

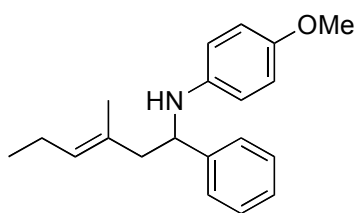
Nickel-Catalyzed Four-Component Connection of Organoaluminum (Organozinc), Isoprene, Aldehydes, and Amines: Stereo- and Regioselective Synthesis of Trisubstituted (*E*)-Homoallylamines

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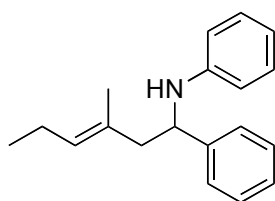
Supplementary Information

General Procedure: Four Component Connection Reaction of Me₃Al, Isoprene, Furan-2-carbaldehyde, and *p*-Anisidine(run 10, Table 2): Into a N₂ purged two-necked round bottom flask containing *p*-anisidine (246 mg, 2.0 mmol) was added THF (2.0 mL) and furan-2-carbaldehyde (96 mg, 1.0 mmol) via a syringe. The mixture was stirred at 30 °C overnight (aldimine, *R_f* = 0.58, hexane:ethyl acetate = 2:1, v/v.) and then was allowed to warm to 50 °C. In to this mixture were introduced a solution of Ni(acac)₂ (25.7 mg, 0.1 mmol) in THF (3.0 mL) via a cannula and isoprene (400 μl, 4 mmol) and Me₃Al (3.6 ml, 1 M hexane, 3.6 mmol) via syringe. The mixture was stirred at the same temperature for 30 min. The mixture was poured into ice-water (25 mL) and extracted with ether (25 mL). The water phase was washed with ethyl acetate (2 x 20 mL). The combined organic phase was dried (MgSO₄) and concentrated *in vacuo*, and the residue was subjected to column chromatography over silica gel (eluent; hexane/ethyl acetate = 64:1, v/v.) to give a mixture of **1j** (89% yield, 251 mg) and **2j** (9% yield): *R_f* = 0.76 (hexane/ethyl acetate = 2:1, v/v). two products were separated by means of recycle HPLC (chloroform).

Spectral and Analytical Data

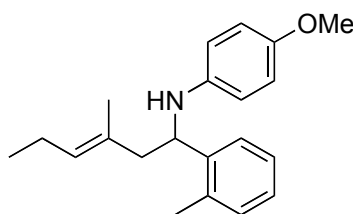


(E)-4-methoxy-N-(3-methyl-1-phenylhex-3-enyl)benzenamine (1a): IR (neat) 3379 (w), 2831~3024 (w), 1605 (w), 1512 (s), 1242 (m), 1042 (w) cm^{-1} ; ^1H NMR (CDCl_3 , 400 MHz) δ 0.98 (t, $J = 7.3$ Hz, 3 H), 1.62 (s, 3 H), 2.05 (quintet, $J = 7.3$ Hz, 2 H), 2.26 (dd, $J = 13.7, 10.3$ Hz, 1 H), 2.45 (dd, $J = 13.7, 4.5$ Hz, 1 H), 3.67 (s, 3 H), 3.90 (br s, 1 H), 4.24 (dd, $J = 10.3, 4.5$ Hz, 1 H), 5.32 (br t, $J = 7.3$ Hz, 1 H), 6.40 (d, $J = 9.0$ Hz, 2 H), 6.65 (d, $J = 9.0$ Hz, 2 H), 7.21 (t, $J = 7.3$ Hz, 1 H), 7.31 (t, $J = 7.4$ Hz, 2 H), 7.36 (d, $J = 7.6$ Hz, 2 H); ^{13}C NMR (CDCl_3 , 100 MHz) δ 14.3, 15.4, 21.3, 50.1, 55.7, 56.5, 114.5, 144.6, 126.0, 126.6, 128.4, 130.8, 131.2, 142.1, 144.9, 151.8. HRMS, calcd for $\text{C}_{20}\text{H}_{25}\text{NO}$: 295.1936, Found m/z (relative intensity): 295.1922 (M^+ , 100).



