Supporting Information for

Copper Promoted N-Alkylation of Sulfoximines Using Alkylboronic acid Under Mild Condition

Surabhi Gupta, a Priyanka Chaudhary, a Nalluchamy Muniyappan, b Shahulhameed Sabiah b and Jeyakumar Kandasamy a*

aDepartment of chemistry, Indian Institute of Technology (BHU), Varanasi, Uttar Pradesh-221005; Fax: 0542- 6702876; Email: jeyakumar.chy@iitbhu.ac.in
bDepartment of chemistry, Pondicherry University, Pondicherry-605014

LIST OF CONTENTS:

<table>
<thead>
<tr>
<th>S. No</th>
<th>CONTENTS</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>General Information</td>
<td>02</td>
</tr>
<tr>
<td>2</td>
<td>Experimental section</td>
<td>02</td>
</tr>
<tr>
<td>3</td>
<td>Experimental procedure for the synthesis of HN-Sulfoximines</td>
<td>02</td>
</tr>
<tr>
<td>4</td>
<td>Experimental procedure for the synthesis of protected L-Methionine sulfoximine</td>
<td>03</td>
</tr>
<tr>
<td>5</td>
<td>Experimental procedure for N-methylation/alkylation of sulfoximines using methyl /alkylboronic acid</td>
<td>05</td>
</tr>
<tr>
<td>6</td>
<td>Experimental procedure for the synthesis of N-Methyl-S-phenyl S-(2-phenylethyl) sulfoximine</td>
<td>05</td>
</tr>
<tr>
<td>7</td>
<td>Analytical data for HN-Sulfoximine</td>
<td>06</td>
</tr>
<tr>
<td>8</td>
<td>Analytical data for N-alkyl Sulfoximine</td>
<td>11</td>
</tr>
<tr>
<td>9</td>
<td>References</td>
<td>19</td>
</tr>
<tr>
<td>10</td>
<td>1H and 13C NMR Spectra’s</td>
<td>20</td>
</tr>
<tr>
<td>11</td>
<td>HRMS Data</td>
<td>120</td>
</tr>
</tbody>
</table>
1) General Information:
Starting materials were prepared using literature procedures or modified procedures as stated below. Boronic acids were purchased from Aldrich or Alfa Aesar chemicals. All the reactions were performed in round bottom flask or pressure tube as described below. Solvents and other chemicals were purchased from commercial sources and used without further purification. Thin layer chromatography was performed using pre-coated plates contained from E. Merck (TLC silica gel 60 F254). TLC plates were visualized by exposure to ultraviolet light (UV), then further analyzed by using iodine chamber or ninhydrin strain. The column chromatography was performed on silica gel (60-120 mesh) using a mixture of ethyl acetate/hexane as an eluent. The $^1$H and $^{13}$C NMR spectra were recorded on Bruker Avance 500 MHz NMR spectrometer and Mass spectra were measured on water’s Quattro Micro V 4.1. The $^1$H NMR and $^{13}$C NMRs of the known sulfoximines were compared with literature reports.

2) Experimental Section:
2.1) Experimental procedure for the synthesis of HN-Sulfoximines

\[
\begin{align*}
\text{Sulfoxide (4.0 mmol) and sodium azide (1.2 equiv) was stirred in CHCl}_3 & \text{ (15 mL) at 0 } ^\circ\text{C for 10 mins. Then, conc. H}_2\text{SO}_4 & \text{ (approx. 2.0 mL for 1 g of sulfoxide) was added dropwise over} \\
& \text{10 min at 0 } ^\circ\text{C. After that the reaction mixture was heated to 45 } ^\circ\text{C for overnight and cooled to} \\
& \text{room temperature. The reaction mixture was quenched by ice-cooled water (10 mL) and CHCl}_3 \\
& \text{layer was separated. The aqueous layer of the reaction mixture was neutralized using 20\%} \\
& \text{NaOH solution and re-extracted with CHCl}_3 (3X100 mL). The combined organic extracts were} \\
& \text{washed with brine, dried over anhyd. Na}_2\text{SO}_4 & \text{and concentrated under reduced pressure. The}
\end{align*}
\]

Sulfoximines 1a-h, 1j-p and 1t have been prepared using literature method A$^1$ while Sulfoximines 1i, 1q-s, 1u and 4 were prepared using literature method B.$^2$
crude residue was purified using column chromatography on silica gel (ethylacetate/hexane) to obtain the sulfoximines 1a-h, 1j-p and 1t in good to excellent yields.

**Method B:** Sulfoxide (4.0 mmol), PhI(OAc)$_2$ (3.0 equiv.) and ammonium carbamate (4.0 equiv.) were added to a 50 mL round bottom flask containing MeOH (10.0 mL). The reaction mixture was stirred for 30 min at 25 $^0$C in an open flask. The progress of reaction was analyzed by TLC. After completion, methanol was removed under vacuo and the crude residue was purified by silica-gel column chromatography using ethyl acetate/ hexane as eluent to obtain the sulfoximines 1i, 1q-s, 1u and 4 in good to excellent yields.

2.2) Experimental procedure for the synthesis of protected L-methionine sulfoximine (4)

![Chemical structure](image)

a) (Boc)$_2$O, Et$_3$N, MeOH; b) t-BuOH, DCC, 4-DMAP, DCM; c) m-CPBA, DCM; d) PhI(OAc)$_2$, NH$_2$COONH$_4$, MeOH

(i) **Experimental procedure for the synthesis of protected L-methionine sulfide A:**

L-Methionine (3 g, 20.1 mmol) was dissolved in methanol (30 mL) and stirred. The (Boc)$_2$O (5.28 g, 24 mmol) and triethylamine (16.8 mL, 120.6 mmol) were added to the reaction mixture and allowed to stir overnight at room temperature. The reaction was monitored using thin layer chromatography (80% Ethylacetate/hexane solvent, Ninhydrin stain). After completion, methanol was evaporated and the residue was dissolved in 1N HCl and extracted with ethyl acetate (3X50 mL). The organic layer was dried over anhydrous sodium sulfate, filtered and evaporated to obtain crude N-Boc protected methionine A in 70%, 3.51 g.

(ii) **Experimental procedure for the synthesis of protected L-methionine sulfide B:**

To a cooled solution of crude Boc-L-methionine A (2 g, 8 mmol) in dry CH$_2$Cl$_2$ (20 mL), DMAP (0.08 g, 0.67
mmol) and tert-butanol (0.71 g, 9.6 mmol) was added. After 10 mins, N,N-dicyclohexylcarbodiimide (DCC) (2.15 g, 10.4 mmol) was added at 0°C and stirred for 12 h. The reaction was monitored using thin layer chromatography (15% Ethylacetate/hexane solvent, Ninhydrin stain). The resulted dicyclohexylurea precipitate was filtered off and washed with DCM (2X10 mL). The collected filtrate was washed with 1M HCl (2X5 mL), saturated NaHCO₃ (2X10 mL) and water (2X5mL) and dried over anhydrous sodium sulfate. Then, the solvent was evaporated in vacuo, and the crude product was purified by column chromatography (SiO₂, 5-20 % ethyl acetate:hexane) to give desired product B in 80 %, 1.96 g.

(iii) Experimental procedure for protected L-methionine sulfoxide C:⁵ To a cooled solution of protected L-methionine B (1 g, 3.28 mmol) in DCM (5 mL) at 0°C, m-CPBA (1.5 equiv.) was added portion wise. After 30 mins, the reaction mixture was allowed to stir at room temperature till the completion of reaction (TLC analysis, 20% MeOH: CHCl₃, Ninhydrin Stain). The reaction mixture was neutralized with saturated NaHCO₃ and extracted with DCM. The organic layer was washed with brine, dried over anhydrous sodium sulfate and evaporated. The crude residue was purified through silica-gel column chromatography to obtain the title compound in 89%, 0.936 g as viscous liquid.

(iv) Experimental procedure for protected L-methionine sulfoximine 4:² The sulfoxide (2.0 mmol, 0.672 g), PhI(OAc)₂ (3.0 equiv., 1.932 g) and ammonium carbamate (4.0 equiv., 0.624 g) were added to a 50 mL round bottom flask containing MeOH (5.0 mL). The reaction mixture was stirred for 30 min at 25 °C in an open flask. The progress of reaction was analyzed by TLC (20% MeOH/CHCl₃ as eluent, Ninhydrin Stain). After completion, methanol was removed under vacuo and the crude residue was purified by silica-gel column chromatography using 40% ethyl acetate/ hexane as eluent to obtain the sulfoximine 4 in 79%, 0.556 g.

