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Synthesis of Alkyl 7-Aryl-6-aroyl-4,7-dihydrotetrazolo[1,5-*a*]pyrimidine-5-carboxylates

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Abstract—Reactions of alkyl aroylpyruvates with a mixture of aromatic aldehyde and 5-aminotetrazole led to the formation of alkyl 7-aryl-6-aroyl-4,7-dihydrotetrazolo[1,5-*a*]pyrimidine-5-carboxylates.

Keywords: aroylpyruvic acids alkyl esters, aromatic aldehyde, 5-aminotetrazole, three-component reaction

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Synthesis of new heterocyclic compounds with potential biological activity and low toxicity is one of the most important tasks of organic chemistry. From this viewpoint, tetrazoles and based on them fused heterocyclic structures are one of the most promising for study classes of chemical compounds. It is known that tetrazoles are virtually not involved into the metabolism of the human body that allows creating on their basis effective and safe drugs [1].

In medical practice, drugs containing tetrazole moiety are commonly used as antihypertensive (Losartan, Valsartan, Candesartan, Irbesartanum), diuretics (Azosemide), antibacterial (Cefobid, Cefmetazole, Cefoperazone, Cefazolin), antithrombotic (Cilostazol), analeptic agents (Corazole) [2]. Some tetrazole derivatives exhibit anti-allergic, anti-asthmatic, antiviral [1], antifungal [3] activities.

Despite the fact that among tetrazole derivatives a large number of compounds with useful properties has been already found, the search for new potentially biologically active compounds derived from tetrazole is relevant and appropriate.

It has previously been shown that the reactions of acylpyruvic acids and their methyl esters with a mixture of 5-aminotetrazole and an aromatic or heteroaromatic aldehyde led to the formation of 7-aryl-6-acyl-5-carboxy(methoxycarbonyl)-4,7-dihydrotetrazolo-[1,5-*a*]pyrimidines [4, 5].

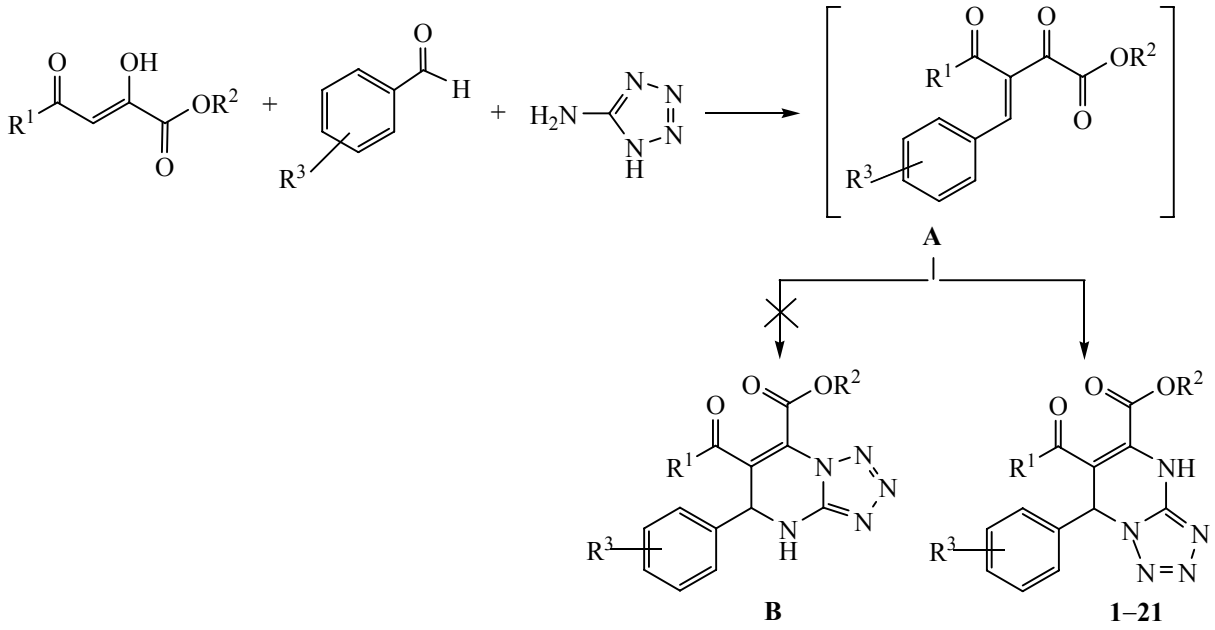
Similarly, the reactions of methyl heteroylpyruvates afforded methyl 7-aryl(heteryl)-6-(2-thienoyl)-4,7-dihydrotetrazolo[1,5-*a*]pyrimidine-5-carboxylates [6, 7].