1b

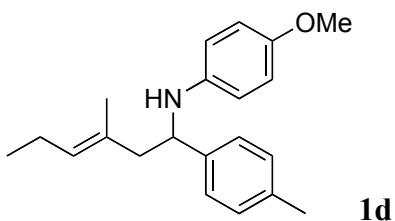
(E)-N-(3-methyl-1-phenylhex-3-enyl)benzenamine (1b): IR (neat) 3395, (w), 3053~2870 (w), 1601 (s), 1504 (s), 1315 (w) cm^{-1} ; ^1H NMR (CDCl_3 , 400 MHz) δ 0.98 (t, $J = 7.2$ Hz, 3 H), 1.62 (s, 3 H), 2.05 (sextet, $J = 7.2$ Hz, 2 H), 2.28 (dd, $J = 13.7, 10.1$ Hz, 1 H), 2.48 (dd, $J = 13.7, 4.4$ Hz, 1 H), 4.14 (br s, 1 H), 4.31 (dd, $J = 10.1, 4.4$ Hz, 1 H), 5.30 (br t, $J = 7.2$ Hz, 1 H), 6.45 (d, $J = 7.2$ Hz, 1 H), 6.62 (t, $J = 7.2$ Hz, 1 H), 7.05 (t, $J = 7.2$ Hz, 1 H), 7.05 (t, $J = 7.2$ Hz, 2 H), 7.21 (t, $J = 7.2$ Hz, 1 H), 7.30 (t, $J = 7.2$ Hz, 2 H), 7.37 (d, $J = 7.2$ Hz, 2 H); ^{13}C NMR (CDCl_3 , 100 MHz) δ 14.3, 15.4, 21.3, 50.0, 55.7, 113.4, 117.2, 126.0, 126.6, 128.4, 128.8, 130.9, 131.1, 144.5, 147.7. HRMS, calcd for $\text{C}_{19}\text{H}_{23}\text{ClNO}$: 265.183, Found m/z (relative intensity): 265.1832 (M^+ , 3), 183.10 (16), 182.10 (100).



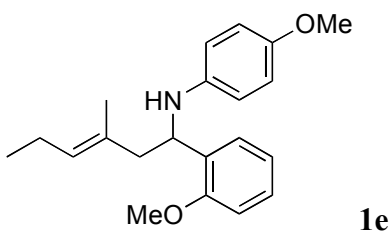
1c

(E)-4-methoxy-N-(3-methyl-1-o-tolylhex-3-enyl)benzenamine (1c): IR (neat) 3379 (w), 2963 (m), 1512 (s), 1242 (s), 1042 (m) cm^{-1} ; ^1H NMR (CDCl_3 , 400 MHz) δ 1.00 (t, $J = 7.3$ Hz, 3 H), 1.65 (s, 3 H), 2.06 (sextet, $J = 7.3$ Hz, 2 H), 2.15 (dd, $J = 13.8, 10.7$ Hz, 1

H), 2.44 (dd, $J = 13.8, 3.5$ Hz, 1 H) 2.46 (s, 3 H), 3.67 (s, 3 H), 3.89 (br s, 1 H) 4.45 (dd, $J = 10.7, 3.5$ Hz, 1 H), 5.35 (br t, $J = 7.3$ Hz, 1 H), 6.32 (d, $J = 8.9$ Hz, 2 H), 6.64 (d, $J = 8.9$ Hz, 2 H), 7.10-7.14 (m, 3 H), 7.48 (d, $J = 7.1$ Hz, 1 H); ^{13}C NMR (CDCl_3 , 100 MHz) δ 14.4, 15.3, 18.9, 21.3, 47.9, 52.7, 55.7, 114.2, 114.6, 125.4, 126.3, 126.5, 130.4, 130.8, 142.2, 142.3, 151.8. HRMS, calcd for $\text{C}_{21}\text{H}_{27}\text{NO}$: 309.2093, Found m/z (relative intensity): 310.2100 (M^{+1} , 14), 309.2082 (M^+ , 60), 227.12 (57), 226.119 (100).

