Supporting Information
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Supporting information

A One Pot Stereoselective Synthesis of Electron Deficient 1-Arylsulphonyl-4 Substituted-$E$, $E$-1, 3 Dienes and their Chemo selective [3+2]-Cycloaddition with Azomethine Ylides - A Simple Synthesis of 1, 3, 4-Trisubstituted Pyrrolidines and Pyrroles

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General methods: All reagents were purchased from Commercial sources and used without further purification. Solvents were distilled prior to use. Column chromatography was performed on silicagel. $^1$H NMR (300 MHz or 400 MHz) and $^{13}$C NMR (75 MHz or 100 MHz) were recorded on Bruker spectrometer using CDCl$_3$ or DMSO as solvent and TMS as an internal standard (Chemical shift in (δ) ppm). The Mass spectra were recorded on Jeol-JMS-DX 303 HF mass spectrometer. Elemental analyses were recorded on a Perkin-Elmer 240C-CHN analyzer. Melting points are uncorrected. Thin layer chromatography (TLC) was performed using commercially available silica gel coated aluminium plate purchased from merck and spots were visualized using iodine vapour and UV lamp.

General procedure for the synthesis of bis (phenylthio) methane (2a-h)

Powdered NaOH (54 mmol) was added to a stirred solution of thiophenol (45.4 mmol) in EtOH (50 mL), after being stirred at 80 °C under N$_2$ for 1 h (after completion of salt formation monitored by TLC (or) up to homogeneous solution was attained), cooled the reaction mixture to r.t., diiodomethane (45.4 mmol) was added at one lot to a mixture and stirred at 80 °C under N$_2$ for 1 h. The reaction progress was monitored by TLC, cooled the mixture to RT and solvent was removed under reduced pressure and quenched the mixture with water (30 mL) and extracted with EtOAc (2x50 mL) washed with water (50 mL) and sat brine (50 mL), dried the organic layer was over Na$_2$SO$_4$. Evaporation of the solvent under vacuum furnished the desired product bis (phenylthio) methane (2a) as a pale yellow liquid with 98% yield. Same procedure applied for the synthesis of all the other bis (phenylthio) methane compounds (2a-h).

Bis(phenylthio)methane (2a)
Yield: 98%; **Nature**: pale yellow liquid; $^1$H NMR (300 MHz/CDCl$_3$) δ 7.66–7.12 (m, 10H, ArH), δ 4.35 (s, 2H, -CH$_2$-) ppm; $^{13}$C NMR (75 MHz/CDCl$_3$) δ 135.2, 130.8, 129.2, 127.2, 40.6 ppm.

**Bis(4-methoxyphenylthio)methane (2b)**

Yield: 94%; **Nature**: pale yellow solid; mp: 74.5 - 75.8 °C; $^1$H NMR (400 MHz/CDCl$_3$) δ 7.39 (d, $J$=8.8 Hz, 4H, ArH), δ 6.84 (d, 4H, $J$=8.8 Hz, ArH), δ 4.16 (s, 2H, -CH$_2$-) ppm; $^{13}$C NMR (100 MHz/CDCl$_3$) δ 157.1, 128.7, 127.8, 114.5, 55.9, 40.2 ppm.

**Bis(4-Bromophenylthio)methane (2c)**

Yield: 96%; **Nature**: white solid; mp: 74.7 – 76.0 °C; $^1$H NMR (CDCl$_3$/400 MHz) δ 7.43 (d, 4H, ArH), 7.26 (d, 4H, ArH), δ 4.29 (s, 2H, -CH$_2$-) ppm; $^{13}$C NMR (CDCl$_3$/100 MHz) δ 128.89, 127.90, 127.34, 116.81, 36.05 ppm.

**Bis (3-Bromophenylthio) methane (2d)**

Yield: 96%; **Nature**: pale yellow liquid; $^1$H NMR (CDCl$_3$/400 MHz) δ 7.54 (t, 2H, ArH), δ 7.38 (d, 2H, ArH), δ 7.32 (d, 2H, ArH), δ 7.17 (t, 2H, ArH), δ 4.34 (s, 2H) ppm; $^{13}$C NMR (CDCl$_3$/100 MHz) δ 136.80, 133.11, 130.37, 130.34, 129.18, 122.82, 40.23 ppm.

**Bis(4-chlorophenylthio)methane (2e)**
Yield: 92%; **Nature**: colourless solid; mp: 71.4 – 72.6 °C; \(^{1}H\) **NMR** (CDCl\(_{3}/400 \text{ MHz}\)) \(\delta 7.36 – 7.26 (m, 8H, \text{ArH}), \delta 4.28 (s, 2H, -\text{CH}_2-) \text{ ppm}; ^{13}C \text{ NMR} \text{(CDCl}_3/100 \text{ MHz}) \delta 133.51, 132.91, 132.32, 129.14, 41.15 \text{ ppm.}

Bis(2,4-dichlorophenylthio)methane (2f)

Yield: 94%; **Nature**: white solid; mp: 105.3 – 106.8 °C; \(^{1}H\) **NMR** (CDCl\(_{3}/400 \text{ MHz}\)) \(\delta 7.47 (s, 2H, \text{ArH}), \delta 7.37 (d, 2H, \text{ArH}), \delta 7.21 (d, 2H, \text{ArH}), \delta 4.30 (s, 2H, -\text{CH}_2-) \text{ ppm}; ^{13}C \text{ NMR} \text{(CDCl}_3/100 \text{ MHz}) \delta 134.23, 133.01, 132.33, 131.84, 130.68, 130.09, 40.69 \text{ ppm.}

Bis(3,4-dichlorophenylthio)methane (2g)

Yield: 99%; **Nature**: pale yellow solid; mp: 60.5 – 61.6 °C; \(^{1}H\) **NMR** (CDCl\(_{3}/400 \text{ MHz}\)) \(\delta 7.42-7.38 (m, 4H, \text{ArH}), \delta 7.22 (m, 2H, \text{ArH}), \delta 4.36 (s, 2H, -\text{CH}_2-) \text{ ppm}; ^{13}C \text{ NMR} \text{(CDCl}_3/100 \text{ MHz}) \delta 136.24, 133.92, 132.66, 131.83, 129.81, 127.55, 37.74 \text{ ppm.}

Bis(2,4-dfluorophenylthio)methane (2h)

Yield: 94%; **Nature**: pale yellow liquid; \(^{1}H\) **NMR** (CDCl\(_{3}/300 \text{ MHz}\)) \(\delta 7.45 – 7.37 (m, 2H), \delta 6.89 – 6.80 (m, 4H), \delta 4.21 (s, 2H, -\text{CH}_2-) \text{ ppm}; ^{13}C \text{ NMR} \text{(CDCl}_3/100 \text{ MHz}) \delta 164.16, 160.85, 136.08, 115.82, 111.59, 104.16, 38.21 \text{ ppm.}

