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SYNTHESIS OF PYRROLO[2,3-*d*]PYRIMIDINES WITH 3-AMINO-2-HYDROXYPROPYL SUBSTITUENTS

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A novel route has been found for the synthesis of pyrimido[5',4':4,5]pyrrolo[2,1-c][1,4]oxazines. They are promising reagents for the preparation of pyrrolo[2,3-d]pyrimidine-6-carboxylic acid amides which contain a 3-amino-2-hydroxypropyl substituent in position 7 of the heterocyclic ring.

Keywords: pyrimido[5',4':4,5]pyrrolo[2,1-*c*][1,4]oxazines, pyrrolo[2,3-*d*]pyrimidines, bromolactonization.

Interest in pyrrolo[2,3-*d*]pyrimidine (7-deazapurine) derivatives increased markedly with the discovery of the nucleoside antibiotics tubercidin, toyocamycin, and sangivamycin [1-3]. The structural similarity of these compounds to purine nucleosides is an important stimulus in the search for pyrrolo[2,3-*d*]pyrimidine series antiviral preparations. In the course of the last 20 years, the attention of many researchers has been concentrated on the β-D-ribofuranosyl fragment modification and its exchange for carbocyclic or acyclic substituents [4-17]. The mechanism of action of all of the synthesized substances is based on the inhibition of viral DNA polymerases. A key role in this process is assigned to the hydroxyl group of a cyclic carbohydrate or acyclic alkyl residue situated near the pyrrole ring nitrogen atom. In this connection the search for methods of synthesis of novel compounds of this class is certainly a current question. In this work, we propose a method for preparing pyrrolo[2,3-*d*]pyrimidines which contain a 3-amino-2-hydroxypropyl substituent at position 7 of the heterocycle.

It is known that the introduction of vicinal aminoalcohol groups in various heterocyclic systems often uses a general approach based on the aminolysis of glycidyl derivatives which are obtained from epichlorohydrin and the corresponding heterocyclic bases [18-20]. We have studied the reaction of methyl 1,3-dimethyl-2,4-dioxo-2,3,4,7-tetrahydro-1*H*-pyrrolo[2,3-*d*]pyrimidine-6-carboxylate (**1**) with 1-chloro-2,3-epoxypropane under the conditions reported in the studies [21-26].

Unfortunately, a positive result in that study was not obtained, but it was found that the alkylation of compound **1** by allyl bromide in DMF in the presence of potassium carbonate gives the methyl 1,3-dimethyl-2,4-dioxo-7-(2-propenyl)-2,3,4,7-tetrahydro-1*H*-pyrrolo[2,3-*d*]pyrimidine-6-carboxylate (**2**) in 45% yield. It was interesting that the oxidation of the double bond of the 2-propenyl fragment was accompanied by lactonization to give the pyrimido[5',4':4,5]pyrrolo[2,1-*c*][1,4]oxazine **3** rather than the product **4** expected from literature data [23, 27, 28]. Undoubtedly, an intramolecular cyclization had become possible due to the

