A Novel Approach to Pyrrolo[2,1-*b*]thiazoles

Anton V. Tverdokhlebov,*[a] Elizaveta V. Resnyanska,[a] Andrey A. Tolmachev,[b] Alexander P. Andrushko[a]

[a] Enamine Ltd. Co., I. Kudry str. 31, apt.17, 02042, Kiev, Ukraine

[b] Kiev National Taras Shevchenko University, Volodimirska str., 62, 01033, Kiev, Ukraine
E-mail: atver@mail.univ.kiev.ua

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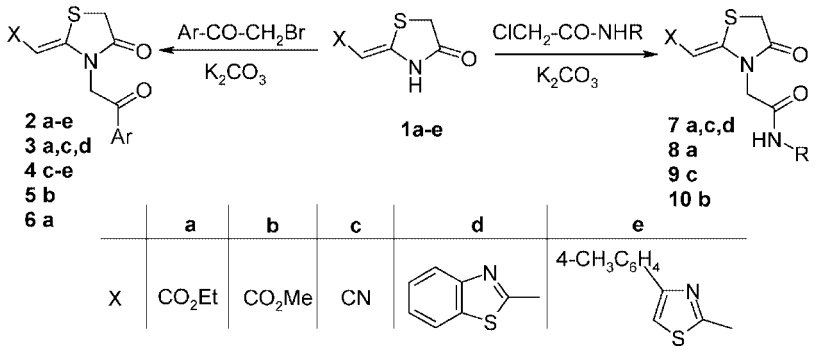
Abstract: 5-Aroyl-2-(dimethylamino)methylidene-2,3-dihydro-3-oxopyrrolo[2,1-*b*]thiazole-7-carboxylic acid esters, -7-carbonitriles and corresponding 7-hetaryl substituted derivatives were prepared. Thus, the substituted acetonitriles (XCH_2CN, where X = CO_2R, CN, hetaryl) were treated with mercaptoacetic acid yielding 2-(X-methylidene)thiazolidin-4-ones, which were N-alkylated with phenacyl bromides. Further formylation of the obtained compounds with excess of $DMF{\cdot}POCl_3$ complex led to the above mentioned pyrrolo[2,1-*b*]thiazoles.

Key words: alkylations, heterocycles, pyrrolo[2,1-*b*]thiazoles, ring closure, 4-thiazolidinones

An increasing interest in pyrrolo[2,1-*b*]thiazoles is caused by high level of biological activities exhibited by certain carboxylic acid derivatives of this system. Thus, pyrrolo[2,1-*b*]thiazole-3-carboxylic acid amides are able to modulate dopaminergic neurotransmission in CNS in vivo[1] while the corresponding 7-carboxylic acid esters were found to be useful for prevention and treatment of various liver diseases.[2] There are two general approaches to pyrrolo[2,1-*b*]thiazole-7-carboxylic acid derivatives. The first one is a thiazole ring annulation to the 2-thioxo-3-pyrrolidinecarboxylic acid esters by the action of 1,2-bielectrophilic reagents.[2] The second one is based on the cycloaddition reactions of thiazolium ylides,[3] imidazo[2,1-*b*]thiazoles[4] or mesoionic thiazolo[3,2-*c*]oxazoles[5] with dimethyl acetylenedicarboxylate and related unsaturated acids derivatives. During our investigations on 2-thiazoleacetonitriles chemistry we have obtained certain pyrrolo[2,1-*b*]thiazole-7-carbonitriles[6a] and related benzo derivatives.[6b] Furthermore, several examples of pyrrolo[2,1-*b*]thiazoles formation from 2-thiazole- or 2-thiazolidineacetic acid derivatives were also reported by other researchers.[7] However, all these findings[6,7] are of episodic character and can not be considered as general synthetic methods. So it is of interest to elaborate general approach to pyrrolo[2,1-*b*]thiazoles on the basis of 2-thiazoleacetic acid and related derivatives. It should complete the above mentioned methods extending the scope of available 7-carboxylic acid derivatives of the target system. The results of our investigations in this field are reported herein.

2-(4-Oxothiazolidin-2-ylidene)acetic acid esters **1a**,**b**, the nitrile **1c** and their heterocyclic analogues **1d**,**e** were selected as starting materials because they are readily available from the corresponding nitriles XCH_2CN and mercaptoacetic acid[8] (Scheme 1). The alkylation of the compounds **1** with 2-bromoacetophenones in the presence of K_2CO_3 was found to proceed smoothly at the nitrogen atom resulting in 3-(2-aryl-2-oxoethyl)-2-methylidenethiazolidin-4-ones **2a**–**e**, **3a**,**c**,**d**, **4c**–**e**, **5b**, **6a**. Similarly, the alkylation with chloroacetic acid anilides yielded *N*-aryl-2-methylidene-4-oxo-3-thiazolidineacetamides **7a**,**c**,**d**, **8a**, **9c**, **10b**. Satzinger reported[8b,c] the N-alkylation of compounds **1a**,**c** and their 5-phenyl substituted derivatives **16** (Figure 1) with simple haloalkanes and dimethyl sulfate under similar conditions. Also it was shown, that



Scheme 1 Ar = **2**: 4-ClC_6H_4, **3**: 4-BrC_6H_4, **4**: 4-$O_2NC_6H_4$, **5**: Ph, **6**: 4-PhC_6H_4; R = **7**: 4-$EtOC_6H_4$, **8**: 3,4-$(MeO)_2C_6H_3$, **9**: 4-MeC_6H_4, **10**: 4-*i*-PrC_6H_4

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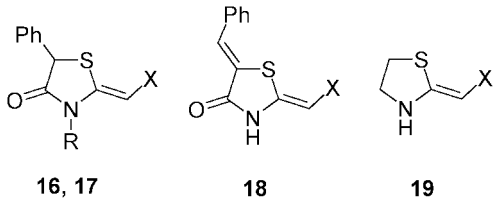
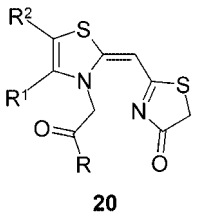
the *N*-methyl derivatives **17** could be alkylated for the second time at C-5 under more drastic circumstances.[8b] Moreover, with benzyl chloride only bis-benzyl derivatives of **16** were obtained anyway.[8b] On the other hand, the alkylation at the exocyclic enamine carbon was described for benzylidene derivatives **18** and deoxo analogues **19**.[7b–d] Nevertheless, in the present case, in spite of a high activity of the alkylating agents decreasing the selectivity, neither exocyclic carbon nor oxomethylene moiety underwent alkylation. Compounds **2**–**6** were the sole products isolated in good yields.



16, **17** **18** **19**

Figure 1 Structures of compounds **16**–**19**; X = **16**–**18**: CN, CO_2Et; **19**: COMe, COPh; R = **16**: H; **17**: Me

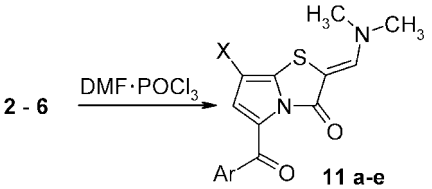
In contrary to compounds **1a**–**c**, their heterocyclic analogues **1d**,**e** in principle could be alkylated at the other nitrogen yielding the products of isomeric structure **20** (Figure 2). The regioisomers **2d**,**e**, **3d**, **4d**,**e**, **7d** and **20** could not be distinguished on the basis of simple spectral data (^1H and ^{13}C NMR). To resolve this problem and to confirm the assigned structures **2d**,**e**, **3d**, **4d**,**e**, **7d** for prepared compounds, the long-range C-H correlation (HMBC experiment) was carried out for the derivative **7d**. It revealed the two correlations of the singlet of endocyclic methylene protons at 4.05 ppm with the signals of 2-C and 4-C of the thiazolone moiety at 148.8 and 172.1 ppm, respectively. Simultaneously, the singlet of the NCH_2 group at 4.57 ppm established the correlations with the same carbons signals. These data confirm finally the structure of **7d** and exclude the isomeric one **20** where there are no carbons capable to exhibit correlations with both methylene signals.



