Synthesis and complete assignments of ^{1}H and ^{13}C NMR spectra of mesoionic 2-(p-trifluoromethylphenyl)-3-methyl-4-(*p*-tolyl)-1,3-thiazolium-5-thiolate and 2-(*p*-chlorophenyl)-3-methyl–4-(p-isopropylphenyl)-1,3-thiazolium-5-thiolate

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Abstract

The synthesis and complete ^{1}H and ^{13}C NMR and ^{19}F NMR spectra of 2-(*p*-trifluoromethylphenyl)-3-methyl-4-(*p*-tolyl)-1,3-thiazolium-5-thiolate **2c** and 2-(*p*-chlorophenyl)-3-methyl–4-(*p*-isopropylphenyl)-1,3-thiazolium-5-thiolate **2d** are described. Their structures are consistent with ^{1}H and ^{13}C NMR spectral assignments obtained by 2D NMR spectrometry. Structures were further confirmed by elemental analysis, IR, UV and mass spectrometry and by X-ray diffraction.

Keywords: ^{1}H NMR, ^{13}C NMR, bidimensional, structural analysis, mesoionic, heterocyclic compounds

Introduction

The elucidation of the structure of mesoionic compounds using conventional unidimensional NMR spectrometry is an arduous task when there are numerous hydrogen and carbon atoms in the substituent groups attached to the mesoionic ring. The task is much simplified by the use of bidimensional NMR spectra although it has been little used for this purpose.

In 1996 we defined[1] mesoionic compounds as "planar five-membered heterocyclic betaines with at least one side-chain whose α-atom is also in the ring plane with dipole moments of the order of 5D. Electrons are delocalized over two regions separated by what are essentially single

bonds. One region which includes the α-atom of the side-chain is associated with the HOMO and negative π-charge whereas the other is associated with the LUMO and positive π-charge".

Structure **1** (Figure 1) is a generic representation of mesoionic compounds, in which **a-f** are atoms or group of atoms derived from C, N, O, S and/or Se, with recommended numbering.
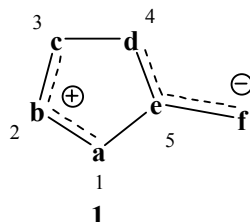

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Figure 1

One feature of special interest of mesoionic compounds is their special physical[2] properties, with the possibility of non-linear optics applications. Another valuable feature is that they possess a wide range of biological activity.[3, 4] Another is that they participate in various synthetic sequences forming new heterocyclic compounds[5].

As asymmetric molecules with built-in charge separation they readily include compounds with elevated hyperpolarizability[6] and low optical absorption coefficients using appropriately substituted electron-donating and electron-withdrawing groups.

On this basis the title compounds **2c**[7] and **2d**[8] have electron-donating groups linked to the negative region of the mesoionic ring, containing the HOMO and have electron-withdrawing groups linked to the positive region of the mesoionic ring containing the LUMO.
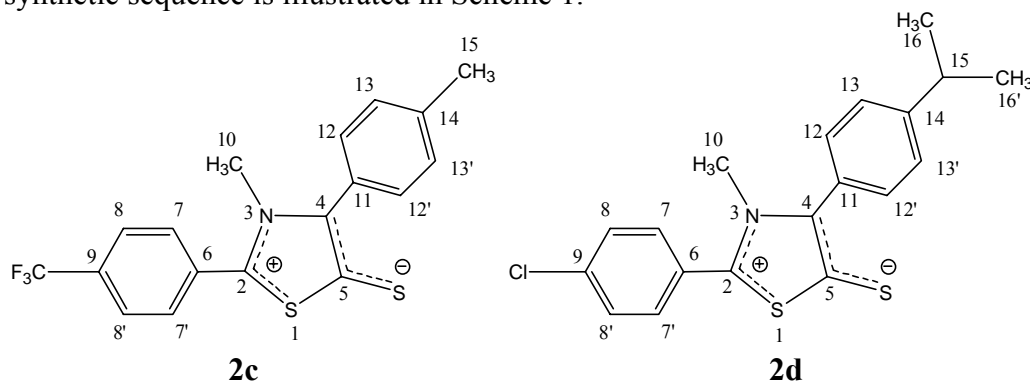
The synthetic sequence is illustrated in Scheme 1.

**2c**   **2d**

Figure 2

The numbering of the mesoionic ring was suggested by us on the basis of our 1996 definition[1] (Figure 1). It begins with the heteroatom, which provides an electron-pair and proceeds in the direction of the region containing the LUMO and positive π-charge.

