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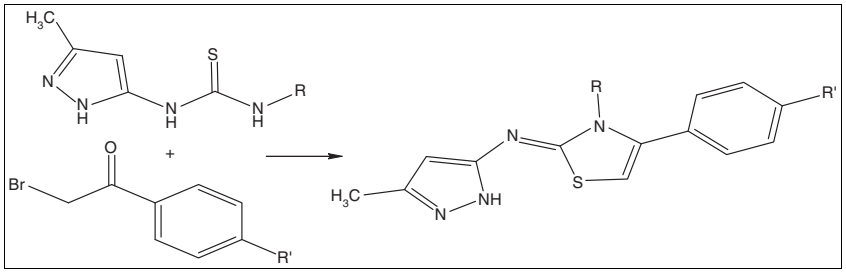
Received May 12, 2012
DOI 10.1002/jhet.1793
Published online 26 November 2013 in Wiley Online Library (wileyonlinelibrary.com).



1-Substituted 3-[3-methyl-1*H*-pyrazol-5-yl]thioureas react with ω-bromoacetophenones forming *N*-substituted (thiazol-2-ylidene)pyrazol-5-amine derivatives. Rational for these conversations are presented.

J. Heterocyclic Chem., **51**, 610 (2014).

INTRODUCTION

Brominated compounds are important intermediates in organic synthesis because they are amenable to a vast number of organic reactions involving functional group transformations [1–4]. α-Haloketones such as phenacyl halides are among the most versatile intermediates in organic synthesis: they react with a large number of nucleophiles to provide a variety of useful compounds [5]. Phenacyl halides have been used as precursors of various pharmaceutically important heteroaromatics such as imidazoles, selenazoles, and oxazoles [6]. In particular, it is well known that phenacyl halides are coupled with thioamides to provide the corresponding thiazoles, in the so-called Hantzsch synthesis [7].

Pyrazolylthiazoles have been used against cardiovascular diseases, as selective inhibitors of fibrinogen-mediated platelet aggregation [8]. Many of these compounds display antinociceptive activity [9], toxicity towards *Caenorhabditis elegans* [10], and phototoxicity against mosquito larvae [11]. The most common route to the synthesis of pyrazolylthiazoles is the reaction of 2-hydrazinothiazoles with β-diketones [12]. An alternate route to trifluoromethyl-substituted pyrazolylthiazoles **6a–e** and **7a–c** has been explored, involving the reaction of 3(5)-trifluoromethyl-5(3)-substituted pyrazole-1-thiocarboxamides **3a–e** and **4a–e** with phenacyl bromides **5a,b** [13] (Scheme 1).

The development of new simple and efficient procedures for the synthesis of important heterocyclic systems is a part of our program. We have recently reported different successful approaches for the synthesis of oxothiazolidines [14,15], pyrazolyloxothiazolidines [16], benzimidazoxadiazoles, naphthoimidazoxadiazoles, tetrachlorothianthrenetetraones [17], thiadiazoles, benzothiadiazinediones, thiadiazepines [18], and benzobisimidazothiadiazoles [19], from reactions between hydrazinecarbothioamides and π-deficient compounds.

In the light of these findings, we undertook to investigate the reactions of phenacyl bromides (**5a,c,d**) with pyrazolylthioureas **8a–c**. As potential nucleophiles, **8a–c** offer the sulfur atom, N^1 or N^3 of the thiourea structure [20], or the endocyclic pyrazole-NH. On the other hand, compounds **5** offer the active methylene group and the carbonyl atoms as electrophilic sites. Thus, several modes of interaction between pyrazolylthioureas **8a–c** and ω-bromoacetophenones **5a,c,d** may be envisaged.

RESULTS AND DISCUSSION

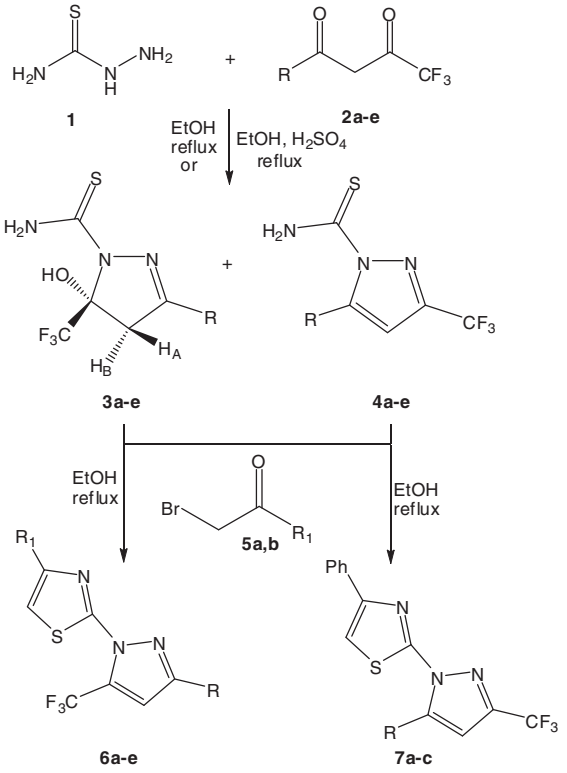
Reaction of pyrazolylthioureas **8a–c** with phenacyl bromides **5a,c,d** in ethanol at reflux gave, as the sole isolated products, thiazolylidenepyrazolamines **9a–i** (Scheme 2).

The IR spectra of **9a–i** showed three absorption bands at about 3280–3295, 1615–1625, and 1580–1605 cm^{-1}, which were assigned to NH, C═N, and Ar—C═C, respectively.

Elemental analyses and mass spectra showed that the elements of H_2O and HBr (Mw-99) had been released. In the electron-impact mass spectra of all the products, loss of R and R′—C_6H_4 gives rise to $m/z = 178$ ($C_7H_6N_4S$). This fragment in turn loses the thiazolimine ($C_3H_2N_2S$) ring, giving rise to $m/z = 81$.