2.3) Experimental procedure for N-methylation/alkylation of sulfoximines using methyl/alkylboronic acid
Sulfoximine (1 mmol), copper (II) acetate (1.5 equiv.), pyridine (2.4 equiv.) and 1,4-dioxane (8 mL) was taken in a pressure tube (50 mL) under open air condition and stirred for 5 mins at room temperature to which methylboronic acid (2.0 equiv.) was added. The pressure tube was closed with Teflon cap and refluxed in a pre-heated oil bath at 100°C until the starting material (sulfoximine) was consumed (as per the time given in manuscript). After that the reaction mixture was cooled to room temperature, diluted with ethyl acetate and washed with distilled water and brine solution. The ethyl acetate layer was dried over anhydrous sodium sulfate, evaporated and purified in silica-gel column chromatography using ethylacetate/hexane as eluent to obtain the N-methylated or alkylated sulfoximines.

2.4) Experimental procedure for the synthesis of N-Methyl-S-phenyl S-(2-phenylethyl) sulfoximine (5a):

\[ \text{N,S-Dimethyl-S-phenyl sulfoximine (169 mg, 1.0 mmol) was stirred in dry THF (3 mL) at } -78 \degree \text{C to which } n-\text{butyllithium (1.6 m in hexane, 1.05 equiv.) was added slowly over a period of 10 min. The reaction temperature was further increased to } -26 \degree \text{C in a period of 30 mins to which benzyl bromide (0.36 mL, 1.05 equiv.) was added slowly. After the addition of Benzyl bromide, the reaction mixture was allowed to stir at room temperature for overnight. After completion, the reaction mixture was quenched by adding water and extracted with dichloromethane. The organic layer was dried with anhydrous sodium sulphate, concentrated and subjected for column chromatography purification with hexane:ethyl acetate to obtain the title compound in 86\% (222 mg).} \]
3) Analytical data for sulfoximines
For all the known compounds $^1$H, $^{13}$CNMR and HRMS is provided. For unreported compounds, Physical appearance, $R_f$ value, IR, $^1$H, $^{13}$CNMR, HRMS and melting point is provided.

3.1 S-Methyl-S-phenylsulfoximine (1a)$^6$

$^1$H NMR (500 MHz, Chloroform-$d$) δ 8.08–7.95 (m, 2H), 7.64–7.60 (m, 1H), 7.55 (t, $J = 7.6$ Hz, 2H), 3.10 (s, 3H), 2.68 (bs, 1H). $^{13}$C NMR (125 MHz, Chloroform-$d$) δ 143.7, 133.2, 129.4, 127.8, 46.3. \textbf{HRMS:} Calc. for C$_7$H$_9$NOSNa [M+Na]$^+$: 178.0303, Obser. 178.0297.

3.2 S-Ethyl-S-phenylsulfoximine (1b)$^6$

$^1$H NMR (500 MHz, Chloroform-$d$) δ 8.01–7.91 (m, 2H), 7.61 (t, $J = 7.4$ Hz, 1H), 7.54 (t, $J = 7.6$ Hz, 2H), 3.17 (q, $J = 7.4$ Hz, 2H), 2.90 (bs, 1H), 1.25 (t, $J = 7.4$ Hz, 3H). $^{13}$C NMR (125 MHz, Chloroform-$d$) δ 141.6, 133.2, 129.3, 128.7, 52.0, 8.0.


3.3 S-Phenyl-S-propylsulfoximine (1c)$^6$

$^1$H NMR (500 MHz, Chloroform-$d$) δ 7.95–7.91 (m, 2H), 7.58 (t, $J = 7.4$ Hz, 1H), 7.51 (t, $J = 7.5$ Hz, 2H), 3.10-3.06 (m, 2H), 2.59 (bs, 1H), 1.74-1.65 (m, 2H), 0.92 (t, $J = 7.5$ Hz, 3H). $^{13}$C NMR (125 MHz, Chloroform-$d$) δ 142.1, 133.0, 129.2, 128.5, 59.3, 17.0, 12.9.


3.4 S-iso-Propyl-S-phenylsulfoximine (1d)$^6$

$^1$H NMR (500 MHz, Chloroform-$d$) δ 7.94-7.92 (m, 2H), 7.60–7.56 (m, 1H), 7.53-7.51 (m, 2H), 3.22 (hept, $J = 6.8$ Hz, 1H), 2.49 (bs, 1H), 1.30 (d, $J = 6.8$ Hz, 3H), 1.25 (d, $J = 6.8$ Hz, 3H). $^{13}$C NMR (125 MHz, Chloroform-$d$) δ 139.9, 133.1, 129.5, 129.0, 56.6, 16.5, 16.1. \textbf{HRMS:} Calc. for C$_9$H$_{14}$NOS [M+H]$^+$: 184.0796, Obser. 184.0782.

3.5 S-Heptyl-S-phenylsulfoximine (1e)

Obtained as Pale yellow liquid. $R_f = 0.30$ (80% EtOAc/Hexane); IR (neat, cm$^{-1}$): 3270, 2929, 1441, 1223, 1111, 991, 752, 679; $^1$H NMR (500 MHz, Chloroform-$d$) δ 7.96–7.92 (m, 2H), 7.60–7.56 (m, 1H), 7.52 (t, $J = 7.6$ Hz, 2H), 3.15–3.04 (m, 2H), 2.52 (bs, 1H), 1.76-1.59 (m, 2H), 1.31–1.17 (m, 8H), 0.81 (t, $J = 7.0$ Hz, 3H), 0.78 (t, $J = 7.0$ Hz, 3H).
Hz, 3H). $^{13}$C NMR (125 MHz, Chloroform-d) $\delta$ 142.2, 133.0, 129.2, 128.5, 57.6, 31.5, 28.8, 28.2, 23.1, 22.6, 14.1. HRMS: Calc. for $\text{C}_{13}\text{H}_{21}\text{NOSNa}$ [M+Na]$^+$: 262.1242, Obsr. 262.1230.

### 3.6 S-Methyl S-p-tolylsulfoximine (1f)$^6$

![Structure](image)

$^1$H NMR (500 MHz, Chloroform-d) $\delta$ 7.86 (d, $J = 7.0$ Hz, 2H), 7.32 (d, $J = 7.8$ Hz, 2H), 3.06 (s, 3H), 2.65 (bs, 1H), 2.42 (s, 3H). $^{13}$C NMR (125 MHz, Chloroform-d) $\delta$ 144.0, 140.6, 130.0, 127.8, 46.4. HRMS: Calc. for $\text{C}_{8}\text{H}_{12}\text{NOS}$ [M+H]$^+$: 170.064, Obsr. 170.0635.

### 3.7 S-(4-Chlorophenyl)-S-methylsulfoximine (1g)$^6$

![Structure](image)

$^1$H NMR (500 MHz, Chloroform-d) $\delta$ 7.94 (d, $J = 8.6$ Hz, 2H), 7.51 (d, $J = 8.6$ Hz, 2H), 3.09 (s, 3H), 2.71 (bs, 1H). $^{13}$C NMR (125 MHz, Chloroform-d) $\delta$ 142.3, 139.9, 129.7, 129.4, 46.4. HRMS: Calc. for $\text{C}_{7}\text{H}_{9}\text{ClNOS}$ [M+H]$^+$: 190.0093, Obsr. 190.008.

### 3.8 S-(4-Bromophenyl)-S-methylsulfoximine (1h)$^6$

![Structure](image)

$^1$H NMR (500 MHz, Chloroform-d) $\delta$ 7.83 (d, $J = 8.6$ Hz, 2H), 7.65 (d, $J = 8.6$ Hz, 2H), 3.06 (s, 3H), 2.64 (bs, 1H). $^{13}$C NMR (125 MHz, Chloroform-d) $\delta$ 142.7, 132.6, 129.4, 128.3, 46.2. HRMS: Calc. for $\text{C}_{7}\text{H}_{9}\text{BrNOS}$ [M+H]$^+$: 233.9588, Obsr. 235.9573.

