Studies with 2-(acetonylthio)benzothiazole. New routes to isoxazoles, isoxazolo[3,4-*b*]pyridines, pyrazolo[1,5-*a*]pyrimidines, pyridines and quinolizines

Fatima Al-Omran* and Adel A. El-Khair

Chemistry Department, Kuwait University, Faculty of Science, PO Box 5969, Safat 13060, Kuwait

Derivatives of isoxazole, isoxazolo[3,4-*b*]pyridine, pyrazolo-[1,5-*a*]pyrimidine and pyridin-2(1*H*)-one incorporating a benzothiazole-2-thio residue have been synthesised. The structures of these newly synthesised compounds are characterised by elemental analysis, IR, ^{1}H and ^{13}C NMR, NOE and MS.

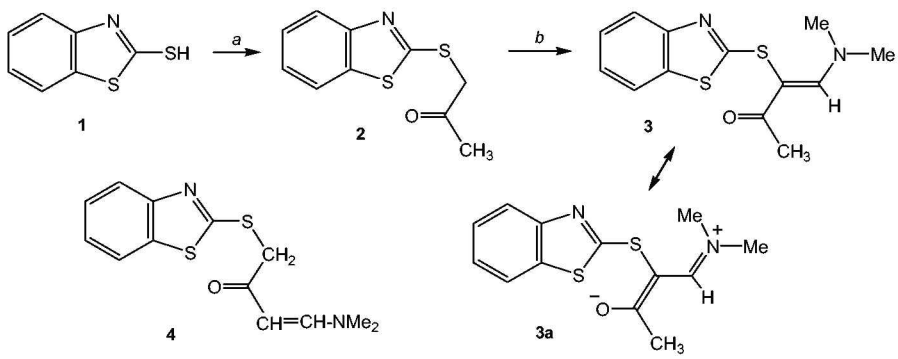
Keywords: enaminones, benzothiazoles, quinolizines, monocyclic and fused pyridines, isoxazoles, pyrazoles, fused pyrimidines

The interesting biological activities of 2-mercaptobenzothiazole, pyridine, isoxazole, pyrazolo[1,5-*a*]pyrimidine, quinolizine and isoxazolo[3,4-*b*]pyridine derivatives have stimulated considerable research work in recent years.[1-7] In connection with our previous interest in the synthesis of polyfunctionally substituted heterocycles utilising enaminones,[6-9] it was of interest to study the behaviour of the hitherto unreported (*Z*)-3-(benzothiazol-2'-ylthio)-4-(*N,N*-dimethylamino)but-3-en-2-one (**3**) towards a variety of reagents in order to obtain a series of compounds in which a sulfur atom links the 2-benzothiazole unit with heteroaromatic rings such as pyridine, isoxazole, pyrazolo[1,5-*a*]pyrimidine, quinolizine and isoxazolo[3,4-*b*]pyridine derivatives, in the hope of obtaining compounds that have biological and pharmaceutical applications.

