

3-Aryl-2-sulfanylpropenoic acids as precursors for some novel (Z)-5-substituted-2-alkoxy-2-trichloromethyl-4-thiazolidinones

Nadia Hanafy Metwally

Department of Chemistry, Faculty of Science, Cairo University, Giza 12613, Egypt

E-mail: nhmmohamed@yahoo.com

DOI: <http://dx.doi.org/10.3998/ark.5550190.0012.a20>

Abstract

3-Aryl-2-sulfanylpropenoic acids **1a-d** react with trichloroacetonitrile under various reaction conditions to give different products. Thus, reaction of **1a-d** with trichloroacetonitrile in absolute ethanol and in the presence of few drops of triethylamine at room temperature affords 1,3-oxathiolan-5-one derivatives **4a-d**. Whereas, compounds **1a-d** react with trichloroacetonitrile in primary alcohols under reflux to afford the corresponding 2-alkoxy-2-trichloromethylthiazolidin-4-one derivatives **7a-l**. Reaction of compounds **1a-d** with trichloroacetonitrile or other nitriles **11a-c** in refluxing glacial acetic acid gave 5-arylmethylene-2,4-thiazolidinediones **8a-d**. The structures of all the newly synthesized products were confirmed based on elemental and spectral data, and a plausible mechanism is postulated to account for their formation. X-ray crystallography was carried out for the products **4a** and **7b**.

Keywords: 3-Aryl-2-sulfanylpropenoic acids, trichloroacetonitrile, 1,3-oxathiolan-5-ones, 5-substituted-2-alkoxy-2-trichloromethyl-4-thiazolidinones, X-ray crystallography

Introduction

3-Aryl-2-sulfanylpropenoic acids are used as intermediates for the synthesis of a variety of heterocyclic sulfur compounds.¹⁻⁵ Additionally, 3-aryl-2-sulfanylpropenoic acids have been found to be useful antidotes for heavy metal poisoning. For example, 3-furyl-2-sulfanylpropenoic acid in particular has been shown to protect against cadmium intoxication in rats.⁶ An earlier investigation indicated that post-cadmium exposure treatment with certain 3-aryl-2-sulfanylpropenoic acids is effective in decreasing liver and kidney cadmium burden in rats.⁷ 3-Aryl-2-sulfanylpropenoic acids can inhibit neuraminidases.⁸ As part of our research interest in developing new routes for the synthesis of new heterocycles,⁹⁻¹² we have already reported some of our work on the synthesis, transformations and biological properties of some thiazolidinones and oxathiolanes.¹³⁻¹⁵ The biological significance of this class of compounds

impelled us to continue working on synthesis of new oxathiolane and thiazolidinone derivatives. We report here the reaction of 3-aryl-2-sulfanylpropenoic acids with trichloroacetonitrile and other nitriles under various reaction conditions to give new 1,3-oxathiolanes, which were transformed into the corresponding thiazolidin-4-one derivatives.