In order to obtain new fused heterocyclic compounds and to evaluate the impact of the nature of the substituent in the aroyl moiety and aromatic aldehydes on the reaction pathway and the target products yield we studied the reactions of methyl aroylpyruvates with a mixture of aromatic aldehyde and 5-aminotetrazole. As a result of the reactions performed previously unknown methyl 7-aryl-6-aroyl-4,7-dihydrotetrazolo-[1,5-*a*]pyrimidine-5-carboxylates **1**–**16** were obtained. It has been found that the reactions proceeded while maintaining the reactants at 130–150°C in the absence of a solvent and a catalyst.

To estimate the effect of the nature of the alkyl group in the molecule of aroylpyruvic acids esters, we performed the reactions of ethyl 4-chlorobenzoylpyruvates with 5-aminotetrazole and an aromatic aldehyde. Under similar conditions, ethyl 7-aryl-6-(4-chlorobenzoyl)-4,7-dihydrotetrazolo[1,5-*a*]pyrimidine-5-carboxylates **17**–**21** were obtained (Scheme 1).

Apparently, in the first stage the reaction produces unsaturated intermediate **A**, which interacts with 5-aminotetrazole to form the reaction product. Isomeric structure **B** is not formed probably due to the lower thermodynamic stability of 1,2-dihydroderivatives in

Scheme 1.



R^1 = 4-$MeOC_6H_4$ (**1**–**4**), 4-$EtOC_6H_4$ (**5**–**10**), 4-HOC_6H_4 (**11**), 4-ClC_6H_4 (**12**–**15**, **17**–**21**), 4-FC_6H_4 (**16**); R^2 = Me (**1**–**16**), Et (**17**–**21**); R^3 = H (**1**, **5**, **11**, **17**), 4-OH (**2**), 2-Cl (**3**), 4-F (**4**), 2-MeO (**6**), 4-Cl (**7**, **14**, **16**), 3-F (**8**), 2-NO_2 (**9**), 4-Br (**10**), 4-MeO (**12**, **21**), 3-MeO (**13**), 4-Me (**15**), 4-NO_2 (**18**), 3-NO_2 (**19**), 2,5-$(MeO)_2$ (**20**).

comparison with the 1,4-dihydroderivatives. This is confirmed by the fact that in the ^{1}H NMR spectra of the compounds obtained there are no splitting of the proton signals in the positions 1 and 2, which is characteristic of structure **B**.

Compounds **1**–**21** were colorless or lightly colored crystalline substances readily soluble in DMF, DMSO, in acetic acid, ethanol, dioxane at heating, and insoluble in water.

The IR spectra of compounds **1**–**21** contained the absorption in the range of 1630–1670 and 1720–1760 cm^{-1} due to the stretching vibrations of the ketone and ester carbonyls, respectively, as well as of the NH groups at 3180–3300 cm^{-1}.

In the ^{1}H NMR the signals were observed of CH_3OCOO (3.23–3.35 ppm, **1**–**16**), CH_3CH_2O [0.90–0.97, 3.70–3.78 ($CH_3\underline{CH}_AH_BO$) and 3.78–3.88 ppm ($CH_3CH_A\underline{H}_BO$), **17**–**21**], C^7H (6.36–7.06 ppm) moieties, aromatic protons (6.73–7.58 ppm), and related groups, and the singlet of NH proton in the position 4 of the heterocycle (10.95–11.60 ppm).

The methylene protons of ethoxycarbonyl moiety in compounds **17**–**21** resonated as a multiplet due to the presence of a chiral center in the molecule.

Mass spectrum of compound **11** contained a peak of molecular ion with m/z = 378 $[M]^+$ (8%) as well as peaks of fragment ions with m/z = 319 $[M - COOCH_3]^+$ (20%), 121 $[C_6H_4OHCO]^+$ (96%), 77 $[C_6H_5]^+$ (45%), which confirms the expected structure.