### 3.9 S-Methyl-S-(4-nitrophenyl)sulfoximine (1i)$^7$

![Structure](image)

$^1$H NMR (500 MHz, Chloroform-d) $\delta$ 8.40–8.33 (m, 2H), 8.23–8.16 (m, 2H), 3.14 (s, 3H), 2.91 (bs, 1H). $^{13}$C NMR (125 MHz, Chloroform-d) $\delta$ 150.6, 149.5, 129.3, 124.6, 46.1. HRMS: Calc. for $\text{C}_{7}\text{H}_{9}\text{N}_{2}\text{O}_{3}\text{S}$ [M+H]$^+$: 201.0334, Obsr. 201.0337.

### 3.10 S-Ethyl-S-(4-methylphenyl)sulfoximine (1j)$^8$

![Structure](image)

$^1$H NMR (500 MHz, Chloroform-d) $\delta$ 7.92–7.61 (m, 2H), 8.23–8.16 (m, 2H), 3.14 (s, 3H), 2.91 (bs, 1H). $^{13}$C NMR (125 MHz, Chloroform-d) $\delta$ 143.8, 138.2, 129.7, 128.5, 51.8, 21.4, 7.8. HRMS: Calc. for $\text{C}_{9}\text{H}_{13}\text{NOSNa}$ [M+Na]$^+$: 206.0616, Obsr. 206.0617.
3.11 S-Ethyl-S-(4-methoxyphenyl)sulfoximine (1k)

Obtained as Brown oil. R<sub>f</sub> = 0.22 (70% EtOAc/Hexane). IR (neat, cm<sup>-1</sup>): 3273, 3064, 3027, 2927, 1530, 1451, 1409, 1220, 1097, 799, 754, 625, 527; <sup>1</sup>H NMR (500 MHz, Chloroform-d) δ 7.84 (d, J = 8.6 Hz, 2H), 6.97 (d, J = 8.6 Hz, 2H), 3.85 (s, 3H), 3.12 (q, J = 7.3 Hz, 2H), 2.59 (bs, 1H), 1.21 (t, J = 7.4 Hz, 3H).<sup>13</sup>C NMR (125 MHz, Chloroform-d) δ 163.4, 132.8, 130.8, 114.4, 55.8, 52.2, 8.1. **HRMS**: Calc. for C<sub>9</sub>H<sub>14</sub>NO<sub>2</sub>S [M+H]<sup>+</sup>: 200.0745, Obs. 200.0746.

3.12 S-Ethyl-S-(4-ethylphenyl)sulfoximine (1l)

Obtained as Yellow liquid. R<sub>f</sub> = 0.24 (80% EtOAc/Hexane). IR (neat, cm<sup>-1</sup>): 3273, 3057, 2970, 2873, 1644, 1596, 1454, 1409, 1209, 1096, 1053, 969, 817, 716; <sup>1</sup>H NMR (500 MHz, Chloroform-d) δ 7.86 (d, J = 8.3 Hz, 2H), 7.36 (d, J = 8.5 Hz, 2H), 3.15 (q, J = 7.4 Hz, 2H), 2.73 (q, J = 7.6 Hz, 2H), 2.63 (bs, 1H), 1.28-1.24 (m, 6H). <sup>13</sup>C NMR (125 MHz, Chloroform-d) δ 150.2, 138.7, 128.9, 128.8, 52.1, 29.0, 15.3, 8.1. **HRMS**: Calc. for C<sub>10</sub>H<sub>16</sub>NOS [M+H]<sup>+</sup>: 198.0953, Obs. 198.0954.

3.13 S-Ethyl-S-(3-methoxyphenyl)sulfoximine (1m)

Obtained as Brown liquid. R<sub>f</sub> = 0.22 (70% EtOAc/Hexane). IR (neat, cm<sup>-1</sup>): 3279, 3062, 3023, 2926, 1599, 1474, 1411, 1321, 1227, 1094, 1019, 993, 792, 751, 680; <sup>1</sup>H NMR (500 MHz, Chloroform-d) δ 7.47-7.45 (m, 1H), 7.41–7.35 (m, 2H), 7.30–7.03 (m, 1H), 3.80 (s, 3H), 3.14–3.04 (m, 2H), 2.51 (bs, 1H), 1.80-1.65 (m, 2H), 0.96 (t, J = 7.4 Hz, 3H). <sup>13</sup>C NMR (125 MHz, Chloroform-d) δ 150.2, 130.1, 120.7, 119.4, 113.1, 55.7, 51.7, 7.9. **HRMS**: Calc. for C<sub>9</sub>H<sub>13</sub>NO<sub>2</sub>SNa [M+Na]<sup>+</sup>: 222.0565, Obs. 222.0554.

3.14 S-(3-Methoxyphenyl)-S-propylsulfoximine (1n)

Obtained as Brown liquid. R<sub>f</sub> = 0.22 (70% EtOAc/Hexane). IR (neat, cm<sup>-1</sup>): 3297, 3064, 3013, 2920, 1599, 1478, 1411, 1321, 1227, 1094, 1019, 993, 794, 756, 670; <sup>1</sup>H NMR (500 MHz, Chloroform-d) δ 7.52 (d, J = 7.7 Hz, 1H), 7.49–7.38 (m, 2H), 7.11 (dd, J = 8.2, 2.4 Hz, 1H), 3.85 (s, 3H), 3.15–3.04 (m, 2H), 2.51 (bs, 1H), 1.80-1.65 (m, 2H), 0.96 (t, J = 7.4 Hz, 3H). <sup>13</sup>C NMR (125 MHz, Chloroform-d) δ 160.2, 143.5, 130.3, 120.7, 119.6, 113.0, 59.3, 55.8,
17.0, 13.0. **HRMS:** Calc. for C₁₀H₁₆NO₂S [M+H]^+: 214.0902, Obser. 214.0887.

### 3.15 S-Ethyl-S-(4-trifluoromethylphenyl)sulfoximine (1o)

Obtained as Transparent oil. Rᵣ = 0.24 (70% EtOAc/Hexane). IR (neat, cm⁻¹): 3270, 3092, 2911, 1900, 1318, 1127, 1097, 1059, 998, 947, 835, 789, 749, 691; ¹H NMR (500 MHz, Chloroform-d) δ 8.10 (d, J = 8.2 Hz, 2H), 7.82 (d, J = 8.2 Hz, 2H), 3.22–3.16 (m, 2H), 2.32 (bs, 1H), 1.27 (t, J = 7.4 Hz, 3H).¹³C NMR (125 MHz, Chloroform-d) δ 145.4, 134.9 (q, J = 33 Hz), 129.3, 126.5 (q, J = 3.7 Hz), 123.4 (q, J = 272.9 Hz), 51.9, 7.9. **HRMS:** Calc. for C₉H₁₁F₃NOS [M+H]^+: 238.0513, Obser. 238.0497.

### 3.16 S,S-Diphenylsulfoximine (1p)

¹H NMR (500 MHz, Chloroform-d) δ 8.12–7.96 (m, 4H), 7.54–7.44 (m, 6H), 3.06 (bs, 1H).¹³C NMR (125 MHz, Chloroform-d) δ 143.5, 132.7, 129.3, 128.0. **HRMS:** Calc. for C₁₂H₁₂NOS [M+H]^+: 218.064, Obser. 218.0642.

### 3.17 S-Phenyl-S-(phenylmethyl)sulfoximine (1q)

¹H NMR (500 MHz, Chloroform-d) δ 7.75–7.73 (m, 2H), 7.59–7.53 (m, 1H), 7.46–7.40 (m, 2H), 7.32–7.28 (m, 1H), 7.27–7.22 (m, 2H), 7.11–7.07 (m, 2H), 4.37 (d, J = 13.4 Hz, 1H), 4.29 (d, J = 13.4 Hz, 1H), 2.83 (bs, 1H).¹³C NMR (125 MHz, Chloroform-d) δ 140.4, 133.2, 131.1, 128.9, 128.8, 128.7, 128.6, 64.7. **HRMS:** Calc. for C₁₃H₁₄NOS [M+H]^+: 232.0796, Obser. 232.0792.