Results and discussion

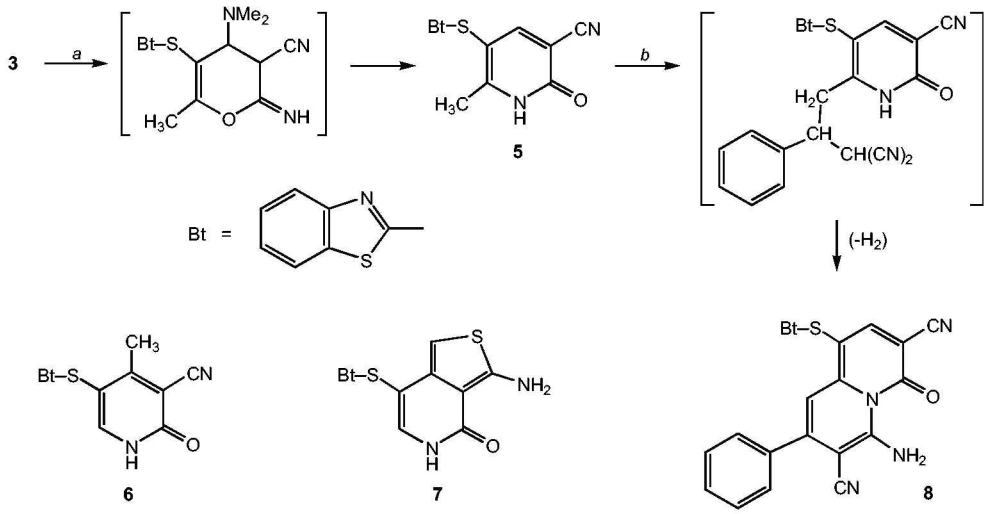
The key intermediate 1-(benzothiazol-2'-ylthio)propan-2-one (**2**) used in our experiments was readily prepared in good yield by the treatment of 2-mercaptobenzothiazole (**1**) with α-chloroacetone in refluxing acetone containing potassium carbonate.[10] Treatment of **2** with DMFDMA afforded a product which could have been either the enaminone **3** or its isomer **4** (*cf.* Scheme 1). The structure was established to be **3** on the basis of its spectral data. The IR spectrum of product showed an absorption band at 1646 cm^{-1} corresponding to the carbonyl group. The absence of a methylene singlet at δ_H 4.27 ppm in the ^{1}H NMR spectrum indicates that the methylene group in **2** was involved in the reaction. Moreover, the ^{1}H NMR spectrum revealed *three* singlet signals at δ_H 2.37, 3.24 and 3.35 ppm corresponding to a *C*-methyl and two *N*-methyl groups, while the higher frequency *singlet* signal at δ_H 8.19 ppm corresponding to a β-proton on a double bond conjugated with the carbonyl group, all indicated the formation of the enaminone **3** and ruled out structure **4** (Scheme 1). The structure of enaminone **3** was assigned as the *Z*-configuration on the following evidence. The nonequivalence of the *N*-methyl groups is due to resonance of the nitrogen lone pair of electrons with the α,β-unsaturated carbonyl group, giving rise to partial double bond character of the C–N bond and thus restricted rotation (resonance form **3a** in Scheme 1).The electron-withdrawing C=O group shifts the β-alkene proton to the deshielded position (δ_H 8.19), which suggests that the alkene has the dimethylamino group *trans* to the carbonyl group. Firm evidence for this conclusion was obtained from nuclear Overhauser effect (NOE) experiments. Thus, on irradiating the alkene proton at δ_H 8.19 ppm both the methyl and *N,N*-dimethylamino signals were enhanced, while irradiating the methyl or the dimethylamino protons enhanced only the alkene proton (*cf.* Scheme 1)

The reactivity of **3** towards nitriles with active methylene groups was investigated. Treatment of compound **3** with malononitrile in refluxing ethanol containing a catalytic amount of piperidine afforded a single product which may be either **5** or **6.** The spectral data did not clearly discriminate between the 2,3,5,6-tetrasubstitution in pyridine **5** and the 2,3,4,5-arrangement in **6.**[7,11-13] However, since the initial condensation product from the reaction of enaminone **3** with malononitrile failed to react with elemental sulfur in DMF/EtOH containing catalytic piperidine to provide the thienopyridine derivative **7** in a reaction characteristic of azines with vicinal methyl and carbonitrile substituents,[11,14] the structure **6** was ruled out and the product assigned to be **5**. The formation of 5-(benzothiazol-2'-ylthio)-6-methyl-2-oxo-1, 2-dihydropyridine-3-carbonitrile **5** is considered most likely based on its similarity to the well-established behaviour



Scheme 1 *Reagents and conditions: a:* CH_3COCH_2Cl/K_2CO_3, Me_2CO; *b*: DMFDMA, heat.