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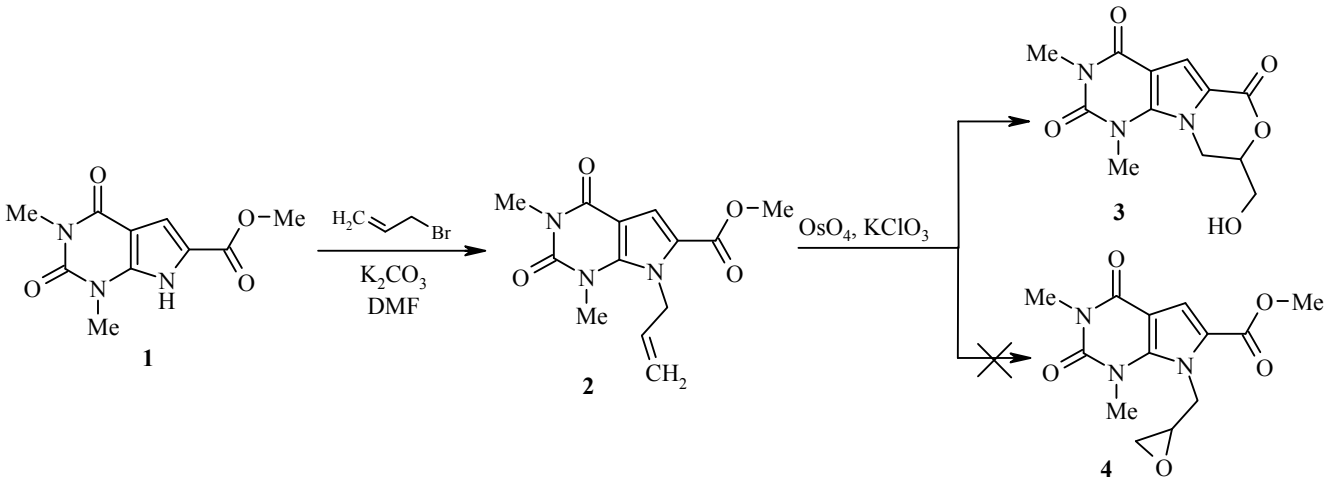
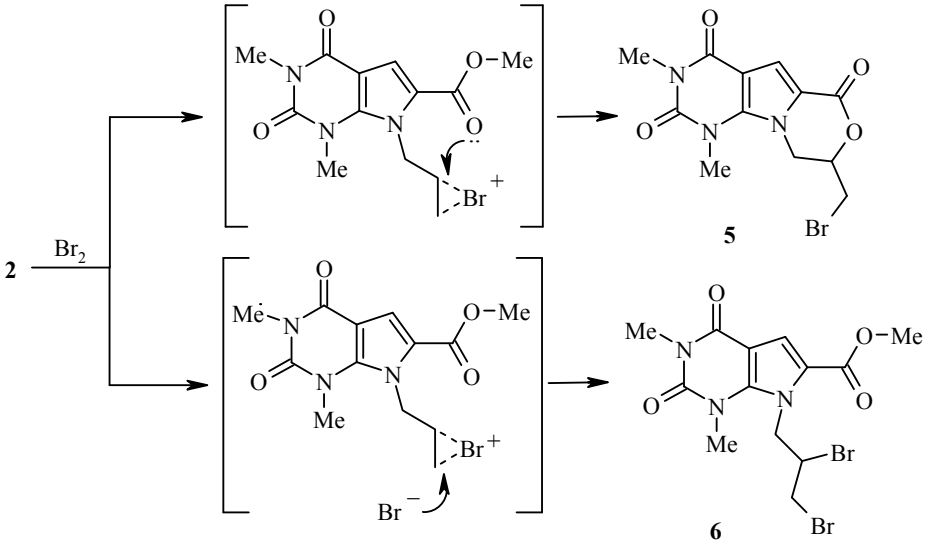
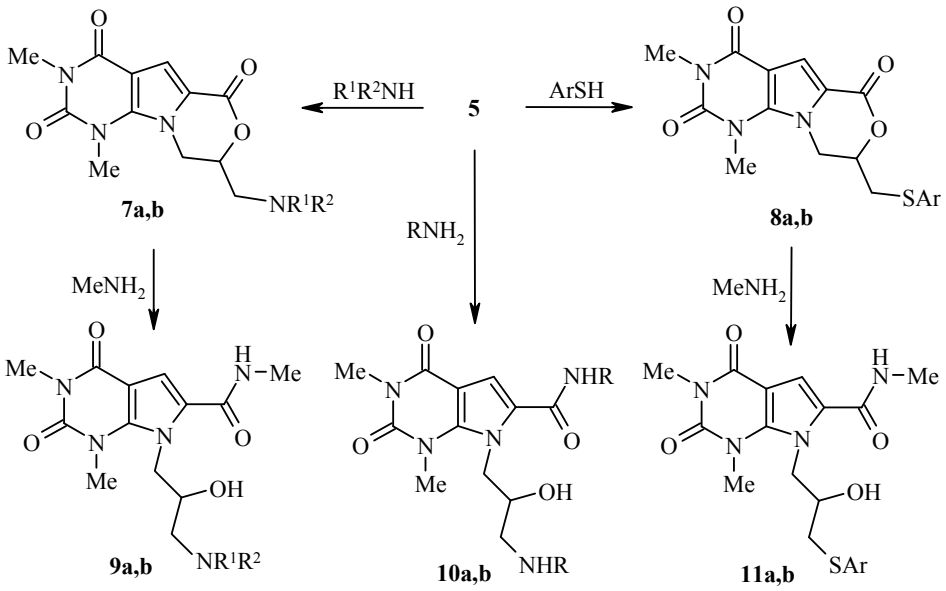