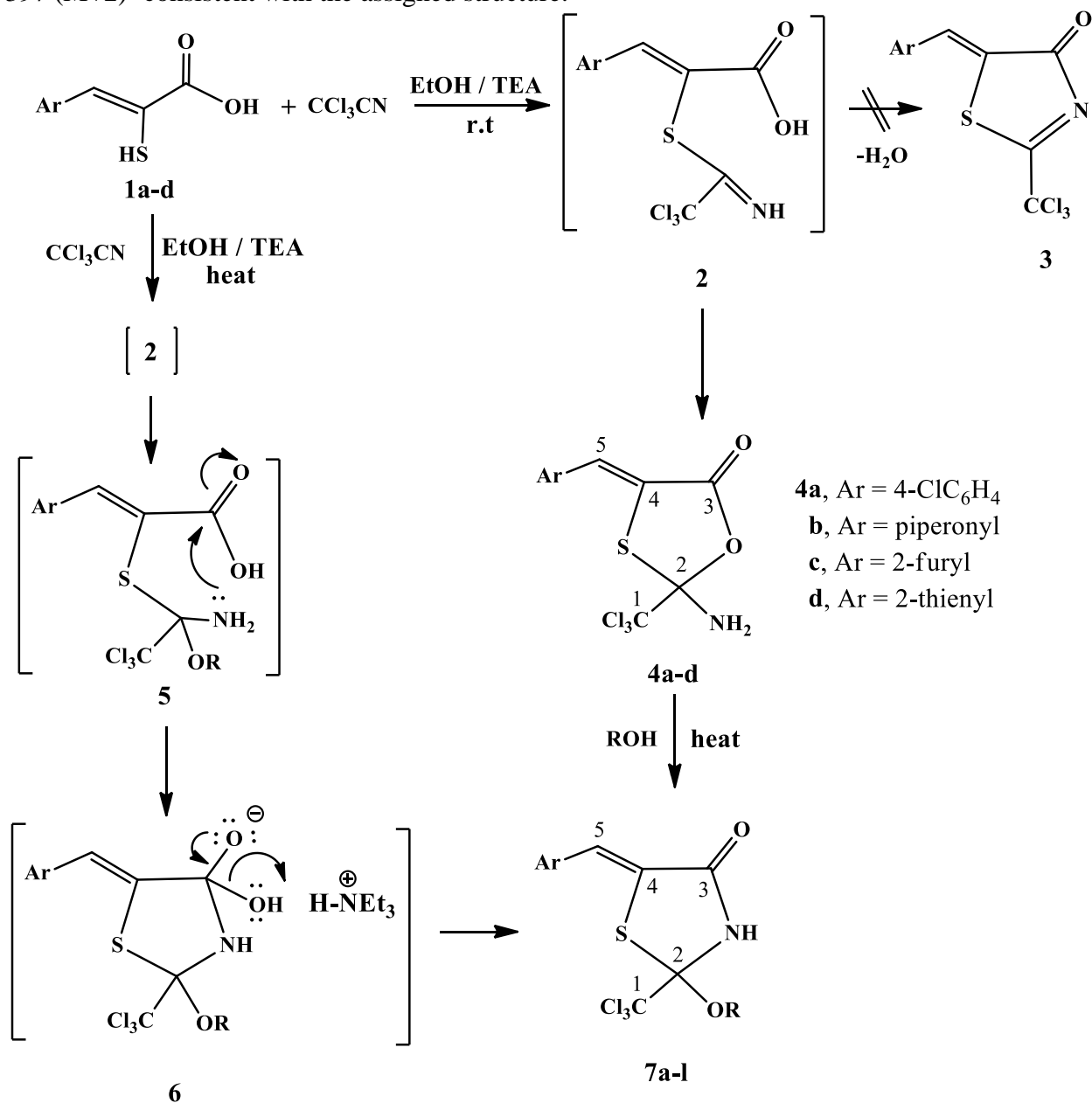
Results and Discussion

The reaction of 3-aryl-2-sulfanylpropenoic acids **1a-d** with trichloroacetonitrile in absolute ethanol and in the presence of a few drops of triethylamine as basic catalyst at room temperature afforded the products **4a-d**. The structures of the products were confirmed by elemental analyses and spectral data (IR, ^1H NMR, ^{13}C NMR, MS and X-ray). For example, the IR spectrum of the isolated product **4a** taken as a typical example of the series showed two absorption bands at ν 3388 and 3309 cm^{-1} corresponding to the amino group and one absorption band at 1751 cm^{-1} corresponding to lactone carbonyl group. The ^1H NMR spectrum of the same product revealed a broad singlet signal (2H, D_2O exchangeable) at δ = 4.51 ppm attributable to NH_2 , and a singlet signal at δ = 7.81 ppm due to a vinylic proton and the aromatic proton signals. The ^{13}C NMR spectrum of **4a** exhibited the following signals: 113.0 ppm for C-1, 115.5 ppm for C-2, 175.5 ppm for C-3, 133.0 ppm for C-4 and 138.7 ppm for C-5, beside the aromatic carbons. Its mass spectrum showed molecular ion peaks at m/z 360 ($\text{M}+1$) $^+$ and 361 ($\text{M}+2$) $^+$ consistent with the assigned structure.

Based on these spectral data the oxathiolane structures **4a-d** were assigned to the above reaction products and alternative structure **3** could be dismissed (Scheme 1). X-ray analysis of compound **4a** (Figure 1, Table 1) gives conclusive evidence for the assigned structure **4**. The formation of **4** is assumed to proceed first *via* addition of the thiol moiety in sulfanylpropenoic acid derivative **1a** to the cyano carbon in trichloroacetonitrile, affording the non-isolable acyclic imine **2**. This, in turn cyclizes to the final isolated product **4** *via* addition of the oxygen nucleophile to the activated azomethine group.

On the other hand, it was found that compounds **1a-d** react with trichloroacetonitrile in absolute ethanol in the presence of few drops of triethylamine at refluxing temperature to afford pale yellow crystalline products. It was expected that this reaction would afford thiazole derivatives **3**. The IR spectrum of **7b** taken as a typical example of the reaction products showed an absorption band at ν 1680 cm^{-1} attributable to a lactam carbonyl group. The ^1H NMR spectrum of the same product revealed a triplet signal at δ = 1.22 ppm and a quartet signal at δ = 3.70 attributable to ethoxy protons. A singlet signal (1H, D_2O exchangeable) appeared at δ = 10.46 ppm, attributable to an NH, a singlet signal at δ = 7.47 ppm due to vinylic proton and a singlet signal at δ = 6.10 due to methylene (O- CH_2 -O) protons, besides the aromatic protons. The ^{13}C NMR spectrum of **7b** exhibited the following signals: 113.0 ppm for C-1, 115.7 ppm for C-2, 176.6 ppm for C-3, 133.8 ppm for C-4, 137.5 ppm for C-5, 111.1 for methylene (O- CH_2 -O), and

aromatic carbon signals. The mass spectrum showed molecular ion peaks at m/z 395 (M)⁺ and 397 ($M+2$)⁺ consistent with the assigned structure.



Scheme 1

An X-ray crystallographic study of a single crystal of **7b** (Figure 2, Table 2) confirmed the structure deduced from NMR studies. Compounds **7a-d** can also be obtained by refluxing **4a-d** in absolute ethanol in the presence of triethylamine. Similarly, refluxing of **4a-d** in other alcohols like methanol or *n*-propanol in the presence of few drops of triethylamine afforded 2-alkoxy-2-trichloromethyl-4-thiazolidinone derivatives **7e-l**. Transformation of **4a-d** into **7a-l** is assumed to proceed *via* ring opening of lactone ring by alcohol to afford the non-isolable acyclic intermediates, then cyclization with elimination of water to afford the final isolated products **7**.