* Correspondent. E-mail: fatima.alomran@ku.edu.kw



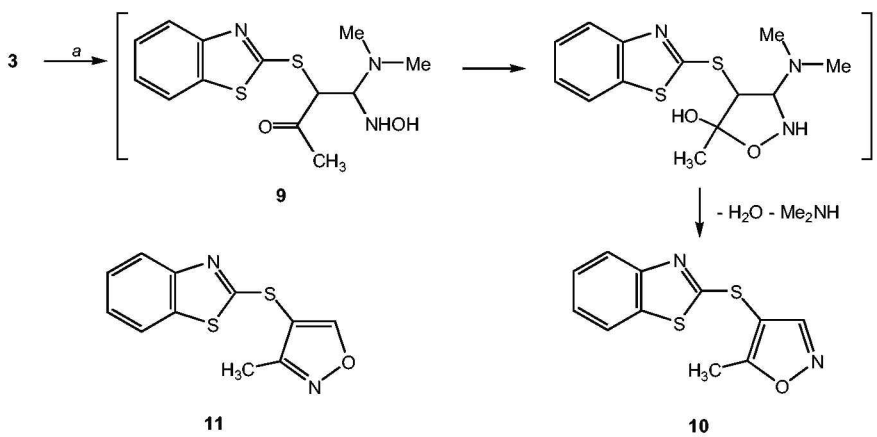
Scheme 2 *Reagents and conditions: a:* $H_2C(CN)_2$, EtOH/pip, reflux,H_2O/HCl; *b*: $PhCH=C(CN)_2$, pyridine/reflux; H_2O/HCl.

of enaminones towards methylene nitriles.[7,8] This was assumed to proceed *via* initial Michael addition of the active methylene reagent to the double bond in enaminone **3** with subsequent cyclisation, then Dimroth-type rearrangement and aromatisation *via* loss of dimethylamine to yield the 2,3,5,6-tetrasubstituted pyridine **5**. (Scheme 2).

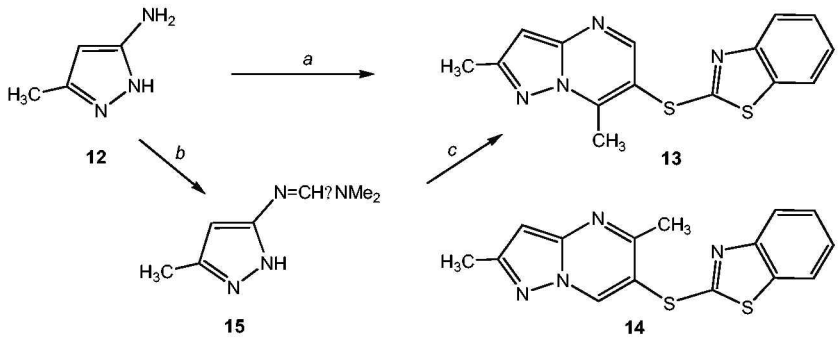
Treatment of **5** with benzylidenemalononitrile in refluxing pyridine afforded the aminoquinolizinone **8** in excellent yield (Scheme 2). The mass spectrum of the reaction product showed a molecular ion peak at *m/z* 451. The ^{1}H NMR spectrum displayed a broad signal integrating for two protons which readily underwent H/D exchange upon addition of D_2O. Also, it revealed, in addition to aromatic signals, two downfield singlets at δ_H 8.54 and 8.56 ppm assignable to the H-2 and H-9 quinolizine ring protons, respectively. The formation of product **8** can be explained from the formation of the Michael adduct intermediate followed by cyclisation and aromatisation (Scheme 2).

Treatment of compound **3** with hydroxylamine hydrochloride in refluxing ethanol afforded an isoxazole derivative in good yield that was assigned the structure **10** rather than **11**, based on the ^{1}H NMR and ^{13}C NMR spectra. The mass spectrum of the product revealed a molecular ion peak at *m/z* 248. The IR spectrum was free of carbonyl absorption. The ^{13}C NMR spectrum showed two downfield signals at δ_c 168.6 and 154.0 ppm. The signal at δ_C 168.6 corresponded to a tertiary carbon, while that at δ_C 154.0 was coupled to a proton. As generally found in the isoxazole system, the carbon resonating at lowest field corresponds to C-5.[15,16] The data are therefore consistent with structure **10**. The formation of **10** is assumed to proceed *via* addition of the hydroxylamine NH_2 group to the active double bond in compound **3** to form the non-isolable intermediate **9** which readily undergoes intramolecular cyclisation to the isoxazole derivative **10** by loss of dimethylamine and water molecules (Scheme 3).