In the ^{13}C NMR spectrum of compound **10** there were the signals of ester (152.64 ppm) and ketone (190.38 ppm) carbonyl groups, C^7H atom (63.57 ppm), aromatic rings (131.71–113.10 ppm), and ethoxy group (14.34, 60.08 ppm).

The research showed that the nature of the substituent in the molecule of both aroylpyruvate and aromatic aldehyde do not affect the reaction direction. The nature of the substituent affects the desired product yield: the latter increases with an increase in electron-withdrawing properties of the substituent. The nature of alkyl substituent in the ester group has no influence on the yield of the resulting compounds.

EXPERIMENTAL

IR spectra were recorded on a Specord M-80 spectrophotometer in mineral oil. ^{1}H NMR spectra were taken on a Bruker 500 (500.13 MHz) instrument in DMSO-d_6 relative to internal TMS. Mass spectrum

was obtained on a Finnigan MAT INCOS-50 spectrometer (70 eV). Elemental analysis was performed on a Perkin Elmer 2400 instrument. Melting points were determined on a M-565 instrument.

Methyl 6-(4-methoxybenzoyl)-7-phenyl-4,7-dihydrotetrazolo[1,5-*a*]pyrimidine-5-carboxylate (1). A mixture of 0.01 mol of methyl aroylpyruvate, 0.01 mol of aryl aldehyde and 0.01 mol of 5-aminotetrazole monohydrate was heated at 130–150°C until the end of gas evolution and the reaction mixture solidification. After cooling, the solid was treated with ethanol, filtered off, and recrystallized from acetic acid. Yield 3.33 g (85%), mp 201–203°C (CH_3COOH). IR spectrum, ν, cm^{-1}: 1640 ($COOCH_3$), 1740 (CO), 3200 (NH). ^1H NMR spectrum (DMSO-d_6), δ, ppm: 3.32 s (3H, $COOCH_3$), 3.75 s (3H, OCH_3), 6.68 s (1H, C^7H), 7.18 m (9H, Ar), 11.23 br.s (1H, NH). Found, %: C 61.28, 61.50; H 4.30, 4.47; N 17.79, 18.01 $C_{20}H_{17}N_5O_4$. Calculated, %: C 61.38; H 4.38; N 17.89.

Compounds **2**–**21** were prepared similarly.

Methyl 7-(4-hydroxyphenyl)-6-(4-methoxybenzoyl)-4,7-dihydrotetrazolo[1,5-*a*]pyrimidine-5-carboxylate (2). Yield 3.11 g (74%), mp 211–213°C (CH_3COOH). IR spectrum, ν, cm^{-1}: 1645 ($COOCH_3$), 1760 (CO), 3150 (NH), 3440 (OH). ^1H NMR spectrum (DMSO-d_6), δ, ppm: 3.36 s (3H, $COOCH_3$), 3.80 s (3H, OCH_3), 6.56 s (1H, C^7H), 7.56 m (8H, Ar), 9.52 s (1H, OH), 11.20 br.s (1H, NH). Found, %: C 58.84, 59.07; H 4.13, 4.30; N 17.08, 17.31. $C_{20}H_{17}N_5O_5$. Calculated, %: C 58.97; H 4.21; N 17.19.

Methyl 6-(4-methoxybenzoyl)-7-(2-chlorophenyl)-4,7-dihydrotetrazolo[1,5-*a*]pyrimidine-5-carboxylate (3). Yield 3.13 g (74%), mp 191–193°C (CH_3COOH). IR spectrum, ν, cm^{-1}: 1630 ($COOCH_3$), 1720 (CO), 3180 (NH). ^1H NMR spectrum (DMSO-d_6), δ, ppm: 3.31 s (3H, $COOCH_3$), 3.75 s (3H, OCH_3), 6.82 s (1H, C^7H), 7.25 m (8H, Ar), 11.35 br.s (1H, NH). Found, %: C 56.29, 56.51; H 3.71, 3.88; N 16.33, 16.56. $C_{20}H_{16}ClN_5O_4$. Calculated, %: C 56.41; H 3.79; N 16.45.