favorable positions of the allyl residue and the methoxycarbonyl groups. Hence it was desirable to study a bromolactonization reaction. This study showed that bromination of the pyrrolo[2,3-*d*]pyrimidine **2** in chloroform is accompanied by the formation of a mixture of compounds **5** and **6** which could be separated by crystallization.



The main reaction product is the pyrimido[5',4':4,5]pyrrolo[2,1-*c*][1,4]oxazine **5** obtained in 53% yield. It should be noted that the only representative of this tricyclic system had been reported by us recently [29]. A characteristic feature of the structure of compound **5** is the presence in the oxazine lactone fragment of two electrophilic centers (bromomethyl and carbonyl groups). In this connection it was important to study the reaction of this product with different nucleophilic reagents. Thus, treatment of compound **5** with thiophenols and secondary amines gives the products of substitution of the bromine atom in the bromomethyl group for the nitrogen- and sulfur-containing substituents in compounds **7a,b** and **8a,b** respectively.

It should also be noted that even prolonged heating of reagent **5** with an excess of the secondary amines does not lead to opening of the lactone ring whereas treatment of compounds **5, 7, 8** with an excess of primary aliphatic amines causes cleavage of the oxazine fragment and gives the products **9-11**. The composition and structure of the synthesized compounds were confirmed by elemental analysis and by mass spectrometric, IR, ^{1}H and ^{13}C NMR spectroscopic data. Hence the ^{1}H NMR spectra of the pyrimido[5',4',:4,5]pyrrolo[2,1-*c*][1,4]-oxazines **3, 5, 7** show signals for the CH_2 group protons as two, one-proton double doublets in the range



7, **9 a** NR^1R^2 =morpholin-4-yl, **b** NR^1R^2 = piperidin-1-yl;
8, **11 a** Ar = 4-MeC_6H_4, **b** Ar = 4-ClC_6H_4; **10 a** R= Me, **b** R= Pr

TABLE 1. Physicochemical Characteristics of the Synthesized Compounds **1-3, 5-11**

Compound	Empirical formula	Found, % / Calculated, %				Mp*, °C	Yield, %
		C	H	N	S (Br)		
1	$C_{10}H_{11}N_3O_4$	50.66 / 50.63	4.63 / 4.67	17.80 / 17.71	—	298-301 (decomp.)	60
2	$C_{13}H_{15}N_3O_4$	56.28 / 56.31	5.54 / 5.45	15.10 / 15.15	—	169-170	45
3	$C_{12}H_{13}N_3O_5$	51.65 / 51.61	4.72 / 4.69	14.99 / 15.05	—	257-259	46
5	$C_{12}H_{12}BrN_3O_4$	42.15 / 42.13	3.50 / 3.54	12.24 / 12.28	23.28 / 23.35	267-270	53
6	$C_{13}H_{15}Br_2N_3O_4$	35.61 / 35.72	3.37 / 3.46	9.57 / 9.61	36.49 / 36.56	218-220	15
7a	$C_{16}H_{20}N_4O_5$	55.12 / 55.17	5.70 / 5.79	16.01 / 16.08	—	258-261	68
7b	$C_{17}H_{22}N_4O_4$	59.05 / 58.95	6.37 / 6.40	16.10 / 16.17	—	194-195	65
8a	$C_{19}H_{19}N_3O_4S$	59.28 / 59.21	5.01 / 4.97	10.99 / 10.90	8.30 / 8.32	160-162	75
8b	$C_{18}H_{16}ClN_3O_4S$	53.33 / 53.27	4.02 / 3.97	10.40 / 10.35	7.83 / 7.90	228-230	72
9a	$C_{17}H_{25}N_5O_5$	53.78 / 53.82	6.59 / 6.64	18.38 / 18.46	—	243-245	75
9b	$C_{18}H_{27}N_5O_4$	57.32 / 57.28	7.11 / 7.21	18.48 / 18.55	—	223-225	64
10a	$C_{14}H_{21}N_5O_4$	52.05 / 52.00	6.57 / 6.55	21.61 / 21.66	—	216-218	65
10b	$C_{18}H_{29}N_5O_4$	57.00 / 56.98	7.73 / 7.70	18.51 / 18.46	—	171-172	61
11a	$C_{20}H_{24}N_4O_4S$	57.72 / 57.68	5.87 / 5.81	13.52 / 13.45	7.66 / 7.70	202-204	91
11b	$C_{19}H_{21}ClN_4O_4S$	52.28 / 52.23	4.77 / 4.84	12.91 / 12.82	7.39 / 7.34	224-226	88