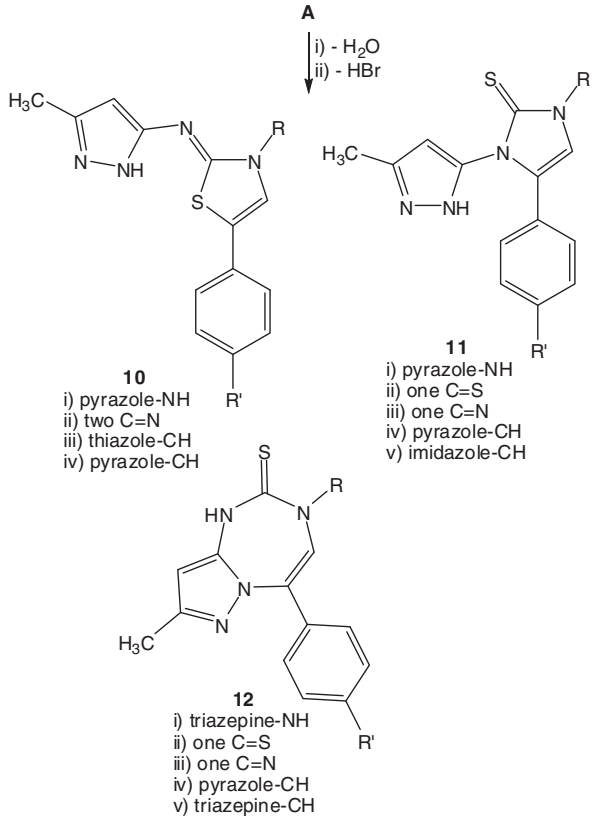
The ^{1}H-NMR spectra of **9a–i** revealed a thiazole-CH signal between 7.13 and 7.35 ppm, a pyrazole-CH signal at 6.01–6.06 ppm, and one pyrazole-NH proton signal for which the range of chemical shifts is relatively narrow (12.26–12.97 ppm).

Scheme 1. Previous work, reaction of trifluoromethyl-5(3)-substituted pyrazol-1-thiocarboxamides with phenacyl bromides.

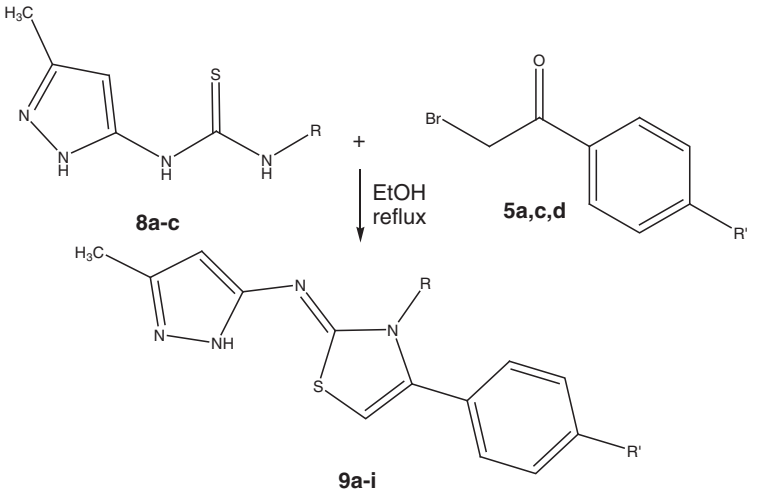


2,3,4: **a**, R = CH_3; **b**, R = CF_3; **c**, R = C_6H_5; **d**, R = *p*-$CH_3OC_6H_4$; **e**, R = *p*-ClC_6H_4
5: **a**, R_1 = C_6H_5; **b**, R_1 = *p*-$CH_3OC_6H_4$
6: **a**, R = CH_3, R_1 = *p*-$CH_3OC_6H_4$; **b**, R = CF_3, R_1 = C_6H_5; **c**, R = R_1 = C_6H_5; **d**, R = *p*-$CH_3OC_6H_4$, R_1 = C_6H_5; **e**, R = *p*-ClC_6H_4, R_1 = *p*-$CH_3OC_6H_4$
7: **a**, R = C_6H_5; **b**, R = *p*-$CH_3OC_6H_4$; **c**, R = *p*-ClC_6H_4

Scheme 3. Isometric products formed via the intermediate **A**.



Scheme 2. Reaction between pyrazolythioureas **8a–c** and phenacyl bromides **5a,c,d**.



5: **a**, R' = H; **c**, R' = Br; **d**, R' = C_6H_5
8: **a**, R = C_6H_5; **b**, R = $C_6H_5CH_2$; **c**, R = CH_2=CH-CH_2
9: **a**, R = C_6H_5, R' = H; **b**, R = $C_6H_5CH_2$, R' = H; **c**, R = CH_2=CH-CH_2, R' = H; **d**, R = C_6H_5, R' = Br; **e**, R = $C_6H_5CH_2$, R' = Br; **f**, R = CH_2=CH-CH_2, R' = Br; **g**, R = R' = C_6H_5; **h**, R = $C_6H_5CH_2$, R' = C_6H_5; **i**, R = CH_2=CH-CH_2, R' = C_6H_5

Further support for the structure of **9a–i** was provided by ^{13}C-NMR spectra, which exhibited signals at δ_c 162.94–163.69, 148.03–149.22, 105.98–106.66, 94.08–94.62, and 10.48–10.92 ppm, corresponding to (thiazole-C2), (pyrazole-C5), (thiazole-C5), (pyrazole-C4), and methyl group, respectively.

The ^{1}H-NMR spectrum of **9c** (R=allyl, R′=H) clearly showed the presence of an allyl group that resonated at 4.52, 5.03–5.15, and 5.75–5.87 ppm, because of allyl-CH_2N, allyl-CH_2=, and allyl-CH=, respectively. The presence of an allyl group was also evident from the ^{13}C-DEPT-NMR spectrum, which exhibited a positive signal at 135.91 ppm (allyl-CH=), and negative signals at 44.86 and 117.82 ppm, because of allyl-CH_2N and allyl-CH_2=, respectively.