20

Figure 2 Structure of compound **20**; $R^1 + R^2$ = benzo; R^1 = 4-MeC_6H_4, R^2 = H

The formylation of the thiazolones **2**–**6** with excess of DMF·$POCl_3$ complex accomplished the preparation of target system by incorporation of a C_1-unit into position 6 (Scheme 2). The pyrrole ring closure is accompanied with the methylene group transformation into its (dimethylamino)methylidene derivative yielding 5-aroyl-2-(dimethylamino)methylidene-2,3-dihydro-3-oxopyrrolo[2,1-*b*]thiazole-7-carboxylic acid esters **11a**,**b**, **12b**, **14b**, **15a**, -carbonitriles **11c**, **12c**, **13c** and their hetaryl substituted analogues **11d**,**e**, **12d**, **13d**,**e**. Unfortunately, attempts to prepare the corresponding pyrrolo[2,1-*b*]thiazole-5-carboxamides via formylation of the 3-thiazolidineacetamides **7**–**10** failed. A mixture of products was formed and only impure pyrrolothiazoles could be isolated from it. Probably, $POCl_3$ coordination at the carboxamide moiety of the starting materials caused side processes producing impurities. So the scope of the method is limited to the preparation of the 5-aroyl derivatives **11**–**15**.



11 a-e
12 a,c,d
13 c-e
14 b
15 a

Scheme 2 Ar = **11**: 4-ClC_6H_4, **12**: 4-BrC_6H_4, **13**: 4-$O_2NC_6H_4$, **14**: Ph, **15**: 4-PhC_6H_4; for the substituent X, see: Scheme 1

Noteworthy is the incorporation of a one-atom unit into the acyclic precursor, which is a widely used strategy in heterocyclic synthesis. However, literature search revealed only the sole application of such an approach to pyrrolo[2,1-*b*]thiazole synthesis via incorporation of a C_1-unit into position 5 of the system.[9] Hence, the sequence described herein represents a novel approach to pyrrolo[2,1-*b*]thiazole skeleton construction.

The structures of pyrrolothiazoles **11**–**15** were confirmed by ^1H, ^{13}C and 2D NMR spectroscopical data. Thus, the signals of both methylene groups observed in the ^1H NMR spectra of the starting compounds **2**–**6** at 3.9–4.3 and 5.2–5.5 ppm disappeared from the spectra of derivatives **11**–**15**. Instead, the six-proton singlet of the dimethylamino group at 3.2–3.3 ppm and two one-proton singlets at 7.9–8.0 and 7.1–7.6 ppm assigned to the methylidene proton and 6-H, respectively, were present therein. For the latter one the long-range C-H-correlation (HMBC) experiment performed for the compound **11d** revealed five correlations with the following carbon signals: 7-C at 110.2 ppm, 5-C at 128.2 ppm, 2-C of the benzothiazole moiety at 153.3 ppm, 7a-C at 160.0 ppm and the carbonyl of the aroyl substituent at C-5 at 181.4 ppm. This correlations set is a weighty evidence for the assigned structure. The singlet of the methylidene proton also exhibited correlations with the signals of 2-C at 87.2 ppm and 3-C at 160.2 ppm. Finally, the mass spectrum of the derivative **11d** established an expected $M^{\cdot+}$ value 465.

To resume, as a result of present investigation the convenient method for preparation of 5-aroyl-2-(dimethylamino)methylidene-2,3-dihydro-3-oxopyrrolo[2,1-*b*]thiazole-7-carboxylic acid derivatives **11a**–**c**, **12a**,**c**, **13c**, **14b**, **15a** and related 7-hetaryl substituted compounds **11d**,**e**,

12d, **13d**,**e** has been worked out. It utilizes readily available starting materials and simple experimental procedures thus completing the well known methods.[2–5] Moreover, the prepared compounds **11**–**15** are the rare examples of 3-oxo derivatives of the target system. To date only three representatives of pyrrolo[2,1-*b*]thiazol-3-ones are described.[7d,10] Finally, the present method offers a novel approach to the formation of pyrrolo[2,1-*b*]thiazole skeleton.

Thiazolidinones **1a**–**d** were prepared as reported.[8] 2-Bromoacetophenones are commercially available or obtained from commercially available acetophenones via standard procedures. Chloroacetic acid anilides were obtained according to the described method.[11] All mps were determined in capillary tubes in a Thiele apparatus and are uncorrected. ^{1}H NMR spectra were recorded on a Varian VXR-300 (300 MHz) spectrometer in DMSO-d_6 solutions. Chemical shifts (δ) are given in ppm downfield from internal $SiMe_4$. *J* values are in Hz. ^{13}C and 2D NMR experiments were performed on a Bruker Avance 500 (500 MHz for ^{1}H and 125 MHz for ^{13}C) spectrometer. For the assignments of hydrogen atoms referred as Ar, R, and X in the experimental part, please see Schemes 1 and 2. Mass spectra were determined on a Varian 212 instrument at 70 eV. The purity of all compounds prepared was checked by ^{1}H NMR spectroscopy.

2-[4-(4-Methylphenyl)-2-thiazolyl]methylidenethiazolidin-4-one (1e)

A solution of 4-(4-methylphenyl)-2-thiazoleacetonitrile (**5**;[12] 2.1 g, 10 mmol) and mercaptoacetic acid (1.1 g, 12 mmol) in anhyd pyridine (5 mL) was refluxed for 6 h. After cooling, the precipitated solid was filtered, washed with H_2O and dried to yield compound **1e** as yellow crystals; mp 214 °C.

^{1}H NMR: δ = 2.33 (s, 3 H, CH_3), 3.87 (s, 2 H, CH_2), 6.34 (s, 1 H, CH), 7.24 (d, 2 H, *J* = 9.0 Hz, C_6H_4), 7.76 (s, 1 H, 5-H_X), 7.89 (d, 2 H, *J* = 9.0 Hz, C_6H_4), 12.16 (s, 1 H, NH).

^{13}C NMR: δ = 21.8 (CH_3), 31.4 (5-C), 92.6 (CHX), 125.7 (2,6-C_{tol}), 130.1 (3,5-C_{tol}), 131.9 (4-C_{tol}), 133.1 (1-C_{tol}), 142.4 (5-C_X), 152.3 (2-C), 165.7 (4-C_X), 166.6 (2-C_X), 172.7 (4-C).

Anal. Calcd for $C_{14}H_{12}N_2OS_2$: C, 58.31; H, 4.19; N, 9.71; S, 22.24. Found: C, 58.16; H, 4.26; N, 9.62; S, 22.29.

2-Thiazolidinylideneacetic Acid Ethyl Esters 2a, 3a, 6a, 7a, 8a; General Procedure

Powdered K_2CO_3 (1.0 g, 7.2 mmol) was added to a solution of ester **1a** (1.1 g, 6 mmol) and the corresponding 2-bromoacetophenone or chloroacetic acid anilide (6 mmol) in EtOH (5 mL) and the resulting mixture was refluxed for 1.5–2 h. After cooling, the precipitated solid was filtered, thoroughly washed with H_2O to remove inorganic materials, dried, and recrystallized (if necessary) from an appropriate solvent to give **2a**, **3a**, **6a**, **7a**, **8a**. An additional portion of products could be obtained after pouring the ethanolic filtrate into H_2O, filtration of the formed solid and recrystallization.

2-{3-[2-(4-Chlorophenyl)-2-oxoethyl]-4-oxo-2-thiazolidinylidene}acetic Acid Ethyl Ester (2a)

Mp 102 °C (DMF–H_2O); yield: 1.5 g (73%).

^{1}H NMR: δ = 1.16 (t, 3 H, *J* = 7.5 Hz, CH_3), 3.99 (s, 2 H, SCH_2), 4.05 (q, 2 H, *J* = 7.5 Hz, OCH_2), 5.35 (s, 2 H, NCH_2), 5.63 (s, 1 H, CH), 7.65 (d, 2 H, *J* = 9.0 Hz, Ar), 8.06 (d, 2 H, *J* = 9.0, Ar).