*Recrystallization solvents: DMF (compound **1**), ethanol (compound **2**), mixture of DMF and ethanol (compounds **3, 5-11**).

4.37-4.96 ppm. A specific feature of the ^{13}C NMR spectra of compounds **3, 5, 7** is the presence of a signal for the C-8 carbon atom at 74.7-77.9 ppm. A comparison of spectroscopic properties of the compounds **3, 5, 7** with the closely structurally related heterocycles synthesized before also pointed to the formation of the 1,4-oxazine fragment [30]. The presence of the hydroxyl groups in compounds **9-11** which were formed upon opening of the oxazine ring, was confirmed from the IR and ^1H NMR spectra.

Thus a study of the reaction of the substrates with primary aliphatic amines has shown promise for the use of these compounds in the preparation of pyrrolo[2,3-*d*]pyrimidines which contain 3-amino-2-hydroxypropyl substituents in position 7 of the heterocycle.

TABLE 2. ^1H NMR Spectra of the Synthesized Compounds **1-3, 5-11**

Compound	Chemical shifts, δ, ppm (*J*, Hz)
1	3.22 (3H, s, NCH_3); 3.49 (3H, s, OCH_3); 3.82 (3H, s, NCH_3); 7.07 (1H, s, H-7); 12.52 (1H, s, NH)
2	3.21 (3H, s, NCH_3); 3.64 (3H, s, OCH_3); 3.74 (3H, s, NCH_3); 4.70 (1H, d, *J* = 17.5, CH); 5.16 (1H, d, *J* = 10.5, CH); 5.33 (2H, s, CH_2); 6.08 (1H, dd, *J* = 10.5, *J* = 17.5, CH); 7.22 (1H, s, H-7)
3	3.25 (3H, s, NCH_3); 3.70-3.72 (5H, m, NCH_3, CH_2); 4.41 (1H, dd, *J* = 10.0, *J* = 13.0) and 4.83 (1H, dd, *J* = 13.0, *J* = 3.0, NCH_2); 4.69-4.72 (1H, m, CH); 5.29 (1H, t, *J* = 6.0, OH); 7.28 (1H, s, H-7)
5	3.25 (3H, s, NCH_3); 3.68 (3H, s, NCH_3); 3.84 (1H, dd, *J* = 11.5, *J* = 5.5) and 3.92 (1H, dd, *J* = 11.5, *J* = 3.5, CH_2Br); 4.39 (1H, dd, *J* = 12.5, *J* = 10.0) and 4.96 (1H, dd, *J* = 12.5, *J* = 2.0, NCH_2); 4.98-5.09 (1H, m, CH); 7.31 (1H, s, H-7)
6	3.25 (3H, s, NCH_3); 3.74 (3H, s, OCH_3); 3.81 (3H, s, NCH_3); 3.99 (2H, d, *J* = 5.5, CH_2Br); 4.69-4.72 (1H, m, CHBr); 5.21-5.25 (2H, m, NCH_2); 7.30 (1H, s, H-7)
7a	2.49 (4H, br. s, $2CH_2$); 2.69 (2H, d, *J* = 5.1, CH_2); 3.23 (3H, s, NCH_3); 3.58 (4H, br. s, $2CH_2$); 3.70 (3H, s, NCH_3); 4.37 (1H, dd, *J* = 13.0, *J* = 9.8) and 4.81 (1H, dd, *J* = 13.0, *J* = 3.1, NCH_2); 4.88-4.92 (1H, m, CH); 7.27 (1H, s, H-7)
7b	1.37-1.39 (2H, m, CH_2); 1.48-1.52 (4H, m, $2CH_2$); 2.44-2.49 (4H, m, $2CH_2$); 2.62-2.66 (2H, m, CH_2); 3.25 (3H, s, NCH_3); 3.71 (3H, s, NCH_3); 4.37 (1H, dd, *J* = 13.0, *J* = 10.0) and 4.78 (1H, dd, *J* = 13.0, *J* = 2.6, NCH_2); 4.87-4.89 (1H, m, CH); 7.27 (1H, s, H-7)
