A Novel Three-Component One-pot Reaction Involving Alkynes, Urea or Thiourea, and Aldehydes.

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General: All chemicals were obtained from commercial suppliers and used without further purification. Anhydrous conditions are not required for the reaction. Melting points were determined using XT-4 apparatus and were not corrected. ¹H and ¹³C-NMR spectra were recorded on Bruker AVANCE DMX-500 spectrometry at 500MHz and 125MHz in DMSO-*d*₆, respectively. Chemical shifts are reported in ppm (δ), relative to the internal standard of tetramethylsilane (TMS). 1D ¹H and ¹³C NMR spectra were acquired under standard conditions (5mm QNP probe). Mass spectra were performed on a Bruker Esquire 3000^{plus} mass spectrometer (Bruker-Franzen Analytik GmbH Bremen, Germany) equipped with ESI interface and ion trap analyzer. HRMS were obtained on a Bruker 7-tesla FT-ICR MS equipped with an electrospray source (Billelca, MA, USA).

General Procedure: A solution of alkyne (2 mmol), aldehyde (2 mmol) and urea or thiourea (3 mmol) in anhydrous acetonitrile (3 mL) containing trifluoroacetic acid (1 mL) and AcOH (3 mL) was refluxed till the reaction was completed (TLC). The reaction mixture was then washed with ice-water and ice-cold 2 M NaOH. The solvent was evaporated and the residue was washed with acetone. The solid product was recrystallized from MeOH to give pure product.

Spectroscopic data for all compounds:

4a: m.p. 217-219 °C. ^1H NMR (500 MHz, DMSO- d_6) δ 9.39 (br s, 2H), 7.75 (m, 2H), 7.44 (m, 8H),

6.38 (d, J = 4 Hz, 1H), 5.46 (d, J = 4 Hz, 1H); ^{13}C NMR (125 MHz, DMSO- d_6) δ 156.1, 144.5, 140.7, 130.5, 130.2, 129.6, 129.3, 129.2, 127.6, 124.8, 102.0, 52.3. IR (KBr): 3037, 1721, 1673, 1205, 1135 cm^{-1} . MS (ESI) m/z 251 ($[\text{M}+\text{H}]^+$). HRMS (ESI): $[\text{M}+\text{H}]^+$: Found 251.1174; Calcd for $\text{C}_{16}\text{H}_{15}\text{N}_2\text{O}$: 251.1179.

4b: m.p. 178-179 °C. ^1H NMR (500 MHz, DMSO- d_6) δ 9.14 (br s, 2H), 7.74 (m, 2H), 7.48 (m, 3H),

7.33 (d, J = 8 Hz, 2H), 7.26 (d, J = 8 Hz, 2H), 6.34 (d, J = 4 Hz, 1H), 5.39 (d, J = 4 Hz, 1H), 2.32 (s, 3H); ^{13}C NMR (125 MHz, DMSO- d_6) δ 155.9, 144.4, 138.7, 137.8, 130.5, 130.2, 130.0, 129.3, 127.6, 124.8, 102.1, 52.2, 21.2. IR (KBr): 3412, 3298, 1725, 1685, 1204, 1188, 1135 cm^{-1} . MS (ESI) m/z 265 ($[\text{M}+\text{H}]^+$). HRMS (ESI): $[\text{M}+\text{H}]^+$: Found 265.1330; Calcd for $\text{C}_{17}\text{H}_{17}\text{N}_2\text{O}$: 265.1335.

4c: m.p. 168-169 °C. ^1H NMR (500 Mz, DMSO- d_6) δ 9.45 (br s, 2H), 7.76 (m, 2H), 7.52 (m, 5H), 7.29

(m, 2H), 6.36 (d, J = 4 Hz, 1H), 5.5 (d, J = 4 Hz, 1H); ^{13}C NMR (DMSO- d_6 , 125 Mz) δ 163.6 and 161.7 (split), 156.1, 144.6, 137.0 and 136.9 (split), 130.5, 130.2, 130.0 and 129.9 (split), 129.3, 124.9, 116.4 and 116.2 (split), 101.7, 51.6. IR (KBr): 3098, 1720, 1674, 1202, 1178, 1136 cm^{-1} . MS (ESI) m/z 269 ($[\text{M}+\text{H}]^+$). HRMS (ESI): $[\text{M}+\text{H}]^+$: Found 269.1078; Calcd for $\text{C}_{16}\text{H}_{14}\text{FN}_2\text{O}$: 269.1085.