### 3.18 S-Ethyl-S-(2-pyridyl)sulfoximine (1r)

Obtained as Yellow oil. Rᵣ = 0.28 (100% EtOAc); IR (neat, cm⁻¹): 3261, 3010, 2920, 2851, 1659, 1579, 1411, 1317, 1223, 1068, 1014, 990, 784, 750, 512; ¹H NMR (500 MHz, Chloroform-d) δ 8.73 (d, J = 4.7 Hz, 1H), 8.12 (d, J = 7.8 Hz, 1H), 7.94–7.91 (m, 1H), 7.50–7.48 (m, 1H), 3.52–3.44 (m, 1H), 3.40–3.32 (m, 1H), 2.81 (bs, 1H), 1.26 (t, J = 7.5 Hz, 3H).¹³C NMR (125 MHz, Chloroform-d) δ 159.3, 150.3, 138.2, 126.8, 122.5, 48.4, 7.4. **HRMS:** Calc. for C₇H₁₄N₂OS [M+H]^+: 171.0592, Obser. 171.0576.
3.19  S,S-Dibenzylsulfoximine (1s)  

![Structure of 1s]

$^1$H NMR (500 MHz, Chloroform-$d$) $\delta$ 7.41 (s, 10H), 4.29 (d, $J = 13.1$ Hz, 2H), 4.17 (d, $J = 13.1$ Hz, 2H), 2.60 (bs, 1H). $^{13}$C NMR (125 MHz, Chloroform-$d$) $\delta$ 131.3, 129.2, 129.1, 128.0, 60.7. **HRMS:** Calc. for C$_{14}$H$_{16}$NOS [M+H]$^+$: 246.0953, Obsr. 246.0951.

3.20  S-Cyclohexyl-5-heptylsulfoximine (1t)

![Structure of 1t]

Obtained as Yellow viscous liquid. R$_f$ = 0.48 (50% EtOAc/Hexane); IR (neat, cm$^{-1}$): 3510, 2920, 2875, 2814, 2313, 1981, 1450, 1129, 958, 849, 770, 691. $^1$H NMR (500 MHz, Chloroform-$d$) $\delta$ 2.95–2.88 (m, 2H), 2.83 (tt, $J =$ 12.2, 3.5 Hz, 1H), 2.67 (bs, 1H), 2.17-2.11 (m, 2H), 1.93–1.89 (m, 2H), 1.84–1.77 (m, 2H), 1.73–1.67 (m, 1H), 1.52-1.44 (m, 2H), 1.42–1.35 (m, 2H), 1.33–1.21 (m, 9H), 0.85 (t, $J =$ 6.9 Hz, 3H). $^{13}$C NMR (125 MHz, Chloroform-$d$) $\delta$ 62.5, 51.2, 31.6, 28.9, 28.7, 25.7, 25.4, 25.2, 22.6, 21.8, 14.1. **HRMS:** Calc. for C$_{13}$H$_{28}$NOS [M+H]$^+$: 246.1892, Obsr. 246.1888.

3.22  L-Methionine Sulfoximine Derivative (4)

![Structure of 4]

$^1$H NMR (500 MHz, Chloroform-$d$) $\delta$ 5.34 (d, $J = 6.3$ Hz, 1H), 4.24 (s, 1H), 3.22–3.04 (m, 2H), 2.96 (s, 3H), 2.85–2.60 (m, 1H), 2.37-2.32 (m, 1H), 2.13-2.05 (m, 1H), 1.44 (s, 9H), 1.40 (s, 9H). $^{13}$C NMR (126 MHz, Chloroform-$d$) $\delta$ 170.5, 155.6, 83.0, 80.3, 53.5, 52.7, 43.1, 28.4, 28.1, 26.7. **HRMS:** Calc. for C$_{14}$H$_{29}$N$_2$O$_5$S [M+H]$^+$: 337.4555, Obsr. 337.1820
4) Analytical data for N-alkyl Sulfoximine

4.1 \(N,S\)-Dimethyl-S-phenylsulfoximine (2a)\(^9\)

Obtained as Yellow liquid. Yield= 158 mg, 94%. \(R_f= 0.20 \) (80% EtOAc/Hexane); \(^1\)H NMR (500 MHz, Chloroform-d) \(\delta\) 7.96–7.81 (m, 2H), 7.64–7.52 (m, 3H), 3.06 (s, 3H), 2.63 (s, 3H). \(^{13}\)C NMR (125 MHz, Chloroform-d) \(\delta\) 138.9, 133.0, 129.6, 128.9, 45.1, 29.7. \textbf{HRMS}: Calc. for \(C_{8}H_{12}NO\) [M+H]\(^+\): 170.064, Obs. 170.0632

4.2 \(N\)-Methyl-S-ethyl-S-phenylsulfoximine (2b)\(^9\)

Obtained as Pale yellow liquid. Yield= 170 mg, 93%. \(R_f= 0.24 \) (80% EtOAc/Hexane); \(^1\)H NMR (500 MHz, Chloroform-d) \(\delta\) 7.84 (d, \(J = 7.3\) Hz, 2H), 7.60 (t, \(J = 7.3\) Hz, 1H), 7.55 (t, \(J = 7.3\) Hz, 2H), 3.24-3.11 (m, 2H), 2.65 (s, 3H), 1.21 (t, \(J = 7.5\) Hz, 3H). \(^{13}\)C NMR (125 MHz, Chloroform-d) \(\delta\) 136.9, 133.0, 129.7, 129.6, 50.7, 29.5, 7.4. \textbf{HRMS}: Calc. for \(C_{9}H_{14}NO\) [M+H]\(^+\): 184.0796, Obs. 184.0787.

4.3 \(N\)-Methyl-S-phenyl-S-propylsulfoximine (2c)

Obtained as Pale yellow liquid. Yield= 187 mg, 95%. \(R_f= 0.30 \) (80% EtOAc/Hexane); IR (neat, cm\(^{-1}\)): 3071, 2983, 2928, 2869, 2811, 1640, 1454, 1241, 1140; \(^1\)H NMR (500 MHz, Chloroform-d) \(\delta\) 7.89–7.75 (m, 2H), 7.60–7.51 (m, 3H), 3.15–3.01 (m, 2H), 2.64 (s, 3H), 1.79–1.60 (m, 2H), 0.92 (t, \(J = 7.5\) Hz, 3H). \(^{13}\)C NMR (125 MHz, Chloroform-d) \(\delta\) 137.7, 132.9, 129.5, 128.5, 58.3, 29.5, 16.6, 13.0. \textbf{HRMS}: Calc. for \(C_{10}H_{16}NO\) [M+H]\(^+\): 198.0953, Obser. 198.0937.

4.4 \(N\)-Methyl-S-iso-propyl-S-phenylsulfoximine (2d)

Obtained as Transparent liquid, Yield= 179 mg, 91%. \(R_f= 0.28 \) (60% EtOAc/Hexane); IR (neat, cm\(^{-1}\)): 3067, 2980, 2919, 2870, 2811, 1640, 1454, 1245, 1144; \(^1\)H NMR (500 MHz, Chloroform-d) \(\delta\) 7.84–7.77 (m, 2H), 7.62–7.58 (m, 1H), 7.57–7.53 (m, 2H), 3.26-3.21 (m, 1H), 2.67 (s, 3H), 1.35 (d, \(J = 6.8\) Hz, 3H), 1.19 (d, \(J = 6.9\) Hz, 3H). \(^{13}\)C NMR (125 MHz, Chloroform-d) \(\delta\) 135.7, 132.9, 130.5, 129.4, 55.9, 29.7, 16.6, 15.7. \textbf{HRMS}: Calc. for \(C_{10}H_{16}NO\) [M+H]\(^+\): 198.0953, Obser. 198.0937.
4.5 *N*-Methyl-*S*-heptyl-*S*-phenylsulfoximine (2e)

Obtained as Transparent oil. Yield= 207 mg, 82%. *R*$_f$ = 0.32 (80% EtOAc/Hexane); IR (neat, cm$^{-1}$): 3274, 2930, 1664, 1441, 1223, 1122, 991, 752, 679; $^1$H NMR (500 MHz, Chloroform-$d$) $\delta$ 7.82-7.80 (m, 2H), 7.60–7.49 (m, 3H), 3.15-3.00 (m, 2H), 2.63 (s, 3H), 1.75–1.55 (m, 2H), 1.25–1.11 (m, 8H), 0.84–0.77 (m, 3H). $^{13}$C NMR (125 MHz, Chloroform-$d$) $\delta$ 137.8, 132.9, 129.5, 128.5, 56.7, 31.5, 29.6, 28.8, 28.3, 22.7, 22.6, 14.1. **HRMS:** Calc. for C$_{14}$H$_{24}$NOS [M+H]$^+$: 254.1579, Obser. 254.1567.