There are possibilities for the formation of various isomers that would behave very similarly spectroscopically (Schemes 3–6). It is probable that all products observed are formed from one of the four labile (1:1) adducts (**A–D**) of pyrazolylthioureas **8a–c** to ω-bromoacetophenones **5a,c,d** (Fig. 1).

Products **10–12** (Scheme 3) might form, if the reaction proceeds via intermediate **A** (Fig. 1).

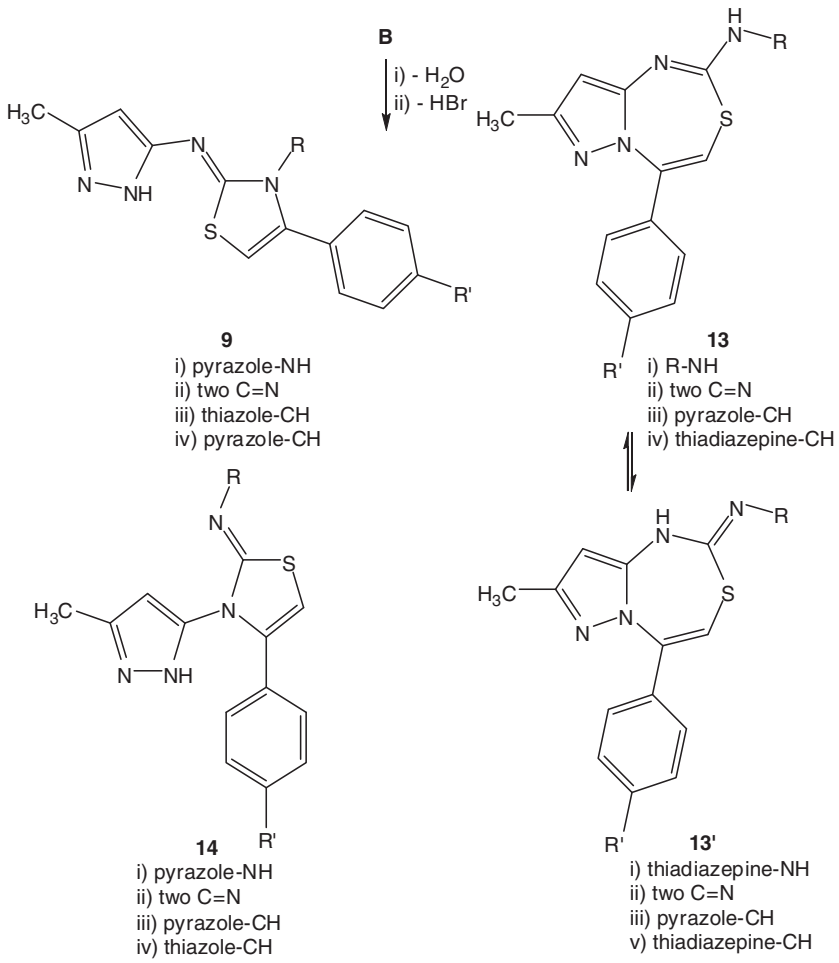
Products **9**, **13**, and **14** (Scheme 4) might form, if the reaction proceeds via intermediate **B** (Fig. 1).

Products **15–17** (Scheme 5) might form, if the reaction proceeds via intermediate **C** (Fig. 1).

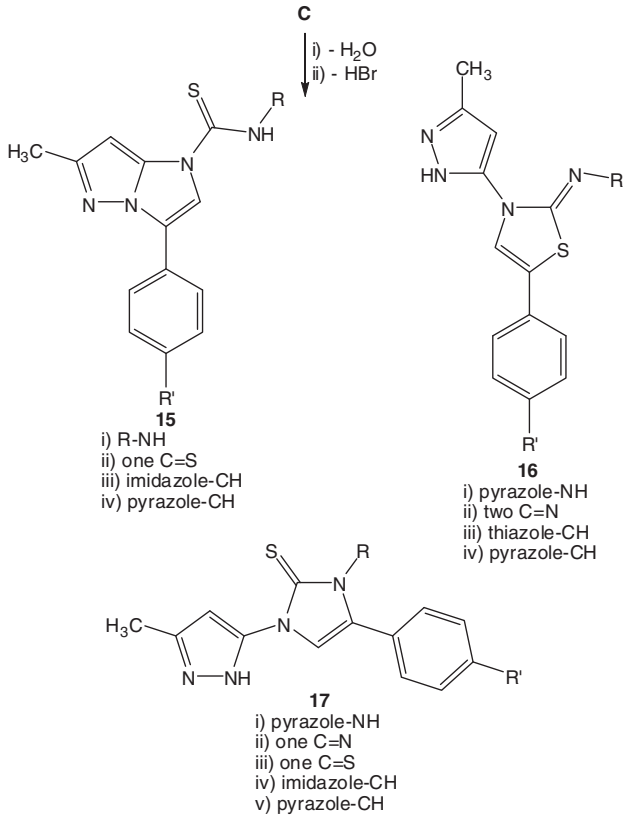
Products **18–20** (Scheme 6) might form, if the reaction proceeds via intermediate **D** (Fig. 1).

7Structures **11**, **12**, **15**, **17**, **18**, and **20** could be excluded, by the absence of any C=S carbon from the ^{13}C-NMR data. Structures **12**, **13**, **13′**, **15**, and **18–20** were also excluded, because of the presence of pyrazole-NH in the ^{1}H-NMR data (δ_H = 12.26–12.97). Finally, structures **10** and **16** could be excluded on the basis of the thiazole-CH chemical shifts (δ_H = 7.13–7.35, consistent with thiazole-H5 as in **9**, but not with thiazole-H4 as in **10** and **16** [21]). Further support for structures **9** comes from 2D NMR correlation. For example, in **9b**, the benzylic protons in group R give HMBC correlation with thiazole-C4 (immediately ruling out **14b**) but not with thiazole-C5; thiazole-C4 lacks an attached proton, but thiazole-C5 possesses one, ruling out structures **10b** and **16b**.