**General procedure for the synthesis of bis (phenyl sulfonyl) methane (3a-h)**

\(\text{H}_2\text{O}_2\) (30% wt) (216 mmol) was added to a stirred solution of bis (phenylthio)methane (2a) (21.6 mmol) in acetic acid (50 mL) at r.t., after being stirred at 100 °C for 5 h. The reaction progress was monitored by LCMS, the mixture was cool to r.t., then quenched
with water (100 mL) and stirred for 15 min, and the product was started crystallized from the solution, filtered the solid and washed the solid with plenty of water to remove the excess of acetic acid and H₂O₂. The pure product bis phenyl sulfonyl methane (3a) was obtained after tituration of crude compound with methanol. Same procedure applied for the synthesis of all the other compounds (3a-h).

Bis phenyl sulfonyl methane (3a)

Yield: 95%; Nature: white solid; mp: 121 – 122 °C; ¹H NMR (300 MHz/CDCl₃) δ 7.97–7.95 (m, 4H, ArH), δ 7.74–7.69 (m, 2H, ArH), δ 7.62–7.56 (m, 4H, ArH), δ 4.75 (s, 2H, -CH₂-) ppm; ¹³C NMR (75 MHz/CDCl₃); δ 138.38, 134.82, 129.37, 128.85, 74.47 ppm; LCMS exhibited the molecular ion peaks at EIMS m/z: 295.0 (M⁺-1)

Bis 4-methoxy phenyl sulfonyl methane (3b)

Yield: 98%; Nature: white solid; mp: 170.2 – 170.9 °C; ¹H NMR (400 MHz/CDCl₃); δ 7.85 (d, 2H, J=9.01 Hz), δ 7.00 (d, 2H, J=9.01 Hz), δ 4.71 (s, 2H, -CH₂-), δ 3.85 (s, 6H, -OCH₃) ppm; ¹³C NMR (75 MHz/CDCl₃) δ 164.45, 131.05, 129.69, 114.41, 74.72, 55.65 ppm; LCMS exhibited the molecular ion peaks at EIMS m/z: 355.1 (M⁺-1).

Bis 4-bromo phenyl sulfonyl methane (3c)

Yield: 95%; Nature: white solid; mp: 208.5 – 209.2 °C; ¹H NMR (CDCl₃/300 MHz) δ 7.81 (d, 4H), δ 7.73 (d, 4H), δ 4.72 (s, 2H, -CH₂-) ppm; ¹³C NMR (CDCl₃/75 MHz) δ 137.09, 132.79, 130.72, 130.40, 74.41 ppm; LCMS exhibited the molecular ion peaks at EIMS m/z: 452.8 (M⁺-1).
Bis 3-bromo phenyl sulfonyl methane (3d)

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3d
\text{Br} \quad \text{O} \quad \text{O} \quad \text{Br}
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Yield: 90%; **Nature**: white solid; mp: 171.4 – 172.3 °C; $^1H$ NMR (CDCl$_3$/300 MHz) $\delta$ 8.14 (m, 2H, ArH), $\delta$ 7.84–7.93 (m, 4H, ArH), $\delta$ 7.47 (t, 2H, ArH), $\delta$ 4.77 (s, 2H, -CH$_2$-) ppm; $^{13}$C NMR (CDCl$_3$/100 MHz) $\delta$ 139.81, 138.11, 131.55, 130.90, 127.56, 123.36, 74.32 ppm; LCMS exhibited the molecular ion peaks at EIMS m/z: 452.7 (M$^+$-1).

Bis 4-Chloro phenyl sulfonyl methane (3e)

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3e
\text{Cl} \quad \text{O} \quad \text{O} \quad \text{Cl}
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Yield: 92%; **Nature**: white solid; mp: 189.7 – 191.4 °C; $^1H$ NMR (CDCl$_3$/300 MHz) $\delta$ 7.91(d, 4H), $\delta$ 7.57 (d, 4H), $\delta$ 4.76 (s, 2H, -CH$_2$-) ppm; $^{13}$C NMR (CDCl$_3$/100 MHz) $\delta$ 141.98, 136.56, 130.40, 129.73, 74.44 ppm; LCMS exhibited the molecular ion peaks at EIMS m/z: 366.14 (M$^+$+1).

Bis 2, 4-dichloro phenyl sulfonyl methane (3f)

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3f
\text{Cl} \quad \text{O} \quad \text{O} \quad \text{Cl}
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Yield: 90%; **Nature**: white solid; mp: 176.8 – 177.4 °C; $^1H$ NMR (CDCl$_3$/300 MHz) $\delta$ 7.90 (s, 2H), $\delta$ 7.79 (d, 2H), $\delta$ 7.63 (d, 2H), $\delta$ 6.00 (s, 2H, -CH$_2$-) ppm; $^{13}$C NMR (CDCl$_3$/75 MHz) $\delta$ 140.79, 133.92, 133.22, 132.99, 131.46, 128.40, 69.45 ppm; LCMS exhibited the molecular ion peaks at EIMS m/z: 435.34 (M$^+$+1).

Bis 3,4-dichloro phenyl sulfonyl methane (3g)
Yield: 97%; **Nature**: white solid; mp: 243.9 – 244.8 °C; \( ^{1} \text{H NMR} \) (CDCl\(_3\)/300 MHz) \( \delta \) 8.01 (s, 2H), \( \delta \) 7.91 (d, 2H), \( \delta \) 7.80 (d, 2H), \( \delta \) 6.25 (s, 2H -CH\(_2\)-) ppm; \( ^{13} \text{C NMR} \) (CDCl\(_3\)/100 MHz) \( \delta \) 138.18, 138.10, 132.29, 131.57, 129.99, 128.47, 71.17 ppm; **LCMS** exhibited the molecular ion peaks at EIMS m/z: 435.24 (M\(^+\)+1).

Bis 2,4-difluoro phenyl sulfonyl methane (3h)

Yield: 99%; **Nature**: white solid; mp: 184.4 – 185.3 °C; \( ^{1} \text{H NMR} \) (CDCl\(_3\)/300 MHz) \( \delta \) 7.81 (m, 2H), \( \delta \) 7.12 – 7.01 (m, 4H), \( \delta \) 5.05 (s, 2H, -CH\(_2\)-) ppm; \( ^{13} \text{C NMR} \) (CDCl\(_3\)/100 MHz) \( \delta \) 168.96, 165.50, 162.04, 158.61, 133.02, 122.32, 112.43, 105.54, 72.17 ppm; **LCMS** exhibited the molecular ion peaks at EIMS m/z: 369.14 (M\(^+\)+1).