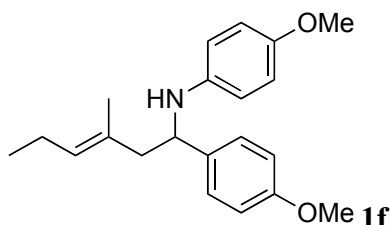


(E)-4-methoxy-N-(3-methyl-1-p-tolylhex-3-enyl)benzenamine (1d): IR (neat) 3381 (w), 2831~2961 (w), 1512 (s), 1238 (s), 1040 (w) cm^{-1} ; ^1H NMR (CDCl_3 , 400 MHz) δ 0.98 (t, $J = 7.3$ Hz, 3 H), 1.61 (s, 3 H), 2.04 (sextet, $J = 7.3$ Hz, 2 H), 2.26 (dd, $J = 13.4, 10.2$ Hz, 1 H), 2.45 (dd, $J = 13.4, 4.3$ Hz, 1 H), 3.67 (s, 3 H), 4.21 (dd, $J = 10.2, 4.3$ Hz, 1 H), 5.30 (br t, $J = 7.3$ Hz, 1 H), 6.42 (d, $J = 9.0$ Hz, 2 H), 6.65 (d, $J = 9.0$ Hz, 2 H), 7.10 (d, $J = 7.9$ Hz, 2 H), 7.26 (d, $J = 7.9$ Hz, 2 H); ^{13}C NMR (CDCl_3 , 100 MHz) δ 14.3, 21.0, 21.2, 50.0, 55.7, 56.3, 114.6, 125.9, 129.1, 130.7, 131.2, 136.1. HRMS, calcd for $\text{C}_{21}\text{H}_{27}\text{NO}$: 309.2093, Found m/z (relative intensity): 309.2068 (M^+ , 100).

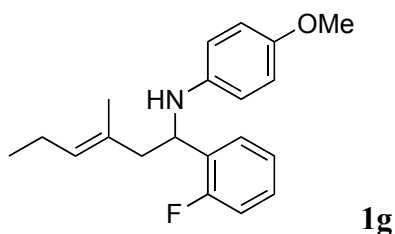


(E)-4-methoxy-N-(1-(2-methoxyphenyl)-3-methylhex-3-enyl)benzenamine (1e): IR (neat) 3387 (w), 2831~2908 (m), 1597 (w), 1512 (s), 1234 (s), 1034 (m) cm^{-1} ; ^1H NMR (CDCl_3 , 400 MHz) δ 0.95 (t, $J = 7.3$ Hz, 3 H), 1.63 (s, 3 H), 2.00 (q, $J = 7.3$ Hz, 2 H), 2.14 (dd, $J = 13.4, 9.8$ Hz, 1 H), 2.57 (dd, $J = 13.4, 4.4$ Hz, 1 H), 3.67 (s, 3 H), 3.89 (s, 3 H), 4.68 (dd, $J = 9.8, 4.4$ Hz, 1 H), 5.25 (br t, $J = 7.3$, 1 H), 6.40 (d, $J = 8.9$ Hz, 2 H), 6.65 (d, $J = 8.9$ Hz, 2 H), 6.87 (d, $J = 7.5$ Hz, 2 H), 7.18 (t, $J = 7.5$ Hz, 1 H), 7.37 (d, $J = 7.5$ Hz, 1 H); ^{13}C NMR (CDCl_3 , 100 MHz) δ 14.4, 15.3, 21.2, 47.2, 55.2, 55.3, 55.7, 110.2, 114.3,