The structures of the title mesoionic compounds were well elucidated by uni- and bidimensional NMR spectrometry (in $CDCl_3$ solution) incorporating techniques such as APT, DEPT, HETCOR or HMQC and HMBC. They were further confirmed by Elemental Analysis, IR, UV, and Mass spectrometry as well as by an X-ray diffraction study.[8]

Results and Discussion

The synthetic sequence worked well. It began (i) with a Strecker reaction of arene aldehydes **3** with sodium cyanide and methylammonium chloride. This gave C-aryl-N-methylglycines **4**. These were then aroylated with ArCOCl (ii) forming C-aryl-N-aroyl-N-methylglycines **5.** They were then converted to the title compounds **2c** and **2d** via cyclo-dehydration to non-isolated 1,3-oxazolium-5-olates **6** followed by a 1,3-dipolar cyclo-addition and cyclo-reversion sequence with CS_2, eliminating CO_2.

The yields of **2c** and **2d** in the final steps were 58% and 46% respectively. They were purified by recrystallization from ethanol.
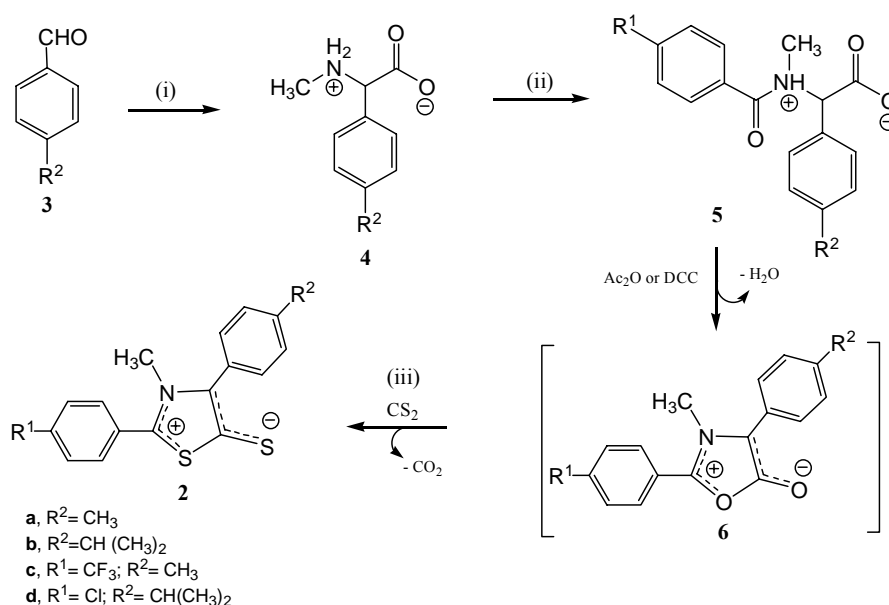
Scheme 1. Synthetic sequence (details in text) for compounds **2c** (R^1= CF_3 and R^2= CH_3) and **2d** (R^1= Cl and R^2= $CH(CH_3)_2$).

The ^{13}C NMR spectra for both **2c** and **2d** gave 14 signals for both compounds. With the aid of APT and DEPT techniques these were attributed as follows: **2c**, two methyl and four methine carbon downward signals and eight quaternary carbon upward signals; **2d**, two methyl and five methine carbon downward signals and seven quaternary carbon upward signals.

The ^1H NMR spectra had intense singlets integrating for 3H for the N-methyl groups carbon C-10 at δ 3.66 and 3.60 ppm respectively for **2c** and **2d**.

For compound **2d** septet at δ 2.89 ppm integrating for 1H corresponded to H-15; while a doublet integrating for 6H δ 1.22 ppm corresponded to the remaining hydrogen atoms of the isopropyl group of carbon atoms 16 and 16′.

Analysis of bidimensional (HETCOR - $^1J_{CH}$) spectra served to correlate the ^{13}C nuclei with ^1H nuclei directly linked *viz.*, δ 7.75 (d, H-7, 7′) with 130.12 (C-7, 7′); δ 7.79 (d, H-8, 8′) with 126.54 (C-8, 8′); δ 7.48 (d, H-12, 12′) with 131.11 (C-12, 12′); δ 7.25 (d, H-13, 13′) with 129.65