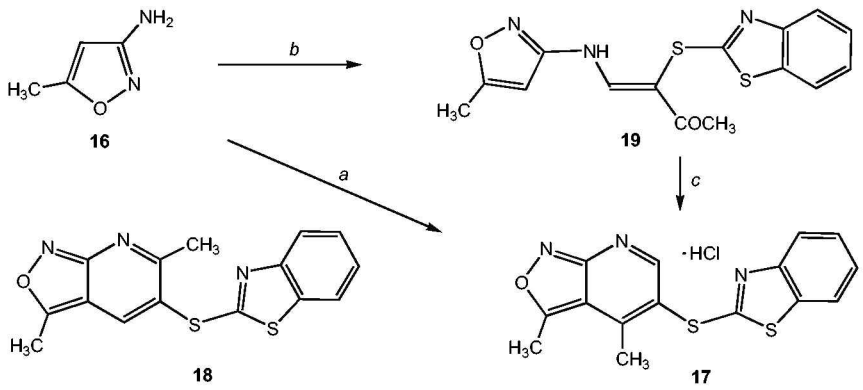
These results prompted us to investigate the behaviour of compound **3** towards heterocyclic amines such as 5-amino-3-methyl-*1H*-pyrazole **12** and 3-amino-5-methylisoxazole **16** as potential approaches to fused heterocyclic systems. Thus, treatment of enaminone **3** with **12** in refluxing ethanol afforded the condensation product with elimination of dimethylamine and water molecules (**13**, Scheme 4). This is consistent with our recent report[9] in which structure **13** rather than structure **14** was assigned. The ^{1}H NMR spectrum reveals a singlet signal at δ_H 8.59 which integrates for one proton and is attributed to the pyrimidine CH-2 in structure **13** and not CH-4 in structure **14**. The mass spectrum of the reaction product revealed a molecular ion peak at *m/z* 312. The absence of carbonyl group



Scheme 3 *Reagents and conditions: a:* $NH_2OH.HCl$, EtOH, reflux.



Scheme 4 *Reagents and conditions: a:* **3**, EtOH, reflux; *b*: DMFDMA, reflux; *c*: **2**, pyr, reflux; H_2O/HCl.



Scheme 5 *Reagents and conditions: a:* **3**, EtOH/pip, reflux 3 h; H_2O/HCl; *b*: **3**, EtOH, reflux 0.5 h; *c*: EtOH/pip, reflux 2 h; H_2O/HCl.

absorption in the IR spectrum indicates that the carbonyl group was involved in the reaction. (Scheme 4)

Further evidence for the proposed structure **13** was obtained by independent synthesis of the same product *via* condensation **12** with DMF DMA and subsequent condensation of the so-formed amidine **15** with the *S*-acetonyl compound **2** in pyridine, to afford a product identical (m.p. and mass spectra) with that obtained from the reaction of **3** with **12**. The formation of pyrimidine derivative **13** is assumed to proceed *via* the addition of the exocyclic amino group in **12** to the α,β-unsaturated moiety in compound **3** followed by cyclisation and aromatisation. It is significant to note that although the ring nitrogen in compound **12** is the most nucleophilic centre,[17,18] it is also the most sterically hindered site. Therefore, addition takes place at the exocyclic NH_2 to afford the pyrazolopyrimidine derivative **13** as shown in Scheme 4. This is consistent with our recent report.[9]

In the same manner, enaminone **3** reacted with 3-amino-5-methylisoxazole (**16**) in refluxing ethanol afforded a single product that could be formulated as **17** or its isomer **18**. The mass spectrum of the reaction product revealed a molecular ion peak at *m/z* 313. The structure **18** was readily ruled out on the basis of the isolated intermediate **19** that was cyclised to **17** in refluxing ethanol in the presence of piperidine (*cf.* Scheme 5).