Scheme 4. Isometric products are formed via intermediate **B**.



Scheme 5. Isometric products are formed via intermediate **C**.



The connectivities are illustrated by compound **9g** (Fig. 2). The broad signal at $\delta_H = 12.6$ (Table 1), detected via integration, is assigned as NH, and the methyl singlet at $\delta_H = 2.30$ is assigned as H-3a. The methyl signal gives a weak COSY correlation to the one-proton singlet at $\delta_H = 6.05$, which is assigned as H-4. The attached carbons at $\delta_C = 94.62$ and 10.87 are assigned as C-4 and C-3a, respectively. Two other carbon signals give HMBC correlation with H-4: those at $\delta_C = 148.03$ (detected only via HMBC) and 140.63. The former correlates only with H-4, whereas the latter also correlates with H-3a; they are therefore assigned as C-5 and C-3 in that order.

The imino carbon C-2′ at $\delta_C = 163.26$ gives HMBC correlation with the singlet at $\delta_H = 7.35$, which is assigned as H-5′; the attached carbon at $\delta_C = 106.16$ is assigned as C-5′. The signal at $\delta_C = 140.08$ also gives HMBC correlation with H-5′; this carbon is assigned as C-4′.

The rest of the ^{1}H spectrum consists of three phenyl groups, two mono-substituted, and one *p*-disubstituted. Assuming *meta* coupling constants to be small, these phenyl groups should give four two-proton (2H) doublets (H-*o′, o″, m″*, and *o‴*), two 2H triplets (H-*m′* and *m‴*), and two one-proton (1H) triplets (H-*p′* and *p‴*). One triplet of each type is visible upfield, at $\delta_H = 7.45$ (2H) and 7.37 (1H); these give COSY correlation with each other, and the signal at $\delta_H = 7.45$ correlates with the 2H doublet at $\delta_H = 7.63$. Thus, the three signals are assigned as those of one mono-substituted ring: $\delta_H = 7.63$, 7.45, and 7.37 are respectively either H-*o′, m′*, and *p′* or H-*o‴, m‴*, and *p‴*. The attached carbons appear at $\delta_C = 126.61$, 128.98, and 127.97, respectively. The non-protonated carbon at $\delta_C = 138.67$ gives HMBC correlation with H-*m′/m‴* at $\delta_H = 7.45$, and therefore is assigned as the *ipso* carbon of this ring. This carbon also gives HMBC correlation with the doublet at $\delta_H = 7.57$, in the *p*-disubstituted ring; thus, the doublet is assigned as H-*m″*. Its attached carbon appears at $\delta_C = 129.09$. This connection means that the mono-substituted phenyl described earlier must be that derived from *p*-phenylphenacyl bromide, that is, H- and C-*o‴, m‴*, and *p‴*. The remaining protons of the *p*-disubstituted ring are the doublet at $\delta_H = 7.54$, which are assigned as H-*o″*, the attached carbon appears at $\delta_C = 129.99$. The other two triplets (one 1H and one 2H) are coresonant, at $\delta_H = 7.58$; they give COSY correlation with the doublet at $\delta_H = 7.27$. Accordingly, the 1H and 2H triplets are assigned as H-*p′* and H-*m′* respectively, and the doublet at $\delta_H = 7.27$ is assigned as H-*o′*. Their attached carbons at $\delta_C = 130.29$, 126.31, and 129.78 are assigned as C-*p′, m′*, and *o′*, respectively. The assignment of the remaining non-protonated carbons is somewhat conjectural: it depends on HMBC correlations in a congested region. The assumption that three-bond correlations are observed leads to the assignments in Table 2.

The formation of thiazolylidenepyrazolamines **9a–i** can be rationalized as in Scheme 7.