4d: m.p. 183-187 °C. ^1H NMR (500 MHz, DMSO- d_6) δ 9.23 (br s, 2H), 7.74 (m, 2H), 7.45 (m, 5H), 7.11 (d, J = 8 Hz, 1H), 7.02 (d, J = 8 Hz, 1H), 6.25 (d, J = 4.5 Hz, 1H), 5.52 (d, J = 4.5 Hz, 1H), 3.82 (s, 3H); ^{13}C NMR (125 MHz, DMSO- d_6) δ 157.6, 156.7, 144.9, 130.7, 130.3, 130.2, 129.3, 128.7, 127.6, 124.7, 121.2, 112.3, 100.6, 56.2, 46.9. IR (KBr): 3296, 3084, 2966, 1716, 1682, 1203, 1128

cm^{-1} . MS (ESI) m/z 281 ($[\text{M}+\text{H}]^+$). HRMS (ESI): $[\text{M}+\text{H}]^+$: Found 281.1290; calcd for $\text{C}_{17}\text{H}_{17}\text{N}_2\text{O}_2$: 281.1285.

4e: m.p. 178-179 °C. ^1H NMR (500 MHz, DMSO- d_6) δ 9.49 (br s, 2H), 8.37 (m, 1H), 8.25 (m, 1H), 7.97 (m, 2H), 7.76 (m, 2H), 7.50 (m, 3H), 6.42 (d, J = 4 Hz, 1H), 5.70 (d, J = 4 Hz, 1H); ^{13}C NMR (125 MHz, DMSO- d_6) δ 156.3, 148.6, 145.0, 142.8, 134.4, 131.2, 130.6, 130.0, 129.3, 124.9, 124.0, 122.6, 100.9, 51.7. IR (KBr): 3098, 1722, 1673, 1203, 1139, 1109 cm^{-1} . MS (ESI) m/z 296 ($[\text{M}+\text{H}]^+$). HRMS (ESI): $[\text{M}+\text{H}]^+$: Found 296.1028; Calcd for $\text{C}_{16}\text{H}_{14}\text{N}_3\text{O}_3$: 296.1030.

4f: m.p. 171-172 °C. ^1H NMR (500 MHz, DMSO- d_6) δ 9.34 (br s, 2H), 7.63 (d, J = 8.5 Hz, 2H), 7.41 (m, 5H), 7.40 (d, J = 8 Hz, 2H), 6.30 (d, J = 3.5 Hz, 1H), 5.43 (d, J = 3.5 Hz, 1H), 2.34 (s, 3H); ^{13}C NMR (125 MHz, DMSO- d_6) δ 156.1, 144.6, 140.8, 140.3, 129.9, 129.6, 129.2, 127.6, 127.4, 124.8, 101.0, 52.4, 21.4. IR (KBr): 3421, 1724, 1683, 1204, 1189, 1131 cm^{-1} . MS (ESI) m/z 265 ($[\text{M}+\text{H}]^+$). HRMS (ESI): $[\text{M}+\text{H}]^+$: Found 265.1339; Calcd for $\text{C}_{17}\text{H}_{17}\text{N}_2\text{O}$: 265.1335.