8a	2.28 (3H, s, CH_3); 3.25 (3H, s, NCH_3); 3.41-3.44 (2H, m, SCH_2); 3.59 (3H, s, NCH_3); 4.40-4.43 (1H, m) and 4.84-4.86 (1H, m, CH_2); 4.87-4.89 (1H, m, CH); 7.15 (2H, d, *J* = 8.0, H Ar); 7.29 (1H, s, H-7); 7.35 (2H, d, *J* = 8.0, H Ar)
8b	3.24 (3H, s, NCH_3); 3.48-3.51 (2H, m, SCH_2); 3.64 (3H, s, NCH_3); 4.42-4.45 (1H, m) and 4.88-4.90 (1H, m, CH_2); 4.90-4.92 (1H, m, CH); 7.28 (1H, s, H-7); 7.38 (2H, d, *J* = 8.8, H Ar); 7.46 (2H, d, *J* = 8.8, H Ar)
9a	2.23 (2H, br. s, CH_2); 2.34 (4H, br. s, $2CH_2$); 2.69 (3H, d, *J* = 4.5, $NHC\underline{H}_3$); 3.22 (3H, s, NCH_3); 3.52 (4H, br. s, $2CH_2$); 3.74 (3H, s, NCH_3); 3.76-3.77 (1H, m, CH); 4.49-4.51 (1H, m, $C\underline{H}H$); 4.98-5.02 (2H, m, $CH\underline{H}$, OH); 7.08 (1H, s, H-7); 8.21 (1H, br. s, NH)
9b	1.33-1.36 (2H, m, CH_2); 1.44-1.47 (4H, m, $2CH_2$); 2.19-2.21 (2H, m, CH_2); 2.34-2.38 (4H, m, $2CH_2$); 2.71 (3H, d, *J* = 5.0, $NHC\underline{H}_3$); 3.23 (3H, s, NCH_3); 3.74-3.76 (4H, m, NCH_3, CH); 4.51-4.53 (1H, m, CH_2) and 4.91-4.93 (2H, m, CH_2, OH); 7.07 (1H, s, H-7); 8.25 (1H, br. s, NH)
10a	1.54 (1H, br. s, NH); 2.24 (3H, s, NCH_3); 2.38-2.41 (2H, m, CH_2); 2.69 (3H, d, *J* = 4.5, $NHC\underline{H}_3$); 3.21 (3H, s, NCH_3); 3.64-3.67 (1H, m, CH); 3.73 (3H, s, NCH_3); 4.55-4.57 (1H, m) and 4.86-4.89 (1H, m, CH_2); 5.01 (1H, br. s, OH); 7.09 (1H, s, H-7); 8.24 (1H, br. s, CONH)
10b	0.83-0.88 (6H, m, $2CH_3$); 1.37-1.39 (2H, m, CH_2); 1.49-1.52 (2H, m, CH_2); 2.42-2.45 (4H, m, $2CH_2$); 3.10-3.20 (2H, m, CH_2); 3.24 (3H, s, NCH_3); 3.65-3.68 (1H, m, CH); 3.76 (3H, s, NCH_3); 4.56-4.59 (1H, m) and 4.89-4.92 (1H, m, CH_2); 5.05 (1H, br. s, OH); 7.15 (1H, s, H-7); 8.31 (1H, br. s, NH)
11a	2.27 (3H, s, CH_3); 2.71 (3H, d, *J* = 4.5, $NHC\underline{H}_3$); 2.94-2.99 (2H, m, SCH_2); 3.22 (3H, s, NCH_3); 3.72-3.74 (4H, m, NCH_3, CH); 4.58-4.60 (1H, m) and 5.07-5.09 (1H, m, CH_2); 5.45 (1H, d, *J* = 5.5, OH); 7.10 (2H, d, *J* = 8.0, H Ar); 7.12 (1H, s, H-7); 7.22 (2H, d, *J* = 8.0, H Ar); 8.27 (1H, br. s, NH)
11b	2.71 (3H, d, *J* = 4.0, $NHC\underline{H}_3$); 2.94-3.07 (2H, m, SCH_2); 3.23 (3H, s, NCH_3); 3.73-3.75 (4H, m, NCH_3, CH); 4.60-4.62 (1H, m) and 5.04-5.08 (1H, m, CH_2); 5.52 (1H, d, *J* = 5.5, OH); 7.13 (1H, s, H-7); 7.35 (4H, br. s, H Ar); 8.26 (1H, br. s, NH)