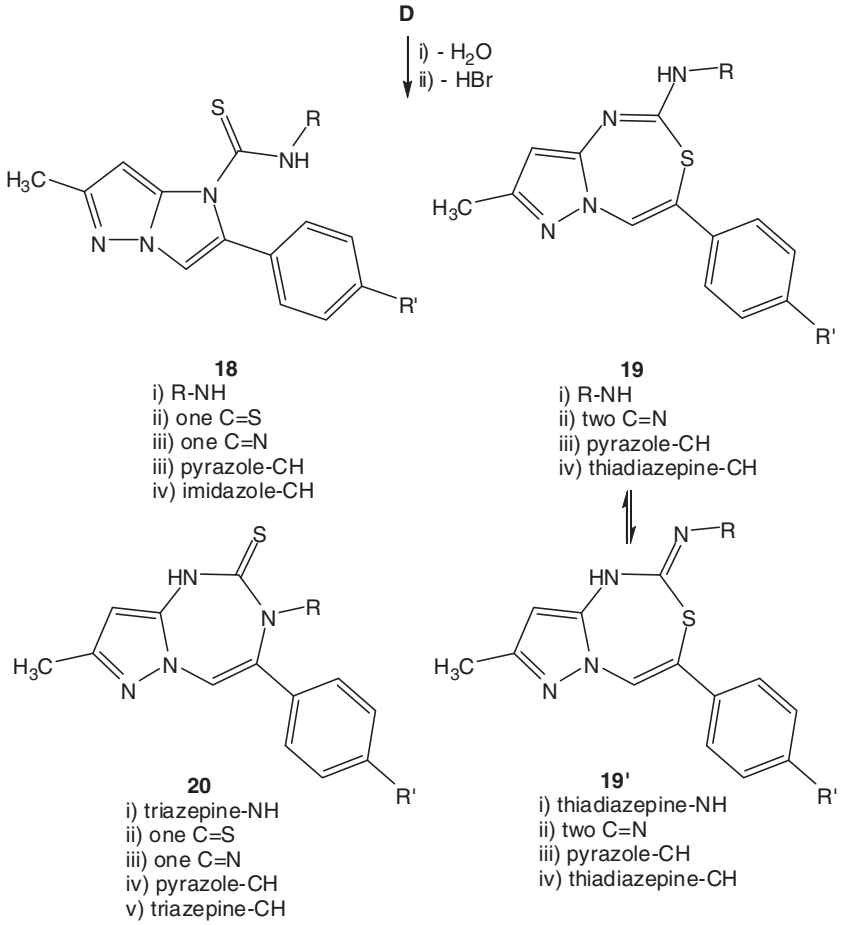
CONCLUSION

Cyclo-condensation of pyrazolylthioureas **8a–c** with ω-bromo-acetophenones **5a,c,d** forms thiazolylidenepyrazolamines **9a–i**. The reaction between **8a–c** and **5a,c,d** can involve attack by four possible sites of compounds **8** (N^1, N^3, pyrazol-NH and SH of thioamide group) on the active methylene and carbonyl group of ω-bromoacetophenones. The thiaheterocyclic N-C-S + C_1 mode of cyclization is found to be favored. Comparison of ^{1}H-NMR and ^{13}C-NMR chemical shifts and 2D NMR correlations for the possible sets of isomers may serve as a useful supplementary tool in finding the correct structure of a heterocycle.

EXPERIMENTAL

General Procedures. Melting points were determined using open glass capillaries on a Gallenkamp melting point apparatus (Weiss-Gallenkamp, Loughborough, UK) and uncorrected. The IR spectra were recorded from potassium bromide disks with a Shimadzu 408 (Shimadzu Corporation, Kyoto, Japan). NMR spectra (400 MHz for ^{1}H, 100 MHz for ^{13}C) were observed in DMSO-d_6 on Bruker AM400 or AV400 spectrometers (Bruker BioSpin, Karlsruhe, Germany) with tetramethylsilane as the internal standard. The ^{13}C signals were assigned with the aid of

Scheme 6. Isometric products are formed via intermediate **D**.



DEPT 135/90, HMBC, and HMQC experiments. Mass spectra were recorded on a Shimadzu Qp-2010 plus instrument (Shimadzu Corporation, Kyoto, Japan), in EI Mode with 70 eV ionization energy. TLC was performed on analytical Merck 9385 silica aluminum sheets (Kieselgel 60) with Pf_{254} indicator; TLC's were viewed $\lambda_{max} = 254$ nm. Elemental analyses were carried out at the Microanalytical Center, Cairo University, Egypt.

Starting materials. Pyrazolylthioureas **8a–c** were prepared according to published procedures [16]. ω-Bromoacetophenones **5a,c,d** were prepared according to published procedures [22,23].

Procedure: preparation of thiazolylidenepyrazolamines 9a–i. A solution of pyrazolylthioureas **8a–c** (0.1 mol) in 10 mL ethanol was added dropwise to (0.1 mol) ω-bromoacetophenones **5a, c,d** in 10 mL ethanol, and the reaction mixture was gently refluxed with stirring for 30 min (for compound **9a**), 1 h (for compound **9b**), 1.5 h (for compound **9c**), 1 h (for compound **9d**), 2 h (for compound **9e**), 2.25 h (for compound **9f**), 2.5 h (for compound **9 g**), 2.5 h (for compound **9 h**), and 3 h (for compound **9i**). The resulting colorless precipitate was filtered off, washed with ethanol, and recrystallized from acetonitrile to give pure crystals of **9a–i**.

(Z)-N-(3,4-Diphenylthiazol-2(3H)-ylidene)-3-methyl-1H-pyrazol-5-amine (9a). This compound was obtained as colorless crystals (250 mg, 75%), mp 280–282°C; IR: NH 3290, C═N 1620, Ar—C═C 1605, 1580 cm^{-1}; ^{1}H-NMR: δ 2.29 (s, 3H, CH_3), 6.04 (s, 1H, pyrazole-CH), 7.22 (s, 1H, thiazole-CH), 7.31–7.65 (m, 10H, Ar—CH), 12.68 ppm (s, 1H, pyrazole-NH); ^{13}C-NMR: δ 10.92 (CH_3), 94.31 (pyrazole-CH), 105.69 (thiazole-CH), 127.23, 127.46, 128.19, 128.39, 129.21, 129.28 (Ar—CH), 131.44, 135.71 (Ar—C), 140.39 (thiazole-C-4), 142.64 (pyrazole-C-3), 148.49 (pyrazole-C-5), 162.66 ppm (thiazole-C-2); MS: *m/z* 332 (M^+, 25), 255 (23), 251 (61), 178 (100), 81 (45), 77 (63). *Anal*. Calcd *for* $C_{19}H_{16}N_4S$: C, 68.65; H, 4.85; N, 16.85; S, 9.65. Found: C, 68.49; H, 4.91; N, 16.99; S, 9.58.

(Z)-N-(3-Benzyl-4-phenylthiazol-2(3H)-ylidene)-3-methyl-1H-pyrazol-5-amine (9b). This compound was obtained as colorless crystals (230 mg, 64%), mp 296–298°C; IR: NH 3285, C═N 1620, Ar—C═C 1600, 1580 cm^{-1}; ^{1}H-NMR: δ 2.19 (s, 3H, CH_3), 5.59 (s, 2H, CH_2), 6.06 (s, 1H, pyrazole-CH), 7.25 (s, 1H, thiazole-CH), 7.34–7.86 (m, 10H, Ar—CH), 12.54 ppm (s, 1H, pyrazole-NH); ^{13}C-NMR: δ 10.62 (CH_3), 42.56 (CH_2), 94.31 (pyrazole-CH), 105.98 (thiazole-CH), 126.74, 127.18, 127.96, 128.68, 129.73, 129.97 (Ar—CH), 131.13, 136.68 (Ar—C), 140.19 (thiazole-C-4), 141.07 (pyrazole-C-3), 148.86 (pyrazole-C-5), 162.64 ppm (thiazole-C-2); MS: *m/z* 346 (M^+, 75), 269 (24), 255 (18), 178 (85), 91 (56), 81 (41), 77 (100). *Anal*. Calcd *for* $C_{20}H_{18}N_4S$: C, 69.34; H, 5.24; N, 16.17; S, 9.26. Found: C, 69.51; H, 5.11; N, 16.38; S, 9.33.