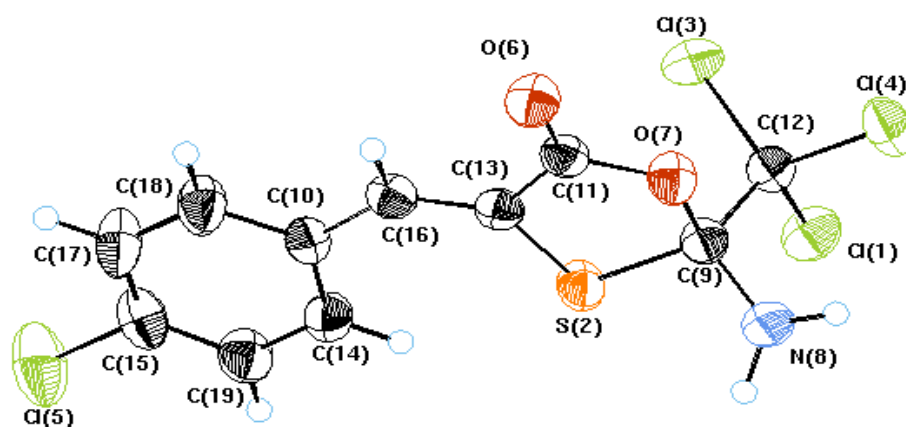


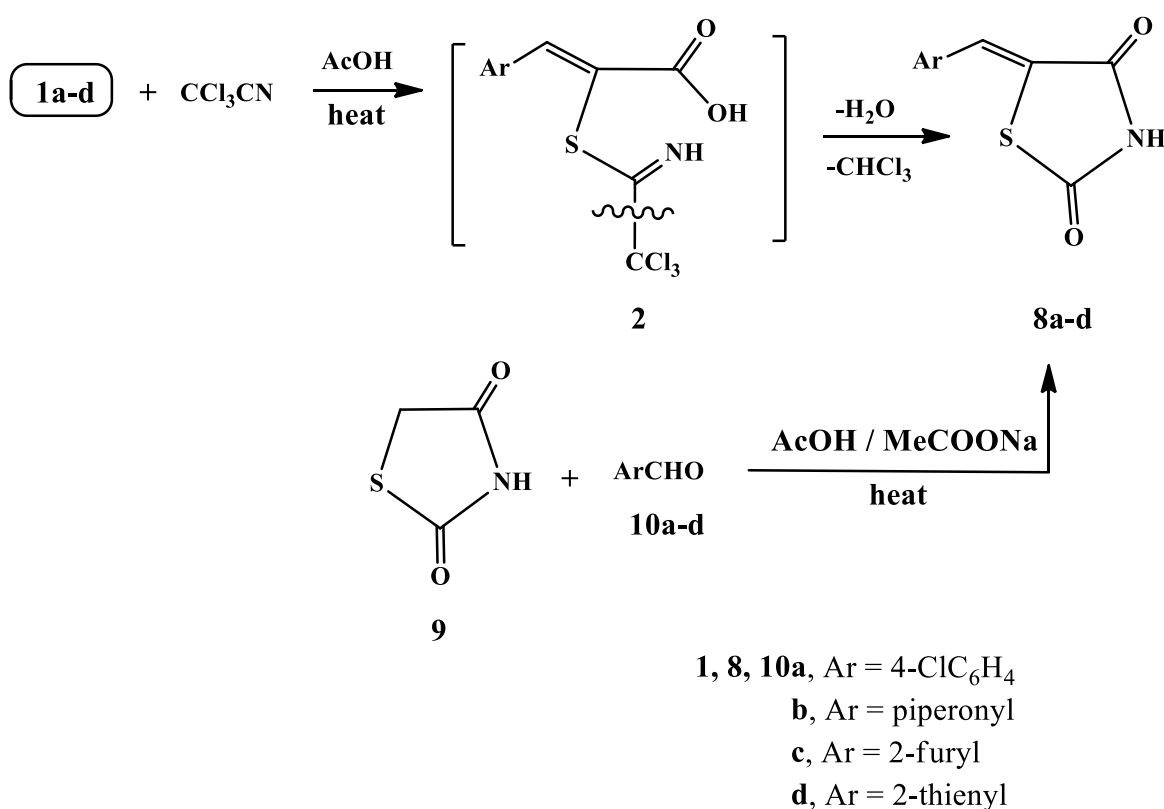
Figure 1. ORTEP drawing of compound **4a**.

Table 1. Selected bond lengths of compound **4a**

Bond	Length (Å)
C9—S2—C13	92.03 (8)
C9—O7—C11	116.09 (13)
O7—C9—C12	105.30 (13)
N8—C9—C12	109.7 (2)
Cl1—C12—C9	110.55 (12)
Cl3—C12—C9	110.45 (13)
Cl4—C12—C9	108.62 (13)
N8—C9	1.399 (2)
O7—C9	1.449 (2)
O7—C11	1.360 (2)
S2—C9	1.828 (2)
C9—C12	1.572 (3)

The ^1H NMR spectra of these products revealed in each case a broad singlet signal (1H, D_2O exchangeable) at $\delta \sim 11.25\text{--}12.90$ attributable to NH, besides a vinylic CH proton at $\delta \sim 7.56\text{--}7.71$ ppm. The mass spectra together with elemental analyses confirmed the structures **8a-d**. These structures were chemically confirmed by an alternative method *via* condensation of 2,4-thiazolidinedione (**9**) with aromatic aldehydes **10a-d** in glacial acetic acid in the presence of anhydrous sodium acetate to give products corresponding in all respects (mp, mixed mp and IR) with products^{16,17} **8a-d**.