**General procedure for the synthesis of 1-aryl sulphonyl-4 substituted-\( ^{E,E} \)-1, 3 dienes (4a-i):**

LHMDS (8.4 mmol, 1.06 molar solution in THF) was added drop wise to a -15 °C cooled solution of biphenyl sulfonyl methane 3a (3.4 mmol) in distilled THF (15 mL) under argon. After being stirred at -15 °C for 1 h, *trans* ethyl 4-bromo crotonate (3.7 mmol) in distilled THF (5 ml) was added drop wise over the period of 10 mins and allow the reaction mixture to come RT over the period of 1-2 h and stirred at r.t., for 24 h. The reaction mixture was quenched with sat NH\(_4\)Cl (20 mL) and extracted with EtOAc (2x20 mL) washed with water (2x20 mL) and sat brine (20 mL), the organic layer was dried over MgSO\(_4\). Evaporation of the solvent under vacuum furnished desired crude product, The crude product was purified by column chromatography on silica gel (230-400 mesh) with 17-20% of EtOAc in hexane afforded the corresponding product (\( ^{2} \text{E, 4} \text{E} \))-ethyl 5-(phenyl sulfonyl)penta-2,4-dienote (4a) as a colourless solid with 75% yield. Same procedure applied for the synthesis of
all the other 1- Arylsulfonyl-4-Sustituted-E,E-1,3-Butadienes (4a-i) and Allyl Bis Arylsulphonyl Sulphones (5a-d).

\[(2E, 4E)\text{-ethyl 5-(phenyl sulfonyl)penta-2,4-dienoate (4a):}\]

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\text{SO} \begin{array}{c}
\text{O} \\
\text{O} \\
\end{array}
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Yield: 75%; Nature: white solid; mp: 71.5–72.5 °C; \(^1\)H NMR (CDCl\textsubscript{3}/300 MHz) \(\delta 7.54\)–7.92 (m, 5H), \(\delta 7.18\) (m, 2H), \(\delta 6.66\) (d, 1H, \(J=14.43\) Hz), \(\delta 6.25\) (d, 1H, \(J=14.94\) Hz), \(\delta 4.19\) (q, 2H, \(J=7.14\) Hz, -CH\textsubscript{2}-CH\textsubscript{3}) and \(\delta 1.25\) (t, 3H, \(J=7.11\) Hz, -CH\textsubscript{2}-CH\textsubscript{3}); \(^13\)C NMR (DMSO-d\textsubscript{6}/75 MHz) \(\delta 165.51, 140.23, 139.22, 138.54, 134.47, 130.24, 127.77, 126.95, 119.40, 60.96, 14.48\) ppm; DEPT-NMR (75 MHz, CDCl\textsubscript{3}) \(\delta 139.23, 137.70, 134.49, 130.90, 130.25, 127.78, 60.97, 14.48\) ppm; LCMS exhibited the molecular ion peak at m/z: 267.1 (M\textsuperscript{+1}); CHN anal. Calc’d. for C\textsubscript{13}H\textsubscript{14}O\textsubscript{4}S: C, 58.63; H, 5.30; S, 12.04; Found: C, 58.52; H, 5.36; S, 11.98.

Further confirmed 4a by X-ray single crystal analysis. Crystal data for 4a: Single crystal X-ray structure of the molecule shown in ORTEP diagram (Fig 1). Detailed X-ray crystallographic data is available from the Cambridge Crystallographic Data Centre, 12 Union Road, Cambridge CB2 1EZ, UK (for compound 4a CCDC#865207).

\[(2E, 4E)\text{-ethyl 5-(4-methoxyphenylsulfonyl) penta-2,4-dienoate (4b)}\]

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\text{SO} \begin{array}{c}
\text{O} \\
\end{array}
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\]
Yield: 72%;  **Nature**: white solid;  \(^1\)H NMR (CDCl\textsubscript{3}/400 MHz) \(\delta 7.79\) (d, 2H, \(J=6.80\) Hz, ArH), \(\delta 7.16\) (m, 2H, ArH), \(\delta 6.98\) (d, 2H, \(J=7.20\) Hz, ArH), \(\delta 6.63\) (d, 1H, \(J=14.40\) Hz), \(\delta 6.22\) (d, 1H, \(J=14.80\) Hz), \(\delta 4.19\) (q, 2H, -CH\textsubscript{2}-CH\textsubscript{3}), \(\delta 3.87\) (s, 3H, -OCH\textsubscript{3}), \(\delta 1.27\) (t, 3H, -CH\textsubscript{2}-CH\textsubscript{3}) ppm;  \(^1^3\)C NMR (CDCl\textsubscript{3}/75 MHz) \(\delta 165.31, 163.98, 138.31, 137.32, 137.15, 131.10, 130.29, 130.17, 114.74, 61.05, 55.73, 14.15\) ppm;  LCMS exhibited the molecular ion peaks at EIMS m/z: 297 (M\textsuperscript{+}+1);  **CHN anal.** Calc’d. for C\textsubscript{14}H\textsubscript{15}O\textsubscript{5}S: C, 56.74; H, 5.44; S, 10.82; Found: C, 56.83; H, 5.36; S, 10.98.

(2\textit{E},4\textit{E})-ethyl 5-(4-bromophenylsulfonyl)penta-2,4-dienoateenoate (4\textit{c})

![Chemical structure of 4c](image)

Yield: 62%;  **Nature**: white floppy solid;  \(^1\)H NMR (CDCl\textsubscript{3}/500 MHz) \(\delta 7.68\) (d, 2H, \(J=8.5\) Hz, ArH), \(\delta 7.622\) (d, 2H, \(J=8.5\) Hz, ArH), \(\delta 7.27\) - 7.12 (m, 2H, ArH), \(\delta 6.57\) (d, 1H, \(J=15.00\) Hz, C1), \(\delta 6.20\) (d, \(J=15.00\) Hz, 1H, C4), \(\delta 4.14\) (q, 2H, \(J=7\) Hz, -CH\textsubscript{2}-CH\textsubscript{3}), \(\delta 1.21\) (t, 3H, \(J=7\) Hz, -CH\textsubscript{2}-CH\textsubscript{3}) ppm;  \(^1^3\)C NMR (CDCl\textsubscript{3}/125 MHz) \(\delta 165.17, 138.80, 138.77, 137.86, 136.11, 132.85, 131.15, 129.41, 129.30, 61.18, 14.15\) ppm;  DEPT-NMR (CDCl\textsubscript{3}/125 MHz) \(\delta 138.80, 137.86, 136.11, 132.85, 131.15, 129.42, 14.15\) ppm.  LCMS exhibited the molecular ion peaks at EIMS m/z: 345.6 (M\textsuperscript{+}+2);  **CHN anal.** Calc’d. for C\textsubscript{13}H\textsubscript{13}BrO\textsubscript{4}S: C, 45.23; H, 3.80; Found: C, 45.52; H, 3.92; S, 9.53.