(Z)-N-(3-Allyl-4-phenylthiazol-2(3H)-ylidene)-3-methyl-1H-pyrazol-5-amine (9c). This compound was obtained as colorless crystals (180 mg, 61%), mp 242–244°C; IR: NH 3280, Ali-CH

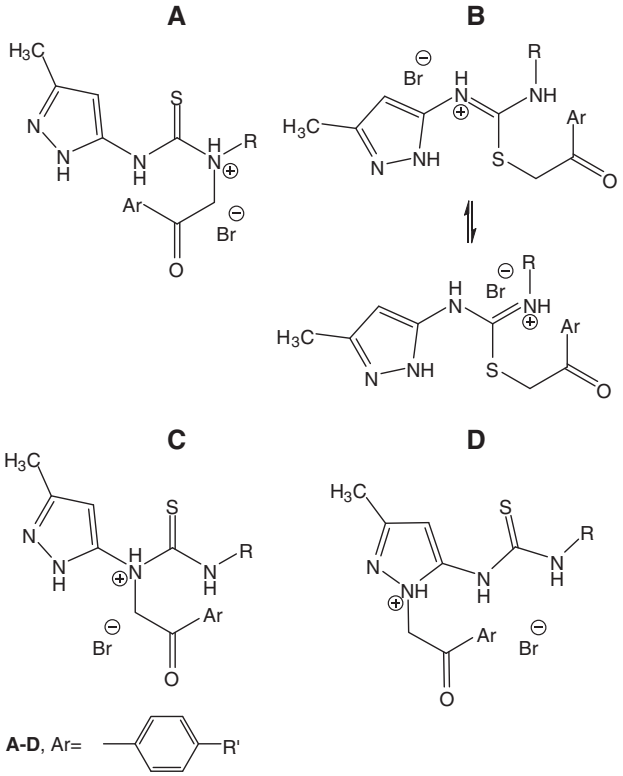


Figure 1. Four labile (1:1) adducts (**A–D**).

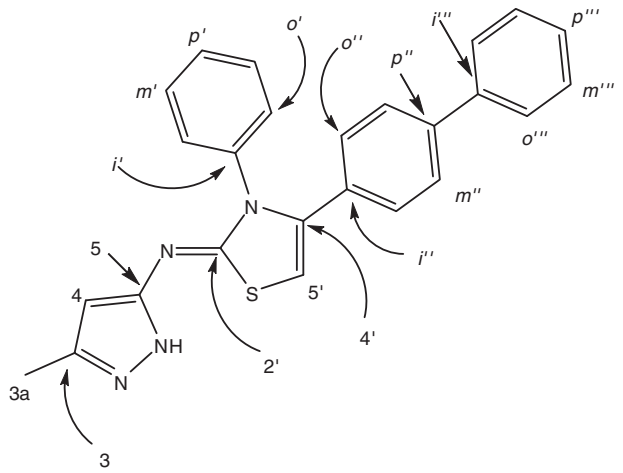


Figure 2. The structure of compound **9g**.

2290, C=N 1615, Ar—C=C 1605, 1585 cm^{-1}; ^{1}H-NMR: δ 2.31 (s, 3H, CH_3), 4.52 (br, 2H, allyl-CH_2N), 5.03–5.15 (m, 2H, allyl-CH_2=), 5.75–5.87 (m, 1H, allyl-CH=), 6.04 (s, 1H, pyrazole-CH), 7.13 (s, 1H, thiazole-CH), 7.01–7.47 (m, 5H, Ar—CH), 12.45 ppm (s, 1H, pyrazole-NH); ^{13}C-NMR: δ 10.59 (CH_3), 44.86 (allyl-CH_2N), 94.14 (pyrazole-CH), 106.11 (thiazole-CH), 117.82 (allyl-CH_2=), 127.41, 128.02, 129.21 (Ar—CH), 135.91 (allyl-CH=), 136.11 (Ar—C), 140.06 (thiazole-C-4), 141.13 (pyrazole-C-3), 149.06 (pyrazole-C-5), 162.98 ppm (thiazole-C-2); MS: *m/z* 296 (M^+, 24), 296 (24), 255 (51), 219 (33), 178 (100), 95 (18), 83 (21), 81 (45), 77 (78), 41 (19). *Anal*. Calcd *for* $C_{16}H_{16}N_4S$: C, 64.84; H, 5.44; N, 18.90; S, 10.82. Found: C, 64.91; H, 5.26; N, 19.03; S, 10.68.

Table 1

^{1}H-NMR and COSY data for compound **9g**.

^{1}H-NMR (DMSO-d_6):	COSY	Assignment
12.6 (b; 1H)		N—H
7.63 (d, *J* = 7.9; 2H)	7.58–7.54, 7.45	H-*o‴*
7.58 (t, *J* = 7.4; 3H)	7.27	H-*m′, p′*
7.57 (d, *J* = 6.7; 2H)	7.63	H-*m″*
7.54 (d, *J* = 7.0; 2H)		H-*o″*
7.45 (t, *J* = 7.6; 2H)	7.63, 7.37	H-*m‴*
7.37 (t, *J* = 7.2; 1H)	7.45	H-*p‴*
7.35 (s, 1H)		H-5′
7.27 (d, *J* = 8.2; 2H)	7.58–7.54	H-*o′*
6.05 (s, 1H)	2.30	H-4
2.30 (s, 3H)	6.05	H-3a