^{13}C NMR: δ = 14.3 (CH_3), 30.7 (5-C), 52.5 (NCH_2), 60.1 (OCH_2), 91.3 (CHX), 129.0 (3,5-C_{Ar}), 133.6 (2,6-C_{Ar}), 134.0 (1-C_{Ar}), 138.4 (4-C_{Ar}), 152.0 (2-C), 165.4 (COO), 174.7 (4-C), 191.7 (COAr).

Anal. Calcd for $C_{15}H_{14}ClNO_4S$: C, 53.02; H, 4.15; N, 4.12; S, 9.44; Cl, 10.43. Found: C, 52.94; H, 4.19; N, 4.03; S, 9.38; Cl, 10.50.

2-{3-[2-(4-Bromophenyl)-2-oxoethyl]-4-oxo-2-thiazolidinylidene}acetic Acid Ethyl Ester (3a)

Mp 145 °C (DMF); yield: 1.8 g (80%).

^{1}H NMR: δ = 1.15 (t, 3 H, *J* = 7.5 Hz, CH_3), 3.99 (s, 2 H, SCH_2), 4.05 (q, 2 H, *J* = 7.5 Hz, OCH_2), 5.35 (s, 2 H, NCH_2), 5.63 (s, 1 H, CH), 7.80 (d, 2 H, *J* = 9.0 Hz, Ar), 7.98 (d, 2 H, *J* = 9.0 Hz, Ar).

^{13}C NMR: δ = 14.3 (CH_3), 33.4 (5-C), 51.9 (NCH_2), 60.9 (OCH_2), 91.3 (CHX), 127.3 (4-C_{Ar}), 131.5 (3,5-C_{Ar}), 132.9 (2,6-C_{Ar}), 134.3 (1-C_{Ar}), 151.2 (2-C), 166.3 (COO), 173.9 (4-C), 191.6 (COAr).

Anal. Calcd for $C_{15}H_{14}BrNO_4S$: C, 46.89; H, 3.67; N, 3.65; S, 8.34; Br, 20.79. Found: C, 46.95; H, 3.78; N, 3.57; S, 8.29; Br, 20.59.

2-{3-[2-(Biphenyl-4-yl)-2-oxoethyl]-4-oxo-2-thiazolidinylidene}acetic Acid Ethyl Ester (6a)

Mp 185 °C (DMF); yield: 2.0 g (88%).

^{1}H NMR: δ = 1.15 (t, 3 H, *J* = 7.5 Hz, CH_3), 4.01 (s, 2 H, SCH_2), 4.05 (q, 2 H, *J* = 7.5 Hz, OCH_2), 5.39 (s, 2 H, NCH_2), 5.63 (s, 1 H, CH), 7.45–7.55 (m, 3 H, Ar), 7.78 (d, 2 H, *J* = 8.0 Hz, Ar), 7.89 (d, 2 H, *J* = 9.0 Hz, Ar), 8.14 (d, 2 H, *J* = 9.0 Hz, Ar).

^{13}C NMR: δ = 14.7 (CH_3), 32.6 (5-C), 52.5 (NCH_2), 60.0 (OCH_2), 91.5 (CHX), 125.5 (2′,6′-C_{Ar}), 127.8 (4′-C_{Ar}), 128.5 (3′,5′-C_{Ar}), 130.8 (3,5-C_{Ar}), 131.4 (2,6-C_{Ar}), 134.0 (1-C_{Ar}), 141.8 (4-C_{Ar}), 143.1 (1′-C_{Ar}), 154.1 (2-C), 165.1 (COO), 172.6 (4-C), 191.3 (COAr).

Anal. Calcd for $C_{21}H_{19}NO_4S$: C, 66.12; H, 5.02; N, 3.67; S, 8.41. Found: C, 66.06; H, 4.95; N, 3.82; S, 8.58.

2-{3-[2-[(4-Ethoxyphenyl)amino]-2-oxoethyl]-4-oxo-2-thiazolidinylidene}acetic Acid Ethyl Ester (7a)

Mp 183 °C (EtOH); yield: 1.6 g (73%).

^{1}H NMR: δ = 1.21 (t, 3 H, *J* = 7.2 Hz, CH_3), 1.33 (t, 3 H, *J* = 6.9 Hz, CH_3), 3.89 (s, 2 H, SCH_2), 3.95 (q, 2 H, *J* = 7.2 Hz, OCH_2), 4.08 (q, 2 H, *J* = 7.2 Hz, OCH_2), 4.45 (s, 2 H, NCH_2), 5.47 (s, 1 H, CH), 6.81 (d, 2 H, *J* = 8.7 Hz, R), 7.43 (d, 2 H, *J* = 9.0 Hz, R), 10.11 (s, 1 H, NH).

^{13}C NMR: δ = 14.5 (CH_3), 14.7 (CH_3), 32.4 (5-C) 46.0 (NCH_2), 60.9 (OCH_2), 63.2 (OCH_2), 92.3 (CHX), 114.0 (3,5-C_R), 120.7 (2,6-C_R), 135.4 (1-C_R), 154.8 (4-C_R), 146.9 (2-C), 166.1 (COO), 167.7 (CONH), 173.7 (4-C).

Anal. Calcd for $C_{17}H_{20}N_2O_5S$: C, 56.03; H, 5.53; N, 7.69; S, 8.80. Found: C, 55.98; H, 5.69; N, 7.61; S, 8.73.

2-{3-[2-[(3,4-dimethoxyphenyl)amino]-2-oxoethyl]-4-oxo-2-thiazolidinylidene}acetic Acid Ethyl Ester (8a)

Mp 193 °C (EtOH); yield: 1.9 g (83%).

^{1}H NMR: δ = 1.17 (t, 3 H, *J* = 7.2 Hz, CH_3), 3.70 (s, 6 H, 2 OCH_3), 3.95 (s, 2 H, SCH_2), 4.06 (q, 2 H, *J* = 7.2 Hz, OCH_2), 4.50 (s, 2 H, NCH_2), 5.55 (s, 1 H, CH), 6.89 (d, 1 H, *J* = 8.8 Hz, R), 7.01 (dd, 1 H, J^3 = 8.8 Hz, J^4 = 2.0 Hz, R), 7.31 (d, 1 H, *J* = 2.0 Hz, R), 10.21 (s, 1 H, NH).

^{13}C NMR: δ = 14.4 (CH_3), 33.6 (5-C) 48.3 (NCH_2), 55.2 (OCH_3), 56.4 (OCH_3), 61.4 (OCH_2), 92.7 (CHX), 108.6 (2-C_R), 113.7 (5-C_R), 120.5 (6-C_R), 135.4 (1-C_R), 147.6 (4-C_R), 149.9 (3-C_R), 158.0 (2-C), 165.2 (COO), 168.8 (CONH), 172.1 (4-C).

Anal. Calcd for $C_{17}H_{20}N_2O_6S$: C, 53.67; H, 5.30; N, 7.36; S, 8.43. Found: C, 53.79; H, 5.18; N, 7.45; S, 8.29.

2-Thiazolidinylideneacetic Acid Methyl Esters 2b, 5b, 10b

The methyl esters were obtained from the ester **1b** according to above procedure using MeOH instead of EtOH to avoid a re-esterification.

2-{3-[2-(4-Chlorophenyl)-2-oxoethyl]-4-oxo-2-thiazolidinylidene}acetic Acid Methyl Ester (2b)
Mp 163 °C (DMF–H_2O); yield: 1.5 g (77%).

^{1}H NMR: δ = 3.58 (s, 3 H, CH_3), 4.01 (s, 2 H, SCH_2), 5.36 (s, 2 H, NCH_2), 5.66 (s, 1 H, CH), 7.67 (d, 2 H, *J* = 8.0 Hz, Ar), 8.07 (d, 2 H, *J* = 8.0 Hz, Ar).

^{13}C NMR: δ = 33.5 (5-C), 51.4 (CH_3), 53.3 (NCH_2), 90.8 (CHX), 129.1 (3,5-C_{Ar}), 133.6 (2,6-C_{Ar}), 134.2 (1-C_{Ar}), 138.3 (4-C_{Ar}), 152.2 (2-C), 166.1 (COO), 174.7 (4-C), 192.9 (COAr).

Anal. Calcd for $C_{14}H_{12}ClNO_4S$: C, 51.62; H, 3.71; N, 4.30; S, 9.84; Cl, 10.88. Found: C, 51.55; H, 3.89; N, 4.36; S, 9.77; Cl, 10.94.