(2\textit{E},4\textit{E})-ethyl 5-(3-bromophenylsulfonyl)penta-2,4-dienoateenoate (4\textit{d})

![Chemical structure of 4d](image)

Yield: 67%;  **Nature**: pale yellow solid;  \(^1\)H NMR (CDCl\textsubscript{3}/500 MHz) \(\delta 7.96\) (s, 1H, ArH), \(7.84\) – 7.68 (m, 2H, ArH), \(\delta 7.62\) (d, 1H, \(J=8.5\) Hz, ArH), \(\delta 7.28\) - 7.13 (m, 2H, \(J=8.5\) Hz, ArH), \(\delta 6.59\) (d, 1H, \(J=14.50\) Hz, C1), \(\delta 6.22\) (d, 1H, \(J=15.50\) Hz, C4), \(\delta 4.14\) (q, 2H, \(J=7\) Hz, -CH\textsubscript{2}-CH\textsubscript{3}), \(\delta 1.21\) (t, 3H, \(J=7.5\) Hz, -CH\textsubscript{2}-CH\textsubscript{3}) ppm;  \(^1^3\)C NMR (CDCl\textsubscript{3}/125 MHz) \(\delta 165.16, 141.66, 139.92, 139.24, 138.06, 137.81, 136.92, 135.86, 127.57, 126.43, 123.34, 61.19, 14.16\) ppm.
LCMS exhibited the molecular ion peaks at EIMS m/z: 364.0 (M++Na); CHN anal. Calc’d. for C_{13}H_{13}BrO_{4}S: C, 45.23; H, 3.80; S, 9.29; Found: C, 45.42; H, 3.75; S, 9.45.

2\(E,4E\)-ethyl 5-(4-chlorophenylsulfonyl)penta-2,4-dienoateenoate (4e)

Yield: 75%; Nature: colourless solid; mp : 117.6 – 119.2 °C; \(^1\)H NMR (CDCl\(_3/400\) MHz) \(\delta\) 7.82 (d, 2H, \(J=8.8\) Hz, ArH), \(\delta\) 7.53 (d, 2H, \(J=8.4\) Hz, ArH), \(\delta\) 7.35 - 7.19 (m, 2H, ), \(\delta\) 6.27 (d, 1H, \(J=14.40\) Hz), \(\delta\) 6.27 (d, 1H, \(J=14.80\) Hz), \(\delta\) 4.21 (q, 2H, \(J=7.2\) Hz, -CH\(_2\)-CH\(_3\)), \(\delta\) 1.28 (t, 3H, \(J=6.8\) Hz, -CH\(_2\)-CH\(_3\)) ppm; \(^{13}\)C NMR (CDCl\(_3/100\) MHz) \(\delta\) 165.31, 140.86, 138.89, 138.37, 138.00, 136.31, 131.26, 129.99, 129.51, 61.32, 14.29 ppm. LCMS exhibited the molecular ion peaks at EIMS m/z: 318.0 (M++H\(_2\)O); CHN anal. Calc’d. for C\(_{13}\)H\(_{13}\)ClO\(_4\)S: C, 51.92; H, 4.36; S, 10.66; Found: C, 52.15; H, 4.56; S, 10.42.

(\(2E,4E\))-ethyl 5-(2,4-dichlorophenylsulfonyl)penta-2,4-dienoateenoate (4f)

Yield: 65%; Nature: pale yellow solid; mp : 121.3 – 122.9 °C; \(^1\)H NMR (CDCl\(_3/400\) MHz) \(\delta\) 7.91 (d, 1H, \(J=2.4\) Hz, ArH), \(\delta\) 7.64 (dd, 1H, \(J=8.8, 2\) Hz, ArH), \(\delta\) 7.57 (d, 1H, \(J=6.80\) Hz, ArH), \(\delta\) 7.31-7.13 (m, 2H), \(\delta\) 6.57 (d, 1H, \(J=14. 4\) Hz, C1), \(\delta\) 6.23 (d, 1H, \(J=15.2\) Hz), \(\delta\) 4.16 (q, 2H, \(J=7.2\) Hz, -CH\(_2\)-CH\(_3\)), \(\delta\) 1.24 (t, 3H, \(J=7.2\) Hz, -CH\(_2\)-CH\(_3\)) ppm; \(^{13}\)C NMR (CDCl\(_3/100\) MHz) \(\delta\) 165.19, 139.66, 139.59, 139.13, 137.73, 135.60, 134.36, 131.69, 131.66, 129.91, 126.68, 61.33, 14.23 ppm; DEPT-NMR (CDCl\(_3/100\) MHz) \(\delta\) 139.58, 137.66, 135.52, 131.61, 129.84, 126.90, 61.25, 14.16 ppm; LCMS exhibited the molecular ion peaks at EIMS m/z: 335.6 (M\(^+\)+2); CHN anal. Calc’d. for C\(_{13}\)H\(_{12}\)Cl\(_2\)O\(_4\)S: C, 46.58; H, 3.61; S, 9.57; Found: C, 46.44; H, 3.52; S, 9.88.

(\(2E,4E\))-ethyl 5-(3,4-dichlorophenylsulfonyl)penta-2,4-dienoateenoate (4g)
Yield: 77%; Nature: pale yellow solid; mp: 112.1 – 133.0 °C; \(^1^H\) NMR (CDCl\(_3/400\) MHz) \(\delta\) 8.11 - 7.45 (m, 3H, ArH), \(\delta\) 7.419 - 7.21 (m, 2H), \(\delta\) 6.84 (d, 1H, \(J=14. 40\) Hz), \(\delta\) 6.31 (d, 1H, \(J=15.20\) Hz), \(\delta\) 4.22 (q, 2H, \(J=6.8\) Hz, -CH\(_2\)-CH\(_3\)), \(\delta\) 1.29 (t, 3H, \(J=7.2\) Hz, -CH\(_2\)-CH\(_3\)) ppm; \(^{13}\)C NMR (CDCl\(_3/100\) MHz) \(\delta\) 165.17, 141.41, 141.04, 137.84, 135.93, 134.17, 133.46, 131.99, 131.77, 131.52, 61.22, 14.17 ppm; LCMS exhibited the molecular ion peaks at EIMS m/z: 335.6 (M\(^{+}+2\)); CHN anal. Calc’d for C\(_{13}\)H\(_{12}\)Cl\(_2\)O\(_4\)S: C, 46.58; H, 3.61; S, 9.57; Found: C, 46.82; H, 3.76; S, 9.67.