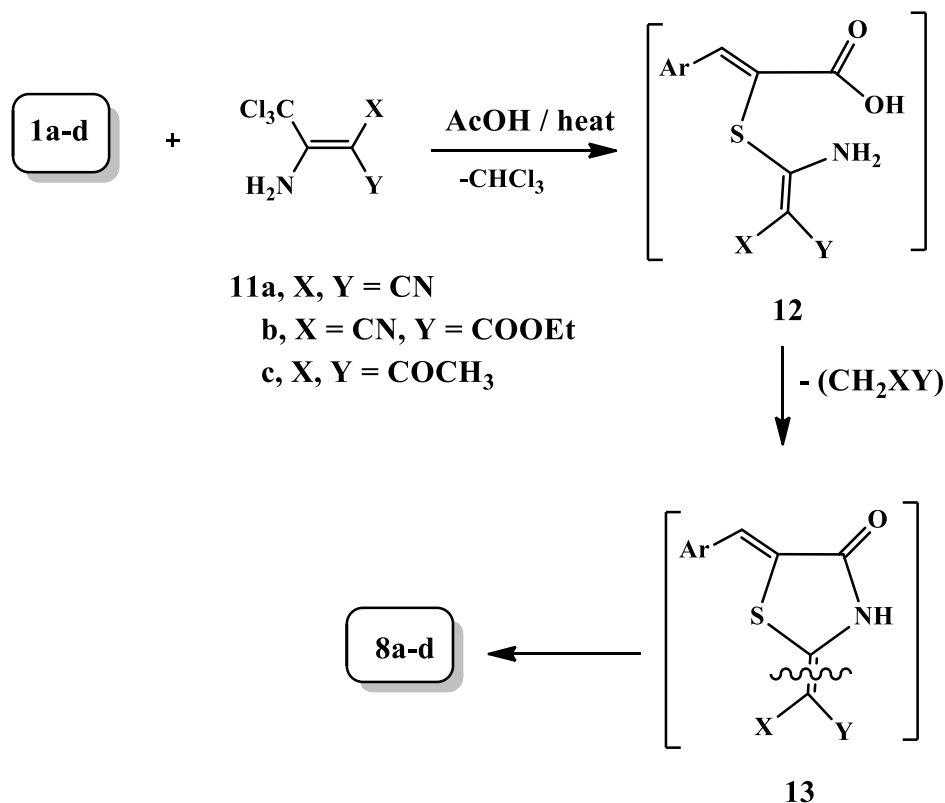
The formation of structure **8** is assumed to proceed via addition of the thiol moiety in the sulfanylpropenoic acid to the cyano carbon in trichloroacetonitrile, then cyclization with elimination of water to give non-isolable product **2**. Acid hydrolysis then affords the 5-arylidene-2,4-thiazolidinediones **8**.



Scheme 2

The reaction of **1a-d** with other nitriles such as 2-(1-amino-2,2,2-trichloroethylidene)malononitrile **11a** in refluxing acetic acid, afforded products identical in all respects (TLC, mp, mixed mp, IR) with **8a-d**. Similarly, compounds **1a-d** were allowed to react with ethyl 3-amino-4,4,4-trichloro-2-cyanobut-2-enoate **11b** or 3-(1-amino-2,2,2-trichloroethylidene)pentane-2,4-dione **11c** under the same reaction conditions to afford products completely identical (TLC, mp, mixed mp, IR) with **8a-d**.

Compounds **8a-d** are assumed to be formed *via* elimination of chloroform, followed by cyclization with elimination of water, then acid hydrolysis with elimination of active nitrile molecule to afford **8** (Scheme 3).



Scheme 3

Experimental Section

General. Melting points were determined on an Electrothermal 9100 apparatus. The IR spectra were recorded as KBr pellets on a Perkin-Elmer 1430 spectrophotometer. The ¹H NMR spectra were taken on a Varian Gemini 300-MHz spectrometer in DMSO-*d*₆ using TMS as internal standard. Mass spectra were measured on a Shimadzu GCMS-GB 1000 PX (70 ev). Elemental analyses were obtained using an Elementar CHNS analyzer Vario EL III (Germany), at the Microanalyses Center of Cairo University, Giza, Egypt. The X-ray crystal analysis was carried out at Dokki National Centre (NRC) at Dokki, Giza, Egypt. 3-Aryl-2-sulfanylpropenoic acids were synthesized according to literature procedures.¹⁸

Synthesis of 2-amino-2-trichloromethyl-4-arylmethylene-1,3-oxathiolan-5-one derivatives (4a-d). General procedure

To a mixture of **1a-d** (10 mmol) and trichloroacetonitrile (10 mmol) in 20 ml of absolute ethanol, 0.2 ml of triethylamine was added. The reaction mixture was stirred at room temperature for 1 h (TLC). The solid formed was filtered off, washed with ethanol, and recrystallized from the appropriate solvent to afford the 1,3-oxathiolan-5-ones **4a-d**.

(Z)-2-Amino-4[(4-chlorophenylmethylene)-2-trichloromethyl]-1,3-oxathiolan-5-one (4a).

Pale yellow crystals; (84%); mp 202-204 °C; (EtOH/dioxane); IR (KBr): 3388, 3309 (NH₂), 1751 cm⁻¹ (CO). ¹H NMR (DMSO-*d*₆): δ = 4.51 (s, 2H, NH₂), 7.45 (d, 2H, *J* = 8.2 Hz, Ar), 7.71 (d, 2H, *J* = 8.1 Hz, Ar), 7.81 (s, 1H); ¹³C NMR (DMSO-*d*₆): δ = 113.0, 115.5, 133.0, 138.7, 140.7, 141.7, 148.7, 175.5; MS: *m/z* (%), 360 (M+1)⁺ (1.3), 361 (M+2)⁺ (0.8), 315 (2.2), 278 (5.3), 250 (5.9), 214 (5.6), 213 (4.9), 205 (1.4), 198 (4.1), 170 (42.9), 168 (100), 149 (3.2), 136 (5.6), 120 (5.6), 108 (29.4), 98 (3.8), 84 (26.2), 75 (11.4), 69 (10.3). Anal. Calcd. for C₁₁H₇Cl₄NO₂S: calcd. C, 36.80; H, 1.97; Cl, 39.50; N, 3.90; S, 8.93; found: C, 36.59; H, 2.15; Cl, 39.30; N, 4.12; S, 8.73.