(C-13, 13′); δ 3.66 (s, H-10) with 40.63 (C-10) and δ 2.38 (s, H-15) with 21.46 (C-15) ppm for
2c and δ 7.55 (d, H-7, 7′) with 130.72 (C-7, 7′); δ 7.45 (d, H-8, 8′) with 129.66 (C-8, 8′); δ 7.48
(d, H-12, 12′) with 130.93 (C-12, 12′); δ 7.26 (d, H-13, 13′) with 126.74 (C-13, 13′); δ 3.60 (s,
H-10) with 40.52 (C-10); δ 2.89 (sept, H-15) with 33.78 (C-15) and δ 1.22 (d, H-16, 16′) with
23.60 (C-16, 16′) ppm for **2d.**

Table 1. ^{1}H (300MHz) and ^{13}C (75MHz) spectra of **2c** and **2d** (CDCl$_3$): chemical shifts (δ, ppm)
and coupling constants (J, Hz, in parentheses)

Carbon	2c δ (^{13}C)[a]	2c δ (^{1}H)[b]	2d δ (^{13}C)[a]	2d δ (^{1}H)[b]	2c δ (^{2}J and ^{3}J$_{CH}$)[c]	2d δ (^{2}J and ^{3}J$_{CH}$)[c]
2	150.68	-	152.18	-	3.66 (H-10), 7.75 (H-7, 7′)	3.60 (H-10), 7.55 (H-7, 7′)
4	141.86	-	141.29	-	3.66 (H-10), 7.48 (H-12, 12′)	3.60 (H-10), 7.48 (H-12, 12′)
5	162.27	-	160.30	-	-	-
6	130.53	-	125.14	-	7.79 (H-8, 8′)	7.45 (H-8, 8′)
7 , 7′	130.12	7.75 d(2H) (9.3Hz)	130.72	7.55 d(2H) (8.6Hz)	7.79 (H-8, 8′)	7.55 (H-7, 7′), 7.45 (H-8, 8′)
8 , 8′	126.54 q ^{3}J$_{CF}$=3.54Hz	7.79 d(2H) (9.3Hz)	129.66	7.45 d(2H) (8.6Hz)	7.79 (H-8, 8′)	7.55 (H-7, 7′), 7.45 (H-8, 8′)
9	133.00 q ^{2}J$_{CF}$=33.18Hz	-	137.63	-	7.79 (H-7, 7′)	7.55 (H-7, 7′), 7.45 (H-8, 8′)
10	40.63	3.66s(3H)	40.52	3.60s(3H)	-	-
11	126.75	-	126.98	-	7.25 (H-13, 13′)	7.48 (H-12, 12′), 7.26 (H-13, 13′)
12 , 12′	131.11	7.48 d(2H) (7.8Hz)	130.93	7.48 d(2H) (8.3Hz)	7.25 (H-13, 13′), 7.48 (H-12, 12′)	7.48 (H-12, 12′), 7.26 (H-13, 13′)
13 , 13′	129.65	7.25 d(2H) (7.8Hz)	126.74	7.26 d(2H) (8.3Hz)	2.38 (H-15), 7.48 (H-12, 12′), 7.25 (H-13, 13′)	7.48 (H-12, 12′), 7.26 (H-13, 13′)
14	139.33	-	149.65	-	2.38 (H-15), 7.48 (H-12, 12′)	1.22 (H-16, 16′), 7.48 (H-12, 12′)
15	21.46	2.38 s(3H)	33.78	2.89 sept(1H)	7.25 (H-13, 13′)	1.22 (H-16, 16′), 7.26 (H-13, 13′)
16 , 16′	-	-	23.60	1.22 d(6H) (7.2Hz)	-	1.22 (H-16, 16′), 2.89(H-15)
CF$_3$	123.36 q ^{1}J$_{CF}$=272.94Hz	-	-	-	-	-

[a] Multiplicity determined by APT and DEPT (s, singlet; d, doublet; t (triplet); q, quartet; sept
(septet); m, (multiplet).
[b] One-bond correlations derived from HETCOR or HMQC data.
[c] Long-range correlations derived from HMQC data.