Methyl 6-(4-methoxybenzoyl)-7-(4-fluorophenyl)-4,7-dihydrotetrazolo[1,5-*a*]pyrimidine-5-carboxylate (4). Yield 2.7 g (66%), mp 197–199°C (CH_3COOH). IR spectrum, ν, cm^{-1}: 1650 ($COOCH_3$), 1755 (CO), 3250 (NH). ^1H NMR spectrum (DMSO-d_6), δ, ppm: 3.32 s (3H, $COOCH_3$), 3.75 s (3H, OCH_3), 6.80 s (1H, C^7H), 7.34 m (8H, Ar), 11.27 br.s (1H, NH). Found, %: C 58.57, 58.81; H 3.85, 4.04; N 16.99, 17.21. $C_{20}H_{16}FN_5O_4$. Calculated, %: C 58.68; H 3.94; N 17.11.

Methyl 7-phenyl-6-(4-ethoxybenzoyl)-4,7-dihydrotetrazolo[1,5-*a*]pyrimidine-5-carboxylate (5). Yield 2.51 g (62%), mp 194–196°C (CH_3COOH). IR spectrum, ν, cm^{-1}: 1760 ($COOCH_3$), 1655 (CO), 3180 (NH). ^1H NMR spectrum (DMSO-d_6), δ, ppm: 1.29 t (3H, $\underline{CH_3}CH_2O$), 3.30 s (3H, $COOCH_3$), 4.04 q (2H, $CH_3\underline{CH_2}O$), 6.81 s (1H, C^7H), 7.08 m (9H, Ar), 11.18 br.s (1H, NH). Found, %: C 62.12, 62.35; H 4.64, 4.81; N 17.17, 17.39. $C_{21}H_{19}N_5O_4$. Calculated, %: C 62.22; H 4.72; N 17.27.

Methyl 7-(2-methoxyphenyl)-6-(4-ethoxybenzoyl)-4,7-dihydrotetrazolo[1,5-*a*]pyrimidine-5-carboxylate (6). Yield 2.91 g (67%), mp 202–204°C (CH_3COOH). IR spectrum, ν, cm^{-1}: 1760 ($COOCH_3$), 1655 (CO), 3180 (NH). ^1H NMR spectrum (DMSO-d_6), δ, ppm: 1.29 t (3H, $\underline{CH_3}CH_2O$), 3.30 s (3H, $COOCH_3$), 3.59 s (3H, OCH_3), 4.04 q (2H, $CH_3\underline{CH_2}O$), 6.81 s (1H, C^7H), 7.08 m (8H, Ar), 11.00 br.s (1H, NH). Found, %: C 60.56, 60.79; H 4.77, 4.94; N 15.96, 16.19. $C_{22}H_{21}N_5O_5$. Calculated, %: C 60.68; H 4.86; N 16.08.

Methyl 7-(4-chlorophenyl)-6-(4-ethoxybenzoyl)-4,7-dihydrotetrazolo[1,5-*a*]pyrimidine-5-carboxylate (7). Yield 2.86 g (65%), mp 199–201°C (CH_3COOH). IR spectrum, ν, cm^{-1}: 1750 ($COOCH_3$), 1660 (CO), 3180 (NH). ^1H NMR spectrum (DMSO-d_6), δ, ppm: 1.29 t (3H, $\underline{CH_3}CH_2O$), 3.31 s (3H, $COOCH_3$), 4.06 q (2H, $CH_3\underline{CH_2}O$), 6.78 s (1H, C^7H), 7.24 m (8H, Ar), 11.00 br.s (1H, NH). Found, %: C 57.22, 57.45; H 4.03, 4.22; N 15.80, 16.03. $C_{21}H_{18}ClN_5O_4$. Calculated, %: C 57.34; H 4.12; N 15.92.

Methyl 7-(3-fluorophenyl)-6-(4-ethoxybenzoyl)-4,7-dihydrotetrazolo[1,5-*a*]pyrimidine-5-carboxylate (8). Yield 3.13 g (74%), mp 204–206°C (CH_3COOH). IR spectrum, ν, cm^{-1}: 1755($COOCH_3$), 1640 (CO), 3220 (NH). ^1H NMR spectrum (DMSO-d_6), δ, ppm: 1.30 t (3H, $\underline{CH_3}CH_2O$), 3.32 s (3H, $COOCH_3$), 4.06 q (2H, $CH_3\underline{CH_2}O$), 6.79 s (1H, C^7H), 7.08 m (8H, Ar), 11.35 br.s (1H, NH). Found, %: C 59.46, 59.70; H 4.20, 4.37; N 16.42, 16.65. $C_{21}H_{18}FN_5O_4$. Calculated, %: C 59.57; H 4.29; N 16.54.