2-[4-Oxo-3-(2-oxo-2-phenylethyl)-2-thiazolidinylidene]acetic Acid Methyl Ester (5b)
Mp 149 °C (dioxane); yield: 1.3 g (75%).

^{1}H NMR: δ = 3.58 (s, 3 H, CH_3), 4.00 (s, 2 H, SCH_2), 5.36 (s, 2 H, NCH_2), 5.63 (s, 1 H, CH), 7.59 (t, 2 H, *J* = 10.0 Hz, Ar), 7.72 (t, 1 H, *J* = 10.0 Hz, Ar), 8.06 (d, 2 H, *J* = 10.0 Hz, Ar).

^{13}C NMR: δ = 32.6 (5-C), 51.4 (CH_3), 52.5 (NCH_2), 92.7 (CHX), 128.2 (3,5-C_{Ar}), 133.4 (2,6-C_{Ar}), 134.5 (4-C_{Ar}), 136.6 (1-C_{Ar}), 158.6 (2-C), 170.8 (COO), 173.7 (4-C), 193.2 (COAr).

Anal. Calcd for $C_{14}H_{13}NO_4S$: C, 57.72:, H, 4.50; N, 4.81; S, 11.01. Found: C, 57.65:, H, 4.39; N, 4.88; S, 11.12.

2-{3-[2-[4-(Isopropyl)phenyl]amino-2-oxoethyl]-4-oxo-2-thiazolidinylidene}acetic Acid Methyl Ester (10b)
Mp 125 °C (MeOH); yield: 1.9 g (91%).

^{1}H NMR: δ = 1.17 [d, 6 H, *J* = 6.0 Hz, $CH(CH_3)_2$], 2.83 [1 H, m, $CH(CH_3)_2$], 3.60 (s, 3 H, OCH_3), 3.95 (s, 2 H, SCH_2), 4.50 (s, 2 H, NCH_2), 5.55 (s, 1 H, CH), 7.17 (d, 2 H, *J* = 9.0 Hz, R), 7.45 (d, 2 H, *J* = 9.0 Hz, R), 10.19 (s, 1 H, NH).

^{13}C NMR: δ = 23.4 [$CH(CH_3)_2$], 31.0 (5-C), 33.8 [$CH(CH_3)_2$], 50.8 (CH_3), 54.3 (NCH_2), 91.3 (CHX), 119.7 (2,6-C_R), 129.7 (3,5-C_R), 138.5 (4-C_R), 139.9 (1-C_R), 162.0 (2-C), 169.1 (COO), 171.4 (4-C), 176.7 (COR).

Anal. Calcd for $C_{17}H_{20}N_2O_4S$: C, 58.60; H, 5.79; N, 8.04; S, 9.20. Found: C, 58.74; H, 5.71; N, 7.95; S, 9.11.

2-Thiazolidinylideneacetonitriles 2c, 3c, 4c, 7c, 9c and 2-Hetarylmethylidene-4-thiazolidinones 2d,e, 3d, 4d,e, 7d; General Procedure
Powdered K_2CO_3 (1.0 g, 7.2 mmol) was added to a solution of **1c**–**e** (6 mmol) and the corresponding alkylating agent (6 mmol) in DMF (5 mL) and the resulting mixture was heated at 120–130 °C for 1.5–2 h. When the derivative **1c** was used as starting material, the cooled mixture was poured into H_2O, the precipitated solid was filtered, dried and recrystallized from aq DMF yielding nitriles **2c**, **3c**, **4c**, **7c**, **9c**. When the alkylation was carried out for compounds **1d**,**e**, the mixture was cooled, the precipitate formed was filtered, thoroughly washed with H_2O to remove inorganic materials and recrystallized (if necessary) from DMF or aq DMF to give **2d**,**e**, **3d**, **4d**,**e**, **7d**.

2-{3-[2-(4-Chlorophenyl)-2-oxoethyl]-4-oxo-2-thiazolidinylidene}acetonitrile (2c)
Mp 137 °C (DMF–H_2O); yield: 1.2 g (68%).

^{1}H NMR: δ = 4.26 (s, 2H, SCH_2), 5.28 (s, 2 H, NCH_2), 5.38 (s, 1 H, CH), 7.66 (d, 2 H, *J* = 9.0 Hz, Ar), 8.05 (d, 2 H, *J* = 9.0 Hz, Ar).

^{13}C NMR: δ = 32.7 (5-C), 51.8 (NCH_2), 65.7 (CHX), 116.5 (CN), 129.0 (3,5-C_{Ar}), 133.5 (2,6-C_{Ar}), 135.9 (1-C_{Ar}), 138.4 (4-C_{Ar}), 156.5 (2-C), 172.8 (4-C), 192.5 (COAr).

Anal. Calcd for $C_{13}H_9ClN_2O_2S$: C, 53.34; H, 3.10; N, 9.57; S, 10.95; Cl, 12.11. Found: C, 53.29; H, 3.21; N, 9.41; S, 11.03; Cl, 12.02.

2-(2-Benzothiazolylmethylidene)-3-[2-(4-chlorophenyl)-2-oxoethyl]thiazolidin-4-one (2d)
Mp 256 °C (DMF); yield: 2.0 g (83%).

^{1}H NMR: δ = 4.03 (s, 2 H, SCH_2), 5.39 (s, 2 H, NCH_2), 6.62 (s, 1 H, CH), 7.28 (t, 1 H, *J* = 7.8 Hz, X), 7.42 (t, 1 H, *J* = 7.8 Hz, X), 7.63 (d, 2 H, *J* = 9.0 Hz, Ar), 7.83 (d, 1 H, *J* = 7.8 Hz, X), 7.89 (d, 1 H, *J* = 7.8 Hz, X), 8.12 (d, 2 H, *J* = 9.0 Hz, Ar).

^{13}C NMR: δ = 33.0 (5-C), 52.1 (NCH_2), 92.5 (CHX), 121.2 (7-C_X), 121.9 (4-C_X), 123.9 (6-C_X), 126.3 (5-C_X), 128.8 (3,5-C_{Ar}), 131.7 (7a-C_X), 133.6 (2,6-C_{Ar}), 135.5 (1-C_{Ar}), 138.2 (4-C_{Ar}), 152.9 (2-C), 153.5 (3a-C_X), 163.8 (2-C_X), 173.2 (4-C), 191.9 (COAr).

Anal. Calcd for $C_{19}H_{13}ClN_2O_2S_2$: C, 56.92; H, 3.27; N, 6.99; S, 16.00; Cl, 8.84. Found: C, 56.88; H, 3.32; N, 7.06; S, 15.87; Cl, 8.79.

3-[2-(4-Chlorophenyl)-2-oxoethyl]-2-[4-(4-methylphenyl)-2-thiazolyl]methylidenethiazolidin-4-one (2e)
Mp 279 °C (DMF); yield: 2.1 g (81%).

^{1}H NMR: δ = 2.34 (s, 3 H, CH_3), 4.06 (s, 2 H, SCH_2), 5.39 (s, 2 H, NCH_2), 6.67 (s, 1 H, CH), 7.26 (d, 2 H, *J* = 9.0 Hz, X), 7.68 (d, 2 H, *J* = 9.0 Hz, Ar), 7.79 (s, 1 H, 5-H_X), 7.91 (d, 2 H, *J* = 9.0 Hz, Ar), 8.11 (d, 2 H, *J* = 9.0 Hz, X).

^{13}C NMR: δ = 21.1 (CH_3), 32.5 (5-C), 52.1 (NCH_2), 91.8 (CHX), 125.2 (2,6-C_{tol}), 129.1 (3,5-C_{Ar}), 130.2 (3,5-C_{tol}), 131.0 (4-C_{tol}), 133.5 (1-C_{tol}), 133.6 (2,6-C_{Ar}), 135.3 (1-C_{Ar}), 137.9 (4-C_{Ar}), 140.8 (5-C_X), 153.5 (2-C), 166.4 (4-C_X), 166.8 (2-C_X), 173.4 (4-C), 191.2 (COAr).