EXPERIMENTAL

IR spectra were recorded on a Bruker Vertex 70 FTIR instrument using KBr pellets. ^{1}H and ^{13}C NMR spectra were recorded on Varian VXR-300 (300 MHz) (compound **7a**), Varian Mercury-400 (400 MHz) (compounds **7b, 8b**), and Bruker Avance 500 instruments (500 MHz and 125 MHz, respectively) (compounds **1-6, 8a, 9-11**) using DMSO-d_6 with TMS as internal standard. Chromato-mass spectra were recorded on an Agilent 1100 LC/MSD VL spectrometer using APCI (atmospheric pressure positive chemical ionization). Monitoring of the reaction progress and purity of the compounds obtained was performed by TLC on Silufol UV-254 plates and revealed using UV light.

The starting methyl 1,3-dimethyl-2,4-dioxo-2,3,4,7-tetrahydro-1*H*-pyrrolo[2,3-*d*]pyrimidine-6-carboxylate (**1**) was prepared using the method [31].

Methyl 1,3-Dimethyl-2,4-dioxo-7-(prop-2-en-1-yl)-2,3,4,7-tetrahydro-1*H*-pyrrolo[2,3-*d*]pyrimidine-6-carboxylate (2). Allyl bromide (15 mmol) was added with stirring to a suspension of compound **1** (2.37 g, 10 mmol) and K_2CO_3 (2.8 g, 20.2 mmol) in DMF (50 ml). The mixture was heated for 6 h at 75ºC, cooled, and diluted with water (50 ml). The product was extracted with chloroform (3×25 ml), solvent evaporated *in vacuo*, and the residue was recrystallized.

8-Hydroxymethyl-1,3-dimethyl-8,9-dihydro-2*H*-pyrimido[5',4':4,5]pyrrolo[2,1-*c*][1,4]oxazine-2,4,6(1*H*,3*H*)-trione (3). A mixture of the pyrrolo[2,3-*d*]pyrimidine **2** (0.5 g, 11.8 mmol), $KClO_3$ (0.3 g), and OsO_4 (10 mg, 0.04 mmol) in 1:1 aqueous MeOH (20 ml) was refluxed for 12 h. The precipitate formed was filtered off and purified by crystallization. IR spectrum, ν, cm^{-1}: 1559 (C=O), 1656 (C=O), 1697 (C=O), 3404 (OH). ^{13}C NMR spectrum, δ, ppm: 158.6 (6-C=O); 158.3 (2-C=O); 151.7 (4-C=O); 139.6 (C-10a); 117.8 (C-5a); 113.2 (C-5); 102.4 (C-4a); 77.9 (C-8); 60.9 (C-9); 45.0 (CH_2OH); 32.1 (NCH_3); 28.5 (NCH_3).