For **2c** utilizing long-distance correlations (HMBC - $^2J_{CH}$ and $^3J_{CH}$) it was possible to assign coupling between ^{13}C and ^1H at 3 bonds distance ($^3J_{CH}$) *viz.*, δ 3.66 (s, H-10) with 150.68 (C-2); δ 7.75 (d, H-7, 7′) with 150.68 (C-2); δ 3.66 (s, H-10) with 141.86 (C-4); δ 7.48 (d, H-12, 12′) with 141.86 (C-4); δ 7.79 (d, H-8, 8′) with 130.56 (C-6); δ 7.79 (d, H-8′) with 126.54 (C-8); δ 7.25 (d, H-13, 13′) with 126.75 (C-11); δ 7.48 (d, H-12′) with 131.11 (C-12); δ 7.25 (d, H-13′) with 129.65 (C-13); δ 2.38 (d, H-15) with 129.65 (C-13, 13′); δ 7.48 (d, H-12, 12′) with 139.33 (C-14); δ 7.25 (d, H-13, 13′) with 21.46 (C-15); δ 7.79 (d, H-8, 8′) with 123.36 ppm (CF$_3$) and at 2 bonds distance ($^2J_{CH}$) δ 7.79 (d, H-8, 8′) with 130.12 (C-7, 7′); δ 7.79 (d, H-8, 8′) with 133.00 (C-9); δ 7.25 (d, H-13) with 131.11 (C-12′); δ 7.48 (d, H-12, 12′) with 129.65 (C-13, 13′) and δ 2.38 (d, H-15) with 139.33 (C-14) ppm. For **2d** at 3 bonds distance ($^3J_{CH}$) δ 3.60 (s, H-10) with 152.18 (C-2); δ 7.55 (d, H-7, 7′) with 152.18 (C-2); δ 3.60 (s, H-10) with 141.29 (C-4); δ 7.48 (d, H-12, 12′) with 141.29 (C-4); δ 7.45 (d, H-8, 8′) with 125.14 (C-6); δ 7.55 (d, H-7′) with 130.72 (C-7); δ 7.45 (d, H-8′) with 129.66 (C-8); δ 7.55 (d, H-7, 7′) with 137.63 (C-9); δ 7.26 (d, H-13, 13′) with 126.98 (C-11); δ 7.48 (d, H-12′) with 130.93 (C-12); δ 7.26 (d, H-13′) with 126.72 (C-13); δ 1.22 (d, H-16, 16′) with 149.65 (C-14) and δ 7.48 (d, H-12, 12′) with 149.65 (C-14) and at 2 bonds distance ($^2J_{CH}$) δ 7.45 (d, H-8, 8′) with 130.72 (C-7, 7′); δ 7.55 (d, H-7, 7′) with 129.66 (C-8, 8′); δ 7.45 (d, H-8, 8′) with 137.63 (C-9); δ 7.48 (d, H-12, 12′) with 126.98 (C-11); δ 7.45 (d, H-8, 8′) with 130.72 (C-7, 7′); δ 7.55 (d, H-7, 7′) with 129.66 (C-8, 8′); δ 7.26 (d, H-13, 13′) with 130.93 (C-12, 12′); δ 7.48 (d, H-12, 12′) with 126.74 (C-13, 13′) and δ 2.89 (m, H-15) with 149.65 (C-14) ppm.

For mesoionic compound **2c** $^{13}C – ^{19}F$ coupling was observed as quartets, one bond distance $^1J_{CF}$ = 272.94 Hz, at two bonds distance $^2J_{CF}$ = 33.18 Hz and at three bond distance $^3J_{CF}$ = 3.54. These were assigned to coupling within the (CF$_3$) with δ 123.36; with coupling to (C-9) at δ 133.0; and with coupling to (C-8 and 8′) at δ 126.54 respectively.

The assignments of the mesoionic ring carbon atoms (C-3), (C-4) and (C-5) are of special importance. The bidimensional correlations and the long distance correlations (HMBC-$^2J_{CH}$ and $^3J_{CH}$) were fundamental to assigning the chemical shifts of these carbon atoms.

The hydrogen atoms of the 10-methyl group and those of the benzene ring (H-7 and H-7′; H-12 and H-12′) at three bonds distance allowed the unequivocal assignment of carbon atoms (C-2) and (C-4). For **2c** and **2d** correlation of the hydrogen atoms of the 10-methyl group and of the benzene ring led to the assignment δ 3.66 (H-10) with 150.68 (C-2); δ 7.75 (H-7 and 7′) with 152.18 (C-2) and of δ 3.60 (H-10) with 152.18 (C-2); δ 7.55 (H-7 and 7′) with 152.18 (C-2) respectively. Similarly δ 3.66 (H-10) with 141.86 (C-4); δ 7.48 (H-12 and 12′) with 141.84 (C-4); δ 3.60 (H-10) with 142.29 (C-4) and δ 7.48 (H-12 and 12′) with 141.29 (C-4) respectively.

This left the assignment of the chemical shifts ^{13}C at δ 162.27 and 160.30 ppm, those without correlation with hydrogen atoms (HMBC of the order of 8 Hz). This allowed them to be assigned to C-5 of **2c** and **2d** respectively. The nearest hydrogen atoms are at 4-bonds distance ($^4J_{CH}$) so that no correlation of the order of 8 Hz was possible with this technique.