Anal. Calcd for $C_{22}H_{17}ClN_2O_2S_2$: C, 59.92; H, 3.89; N, 6.35; S, 14.54; Cl, 8.04. Found: C, 60.02; H, 3.84; N, 6.21; S, 14.67; Cl, 8.12.

2-{3-[2-(4-Bromophenyl)-2-oxoethyl]-4-oxo-2-thiazolidinylidene}acetonitrile (3c)
Mp 185 °C (DMF–H_2O); yield: 1.8 g (89%).

^{1}H NMR: δ = 4.26 (s, 2 H, SCH_2), 5.28 (s, 2 H, NCH_2), 5.38 (s, 1 H, CH), 7.80 (d, 2 H, *J* = 8.4 Hz, Ar), 7.97 (d, 2 H, *J* = 8.4 Hz, Ar).

^{13}C NMR: δ = 31.6 (5-C), 51.8 (NCH_2), 65.6 (CHX), 119.6 (CN), 130.3 (4-C_{Ar}), 130.5 (3,5-C_{Ar}), 132.3 (2,6-C_{Ar}), 140.1 (1-C_{Ar}), 162.6 (2-C), 169.6 (4-C), 192.9 (COAr).

Anal. Calcd for $C_{13}H_9BrN_2O_2S$: C, 46.31; H, 2.69; N, 8.31; S, 9.51; Br, 23.70. Found: C, 46.32; H, 2.74; N, 8.23; S, 9.58; Br, 23.79.

2-(2-Benzothiazolylmethylidene)-3-[2-(4-bromophenyl)-2-oxoethyl]thiazolidin-4-one (3d)
Mp 289 °C (DMF); yield: 2.3 g (86%).

^{1}H NMR: δ = 4.08 (s, 2 H, SCH_2), 5.41 (s, 2 H, NCH_2), 6.70 (s, 1 H, CH), 7.31 (t, 1 H, *J* = 7.8 Hz, X), 7.45 (t, 1 H, *J* = 7.8 Hz, X), 7.85 (m, 3 H, X, Ar), 7.97 (d, 1 H, *J* = 7.8 Hz, X), 8.03 (d, 2 H, *J* = 8.4 Hz, Ar).

^{13}C NMR: δ = 33.6 (5-C), 52.1 (NCH_2), 92.7 (CHX), 122.7 (7-C_X), 122.9 (4-C_X), 124.9 (6-C_X), 125.8 (5-C_X), 127.3 (4-C_{Ar}), 130.1 (3,5-C_{Ar}), 131.8 (7a-C_X), 135.9 (2,6-C_{Ar}), 136.8 (1-C_{Ar}), 151.8 (3a-C_X), 156.1 (2-C), 161.8 (2-C_X), 171.9 (4-C), 193.1 (COAr).

Anal. Calcd for $C_{19}H_{13}BrN_2O_2S_2$: C, 51.24; H, 2.94; N, 6.29; S, 14.40; Br, 17.94. Found: C, 51.19; H, 2.99; N, 6.32; S, 14.28; Br, 18.01.

2-{3-[2-(4-Nitrophenyl)-2-oxoethyl]-4-oxo-2-thiazolidinylidene}acetonitrile (4c)
Mp 196 °C (DMF–H_2O); yield: 1.4 g (77%).

^{1}H NMR: δ = 4.28 (s, 2 H, SCH_2), 5.38 (s, 2 H, NCH_2), 5.44 (s, 1 H, CH), 8.28 (d, 2 H, *J* = 9.0 Hz, Ar), 8.39 (d, 2 H, *J* = 9.0 Hz, Ar).

^{13}C NMR: δ = 32.8 (5-C), 52.1 (NCH_2), 65.6 (CHX), 116.5 (CN), 123.5 (3,5-C_{Ar}), 133.4 (2,6-C_{Ar}), 142.9 (1-C_{Ar}), 149.4 (4-C_{Ar}), 156.6 (2-C), 173.0 (4-C), 193.1 (COAr).

Anal. Calcd for $C_{13}H_9N_3O_4S$: C, 51.48; H, 2.99; N, 13.85; S, 10.57. Found: C, 51.33; H, 3.08; N, 13.80; S, 10.63.

2-(2-Benzothiazolylmethylidene)-3-[2-(4-nitrophenyl)-2-oxoethyl]thiazolidin-4-one (4d)
Mp 219 °C (DMF); yield: 1.9 g (77%).

^{1}H NMR: δ = 4.10 (s, 2 H, SCH_2), 5.51 (s, 2 H, NCH_2), 6.76 (s, 1 H, CH), 7.31 (t, 1 H, *J* = 9.0 Hz, X), 7.45 (t, 1 H, *J* = 9.0 Hz, X), 7.85 (d, 1 H, *J* = 9.0 Hz, X), 7.97 (d, 1 H, *J* = 9.0 Hz, X), 8.35 (d, 2 H, *J* = 9.0 Hz, Ar), 8.42 (d, 2 H, *J* = 9.0 Hz, Ar).

^{13}C NMR: δ = 32.4 (5-C), 52.1 (NCH_2), 92.6 (CHX), 123.0 (4-C_X), 123.2 (7-C_X), 125.6 (6-C_X), 125.4 (5-C_X), 128.5 (3,5-C_{Ar}), 132.4 (7a-C_X), 133.8 (2,6-C_{Ar}), 141.2 (1-C_{Ar}), 149.1 (4-C_{Ar}), 149.8 (3a-C_X), 157.7 (2-C), 167.5 (2-C_X), 169.9 (4-C), 193.9 (COAr).

Anal. Calcd for $C_{19}H_{13}N_3O_4S_2$: C, 55.46; H, 3.18; N, 10.21; S, 15.59. Found: C, 55.41; H, 3.07; N, 10.28; S, 15.67.

2-[4-(4-Methylphenyl)-2-thiazolyl]methylidene-3-[2-(4-nitrophenyl)-2-oxoethyl]thiazolidin-4-one (4e)
Mp 256 °C (DMF); yield: 2.2 g (81%).

^{1}H NMR: δ = 2.34 (s, 3 H, CH_3), 4.08 (s, 2 H, SCH_2), 5.47 (s, 2 H, NCH_2), 6.71 (s, 1 H, CH), 7.26 (d, 2 H, *J* = 9.0 Hz, X), 7.79 (s, 1 H, 5-H_X), 7.91 (d, 2 H, *J* = 9.0 Hz, X), 8.33 (d, 2 H, *J* = 9.0 Hz, Ar), 8.41 (d, 2 H, *J* = 9.0 Hz, Ar).

^{13}C NMR: δ = 21.2 (CH_3), 31.6 (5-C), 52.6 (NCH_2), 91.6 (CHX), 125.7 (2,6-C_{tol}), 128.6 (3,5-C_{Ar}), 130.0 (3,5-C_{tol}), 132.9 (4-C_{tol}), 133.3 (1-C_{tol}), 133.4 (2,6-C_{Ar}), 140.4 (5-C_X), 142.7 (1-C_{Ar}), 149.6 (4-C_{Ar}), 158.4 (2-C), 167.8 (4-C_X), 166.1 (2-C_X), 171.4 (4-C), 192.8 (COAr).

Anal. Calcd for $C_{22}H_{17}N_3O_4S_2$: C, 58.52; H, 3.80; N, 9.31; S, 14.20. Found: C, 58.66; H, 3.77; N, 9.48; S, 14.09.

2-Cyanomethylidene-*N*-(4-ethoxyphenyl)-4-oxo-3-thiazolidineacetamide (7c)
Mp 230 °C (DMF–H_2O); yield: 1.8 g (92%).

^{1}H NMR: δ = 1.34 (t, 3 H, *J* = 7.2 Hz, CH_3), 3.97 (q, 2 H, *J* = 7.2 Hz, OCH_2), 4.15 (s, 2 H, SCH_2), 4.42 (s, 2 H, NCH_2), 5.21 (s, 1 H, CH), 6.80 (d, 2 H, *J* = 9.0 Hz, R), 7.42 (d, 2 H, *J* = 9.0 Hz, R), 10.04 (s, 1 H, NH).