\((2E,4E)\)-ethyl 5-(2,4-difluorophenylsulfonyl)penta-2,4-dienoatoenoate (4h)

Yield: 74%; Nature: white solid; mp: 99.3 – 100.4 °C; \(^1^H\) NMR (CDCl\(_3/400\) MHz) \(\delta\) 7.95-7.90 (m, 1H, ArH), \(\delta\) 7.30-7.17 (m, 1H), \(\delta\) 6.98 (t, 1H, ArH), \(\delta\) 6.90 (t, 1H, ArH), \(\delta\) 6.73 (d, 1H, \(J=14. 4\) Hz), \(\delta\) 6.24 (d, 1H, \(J=15.2\) Hz), \(\delta\) 4.17 (q, 2H, \(J=6.8\) Hz, -CH\(_2\)-CH\(_3\)), \(\delta\) 1.25 (t, 3H, \(J=7.2\) Hz, -CH\(_2\)-CH\(_3\)) ppm; \(^{13}\)C NMR (CDCl\(_3/100\) MHz) \(\delta\) 168.11, 165.53, 161.79, 140.55, 137.85, 135.18, 131.86, 131.49, 124.47, 112.60, 106.15, 61.20, 14.15 ppm; DEPT-NMR (CDCl\(_3/100\) MHz) \(\delta\) 140.55, 137.82, 135.17, 131.85, 131.53, 112.61, 106.16, 61.21, 14.15 ppm; LCMS exhibited the molecular ion peaks at EIMS m/z: 320.0 (M\(^{+}+\)H\(_2\)O); CHN anal. Calc’d for C\(_{13}\)H\(_{12}\)F\(_2\)O\(_4\)S: C, 51.65; H, 4.00; S, 10.61; Found: C, 51.82; H, 3.96; S, 10.67.

\((2E, 4E)\)-5-(phenylsulfonyl) penta-2,4-dienenitrile (4i)
Yield: 65%; **Nature**: pale brown solid; $^1$H NMR (CDCl$_3$/400 MHz) δ 7.92-7.58 (m, 5H, ArH), δ 7.24 (dd, 1H, $J$=14.97, 14.73 Hz), δ 6.98 (dd, 1H, $J$=15.97, 15.92 Hz), δ 6.71 (d, 1H, $J$=14.81 Hz), δ 5.82 (d, 1H, $J$=15.97 Hz) ppm; $^{13}$C NMR (CDCl$_3$/100 MHz) δ 144.45, 139.13, 137.95, 136.66, 134.21, 129.64, 128.02, 116.20, 108.55 ppm; DEPT-NMR (100 MHz; CDCl$_3$) δ 144.43, 137.99, 136.62, 134.21, 129.64, 128.03, 108.54 ppm; LCMS exhibited the molecular ion peaks at EIMS m/z: 219.1 (M$^+$+1); CHN anal. Calc’d. for C$_{11}$H$_9$NO$_2$S: C, 60.26; H, 4.14; N, 6.39; S, 14.62; Found: C, 60.56; H, 3.95; N, 6.59; S, 14.67.

**General procedure for the synthesis of 1, 3,4-trisubstituted pyrrolidines (8a-J)**

TFA (0.38 mmol) in CH$_2$Cl$_2$ (1 mL) was added to a stirred solution of $E,E$-1-arylsulphonyl-4-ethoxycarbonyl-1,3-butadiene (4a) (3.8 mmol) and N-(methoxymethyl)-N-((trimethyl silyl)methyl)tert-butylamine (7a) (4.7 mmol) in dry CH$_2$Cl$_2$ (15 mL) at 0 deg under N$_2$ atm, the reaction mixture was allowed to come to r.t., and stirred for 30 min. After completion of reaction monitored by TLC, the reaction mixture was quenched with 10% aq soln of NaHCO$_3$ (30 mL) and extracted with CH$_2$Cl$_2$ (2x30 mL) washed with water (30 mL) and sat brine (30 mL), dried the organic layer over MgSO$_4$. Evaporation of the solvent under vacuum and the crude product was subjected to column chromatography (25% EtOAc in n-hexane) to yield analytically pure (3$S$,4$R$)-ethyl 1-tert-butyl-4-((E)-2-(phenylsulfonyl)vinyl)pyrrolidine-3-carboxylate (8a) as a pale yellow gummy. Same procedure applied for the synthesis of all the other 1, 3,4-trisubstituted pyrrolidines (8a-i).

(3$S$,4$R$)-ethyl 1-tert-butyl-4-((E)-2-(phenylsulfonyl)vinyl)pyrrolidine-3-carboxylate (8a)

![Chemical Structure](image)

Yield: 76%; **Nature**: pale yellow gummy liquid; $^1$H NMR (CDCl$_3$/400 MHz) δ 7.79 (m, 2H), δ 7.45-7.574 (m, 3H), δ 6.89 (dd, 1H, $J$=15.03 Hz), δ 6.30 (d, 1H, $J$=15.80 Hz), δ 4.01 (q, 1H, $J$=7.2 Hz), δ 3.08 (m, 1H), δ 2.96 (t, 1H, $J$=8.8 Hz), δ 2.87 (t, 1H, $J$=8.68 Hz), δ 2.80 (t, 1H, $J$=7.52 Hz), δ 2.72 (q, 1H, $J$=7.76 Hz), δ 2.55 (t, 1H, $J$=7.68 Hz), δ 1.18 (t, 3H, $J$=7.12 Hz), δ
1.08 (s, 9H) ppm; $^{13}$C NMR (CDCl$_3$/100 MHz) δ 172.85, 146.98, 140.37, 133.28, 130.75, 129.19, 127.54, 60.90, 52.37, 51.14, 49.06, 48.15, 43.04, 25.75, 14.02 ppm; Dept NMR (CDCl$_3$/100 MHz) δ 133.80, 133.42, 128.97, 128.80, 125.31, 121.68, 60.23, 30.37, 14.42 ppm; LCMS exhibited the molecular ion peaks at EIMS m/z: 366.1 (M+1); CHN anal. calc’d. for C$_{19}$H$_{27}$NO$_4$S: C, 62.44; H, 7.45; S, 8.77; N, 3.83 Found: C, 62.53; H, 7.37; S, 8.92; N, 3.93.