A more detailed analysis of the chemical shifts of mesoionic ring carbon atoms (C-2, C-4 and C-5) suggests that the values are influenced by shielding in the HOMO region and deshielding in the LUMO region.

The assignments of C-4 at δ 141.86 and 141.29 ppm of **2c** and **2d** respectively are considered as due to shielding when compared with C-5 at δ 162.27 and 160.03 ppm respectively. We consider that the electron delocalization in the HOMO region restricts negative π-charge to C-4.

The chemical shifts at δ 150.68 and 152.18 ppm respectively are influenced by deshielding in the LUMO region in which positive π-charge is delocalized.

For the *p*-substituted aromatic rings of **2c** and **2d**, the bidimensional correlations confirm well the assignments of the carbon and hydrogen atoms of the molecules. The ^{1}H NMR spectra show four doublets in the aromatic region, integrating for 2H <u>viz</u>., (H-7 and H-7', H-8 and H-8', H-12 and H-12', H-13 and H-13').

For compound **2c** the hydrogen atoms (H-8, 8') at δ 7.79 ppm were well assigned by one-bond correlation (HETCOR - $^1J_{CH}$) with the carbon quartet of C-8 and C-8' at δ 126.54 ppm ($^3J_{CF}$ = 3.54 Hz). The hydrogen atoms (H-7 and H-7') at δ 7.75 ppm, considered more shielded, had a three-bond correlation (HMBC - $^3J_{CH}$) with the quartet of C-9 at δ 133.00 ppm ($^2J_{CF}$ = 33.18 Hz). Other correlations supported these assignments, *viz*., of H-7 and H-7' at δ 7.75 ppm with C-2 at δ 150.68 ppm; of H-8 and H-8' at δ 7.79 ppm with C-6 at δ 130.53 ppm. Furthermore using other long-distance correlations the hydrogen atoms H-13 and H-13' at δ 7.25 ppm were correlated with the signals of C-15 at δ 21.46 ppm and of C-11 at δ 126.75 ppm. Finally the hydrogen atoms H-12 and H-12' at δ 7.48 ppm were correlated with C-4 of the mesoionic ring at δ 141.86 ppm and with C-14 at δ 139.33 ppm.

For compound **2d** the aromatic hydrogen signals were well confirmed by long-distance correlations (HMBC - $^2J_{CH}$ and $^3J_{CH}$), C-15 of the isopropyl group at δ 33.78 ppm correlated with the hydrogen atoms H-16 and H-16' at δ 1.22 ppm and with H-13 and H-13' at δ 7.26 ppm. The carbon atom C-4 of the mesoionic ring at δ 141.29 ppm correlated with the hydrogen atoms H-12 and H-12' at δ 7.48 ppm. Other important correlations were attributed to the carbon atom C-11 at δ 126.89 ppm and H-12 and 12' at δ 7.25 ppm and to carbon C-14 at δ 149.65 ppm with the hydrogen atoms H-16 and 16' at δ 1.22 ppm. Furthermore, C-2 at δ 151.14 ppm correlated at long-distance with hydrogen atoms H-7 and H-7' at δ 7.55 ppm. These, for their part, also correlated with C-9 at δ 137.63 ppm and C-6 at δ 125.14 ppm. Finally H-8 and H-8' at δ 7.79 ppm correlated with C-9 at δ 137.63 ppm.

These assignments by long-distance correlation (HMBC - ^2J and $^3J_{CH}$) were confirmed by correlation of bidimensional spectra (HETCOR - $^1J_{CH}$), already mentioned (Table 1).

Conclusions

The synthetic methodology used in the preparation of the two mesoionic compounds worked well giving good yields.

Structural analysis using combinations of techniques uni - and bidimensional NMR served to authenticate the ^{1}H and ^{13}C correlations unequivocally.

