Synthesis of New 1-Phenylthieno[1,2,4]triazolo[4,3-*a*]pyrimidin-5(4*H*)-one Derivatives

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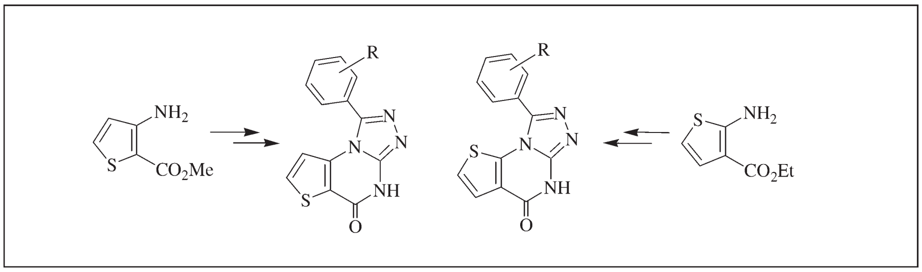

A series of novel 1-phenylthieno[1,2,4]triazolo[4,3-*a*]pyrimidin-5(4*H*)-one derivatives **5** and **6** were synthesized by oxidative cyclization of thienopyrimidinonyl hydrazones using iodobenzene diacetate.

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INTRODUCTION

The heterocyclic compounds containing 1,2,4-triazole nucleus have attracted considerable interest for many years due to their diverse biological activities, such as antifungal, bactericidal, antitumor, and anti-inflamatory agents [1–4]. Futhermore, it has been noticed that introduction of an additional ring to the triazolopyrimidine system which is one of the fused 1,2,4-triazole compound tends to exert profound influence in conferring new biological activities in these molecules. Recently, thienotriazolopyrimidinone **1** and pyrazolotriazolopyrimidine **2** derivatives of tricyclic heterocyclic compounds (five-six-five ring systems) as shown in Figure 1 have been explored for xanthine oxidase inhibitor, and adenosine A_1/A_{2A} or A_{2A}/A_3 receptor antagonists, respectively [5,6]. And, triazoloquinazolinone **3** and its analogs were known to have antibacterial and H_1-antihistaminic activity [7,8]. Similar analogues based on the substituted thieno[3,2-*e*]triazolopyrimidinone moiety were also reported [9]. We have recently designed and synthesized a series of thienotriazolopyrimidine compounds **4** of potential biological interest using iodobenzene diacetate [10].

As a continuation of our works for biologically active thienopyridine or thienopyrimidine derivatives [11] we now describe the synthesis of new 1-phenylthieno[2,3-*e*][1,2,4]triazolo[4,3-*a*]pyrimidin-5(4*H*)-one derivatives (**5**) and 1-phenylthieno[3,2-*e*][1,2,4]triazolo[4,3-*a*]pyrimidin-5(4*H*)-one derivatives (**6**), which are structurally related to **1** and **3** as one of tricyclic skeleton in the hope of obtaining compounds of diverse pharmaceutical activities.

RESULTS AND DISCUSSION

Compound **5** and **6** were prepared according to Scheme 1. The key intermediate 2-thioxo-2,3-dihydrothieno[3,2-*d*]pyrimidin-4(1*H*)-one **(11)** and 2-thioxo-2,3-dihydrothieno[2,3-*d*]pyrimidin-4(1*H*)-one **(12)** were synthesized respectively from the amino esters **7** and **8** with ammonium thiocyanate and benzoyl chloride in acetone at reflux, with subsequent heating of the resultant thienyl benzoylthioureas **9** and **10** with an ethanolic potassium hydroxide solution and acidification [12]. The spectroscopic data and elemental analyses are in agreement with the assigned structures of new compounds **9, 10, 11,** and **12**. The methylation of **11** and **12** with methyl iodide and aqueous sodium hydroxide afforded methylthio derivatives **13** and **14** which upon nucleophilic displacement of the methylthio group with hydrazine gave the respective hydrazine derivatives **15** and **16**. Condensation of **15** and **16** with appropriate aromatic aldehydes in ethanol containing a few drops of piperidine furnished the corresponding arylhydrazones **17** and **18**. The oxidative cyclization of the latter compounds to final products **5** and **6** was respectively achieved using iodobenzene diacetate in good yields [10]. For instance, when a solution of **17a** or **18a** in dichloromethane was treated with 1.2 equiv of iodobenzene diacetate at room temperature, the only one product was obtained as solid within 1 h. The crude product was filtered and purified by recrystallization to give pure compound 1-phenylthieno [2,3-*e*][1,2,4]triazolo[4,3-*a*]pyrimidin-5(4*H*)-one **(5a)** or 1-phenylthieno[3,2-*e*][1,2,4]triazolo[4,3-*a*]pyrimidin-5(4*H*)-one **(6a)** in 62–66% yield. The structure of these compounds was confirmed by elemental analysis,

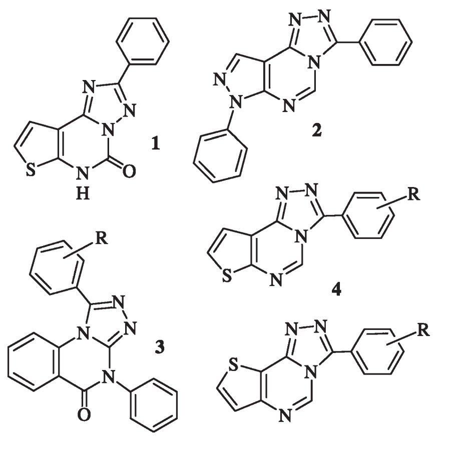
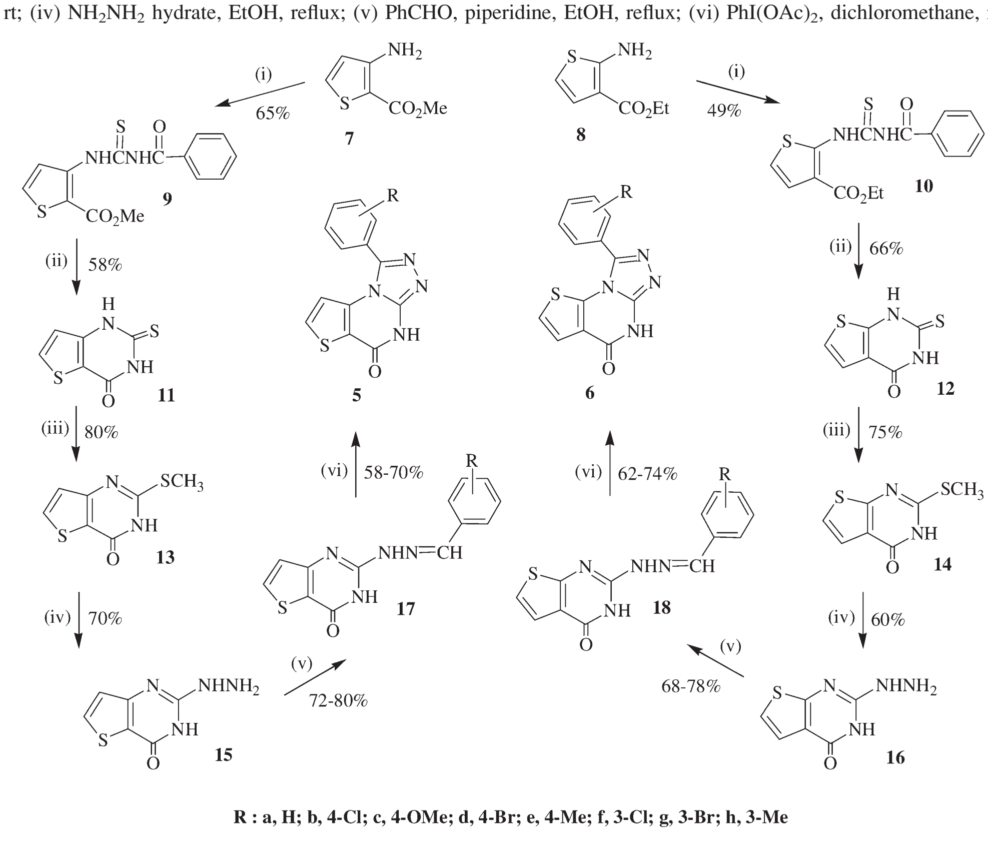


Figure 1. Heterocyclic compounds containing 1,2,4-triazole.