4.6 *N*-Methyl-*S*-methyl-*S*-(4-methylphenyl)sulfoximine (2f)$^{10}$

Obtained as Pale yellow liquid. Yield= 172 mg, 94%. *R*$_f$ = 0.22 (60% EtOAc/Hex); $^1$H NMR (500 MHz, Chloroform-$d$) $\delta$ 7.75 (d, *J* = 8.2 Hz, 2H), 7.34 (d, *J* = 7.9 Hz, 2H), 3.04 (s, 3H), 2.61 (s, 3H), 2.43 (s, 3H). $^{13}$C NMR (125 MHz, Chloroform-$d$) $\delta$ 143.9, 135.7, 130.3, 128.9, 45.2, 29.6, 21.6. **HRMS:** Calc. for C$_9$H$_{14}$NOS [M+H]$^+$: 184.0796, Obser. 184.0795.

4.7 *N*-Methyl-*S*-(4-chlorophenyl)-*S*-methylsulfoximine (2g)$^{10}$

Obtained as White solid. Yield= 181 mg, 89%. *R*$_f$ = 0.28 (80% EtOAc/Hexane); $^1$H NMR (500 MHz, Chloroform-$d$) $\delta$ 7.82–7.78 (m, 2H), 7.53–7.49 (m, 2H), 3.04 (s, 3H), 2.60 (s, 3H). $^{13}$C NMR (125 MHz, Chloroform-$d$) $\delta$ 139.7, 137.5, 130.4, 129.9, 45.1, 29.6. **HRMS:** Calc. for C$_{8}$H$_{11}$ClNOS [M+H]$^+$: 204.025, Obser. 204.0236.

4.8 *N*-Methyl-*S*-(4-bromophenyl)-*S*-methylsulfoximine (2h)$^{10}$

Obtained as White solid. Yield= 231 mg, 93%. *R*$_f$ = 0.20 (80% EtOAc/Hexane); $^1$H NMR (500 MHz, Chloroform-$d$) $\delta$ 7.77–7.72 (m, 2H), 7.72–7.67 (m, 2H), 3.06 (s, 3H), 2.62 (s, 3H). $^{13}$C NMR (125 MHz, Chloroform-$d$) $\delta$ 138.0, 133.0, 130.6, 128.3, 45.1, 29.7. **HRMS:** Calc. for C$_{8}$H$_{11}$BrNOS [M+H]$^+$: 247.9745, Obser. 249.9717.
4.9 N-Methyl-S-methyl-S-(4-nitrophenyl)sulfoximine (2i)\textsuperscript{10}

\[
\begin{align*}
\text{O} & \quad \text{S} & \quad \text{N} \\
\text{CH}_3 & \quad \text{CH}_3 & \quad \text{O}_2\text{N} \\
\end{align*}
\]

Obtained as Yellow solid. Yield = 195 mg, 91%. R\textsubscript{f} = 0.36 (80% EtOAc/Hexane); \textsuperscript{1}H NMR (500 MHz, Chloroform-\textit{d}) \(\delta\) 8.40 (d, \(J = 8.9\) Hz, 2H), 8.09 (d, \(J = 8.9\) Hz, 2H), 3.12 (s, 3H), 2.65 (s, 3H). \textsuperscript{13}C NMR (125 MHz, Chloroform-\textit{d}) \(\delta\) 150.7, 145.6, 130.3, 124.8, 44.9, 29.6. \textbf{HRMS:} Calc. for C\textsubscript{8}H\textsubscript{11}N\textsubscript{2}O\textsubscript{3}S [M+H]\textsuperscript{+}: 215.049, Obser. 215.0496.

4.10 N-Methyl-S-ethyl-S-(4-methylphenyl)sulfoximine (2j)

\[
\begin{align*}
\text{O} & \quad \text{S} & \quad \text{N} \\
\text{CH}_3 & \quad \text{CH}_3 & \quad \text{H}_3\text{C} \\
\end{align*}
\]

Obtained as Transparent liquid. Yield = 181 mg, 92%. R\textsubscript{f} = 0.24 (80% EtOAc/Hex); IR (neat, cm\textsuperscript{-1}): 3370, 2919, 2811, 2361, 2089, 1660, 1595, 1408, 1234, 1144, 971, 815, 759; \textsuperscript{1}H NMR (500 MHz, Chloroform-\textit{d}) \(\delta\) 7.69 (d, \(J = 8.2\) Hz, 2H), 7.33 (d, \(J = 7.9\) Hz, 2H), 3.17-3.08 (m, 2H), 2.63 (s, 3H), 2.42 (s, 3H), 1.19 (t, \(J = 7.4\) Hz, 3H). \textsuperscript{13}C NMR (125 MHz, Chloroform-\textit{d}) \(\delta\) 143.8, 133.7, 130.2, 129.7, 50.9, 29.5, 21.6, 7.5. \textbf{HRMS:} Calc. for C\textsubscript{10}H\textsubscript{16}NOS [M+H]\textsuperscript{+}: 198.0953, Obser. 198.0949.

4.11 N-Methyl-S-ethyl-S-(4-methoxyphenyl)sulfoximine (2k)

\[
\begin{align*}
\text{O} & \quad \text{S} & \quad \text{N} \\
\text{CH}_3 & \quad \text{CH}_3 & \quad \text{MeO} \\
\end{align*}
\]

Obtained as Yellow liquid. Yield = 194 mg, 91%. R\textsubscript{f} = 0.28 (100% EtOAc); IR (neat, cm\textsuperscript{-1}): 3557, 2929, 2572, 2302, 2084, 1906, 1737, 1589, 1479, 1139, 1098, 1020, 974, 836, 767; \textsuperscript{1}H NMR (500 MHz, Chloroform-\textit{d}) \(\delta\) 7.74 (d, \(J = 8.9\) Hz, 2H), 7.01 (d, \(J = 8.9\) Hz, 2H), 3.86 (s, 3H), 3.18–3.09 (m, 2H), 2.64 (s, 3H), 1.20 (t, \(J = 7.4\) Hz, 3H). \textsuperscript{13}C NMR (125 MHz, Chloroform-\textit{d}) \(\delta\) 163.4, 131.8, 127.9, 114.8, 55.7, 51.0, 29.5, 7.6. \textbf{HRMS:} Calc. for C\textsubscript{10}H\textsubscript{16}NO\textsubscript{2}S [M+H]\textsuperscript{+}: 214.0902, Obser. 214.0901.

4.12 N-Methyl-S-ethyl-S-(4-ethylphenyl)sulfoximine (2l)

\[
\begin{align*}
\text{O} & \quad \text{S} & \quad \text{N} \\
\text{CH}_3 & \quad \text{CH}_3 & \quad \text{Et} \\
\end{align*}
\]

Obtained as Yellow viscous liquid. Yield = 196 mg, 93%. R\textsubscript{f} = 0.24 (100% EtOAc); IR (neat, cm\textsuperscript{-1}): 3508, 3062, 2932, 2804, 2321, 2099, 1920, 1741, 1646, 1580, 1447, 927, 859, 728, 689.; \textsuperscript{1}H NMR (500 MHz, Chloroform-\textit{d}) \(\delta\) 7.74 (d, \(J = 8.2\) Hz, 2H), 7.38 (d, \(J = 8.0\) Hz, 2H), 3.20-3.11 (m, 2H), 2.74 (q, \(J = 7.6\) Hz, 2H), 2.67 (s, 3H), 1.28 (t, \(J = 7.6\) Hz, 3H), 1.22 (t, \(J = 7.4\) Hz, 3H). \textsuperscript{13}C NMR (125 MHz, Chloroform-\textit{d}) \(\delta\) 150.0, 134.1, 129.9, 129.1, 51.0, 29.6, 29.0, 15.3, 7.6. \textbf{HRMS:} Calc. for C\textsubscript{11}H\textsubscript{18}NOS [M+H]\textsuperscript{+}: 212.1109, Obser. 212.1097.
4.13 *N*-Methyl-*S*-ethyl-*S*-(3-methoxyphenyl)sulfoximine (2m)