^{13}C NMR: δ = 14.7 (CH_3), 31.6 (5-C), 45.5 (NCH_2), 63.0 (OCH_2), 66.5 (CHX), 114.3 (3,5-C_R), 116.6 (CN), 120.9 (2,6-C_R), 135.0 (1-C_R), 152.4 (2-C), 154.8 (4-C_R), 167.6 (CONH), 171.8 (4-C).

Anal. Calcd for $C_{15}H_{15}N_3O_3S$: C, 56.77; H, 4.76; N, 13.24; S, 10.10. Found: C, 56.81; H, 4.59; N, 13.19; S, 10.13.

2-(2-Benzothiazolylmethylidene)-*N*-(4-ethoxyphenyl)-4-oxo-3-thiazolidineacetamide (7d)
Mp 254 °C (DMF–H_2O); yield: 2.3 g (90%).

^{1}H NMR: δ = 1.33 (t, 3 H, *J* = 6.9, CH_3), 3.98 (q, 4 H, *J* = 6.9 Hz, OCH_2), 4.05 (s, 2 H, SCH_2), 4.57 (s, 2 H, NCH_2), 6.53 (s, 1 H, CH), 6.82 (d, 2 H, *J* = 8.7 Hz, R), 7.29 (t, 1 H, *J* = 8.1 Hz, X), 7.45 (m, 3 H, R, X), 7.83 (d, 1 H, *J* = 8.1 Hz, X), 7.91 (d, 1 H, *J* = 8.1 Hz, X), 10.09 (s, 1 H, NH).

^{13}C NMR: δ = 14.6 (CH_3), 31.9 (5-C), 45.5 (NCH_2), 63.0 (OCH_2), 93.7 (CHX), 114.4 (3,5-C_R), 120.6 (2,6-C_R), 121.2 (7-C_X), 121.7 (4-C_X), 123.9 (6-C_X), 126.2 (5-C_X), 131.5 (1-C_R), 133.3 (7a-C_X), 148.8 (2-C), 153.2 (3a-C_X), 154.6 (4-C_R), 163.5 (2-C_X), 163.9 (CONH), 172.1 (4-C).

Anal. Calcd for $C_{21}H_{19}N_3O_3S_2$: C, 59.28; H, 4.50; N, 9.87; S, 15.07. Found: C, 59.35; H, 4.42; N, 9.84; S, 15.11.

2-Cyanomethylidene-*N*-(4-methylphenyl)-4-oxo-3-thiazolidineacetamide (9c)
Mp 207 °C (DMF–H_2O); yield: 1.5 g (87%).

^{1}H NMR: δ = 2.24 (s, 3 H, CH_3), 4.20 (s, 2 H, SCH_2), 4.45 (s, 2 H, NCH_2), 5.36 (s, 1 H, CH), 7.11 (d, 2 H, *J* = 8.4 Hz, R), 7.42 (d, 2 H, *J* = 8.4 Hz, R), 10.21 (s, 1 H, NH).

^{13}C NMR: δ = 20.6 (CH_3), 30.9 (5-C), 44.6 (NCH_2), 66.8 (CHX), 118.2 (CN), 120.4 (2,6-C_R), 127.1 (3,5-C_R), 133.1 (4-C_R), 137.4 (1-C_R), 153.7 (2-C), 165.0 (CONH), 169.5 (4-C).

Anal. Calcd for $C_{14}H_{13}N_3O_2S$: C, 58.52; H, 4.56; N, 14.62; S, 11.16. Found: C, 58.44; H, 4.59; N, 14.77; S, 11.09.

5-Aroyl-2-(dimethylamino)methylidene-2,3-dihydro-3-oxopyrrolo[2,1-*b*]thiazoles 11–15; General Procedure
Appropriate **2**–**6** (3 mmol) was added to a cold solution of $POCl_3$ (1.4 g, 9 mmol) in anhyd DMF (5 mL) and the mixture was gently heated to dissolve the starting material. The resulting solution was kept at 50–55 °C for 2 h. After cooling, the precipitated solid was filtered and washed consecutively with H_2O, aq sat. $NaHCO_3$ solution and again with H_2O to afford pure **11**–**15**. Further quantities of derivatives **11**–**15** were obtained when the filtrate was poured onto crushed ice, the precipitate formed was filtered, washed as above and recrystallized from DMF or aq DMF.

5-(4-Chlorobenzoyl)-2-(dimethylamino)methylidene-2,3-dihydro-3-oxopyrrolo[2,1-*b*]thiazole-7-carboxylic Acid Ethyl Ester (11a)
Mp 175 °C (DMF–H_2O); yield: 0.8 g (66%).

^{1}H NMR: δ = 1.28 (t, 3 H, *J* = 7.4 Hz, CH_3), 3.26 [s, 6 H, $N(CH_3)_2$], 4.24 (q, 2 H, *J* = 7.4, CH_2), 7.17 (s, 1 H, 6-H), 7.56 (d, 2 H, *J* = 8.4, Ar), 7.78 (d, 2 H, *J* = 8.4, Ar), 7.90 (s, 1 H, =CHN).

^{13}C NMR: δ = 14.5 (CH_3), 40.0 [$N(CH_3)_2$], 59.0 (OCH_2), 87.2 (2-C), 107.9 (7-C), 124.4 (6-C), 126.1 (3,5-C_{Ar}), 127.7 (1-C_{Ar}), 129.9 (2,6-C_{Ar}), 137.6 (5-C), 140.3 (4-C_{Ar}), 141.1 (7a-C), 150.4 (=CHN), 159.5 (3-C), 162.9 (7-CO), 182.1 (5-CO).

Anal. Calcd for $C_{19}H_{17}ClN_2O_4S$: C, 56.37; H, 4.23; N, 6.92; S, 7.92; Cl, 8.76. Found: C, 56.36; H, 4.19; N, 6.84; S, 8.03; Cl, 8.61.

5-(4-Chlorobenzoyl)-2-(dimethylamino)methylidene-2,3-dihydro-3-oxopyrrolo[2,1-*b*]thiazole-7-carboxylic Acid Methyl Ester (11b)
Mp 198 °C (DMF–H_2O); yield: 0.9 g (77%).

^{1}H NMR: δ = 3.26 [s, 6 H, $N(CH_3)_2$], 3.78 (s, 3 H, OCH_3), 7.18 (s, 1 H, 6-H), 7.56 (d, 2 H, *J* = 9.0 Hz, Ar), 7.78 (d, 2 H, *J* = 9.0 Hz, Ar), 7.91 (s, 1 H, =CHN).

^{13}C NMR: δ = 40.9 [$N(CH_3)_2$], 51.6 (OCH_3), 87.9 (2-C), 106.9 (7-C), 124.4 (6-C), 127.1 (1-C_{Ar}), 128.5 (3,5-C_{Ar}), 129.7 (2,6-C_{Ar}), 137.6 (5-C), 140.1 (4-C_{Ar}), 141.2 (7a-C), 151.3 (=CHN), 160.0 (3-C), 163.1 (7-CO), 183.5 (5-CO).

Anal. Calcd for $C_{18}H_{15}ClN_2O_4S$: C, 55.32; H, 3.87; N, 7.17; S, 8.20; Cl, 9.07. Found: C, 55.28; H, 3.98; N, 7.19; S, 8.11; Cl, 9.16.

5-(4-Chlorobenzoyl)-2-(dimethylamino)methylidene-2,3-dihydro-3-oxopyrrolo[2,1-*b*]thiazole-7-carbonitrile (11c)
Mp 130 °C (DMF–H_2O); yield: 0.7 g (65%).

^{1}H NMR: δ = 3.27 [s, 6 H, $N(CH_3)_2$], 7.45 (s, 1 H, 6-H), 7.56 (d, 2 H, *J* = 9.0 Hz, Ar), 7.79 (d, 2 H, *J* = 9.0 Hz, Ar), 7.97 (s, 1 H, =CHN).

^{13}C NMR: δ = 41.1 [$N(CH_3)_2$], 77.6 (7-C), 92.8 (2-C), 108.0 (CN), 123.4 (6-C), 126.1 (3,5-C_{Ar}), 131.7 (2,6-C_{Ar}), 135.5 (5-C), 136.2 (1-

C_{Ar}), 140.3 (4-C_{Ar}), 144.0 (7a-C), 150.6 (=CHN), 157.5 (3-C), 180.6 (5-CO).

