^{-1}): 3422 (ν_{OH}), 3053 (ν_{NH}), 1697 ($\nu_{O-C=O-}$), 1636 ($\nu_{C=O}$), 1521 ($\nu_{C=N}$), 1476 (ν_{C-N}).

PMR spectrum (δ, ppm, J/Hz): 10.89 (1H, s, OH), 8.1 (1H, d, J = 13.6, =CH), 8.05 (1H, d, J = 13.6, NH), 7.89 (1H, d, J = 8.1, H-9), 7.78 (1H, d, J = 8.4, H-3′,5′), 7.52 (1H, t, J = 8.1, H-7), 7.21 (1H, t, J = 8.1, H-8), 7.17 (1H, d, J = 8.1, H-6), 6.96 (2H, d, J = 8.4, H-2′,6′), 3.91 (2H, t, J = 5.8, H-1), 2.35 (2H, t, J = 6.5, H-3), 1.82 (2H, m, H-2).

4-(5-Bromo-2-hydroxycarbonylphenylamino)methylidenemackinazolinone (9g). By analogy with the above, **8** (0.228 g, 1 mmol) and 5-bromo-*o*-aminobenzoic acid (0.216 g, 1 mmol) afforded **9g** (0.164 g, 38.6%), $C_{20}H_{16}BrN_3O_3$, mp 274–276°C (aq. DMF), R_f 0.61 (system C). Mass spectrum (*m*/*z*, %): 425/427 (64) $[M]^+$, 408 (4.9) $[M – OH]^+$, 380/382 (100) $[M – COOH]^+$, 301 (5.6), 226 (31.5), 211 (20.3), 198 (32), 183 (21), 145 (12.6), 120 (31).

PMR spectrum (δ, ppm, J/Hz): 8.2 (1H, d, J = 13.1, =CH), 7.98 (1H, d, J = 2.2, H-6′), 7.89 (1H, d, J = 8.0, H-9), 7.53 (1H, t, J = 7.5, H-7), 7.42 (1H, dd, J = 9.0, 2.2, H-4′), 7.23 (1H, d, J = 7.5, H-6), 7.18 (1H, t, J = 8.0, H-8), 7.03 (1H, d, J = 9.0, H-3′), 3.92 (2H, t, J = 5.2, H-1), 2.35 (2H, t, J = 5.2, H-3), 1.86 (2H, m, H-2).

ACKNOWLEDGMENT

The work was supported financially by the RU TsNT (Project No. FA-F3-T047).

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