Obtained as Brown liquid. Yield= 198 mg, 93%, \( R_f = 0.18 \) (60% EtOAc/Hexane); IR (neat, cm\(^{-1}\)):
3547, 2921, 2572, 2302, 2054, 1916, 1737, 1589, 1479, 1139, 1098, 1020, 993, 794, 756, 670; \(^1\)H NMR (500 MHz, Chloroform-d) \( \delta 7.47-7.42 \) (m, 1H), 7.41-7.36 (m, 1H), 7.36-7.32 (m, 1H), 7.13-7.10 (m, 1H), 3.85 (s, 3H), 3.20-3.10 (m, 2H), 2.67 (s, 3H), 1.22 (t, \( J = 7.4 \) Hz, 3H). \(^13\)C NMR (125 MHz, Chloroform-d) \( \delta 160.5, 138.5, 130.5, 121.7, 119.4, 114.1, 55.8, 51.0, 29.6, 7.5. \)

**HRMS:** Calc. for C\(_{10}\)H\(_{16}\)NO\(_2\)S [M+H]\(^+\): 214.0902, Obser. 214.0887.

4.14 *N*-Methyl-*S*-(3-methoxyphenyl)-*S*-propylsulfoximine (2n)

Obtained as Brown liquid. Yield= 209 mg, 92%. \( R_f = 0.20 \) (60% EtOAc/Hexane); IR (neat, cm\(^{-1}\)):
3347, 2919, 2570, 2302, 1917, 1737, 1640, 1479, 1139, 1098, 1020, 993, 795, 756, 671; \(^1\)H NMR (500 MHz, Chloroform-d) \( \delta 7.45 \) (t, \( J = 7.9 \) Hz, 1H), 7.42-7.38 (m, 1H), 7.37-7.33 (m, 1H), 7.13-7.10 (m, 1H), 3.86 (s, 3H), 3.15-3.02 (m, 2H), 2.66 (s, 3H), 1.83-1.74 (m, 1H), 1.70-1.62 (m, 1H), 0.94 (t, \( J = 7.4 \) Hz, 3H). \(^13\)C NMR (125 MHz, Chloroform-d) \( \delta 160.5, 139.1, 130.5, 121.6, 119.4, 114.0, 58.4, 55.8, 29.6, 16.6, 13.0. \)

**HRMS:** Calc. for C\(_{11}\)H\(_{18}\)NO\(_2\)S [M+H]\(^+\): 228.1058, Obser. 228.1045.

4.15 *N*-Methyl-*S*-ethyl-*S*-(4-trifluoromethylphenyl)sulfoximine (2o)

Obtained as Yellow liquid. Yield= 205 mg, 82%. \( R_f = 0.24 \) (60% EtOAc/Hexane); IR (neat, cm\(^{-1}\)):
2919, 2807, 2300, 2099, 1817, 1611, 1401, 1318, 1241, 1130, 970, 844, 769; \(^1\)H NMR (500 MHz, Chloroform-d) \( \delta 7.98 \) (d, \( J = 8.3 \) Hz, 2H), 7.83 (d, \( J = 8.3 \) Hz, 2H), 3.25-3.11 (m, 2H), 2.67 (s, 3H), 1.25 (t, \( J = 7.5 \) Hz, 3H). \(^13\)C NMR (125 MHz, Chloroform-d) \( \delta 141.3, 134.9 \) (q, \( J = 32.8 \) Hz), 130.3, 126.7 (q, \( J = 3.2 \) Hz), 123.5 (q, \( J = 272.8 \) Hz), 50.9, 29.6, 7.5. \)

**HRMS:** Calc. for C\(_{10}\)H\(_{13}\)F\(_3\)NO\(_2\)S [M+H]\(^+\): 252.0653.
4.16 N-Methyl-S,S-diphenylsulfoximine (2p)\(^9\)

![Chemical Structure of 2p]

Obtained as White solid. Yield = 208 mg, 90%. \(R_f = 0.40\) (50% EtOAc/Hex); \(^1\)H NMR (500 MHz, Chloroform-\(d\)) \(\delta 7.96-7.94\) (m, 4H), 7.51–7.43 (m, 6H), 2.81 (s, 3H). \(^{13}\)C NMR (125 MHz, Chloroform-\(d\)) \(\delta 140.5, 132.5, 129.3, 128.6, 29.7\). **HRMS:** Calc. for C\(_{13}\)H\(_{14}\)NOS [M+H]\(^+\): 232.0796, Obs. 232.0794.

4.17 N-Methyl-S,S-dibenzylsulfoximine (2q)

![Chemical Structure of 2q]

Obtained as White solid. Yield = 213 mg, 87%. \(R_f = 0.44\) (60% EtOAc/Hexane); IR (KBr, cm\(^{-1}\)) 3067, 2927, 2852, 2359, 2330, 1448, 1246, 1240, 1145, 1100, 1080; \(^1\)H NMR (400 MHz, Chloroform-\(d\)) \(\delta 7.58-7.54\) (m, 3H), 7.44–7.40 (m, 2H), 7.26–7.16 (m, 3H), 7.00 (d, \(J = 7.5\) Hz, 2H), 4.37 (s, 2H), 2.73 (s, 3H). \(^{13}\)C NMR (100 MHz, Chloroform-\(d\)) \(\delta 136.4, 133.0, 131.3, 130.0, 129.1, 128.7, 128.4, 126.5, 62.9, 29.9\). **HRMS:** Calc. for C\(_{14}\)H\(_{16}\)NOS [M+H]\(^+\): 246.0953, Obs. 246.0949.

4.18 N-Methyl-ethyl-S-(2-pyridyl)sulfoximine (2r)

![Chemical Structure of 2r]

Obtained as White solid. Yield = 158 mg, 86%. \(R_f = 0.34\) (100% EtOAc); IR (KBr, cm\(^{-1}\)) 3260, 3014, 2930, 2871, 1662, 1580, 1411, 1319, 1223, 1068, 1014, 990, 784, 754, 512; \(^1\)H NMR (500 MHz, Chloroform-\(d\)) \(\delta 8.76\) (d, \(J = 4.0\) Hz, 1H), 8.09 (d, \(J = 7.8\) Hz, 1H), 7.95–7.91 (m, 1H), 7.49–7.47 (m, 1H), 3.51 (dq, \(J = 14.8, 7.4\) Hz, 1H), 3.34 (dq, \(J = 15.0, 7.5\) Hz, 1H), 2.67 (s, 3H), 1.24 (t, \(J = 7.4\) Hz, 3H). \(^{13}\)C NMR (100 MHz, Chloroform-\(d\)) \(\delta 156.3, 150.7, 137.9, 126.5, 124.8, 47.2, 29.8, 7.1\). **HRMS:** Calc. for C\(_8\)H\(_{13}\)N\(_2\)OS [M+H]\(^+\): 185.0749, Obs. 185.0733.

4.19 N-Methyl-S,S-dibenzylsulfoximine (2s)

![Chemical Structure of 2s]

Obtained as White solid. Yield = 225 mg, 87%. \(R_f = 0.32\) (60% EtOAc/Hexane); IR (KBr, cm\(^{-1}\)) 3275, 3100, 3062, 3010, 2996, 2908, 1497,1440, 1416, 1246, 1136, 1053, 1037, 760, 698, 580; \(^1\)H NMR (500 MHz, Chloroform-\(d\)) \(\delta 7.39–7.34\) (m, \(J = 4.9, 4.2\) Hz, 10H), 4.21–4.11 (m, 4H), 2.76 (s, 3H). \(^{13}\)C NMR (125 MHz, Chloroform-\(d\)) \(\delta 131.1, 128.9, 128.9, 128.8, 57.9, 29.7\). **HRMS:** Calc. for C\(_{15}\)H\(_{18}\)NOS [M+H]\(^+\): 260.1109, Obs. 260.1114.
4.20 N-Methyl-S-cyclohexyl-S-heptylsulfoximine (2t)

Obtained as Yellow viscous liquid. Yield = 212 mg, 82%. Rf = 0.44 (40% EtOAc/Hexane); IR (neat, cm⁻¹): 3530, 2924, 2875, 2811, 2313, 1981, 1640, 1450, 1133, 958, 860, 770, 670; ¹H NMR (500 MHz, Chloroform-d) δ 2.99–2.84 (m, 3H), 2.78 (s, 3H), 1.90 (d, J = 11.6 Hz, 2H), 1.77–1.69 (m, 3H), 1.54–1.45 (m, 3H), 1.41–1.21 (m, 12H), 0.86 (t, J = 6.7 Hz, 3H). ¹³C NMR (125 MHz, Chloroform-d) δ 61.1, 48.4, 31.6, 28.9, 28.9, 26.4, 26.2, 25.8, 25.7, 25.4, 22.8, 22.6. HRMS: Calc. for C₁₄H₃₀NOS [M+H]⁺: 260.2048, Obser. 260.2045.