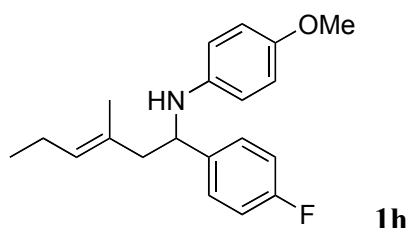
120.7, 126.8, 127.3, 130.0, 131.7, 142.2, 151.7, 156.5. HRMS, calcd for C₂₁H₂₇NO₂: 325.2042, Found *m/z* (relative intensity): 325.2025 (M⁺, 100).



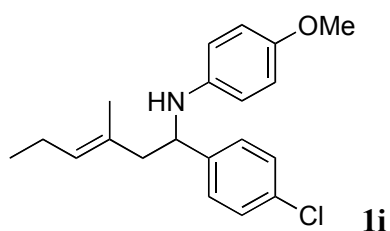
(E)-4-methoxy-N-(1-(4-methoxyphenyl)-3-methylhex-3-enyl)benzenamine (1f): IR (neat) 3381 (w), 2833~2908 (m), 1611 (m), 1514 (s), 1240 (s), 1038 (m) cm⁻¹; ¹H NMR (CDCl₃, 400 MHz) δ 0.98 (t, *J* = 7.3 Hz, 3 H), 2.04 (sextet, *J* = 7.3 Hz, 2 H), 2.25 (dd, *J* = 13.7, 10.1 Hz, 1 H), 2.42 (dd, *J* = 13.7, 4.4 Hz, 1 H), 3.67 (s, 3 H), 3.76 (s, 3 H), 4.20 (dd, *J* = 10.1, 4.4 Hz, 1 H), 5.29 (br t, *J* = 7.3, 1 H), 6.41 (d, *J* = 9.0 Hz, 2 H), 6.65 (d, *J* = 9.0 Hz, 2 H), 6.84 (d, *J* = 8.8 Hz, 2 H), 7.28 (d, *J* = 8.8 Hz, 2 H); ¹³C NMR (CDCl₃, 100 MHz) δ 14.3, 15.4, 21.2, 50.2, 55.2, 55.7, 55.9, 113.8, 114.6, 130.7, 131.2, 136.8, 142.1, 151.8, 158.3. HRMS, calcd for C₂₁H₂₇NO₂: 325.2042, Found *m/z* (relative intensity): 325.2024 (M⁺, 100).



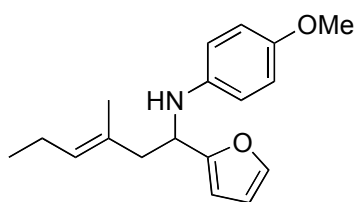
(E)-N-(1-(2-fluorophenyl)-3-methylhex-3-enyl)-4-methoxybenzenamine (1g): IR (neat) 3387 (w), 2963 (m), 1512 (s), 1242 (s), 1042 (m) cm⁻¹; ¹H NMR (CDCl₃, 400 MHz) δ 0.98 (t, *J* = 7.5 Hz, 3 H), 1.64 (s, 3 H), 2.02 (quintet, *J* = 7.5 Hz, 2 H), 2.25 (dd, *J* = 13.6, 9.6 Hz, 1 H), 2.55 (dd, *J* = 13.6, 4.6 Hz, 1 H), 3.68 (s, 3 H), 3.86 (br s, 1 H), 4.64 (dd, *J* = 9.6, 4.6 Hz, 1 H), 5.26 (br t, *J* = 7.5 Hz, 1 H), 6.42 (d, *J* = 8.8 Hz, 2 H), 6.67 (d, *J* = 8.8 Hz, 2 H), 7.01 (d, *J* = 7.8 Hz, 1 H), 7.05 (t, *J* = 7.8 Hz, 1 H), 7.18 (dm, *J* = 7.8 Hz, 1 H), 7.42 (t, *J* = 7.8 Hz, 1 H); ¹³C NMR (CDCl₃, 100 MHz) δ 14.3, 15.3, 21.2, 47.8, 50.1, 55.6, 114.3, 114.6, 115.0, 115.2, 124.18, 124.22, 127.61, 127.65, 127.91, 128.0, 130.8, 141.7, 152.0, 159.0, 161.5. HRMS, calcd for C₂₀H₂₄FNO: 313.1842, Found *m/z* (relative intensity): 314.20 (M+1⁺, 24), 313.1849 (M⁺, 100).