Methyl 7-(2-nitrophenyl)-6-(4-ethoxybenzoyl)-4,7-dihydrotetrazolo[1,5-*a*]pyrimidine-5-carboxylate (9). Yield 3.24 g (72%), mp 208–210°C (CH_3COOH). IR spectrum, ν, cm^{-1}: 1740 ($COOCH_3$), 1650 (CO), 3220 (NH). ^1H NMR spectrum (DMSO-d_6), δ, ppm: 1.32 t (3H, $\underline{CH_3}CH_2O$), 3.31 s (3H, $COOCH_3$), 4.05 q (2H, $CH_3\underline{CH_2}O$), 6.84 s (1H, C^7H), 7.42 m (8H, Ar),

11.30 br.s (1H, NH). Found, %: C 55.90, 56.12; H 3.95, 4.12; N 18.54, 18.77. $C_{21}H_{18}N_6O_6$. Calculated, %: C 56.00; H 4.03; N 18.66.

Methyl 7-(4-bromophenyl)-6-(4-ethoxybenzoyl)-4,7-dihydrotetrazolo[1,5-*a*]pyrimidine-5-carboxylate (10). Yield 3.15 g (63%), mp 190–192°C (CH_3COOH). IR spectrum, ν, cm^{-1}: 1740 ($COOCH_3$), 1651 (CO), 3180 (NH). ^1H NMR spectrum (DMSO-d_6), δ, ppm: 1.31 t (3H, $\underline{CH_3}CH_2O$), 3.31 s (3H, $COOCH_3$), 4.06 q (2H, $CH_3\underline{CH_2}O$), 6.77 s (1H, C^7H), 7.21 m (8H, Ar), 11.25 br.s (1H, NH). Found, %: C 52.00, 52.20; H 3.66, 3.84; N 14.35, 14.59. $C_{21}H_{18}BrN_5O_4$. Calculated, %: C 52.08; H 3.75; N 14.46.

Methyl 7-phenyl-6-(4-hydroxybenzoyl)-4,7-dihydrotetrazolo[1,5-*a*]pyrimidine-5-carboxylate (11). Yield 2.49 g (66%), mp 241–243°C (CH_3COOH). IR spectrum, ν, cm^{-1}: 1720 ($COOCH_3$), 1645 (CO), 3180 (NH). ^1H NMR spectrum (DMSO-d_6), δ, ppm: 3.31 s (3H, $COOCH_3$), 6.81 s (1H, C^7H), 7.25 m (9H Ar), 10.38 s (1H, OH), 11.35 br.s (1H, NH). Found, %: C 60.37, 60.60; H 3.93, 4.09; N 18.43, 18.68. $C_{19}H_{15}N_5O_4$. Calculated, %: C 60.48; H 4.01; N 18.56.

Methyl 7-(4-methoxyphenyl)-6-(4-chlorobenzoyl)-4,7-dihydrotetrazolo[1,5-*a*]pyrimidine-5-carboxylate (12). Yield 2.90 g (68%), mp 198–200°C (CH_3COOH). IR spectrum, ν, cm^{-1}: 1750 ($COOCH_3$), 1665 (CO), 3180 (NH). ^1H NMR spectrum (DMSO-d_6), δ, ppm: 3.33 s (3H, $COOCH_3$), 3.64 s (1H, OCH_3), 6.72 s (1H, C^7H), 7.43 m (8H, Ar), 11.31 s (1H, NH). Found, %: C 56.29, 56.52; H 3.70, 3.89; N 16.33, 16.56. $C_{20}H_{16}ClN_5O_4$. Calculated, %: C 56.41; H 3.79; N 16.45.