(Z)-2-Amino-2-trichloromethyl-4-(1,3-benzodioxol-5-ylmethylene)-1,3-oxathiolan-5-one (4b).

Pale yellow crystals; (80%); mp 168-170 °C; (EtOH/dioxane); IR (KBr): 3376, 3309 (NH₂), 1743 cm⁻¹ (CO). ¹H NMR (DMSO-*d*₆): δ = 4.50 (s, 2H, NH₂), 6.09 (s, 2H), 7.25-7.63 (m, 3H), 7.76 (s, 1H); MS: *m/z* (%), 367 (M-1)⁺ (0.15), 369 (M+1)⁺ (0.12), 315 (0.2), 224 (3.9), 206 (8.1), 178 (100), 149 (6.6), 120 (15.6), 108 (20.2), 76 (4.2), 69 (5.4), 55 (3.1). Anal. Calcd. for C₁₂H₈Cl₃NO₄S: C, 39.10; H, 2.19; Cl, 28.85; N, 3.80; S, 8.70; found: C, 39.29; H, 1.97; Cl, 28.64; N, 3.57; S, 8.86.

(Z)-2-Amino-2-trichloromethyl-4-(furyl-2-ylmethylene)-1,3-oxathiolan-5-one (4c).

Whitish brown crystals; (75%); mp 144-146 °C (toluene); IR (KBr): 3391, 3143 (NH₂) and 1698 cm⁻¹ (CO). ¹H NMR (DMSO-*d*₆) δ = 4.47 (s, 2H, NH₂), 7.19-7.99 (m, 3H), 8.22 (s, 1H); Anal. Calcd. for C₉H₆Cl₃NO₃S: C, 34.36; H, 1.92; Cl, 33.81; N, 4.45; S, 10.19. Found: C, 34.18; H, 1.70; Cl, 33.62; N, 4.64; S, 10.40.

(Z)-2-Amino-2-trichloromethyl-4-(thienyl-2-ylmethylene)-1,3-oxathiolan-5-one (4d).

pale yellow crystals; (72%), mp 148-150 °C (EtOH/dioxane). IR (KBr): 3387, 3138 (NH₂) and 1696 cm⁻¹ (CO). ¹H NMR (DMSO-*d*₆) δ = 4.65 (s, 2H, NH₂), 7.19-7.99 (m, 3H), 8.22 (s, 1H); Anal. Calcd. for C₉H₆Cl₃NO₂S₂: C, 32.69; H, 1.83; Cl, 32.17; N, 4.24; S, 19.40. Found: C, 32.90; H, 1.62; Cl, 32.37; N, 4.64; S, 19.56.

Synthesis of (Z)-5-arylmethylene-2-alkoxy-2-trichloromethyl-1,3-thiazol-4-ones (7a-l).

To a mixture of **1a-d** (10 mmol) and trichloroacetonitrile (10 mmol) in absolute ethanol (20 ml) or methanol or *n*-propanol, 0.2 ml of triethylamine was added. The reaction mixture was refluxed for 2-5 h (TLC), whereby a solid precipitated, was filtered off, and recrystallized from the appropriate solvent to give 2-alkoxy-2-trichloromethyl-5-arylmethylene-4-thiazolidinones **7a-l**, respectively.

Conversion of (4a-d) into (7a-l)

To **4a-d** (10 mmol) of absolute ethanol or methanol or *n*-propanol (20 ml), 0.2 ml of triethylamine was added. The reaction mixture was refluxed for 2-3 h (TLC), whereby a solid precipitated, was filtered off, and recrystallized from the appropriate solvent to give compounds **7a-l**, respectively.

(Z)-5-[4-(Chlorophenylmethylene)-2-ethoxy-2-(trichloromethyl)]thiazolidin-4-one (7a).

Yellow crystals; (80%); mp 208-210 °C; (EtOH/dioxane); IR (KBr): 3138, 3035 (NH), 1685 cm⁻¹ (CO). ¹H NMR (DMSO-*d*₆): δ = 1.17 (t, 3H, *J* = 6.3 Hz, CH₃), 4.03 (q, 2H, *J* = 7.5 Hz, CH₂), 7.48 (d, 2H, *J* = 8.0 Hz, Ar), 7.80 (d, 2H, *J* = 8.0 Hz, Ar), 7.83 (s, 1H), 10.44 (s, 1H, NH). Anal. Calcd. for C₁₃H₁₁Cl₄NO₂S: C, 40.33; H, 2.86; Cl, 36.63; N, 3.62; S, 8.28; found: C, 36.59; H, 2.15; Cl, 36.79; N, 3.86; S, 8.64.

(Z)-5-(1,3-Benzodioxol-5-ylmethylene)-2-ethoxy-2-(trichloromethyl)thiazolidin-4-one (7b).