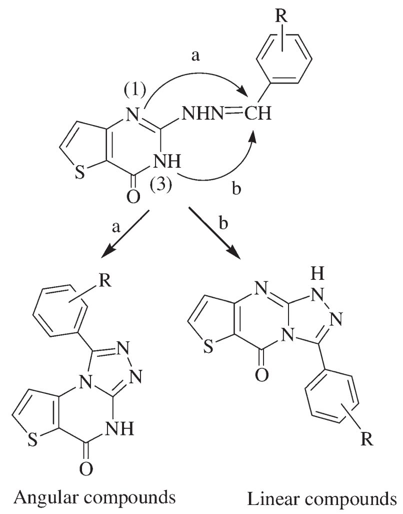
^{1}H NMR and IR spectra. IR spectra of compound **5a** and **6a** revealed absorption bands at 3436–3430 cm^{-1} for NH, 1662–1660 cm^{-1} for CO. The mass spectral data of these compounds showed same molecular ion peak at m/z = 268 with very similar fragmentation pattern, and also showed ion at m/z = 152 which could be attributed to the loss of N—N=C-phenyl from the molecular ion. The ^{1}H NMR spectrum of **5a** showed two doublets at 6.63 and 7.94 for thiophene protons (H-8 and H-7), multiplet signals at 7.70–7.57 for aromatic protons and singlet at 12.75 for NH group, while **6a** showed two doublets at 7.21 and 7.39 for thiophene protons (H-6 and H-7), multiplet signals at 7.68–7.55 for aromatic protons and singlet at 8.82 for NH. It is noteworthy that the β proton (H-8) of thiophene in **5a** appeared at δ 6.63 in higher field, whereas the β proton (H-7) of **15** or **17a** was found to appear at δ 7.01−7.10 in more down field. This may be attributed to the through-space anisotropic effect of the phenyl group on this proton in **5a**.

As shown in Scheme 2, the oxidative cyclization of the hydrazone derivatives, **17** and **18**, toward two nitrogen atoms, N(1) or N(3), may provide two kinds of structural isomers, angular triazole compounds or linear triazole compounds or a mixture of both. To provide a decisive evidence for the assigned structure of **5** and **6**, an authentic sample of **5a** was prepared by an alternative synthesis (Scheme 3) and compared with the product isolated from the oxidative cyclization of **17a**. The synthetic strategy for authentic **5a** was based on oxidative cyclization of the hydrazone **17A** protected with benzyl group at N(3) atom to exclusively afford the angular compound. In this route, 7 was reacted with

Scheme 1. Synthesis of **5** and **6**. Reagents and conditions: (i) NH_4NCS, C_6H_5COCl, acetone, reflux; (ii) KOH, EtOH, reflux; H_2O, HCl, rt; (iii) MeI, 2N NaOH, rt; (iv) NH_2NH_2 hydrate, EtOH, reflux; (v) PhCHO, piperidine, EtOH, reflux; (vi) $PhI(OAc)_2$, dichloromethane, rt.



Scheme 2. Two possible ways for the oxidative cyclization of thienopyrimidinonyl hydrazone **17**.



benzyl isothiocyanate to give **11A**, which was methylated with dimethyl sulfate to afford **13A**. Treatment of **13A** with hydrazine hydrate gave **15A**, and the reaction of the latter with benzaldehyde to yield the hydrazone **17A**. The oxidative cyclization of **17A** with iodobenzene diacetate, and the subsequent deprotection of benzyl group in **19A** gave **5a**. This was identical in all respects (mp, IR, ^{1}H NMR, and MS spectra) with **5a** obtained from the oxidative cyclization of **17a**. In a similar manner the assigned structure **6a** was also confirmed by its comparison with an authentic sample, which was prepared by the same method as depicted in Scheme 3. This finding indicates that **5a** has angular structure, not linear structure, and that both **5** and **6** were prepared unambiguously by regioselective cyclization as outlined in Scheme 1. This result is consistent with one reported in a recent report, which was regioselective cyclization of aldehyde *N*-[6-benzyl-5(4*H*)-*as*-triazinon-3-yl]hydrazones [13].

In conclusion, we have reported the synthesis of new phenylthieno[2,3-*e*][1,2,4]triazolo[4,3-*a*]pyrimidin-5(4*H*)-one derivatives **(5)** and phenyl thieno[3,2-*e*][1,2,4] triazolo[4,3-*a*]pyrimidin-5(4*H*)-one derivatives **(6)** with potential biological activities by oxidative cyclization of thienopyrimidinonyl hydrazones.

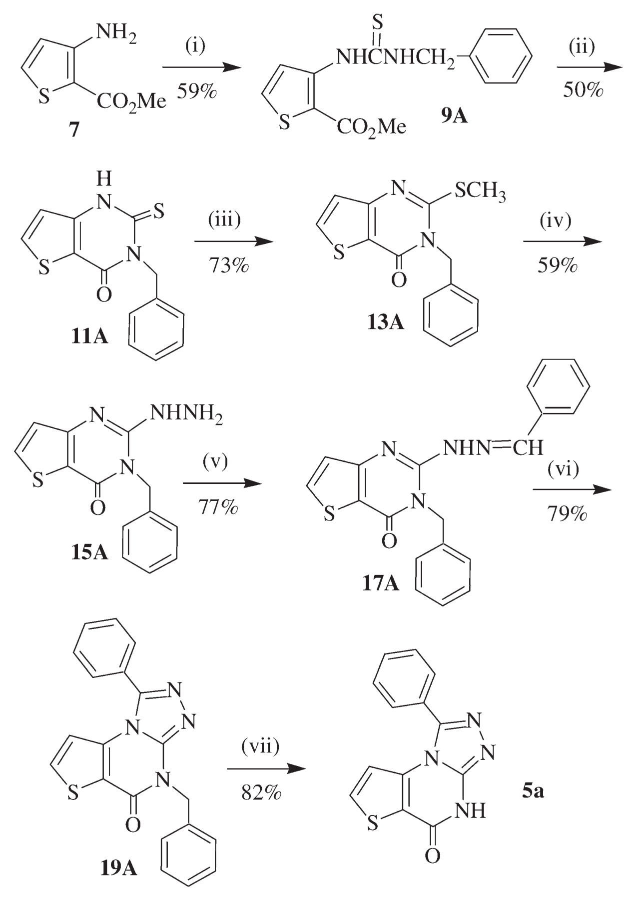
EXPERIMENTAL

Melting points were determined in capillary tubes on Büchi apparatus and are uncorrected. Each compound of the reactions was checked on thin-layer chromatograpohy of Merck Kieselgel 60F_{254} and purified by column chromatograpohy Merck silica gel (70–230 mesh). The ^{1}H NMR spectra were recorded on Bruker DRX-300 FT NMR spectrometer (300 MHz) with Me_4Si as internal standard and chemical shifts are given in ppm (δ). IR spectra were recorded using an EXCALIBUR FTS-3000 FTIR spectrophotometer. Electron ionization mass spectra were recorded on a HP 59580 B spectrometer. Elemental analyses were performed on a Carlo Erba 1106 elemental analyzer.