(3R,4S)-ethyl 1-cyclopentyl-4-((E)-2-(phenylsulfonyl)vinyl)pyrrolidine-3-carboxylate (8b)

Yield: 75%; Nature: colourless liquid; $^1$H NMR (CDCl$_3$/400 MHz) δ 7.81 (d, 2H), δ 7.45-7.57 (m, 3H), δ 6.90 (dd, 1H, J=15.21 Hz, 14.81 Hz), δ 6.32 (d, 1H, J=16.01 Hz), δ 4.00 (q, 2H), δ 3.18 (m, 1H), δ 2.78 (m, 4H), δ 2.46 (m, 2H), δ 1.70 (m, 2H), δ 1.60 (m, 2H), δ 1.38 (m, 4H), δ 1.10 (t, 3H) ppm; $^{13}$C NMR (CDCl$_3$/100 MHz) δ 172.69, 146.72, 140.34, 133.40, 131.01, 129.29, 127.64, 66.37, 61.13, 57.97, 55.75, 48.11, 42.92, 31.67, 30.92, 24.05, 24.02, 14.08 ppm; Dept NMR (CDCl$_3$/100 MHz) δ 146.72, 133.41, 131.01, 129.29, 127.64, 66.37, 61.14, 57.98, 55.75, 48.10, 42.92, 31.67, 24.05, 24.02 14.09 ppm; LCMS exhibited the molecular ion peaks at EIMS m/z: 377.8 (M+1); CHN anal. calc’d. for C$_{20}$H$_{27}$NO$_4$S: C, 63.63; H, 7.21; S, 8.49; N, 3.71 Found: C, 63.53; H, 7.37; S, 8.52; N, 3.73.

(3R,4S)-ethyl 1-benzyl-4-((E)-2-(phenylsulfonyl)vinyl)pyrrolidine-3-carboxylate (8c)

Yield: 67%; Nature: pale yellow liquid; $^1$H NMR (CDCl$_3$/400 MHz) δ 7.86 (d, 2H), δ 7.52-7.65 (m, 3H), δ 6.97 (dd, 1H, J=15.21 Hz, 14.81 Hz), δ 6.36 (d, 1H, J=16.01 Hz), δ 4.07 (q,
(3R,4S)-ethyl 4-((E)-2-(4-methoxyphenylsulfonyl)vinyl)-1-benzylpyrrolidine-3-carboxylate (8d)

Yield: 82%; Nature: pale yellow gummy liquid; $^1$H NMR (CDCl$_3$/400 MHz) $\delta$ 7.79 (d, 2H), $\delta$ 7.16 (m, 5H), $\delta$ 6.88 (d, 2H), $\delta$ 6.90 (dd, 1H, $J$=15.21 Hz, 14.81 Hz), $\delta$ 6.35 (d, 1H, $J$=16.01 Hz), $\delta$ 4.03 (q, 2H), $\delta$ 3.56 (s, 2H), $\delta$ 3.22 (m, 1H), $\delta$ 2.74 (m, 4H), $\delta$ 2.48 (m, 1H), $\delta$ 1.26 (t, 3H) ppm; $^{13}$C NMR (CDCl$_3$/100 MHz) $\delta$ 172.77, 145.84, 140.65, 137.91, 136.21, 131.54, 130.73, 129.37, 128.58, 128.28, 126.25, 62.36, 61.05, 59.57, 58.36, 56.52, 47.86, 42.35, 14.15 ppm; LCMS exhibited the molecular ion peaks at EIMS m/z: 430.18 (M$^+$+1); CHN anal. calc’d. for C$_{23}$H$_{27}$NO$_5$S: C, 64.31; H, 6.34; S, 7.47; N, 3.26 Found: C, 64.10; H, 6.51; S, 7.62; N, 3.43.

(3R,4S)-ethyl 4-((E)-2-(4-chlorophenylsulfonyl)vinyl)-1-benzylpyrrolidine-3-carboxylate (8e)

Yield: 82%; Nature: pale yellow gummy liquid; $^1$H NMR (CDCl$_3$/400 MHz) $\delta$ 7.79 (d, 2H), $\delta$ 7.16 (m, 5H), $\delta$ 6.88 (d, 2H), $\delta$ 6.90 (dd, 1H, $J$=15.21 Hz, 14.81 Hz), $\delta$ 6.35 (d, 1H, $J$=16.01 Hz), $\delta$ 4.03 (q, 2H), $\delta$ 3.56 (s, 2H), $\delta$ 3.22 (m, 1H), $\delta$ 2.74 (m, 4H), $\delta$ 2.48 (m, 1H), $\delta$ 1.26 (t, 3H) ppm; $^{13}$C NMR (CDCl$_3$/100 MHz) $\delta$ 172.77, 145.84, 140.65, 137.91, 136.21, 131.54, 130.73, 129.37, 128.58, 128.28, 126.25, 62.36, 61.05, 59.57, 58.36, 56.52, 47.86, 42.35, 14.15 ppm; LCMS exhibited the molecular ion peaks at EIMS m/z: 430.18 (M$^+$+1); CHN anal. calc’d. for C$_{23}$H$_{27}$NO$_5$S: C, 64.31; H, 6.34; S, 7.47; N, 3.26 Found: C, 64.10; H, 6.51; S, 7.62; N, 3.43.
Yield: 74%; Nature: pale yellow liquid; $^1$H NMR (CDCl$_3$/400 MHz) δ 7.80 (d, 2H, J=6.8 Hz), δ 7.50 (d, 2H, J=5.6 Hz), δ 7.80 (m, 5H), δ 7.03 (dd, 1H, J=15 Hz), δ 6.37 (d, 1H, J=15 Hz), δ 4.11 (q, 2H), δ 3.60 (s, 2H), δ 3.30 (m, 1H), δ 2.94-2.83 (m, 4H), δ 2.53 (m, 1H), δ 1.19 (t, 3H) ppm; $^{13}$C NMR (CDCl$_3$/100 MHz) δ 172.90, 147.84, 140.15, 138.91, 138.21, 130.44, 129.73, 129.17, 128.88, 128.38, 127.28, 61.16, 59.42, 58.26, 56.22, 48.36, 42.95, 14.13 ppm; LCMS exhibited the molecular ion peaks at EIMS m/z: 434.1 (M+1); CHN anal. calc’d. for C$_{22}$H$_{24}$ClNO$_4$S: C, 60.89; H, 5.57; S, 7.39; N, 3.23 Found: C, 61.10; H, 5.51; S, 7.52; N, 3.44.