Pale yellow crystals; (80%); mp 190-192 °C; (EtOH); IR (KBr): 3143, 3047 (NH) and 1682 cm⁻¹ (CO). ¹H NMR (DMSO-*d*₆) δ = 1.22 (t, 2H, *J* = 6 Hz), 3.70 (q, 3H, *J* = 7.2 Hz), 6.10 (s, 2H), 7.08-7.13 (m, 3H), 7.47 (s, 1H), 10.46 (s, 1H, NH). ¹³C NMR (DMSO-*d*₆) δ = 24.0, 71.2, 111.1, 113.0, 115.7, 118.3, 118.4, 132.6, 133.8, 136.0, 137.5, 157.3, 157.5, 176.6. Anal. Calcd. for C₁₄H₁₂Cl₃NO₄S: C, 42.39; H, 3.05; Cl, 26.81; N, 3.53; S, 8.08. Found: C, 42.18; H, 3.25; Cl, 26.58; N, 3.75; S, 8.29.

(Z)-5-(Furyl-2-ylmethylene)-2-ethoxy-2-(trichloromethyl)thiazolidin-4-one (7c).

Brown crystals; (71%); mp 165-167 °C (EtOH); IR (KBr): 3130, 3035 (NH) and 1684 cm⁻¹ (CO); ¹H NMR (DMSO-*d*₆) δ = 1.21 (t, 2H, *J* = 6.2 Hz), 3.73 (q, 3H, *J* = 7.4 Hz), 6.91-8.21 (m, 3H), 7.36 (s, 1H), 10.37 (s, 1H, NH); Anal. Calcd. for C₁₁H₁₀Cl₃NO₃S: C, 38.56; H, 2.94; Cl, 31.04; N, 4.09; S, 9.36. Found: C, 38.78; H, 2.73; Cl, 31.26; N, 4.32; S, 9.14.

(Z)-5-(Thienyl-2-ylmethylene)-2-ethoxy-2-(trichloromethyl)thiazolidin-4-one (7d).

Brownish yellow crystals; (74%); mp 169-171 °C (EtOH); IR (KBr): 3135, 3040 (NH) and 1687 cm⁻¹ (CO). ¹H NMR (DMSO-*d*₆) δ 1.19 (t, 2H, *J* = 6.1 Hz), 3.70 (q, 3H, *J* = 7.3 Hz), 7.64-8.15 (m, 3H), 7.40 (s, 1H), 10.38 (s, 1H, NH). Anal. Calcd. for C₁₁H₁₀Cl₃NO₂S₂: C, 36.83; H, 2.81; Cl, 29.65; N, 3.90; S, 17.88. Found: C, 37.04; H, 2.63; Cl, 29.42; N, 3.67; S, 17.67.

(Z)-5-[4-(Chlorophenylmethylene)-2-methoxy-2-(trichloromethyl)]-thiazolidin-4-one (7e).

Yellow crystals; (77%); mp 210-212 °C; (EtOH/dioxane); IR (KBr): 3110, 3027 (NH), 1686 cm⁻¹ (CO). ¹H NMR (DMSO-*d*₆): δ = 3.44 (s, 3H, CH₃), 7.61 (d, 2H, *J* = 8.2 Hz, Ar), 7.78 (s, 1H), 7.82 (d, 2H, *J* = 8.2 Hz, Ar), 10.57 (s, 1H, NH). Anal. Calcd. for C₁₂H₉Cl₄NO₂S: C, 38.63; H, 2.43; Cl, 38.01; N, 3.75; S, 8.59; found: C, 38.21; H, 2.26; N, 3.98; S, 8.40.

(Z)-5-(1,3-Benzodioxol-5-ylmethylene)-2-methoxy-2-(trichloromethyl)thiazolidin-4-one (7f).

Yellowish-white crystals; (65%); mp 138-140 °C (EtOH); IR (KBr): 3140 (NH), 1680 cm⁻¹ (CO). ¹H NMR (DMSO-*d*₆): δ = 3.66 (s, 3H), 6.09 (s, 2H), 6.93-7.57 (m, 3H), 7.77 (s, 1H) 10.47 (br., 1H, NH); MS: *m/z* (%); 381 (M⁺, 9.5), 368 (10.7), 356 (19), 324 (16.7), 233 (11.9), 220 (25), 209 (22.6), 189 (21.4), 177 (100), 144 (38.1), 120 (28.6), 107 (35.7), 89 (38.1), 68 (50). Anal. Calcd. for C₁₃H₁₀Cl₃NO₄S: C, 40.81; H, 2.63; Cl, 27.80; N, 3.66; S, 8.38. Found: C, 40.60; H, 2.35; Cl, 28.03; N, 3.43; S, 8.65.

(Z)-5-(Furyl-2-ylmethylene)-2-methoxy-2-(trichloromethyl)thiazolidin-4-one (7g). Brown crystals; (60%); mp 134-136 °C (EtOH); IR (KBr): 3130, 3035 (NH), 1684 cm^{-1} (CO). ^1H NMR (DMSO- d_6): δ = 3.53 (s, 3H), 6.81-8.18 (m, 3H), 7.35 (s, 1H), 10.41 (s, 1H, NH); Anal.Calcd. for $\text{C}_{10}\text{H}_8\text{Cl}_3\text{NO}_3\text{S}$: C, 36.55; H, 2.45; Cl, 32.37; N, 4.26; S, 9.76. Found: C, 36.76; H, 2.67; Cl, 32.16; N, 4.60; S, 9.55.