4.21 N-Ethyl-S-ethyl-S-phenylsulfoximine (3a)

Obtained as Transparent oil. Yield = 177 mg, 90%. Rf = 0.30 (40% EtOAc/Hexane); IR (neat, cm⁻¹): 3061, 2975, 2930, 2873, 2818, 1644, 1445, 1249, 1151; ¹H NMR (500 MHz, Chloroform-d) δ 7.95–7.75 (m, 2H), 7.64–7.57 (m, 1H), 7.57–7.49 (m, 2H), 3.23–3.10 (m, 2H), 2.87 (dq, J = 12.3, 7.2 Hz, 1H), 2.87 (dq, J = 12.3, 7.2 Hz, 1H), 1.18 (dt, J = 14.4, 7.3 Hz, 6H). ¹³C NMR (125 MHz, Chloroform-d) δ 137.9, 132.9, 129.6, 129.4, 51.0, 38.6, 18.5, 7.6. HRMS: Calc. for C₁₀H₁₅NOS [M+H]⁺: 198.0953, Obser. 198.0926.

4.22 N-Propyl-S-ethyl-S-phenylsulfoximine (3b)

Obtained as Transparent oil, yield = (192 mg, 91%), Rf = 0.34 (40% EtOAc/Hexane); IR (neat, cm⁻¹): 3073, 2995, 2934, 2870, 2820, 1640, 1445, 1249, 1140; ¹H NMR (500 MHz, Chloroform-d) δ 7.82 (d, J = 7.0 Hz, 2H), 7.57 (dd, J = 8.4, 6.2 Hz, 1H), 7.52 (t, J = 7.3 Hz, 2H), 3.21–3.08 (m, 2H), 2.91 (dt, J = 12.1, 7.2 Hz, 1H), 2.74 (dt, J = 12.1, 7.2 Hz, 1H), 1.54 (h, J = 7.3 Hz, 2H), 1.18 (t, J = 7.4 Hz, 3H), 0.86 (t, J = 7.4 Hz, 3H). ¹³C NMR (125 MHz, Chloroform-d) δ 137.9, 132.8, 129.6, 129.4, 50.9, 45.7, 26.2, 11.9, 7.6. HRMS: Calc. for C₁₁H₁₇NOS [M+H]⁺: 212.1109, Obser. 212.1081.
4.23 N-Butyl-S-ethyl-S-phenylsulfoximine (3c)

Obtained as Pale yellow oil. Yield = 205 mg, 91%. Rf = 0.26 (50% EtOAc/Hexane); IR (neat, cm⁻¹): 3831, 3404, 2928, 2674, 2097, 1658, 1581, 1531, 1447, 1368, 1085; ^1H NMR (500 MHz, Chloroform-d) δ 7.84 (d, J = 7.4 Hz, 2H), 7.66–7.46 (m, 3H), 3.16 (m, 2H), 2.96 (dt, J = 12.3, 7.2 Hz, 1H), 2.79 (dt, J = 12.2, 7.2 Hz, 1H), 1.56-1.50 (m, 2H), 1.33 (h, J = 7.3 Hz, 2H), 1.19 (t, J = 7.4 Hz, 3H), 0.85 (t, J = 7.4 Hz, 3H). ^13C NMR (125 MHz, Chloroform-d) δ 138.0, 132.8, 129.6, 129.4, 51.0, 43.6, 35.2, 20.5, 14.0, 7.6. HRMS: Calc. for C_{12}H_{20}NOS [M+H]^+: 226.1266, Obser. 226.1273

4.24 N-Ethylphenyl-S-ethyl-S-phenylsulfoximine (3d)

Obtained as Viscous oil. Yield = 256 mg, 94%. Rf = 0.32 (60% EtOAc/Hexane); IR (neat, cm⁻¹): 3631, 3444, 2928, 2676, 2087, 1658, 1581, 1521, 1447, 1368, 1085 976, 863, 782, 742, 688; ^1H NMR (500 MHz, Chloroform-d) δ 7.71 (d, J = 7.2 Hz, 2H), 7.57 (t, J = 7.4 Hz, 1H), 7.49 (t, J = 7.6 Hz, 2H), 7.26–7.22 (m, 2H), 7.18 (d, J = 7.1 Hz, 3H), 3.26 (dt, J = 12.0, 7.9 Hz, 1H), 3.20-3.11 (m, 2H), 3.02 (dt, J = 12.0, 7.9 Hz, 1H), 2.93–2.83 (m, 2H), 1.20 (t, J = 7.4 Hz, 3H). ^13C NMR (125 MHz, Chloroform-d) δ 140.7, 137.7, 132.9, 129.7, 129.4, 129.2, 128.3, 126.1, 51.1, 45.8, 39.8, 7.7. HRMS: Calc. for C_{16}H_{20}NOS [M+H]^+: 274.1266, Obser. 274.1263

4.25 N-Cyclopropyl-S-ethyl-S-phenylsulfoximine (3e)

Obtained as Viscous oil, Yield = 198 mg, 95%. Rf = 0.42 (60% EtOAc/Hexane); IR (neat, cm⁻¹): 3577, 3391, 3054, 3017, 2905, 2870, 2814, 2673, 1990, 1730, 1640, 863, 793, 742, 690. ^1H NMR (500 MHz, Chloroform-d) δ 7.90 (d, J = 7.8 Hz, 2H), 7.63–7.59 (m, 1H), 7.56 (t, J = 7.4 Hz, 2H), 3.25-3.11 (m, 2H), 2.38 (tt, J = 7.4, 4.0 Hz, 1H), 1.19 (t, J = 7.4 Hz, 3H), 0.61-0.56 (m, 1H), 0.51–0.43 (m, 1H), 0.42–0.35 (m, 2H). ^13C NMR (125 MHz, Chloroform-d) δ 138.2, 133.0, 129.5, 129.4, 50.7, 26.2, 7.4, 7.2, 6.4. HRMS: Calc. for C_{11}H_{16}NOS [M+H]^+: 210.0953, Obser. 210.0946
4.26 N-Cyclohexyl-S-ethyl-S-phenylsulfoximine (3f)

Obtained as Transparent liquid. Yield= 228 mg, 91%. Rf = 0.38 (40% EtOAc/Hexane); IR (neat, cm⁻¹): 3059, 2940, 2852, 2359, 2331, 1448, 1247, 1130.; ¹H NMR (500 MHz, Chloroform-d) δ 7.86 (d, J = 7.4 Hz, 2H), 7.57 (t, J = 7.3 Hz, 1H), 7.52 (t, J = 7.4 Hz, 2H), 3.18-3.06 (m, 2H), 2.91-2.85 (m, 1H), 1.88-1.86 (m, 1H), 1.70–1.63 (m, 3H), 1.46–1.21 (m, 3H), 1.17-1.14 (m, 4H), 1.12–1.05 (m, 2H). ¹³C NMR (125 MHz, Chloroform-d) δ 139.2, 132.7, 129.5, 129.2, 54.0, 51.2, 37.9, 36.7, 25.8, 25.6, 25.4, 7.6. HRMS: Calc. for C₁₄H₂₂NOS [M+H]⁺: 252.1422, Obser. 252.1419