(3R,4S)-ethyl 4-((E)-2-(4-bromophenylsulfonyl)vinyl)-1-benzylpyrrolidine-3-carboxylate (8f)

Yield: 79%; Nature: pale yellow liquid; $^1$H NMR (CDCl$_3$/400 MHz) δ 7.67 (m, 4H), δ 7.24 (m, 5H), δ 6.92 (dd, 1H, J=14.81 Hz), δ 6.27 (d, 1H, J=15.2 Hz), δ 4.07 (q, 2H), δ 3.61 (s, 2H), δ 3.23 (m, 1H), δ 2.88 (m, 4H), δ 2.45 (m, 1H), δ 1.24 (t, 3H) ppm; $^{13}$C NMR (CDCl$_3$/100 MHz) δ 174.10, 149.15, 140.69, 139.45, 133.94, 131.62, 129.92, 129.36, 128.63, 128.14, 127.93, 62.38, 61.15, 60.00, 57.45, 49.58, 44.17, 15.47 ppm; LCMS exhibited the molecular ion peaks at EIMS m/z: 479.28 (M+2); CHN anal. calc’d. for C$_{22}$H$_{24}$BrNO$_4$S: C, 55.23; H, 5.06; S, 6.70; N, 2.93 Found: C, 55.45; H, 5.31; S, 6.52; N, 3.24.

(3R,4S)-ethyl 4-((E)-2-(3-bromophenylsulfonyl)vinyl)-1-benzylpyrrolidine-3-carboxylate (8g)
Yield: 86%; Nature: pale yellow liquid; $^1$H NMR (CDCl$_3$/400 MHz) δ 7.92 (s, 1H), δ 7.70 (m, 3H), δ 7.35 (m, 5H), δ 6.92 (dd, 1H, J=14.4 Hz), δ 6.31 (d, 1H, J=14.8 Hz), δ 4.04 (q, 2H), δ 3.53 (s, 2H), δ 3.21 (m, 1H), δ 2.85 (m, 4H), δ 2.45 (m, 1H), δ 1.17 (t, 3H) ppm; $^{13}$C NMR (CDCl$_3$/100 MHz) δ 173.69, 147.30, 141.30, 137.67, 135.44, 130.57, 129.65, 129.36, 127.56, 126.34, 125.16, 60.12, 58.88, 57.34, 55.13, 47.29, 41.81, 13.20 ppm; LCMS exhibited the molecular ion peaks at EIMS m/z: 479.28 (M+2); CHN anal. calc’d. for C$_{22}$H$_{24}$BrNO$_4$S: C, 55.23; H, 5.06; S, 6.70; N, 2.93 Found: C, 55.55; H, 5.38; S, 6.98; N, 2.75.

(3R,4S)-ethyl 4-((E)-2-(2,4-dichlorophenylsulfonyl)vinyl)-1-benzylpyrrolidine-3-carboxylate (8h)

Yield: 78%; Nature: pale yellow liquid; $^1$H NMR (CDCl$_3$/400 MHz) δ 8.02 (d, 1H), δ 7.28-7.16 (m, 8H), δ 6.43 (d, 1H, J=15.2 Hz), δ 4.04 (q, 2H), δ 3.52 (s, 2H), δ 3.20 (m, 1H), δ 2.83 (m, 4H), δ 2.48 (m, 1H), δ 1.13 (t, 3H) ppm; $^{13}$C NMR (CDCl$_3$/100 MHz) δ 172.91, 151.05, 146.21, 140.60, 138.36, 133.43, 132.01, 131.76, 128.70, 127.91, 127.14, 61.22, 59.49, 58.36, 56.39, 52.13, 43.28, 14.23 ppm; LCMS exhibited the molecular ion peaks at EIMS m/z: 468.28 (M+1); CHN anal. calc’d. for C$_{22}$H$_{23}$Cl$_2$NO$_4$S: C, 56.41; H, 4.95; S, 6.85; N, 2.99 Found: C, 56.55; H, 5.08; S, 6.98; N, 2.75.

(3R,4S)-ethyl 4-((E)-2-(3,4-dichlorophenylsulfonyl)vinyl)-1-benzylpyrrolidine-3-carboxylate (8i)
Yield: 83%; Nature: pale yellow liquid; \(^1\)H NMR (CDCl\(_3/400\) MHz) \(\delta\) 8.02 (d, 1H), \(\delta\) 7.28-7.16 (m, 8H), \(\delta\) 6.43 (d, 1H, \(J=15.2\) Hz), \(\delta\) 4.04 (q, 2H), \(\delta\) 3.52 (s, 2H), \(\delta\) 3.20 (m, 1H), \(\delta\) 2.83 (m, 4H), \(\delta\) 2.48 (m, 1H), \(\delta\) 1.13 (t, 3H) ppm; \(^{13}\)C NMR (CDCl\(_3/100\) MHz) \(\delta\) 172.91, 151.05, 146.21, 140.60, 138.36, 133.43, 132.01, 131.76, 128.70, 127.91, 127.14, 61.22, 59.49, 58.36, 56.39, 52.13, 43.28, 14.23 ppm; LCMS exhibited the molecular ion peaks at EIMS m/z: 468.24 (M+1); CHN anal. calc’d. for C\(_{22}\)H\(_{23}\)Cl\(_2\)NO\(_4\)S: C, 56.41; H, 4.95; S, 6.85; N, 2.99 Found: C, 56.65; H, 5.18; S, 7.05; N, 2.85.

**(3R,4S)-ethyl 4-((E)-2-(2,4-difluorophenylsulfonyl)vinyl)-1-benzylpyrrolidine-3-carboxylate (8J)**

Yield: 80%; Nature: colourless liquid; \(^1\)H NMR (CDCl\(_3/400\) MHz) \(\delta\) 7.91 (m, 1H), \(\delta\) 7.29-7.01 (m, 7H), \(\delta\) 6.95 (dd, 1H, \(J=14.4\) Hz), \(\delta\) 6.52 (d, 1H, \(J=14.8\) Hz), \(\delta\) 4.15 (q, 2H), \(\delta\) 3.63 (s, 2H), \(\delta\) 3.33 (m, 1H), \(\delta\) 2.84 (m, 4H), \(\delta\) 2.56 (m, 1H), \(\delta\) 1.25 (t, 3H) ppm; \(^{13}\)C NMR (CDCl\(_3/100\) MHz) \(\delta\) 172.90, 149.94, 138.61, 131.66, 129.62, 128.59, 128.38, 127.23, 112.35, 112.10, 105.99, 61.15, 59.70, 58.24, 56.24, 48.32, 43.14, 14.13 ppm; LCMS exhibited the molecular ion peaks at EIMS m/z: 436.2 (M+1); CHN anal. calc’d. for C\(_{22}\)H\(_{23}\)F\(_2\)NO\(_4\)S: C, 60.68; H, 5.32; S, 7.36; N, 3.22 Found: C, 60.47; H, 5.41; S, 7.52; N, 3.28.