Anal. Calcd for $C_{17}H_{12}ClN_3O_2S$: C, 57.06; H, 3.38; N, 11.74; S, 8.96; Cl, 9.91. Found: C, 57.13; H, 3.27; N, 11.71; S, 9.01; Cl, 9.95.

7-(2-Benzothiazolyl)-5-(4-chlorobenzoyl)-2-(dimethylamino)methylidenepyrrolo[2,1-*b*]thiazol-3(2*H*)-one (11d)
Mp 165 °C (DMF); yield: 1.2 g (86%).

^{1}H NMR: δ = 3.27 [s, 6 H, $N(CH_3)_2$], 7.43 (t, 1 H, *J* = 8.0 Hz, X), 7.54 (t, 1 H, *J* = 8.0 Hz, X), 7.59 (s, 1 H, 6-H), 7.63 (d, 2 H, *J* = 8.4 Hz, Ar), 7.88 (d, 2 H, *J* = 8.4 Hz, Ar), 7.99 (s, 1 H, =CHN), 8.01 (d, 1 H, *J* = 8.0 Hz, X), 8.13 (d, 1 H, *J* = 8.0 Hz, X).

^{13}C NMR: δ = 40.2 [$N(CH_3)_2$], 87.2 (2-C), 110.2 (7-C), 121.8 (7-C_X) 122.2 (4-C_X), 123.7 (6-C), 124.6 (6-C_X), 126.5 (5-C_X), 128.2 (5-C), 128.5 (3,5-C_{Ar}), 130.8 (2,6-C_{Ar}), 133.4 (7a-C_X), 134.8 (3a-C_X), 136.8 (4-C_{Ar}), 137.4 (1-C_{Ar}), 150.5 (=CHN), 153.3 (2-C_X), 160.0 (7a-C), 160.2 (3-C), 181.4 (5-CO).

Anal. Calcd for $C_{23}H_{16}ClN_3O_2S_2$: C, 59.28; H, 3.46; N, 9.02; S, 13.76; Cl, 7.61. Found: C, 59.34; H, 3.44; N, 8.94; S, 13.84; Cl, 7.58.

5-(4-Chlorobenzoyl)-2-(dimethylamino)methylidene-7-[4-(4-methylphenyl)-2-thiazolyl]pyrrolo[2,1-*b*]thiazol-3(2*H*)-one (11e)
Mp >300 °C (DMF); yield: 1.3 g (87%).

^{1}H NMR: δ = 2.41 (s, 3 H, CH_3), 3.29 [s, 6 H, $N(CH_3)_2$], 7.37 (d, 2 H, *J* = 7.6 Hz, X), 7.61 (m, 3 H, 6-H, Ar), 7.82 (m, 4 H, Ar, X), 7.95 (s, 1 H, =CHN), 8.25 (s, 1 H, 5-H_X).

^{13}C NMR: δ = 21.1 (CH_3), 40.2 [$N(CH_3)_2$], 87.6 (2-C), 102.3 (7-C), 118.3 (6-C), 124.2 (2,6-C_{tol}), 124.9 (5-C_X), 126.2 (4-C_X), 126.5 (3,5-C_{Ar}), 128.1 (5-C), 128.6 (3,5-C_{tol}), 129.1 (4-C_{Ar}), 132.0 (2,6-C_{Ar}), 135.5 (1-C_{tol}), 137.4 (1-C_{Ar}), 139.0 (4-C_{tol}), 150.6 (=CHN), 156.7 (2-C_X), 159.4 (7a-C), 160.5 (3-C), 183.0 (5-CO).

Anal. Calcd for $C_{26}H_{20}ClN_3O_2S_2$: C, 61.71; H, 3.98; N, 8.30; S, 12.67; Cl, 7.01. Found: C, 61.66; H, 4.06; N, 8.27; S, 12.62; Cl, 7.15.

5-(4-Bromobenzoyl)-2-(dimethylamino)methylidene-2,3-dihydro-3-oxopyrrolo[2,1-*b*]thiazole-7-carboxylic Acid Ethyl Ester (12a)
Mp 185 °C (DMF); yield: 1.0 g (74%).

^{1}H NMR: δ = 1.27 (t, 3 H, *J* = 7.5 Hz, CH_3), 3.26 [s, 6 H, $N(CH_3)_2$], 4.24 (q, 2 H, *J* = 7.5 Hz, CH_2), 7.17 (s, 1 H, 6-H), 7.71 (m, 4 H, Ar), 7.90 (s, 1 H, =CHN).

^{13}C NMR: δ = 14.4 (CH_3), 41.3 [$N(CH_3)_2$], 59.2 (OCH_2), 89.9 (2-C), 105.6 (7-C), 122.8 (6-C), 127.4 (3,5-C_{Ar}), 127.5 (4-C_{Ar}), 128.0 (1-C_{Ar}), 130.1 (2,6-C_{Ar}), 140.8 (5-C), 141.5 (7a-C), 149.2 (=CHN), 157.0 (3-C), 162.3 (7-CO), 184.8 (5-CO).

Anal. Calcd for $C_{19}H_{17}BrN_2O_4S$: C, 50.79; H, 3.81; N, 6.23; S, 7.14; Br, 17.78. Found: C, 50.62; H, 3.88; N, 6.22; S, 7.11; Br, 17.92.

5-(4-Bromobenzoyl)-2-(dimethylamino)methylidene-2,3-dihydro-3-oxopyrrolo[2,1-*b*]thiazole-7-carbonitrile (12c)
Mp 179 °C (DMF); yield: 1.1 g (91%).

^{1}H NMR: δ = 3.26 [s, 6 H, $N(CH_3)_2$], 7.45 (s, 1 H, 6-H), 7.71 (m, 4 H, Ar), 7.97 (s, 1 H, =CHN).

^{13}C NMR: δ = 42.9 [$N(CH_3)_2$9, 75.3 (7-C), 95.3 (2-C), 108.0 (CN), 120.0 (6-C), 127.1 (4-C_{Ar}), 129.3 (3,5-C_{Ar}), 133.3 (2,6-C_{Ar}), 137.1 (1-C_{Ar}), 139.1 (5-C), 146.4 (7a-C), 150.2 (=CHN), 154.2 (3-C), 182.2 (5-CO).

Anal. Calcd for $C_{17}H_{12}BrN_3O_2S$: C, 50.76; H, 3.01; N, 10.45; S, 7.97; Br, 19.86. Found: C, 50.69; H, 3.06; N, 10.49; S, 8.09; Br, 19.71.

7-(2-Benzothiazolyl)-5-(4-bromobenzoyl)-2-(dimethylamino)methylidenepyrrolo[2,1-*b*]thiazol-3(2*H*)-one (12d)
Mp 209 °C (DMF); yield: 1.3 g (87%).

^{1}H NMR: δ = 3.30 [s, 6 H, $N(CH_3)_2$], 7.38 (t, 1 H, *J* = 6.0 Hz, X), 7.50 (m, 2 H, 6-H, X), 7.74 (m, 4 H, Ar), 7.93 (s, 1 H, =CHN), 7.96 (d, 1 H, *J* = 6.0 Hz, X), 8.06 (d, 1 H, *J* = 6.0 Hz, X).

^{13}C NMR: δ = 41.3 [$N(CH_3)_2$], 87.5 (2-C), 106.0 (7-C), 120.5 (6-C), 123.3 (7-C_X) 124.0 (6-C_X), 124.2 (5-C_X), 125.0 (4-C_X), 128.5 (4-C_{Ar}), 128.9 (5-C), 129.0 (3,5-C_{Ar}), 130.7 (2,6-C_{Ar}), 132.6 (7a-C_X), 136.5 (3a-C_X), 137.5 (1-C_{Ar}), 149.2 (=CHN), 156.4 (2-C_X), 159.2 (7a-C), 160.6 (3-C), 182.6 (5-CO).

Anal. Calcd for $C_{23}H_{16}BrN_3O_2S_2$: C, 54.12; H, 3.16; N, 8.23; S, 12.56; Br, 15.65. Found: C, 54.08; H, 3.13; N, 8.19; S, 12.64; Br, 15.44.