Conclusion

The synthesis of novel pyridine, isoxazole, pyrazolo[1,5-*a*] pyrimidine,quinolizine and isoxazolo[3,4-*b*]pyridine derivatives incorporating a benzothiazole-2-thio moiety, utilising novel (*Z*)-3-(benzothiazol-2'-ylthio)-4-(*N,N*-dimethylamino)but-3-en-2-one, is reported, with a view to the possible biological and pharmaceutical applications of these compounds.

Experimental

The IR spectra (KBr) were recorded on a Perkin Elmer FTIR System 2000 instrument. ^1H, ^{13}C NMR and NOE spectra were recorded on a Bruker 400 MHz spectrometer, and Bruker AVANCE II-600 with DMSO-d_6 or $CDCl_3$ as solvent and tetramethylsilane (TMS) as internal standard; chemical shifts are reported as δ (ppm from TMS). Mass spectra were measured on a GC/MS DFS, THERMO instrument. Microanalyses are obtained using a LECO 932 CHNS analyser. Compound **15** was prepared according to our recent report.[7]

1-(Benzothiazol-2'-ylthio) propan-2-one (**2**): The 2-mercaptobenzothiazole **1** (1.67 g, 10 mmol), chloroacetone (0.79 g, 10 mmol) and potassium carbonate (1.38 g, 10 mmol) in acetone (100 ml) were heated to reflux on a water bath for 2 h. The solvent was then removed under reduced pressure. The residual solid was collected by filtration and recrystallised from ethanol as pale yellow crystals (1.47 g, 66%), m.p. 67–68 °C. (Lit.[10] m.p. 67 °C). IR: ν_{max} 1721 cm^{-1} (C=O). NMR: δ_H ($CDCl_3$) 2.43 (s, 3H, CH_3), 4.27 (s, 2H, CH_2), 7.28–7.48 (m, 2H, benzothiazole-H), 7.76 (d, 1H, J = 7 Hz, benzothiazole-H), 7.84 ppm (d, 1H, J = 7 Hz, benzothiazole-H); δ_C (DMSO-d_6) 199.0 (keto), 164.4 (C-2'), 143.9, 134.2, 129.4, 125.4, 122.9, 122.7 (benzothiazole-C), 44.2 (CH_2) and 29.7 ppm (CH_3). Anal. Found C, 53.97; H, 3.74; N, 6.38. $C_{10}H_9NOS_2$ (223.31) requires: C, 53.87; H, 4.06; N, 6.27%.

(Z)-3-(Benzothiazol-2'-ylthio)-4-(N,N-dimethylamino)but-3-en-2-one (**3**): Compound **2** (2.23 g, 10 mmol) and dimethylformamide dimethylacetal (DMFDMA) (1.33 g, 10 mmol) were heated for 5 minutes in an oil bath. The reaction mixture was allowed to cool to room temperature and then triturated with ethanol (20 mL). The solid product so formed was collected by filtration and recrystallised from ethanol as off-white crystals (2.43 g, 82%), m.p. 103–105 °C C. IR: ν_{max} 1646 cm^{-1} (keto CO). NMR: δ_H ($CDCl_3$) 2.37 (s, 3H, CH_3); 3.24 (s, 3H, NCH_3), 3.35 (s, 3H, NCH_3), 7.24–7.42 (m, 2H, benzothiazole-H), 7.72 (d, 1H, J = 7 Hz, benzothiazole-H), 7.83 (d, 1H, J = 7 Hz, benzothiazole-H), 8.19 ppm (s, 1H, H-4); δ_C (DMSO-d_6) 194.4 (C=O), 175.1 (C-2'), 156.8, 155.2, 135.4, 126.6, 124.3, 122.1 and 121.5 (benzothiazole-C and C-4), 91.9 (C-3), 48.5 (*N,N*-Me_2) and 26.6 ppm (CH_3). Anal. Found C, 56.23; H, 4.92; N, 10.22. $C_{13}H_{14}N_2OS_2$ (278.39) requires C, 56.08; H, 5.07; N, 10.07%.