4.27 L-Methionine Sulfoximine Derivative (4a)

Obtained as White semi-solid. Yield= 319 mg, 91%. Rf = 0.48 (20% MeOH/CHCl₃); IR (neat, cm⁻¹): 3845, 3322, 2941, 2817, 2641, 2320, 2082, 1717, 1529, 1446, 1223, 1148, 1047, 853, 744; ¹H NMR (500 MHz, Chloroform-d) δ 5.31 (m, 1H), 4.28–4.20 (m, 1H), 3.26–3.00 (m, 2H), 2.90 (s, 3H), 2.77 (d, J = 3.4 Hz, 3H), 2.37-2.28 (m, 1H), 2.14–2.04 (m, 1H), 1.47 (s, 9H), 1.43 (s, 9H), 0.55 (dt, J = 7.4, 4.2 Hz, 2H), 0.46 (dt, J = 6.2, 3.2 Hz, 2H). ¹³C NMR (125 MHz, Chloroform-d) δ 170.6, 155.6, 83.1, 83.1, 80.4, 52.8, 50.0, 39.0, 39.0, 29.2, 29.2, 28.4, 28.1, 27.0. HRMS: Calc. for C₁₅H₃₃N₂O₅S [M+H]⁺: 351.1954, Obser. 351.1964

4.28 L-Methionine Sulfoximine Derivative (4b)

Obtained as White semi-solid. Yield= 334 mg, 89%. Rf = 0.44 (20% MeOH/CHCl₃); IR (neat, cm⁻¹): 3885, 3342, 2949, 2661, 2320, 2082, 1719, 1530, 1440, 1223, 1148, 1047, 844, 746; ¹H NMR (500 MHz, Chloroform-d) δ 5.38 (dd, J = 42.7, 6.7 Hz, 1H), 4.23 (s, 1H), 3.32–3.02 (m, 2H), 2.94 (d, J = 7.8 Hz, 3H), 2.57–2.49 (m, 1H), 2.40-2.33 (m, 1H), 2.15-2.06 (m, 1H), 1.89 (s, 1H), 1.46 (s, 9H), 1.43 (s, 9H), 0.55 (dt, J = 7.4, 4.2 Hz, 2H), 0.46 (dt, J = 6.2, 3.2 Hz, 2H). ¹³C NMR (125 MHz, Chloroform-d) δ 170.4, 155.4, 82.9, 80.1, 52.7, 50.4, 50.2, 39.3, 29.6, 28.4, 28.2, 27.9, 25.6, 6.7. HRMS: Calc. for C₁₇H₃₃N₂O₅S [M+H]⁺: 377.211, Obser. 377.2138.
4.29 N-Methyl S-phenyl S-(2-phenylethyl) sulfoximine (5a)$^{11}$

Obtained as transparent oil. Yield= 222 mg, 86%. $^1$H NMR (500 MHz, Chloroform-d) δ 7.97–7.90 (m, 2H), 7.70–7.59 (m, 3H), 7.32–7.21 (m, 3H), 7.18–7.12 (m, 2H), 3.50 (m, 1H), 3.38 (m, 1H), 3.17 (m, 1H), 3.01 (m, 1H), 2.76 (s, 3H).

$^{13}$C NMR (125 MHz, Chloroform-d) δ 137.9, 137.6, 133.1, 129.6, 129.5, 128.9, 128.5, 126.9, 57.8, 29.6, 28.9.

References

1d

[Chemical structure of 1d]
$1f$
$\text{SO}_2\text{NH}$

1n

$\text{OMe}$
$\text{O}$

$\text{S}$

$\text{NH}$

$\text{Bn}$

1q

\[ f_1 \text{ (ppm)} \]

140.46
133.24
131.17
128.88
128.82
128.60
126.50
131.17
133.24
140.46

\[ \text{Page 53} \]
\[
\begin{align*}
&26.70 \quad 28.10 \quad 28.41 \quad 43.11 \quad 52.74 \quad 53.57 \quad 76.98 \quad 77.23 \quad 77.48 \quad 80.33 \quad 83.05 \\
&155.61 \quad 170.59 \quad 155.61
\end{align*}
\]
The image shows a chemical structure labeled as 2b. The structure includes a benzene ring with a sulfonamide group and a methyl group. The spectrum below the structure indicates different chemical shifts in ppm, with values such as 7.48, 29.51, 50.79, 77.23, 77.48, 129.60, 129.76, and 136.92. The spectrum is labeled with f1 (ppm) on the x-axis and values ranging from 0 to 210 on the y-axis.
2h
**Chemical Structure**

![Chemical Structure Diagram](image)

** peaks at ppm: **
- 143.86
- 133.77
- 130.24

** peaks at ppm: **
- 77.48
- 77.23
- 77.48

** peaks at ppm: **
- 50.94
- 29.56
- 21.65
- 7.55
\[ \text{2t} \]

- S

- CH₃

- \( n-C_7H_{15} \)
3c
3f
3f
4b
5a

**NMR Spectrum**

- Chemical shifts: 7.4-7.9 ppm
- Peaks at: 1.96, 3.03, 3.49, 2.02, 1.01, 0.93, 1.04, 0.30
7) Mass Spectroscopy for HN-Sulfoximines

**Figure 7.1** Mass Spectroscopy of product 1a

![Mass Spectroscopy of product 1a](image1)

**Chemical Formula:** C₇H₁₀N₂O₂S

**Exact Mass:** 155.0405

**Figure 7.2** Mass Spectroscopy of product 1b

![Mass Spectroscopy of product 1b](image2)

**Chemical Formula:** C₉H₁₁NOS

**Exact Mass:** 169.0561
Figure 7.3 Mass Spectroscopy of product 1c

Figure 7.4 Mass Spectroscopy of product 1d
**Figure 7.5** Mass Spectroscopy of product 1e

**Figure 7.6** Mass Spectroscopy of product 1f
**Figure 7.7** Mass Spectroscopy of product 1g

**Figure 7.8** Mass Spectroscopy of product 1h
Figure 7.9 Mass Spectroscopy of product 1i

Figure 7.10 Mass Spectroscopy of product 1j
Figure 7.11 Mass Spectroscopy of product 1k

Figure 7.12 Mass Spectroscopy of product 1l
Figure 7.13 Mass Spectroscopy of product 1m

Figure 7.14 Mass Spectroscopy of product 1n
Figure 7.15 Mass Spectroscopy of product 1o

Figure 7.16 Mass Spectroscopy of product 1p
Figure 7.17 Mass Spectroscopy of product 1q

Figure 7.18 Mass Spectroscopy of product 1r
Figure 7.19 Mass Spectroscopy of product 1s

Figure 7.20 Mass Spectroscopy of product 1t
Figure 7.21 Mass Spectroscopy of product 4
8) Mass Spectroscopy for N-Alkyl sulfoximines

**Figure 8.1** Mass Spectroscopy of product 2a

**Figure 8.2** Mass Spectroscopy of product 2b
Figure 8.3 Mass Spectroscopy of product 2c

Figure 8.4 Mass Spectroscopy of product 2d
Figure 8.5 Mass Spectroscopy of product 2e

Figure 8.6 Mass Spectroscopy of product 2f
Figure 8.7 Mass Spectroscopy of product 2g

Figure 8.8 Mass Spectroscopy of product 2h
Figure 8.9 Mass Spectroscopy of product 2i

Figure 8.10 Mass Spectroscopy of product 2j
Figure 8.11 Mass Spectroscopy of product 2k

Figure 8.12 Mass Spectroscopy of product 2l
**Figure 8.13** Mass Spectroscopy of product 2m

**Figure 8.14** Mass Spectroscopy of product 2n

- **Chemical Formula:** C_{10}H_{15}NO_{2}S
- **Exact Mass:** 213.0823

- **Chemical Formula:** C_{11}H_{17}NO_{2}S
- **Exact Mass:** 227.0980
Figure 8.15 Mass Spectroscopy of product 2o

Figure 8.16 Mass Spectroscopy of product 2p
Figure 8.17 Mass Spectroscopy of product 2q

Figure 8.18 Mass Spectroscopy of product 2r
Figure 8.19 Mass Spectroscopy of product 2s

Figure 8.20 Mass Spectroscopy of product 2t
Figure 8.21 Mass Spectroscopy of product 3a

---

Figure 8.22 Mass Spectroscopy of product 3b
Figure 8.23 Mass Spectroscopy of product 3c

Figure 8.24 Mass Spectroscopy of product 3d
Figure 8.25 Mass Spectroscopy of product 3e

Figure 8.26 Mass Spectroscopy of product 3f
Figure 8.27 Mass Spectroscopy of product 4a

Figure 8.28 Mass Spectroscopy of product 4b