4g: m.p. 163-164 °C. **¹H NMR** (500 MHz, DMSO-*d*₆) δ 9.24 (br s, 2H), 7.63 (d, *J* = 8.5 Hz, 2H), 7.31

(m, 6H), 6.26 (d, *J* = 4 Hz, 1H), 5.38 (d, *J* = 4 Hz, 1H), 2.34 (s, 3H), 2.32 (s, 3H); **¹³C NMR** (125 MHz, DMSO-*d*₆) δ 156.0, 144.5, 140.2, 138.6, 137.9, 130.0, 129.8, 127.5, 127.4, 124.7, 101.1, 52.1, 21.4, 21.2. **IR** (KBr): 3433, 1724, 1684, 1206, 1183, 1130 cm⁻¹. **MS** (ESI) *m/z* 279 ([M+H]⁺). **HRMS** (ESI): [M+H]⁺: Found 279.1487; Calcd for C₁₈H₁₉N₂O: 279.1492.

4h: m.p. 209-210 °C. **¹H NMR** (500 Mz, DMSO-*d*₆) δ 9.21 (br s, 2H), 7.64 (d, *J* = 8.5 Hz, 2H), 7.56 (d,

J = 6 Hz, 2H), 7.46 (t, *J* = 3.5 Hz, 2H), 7.30 (d, *J* = 8.0 Hz, 2H), 6.22 (d, *J* = 4.0 Hz, 1H), 5.73 (d, *J* = 3.5 Hz, 1H), 2.35 (s, 3H); **¹³C NMR** (125 Mz, DMSO-*d*₆) δ 156.2, 145.2, 140.4, 137.2, 132.3, 131.0, 130.7, 130.4, 129.8, 128.6, 127.2, 124.8, 98.8, 50.7, 21.3. **IR** (KBr): 3367, 2923, 2853, 1731, 1654, 1647, 1200, 1132 cm⁻¹. **MS** (ESI) *m/z* 299 ([M+H]⁺). **HRMS** (ESI): [M+H]⁺: Found 299.0946;

Calcd for C₁₇H₁₆ClN₂O: 299.0946.

4i: m.p. 167-168 °C. **¹H NMR** (500 Mz, DMSO-*d*₆) δ 9.36 (br s, 2H), 7.63 (d, *J* = 7.5 Hz, 2H), 7.51 (m,

4H), 7.30 (d, *J* = 8.0 Hz, 2H), 6.27 (d, *J* = 4.0 Hz, 1H), 5.47 (d, *J* = 4.0 Hz, 1H), 2.35 (s, 3H); **¹³C NMR** (125 Mz, DMSO-*d*₆) δ 156.1, 144.8, 140.3, 139.8, 133.7, 129.8, 129.7, 129.5, 127.3, 124.8, 100.5, 51.7, 21.3. **IR** (KBr): 3326, 2976, 1724, 1683, 1204, 1186, 1135 cm⁻¹. **MS** (ESI) *m/z* 299 ([M+H]⁺). **HRMS** (ESI): [M+H]⁺: Found 299.0946; Calcd for C₁₇H₁₆ClN₂O: 299.0947.

4j: m.p. 186-187 °C. ^1H NMR (500 Mz, DMSO- d_6) δ 9.46 (br s, 2H), 8.37 (s, 1H), 8.26(m, 1H), 7.97

(d, J = 8 Hz, 1H), 7.78 (m, 1H), 7.65 (d, J = 8.5 Hz, 2H), 7.31 (d, J = 8 Hz, 2H), 6.35 (d, J = 4.0 Hz, 1H), 5.69 (d, J = 4.0 Hz, 1H), 2.35 (s, 3H); ^{13}C NMR (125 Mz, DMSO- d_6) δ 156.3, 148.5, 145.0, 142.9, 140.5, 134.4, 131.2, 129.8, 127.3, 124.9, 124.0, 122.6, 100.0, 51.6, 21.4. **IR** (KBr): 2926, 1730, 1530, 1201, 1140 cm^{-1} . **MS** (ESI) m/z 310 ($[\text{M}+\text{H}]^+$). **HRMS** (ESI): $[\text{M}+\text{H}]^+$: Found 310.1176; Calcd for $\text{C}_{17}\text{H}_{16}\text{N}_3\text{O}_3$: 310.1186.