5-(Benzothiazol-2'-ylthio)-6-methyl-2-oxo-1,2-dihydropyridine-3-carbonitrile (**5**): A mixture of **3** (2.78 g, 10 mmol) and malononitrile (0.66 g, 10 mmol) in ethanol (20 mL) containing a few drops of piperidine was refluxed for 2 h. The reaction mixture was allowed to cool to room temperature and neutralised with aqueous hydrochloric acid (10%). The solid product so formed was collected by filtration and recrystallised from ethanol as off-white crystals (2.42 g, 81%) m.p. 180–182 °C. IR: ν_{max} 3432 (NH), 2226 (CN), 1656 cm^{-1} (amide CO). NMR (DMSO-d_6): δ_H 2.43 (s, 3H, CH_3), 7.34 (t, 1H, J = 7 Hz, benzothiazole-H), 7.46 (t, 1H, J = 7 Hz, benzothiazole-H), 7.84 (d, 1H, J = 7 Hz, benzothiazole-H), 7.97 (d, 1H, J = 7 Hz, benzothiazole-H), 8.53 (s, 1H, H-4), 13.35 (br.s, 1H, NH, D_2O exchangeable); δ_C 168.8 (CO), 161.7, 161.0 (C-2', C-6), 156.2 (C-4), 154.7, 135.6, 127.4, 125.4, 122.6, 121.8 (benzothiazole-C), 116.3 (CN), 104.5 (C-5), 102.7 (C-3) and 19.6 ppm (CH_3). Anal. Found C, 56.33; H, 3.18; N, 14.08. $C_{14}H_9N_3OS_2$ (299.37) requires: C, 56.16; H, 3.03; N, 14.04%.

6-Amino-1-(benzothiazol-2'-ylthio)-4-oxo-8-phenyl-4H-quinolizine-3,7-dicarbonitrile (**8**): A mixture of the pyridone **5** (2.78 g, 10 mmol) and benzylidenemalononitrile (1.54 g, 10 mmol) in pyridine (20 mL) was refluxed for 8 h. The reaction was poured into ice-cold water and neutralised with 10% HCl. The solid product so formed was collected by filtration and recrystallised from a mixture of EtOH: DMF (2: 1) as brown crystals (3.65 g, 81%), m.p. 158–160 °C. IR: ν_{max} 3441–3425 (NH_2), 2226 (2CN), 1652 cm^{-1} (amide CO). NMR (DMSO-d_6): δ_H 7.34–7.99 (m, 9H, benzothiazole and phenyl-H), 8.54 (s, 1H, H-2), 8.56 (s, 1H, H-9), 13.37 ppm (br.s, 2H, NH_2, D_2O-exchangeable); δ_C 169.7 (C-6), 162.3 (C-2), 161.0 (CO), 156.2 (benzothiazole C-2), 154.5 (benzothiazole C-3a), 135.8 (C-8), 135.2 (benzothiazole C-7a), 132.1, 130.9, 128.9, 127.4 (phenyl C), 125.3, 125.0, 122.2, 121.8 (benzothiazole C), 122.6 (C-9a), 117.2 (C-1), 116.3 (C-9), 115.9, 115.0 (2CN), 104.4, 102.3 ppm (C-3, C-7). MS (EI): *m/z* 451 [M^+]. Anal. Found: C, 63.92; H, 2.66; N, 15.33. $C_{24}H_{13}N_5OS_2$ (451.52) requires: C, 63.84; H, 2.90; N, 15.51%.

2-(5-Methylisoxazol-4-ylthio)benzothiazole (**10**): A mixture of **3** (2.78 g, 10 mmol) and hydroxylamine hydrochloride (0.69 g, 10 mmol) in ethanol (20 mL) was refluxed for 2 h. The reaction mixture was allowed to cool to room temperature. The solid product which separated was collected by filtration and recrystallised from ethanol as pale brown crystals (1.61 g, 65%) m.p. 144–146 °C. NMR ($CDCl_3$): δ_H 2.39 (s, 3H, CH_3), 7.29–7.93 (m, 4H, benzothiazole-H), 8.43 ppm (s, 1H, H-3'); δ_C 168.6 (C-5'), 163.7 (C-2), 154.0 (C-3'), 152.7, 135.2, 126.5, 124.5, 122.4, 121.7 (benzothiazole-C), 102.0 (C-4'), 11.2 ppm (CH_3). MS (EI): *m/z* 248 [M^+]. Anal. Found C, 53.04; H, 3.43; N, 11.43. $C_{11}H_8N_2OS_2$ (248.32) requires: C, 53.20; H, 3.24; N, 11.28%.