General procedure for the preparation of 9 and 10. Benzoyl chloride (5.6 mL, 48 mmol) was added dropwise to a solution of ammonium thiocyanate (5.2 g, 68 mmol) in an anhydrous acetone (40 mL). The reaction mixture was refluxed for 30 min, and then a solution of amino ester **7** or **8** (48 mmol) in anhydrous acetone (60 mL) was added. The resulting solution was kept at reflux for 2 h and filtered while hot. After cooling and evaporation of the solvent, the solid product was purified by recrystallization from ethanol.

Methyl 3-(3-benzoylthioureido)thiophene-2-carboxylate (9). The compound was obtained from **7** in 75% yield, mp 159–160°C; ^{1}H NMR (dimethyl sulfoxide-d_6): δ 13.7 (s, 1H, NH), 11.7 (s, 1H, NH), 8.53 (d, J = 5.8 Hz, 1H, H-5, thiophene), 7.97 (d, 2H, Ar), 7.92 (d, J = 5.8 Hz, 1H, H-4, thiophene), 7.63 (t, 1H, Ar), 7.52 (t, 2H, Ar), 3.85 (s, 3H), ms: (m/z) 320 (M^+). Anal.

Scheme 3. Alternative synthesis of **5a**. Reagents and conditions: (i) $C_6H_5CH_2NCS$, EtOH, reflux; (ii) KOH, EtOH, reflux; H_2O, HCl, rt; (iii) $(CH_3)_2SO_4$, NaOH, EtOH, reflux; (iv) NH_2NH_2 hydrate, EtOH, reflux; (v) PhCHO, piperidine, EtOH, reflux; (vi) $PhI(OAc)_2$, dichloromethane, rt; (vii) H_2/Pd, HCl, DMF, rt.



Calcd. for $C_{14}H_{12}N_2O_3S_2$: C, 52.48; H, 3.78, N, 8.74. Found: C, 52.60; H, 3.59; N, 8.88.

Ethyl 2-(3-benzoylthioureido)thiophene-3-carboxylate (10). The compound was obtained from **8** in 70% yield, mp 174–175°C; ^{1}H NMR (dimethyl sulfoxide-d_6): δ 14.5 (s, 1H, NH), 11.9 (s, 1H, NH), 7.98 (d, 2H, Ar), 7.64 (t, 1H, Ar), 7.53 (t, 2H, Ar), 7.32 (d, J = 5.8 Hz, 1H, H-5, thiophene), 7.12 (d, J = 5.8 Hz, 1H, H-4, thiophene), ms: (m/z) 334 (M^+). Anal. Calcd. for $C_{15}H_{14}N_2O_3S_2$: C, 53.87; H, 4.22, N, 8.38. Found: C, 53.69; H, 4.04; N, 8.57.

General procedure for the preparation of 11 and 12. To a hot potassium hydroxide solution (1.2 g, 21.4 mmol) in absolute ethanol (50 mL) was added the thienylthiourea **9** or **10** (12 mmol), and the mixture was refluxed for 2 h. The suspension was filtered while hot and the solid washed with hot ethanol to give the corresponding product of potassium salt. The product suspended in water (60 mL) was acidified with concentrated hydrochloric acid, and the mixture was stirred at room temperature for 1 h. The solid was collected by filtration and purified by recrystallization from ethanol.

2-Thioxo-2,3-dihydrothieno[3,2-d]pyrimidin-4(1H)-one (11). The compound was obtained from **9** in 65% yield, mp 341–343°C; IR(KBr) 3120 and 3075 (NH), 1670 (C=O) cm^{-1}; ^{1}H NMR (dimethyl sulfoxide-d_6): δ 13.2 (s, 1H, NH), 12.5 (s, 1H, NH), 8.16 (d, J = 5.8 Hz, 1H, H-6, thiophene), 7.03 (d, J = 5.8 Hz, 1H, H-7, thiophene), ms: (m/z) 184 (M^+). Anal. Calcd. for $C_6H_4N_2OS_2$: C, 39.11; H, 2.19, N, 15.20. Found: C, 39.30; H, 2.03; N, 15.46.

2-Thioxo-2,3-dihydrothieno[2,3-d]pyrimidin-4(1H)-one (12). The compound was obtained from **9** in 60% yield, mp 305–307°C; IR(KBr) 3110 and 3080 (NH), 1675 (C=O) cm^{-1}; ^{1}H NMR (dimethyl sulfoxide-d_6): δ 13.4 (s, 1H, NH), 12.4 (s, 1H, NH), 7.26 (d, J = 5.8 Hz, 1H, H-6, thiophene), 7.19 (d, J = 5.8 Hz, 1H, H-5, thiophene), ms: (m/z) 184 (M^+). Anal. Calcd. for $C_6H_4N_2OS_2$: C, 39.11; H, 2.19, N, 15.20. Found: C, 39.25; H, 2.30; N, 15.09.

General procedure for the preparation of 13 and 14. To a cooling solution of the thioxo derivative **11** or **12** (5.4 mmol) in 2*N* sodium hydroxide solution (20 mL) at 5°C was added methyl iodide (2.50 g, 16.2 mmol), and the mixture was refluxed for 2 h. The precipitates were collected by filtration, dissolved in hot water and neutralized with 10% hydrochloric solution. The solid obtained was filtered, washed with water, dried, and recrystallized from ethanol.

2-(Methylthio)thieno[3,2-d]pyrimidin-4(3H)-one (13). The compound was obtained from **11** in 71% yield, mp 286–287°C; IR(KBr) 1685 (C=O) cm^{-1}; ^{1}H NMR (dimethyl sulfoxide-d_6): δ 12.7 (s, 1H, NH), 7.41 (d, J = 5.8 Hz, 1H, H-6, thiophene), 7.28 (d, J = 5.8 Hz, 1H, H-7, thiophene), 2.52 (s, 3H, Me), ms: (m/z) 198 (M^+). Anal. Calcd. for $C_7H_6N_2OS_2$: C, 42.40; H, 3.05, N, 14.13. Found: C, 42.58; H, 3.13; N, 14.30.

2-(Methylthio)thieno[2,3-d]pyrimidin-4(3H)-one (14). The compound was obtained from **12** in 69% yield, mp 241–242°C; IR(KBr) 1680 (C=O) cm^{-1}; ^{1}H NMR (dimethyl sulfoxide-d_6): δ 12.8 (s, 1H, NH), 8.12 (d, J = 5.8 Hz, 1H, H-6, thiophene), 7.29 (d, J = 5.8 Hz, 1H, H-5, thiophene), 2.53 (s, 3H, Me), ms: (m/z) 198 (M^+). Anal. Calcd. for $C_7H_6N_2OS_2$: C, 42.40; H, 3.05, N, 14.13. Found: C, 42.21; H, 3.16; N, 13.96.

General procedure for the preparation of 15 and 16. A mixture of methylthiothienopyrimidinone **13** or **14** (3 mmol) and hydrazine hydrate (15 mL) in absolute ethanol (20 mL) was refluxed for 72 h. After cooling, the solid products formed were filtered, dried, and recrystallized from ethanol.