(E)-N-(1-(4-fluorophenyl)-3-methylhex-3-enyl)-4-methoxybenzenamine (1h): IR (neat) 3379 (w), 2963 (m), 2831 (m), 1604 (w), 1512 (s), 1458 (w), 1242 (s), 1042 (w) cm^{-1} ; ^1H NMR (CDCl_3 , 400 MHz) δ 0.98 (t, $J = 7.3$ Hz, 3 H), 1.61 (s, 3 H), 2.04 (sextet, $J = 7.3$ Hz, 2 H), 2.24 (dd, $J = 13.4, 10.0$ Hz, 1 H), 2.41 (dd, $J = 13.4, 4.5$ Hz, 1 H), 3.68 (s, 3 H), 3.89 (br s, 1 H), 4.22 (dd, $J = 10.0, 4.5$ Hz, 1 H), 5.28 (br t, $J = 7.3$ Hz, 1 H), 6.39 (d, $J = 8.9$, 2 H), 6.66 (d, $J = 8.9$ Hz, 2 H), 6.99 (t, $J = 8.7$ Hz, 1 H), 7.32 (d, $J = 8.7$ Hz, 2 H). ^{13}C NMR (CDCl_3 , 100 MHz) δ 14.3, 15.4, 21.3, 50.2, 55.7, 55.9, 114.5, 114.6, 115.1, 115.3, 127.4, 127.5, 130.9, 131.0, 140.41, 140.43, 152.0, 160.4, 162.8. HRMS, calcd for $\text{C}_{20}\text{H}_{24}\text{FNO}$: 313.1842, Found m/z (relative intensity): 314.18 (M+1, 31), 313.1818 (M, 65).

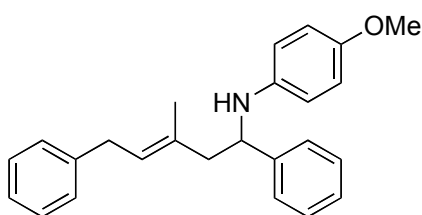


(E)-N-(1-(4-chlorophenyl)-3-methylhex-3-enyl)-4-methoxybenzenamine (1i): IR (neat) 3379 (w), 2831-2963 (m), 1620 (w), 1512 (s), 1242 (s), 1042 (m) cm^{-1} ; ^1H NMR (CDCl_3 , 400 MHz) δ 0.98 (t, $J = 7.3$ Hz, 3 H), 1.62 (s, 3 H), 2.04 (sextet, $J = 7.3, 4.1$ Hz, 2 H), 2.23 (dd, $J = 13.8, 10.2$ Hz, 1 H), 2.42 (dd, $J = 13.8, 4.2$ Hz, 1 H), 3.88 (br s, 3 H), 4.21 (dd, $J = 10.2, 4.2$ Hz, 1 H), 5.29 (br t, $J = 7.3$ Hz, 1 H), 6.38 (d, $J = 8.8$ Hz, 2 H), 6.66 (d, $J = 8.8$ Hz, 2 H), 7.25-7.33 (m, 5 H); ^{13}C NMR (CDCl_3 , 100 MHz) δ 14.3, 15.4, 21.3, 50.0, 55.9, 114.5, 114.6, 128.6, 130.8, 131.1, 141.8, 143.4, 152.0. HRMS, calcd for $\text{C}_{20}\text{H}_{24}\text{ClNO}$: 329.1546, Found m/z (relative intensity): 329.1541 (M^+ , 100).