Methyl 7-(3-methoxyphenyl)-6-(4-chlorobenzoyl)-4,7-dihydrotetrazolo[1,5-*a*]pyrimidine-5-carboxylate (13). Yield 2.68 g (63%), mp 219–220°C (CH_3COOH). IR spectrum, ν, cm^{-1}: 1745 ($COOCH_3$), 1645 (CO), 3220 (NH). ^1H NMR spectrum (DMSO-d_6), δ, ppm: 3.33 s (3H, $COOCH_3$), 3.62 s (1H, OCH_3), 6.73 s (1H, C^7H), 7.56 m (8H, Ar), 11.39 s (1H, NH). Found, %: C 56.31, 56.50; H 3.71, 3.87; N 16.32, 16.57. $C_{20}H_{16}ClN_5O_4$. Calculated, %: C 56.41; H 3.79; N 16.45.

Methyl 7-(4-chlorophenyl)-6-(4-chlorobenzoyl)-4,7-dihydrotetrazolo[1,5-*a*]pyrimidine-5-carboxylate (14). Yield 3.05 g (71%), mp 202–204°C (CH_3COOH). IR spectrum, ν, cm^{-1}: 1745 ($COOCH_3$), 1645 (CO), 3180 (NH). ^1H NMR spectrum (DMSO-d_6), δ, ppm: 3.32 s (3H, $COOCH_3$), 6.80 s (1H, C^7H), 7.27 m (8H, Ar), 11.30 s (1H, NH). Found, %: C 52.91, 53.16; H 2.97, 3.14; N 16.17, 16.41. $C_{19}H_{13}Cl_2N_5O_3$. Calculated, %: C 53.04; H 3.05; N 16.28.

Methyl 7-(4-methylphenyl)-6-(4-chlorobenzoyl)-4,7-dihydrotetrazolo[1,5-*a*]pyrimidine-5-carboxylate (15). Yield 2.58 g (63%), mp 210–212°C (CH_3COOH). IR spectrum, ν, cm^{-1}: 1750 ($COOCH_3$), 1660 (CO), 3180 (NH). ^1H NMR spectrum (DMSO-d_6), δ, ppm: 2.19 s (3H, CH_3), 3.33 s (3H, $COOCH_3$), 6.72 s (1H, C^7H), 7.42 m (8H, Ar), 11.40 s (1H, NH). Found, %: C 58.50, 58.73; H 3.86, 4.03; N 16.98, 17.22. $C_{20}H_{16}ClN_5O_3$. Calculated, %: C 58.61; H 3.94; N 17.09.

Methyl 7-(4-chlorophenyl)-6-(4-fluorobenzoyl)-4,7-dihydrotetrazolo[1,5-*a*]pyrimidine-5-carboxylate (16). Yield 2.86 g (69%), mp 222–224°C (CH_3COOH). IR spectrum, ν, cm^{-1}: 1745 ($COOCH_3$), 1660 (CO), 3220 (NH). ^1H NMR spectrum (DMSO-d_6), δ, ppm: 3.33 s (3H, $COOCH_3$), 6.80 s (1H, C^7H), 7.40 m (8H, Ar), 11.40 s (1H, NH). Found, %: C 55.05, 55.27; H 3.08, 3.25; N 16.79, 17.03. $C_{19}H_{13}ClFN_5O_3$. Calculated, %: C 55.15; H 3.17; N 16.92.

Ethyl 7-phenyl-6-(4-chlorobenzoyl)-4,7-dihydrotetrazolo[1,5-*a*]pyrimidine-5-carboxylate (17). Yield 2.70 g (66%), mp 231–233°C (CH_3COOH). IR spectrum, ν, cm^{-1}: 1744 ($COOC_2H_5$), 1652 (CO), 3120 (NH). ^1H NMR spectrum (DMSO-d_6), δ, ppm: 0.92 m (3H, $OCH_2\underline{CH_3}$), 3.73 m (1H, $CH_3\underline{CH_A}H_BO$, *J* 6.0 Hz), 3.88 m (1H, $CH_3CH_A\underline{H_B}O$, *J* 6.0 Hz), 6.84 s (1H, C^7H), 7.40 m (9H, Ar), 11.45 s (1H, NH). Found, %: C 58.49, 58.74; H 3.86, 4.04; N 16.96, 17.21. $C_{20}H_{16}ClN_5O_3$. Calculated, %: C 58.61; H 3.94; N 17.09.