2-Hydrazinothieno[3,2-d]prrimidin-4(3H)-one (15). The compound was obtained from **13** in 72% yield, mp 352–353°C; ^{1}H NMR (dimethyl sulfoxide-d_6): δ 8.95 (bs, 1H, NH), 7.91 (d, J = 5.8 Hz, 1H, H-6, thiophene), 7.01 (d, J = 5.8 Hz, 1H, H-7, thiophene), 2.48 (bs, 2H, NH_2), ms: m/z (%) 182 (M^+, 96), 168 (48), 152 (100), 125 (85), 97 (22). Anal. Calcd. for $C_7H_6N_2OS_2$: C, 42.40; H, 3.05, N, 14.13. Found: C, 42.58; H, 3.13; N, 14.30.

2-Hydrazinothieno[2,3-d]prrimidin-4(3H)-one (16). The compound was obtained from **14** in 66% yield, mp 236–237°C; ^{1}H NMR (dimethyl sulfoxide-d_6): δ 8.45 (bs, 1H, NH), 7.09 (d, J = 5.8 Hz, 1H, H-6, thiophene), 7.01 (d, J = 5.8 Hz, 1H, H-5, thiophene), 2.50 (bs, 2H, NH_2), ms: m/z (%) 182 (M^+, 90), 166 (40), 151 (66), 125 (44). Anal. Calcd. for $C_7H_6N_2OS_2$: C, 42.40; H, 3.05, N, 14.13. Found: C, 42.22; H, 3.16; N, 14.01.

General procedure for the preparation of 17a-h and 18a-h. A mixture of the hydrazine **15** or **16** (10 mmol) and the appropriate aldehyde (10 mmol) in absolute ethanol (30 mL) containing a few drops of piperidine was refluxed for 3 h. After cooling, the solid products formed were filtered, dried, and recrystallized from ethanol.

(E)-2-(2-Benzylidenehydrazinyl)thieno[3,2-d]pyrimidin-4(3H)-one (17a). Yield 78%, mp 297–299°C; ^{1}H NMR (dimethyl sulfoxide-d_6): δ 11.57 (bs, 2H, NH), 8.02 (m, 2H, imine proton and H-6, thiophene), 7.94 (m, 2H, H-2′ and H-6′, phenyl), 7.40(m, 3H, H-3′, H-4′ and H-5′, phenyl), 7.10 (d, J = 5.8 Hz, 1H, H-7, thiophene), ms: m/z (%) 270 (M^+, 65), 193 (39), 167 (100), 125 (42). Anal. Calcd. for $C_{13}H_{10}N_4OS$: C, 57.76; H, 3.73, N, 20.73. Found: C, 57.92; H, 3.62; N, 20.59.

(E)-2-(2-(4-Chlorobenzylidene)hydrazinyl)thieno[3,2-d]pyrimidin-4(3H)-one (17b). Yield 82%, mp 315–317°C; ^{1}H NMR (dimethyl sulfoxide-d_6): δ 11.75 (bs, 2H, NH), 8.02 (m, 4H, imine proton, H-6, H-2′ and H-6′), 7.43 (d, 2H, H-3′ and H-5′), 7.11 (d, J = 5.8 Hz, 1H, H-7), ms: m/z (%) 304 (M^+, 32), 193 (34), 167 (100), 126 (30). Anal. Calcd. for $C_{13}H_9ClN_4OS$: C, 51.23; H, 2.98, N, 18.38. Found: C, 51.01; H, 3.09; N, 18.49.

(E)-2-(2-(4-Methoxybenzylidene)hydrazinyl)thieno[3,2-d]pyrimidin-4(3H)-one (17c). Yield 69%, mp 261–263°C; ^{1}H NMR (dimethyl sulfoxide-d_6): δ 11.47 (bs, 2H, NH), 8.02 (d, J = 5.8 Hz, 1H, H-6), 7.98 (s, 1H, imine proton), 7.88 (d, 2H, H-2′ and H-6′), 7.08 (d, J = 5.8 Hz, 1H, H-7), 6.95 (d, 2H, H-3′ and H-5′), 3.78 (s, 3H, OMe), ms: m/z (%) 300 (M^+, 41), 167 (100), 126 (28). Anal. Calcd. for $C_{14}H_{12}N_4O_2S$: C, 55.99; H, 4.03, N, 18.65. Found: C, 56.13; H, 3.91; N, 18.49.

(E)-2-(2-(4-Bromobenzylidene)hydrazinyl)thieno[3,2-d]pyrimidin-4(3H)-one (17d). Yield 65%, mp 323–325°C; ^{1}H NMR (dimethyl sulfoxide-d_6): δ 11.67 (bs, 2H, NH), 8.02 (d, J = 5.8 Hz, 1H, H-6), 7.99 (s, 1H, imine proton), 7.92 (d, 2H, H-2′ and H-6′), 7.58 (d, 2H, H-3′ and H-5′), 7.09 (d, J = 5.8 Hz, 1H, H-7), ms: m/z (%) 349 (M^+, 33), 193 (34), 167 (100), 126 (35). Anal. Calcd. for $C_{13}H_9BrN_4OS$: C, 44.71; H, 2.60, N, 16.04. Found: C, 44.84; H, 2.51; N, 16.22.

(E)-2-(2-(4-Methylbenzylidene)hydrazinyl)thieno[3,2-d]pyrimidin-4(3H)-one (17e). Yield 58%, mp 263–265°C; ^{1}H NMR (dimethyl sulfoxide-d_6): δ 11.67 (bs, 2H, NH), 8.00 (m, 2H, imine proton and H-6), 7.80 (d, 2H, H-2′ and H-6′), 7.19 (d, 2H, H-3′ and H-5′), 7.08 (d, J = 5.8 Hz, 1H, H-7), 2.32 (s, 3H, Me), ms: m/z (%) 284 (M^+, 62), 193 (25), 167 (100), 126 (30). Anal. Calcd. for $C_{14}H_{12}N_4OS$: C, 59.14; H, 4.25, N, 19.70. Found: C, 59.30; H, 4.19; N, 19.88.

(E)-2-(2-(3-Chlorobenzylidene)hydrazinyl)thieno[3,2-d]pyrimidin-4(3H)-one (17f). Yield 64%, mp 296–298°C; ^{1}H NMR (dimethyl sulfoxide-d$_6$): δ 11.77 (bs, 2H, NH), 8.26 (s, 1H, imine proton), 8.03 (d, J = 5.8 Hz, 1H, H-6), 8.00 (s, 1H, H-2′), 7.73 (d, 1H, H-6′), 7.40 (m, 2H, H-4′ and H-5′), 7.09 (d, J = 5.8 Hz, 1H, H-7), ms: m/z (%) 304 (M^+, 55), 193 (20), 167 (100), 126 (26). Anal. Calcd. for $C_{13}H_9ClN_4OS$: C, 51.23; H, 2.98, N, 18.38. Found: C, 51.11; H, 3.07; N, 18.50.

(E)-2-(2-(3-Bromobenzylidene)hydrazinyl)thieno[3,2-d]pyrimidin-4(3H)-one (17g). Yield 68%, mp 286–288°C; ^{1}H NMR (dimethyl sulfoxide-d$_6$): δ 11.72 (bs, 2H, NH), 8.36 (s, 1H, imine proton), 8.03 (d, J = 5.8 Hz, 1H, H-6), 7.99 (s, 1H, H-2′), 7.79 (d, 1H, H-6′), 7.53 (d, 1H, H-4′), 7.34 (t, 1H, H-5′), 7.09 (d, J = 5.8 Hz, 1H, H-7), ms: m/z (%) 349 (M^+, 42), 193 (40), 167 (100), 126 (39). Anal. Calcd. for $C_{13}H_9BrN_4OS$: C, 44.71; H, 2.60, N, 16.04. Found: C, 44.60; H, 2.72; N, 16.17.