Experimental Section

General Procedures. Solvents and reagents were purified and dried when necessary. The course of reactions forming mesoionic compounds was monitored by TLC using silica gel G. Hexane/chloroform mixtures were used as eluents. The final products were purified by column chromatography using neutral alumina (Merck) and the same eluents as used for TLC. Melting points were determined on a platinum plate in a Koffler apparatus coupled with a Carl-Zeiss microscope and are uncorrected. Mass spectra were obtained on a Finnigan GCQ Mat quadrupole Ion-Trap Spectrometer. IR spectra were obtained on a Bomen-Michelson IFS 66 spectrometer, using KBr discs. NMR spectra were obtained on a VARIAN spectrometer UNITY PLUS with a 5 mm probe with a channel magnetic field gradient operating at 300MHz for NMR ^{1}H and 75 MHz for NMR ^{13}C. Chemical shifts were given in ppm referred to TMS for ^{1}H and CDCl$_3$ for ^{13}C. Multiplicities of NMR bands were indicated as follows s (singlet); d (doublet); t (triplet), q (quartet), sept (septet), m (multiplet). The number of hydrogen atoms on each carbon was determined by DEPT with nutation angle 135° (CH and CH$_3$ opposed to CH$_2$) and by APT. The carbon atoms without hydrogen were characterized by the subtraction of the BB (Broad Band) Spectrum from the DEPT 135 homonuclear spectrum. The bidimensional data were obtained using the VARIAN gCOSY program for correlation (^{1}H): H x H – COSY and for heteronuclear correlation carbon and linked hydrogen (HETCOR – ^{1}J$_{CH}$) with pulse optimized for J$_{CH}$ = 140 Hz (supplied by VARIAN) without using the pulse gradient. The acquisition time used was 62 ms, spectral windows equal to 16501.7 Hz for ^{13}C and 3127.4 Hz for ^{1}H. Temperature controlled at 25°C and the sample stopped (spin=0). The total time of the experiment was 4 hours and 46 minutes. Using the VARIAN program gHMBC with a long distance coupling J$_{CH}$ (2 and 3 bond) = 8Hz, with field gradient equal to 1.6 ms (gt^0) - 72 G/cm and 1.0 ms (gt1) – 9.0 G/cm acquisition time = 164 ms and spectral windows = 3127.4 Hz for ^{1}H and 16501.7 Hz for ^{13}C. Waiting time equal to 1s, steady-state equal to 32. Temperature controlled at 25°C and the sample stopped (spin=0). Total time of the experiment 2 hours and 48 minutes.

***N*-Methyl-*C*-*p*-tolylglycine (4a).** Potassium cyanide (16.5g, 250 mmoles) and methyl ammonium chloride (16.87g, 250 mmoles) were dissolved in 100 ml of distilled water. (30g, 250 mmoles) of the *p*-tolualdehyde **3a** in 100 ml of methanol was added in portions with vigorous stirring. After two hours of reaction a further 250 ml of water was added and the mixture then added to 250 ml of toluene. The toluene phase was separated then extracted three times with 100 ml portions of 6N HCl aq. The combined acid extract was refluxed for 8 hours giving the desired product in the form of white crystals on cooling. The reaction furnished 28.3g of the desired product (65% yield) with m.p. 219 ^{o}C. IR (ν cm^{-1}): 3100-2450 (NH of NH$_2^+$); 3043 (C-H$_{Ar}$); 1737 (C=O); 2955, 2795 (C -H$_{Aliph}$,), 1600, 1560 and 1462 (C=C$_{Ar}$); Mass Spectrum m/e (%) – 179 (13.23), 134 (100), 135 (10.16), 120 (4.94), 119 (1.66), 91 (14.83) and 42 (34.69); ^{1}H-NMR δ (ppm): 2.27 (s, 3H, CH$_3$C$_{Ar}$), 3.65 (s, 3H, CH$_3$ – N), 4.96 (s, 1H, CH), 7.24 (d, 2H, CH$_{Ar}$ J=8.1 Hz), 7.36 (d, 2H, CH$_{Ar}$ J=8.1 Hz);^{13}C-NMR δ (ppm): 21.14, 31.00, 63.18, 128.23, 129.05, 130.12, 139.96 and 169.56.

***N*- Methyl-*C-p*-isopropylphenylglycine (4b).** Compound **4b** was obtained from potassium cyanide (16,5g, 250 mmoles), methyl ammonium chloride (16.87g, 250 mmoles) and *p*-isopropylbenzaldehyde **3b** (37g, 250 mmoles) as described for **3a.** The reaction furnished 37g of the desired product (70% yield) with m.p. 165 ^{o}C. IR (ν cm^{-1}): 3100-2400 (NH of NH$_2^{+}$); 3087 (C-H$_{Ar}$); 1740 (C=O); 2971, 2743 (C -H$_{Aliph,}$), 1588, 1550 (C=C$_{Ar}$); Mass Spectrum m/e (%) – 207 (2.09), 163 (11.37), 162 (100), 147 (12.30), 120 (3.44) and 42 (7.25); ^{1}H NMR - DMSO d$_6$, δ; 1.14 (d, 6H, CH$_3$, J = 6.3 Hz); 2.39 (s, 3H, CH$_3$N); 2.86 (sept, 1H, CH, J = 6.3 Hz); 4.95 (s, 1H, CH), 7.27 (dd, 4H, aromatic, AA´BB´ system, J= 8.1 Hz), 7.42 (dd, 4H, aromatic, AA´BB´ system, J= 8.1 Hz) and 9.67 (s, 1H, N-H).