Ethyl 7-(4-nitrophenyl)-6-(4-chlorobenzoyl)-4,7-dihydrotetrazolo[1,5-*a*]pyrimidine-5-carboxylate (18). Yield 3.23 g (71%), mp 220–222°C (CH_3COOH). IR spectrum, ν, cm^{-1}: 1750 ($COOC_2H_5$), 1668 (CO), 3180 (NH). ^1H NMR spectrum (DMSO-d_6), δ, ppm: 0.93 m (3H, $OCH_2\underline{CH_3}$), 3.74 m (1H, $CH_3\underline{CH_A}H_BO$, *J* 6.5 Hz), 3.85 m (1H, $CH_3CH_A\underline{H_B}O$, *J* 6.5 Hz), 6.96 s (1H, C^7H), 7.52 m (8H, Ar), 11.63 s (1H, NH). Found, %: C 52.71, 52.94; H 3.22, 3.42; N 18.37, 18.61. $C_{20}H_{15}ClN_6O_5$. Calculated, %: C 52.82; H 3.32; N 18.48.

Ethyl 7-(3-nitrophenyl)-6-(4-chlorobenzoyl)-4,7-dihydrotetrazolo[1,5-*a*]pyrimidine-5-carboxylate (19). Yield 3.87 g (85%), mp 215–217°C (CH_3COOH). IR spectrum, ν, cm^{-1}: 1724 ($COOC_2H_5$), 1672 (CO), 3180 (NH). ^1H NMR spectrum (DMSO-d_6), δ, ppm: 0.97 m (3H, $OCH_2\underline{CH_3}$), 3.75 m (1H, $CH_3\underline{CH_A}H_BO$, *J* 6.5 Hz), 3.84 m (1H, $CH_3CH_A\underline{H_B}O$, *J* 6.5 Hz), 7.02 s (1H, C^7H), 7.64 m (8H, Ar), 11.57 s (1H, NH). Found, %: C 52.70, 52.90; H 3.24, 3.40; N 18.35, 18.58. $C_{20}H_{15}ClN_6O_5$. Calculated, %: C 52.82; H 3.32; N 18.48.

Ethyl 7-(2,5-dimethoxyphenyl)-6-(4-chlorobenzoyl)-4,7-dihydrotetrazolo[1,5-*a*]pyrimidine-5-carboxylate (20). Yield 2.91 g (62%), mp 218–220°C (CH_3COOH). IR spectrum, ν, cm^{-1}: 1740 ($COOC_2H_5$), 1644 (CO), 3120 (NH). ^1H NMR spectrum (DMSO-d_6), δ, ppm: 0.91 m (3H, $OCH_2\underline{CH_3}$), 3.55 s and 3.61 s [6H, $(\underline{CH_3}O)_2C_6H_3$], 3.75 m (1H, $CH_3\underline{CH_A}H_BO$, *J* 6.0 Hz), 3.88 m (1H, $CH_3CH_A\underline{H_B}O$, *J* 6.0 Hz), 6.71 s (1H, C^7H), 7.50 m (7H, Ar), 11.35 s (1H, NH). Found, %: C 56.15, 56.36; H 4.20, 4.37; N 14.78, 15.01. $C_{22}H_{20}ClN_5O_5$. Calculated, %: C 56.24; H 4.29; N 14.90.

Ethyl 7-(4-methoxyphenyl)-6-(4-chlorobenzoyl)-4,7-dihydrotetrazolo[1,5-*a*]pyrimidine-5-carboxylate (21). Yield 3.03 g (69%), mp 227–230°C (CH_3COOH). IR spectrum, ν, cm^{-1}: 1740 ($COOC_2H_5$), 1648 (CO), 3140 (NH). ^1H NMR spectrum (DMSO-d_6), δ, ppm: 0.93 m (3H, $OCH_2\underline{CH_3}$), 3.64 s (3H, $\underline{CH_3}OC_6H_4$), 3.70 m (1H, $CH_3\underline{CH_A}H_BO$, *J* 6.5 Hz), 3.78 m (1H, $CH_3CH_A\underline{H_B}O$, *J* 6.5 Hz), 6.72 s (1H, C^7H), 7.43 m (8H, Ar), 11.40 s (1H, NH). Found, %: C 57.22, 57.45; H 4.03, 4.22; N 15.80, 16.03. $C_{21}H_{18}ClN_5O_4$. Calculated, %: C 57.34; H 4.12; N 15.92.

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