2-(Dimethylamino)methylidene-2,3-dihydro-5-(4-nitrobenzoyl)-3-oxopyrrolo[2,1-*b*]thiazole-7-carbonitrile (13c)
Mp 237 °C (DMF–H_2O); yield: 0.65 g (59%).

^{1}H NMR: δ = 3.26 [s, 6 H, $N(CH_3)_2$], 7.55 (s, 1 H, 6-H), 7.97 (s, 1 H, =CHN), 7.99 (d, 2 H, *J* = 8.7 Hz, Ar), 8.30 (d, 2 H, *J* = 8.7 Hz, Ar).

^{13}C NMR: δ = 42.1 [$N(CH_3)_2$], 74.3 (7-C), 95.7 (2-C), 108.3 (CN), 119.0 (6-C), 129.0 (3,5-C_{Ar}), 132.9 (2,6-C_{Ar}), 139.3 (5-C), 141.6 (1-C_{Ar}), 147.0 (7a-C), 149.6 (4-C_{Ar}), 151.6 (=CHN), 154.3 (3-C), 182.6 (5-CO).

Anal. Calcd for $C_{17}H_{12}N_4O_4S$: C, 55.43; H, 3.28; N, 15.21; S, 8.70. Found: C, 55.49; H, 3.22; N, 15.13; S, 8.76.

7-(2-Benzothiazolyl)-2-(dimethylamino)methylidene-5-(4-nitrobenzoyl)pyrrolo[2,1-*b*]thiazol-3(2*H*)-one (13d)
Mp 220 °C (dec.) (DMF); yield: 1.1 g (77%).

^{1}H NMR: δ = 3.28 [s, 6 H, $N(CH_3)_2$], 7.38 (t, 1 H, *J* = 7.5 Hz, X), 7.49 (t, 1 H, *J* = 7.5 Hz, X), 7.58 (s, 1 H, 6-H), 7.91 (s, 1 H, =CHN), 7.95 (d, 1 H, *J* = 7.5 Hz, X), 8.02 (d, 2 H, *J* = 9.0 Hz, Ar), 8.07 (d, 1 H, *J* = 7.5 Hz, X), 8.31 (d, 2 H, *J* = 9.0 Hz, Ar).

^{13}C NMR: δ = 41.3 [$N(CH_3)_2$], 88.6 (2-C), 104.9 (7-C), 119.7 (6-C), 123.1 (7-C_X) 124.4 (5-C_X), 124.9 (6-C_X), 125.6 (4-C_X), 126.8 (5-C), 129.5 (3,5-C_{Ar}), 131.7 (2,6-C_{Ar}), 132.5 (7a-C_X), 138.1 (3a-C_X), 140.2 (1-C_{Ar}), 148.5 (=CHN), 148.6 (4-C_{Ar}), 153.9 (2-C_X), 163.1 (7a-C), 164.4 (3-C), 182.9 (5-CO).

Anal. Calcd for $C_{23}H_{16}N_4O_4S_2$: C, 57.97; H, 3.38; N, 11.76; S, 13.46. Found: C, 57.94; H, 3.47; N, 11.71; S, 13.49.

2-(Dimethylamino)methylidene-7-[4-(4-methylphenyl)-2-thiazolyl]-5-(4-nitrobenzoyl)pyrrolo[2,1-*b*]thiazol-3(2*H*)-one (13e)
Mp 160 °C (dec.) (DMF); yield: 1.1 g (71%).

^{1}H NMR: δ = 2.35 (s, 3 H, CH_3), 3.27 [s, 6 H, $N(CH_3)_2$], 7.28 (d, 2 H, *J* = 9.0 Hz, X), 7.57 (s, 1 H, 6-H), 7.92 (m, 4 H, X, =CHN, 5-H_X), 8.02 (d, 2 H, *J* = 6.0 Hz, Ar), 8.33 (d, 2 H, *J* = 6.0 Hz, Ar).

^{13}C NMR: δ = 21.8 (CH_3), 40.9 [$N(CH_3)_2$], 85.6 (2-C), 102.2 (7-C), 118.6 (6-C), 124.2 (2,6-C_{tol}), 126.0 (3,5-C_{Ar}), 126.9 (5-C_X), 128.1 (3,5-C_{tol}), 128.5 (4-C_X), 129.8 (5-C), 131.7 (2,6-C_{Ar}), 135.7 (1-C_{tol}), 139.0 (4-C_{tol}), 141.1 (1-C_{Ar}), 148.6 (4-C_{Ar}), 153.4 (=CHN), 156.4 (7a-C), 159.6 (2-C_X), 162.6 (3-C), 183.0 (5-CO).

Anal. Calcd for $C_{26}H_{20}N_4O_4S_2$: C, 60.45; H, 3.90; N, 10.85; S, 12.41. Found: C, 60.38; H, 3.92; N, 10.71; S, 12.46.

5-Benzoyl-2-(dimethylamino)methylidene-2,3-dihydro-3-oxopyrrolo[2,1-*b*]thiazole-7-carboxylic Acid Methyl Ester (14b)
Mp 126 °C (DMF–H_2O); yield: 0.9 g (84%).

^{1}H NMR: δ = 3.27 [s, 6 H, $N(CH_3)_2$], 3.78 (s, 3 H, OCH_3), 7.12 (s, 1 H, 6-H), 7.52 (t, 2 H, *J* = 7.5 Hz, Ar), 7.64 (t, 1 H, *J* = 7.5 Hz, Ar), 7.79 (d, 2 H, *J* = 7.5 Hz, Ar), 7.91 (s, 1 H, =CHN).

^{13}C NMR: δ = 40.0 [$N(CH_3)_2$], 51.7 (OCH_3), 87.0 (2-C), 106.6 (7-C), 124.7 (6-C), 128.3 (1-C_{Ar}), 128.7 (2,6-C_{Ar}), 129.3 (3,5-C_{Ar}), 133.0 (4-C_{Ar}), 137.8 (5-C), 140.4 (7a-C), 150.6 (=CHN), 160.2 (3-C), 162.8 (7-CO), 182.5 (5-CO).

Anal. Calcd for $C_{18}H_{16}N_2O_4S$: C, 60.66; H, 4.53; N, 7.86; S, 9.00. Found: C, 60.59; H, 4.59; N, 7.70; S, 8.92.

5-(Biphenyl-4-ylcarbonyl)-2-(dimethylamino)methylidene-2,3-dihydro-3-oxopyrrolo[2,1-*b*]thiazole-7-carboxylic Acid Ethyl Ester (15a)
Mp 192 °C (DMF); yield: 1.2 g (89%).

^{1}H NMR: δ = 1.28 (t, 3 H, *J* = 7.0 Hz, CH_3), 3.26 [s, 6 H, $N(CH_3)_2$], 4.25 (q, 2 H, *J* = 7.0 Hz, CH_2), 7.16 (s, 1 H, 6-H), 7.43 (t, 1 H, *J* = 7.5 Hz, Ar), 7.51 (t, 2 H, *J* = 7.5 Hz, Ar), 7.75 (d, 2 H, *J* = 7.5 Hz, Ar), 7.82 (2 H, d, *J* = 8.4 Hz, Ar), 7.90 (m, 3 H, Ar, =CHN).

^{13}C NMR: δ = 14.9 (CH_3), 41.3 [$N(CH_3)_2$], 59.0 (OCH_2), 89.9 (2-C), 104.6 (7-C), 121.4 (6-C), 125.3 (3,5-C_{Ar}), 125.5 (2′,6′-C_{Ar}), 127.8 (4′-C_{Ar}), 128.5 (3′,5′-C_{Ar}), 128.6 (1-C_{Ar}), 129.6 (2,6-C_{Ar}), 131.7 (4-C_{Ar}), 141.2 (5-C), 143.2 (7a-C), 143.3 (1′-C_{Ar}), 146.3 (=CHN), 156.3 (3-C), 162.4 (7-CO), 183.5 (5-CO).

Anal. Calcd for $C_{25}H_{22}N_2O_4S$: C, 67.25; H, 4.97; N, 6.27; S, 7.18. Found: C, 67.32; H, 5.06; N, 6.23; S, 7.16.

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