(E)-2-(2-(3-Methylbenzylidene)hydrazinyl)thieno[3,2-d]pyrimidin-4(3H)-one (17h). Yield 55%, mp 235–237°C; ^{1}H NMR (dimethyl sulfoxide-d$_6$): δ 11.55 (bs, 2H, NH), 8.02 (d, J = 5.8 Hz, 1H, H-6), 8.00 (s, 1H, imine proton), 7.77 (s, 1H, H-2′), 7.67 (d, 1H, H-6′), 7.53 (t, 1H, H-5′), 7.17 (d, 1H, H-4′), 7.09 (d, J = 5.8 Hz, 1H, H-7), 2.34 (s, 3H, Me), ms: m/z (%) 284 (M^+, 50), 193 (28), 167 (100), 126 (32). Anal. Calcd. for $C_{14}H_{12}N_4OS$: C, 59.14; H, 4.25, N, 19.70. Found: C, 58.98; H, 4.15; N, 19.86.

(E)-2-(2-Benzylidenehydrazinyl)thieno[2,3-d]pyrimidin-4(3H)-one (18a). Yield 68%, mp 281–283°C; ^{1}H NMR (dimethyl sulfoxide-d$_6$): δ 11.58 (bs, 2H, NH), 8.03 (s, 1H, imine proton), 7.96 (m, 2H, phenyl), 7.38 (m, 3H, phenyl), 7.19 (d, J = 5.8 Hz, 1H, H-6, thiophene), 7.09 (d, J = 5.8 Hz, 1H, H-5, thiophene), ms: m/z (%) 270 (M^+, 100), 193 (41), 167 (95), 125 (76). Anal. Calcd. for $C_{13}H_{10}N_4OS$: C, 57.76; H, 3.73, N, 20.73. Found: C, 57.88; H, 3.82; N, 20.60.

(E)-2-(2-(4-Chlorobenzylidene)hydrazinyl)thieno[2,3-d]pyrimidin-4(3H)-one (18b). Yield 73%, mp 310–312°C; ^{1}H NMR (dimethyl sulfoxide-d$_6$): δ 11.68 (bs, 2H, NH), 8.00 (m, 3H, imine proton, H-2′ and H-6′), 7.45 (d, 2H, H-3′ and H-5′), 7.19 (d, J = 5.8 Hz, 1H, H-6), 7.09 (d, J = 5.8 Hz, 1H, H-5), ms: m/z (%) 304 (M^+, 53), 193 (38), 167 (83), 125 (100). Anal. Calcd. for $C_{13}H_9ClN_4OS$: C, 51.23; H, 2.98, N, 18.38. Found: C, 51.40; H, 3.12; N, 18.53.

(E)-2-(2-(4-Methoxybenzylidene)hydrazinyl)thieno[2,3-d]pyrimidin-4(3H)-one (18c). Yield 60%, mp 263–265°C; ^{1}H NMR (dimethyl sulfoxide-d$_6$): δ 11.48 (bs, 2H, NH), 7.98 (s, 1H, imine proton), 7.88 (d, 2H, H-2′ and H-6′), 7.17 (d, J = 5.8 Hz, 1H, H-6), 7.07 (d, J = 5.8 Hz, 1H, H-5), 6.95 (d, 2H, H-3′ and H-5′), 3.78 (s, 3H, OMe), ms: m/z (%) 300 (M^+, 100), 167 (93), 125 (75), 77 (20). Anal. Calcd. for $C_{14}H_{12}N_4O_2S$: C, 55.99; H, 4.03, N, 18.65. Found: C, 56.19; H, 3.94; N, 18.73.

(E)-2-(2-(4-Bromobenzylidene)hydrazinyl)thieno[2,3-d]pyrimidin-4(3H)-one (18d). Yield 60%, mp 296–298°C; ^{1}H NMR (dimethyl sulfoxide-d$_6$): δ 11.87 (bs, 2H, NH), 8.00 (s, 1H, imine proton), 7.93 (d, 2H, H-2′ and H-6′), 7.58 (d, 2H, H-3′ and H-5′), 7.19 (d, J = 5.8 Hz, 1H, H-6), 7.09 (d, J = 5.8 Hz, 1H, H-5), ms: m/z (%) 349 (M^+, 46), 193 (35), 167 (100), 125 (64). Anal. Calcd. for $C_{13}H_9BrN_4OS$: C, 44.71; H, 2.60, N, 16.04. Found: C, 44.60; H, 2.69; N, 16.17.

(E)-2-(2-(4-Methylbenzylidene)hydrazinyl)thieno[2,3-d]pyrimidin-4(3H)-one (18e). Yield 50%, mp 283–285°C; ^{1}H NMR (dimethyl sulfoxide-d$_6$): δ 11.52 (bs, 2H, NH), 8.00 (s, 1H, imine proton), 7.83 (d, 2H, H-2′ and H-6′), 7.19 (m, 3H, H-3′, H-5′ and H-6), 7.08 (d, J = 5.8 Hz, 1H, H-5), 2.32 (s, 3H, Me), ms: m/z (%) 284 (M^+, 80), 193 (45), 167 (100), 126 (51). Anal. Calcd. for $C_{14}H_{12}N_4OS$: C, 59.14; H, 4.25, N, 19.70. Found: C, 58.98; H, 4.16; N, 19.84.

(E)-2-(2-(3-Chlorobenzylidene)hydrazinyl)thieno[2,3-d]pyrimidin-4(3H)-one (18f). Yield 60%, mp 285–287°C; ^{1}H NMR (dimethyl sulfoxide-d$_6$): δ 11.75 (bs, 2H, NH), 8.27 (s, 1H, imine proton), 8.01 (s, 1H, H-2′), 7.73 (d, 1H, H-6′), 7.40 (m, 2H, H-4′ and H-5′), 7.20 (d, J = 5.8 Hz, 1H, H-6), 7.10 (d, J = 5.8 Hz, 1H, H-5), ms: m/z (%) 304 (M^+, 40), 193 (22), 167 (100), 126 (20). Anal. Calcd. for $C_{13}H_9ClN_4OS$: C, 51.23; H, 2.98, N, 18.38. Found: C, 51.40; H, 3.11; N, 18.56.

(E)-2-(2-(3-Bromobenzylidene)hydrazinyl)thieno[2,3 -d]pyrimidin-4(3H)-one (18g). Yield 60%, mp 285–287°C; ^{1}H NMR (dimethyl sulfoxide-d$_6$): δ 11.80 (bs, 2H, NH), 8.37 (s, 1H, imine proton), 7.98 (s, 1H, H-2′), 7.78 (d, 1H, H-6′), 7.53 (d, 1H, H-4′), 7.34 (t, 1H, H-5′), 7.20 (d, J = 5.8 Hz, 1H, H-6), 7.10 (d, J = 5.8 Hz, 1H, H-5), ms: m/z (%) 349 (M^+, 55), 193 (44), 167 (100), 126 (48). Anal. Calcd. for $C_{13}H_9BrN_4OS$: C, 44.71; H, 2.60, N, 16.04. Found: C, 44.84; H, 2.76; N, 16.11.