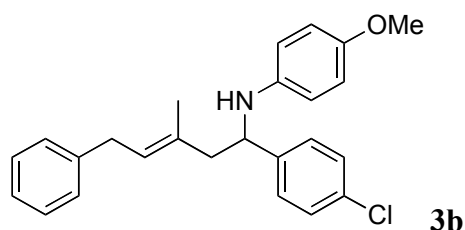
1j

(E)-N-(1-(furan-2-yl)-3-methylhex-3-enyl)-4-methoxybenzenamine (1j): IR (neat) 3385 (w), 2831-2961 (m), 1618 (w), 1512 (s), 1238 (s), 1040 (m) cm^{-1} ; ^1H NMR (CDCl_3 , 400 MHz) δ 0.94 (t, $J = 7.4$ Hz, 3 H), 1.55 (s, 3 H), 2.00 (quintet, $J = 7.4$ Hz, 2 H), 2.45 (dd, $J = 13.3, 8.7$ Hz, 1 H), 2.58 (dd, $J = 13.3, 5.6$ Hz, 1 H), 3.71 (s, 3 H), 4.40 (dd, $J = 8.7, 5.6$ Hz, 1 H), 5.26 (br t, $J = 7.4$ Hz, 1 H), 6.13 (d, $J = 3.2$ Hz, 1 H), 6.27 (dd, $J = 3.2, 2.0$ Hz, 1 H), 6.53 (d, $J = 9.0$ Hz, 2 H), 6.71 (d, $J = 9.0$ Hz, 2 H), 7.32 (d, $J = 2.0$ Hz, 2 H); ^{13}C NMR (CDCl_3 , 100 MHz) δ 14.2, 15.4, 21.2, 45.7, 51.3, 55.7, 105.5, 110.0, 114.6, 114.8, 130.4, 130.8, 141.0, 141.7, 152.2, 156.7. HRMS, calcd for $\text{C}_{18}\text{H}_{23}\text{NO}_2$: 285.1729, Found m/z (relative intensity): 286.1738 ($\text{M}+1^+$, 52), 285.1745 (M^+ , 76).



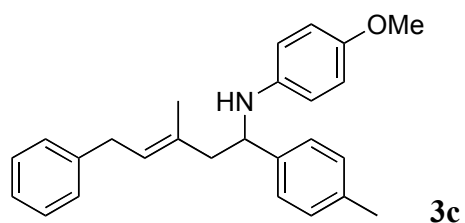
3a

(E)-4-methoxy-N-(3-methyl-1,5-diphenylpent-3-enyl)benzenamine (3a): IR (neat) 3387 (w), 2831~3024 (w), 1605 (w), 1512 (s), 1242 (s), 1034 (m) cm^{-1} ; ^1H NMR (CDCl_3 , 400 MHz) δ 1.76 (s, 3 H), 2.34 (dd, $J = 13.7, 10.1$ Hz, 1 H), 2.52 (dd, $J = 13.7, 4.5$ Hz, 1 H), 3.34 (dd, $J = 15.4, 7.4$ Hz, 1 H), 3.44 (dd, $J = 15.4, 7.4$ Hz, 1 H), 3.67 (s, 3 H), 3.87 (br s, 1 H), 4.30 (dd, $J = 10.1, 4.5$ Hz, 2 H), 5.53 (t, $J = 7.4$ Hz, 1 H), 6.34 (d, $J = 8.9$ Hz, 2 H), 6.64 (d, $J = 8.9$ Hz, 2 H), 7.12-7.38 (m, 10 H); ^{13}C NMR (CDCl_3 , 100 MHz) δ 15.7, 34.3, 50.0, 55.7, 56.5, 114.4, 114.6, 125.8, 126.0, 126.7, 127.6, 128.2, 128.4, 132.9, 141.0, 141.9, 144.6, 151.8. HRMS, calcd for $\text{C}_{25}\text{H}_{27}\text{NO}$: 357.2093, Found m/z (relative intensity): 357.2100 (M^+ , 100).