Bromination of the Pyrrolo[2,3-*d*]pyrimidine 2. Bromine (1.86 ml, 36.0 mmol) in chloroform (5 ml) was added dropwise with stirring to a suspension of the pyrrolo[2,3-*d*]pyrimidine **2** (5.0 g, 18.0 mmol) in chloroform (25 ml). The mixture was heated at 50ºC until became homogeneous. The mixture was cooled and the oily residue was separated by decantation, diluted with EtOH (20 ml), and held for 10 min at 70-80ºC. The precipitate formed was filtered off and purified by crystallization (compound **5**). The solvent after decantation was evaporated *in vacuo* and the residue obtained was refluxed for 5 min in EtOH (20 ml). The precipitate formed was filtered off and purified by crystallization (compound **6**).

8-Bromomethyl-1,3-dimethyl-8,9-dihydro-2*H*-pyrimido[5',4':4,5]pyrrolo[2,1-*c*][1,4]oxazino-2,4,6(1H,3H)-trione (5). IR spectrum, ν, cm^{-1}: 1557 (C=O), 1660 (C=O), 1690 (C=O). ^{13}C NMR spectrum, δ, ppm: 158.9 (2-C=O); 158.3 (6-C=O); 151.6 (4-C=O); 139.8 (C-10a); 117.4 (C-5a); 113.7 (C-5); 102.3 (C-4a); 75.5 (C-8); 46.4 (C-9); 32.2 (CH_2Br); 32.1 (NCH_3); 28.5 (NCH_3). Mass spectrum, *m/z*: 344/342 ($^{81}Br/^{79}Br$) $[M+H]^+$ (100).

Methyl 7-(2,3-Dibromopropyl)-1,3-dimethyl-2,4-dioxo-2,3,4,7-tetrahydro-1*H*-pyrrolo[2,3-*d*]pyrimidine-6-carboxylate (6). ^{13}C NMR spectrum, δ, ppm: 161.0 (O–C=O); 158.3 (2-C=O); 152.3 (4-C=O); 143.5 (C-8); 121.9 (C-6); 115.5 (C-5); 101.6 (C-9); 53.1 (CHBr); 52.3 (OCH_3); 50.7 (NCH_2); 35.9 (CH_2Br); 33.8 (NCH_3); 28.6 (NCH_3).

1,3-Dimethyl-8-(morpholin-4-ylmethyl)-8,9-dihydro-2*H*-pyrimido[5',4':4,5]pyrrolo[2,1-*c*][1,4]oxazino-2,4,6(1*H*,3*H*)-trione (7a). A mixture of compound **5** (0.34 g, 1 mmol) and morpholine (0.26 g, 3 mmol) was heated for 5 h at 110-120ºC, cooled, and diluted with EtOH (10 ml). The mixture was left for 3-4 h at room temperature and the precipitate formed was filtered off and purified by crystallization. IR spectrum, ν, cm^{-1}: 1685 (C=O); 1689 (C=O); 1726 (C=O). ^{13}C NMR spectrum, δ, ppm: 157.9 (6-C=O); 157.8 (2-C=O); 151.2 (4-C=O); 139.5 (C-10a); 117.3 (C-5a); 112.7 (C-5); 101.9 (C-4a); 74.7 (C-8); 58.6 (C-9); 45.7 (C-11); 31.6 (NCH_3); 28.0 (NCH_3); 66.1 ($O(CH_2)_2$); 53.7 ($N(CH_2)_2$). Mass spectrum, *m/z*: 349 $[M+H]^+$ (100).

1,3-Dimethyl-8-(piperidin-1-ylmethyl)-8,9-dihydro-2*H*-pyrimido[5',4':4,5]pyrrolo[2,1-*c*][1,4]oxazino-2,4,6(1*H*,3*H*)-trione (7b) was prepared similarly. ^{13}C NMR spectrum, δ, ppm: 158.5 (6-C=O); 158.3 (2-C=O); 151.7 (4-C=O); 139.6 (C-10a); 117.9 (C-5a); 113.2 (C-5); 102.4 (C-4a); 75.5 (C-8); 59.5 (C-9);

55.1 ($N(CH_2)_2$); 46.3 (C-11); 39.6 (NCH_3); 32.2 (NCH_3); 28.5 ($(CH_2)_2$); 26.1 (CH_2). Mass spectrum, *m/z*: 347 $[M+H]^+$ (100).