**General procedure for the synthesis of 1, 3,4-trisubstituted pyrroles (10a-c)**

Activated MnO\(_2\) on silica (5 equiv) (freshly prepared) was added to a stirred solution of ethyl-1-tert-butyl-4-((E)-2-(phenylsulfonyl)vinyl)pyrrolidine-3-carboxylate (8a) (1 g, 2.74 mol) in dry 1,4-dioxane (20 mL) under argon. After being stirred at reflux for 5 h, the reaction was monitored by TLC after completion of reaction, filtered the reaction mixture through celitepade and washed the pade with 1,4-dioxane. Evaporation of the filtrate under vacuum furnished the crude product, which was subjected to column chromatography (25% EtOAc in n-hexane) to yield analytically pure ethyl 1-tert-butyl-4-((E)-2-(phenylsulfonyl)vinyl)-1H-pyrrole-3-carboxylate (10a) as a pale yellow gummy liquid with
68% yield. Same procedure applied for the synthesis of all the other 1, 3,4-trisubstituted pyrroles (8a-i).

**Preparation of Active MnO$_2$ on Silica Gel**

Chromatographic grade silica gel (30 g, 60-120 mesh,) was added to a stirred solution of KMnO$_4$ (2 g) in water (30 mL at r.t., and the flask connected to a rotary evaporator to strip off the water at 60 °C. The purple solid was ground to fine powder and then added with vigorous stirring to a solution of MnSO$_4$.H$_2$O (4.6 g) in H$_2$O (50 mL). The resulting brown precipitate was filtered with water until no more Mn (II) ion could be detected in the washed water by adding ammonia. After being dried at 100 °C for 2 h, each gram of this supported reagent contained 0.83 mmol of MnO$_2$.

**ethyl 1-tert-butyl-4-((E)-2-(phenylsulfonyl)vinyl)-1H-pyrrole-3-carboxylate (10a)**

Yield: 68%; Nature: pale yellow gummy liquid; $^1$H NMR (CDCl$_3$/400 MHz) δ 8.02 (d, 1H, $J$=15.41 Hz), δ 7.93 (m, 2H), δ 7.51 (m, 4H), δ 7.11 (s, 1H), δ 6.98 (d, 1H, $J$=15.36 Hz), δ 4.26 (q, 2H), δ 1.38 (s, 9H) and δ 1.34 (t, 3H) ppm; $^{13}$C NMR (CDCl$_3$/400 MHz) δ 164.13, 138.47, 133.73, 133.34, 128.89, 128.73, 125.23, 121.60, 116.08, 116.04, 60.15, 56.78, 30.29, 14.36 ppm; LCMS exhibited the molecular ion peaks at EIMS m/z: 384.4 (M$^+$+Na). CHN anal. calc’d. for C$_{19}$H$_{23}$NO$_4$S: C, 63.13; H, 6.41; S, 8.87; N, 3.88 Found: C, 63.47; H, 6.47; S, 8.52; N, 3.68.

**ethyl 1-cyclopentyl-4-((E)-2-(phenylsulfonyl)vinyl)-1H-pyrrole-3-carboxylate (10b)**
Yield: 73%; Nature: pale yellow liquid; $^1$H NMR (CDCl$_3$/400 MHz) $\delta$ 8.02 (d, 1H, $J$=15.43 Hz), $\delta$ 7.93 (m, 2H), $\delta$ 7.51 (m, 4H), $\delta$ 7.11 (s, 1H), $\delta$ 6.98 (d, 1H, $J$=15.25 Hz), $\delta$ 4.29 (q, 2H), $\delta$ 3.71 (m, 1H), $\delta$ 2.08 – 1.46 (m, 8H), $\delta$ 1.30 (t, 3H) ppm. LCMS exhibited the molecular ion peaks at EIMS m/z: 396.2 (M$^+$Na).

ethyl 1-benzyl-4-((E)-2-(phenylsulfonyl)vinyl)-1H-pyrrole-3-carboxylate (10c)

Yield: 76%; Nature: pale yellow floppy liquid; $^1$H NMR (CDCl$_3$/300 MHz) $\delta$ 8.02 (d, 1H, $J$=15.45 Hz), $\delta$ 7.93 (dd, 2H), $\delta$ 7.56 (m, 3H), $\delta$ 7.56 (m, 3H), $\delta$ 7.49 (m, 4H), $\delta$ 7.15 (m, 2H), $\delta$ 6.99 (d, 1H, $J$ = 15.24 Hz), $\delta$ 6.95 (s, 1H), $\delta$ 5.03 (s, 2H), $\delta$ 4.26 (q, 2H), $\delta$ 1.30 (t, 3H) ppm. LCMS exhibited the molecular ion peaks at EIMS m/z: 418.13 (M$^+$Na).
H NMR Spectrum of Bis (3-Bromophenylthio) methane (2d)
$^{13}$C NMR Spectrum of Bis (3-Bromophenythio) methane (2d)
$^{1}H$ NMR Spectrum of 2,4-dichlorophenyl sulfonyl methane (8g)
$^1$H NMR spectrum of (2E,4E)-ethyl 8-(phenyl sulfinyl)perita-2,4-dienoate (4a)
$^{13}$C NMR: spectrum of (2E,4E)-ethyl 5-(phenylsulfonyl)pent-2,4-dienoate (4a)
Dept NMR spectrum of (2E, 4E)-ethyl 5-(phenyl sulfonyl)penta-2,4-diene (4a)
$^1$H NMR: Spectrum of (3S,4S)-ethyl 1-tert-butyl-4-((E)-2-[(phenylsulfonyl)vinyl]pyrrololine-3-carboxylate (8a)
$^{13}$C NMR Spectrum of (3S,4R)-ethyl 1-tert-butyl 4-(($\text{E}$)-2-(phenylsulfonylvinyl) pyrrolidine-3-carboxylate (8a)
Dept NMR. Spectrum of (3S,4R)-ethyl 1-tert-buty1-4-[(E)-2-(phenylsulfonyl)vinyl] pyrroldidine-3-carboxylate (8a)
$^{13}$C NMR Spectrum of ethyl 1-tert-butyll-(E)-2-(phenylsulfanyl)vinyl)-1H-pyrrole-3-carboxylate (10a)