6-(Benzothiazol-2'-ylthio)-2,7-dimethylpyrazolo[1,5-a]pyrimidine (**13**): *Method A:* A solution of the enaminone **3** (2.78 g, 10 mmol) and the pyrazolamine **12** (0.97 g, 10 mmol) in ethanol (20 mL) was refluxed for 3 h. The reaction mixture was allowed to cool to room temperature. The solid product so formed was collected by filtration and recrystallised from ethanol as beige crystals (81%), m.p. 112–114 °C.

Method B: A suspension of the benzothiazolylthioacetone **2** (2.23 g, 10 mmol) in pyridine (30 mL) was treated with the amidine **15**[7] (1.52 g, 10 mmol). The mixture was refluxed for 3 h. than was allowed to cool to room temperature and neutralised with hydrochloric acid (10%). The solid product so formed was collected by filtration and recrystallised from ethanol as brown crystals (74%). NMR ($CDCl_3$): δ_H 2.60 (s, 3H, CH_3), 3.06 (s, 3H, CH_3), 6.62 (s, 1H, H-3), 7.31 (t, 1H, J = 8 Hz benzothiazole-H), 7.42 (t, 1H, J = 8 Hz, benzothiazole-H), 7.69 (d, 1H, J = 8 Hz, benzothiazole-H), 7.87 (d, 1H, ethanol 8 Hz, benzothiazole-H), 8.59 ppm (s, 1H, H-5); δ_C 167.7 (C-7), 157.0, 154.0, 153.5, 152.0 (C-2', C-2, C-5 and C-3a), 149.2, 135.3, 126.5, 124.7, 122.1, 121.0 (benzothiazole-C), 108.4 (C-6), 98.0 (C-3), 15.77 and 14.89 ppm ($2CH_3$). MS (EI): *m/z* 312 [M^+]. Anal. Found C, 57.56; H, 3.90; N, 17.76; S, 20.43. $C_{15}H_{12}N_4S_2$ (312.41) requires: C, 57.66; H, 3.87; N, 17.93; S, 20.52%.

5-(Benzothiazol-2'-ylthio)-3,4-dimethylisoxazolo[3,4-b]pyridine hydrochloride (**17**): A mixture of the enaminone **3** (2.78 g, 10 mmol) and the isoxazolamine **16** (0.97 g, 10 mmol) in ethanol (20 mL) containing a few drops of piperidine was refluxed for 3 h. The reaction mixture was allowed to cool, then poured into ice-cold water and neutralised with 10% HCl. The solid product so formed was collected by filtration and recrystallised from ethanol as pale brown crystals (73%), m.p. 120–122 °C. NMR ($CDCl_3$): δ_H 2.38 (3H, s, CH_3), 2.48 (3H, s, CH_3), 7.27–7.99 (m, 4H, benzothiazole-H), 8.22 (s, 1H, H-6); δ_C 168.4 (C-3), 160.1 (C-2'), 154.7, 153.4, 152.9 (C-7a, C-3a' and C-6), 149.4 (C-5), 135.1, 135.0 (C-4 and C-7a'), 121.3, 122.2, 124.6, 125.4 (benzothiazole-C), 103.3 (C-3a), 15.0 and 12.7 ppm ($2CH_3$). MS (EI): *m/z* 313 [M^+-HCl]. Anal. Found C, 51.31; H, 3.62; N, 12.29. $C_{15}H_{12}ClN_3OS_2$ (349.86) requires: C, 51.49, H, 3.45; N, 12.01%.