(E)-2-(2-(3-Methylbenzylidene)hydrazinyl)thieno[2,3 -d]pyrimidin-4(3H)-one (18h). Yield 50%, mp 274–276°C; ^{1}H NMR (dimethyl sulfoxide-d$_6$): δ 11.53 (bs, 2H, NH), 8.00 (s, 1H, imine proton), 7.78 (s, 1H, H-2′), 7.68 (d, 1H, H-6′), 7.27 (t, 1H, H-5′), 7.22–7.16 (m, 2H, H-4′ and H-6), 7.09 (d, J = 5.8 Hz, 1H, H-5), 2.34 (s, 3H, Me), ms: m/z (%) 284 (M^+, 95), 193 (65), 167 (100), 126 (58). Anal. Calcd. for $C_{14}H_{12}N_4OS$: C, 59.14; H, 4.25, N, 19.70. Found: C, 59.34; H, 4.36; N, 19.89.

General procedure for the preparation of 5 and 6. To a solution of **17a-h** or **18a-h** (0.01 mole) in dry dichloromethane (20 mL), iodobenzene diacetate (0.012 mole) was slowly added. The reaction mixture was stirred for 1 h at room temperature. After evaporation the precipitate was filtered and recrystallized from a mixture of chloroform and ethanol.

1-Phenylthieno[2,3-e][1,2,4]triazolo[4,3-a]pyrimidin-5(4H)-one (5a). Yield 62%, mp 265–267°C; IR (KBr) 3436, 1660 cm^{-1}; ^{1}H NMR (dimethyl sulfoxide-d$_6$): δ 12.75 (bs, 1H, NH), 7.94 (d, J = 5.8 Hz, 1H, thiophene, H-7), 7.70–7.63 (m, 2H, phenyl, H-2′ and H-6′), 7.61–7.57 (m, 3H, H-3′, H-4′ and H-5′), 6.63 (d, J = 5.8 Hz, 1H, H-8), ms: m/z (%) 268 (M^+, 100), 152 (40), 110 (31), 96 (20), 84 (37), 77 (30), 66 (31), 57(45). Anal. Calcd. for $C_{13}H_8N_4OS$: C, 55.20; H, 3.01, N, 20.88. Found: C, 55.39; H, 3.19; N, 20.73.

1-(4-Chlorophenyl)thieno[2,3-e][1,2,4]triazolo[4,3-a] pyramidin-5(4H)-one (5b). Yield 70%, mp 289–291°C; IR (KBr) 3430, 1662 cm^{-1}; ^{1}H NMR (dimethyl sulfoxide-d$_6$): δ 12.02 (bs, 1H, NH), 7.93 (d, J = 5.8 Hz, 1H, thiophene, H-7), 7.71 (d, 2H, phenyl, H-2′ and H-6′), 7.67 (d, 2H, H-3′ and H-5′), 6.72 (d, J = 5.8 Hz, 1H, H-8), ms: m/z (%) 302 (M^+, 66), 152 (78), 125 (33), 84 (79), 66 (99), 57(20). Anal. Calcd. for $C_{13}H_7ClN_4OS$: C, 51.58; H, 2.33, N, 18.51. Found: C, 51.40; H, 2.41; N, 18.70.

1-(4-Methoxyphenyl)thieno[2,3-e][1,2,4]triazolo[4,3-a] pyramidin-5(4H)-one (5c). Yield 66%, mp 299–301°C; IR (KBr) 3430, 1663 cm^{-1}; ^{1}H NMR (dimethyl sulfoxide-d$_6$): δ 11.32

(bs, 1H, NH), 7.73 (d, J = 5.8 Hz, 1H, thiophene, H-7), 7.61 (d, 2H, phenyl, H-2′ and H-6′), 7.08 (d, 2H, H-3′ and H-5′), 6.87 (d, J = 5.8 Hz, 1H, H-8), 3.93 (s, 3H, OMe), ms: m/z (%) 298 (M^+, 66), 161 (24), 151 (21), 130 (28), 110 (20), 97 (30), 84 (70), 73 (41), 58 (55). Anal. Calcd. for $C_{14}H_{10}N_4O_2S$: C, 56.37; H, 2.41, N, 18.78. Found: C, 56.22; H, 2.51; N, 18.93.

1-(4-Bromophenyl)thieno[2,3-e][1,2,4]triazolo[4,3-a] pyramidin-5(4H)-one (5d). Yield 69%, mp 323–325°C; IR (KBr) 3433, 1660 cm^{-1}; ^{1}H NMR (dimethyl sulfoxide-d_6): δ 10.90 (bs, 1H, NH), 7.78–7.74 (m, 3H, thiophene, H-7 and phenyl, H-2′ and H-6′), 7.60 (d, 2H, H-3′ and H-5′), 6.75 (d, J = 5.8 Hz, 1H, H-8), ms: m/z (%) 347 (M^+, 15), 200 (21), 183 (30), 152 (19), 129 (16), 97 (22), 84 (91), 73 (40), 66 (100), 57 (62). Anal. Calcd. for $C_{13}H_7BrN_4OS$: C, 44.97; H, 2.03, N, 16.14. Found: C, 44.89; H, 2.12; N, 16.30.

1-p-Tolylthieno[2,3-e][1,2,4]triazolo[4,3-a]pyramidin-5(4H)-one (5e). Yield 58%, mp 265–267°C; IR (KBr) 3435, 1662 cm^{-1}; ^{1}H NMR (dimethyl sulfoxide-d_6): δ 11.20 (bs, 1H, NH), 8.08 (d, J = 5.8 Hz, 1H, thiophene, H-7), 7.58 (d, 2H, phenyl, H-2′ and H-6′), 7.42 (d, 2H, H-3′ and H-5′), 6.63 (d, J = 5.8 Hz, 1H, H-8), 2.43 (s, 1H, Me), ms: m/z (%) 282 (M^+, 14), 152 (11), 129 (10), 97 (10), 84 (82), 73 (10), 66 (100), 57 (15). Anal. Calcd. for $C_{14}H_{10}N_4OS$: C, 59.56; H, 3.57, N, 19.85. Found: C, 59.69; H, 3.70; N, 19.98.

1-(3-Chlorophenyl)thieno[2,3-e][1,2,4]triazolo[4,3-a] pyramidin-5(4H)-one (5f). Yield 65%, mp 396–399°C; IR (KBr) 3430, 1663 cm^{-1}; ^{1}H NMR (dimethyl sulfoxide-d_6): δ 10.72 (bs, 1H, NH), 7.88 (d, J = 5.8 Hz, 1H, thiophene, H-7), 7.74 (s, 1H, phenyl, H-2′), 7.67–7.59 (m, 3H, phenyl, H-4′, H-5′ and H-6′), 6.76 (d, J = 5.8 Hz, 1H, H-8), ms: m/z (%) 302 (M^+, 33), 152 (19), 129 (12), 97 (20), 84 (82), 66 (95), 57 (48). Anal. Calcd. for $C_{13}H_7ClN_4OS$: C, 51.58; H, 2.33, N, 18.51. Found: C, 51.69; H, 2.24; N, 18.68.

1-(3-Bromophenyl)thieno[2,3-e][1,2,4]triazolo[4,3-a] pyramidin-5(4H)-one (5g). Yield 71%, mp > 400°C; IR (KBr) 3435, 1660 cm^{-1}; ^{1}H NMR (dimethyl sulfoxide-d_6): δ 12.32 (bs, 1H, NH), 7.88–7.83 (m, 2H, thiophene, H-7 and phenyl, H-2′), 7.78 (d, 1H, H-6′), 7.68 (d, 1H, H-4′), 7.53 (t, 1H, H-5′), 6.77 (d, J = 5.8 Hz, 1H, H-8), ms: m/z (%) 347 (M^+, 20), 200 (19), 183 (30), 152 (20), 97 (30), 84 (95), 73 (39), 66 (100), 57 (69). Anal. Calcd. for $C_{13}H_7BrN_4OS$: C, 44.97; H, 2.03, N, 16.14. Found: C, 45.10; H, 2.10; N, 16.03.