8-[(Arylsulfanyl)methyl]-1,3-dimethyl-8,9-dihydro-2*H*-pyrimido[5',4':4,5]pyrrolo[2,1-*c*][1,4]oxazino-2,4,6(1*H*,3*H*)-triones 8a,b (General Method). A mixture of compound **5** (0.34 g, 1.0 mmol), the corresponding thiophenol (1.1 mmol), and Et_3N (1.1 mmol) in MeCN (10 ml) was refluxed for 2 h. The mixture was left for 3-4 h at room temperature and the precipitate formed was filtered off and purified by recrystallization.

1,3-Dimethyl-8-[(4-methylphenylsulfanyl)methyl]-8,9-dihydro-2*H*-pyrimido[5',4':4,5]pyrrolo[2,1-*c*]-[1,4]oxazino-2,4,6(1H,3H)-trione (8a). IR spectrum, ν, cm^{-1}: 1664 (C=O), 1695 (C=O), 1722 (C=O).

Reaction of the Pyrimido[5',4':4,5]pyrrolo[2,1-*c*][1,4]oxazines 5, 7a,b, 8a,b with Methylamine (General Method). A mixture of one of the pyrimido[5',4':4,5][pyrrolo[2,1-*c*][1,4]oxazines **5, 7a,b, 8a,b** (0.8 mmol) and $MeNH_2$ (4.0 mmol) in MeOH (10 ml) was refluxed for 3 h, and the precipitate formed was filtered off and purified by crystallization.

7-[Hydroxy-3-(morpholin-4-yl)propyl]-*N*,1,3-trimethyl-2,4-dioxo-2,3,4,7-tetrahydro-1*H*-pyrrolo-[2,3-*d*]pyrimidine-6-carboxamide (9a). IR spectrum, ν, cm^{-1}: 1551 (C=O), 1653 (C=O), 1687 (C=O), 3301 (NH), 3406 (OH). Mass spectrum, *m/z*: 380 $[M+H]^+$ (100).

7-[2-Hydroxy-3-(methylamino)propyl]-*N*,1,3-trimethyl-2,4-dioxo-2,3,4,7-tetrahydro-1*H*-pyrrolo-[2,3-*d*]pyrimidine-6-carboxamide (10a). IR spectrum, ν, cm^{-1}: 1645 (br., C=O), 1705 (C=O), 2929-3101 (NH), 3294 (NH), 3395 (OH).

7-{2-Hydroxy-3-[(4-methylphenyl)sulfanyl]propyl}-*N*,1,3-trimethyl-2,4-dioxo-2,3,4,7-tetrahydro-1*H*-pyrrolo[2,3-*d*]pyrimidine-6-carboxamide (11a). IR spectrum, ν, cm^{-1}: 1650 (br., C=O), 1703 (C=O), 3393 (NH), 3453 (OH).

7-{-3-[(4-Chlorophenyl)sulfanyl-2-hydroxy]propyl}-*N*,1,3-trimethyl-2,4-dioxo-2,3,4,7-tetrahydro-1*H*-pyrrolo[2,3-*d*]pyrimidine-6-carboxamide (11b). IR spectrum, ν, cm^{-1}: 1649 (br., C=O), 1702 (C=O), 3392 (NH), 3442 (OH).

7-[2-Hydroxy-3-(propylamino)propyl]-*N*,1,3-trimethyl-2,4-dioxo-2,3,4,7-tetrahydro-1*H*-pyrrolo-[2,3-*d*]pyrimidine-6-carboxamide (10b). A mixture of compound **5** (0.34 g, 1 mmol) and propylamine (5 mmol) was refluxed for 5 h and the precipitate formed was filtered off and purified by crystallization. IR spectrum, ν, cm^{-1}: 1651 (br., C=O), 1698 (C=O), 2960-3100 (NH), 3310 (NH); 3396 (OH).

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