4k: m.p. 156-157 °C. ^1H NMR (500 Mz, DMSO- d_6) δ 9.34 (br s, 2H), 7.77 (m, 2H), 7.49 (m, 2H), 7.30 (m, 4H), 6.32 (d, J = 3.5 Hz, 1H), 5.45 (d, J = 4.5 Hz, 1H); ^{13}C NMR (125 Mz, DMSO- d_6) δ 164.5

and 162.5 (split), 163.7 and 161.7 (split), 156.0, 143.8, 137.0, 130.1 and 130.0 (split), 127.4 and 127.3 (split), 126.9, 116.5 and 116.3 (split), 116.4 and 116.2 (split), 101.6, 51.7. **IR** (KBr): 3434, 2923, 2852, 1726, 1509, 1205, 1195 cm^{-1} . **MS** (ESI) m/z 287 ($[\text{M}+\text{H}]^+$); **HRMS** (ESI): $[\text{M}+\text{H}]^+$: Found 287.0992; Calcd for $\text{C}_{16}\text{H}_{13}\text{F}_2\text{N}_2\text{O}$: 287.0990.

4l: m.p. 196-197 °C. ^1H NMR (500 MHz, DMSO- d_6) δ 9.47 (br s, 2H), 8.31 (m, 2H), 7.80 (m, 4H),

7.36 (m, 2H), 6.39 (d, J = 3.5 Hz, 1H), 5.66 (d, J = 4 Hz, 1H); ^{13}C NMR (125 MHz, DMSO- d_6) δ 164.5 and 162.5 (split), 156.2, 148.0, 147.7, 144.1, 129.1, 127.4 and 127.3 (split), 126.6, 124.7, 116.5 and 116.3 (split), 100.7, 51.8. **IR** (KBr): 3109, 1736, 1671, 1518, 1347, 1198 cm^{-1} . **MS** (ESI) m/z 314 ($[\text{M}+\text{H}]^+$). **HRMS** (ESI): $[\text{M}+\text{H}]^+$: Found 314.0930; Calcd for $\text{C}_{16}\text{H}_{13}\text{FN}_3\text{O}_3$: 314.0935.

4m: m.p. 159-160 °C. ^1H NMR (500 MHz, DMSO- d_6) δ 10.13 (br s, 2H), 7.75 (m, 2H), 7.54 (m, 5H),

7.28 (m, 2H), 6.35 (d, J = 4 Hz, 1H), 5.50 (d, J = 4 Hz, 1H), 2.9 (s, 3H); ^{13}C NMR (125 MHz, DMSO- d_6) δ 163.6 and 161.7 (split), 155.0, 144.5, 137.2, 130.5, 130.2, 130.0 and 129.9 (split), 129.3, 124.9, 116.4 and 116.2 (split), 101.8, 52.1, 28.0. IR (KBr): 3080, 2929, 2852, 1734, 1510, 1207, 1192, 1125 cm^{-1} . MS (ESI) m/z 283 ($[\text{M}+\text{H}]^+$). HRMS (ESI): $[\text{M}+\text{H}]^+$: Found 283.1246; Calcd for $\text{C}_{17}\text{H}_{16}\text{FN}_2\text{O}$: 283.1241.

4n: m.p. 154-155 °C. ^1H NMR (500 MHz, DMSO- d_6) δ 10.03 (br s, 2H), 7.75 (m, 2H), 7.53 (m, 3H),

7.48 (m, 2H), 7.28 (m, 2H), 6.35 (d, J = 3.5 Hz, 1H), 5.50 (d, J = 3.5 Hz, 1H), 3.40 (s, 2H), 1.21 (t, J = 7.0 Hz, 3H); ^{13}C NMR (125 MHz, DMSO- d_6) δ 163.6 and 161.6 (split), 154.1, 144.5, 137.2, 130.5, 130.2, 130.0 and 129.9 (split), 129.3, 124.8, 116.4 and 116.2 (split), 102.0, 51.9, 36.5, 14.2. IR (KBr): 3080, 2977, 2930, 1731, 1683, 1511, 1207, 1181, 1130 cm^{-1} . MS (ESI) m/z 297 ($[\text{M}+\text{H}]^+$). HRMS (ESI): $[\text{M}+\text{H}]^+$: Found 297.1394; Calcd for $\text{C}_{18}\text{H}_{18}\text{FN}_2\text{O}$: 297.1398.

