3-Aryl-1-benzoylthioureas with α-bromoketones in water form 2-*N*-benzoyl-3-arylthiazol-2(3*H*)-imines, not 3-aryl-1-benzoylimidazoline-2-thiones

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The products obtained by the reaction of 1-benzoyl-3-phenylthioureas with α-bromoketones in water in the presence of triethylamine are not imidazoline-2-thiones as reported (*J. Chem. Res.* 2005, 689–690); rather they are thiazol-2-imine derivatives.

Keywords: thiazol-2-imines, imidazoline-2-thiones, reactions in water, thioureas, α-haloketones

Recently we have reported[1] that the products of reaction of benzoyl-3-phenylthioureas with bromine and acetone or other enolisable ketone in the presence of triethylamine are thiazol-2-imine derivatives and not imidazoline-2-thiones as earlier claimed.[2] Experimental evidence in favour of our interpretation included crystal structure determinations of three of the products. The first step of the thiazolimine formation involves the reaction of the 1-benzoyl-3-phenylthioureas with the *in situ* generated α-bromoketones. We were surprised to see that when an analogous reaction was performed in water with a preformed α-haloketone, it was reported to give imidazoline-2-thione derivatives.[3] Water as a reaction medium has special effects; it is known to accelerate the reaction rates and even to alter the reaction path in some cases.[4] We were thus interested to discover whether water has any special role in this particular case, or whether it is just another error of identification.

Results and discussion

When 1-benzoyl-3-(4-chlorophenyl)thiourea (**1a**) (5 mmol) was reacted with α-bromoacetone (5 mmol) in water (20 ml) in the presence of triethylamine (5 mmol) and was heated at 100°C for 15 minutes, according to the experimental procedure of Wang *et al.*,[3] the product isolated was identical in all respects (m.p, IR, ^{1}H NMR and ^{13}C NMR) to that reported by the earlier workers. However, X-ray crystallographic analysis[5-8] (Fig. 1) revealed the product as having the thiazolimine skeleton (**2a**) analogous to those of our recent report,[1] and not the imidazoline-2-thione derivative as previously[3] stated.

This is not an isolated instance of the thiazolimine skeleton being formed in aqueous medium. When 1-benzoyl-3-phenylthiourea (**1b**) was treated with α-bromoacetone under identical conditions, the product obtained (**2b**) was identical in all respects (m.p., IR, ^{1}H NMR and ^{13}C NMR) to that reported.[3] The structure of **2b** has already been confirmed as having the thiazolimine skeleton by X-ray crystallographic analysis.[1] Again, when 1-benzoyl-3-phenylthiourea (**1b**) and 1-(3-bromobenzoyl)-3-phenylthiourea (**1c**) were reacted separately with α-bromoacetophenone and α-bromoacetone, they gave products **2c** and **2d** respectively. Products **2c** and **2d** were again found to be identical (m.p., IR, ^{1}H and ^{13}C NMR) to the structures which were earlier confirmed as having thiazolimine structures by single crystal X-ray analysis.[1]

In conclusion, we have unambiguously proved that the product obtained by the reaction of three 1-benzoyl-3-phenylthioureas with α-bromoketones in the presence of triethylamine in an aqueous medium are thiazolimine derivatives, not imidazole-2-thiones as reported earlier.[3] We believe that all other structures reported by Wang *et al.*[3] can be expected to have thiazole and not imidazole rings.

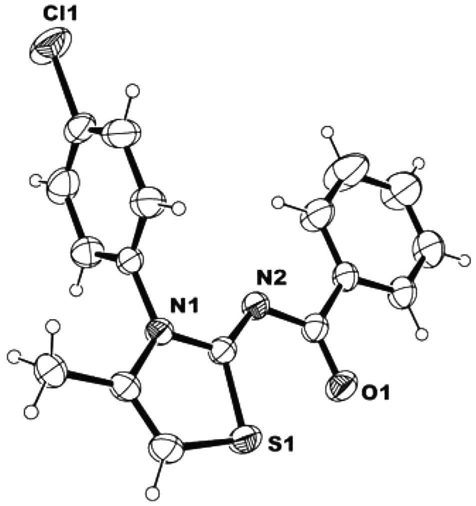
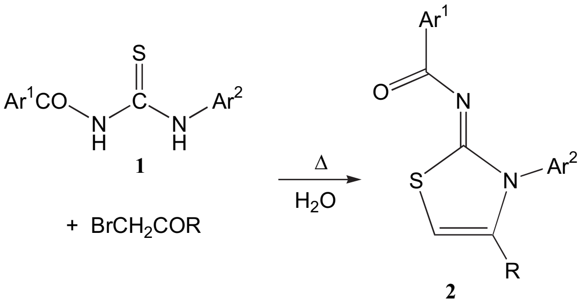