3-(Benzothiazol-2'-ylthio)-4-(5"-methylisoxazol-3"-yl-amino)but-3-en-2-one (**19**): A mixture of the enaminone **3** (2.78 g, 10 mmol) and the isoxazolamine **16** (0.97 g, 10 mmol) in ethanol (20 mL) was refluxed for 0.5 h. The reaction mixture was allowed to cool, then poured into ice-cold water and neutralised with 10% HCl. The solid product so formed was collected by filtration and recrystallised from ethanol as off-white crystals (71%), m.p. 101–102 °C. NMR ($CDCl_3$): δ_H 2.38 (3H, s, CH_3), 2.42 (3H, s, CH_3), 4.25 (bs,1H, NH), 5.98 (s, 1H, H-4"), 7.23–7.89 (m, 5H, benzothiazole-H, H-4); δ_C 201.8 (C-2), 168.2 (C-3"), 156.1 (C-2'), 155.1 (C-5"), 153.3 (C-3'a), 152.6 (C-4), 135.0 (C-7'a), 126.1 (C-3), 124.9, 124.0, 121.8, 121.5 (benzothiazole –C), and 99.7 (C-4"), 15.9, 12.7 ppm ($2CH_3$). MS (EI): *m/z* 331 [M^+]. Anal. Found C, 54.21; H, 3.82; N, 12.73. $C_{15}H_{13}N_3O_2S_2$ (331.41) requires: C, 54.36, H, 3.95; N, 12.76%.

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References

1 R.V. Kumar, K.R. Kumar and K.R. Gopal, *J. Heterocyclic Chem.*, 2005, **42**, 153.
2 K. Bogdanowicz-Szwed and M. Krasodomska, *Monatsh. Chem.*, 2006, **137**, 347.
3 M. Sechi, L. Sannia, M. Orecchioni, F. Carta, G. Paglietti and N. Neamati, *J. Heterocycl. Chem.*, 2003, **40**, 1097.
4 V.J. Ram and N. Haque, *Indian J. Chem.*, 1995, **34B**, 514.
5 V.J. Ram, P. Srivastava, M. Nath and A.S. Saxena, *Synthesis*, 1999, 1884.
6 F. Al-Omran, A-Z.A. Elassar and A.A. El-Khair, *Tetrahedron*, 2001, **57**, 10163.
7 F. Al-Omran, *J. Heterocyclic Chem.*, 2000, **37**, 1219.
8 F. Al-Omran and A.A. El-Khair, *J. Heterocyclic Chem.*, 2008, **45**, 1057.
9 F. Al-Omran and A.A. El-Khair, *J. Heterocyclic Chem.*, 2005, **42**, 307.
10 V. Calo, V. Fiandanese, A. Nacci and A. Volpe, *Tetrahedron*, 1996, **52**, 2155.
11 T.M. Abu Elmaati, *J. Heterocyclic Chem.*, 2004, **41**, 947.
12 F.A. Abu-Shanab, A.D. Redhouse, J.R. Thompson and B.J. Wakefield, *Synthesis*,1995, 557.
13 F.A. Abu-Shanab, A. M. Hessen and S.A.S. Mousa, *J. Heterocyclic Chem.*, 2007, **44**,787
14 F. Al-Omran, M.A.A. El-Khalik, H. Al-Awadi and M.H. Elnagdi, *Tetrahedron*, 1996, **52**, 11915.
15 M. Sutharchanadevi and R. Murugan, *Comprehensive Heterocyclic Chemistry II*, Pergamon Press. New York, 1996, **3**, 221.
16 E. Dominguez, E. Ibeas, E.M. de Marigorta, J.K. Palacios and R. San Martin. *J. Org. Chem.*, 1996, **61**, 5435.
17 K.M. Dawood, A.M. Farag and Z.E. Kandeel, *J. Chem. Res. (S)*, 1999, 88; *(M)*, 537.
18 M.H. Elnagdi, N.H. Taha, F.A. Abdel-EL All, R.M. Abdel Motaleb and F.F. Mohmoud, *Coll. Czech. Chem. Commun.*, 1989, **54**, 1082.