6a: m.p. 177-178 °C. ^1H NMR (500 MHz, DMSO- d_6) δ 9.78 (br s, 2H), 7.48 (m, 7H), 7.43 (m, 1H),

7.25 (d, J = 7.5 Hz, 1H), 6.75 (d, J = 1.5 Hz, 1H), 6.22 (d, J = 1.5 Hz, 1H); ^{13}C NMR (125 MHz, DMSO- d_6) δ 168.6, 140.0, 135.1, 133.0, 129.7, 129.5, 129.4, 128.7, 128.1, 127.3, 125.0, 70.9. IR (KBr): 3425, 3033, 1676, 1202, 1136 cm^{-1} . MS (ESI) m/z 267 ($[\text{M}+\text{H}]^+$). HRMS (ESI): $[\text{M}+\text{H}]^+$: Found 267.0953; Calcd for $\text{C}_{16}\text{H}_{15}\text{N}_2\text{S}$: 267.0950.

6b: m.p. 179-180 °C. ^1H NMR (500 MHz, DMSO- d_6) δ 9.96 (br s, 2H), 7.42 (d, J = 7.5 Hz, 1H), 7.36

(d, J = 8.0 Hz, 1H), 7.26 (m, 7H), 6.71 (d, J = 1.0 Hz, 1H), 6.18 (d, J = 1.5 Hz, 1H), 2.32 (s, 3H); ^{13}C NMR (125 MHz, DMSO- d_6) δ 168.8, 138.9, 136.9, 135.1, 133.0, 130.1, 129.5, 128.6, 128.1, 127.2, 124.9, 70.5. IR (KBr): 3422, 2926, 1671, 1637, 1205, 1178, 1191 cm^{-1} . MS (ESI) m/z 281 ($[\text{M}+\text{H}]^+$). HRMS (ESI): $[\text{M}+\text{H}]^+$: Found 281.1104; Calcd for $\text{C}_{17}\text{H}_{17}\text{N}_2\text{S}$: 281.1107.

6c: m.p. 190-191 °C. ^1H NMR (500 MHz, DMSO- d_6) δ 10.0 (br s, 2H), 7.55 (m, 2H), 7.42 (m, 2H),

7.28 (m, 5H), 6.73 (d, J = 2.0 Hz, 1H), 6.25 (d, J = 1.5 Hz, 1H); ^{13}C NMR (125 MHz, DMSO- d_6) δ 168.9, 163.8 and 161.8 (split), 136.2 and 136.1 (split), 135.1, 132.9, 129.6 and 129.5 (split), 129.4, 128.7, 128.2, 125.2, 116.6 and 116.4 (split), 70.0. IR (KBr): 3026, 1674, 1205, 1159, 1131 cm^{-1} . MS (ESI) m/z 285 ($[\text{M}+\text{H}]^+$). HRMS (ESI): $[\text{M}+\text{H}]^+$: Found 285.0851; Calcd for $\text{C}_{16}\text{H}_{14}\text{FN}_2\text{S}$: 285.0856.

6d: m.p. 178-179 °C. ^1H NMR (500 MHz, DMSO- d_6) δ 9.82 (br s, 2H), 7.40 (m, 5H), 7.25 (m, 2H),

7.02 (m, 2H), 6.68 (d, J = 1.5 Hz, 1H), 6.17 (d, J = 1.7 Hz, 1H), 3.77 (s, 3H); ^{13}C NMR (125 MHz, DMSO- d_6) δ 168.5, 160.2, 135.1, 133.1, 131.8, 129.5, 128.7, 128.6, 128.1, 124.8, 114.9, 70.3, 55.7. IR (KBr): 3023, 2841, 1675, 1203, 1134 cm^{-1} . MS (ESI) m/z 297 ($[\text{M}+\text{H}]^+$). HRMS (ESI): $[\text{M}+\text{H}]^+$: Found 297.1060; Calcd for $\text{C}_{17}\text{H}_{17}\text{N}_2\text{OS}$: 297.1056.