Fig. 1 ORTEP view of compound **2a**



Scheme 1

Table 1 Thiazolimines (**2**) from thioureas (**1**) and α-bromoketones (R = Me, Ph) in water (Scheme 1)

	Thiourea		Bromo-ketone	Product
	Ar^1	Ar^2	R	
1a	Ph	4-ClC$_6$H$_4$	Me	**2a**
1b	Ph	Ph	Me	**2b**
1b	Ph	Ph	Ph	**2c**
1c	3-BrC$_6$H$_4$	Ph	Me	**2d**

Experimental

IR spectra were recorded in KBr on a Nicolet Impact 410 spectrophotometer. NMR spectra were recorded in CDCl$_3$ with tetramethylsilane as internal standard for ^{1}H NMR (400 MHz) and CDCl$_3$ solvent as the internal standard for ^{13}C NMR (100 MHz). Melting points were recorded on Buchi B-545 melting point apparatus. Crystal data were collected with a Bruker Smart Apex-II

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CCD diffractometer using graphite monochromated MoKα radiation (λ = 0.71073 Å) at 298 K.

3-Aryl-N(2)-benzoylthiazol-2(3H)-imines (**2a–d**)
To a suspension of 1-benzoyl-3-arylthiourea (5 mmol) in water (20 ml) were added the α-bromocarbonyl compound (5 mmol) and triethylamine (5 mmol). The mixture was heated under reflux and the completion of reaction (45 min) was monitored by thin layer chromatography. After cooling the crude product was filtered off and recrystallised from EtOH: H_2O (4:1). For single crystal X-ray diffraction analysis a sample was recrystallised from EtOAc–hexane (4 : 1).

N(2)-Benzoyl-3-(4-chlorophenyl)-4-methylthiazol-2(3H)-imine (**2a**): M.p. 213–-215°C (Lit.[3] for reported 1-benzoyl-3-(4-chlorophenyl)-4-methyl-1,3-dihydro-2*H*-imidazole-2-thione, m.p. 211–212°C). IR (KBr): 708, 797, 835, 907, 1017, 1089, 1171, 1272, 1343, 1462, 1492, 1563, 1598 cm^{-1}. ^1H NMR (400 MHz, $CDCl_3$): δ 2.04 (s, 3H), 6.37 (s, 1H), 7.25–7.43 (m, 5H), 7.54 (d, J = 8.4 Hz, 2H), 8.03 (d, J = 7.6 Hz, 2H). ^{13}C NMR (100 MHz, $CDCl_3$); δ 15.1, 104.9, 128.1, 129.3, 129.6, 129.8, 131.6, 134.0, 135.2, 135.9, 136.7, 170.1, 174.4.

The products **2b–d** gave melting points and spectra consistent with the published data.[1]

X-ray crystal structure determination of compound **2a**
All the crystals were isolated in rectangular shape from EtOAc–hexane (4:1). Crystal dimensions: 0.50 × 0.25 × 0.15 mm. $C_{17}H_{13}ClN_2OS$: Mr = 328.80. Orthorhombic, space group Pnma; a = 20.1029(9) Å, b = 6.9451(3) Å, c = 11.2865(4) Å; $\alpha = \beta = \gamma = 90^o$; V = 1575.78(11) $Å^3$; Z = 4; ρ_{cal} = 1.386 mg/m^3; $\mu(mm^{-1})$ = 0.377; F (000) = 680; Reflections collected/unique = 9609/1964, Refinement method: full-matrix least-squares on F^2. Final R indices $[I>2\sigma_I]$ R_1 = 0.0380, wR_2 = 0.0962, R indices (all data) R_1 = 0.0589, wR_2 = 0.1026; Goodness of fit = 1.059.

Cell parameters were retrieved using SMART software and refined with SAINT on all observed reflections. Data reduction was performed with the SAINT software and corrected for Lorentz and polarisation effects. Absorption corrections were applied with the program SADABS. The structure was solved by direct methods implemented in SHELX-9716 program and refined by full-matrix least-squares methods on F2. All non-hydrogen atomic positions were located in difference Fourier maps and refined anisotropically. The hydrogen atoms were placed in their geometrically generated positions.

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