(Z)-5-(Thienyl-2-ylmethylene)-2-methoxy-2-(trichloromethyl)thiazolidin-4-one (7h). Yellowish-brown crystals; (62%); mp 138-140 °C (EtOH); IR (KBr): 3137, 3044 (NH), 1684 cm^{-1} (CO). ^1H NMR (DMSO- d_6): δ = 3.48 (s, 3H), 6.78-8.08 (m, 3H), 7.37 (s, 1H), 10.44 (s, 1H, NH). Anal.Calcd. for $\text{C}_{10}\text{H}_8\text{Cl}_3\text{NO}_2\text{S}_2$: C, 34.85; H, 2.34; Cl, 30.86; N, 4.06; S, 18.61. Found: C, 34.64; H, 2.54; Cl, 30.67; N, 4.28; S, 18.41.

(Z)-5-[4-(Chorophenylmethylene)-2-propoxy-2-(trichloromethyl)]-thiazolidin-4-one (7i). Pale yellow crystals; (67%); mp 196-198 °C (EtOH/dioxane); IR (KBr): 3126, 3033 (NH), 1686 cm^{-1} (CO). ^1H NMR (DMSO- d_6): δ = 1.11 (t, 3H, J = 6.8), 1.61 (m, 2H), 3.61 (t, 2H, J = 6.2 Hz), 7.54 (d, 2H, J = 8.0 Hz, Ar), 7.78 (s, 1H), 7.79 (d, 2H, J = 8.0 Hz, Ar) 10.51 (s, 1H, NH). Anal. Calcd. for $\text{C}_{14}\text{H}_{13}\text{Cl}_4\text{NO}_2\text{S}$: C, 41.92; H, 3.27; Cl, 35.35; N, 3.49; S, 7.99; found: C, 41.74; H, 3.46; N, 3.71; S, 7.81.

(Z)-5-(1,3-Benzodioxol-5-ylmethylene)-2-propoxy-2-(trichloromethyl)-thiazolidin-4-one (7j). Yellow crystals; (66%); mp 173-175 °C (EtOH/dioxane); IR (KBr): 3142, 3028 (NH), 1685 cm^{-1} (CO). ^1H NMR (DMSO- d_6): δ = 0.92 (t, 3H, J = 7.2 Hz), 1.58 (m, 2H), 3.58 (t, 2H, J = 6.2 Hz), 6.10 (s, 2H, CH_2), 7.06-7.12 (m, 3H), 7.47 (s, 1H), 10.43 (br., 1H, NH). Anal.Calcd. for $\text{C}_{15}\text{H}_{14}\text{Cl}_3\text{NO}_4\text{S}$: C, 43.87; H, 3.44; Cl, 25.90; N, 3.41; S, 7.81. Found: C, 43.66; H, 3.25; Cl, 25.68; N, 3.64; S, 7.60.

(Z)-5-(Furyl-2-ylmethylene)-2-propoxy-2-(trichloromethyl)thiazolidin-4-one (7k). Brown crystals; (58%); mp 155-157 °C (MeOH); IR (KBr): 3309 (NH), 1684 cm^{-1} (CO). ^1H NMR (DMSO- d_6): δ = 0.91 (t, 3H, J = 6.3 Hz), 1.58 (m, 2H), 3.61 (t, 2H, J = 7.0 Hz), 7.28-7.75 (m, 3H), 7.92 (s, 1H), 10.44 (br., 1H, NH). Anal.Calcd. for $\text{C}_{12}\text{H}_{12}\text{Cl}_3\text{NO}_3\text{S}$: C, 40.41; H, 3.39; Cl, 29.82; N, 3.93; S, 8.99. Found: C, 40.18; H, 3.17; Cl, 29.61; N, 3.69; S, 9.28.

(Z)-5-(Thienyl-2-ylmethylene)-2-propoxy-2-(trichloromethyl)thiazolidin-4-one (7l). Yellowish-brown crystals; (67%); mp 165-167 °C (toluene); IR (KBr): 3309 (NH), 1687 cm^{-1} (CO). ^1H NMR (DMSO- d_6): δ = 0.99 (t, 3H, J = 6.6 Hz), 1.62 (m, 2H), 3.62 (t, 2H, J = 7.7 Hz), 7.23-7.82 (m, 3H), 7.79 (s, 1H), 10.47 (br., 1H, NH). Anal.Calcd. for $\text{C}_{12}\text{H}_{12}\text{Cl}_3\text{NO}_2\text{S}_2$: C, 38.67; H, 3.25; Cl, 28.54; N, 3.76; S, 17.21. Found: C, 38.38; H, 3.45; Cl, 28.75; N, 3.52; S, 17.42.

Reaction of 1a-d with nitriles: Synthesis of 5-arylidene-2,4-thiazolidine derivatives (8a-d)

A mixture of **1a-d** (10 mmol) and trichloroacetonitrile or 2-(1-amino-2,2,2-trichloroethylidene)malononitrile **11a** or ethyl 3-amino-4,4,4-trichloro-2-cyanobut-2-enoate **11b** or 3-(1-amino-2,2,2-trichloroethylidene)pentane-2,4-dione **11c** (10 mmol) in 20 ml of glacial acetic acid was refluxed for 2 h (TLC). The coloured solid precipitated, was filtered off, and recrystallized from the proper solvent.

5-(4-Chlorophenylmethylene)-2,4-thiazolidinedione (8a). Yellow crystals; (82%), mp, 241-243 °C (AcOH); IR (KBr): 3146 (NH), 1753 (CO), 1721 cm^{-1} (CO). ^1H NMR (DMSO- d_6): δ =

7.37 (d, 2H, $J = 7.8$ Hz, Ar.), 7.71 (s, 1H), 7.97 (d, 2H, $J = 7.8$ Hz, Ar), 10.25 (s, 1H, NH). Anal. Calcd. for $C_{10}H_6ClNO_2S_2$: C, 50.11; H, 2.52; Cl, 14.79; N, 5.84; S, 13.38. Found: C, 50.20; H, 2.34; N, 5.60; S, 13.56.