1-m-Tolylthieno[2,3-e][1,2,4]triazolo[4,3-a]pyramidin-5(4H)-one (5h). Yield 61%, mp > 400°C; IR (KBr) 3430, 1666 cm^{-1}; ^{1}H NMR (dimethyl sulfoxide-d_6): δ 13.10 (bs, 1H, NH), 7.84 (d, J = 5.8 Hz, 1H, thiophene, H-7), 7.47–7.40 (m, 4H, phenyl, H-2′, H-4′ H-5′ and H-6′), 6.71 (d, J = 5.8 Hz, 1H, H-8), 2.39 (s, 1H, Me), ms: m/z (%) 282 (M^+, 22), 152 (5), 149 (19), 84 (35), 66 (99), 52 (10). Anal. Calcd. for $C_{14}H_{10}N_4OS$: C, 59.56; H, 3.57, N, 19.85. Found: C, 59.67; H, 3.62; N, 19.69.

1-Phenylthieno[3,2-e][1,2,4]triazolo[4,3-a]pyrimidin-5(4H)-one (6a). Yield 66%, mp > 400°C; IR (KBr) 3430, 1662 cm^{-1}; ^{1}H NMR (dimethyl sulfoxide-d_6): δ 8.82 (bs, 1H, NH), 7.68–7.66 (m, 2H, phenyl, H-2′ and H-6′), 7.58–7.55 (m, 3H, H-3′, H-4′ and H-5′), 7.39 (d, J = 5.8 Hz, 1H, thiophene, H-7), 7.21 (d, J = 5.8 Hz, 1H, H-6), ms: m/z (%) 268 (M^+, 100), 152 (21), 110 (10), 84 (48), 66 (100), 57(10). Anal. Calcd. for $C_{13}H_8N_4OS$: C, 55.20; H, 3.01, N, 20.88. Found: C, 55.09; H, 3.12; N, 20.92.

1-(4-Chlorophenyl)thieno[3,2-e][1,2,4]triazolo[4,3-a] pyramidin-5(4H)-one (6b). Yield 72%, mp 396–398°C; IR (KBr) 3420, 1664 cm^{-1}; ^{1}H NMR (dimethyl sulfoxide-d_6): δ 9.12 (bs, 1H, NH), 7.75 (d, 2H, phenyl, H-2′ and H-6′), 7.65 (d, 2H, H-3′ and H-5′), 7.37 (d, J = 5.8 Hz, 1H, thiophene, H-7), 7.25 (d, J = 5.8 Hz, 1H, H-6), ms: m/z (%) 302 (M^+, 10), 152 (8), 125 (7), 84 (100), 66 (99). Anal. Calcd. for $C_{13}H_7ClN_4OS$: C, 51.58; H, 2.33, N, 18.51. Found: C, 51.69; H, 2.40; N, 18.67.

1-(4-Methoxyphenyl)thieno[3,2-e][1,2,4]triazolo[4,3-a] pyramidin-5(4H)-one (6c). Yield 60%, mp 388–390°C; IR (KBr) 3436, 1660 cm^{-1}; ^{1}H NMR (dimethyl sulfoxide-d_6): δ 11.60 (bs, 1H, NH), 7.61 (d, 2H, phenyl, H-2′ and H-6′), 7.36 (d, J = 5.8 Hz, 1H, thiophene, H-7), 7.26 (d, J = 5.8 Hz, 1H, H-6), 7.16 (d, 2H, H-3′ and H-5′), 3.85 (s, 3H, OMe), ms: m/z (%) 298 (M^+, 10), 149 (22), 84 (81), 66 (99). Anal. Calcd. for $C_{14}H_{10}N_4O_2S$: C, 56.37; H, 2.41, N, 18.78. Found: C, 56.45; H, 2.50; N, 18.89.

1-(4-Bromophenyl)thieno[3,2-e][1,2,4]triazolo[4,3-a] pyramidin-5(4H)-one (6d). Yield 59%, mp 386–388°C; IR (KBr) 3430, 1662 cm^{-1}; ^{1}H NMR (dimethyl sulfoxide-d_6): δ 8.10 (bs, 1H, NH), 7.81 (d, 2H, phenyl, H-2′ and H-6′), 7.66 (d, 2H, H-3′ and H-5′), 7.37 (d, J = 5.8 Hz, 1H, thiophene, H-7), 7.27 (d, J = 5.8 Hz, 1H, H-6), ms: m/z (%) 347 (M^+, 8), 152 (9), 100 (10), 84 (65), 66 (100). Anal. Calcd. for $C_{13}H_7BrN_4OS$: C, 44.97; H, 2.03, N, 16.14. Found: C, 45.15; H, 2.10; N, 16.26.

1-p-Tolylthieno[3,2-e][1,2,4]triazolo[4,3-a]pyramidin-5(4H)-one (6e). Yield 61%, mp > 400°C; IR (KBr) 3430, 1662 cm^{-1}; ^{1}H NMR (dimethyl sulfoxide-d_6): δ 8.84 (bs, 1H, NH), 7.54 (d, 2H, phenyl, H-2′ and H-6′), 7.42 (d, 2H, H-3′ and H-5′), 7.35 (d, J = 5.8 Hz, 1H, thiophene, H-7), 7.21 (d, J = 5.8 Hz, 1H, H-6), 2.41 (s, 1H, Me), ms: m/z (%) 282 (M^+, 11), 152 (8), 129 (10), 100 (25), 84 (62), 66 (100). Anal. Calcd. for $C_{14}H_{10}N_4OS$: C, 59.56; H, 3.57, N, 19.85. Found: C, 59.66; H, 3.44; N, 20.02.

1-(3-Chlorophenyl)thieno[3,2-e][1,2,4]triazolo[4,3-a] pyramidin-5(4H)-one (6f). Yield 70%, mp > 400°C; IR (KBr) 3433, 1663 cm^{-1}; ^{1}H NMR (dimethyl sulfoxide-d_6): δ 10.34 (bs, 1H, NH), 7.80 (s, 1H, phenyl, H-2′), 7.69–7.65 (m, 2H, phenyl, H-4′ and H-6′), 7.61 (t, 1H, H-5′), 7.35 (d, J = 5.8 Hz, 1H, thiophene, H-7), 7.23 (d, J = 5.8 Hz, 1H, H-6), ms: m/z (%) 302 (M^+, 5), 152 (19), 126 (12), 97 (10), 84 (55), 66 (100), 55 (20). Anal. Calcd. for $C_{13}H_7ClN_4OS$: C, 51.58; H, 2.33, N, 18.51. Found: C, 51.73; H, 2.41; N, 18.36.

1-(3-Bromophenyl)thieno[3,2-e][1,2,4]triazolo[4,3-a] pyramidin-5(4H)-one (6g). Yield 71%, mp > 400°C; IR (KBr) 3430, 1660 cm^{-1}; ^{1}H NMR (dimethyl sulfoxide-d_6): δ 8.30 (bs, 1H, NH), 7.94 (s, 1H, phenyl, H-2′), 7.81 (d, 1H, H-6′), 7.73 (d, 1H, H-4′), 7.54 (t, 1H, H-5′), 7.36 (d, J = 5.8 Hz, 1H, thiophene, H-7), 7.26 (d, J = 5.8 Hz, 1H, H-6) ms: m/z (%) 347 (M^+, 7), 152 (11), 97 (10), 84 (55), 66 (100), 60 (22), 54 (23). Anal. Calcd. for $C_{13}H_7BrN_4OS$: C, 44.97; H, 2.03, N, 16.14. Found: C, 45.17; H, 2.15; N, 16.32.