6e: m.p. 169-170 °C. ^1H NMR (500 MHz, DMSO- d_6) δ 9.99 (br s, 2H), 7.53 (m, 4H), 7.44 (m, 2H),

7.30 (m, 3H), 6.76 (d, J = 1.4 Hz, 1H), 6.26 (d, J = 1.8 Hz, 1H);

^{13}C NMR (125 MHz, DMSO- d_6) δ 168.9, 138.9, 135.1, 134.1,

132.7, 129.6, 129.5, 129.2, 128.7, 128.2, 125.2, 70.0. IR (KBr):

3026, 1672, 1206, 1188, 1129 cm^{-1} . MS (ESI) m/z 301

($[\text{M}+\text{H}]^+$). HRMS (ESI): $[\text{M}+\text{H}]^+$: Found 301.0556; Calcd for

$\text{C}_{16}\text{H}_{14}\text{ClN}_2\text{S}$: 301.0561.

6f: m.p. 161-162 °C. ^1H NMR (500 MHz, DMSO- d_6) δ 9.87 (br s, 2H), 8.32 (m, 2H), 7.76 (m, 2H),

7.43 (m, 5H), 6.83 (s, 1H), 6.41 (s, 1H); ^{13}C NMR (125 MHz,

DMSO- d_6) δ 168.7, 148.2, 147.1, 135.1, 132.6, 129.5, 128.8,

128.6, 128.2, 125.5, 124.8, 70.3. IR (KBr): 3422, 2925, 1670,

1205, 1178, 1186, 1131 cm^{-1} . MS (ESI) m/z 312 ($[\text{M}+\text{H}]^+$).

HRMS (ESI): $[\text{M}+\text{H}]^+$: Found 312.0806; Calcd for $\text{C}_{16}\text{H}_{14}\text{N}_3\text{O}_2\text{S}$:

312.0801.

6g: m.p. 176-177 °C. ^1H NMR (500 MHz, DMSO- d_6) δ 9.81 (br s, 2H), 8.38 (s, 1H), 8.28 (m, 1H),

7.97 (d, J = 8.0 Hz, 1H), 7.78 (t, J = 8.0 Hz, 1H), 7.44 (t, J = 8.0 Hz,

2H), 7.33 (t, J = 7.5 Hz, 1H), 7.28 (d, J = 8.0 Hz, 2H), 6.85 (s, 1H),

6.43 (d, J = 1.0 Hz, 1H); ^{13}C NMR (125 MHz, DMSO- d_6) δ 168.8,

148.6, 142.2, 135.1, 133.9, 132.8, 131.3, 129.4, 128.7, 128.2, 125.5,

124.2, 122.3, 70.4. IR (KBr): 3026, 1672, 1204, 1182, 1135 cm^{-1} .

MS (ESI) m/z 312 ($[\text{M}+\text{H}]^+$). HRMS (ESI): $[\text{M}+\text{H}]^+$: Found

312.0805; Calcd for $\text{C}_{16}\text{H}_{14}\text{N}_3\text{O}_2\text{S}$: 312.0801.

6h: m.p. 174-175 °C. **¹H NMR** (500 Mz, DMSO-*d*₆) δ 10.01 (s, 2H), 7.28 (m, 8H), 6.70 (s, 1H), 6.15

(s, 1H), 2.29 (s, 3H); **¹³C NMR** (125 Mz, DMSO-*d*₆) δ 169.4, 163.4 and 161.5 (split), 139.5, 137.4, 133.3, 132.3, 130.9 and 130.8 (split), 130.7, 127.7, 124.5, 117.1 and 116.9 (split), 70.8, 21.7. **IR** (KBr): 3425, 2923, 2855, 1641, 1628, 1164, 1115 cm⁻¹.

MS (ESI) *m/z* 299 ([M+H]⁺); **HRMS** (ESI): [M+H]⁺: Found 299.1020; Calcd for C₁₇H₁₅FN₂S: 299.1013.