5-(1,3-Benzodioxol-5-ylmethylene)-2,4-thiazolidinedione (8b). Yellow crystals; (84%); mp 246-248 °C (AcOH); IR (KBr): 3141 (NH), 1739 (CO), 1697 cm^{-1} (CO). 1H NMR (DMSO- d_6): $\delta = 6.10$ (s, 2H), 6.93 (d, 1H, $J = 8.2$ Hz), 7.25 (d, 1H, $J = 9.6$ Hz), 7.58 (s, 1H), 7.77 (s, 1H), 12.90 (s, 1H, NH); MS: m/z (%); 249 (M^+ , 0.21), 224 (22.79), 206 (1.96), 193 (2.38), 178 (100), 165 (4.26), 149 (13.05), 135 (10.81), 120 (18.21), 105 (2.09), 93 (4.65), 77 (11.09), 69 (7.59), 50 (4.38). Anal. Calcd. for $C_{11}H_7NO_4S$: C, 53.01; H, 2.83; N, 5.62; S, 12.86. Found: C, 53.22; H, 2.61; N, 5.95; S, 12.63.

5-(Furyl-2-ylmethylene)-2,4-thiazolidinedione (8c). Brown crystals; (68%); mp 235-237 °C (AcOH); IR (KBr): 3133 (NH) and 1725 (CO), 1685 cm^{-1} (CO). 1H NMR (DMSO- d_6): $\delta = 6.90$ -8.21 (m, 3H), 7.56 (s, 1H), 11.48 (s, 1H, NH). Anal. Calcd. for $C_8H_5NO_3S$: C, 49.23; H, 2.58; N, 7.18; S, 18.43. Found: C, 49.45; H, 2.81; N, 7.42; S, 18.24.

5-(Thienyl-2-ylmethylene)-2,4-thiazolidinedione (8d). Yellow crystals; (70%); mp 230-232 °C (EtOH); IR (KBr): 3125 (NH) and 1733 (CO), 1679 cm^{-1} (CO). 1H NMR (DMSO- d_6): $\delta = 7.50$ -8.16 (m, 3H), 7.61 (s, 1H), 11.44 (s, 1H, NH). Anal. Calcd. for $C_8H_5NO_2S_2$: C, 45.48; H, 2.39; N, 6.63; S, 30.36. Found: C, 45.66; H, 2.18; N, 6.86; S, 30.57.

Crystallographic data for the structural analysis of compounds **4a** and **7b** has been deposited with the Cambridge Crystallographic Data centre (CCDC) under the numbers 808332 and 808807, respectively. Copies of the information may be obtained free of charge from the Director, CCDC, 12 Union Road, Cambridge CB2 IEZ, UK (Fax: +44-01223-336033; e-mail: deposit@ccdc.cam.ac.uk or www: <http://www.ccdc.cam.ac.uk>).

References

1. Kambe, S; Sairto, K; Sakurai, A.; Midorikawa, H. *Synthesis* **1981**, 531.
2. Elnagdi, M. H.; El Moghayer, M. R. H.; Hammam, A. G. *Synthesis* **1981**, 635.
3. Harhash, A. H.; Elnagdi, M. H.; Abdallah, S. O. *Indian J. Chem.* **1973**, 11, 128.
4. Metwally, N. H. *Indian J. Chem.* **2000**, 39B, 757.
5. Srivastava, T.; Gaikwad, A. K.; Haq, W.; Sinha, S.; Katti, S. B. *Arkivoc* **2005**, (ii), 120.
6. Chatterjee, M.; Dwiveli, V. K.; Khandekar, K.; Tandon, S. K. *Biomed. Environm. Sci.* **2004**, 17, 27.
7. Tandon, S. K.; Sharma, B. L.; Kachru, D. N. *Pharmacol. Toxicol.* **1989**, 64, 380.
8. Peterson, F. E.; Watson, D. J. *Med. Chem.* **1970**, 13, 697.
9. Ead, H. A.; Abdallah, S. O.; Kassab, N. A.; Metwally, N. H. *Sulfur Lett.* **1989**, 9, 23.
10. Metwally, N. H. *Synth. Commun.*, **2007**, 37, 4227.
11. Metwally, N. H. *Phosphorus, Sulfur, Silicon Rel. Elem.* **2008**, 183, 34.

12. Metwally, N. H.; Abdalla, M. A.; Mosselhi A, M.; El-Desoky, E. A. *Carbohydrate Res.* **2010**, *345*, 1135.
13. Ead, H. A.; Abdallah, S. O.; Kassab, N. A.; Metwally, N. H.; Saleh, Y. E. *Arch. Pharm. (Weinheim)* **1987**, *320*, 1227.
14. Ead, H. A.; Metwally, N. H. *Arch. Pharm. (Weinheim)* **1990**, *323*, 57.
15. Ead, H. A.; Abdelaziz , M. A.; Metwally, N. H. *Pol. J. Chem.* **1991**, *65*, 1291.
16. Shelke K. F.; Sapkal S. B.; Madja B. R.; Shingate B. B.; Shingare M. S. *Bull., Catal. Soc.* **2009**, *8*, 30.
17. Prashant S.; Kamlesh K.; Anju K.; Rashmi K.; Ramesh C. *Catal. Lett.* **2009**, *130*, 648.
18. Campaigne, E.; Cline, R. E. *J. Org. Chem.* **1956**, *21*, 32.