***N*- (*p*-Trifluoromethylbenzoyl)-*N*-methyl-*C-p*-tolylglycine (5c).** A solution of N-methyl-C-p-tolylglycine **4a** (2.0g, 11 mmoles) was dissolved in 50ml of 10% NaOH aq. with stirring which then continued for a further two hours. (2.32g, 11.2 mmols) of the *p*-trifluoromethylbenzoyl chloride was added dropwise and stirring continued for another two hours. During this time the crude product precipitated and the reaction mixture was then neutralized with 10% aq. HCl. The white crystalline product was filtered off, washed with water and air-dried. It was used in the final steps of the sequence without further purification. On recrystallization from ethanol/water the product was obtained in the form of white crystals (1.53g 56% yield) with m.p. 159 ^{o}C. IR (ν cm^{-1}): 3200-2500 (NH of NH$_2^{+}$); 3111, 3085 (C-H$_{Ar}$); 2955, 2795 (C-H $_{Aliph,}$); 1714 (C=O, acid); 1630 (C=O, amide) and 1599, 1516 (C=C$_{Ar}$); Mass Spectrum m/e (%) – 351 (3.23), 306 (20.58), 178 (100), 173 (75.44), 163 (4.56), 145 (23.31), 132 (68.58), 117 (6.03 and 91 (9.65); ^{1}H-NMR δ (ppm): 2.35 (s, 3H, CH$_3$–C$_{Ar}$), 2.72 (s, 3H, CH$_3$ – N), 6.38 (s,1H, CH), 7.18-8.20 (m, 8H, aromatic, AA´BB´).

***N-p*-Chlorobenzoyl-*N*-methyl-*C-p*-isopropylphenylglycine (5d).** Compound **5d** was obtained from *N*-Methyl-*C-p*-isopropylphenylglycine **4b** (7.00g, 47.30 mmol) and *p*-chlorobenzoyl chloride (8.27g, 47.30 mmol) as described for **5c.** The product was obtained in the form of white crystals (10.16g, 75% yield) with m.p. 146 ^{0}C. IR (ν cm^{-1}): 3117-2540 (NH of NH$_2^{+}$); 3097, 3067 (C-H$_{Ar}$); 2968, 2913 (C-H $_{Aliph,}$), 1729 (C=O, acid); 1647 (C=O, amide), 1601, 1553 (C=C$_{Ar}$); Mass Spectrum m/e (%) – 347 and 345 (3.21 and 9.27), 206 (100), 303 and 301 (11.92 and 36.19), 160 (67.81), 141 (10.89), 139 (31.17), 113 and 111 (3.67 and 11.23); ^{1}H NMR -CDCl$_3$ – δ; 1.26 (d, 6H, CH$_3$, J = 6.0 Hz); 2.75 (s, 3H, CH$_3$ – N); 2.92 (septet. 1H, CH, J = 6.0 Hz, CH); 6.39(s, 1H, CH) and 7.25 – 7.41(m, 8H, aromatic, AA´BB´) ;^{13}C-NMR δ (ppm): 23.8, 33.7, 34.9, 60.8, 127.0, 128.3, 128.7, 129.4, 130.4, 133.6, 136.1, 149.5, 171.9 and 174.0.

Mesoionic 2-(p-trifluoromethylphenyl)-3-methyl-4-(p-tolyl)-1,3-thiazolium-5-thiolate (2c). *N*-(*p*-Trifluoromethylbenzoyl)-*N*-methyl-*C-p*-tolylglycine **5c** (0.5g, 1.7mmoles) and 1,3-dicyclohexylcarbodiimide (DCC, 0.32g, 1.57 mmoles) were refluxed in chloroform 20 ml for one hour. Carbon disulphide 5 ml was added forming a red solution, which was refluxed for another hour. The solvent was then removed on the rotary evaporator at reduced pressure leaving a red solid. The residue was chromatographed on neutral alumina and the product eluted with chloroform/hexane. Slow evaporation of the solvent furnished the product as red crystals in 58% yield with m.p. 203-205°C. Elemental analysis, calc. for C$_{18}$H$_{14}$F$_3$NS$_2$: C = 59.16; H = 3.86; N = 3.83; S = 17.55%; Found: C = 58.78; H = 3.78; N = 4.07; S = 18.01%; IR (KBr, ν cm^{-1}): 3030 (C-H$_{Ar}$), 2921, 2850 (C-H $_{Aliph}$), 1659, 1613, 1600, 1431 (C=C$_{Ar}$ and C=N mesoionic ring), 1407, 1323 (C-H, def. sym. and asym. of =N^{+}-CH$_3$), 1295 (C-S^{-}), 1172, 1130 (C-F), 1066, 1016 (C-H),