1-m-Tolylthieno[3,2-e][1,2,4]triazolo[4,3-a]pyramidin-5(4H)-one (6h). Yield 61%, mp > 400°C; IR (KBr) 3430, 1662 cm^{-1}; ^{1}H NMR (dimethyl sulfoxide-d_6): δ 8.38 (bs, 1H, NH), 7.48–7.39 (m, 4H, phenyl, H-2′, H-4′ H-5′ and H-6′), 7.34 (d, J = 5.8 Hz, 1H, thiophene, H-7), 7.18 (d, J = 5.8 Hz, 1H, H-6), 2.41 (s, 1H, Me), ms: m/z (%) 282 (M^+, 5), 152 (10), 84 (68), 66 (100), 60 (21), 54 (25). Anal. Calcd. for $C_{14}H_{10}N_4OS$:

C, 59.56; H, 3.57, N, 19.85. Found: C, 59.74; H, 3.49; N, 20.01.

Preparation of 5a by alternative synthesis (Scheme 3). The preparation of **5a** from **7** was achieved through a serial of reactions as shown Scheme 3.

Methyl-3(3-benzylthioureido)thiophene-2-carboxylate (9A). Yield 59%, mp 132–133°C; ^{1}H NMR (dimethyl sulfoxide-d$_6$): δ 10.08 (s, 1H, NH), δ 9.59 (s, 1H, NH), 8.36 (d, J = 5.8 Hz, 1H, thiophene, H-5), 7.80 (d, J = 5.8 Hz, 1H, H-4), 7.37–7.27 (m, 5H, phenyl), 4.75 (d, 2H, benzyl), 3.82 (s, 3H, Me), ms: m/z 306 (M$^+$), Anal. Calcd. for $C_{14}H_{14}N_2O_2S_2$: C, 54.88; H, 4.61, N, 9.14. Found: C, 54.69; H, 4.44; N, 9.32.

3-Benzyl-2-thioxo-2,3-dihydrothieno[2,3-d]pyrimidin-4(1H)-one (11A). Yield 50%, mp 240–242°C; ^{1}H NMR (dimethyl sulfoxide-d$_6$): δ 13.56 (s, 1H, NH), 8.20 (d, J = 5.8 Hz, 1H, thiophene, H-6), 7.05 (d, J = 5.8 Hz, 1H, H-7), 7.30–7.22 (m, 5H, phenyl), 5.63 (s, 2H, benzyl), ms: m/z 274 (M$^+$), Anal. Calcd. for $C_{13}H_{10}N_2OS_2$: C, 56.91; H, 3.67, N, 10.21. Found: C, 56.75; H, 3.77; N, 10.09.

3-Benzyl-2-(methylthio)thieno[3,2-d]pyrimidin-4(3H)-one (13A). Yield 73%, mp 171–173°C; ^{1}H NMR (dimethyl sulfoxide-d$_6$): δ 8.18 (d, J = 5.8 Hz, 1H, thiophene, H-6), 7.34 (d, J = 5.8 Hz, 1H, H-7), 7.31–7.19 (m, 5H, phenyl), 5.32 (s, 2H, benzyl), 2.56 (s, 3H, Me), ms: m/z 288 (M$^+$), Anal. Calcd. for $C_{14}H_{12}N_2OS_2$: C, 58.31; H, 4.19, N, 9.71. Found: C, 58.47; H, 4.32; N, 9.50.

3-Benzyl-2-hydrazinylthieno[3,2-d]pyrimidin-4(3H)-one (15A). Yield 59%, mp 194–196°C; ^{1}H NMR (dimethyl sulfoxide-d$_6$): δ 10.19 (s, 1H, NH), 8.02 (d, J = 5.8 Hz, 1H, thiophene, H-6), 7.10 (d, J = 5.8 Hz, 1H, H-7), 7.30–7.15 (m, 5H, phenyl), 5.25 (s, 2H, benzyl), 4.29 (bs, 2H,NH$_2$), ms: m/z 272 (M$^+$), Anal. Calcd. for $C_{13}H_{12}N_4OS$: C, 57.34; H, 4.44, N, 20.57. Found: C, 57.13; H, 4.30; N, 20.40.

3-Benzyl-(E)-2-(2-benzylidenehydrazinyl)thieno[3,2-d]pyrimidin-4(3H)-one (17A). Yield 77%, mp 185–187°C; ^{1}H NMR (dimethyl sulfoxide-d$_6$): δ 9.52 (s, 1H, NH), 8.45 (s, 1H, imine proton), 7.77 (d, 2H, N=C—Ph, H-2′ and H-6′), 7.65 (d, J = 5.8 Hz, 1H, thiophene, H-6), 7.60 (d, 2H, CH$_2$-Ph, H-2″, and H-6″), 7.40 (m, 3H, N=C—Ph, H-3′, H-4′ and H-5′), 7.33–7.22 (m, 3H, CH$_2$-Ph, H-3″, H-4″, and H-5″), 6.87 (d, J = 5.8 Hz, 1H, H-7), 5.36 (s, 2H, benzyl), ms: m/z 360 (M$^+$), Anal. Calcd. for $C_{20}H_{16}N_4OS$: C, 66.65; H, 4.47, N, 15.54. Found: C, 66.54; H, 4.29; N, 15.40.

4-Benzyl-1-phenylthieno[2,3-e][1,2,4]triazolo[4,3-a]pyrimidin-5(4H)-one (19A). Yield 79%, mp 224–226°C; ^{1}H NMR (dimethyl sulfoxide-d$_6$): δ 8.09 (d, J = 5.8 Hz, 1H, thiophene, H-7), 7.77–7.75 (m, 2H, N=C—Ph, H-2′ and H-6′), 7.67–7.45 (m, 8H, N=C—Ph, H-3′, H-4′, H-5′ and CH$_2$-Ph, H-2″, H-3″, H-4″, H-5″, H-6″), 6.74 (d, J = 5.8 Hz, 1H, H-8), 5.59 (s, 2H, benzyl), ms: m/z 358 (M$^+$), Anal. Calcd. for $C_{20}H_{14}N_4OS$: C, 67.02; H, 3.94, N, 15.63. Found: C, 66.88; H, 3.81; N, 15.82.

1-Phenylthieno[2,3-e][1,2,4]triazolo[4,3-a]pyrimidin-5(4H)-one (5a). Yield 82%, mp 265–267°C; IR (KBr) 3430, 1662 cm^{-1}; ^{1}H NMR (dimethyl sulfoxide-d$_6$): δ 11.66 (bs, 1H, NH), 7.94 (d, J = 5.8 Hz, 1H, thiophene, H-7), 7.71–7.62 (m, 2H, phenyl, H-2′ and H-6′), 7.60–7.57 (m, 3H, H-3′, H-4′ and H-5′), 6.63 (d, J = 5.8 Hz, 1H, H-8), ms: m/z (%) 268 (M$^+$, 100), 152 (52), 110 (40), 96 (10), 84 (41), 77 (30), 66 (26), 57(54). Anal. Calcd. for $C_{13}H_8N_4OS$: C, 55.20; H, 3.01, N, 20.88. Found: C, 55.09; H, 3.12; N, 20.79.

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