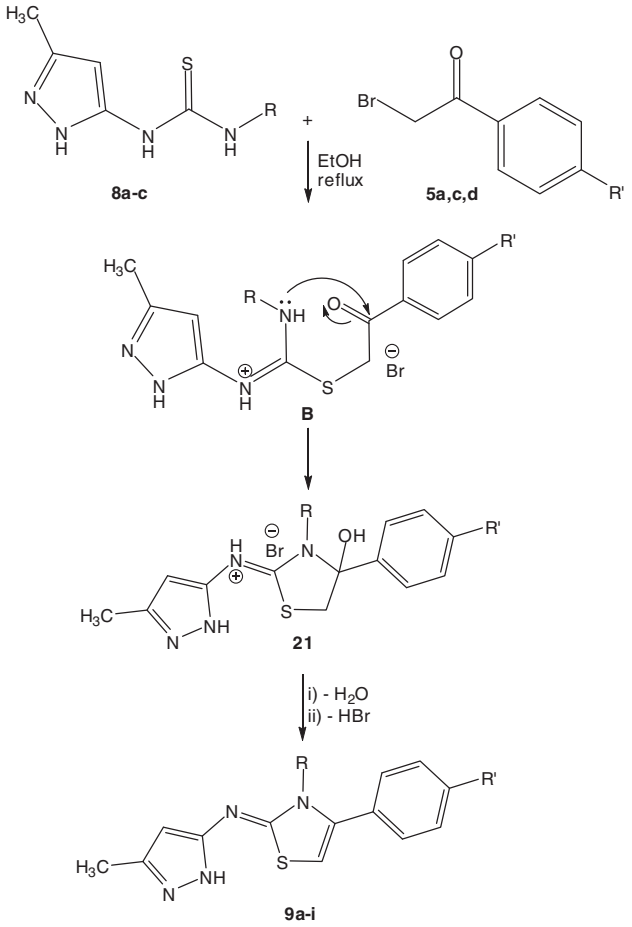
Table 2

HSQC and HMBC data for compound **9g**.

^{13}C-NMR (DMSO-d_6)	HSQC	HMBC	Assignment
163.26		7.35	C-2′
148.03		6.05	C-5
140.63		6.05, 2.30	C-3
140.08		7.63, 7.35	C-4″
138.67		7.58–7.57, 7.45	C-*i‴*
134.88		7.54	C-*i″*
130.29	7.58	7.58	C-*p′*
129.99	7.54	7.57	C-*o″*
129.78	7.27	7.27	C-*o′*
129.09	7.57	7.45	C-*m″*
128.98	7.45	7.54	C-*m‴*
128.78		7.58	C-*i′*
128.19		7.63	C-*p″*
127.97	7.37	7.63	C-*p‴*
126.61	7.63	7.63–7.58, 7.37, 7.27	C-*o‴*
126.31	7.58		C-*m′*
106.16	7.35	7.45	C-5′
94.62	6.05		C-4
10.87	2.30	2.30	C-3a

(Z)-N-[4-(4-Bromophenyl)-3-phenylthiazol-2(3H)-ylidene]-3-methyl-1H-pyrazol-5-amine (9d). This compound was obtained as colorless crystals (260 mg, 63%), mp 274–276°C; IR: NH 3295, Ali-CH 2950, C=N 1620, Ar—C=C 1600, 1580 cm^{-1}; ^{1}H-NMR: δ 2.31 (s, 3H, CH_3), 6.05 (s, 1H, pyrazole-CH), 7.31 (s, 1H, thiazole-CH), 7.22–7.64 (m, 9H, Ar—CH), 12.97 ppm (s, 1H, pyrazole-NH); ^{13}C-NMR: δ 10.64 (CH_3), 94.16 (pyrazole-CH), 106.31 (thiazole-CH), 126.12, 127.22, 128.40, 129.72, 134.13 (Ar—CH), 136.14, 141.42 (Ar—C), 140.01 (thiazole-C-4), 141.06 (pyrazole-C-3), 149.06 (pyrazole-C-5), 163.69 ppm (thiazole-C-2); MS: *m/z* 412/410 (M^+, 23), 332 (100), 331 (79), 255 (45), 178 (71), 156 (47), 81 (36), 77 (51). *Anal*. Calcd *for* $C_{19}H_{15}BrN_4S$: C, 55.48; H, 3.68; N, 13.62; S, 7.80. Found: C, 55.56; H, 3.76; N, 13.56; S, 7.99.

Scheme 7. Rationalize for the formation of thiazolylidenepyrazolamines **9a–i**.



(Z)-N-[3-Benzyl-4-(4-bromophenyl)thiazol-2(3H)-ylidene]-3-methyl-1H-pyrazol-5-amine (9e). This compound was obtained as colorless crystals (240 mg, 56%), mp 289–291°C; IR: NH 3290, C═N 1615, Ar—C═C 1605, 1585 cm^{-1}; ^{1}H-NMR: δ 2.30 (s, 3H, CH_3), 5.48 (s, 2H, CH_2), 6.03 (s, 1H, pyrazole-CH), 7.29 (s, 1H, thiazole-CH), 7.04–7.87 (m, 9H, Ar—CH), 12.42 ppm (s, 1H, pyrazole-NH); ^{13}C-NMR: δ 10.48 (CH_3), 42.44 (CH_2), 94.11 (pyrazole-CH), 106.66 (thiazole-CH), 126.25, 127.18, 128.31, 129.13, 130.77 (Ar—CH), 131.44, 135.68 (Ar—C), 140.02 (thiazole-C-4), 140.93 (pyrazole-C-3), 149.22 (pyrazole-C-5), 162.96 ppm (thiazole-C-2); MS: *m/z* 426/424 (M^+, 33), 332 (27), 255 (56), 187 (100), 178 (25), 91 (55), 81 (23), 77 (63). *Anal*. Calcd *for* $C_{20}H_{17}BrN_4S$: C, 56.48; H, 4.03; N, 13.17; S, 7.54. Found: C, 56.51; H, 4.18; N, 13.36; S, 7.39.