844 (C -H$_{Ar}$); Mass Spectrum m/e (%): 365 (100), 350 (6.45), 233 (9.60), 179 (24.19); ^{1}H NMR - CDCl$_3$ – δ; 2.38 (s, 3H, H-15), 3.66 (s, 3H, H-10), 7.75 (d, 2H, H-7 and 7′, J=9.3 Hz), 7.79 (d, 2H, H-8 and 8′, J=9.3 Hz), 7.48 (d, 2H, H-12 and 12′, J=7.8 Hz), 7.25 (d, 2H, H-13 and 13′, J=7.8 Hz); ^{13}C NMR - DMSO-d[6] - δ: 162.27 (C-5), 142.07 (C-4), 151.14 (C-2), 139.57 (C-14), 133.00 (C-9, J= 33.18 Hz), 131.11 (C-12 and 12′), 130.12 (C-7 and 7′), 126.54 (C-8 and 8′, J= 3.54 Hz), 126.75 (C-11), 129.65 (C-13 and 13′), 130.53 (C-6), 123.36 (C-F, J= 272.94 Hz), 40.56 (C-10) and 21.40 (C-15).

Mesoionic 2-(*p*-chlorophenyl)-3-methyl–4-(*p*-isopropylphenyl)-1,3-thiazolium-5-thiolate (2d). N-*p*-Chlorobenzoyl-*N*-methyl-C-p-isopropylphenylglycine **5d** (5.0g, 16 mmoles) was dissolved in 20 ml of acetic anhydride and heated at 55 ^{o}C for 15 minutes with stirring. After cooling to ambient temperature, carbon disulphide 20 ml was added and the reaction mixture allowed to stand for 48 hours. Methanol-water (1:1 v/v) was then added until the mixture became cloudy: it was then left for a further 24 hours. The desired product formed as orange-red crystals, which were recrystallized from methanol. Following the general method, this compound was obtained in 46% yield (2.39 g) with m.p. 177 ^{o}C. Elemental analysis, calc. for C$_{19}$H$_{18}$Cl N S$_2$: C = 63.40; H = 5.04; N = 3.89; S = 17.82%; Found: C = 63.57; H = 5.07; N = 3.83; S = 17.73%; IR (KBr, ν cm^{-1}): 3012 (C-H$_{Ar}$), 2959, 2927 (C-H $_{Aliph}$), 1607, 1601, 1485, 1431 (C=C$_{Ar}$ and C=N mesionic ring), 1399, 1384 (C-H, def. sym. and asym. of =N$^+$-CH$_3$), 1295 (C-S$^-$), 1172, 1130 (C-F), 1066, 1016 (ν C$_{Ar}$-Cl), 844 (C -H$_{Ar}$); MS - m/e (%); 361 and 359 (10.16 and 23.61), 346 and 344 (5.85 and 15.37), 319 and 317 (19.53 and 48.69), 304 and 302 (4.20 and 10.47), 179 (6.71), 165 (100.00), 121 (26.68), 89 (8.16), 77 (3.90); ^{1}H NMR - CDCl$_3$ – δ; 1.22 (d, 6H, H-16 and 16′, J =7.2 Hz), 2.89 (septet.,1H, H-15, J =6.3 Hz), 3.60 (s, 3H, H-10), 7.55 (d, 2H, H-7 and 7′, J=8.6 Hz), 7.45 (d, 2H, H-8 and 8′, J=8.6 Hz), 7.48 (d, 2H, H-12 and 12′, J=8.3 Hz), 7.26 (d, 2H, H-13 and 13′, J=8.3 Hz); ^{13}C NMR - DMSO-d[6] - δ; 160.30 (C-5), 141.29 (C-4), 152.18 (C-2), 149.65 (C-14), 137.63 (C-9), 130.93 (C-12 and 12′), 130.72 (C-7 and 7′), 129.66 (C-8 and 8′), 126.98 (C-11), 126.74 (C-13 and 13′), 125.14 (C-6), 40.52 (C-10), 33.78 (C-15) and 23.60 (C-16 and 16′).

Acknowledgements

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