(Z)-N-[3-Allyl-4-(4-bromophenyl)thiazol-2(3H)-ylidene]-3-methyl-1H-pyrazol-5-amine (9f). This compound was obtained as colorless crystals (200 mg, 53%), mp 250–252°C; IR: NH 3285, C═N 1620, Ar—C═C 1600 cm^{-1}; ^{1}H-NMR: δ 2.22 (s, 3H, CH_3), 4.51 (br, 2H, allyl-CH_2N), 5.11–5.16 (m, 2H, allyl-CH_2═), 5.55–5.77 (m, 1H, allyl-CH═), 6.01 (s, 1H, pyrazole-CH), 7.15 (s, 1H, thiazole-CH), 7.22–7.44 (m, 4H, Ar—CH), 12.27 ppm (s, 1H, pyrazole-NH); ^{13}C-NMR: δ 10.71 (CH_3), 44.82 (allyl-CH_2N), 94.33 (pyrazole-CH), 105.98 (thiazole-CH), 117.86 (allyl-CH_2═), 128.12, 129.33 (Ar—CH), 135.86 (allyl-CH═), 131.23, 136.02 (Ar—C), 139.51 (thiazole-C-4), 140.02 (pyrazole-C-3), 148.88 (pyrazole-C-5), 162.98 ppm (thiazole-C-2); MS: *m/z* 376/374 (M^+, 24), 332 (43), 255 (25), 178 (75), 154 (66), 81 (87), 77 (100). *Anal*. Calcd *for* $C_{16}H_{15}BrN_4S$: C, 51.21; H, 4.03; N, 14.93; S, 8.54. Found: C, 51.38; H, 4.19; N, 15.01; S, 8.43.

(Z)-N-[4-(biphenyl-4-yl)-3-phenylthiazol-2(3H)-ylidene]-3-methyl-1H-pyrazol-5-amine (9g). This compound was obtained as colorless crystals (280 mg, 69%), mp 316–318°C; IR: NH 3290, Ar—H 3100, C═N 1620, Ar—C═C 1600 cm^{-1}; ^{1}H-NMR and ^{13}C-NMR (see Tables 1 and 2); MS: *m/z* 408 (M^+, 20), 331 (23), 254 (56), 251 (61), 178 (46), 81 (41), 77 (100). *Anal*. Calcd *for* $C_{25}H_{20}N_4S$: C, 73.50; H, 4.93; N, 13.71; S, 7.85. Found: C, 73.39; H, 5.11; N, 13.66; S, 7.81.

(Z)-N-[3-Benzyl-4-(biphenyl-4-yl)thiazol-2(3H)-ylidene]-3-methyl-1H-pyrazol-5-amine (9h). This compound was obtained as colorless crystals (270 mg, 64%), mp 340–342°C; IR: NH 3285, C═N 1615, Ar—C═C 1600, 1585 cm^{-1}; ^{1}H-NMR: δ 2.23 (s, 3H, CH_3), 5.56 (s, 2H, CH_2), 6.01 (s, 1H, pyrazole-CH), 7.22 (s, 1H, thiazole-CH), 7.21–7.46 (m, 14H, Ar—CH), 12.38 ppm (s, 1H, pyrazole-NH); ^{13}C-NMR: δ 10.62 (CH_3), 42.51 (CH_2), 94.08 (pyrazole-CH), 106.29 (thiazole-CH), 126.22, 126.54, 127.28, 128.26, 128.41, 128.82, 129.43, 129.87 (Ar—CH), 130.23, 135.18 136.13 (Ar—C), 140.04 (thiazole-C-4), 141.28 (pyrazole-C-3), 149.04 (pyrazole-C-5), 163.33 ppm (thiazole-C-2); MS: *m/z* 422 (M^+, 75), 331 (22), 254 (23), 178 (56), 91 (16), 81 (100), 77 (78). *Anal*. Calcd *for* $C_{26}H_{22}N_4S$: C, 73.90; H, 5.25; N, 13.26; S, 7.59. Found: C, 74.06; H, 5.11; N, 13.38; S, 7.67.

(Z)-N-[3-Allyl-4-(biphenyl-4-yl)thiazol-2(3H)-ylidene]-3-methyl-1H-pyrazol-5-amine (9i). This compound was obtained as colorless crystals (220 mg, 59%), mp 280–282°C; IR: NH 3285, C═N 1620, Ar—C═C 1600, 1585 cm^{-1}; ^{1}H-NMR: δ 2.26 (s, 3H, CH_3), 4.51 (br, 2H, allyl-CH_2N), 5.01–5.18 (m, 2H, allyl-CH_2═), 5.65–5.77 (m, 1H, allyl-CH═), 6.06 (s, 1H, pyrazole-CH), 7.20 (s, 1H, thiazole-CH), 7.11–7.57 (m, 9H, Ar—CH), 12.26 ppm (s, 1H, pyrazole-NH); ^{13}C-NMR: δ 10.66 (CH_3), 44.85 (allyl-CH_2N), 94.44 (pyrazole-CH), 106.11 (thiazole-CH), 116.89 (allyl-CH_2═), 127.44, 128.12, 129.21, 129.39, 131.46 (Ar—CH), 135.77 (allyl-CH═), 132.36, 136.11 (Ar—C), 140.11 (thiazole-C-4), 141.53 (pyrazole-C-3), 148.86 (pyrazole-C-5), 162.98 ppm (thiazole-C-2); MS: *m/z* 372 (M^+, 33), 331 (26), 295 (48), 219 (24), 178 (100), 96 (18), 81 (52), 77 (42), 41 (23). *Anal*. Calcd *for* $C_{22}H_{20}N_4S$: C, 70.94; H, 5.41; N, 15.04; S, 8.61. Found: C, 71.05; H, 5.33; N, 15.13; S, 8.46.

Acknowledgments. Purchase of the AV-400 NMR spectrometer was assisted by the National Science Foundation (CHE 03-42251).

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