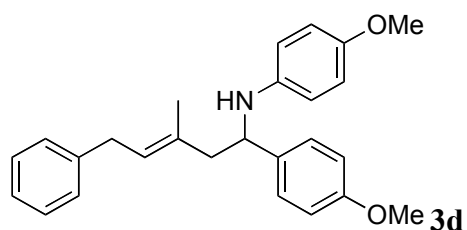


(E)-N-(1-(4-chlorophenyl)-3-methyl-5-phenylpent-3-enyl)-4-methoxybenzenamine

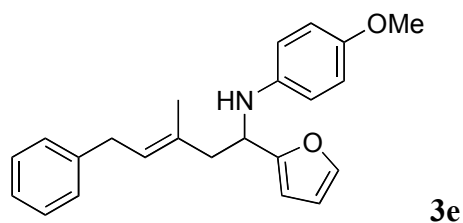
(3b): IR (neat) 3384 (w), 2831~3026 (w), 1601 (w), 1512 (s), 1238 (m), 1038 (w) cm^{-1} ; ^1H NMR (CDCl_3 , 400 MHz) δ 1.74 (s, 3 H), 2.32 (dd, $J = 13.5, 9.8$ Hz, 1 H), 2.48 (dd, $J = 13.5, 4.7$ Hz, 1 H), 3.33 (dd, $J = 15.3, 7.4$ Hz, 1 H), 3.42 (dd, $J = 15.3, 7.4$ Hz, 1 H), 3.67 (s, 3 H), 4.27 (dd, $J = 9.8, 4.7$ Hz, 1 H), 5.48 (t, $J = 7.4$ Hz, 1 H), 6.33 (d, $J = 8.8$ Hz, 2 H), 6.65 (d, $J = 8.8$ Hz, 2 H), 7.12 (d, $J = 7.5$ Hz, 2 H), 7.20 (t, $J = 7.5$ Hz, 1 H), 7.27 (d, $J = 8.0$ Hz, 4 H), 7.28 (t, $J = 7.5$ Hz, 2 H); ^{13}C NMR (CDCl_3 , 100 MHz) δ 15.7, 34.3, 49.8, 55.6, 55.7, 56.1, 56.2, 114.6, 125.8, 127.5, 127.9, 128.0, 128.4, 128.6, 132.3, 132.4, 140.9, 141.3, 143.0, 152.1. HRMS, calcd for $\text{C}_{25}\text{H}_{26}\text{ClNO}$: 391.1703, Found m/z (relative intensity): 318.1855 ($\text{M}+1^+$, 17), 391.1738 (M^+ , 10), 246.07 (100).



(E)-4-methoxy-N-(3-methyl-5-phenyl-1-p-tolylpent-3-enyl)benzenamine (3c): IR (neat) 3387 (w), 2831~3024 (m), 1605 (w), 1512 (s), 1242 (s), 1034 (m) cm^{-1} ; ^1H NMR (CDCl_3 , 400 MHz) δ 1.75 (s, 3 H), 2.32 (s, 3 H), 2.33 (dd, $J = 13.5, 10.1$ Hz, 1 H), 2.50 (dd, $J = 13.5, 4.7$ Hz, 1 H), 3.34 (dd, $J = 15.4, 7.5$ Hz, 1 H), 3.43 (dd, $J = 15.4, 7.5$ Hz, 1 H), 3.68 (s, 3 H), 4.27 (dd, $J = 10.1, 4.7$ Hz, 1 H), 5.50 (br t, $J = 7.5$ Hz, 1 H), 6.35 (d, $J = 8.8$ Hz, 2 H), 6.64 (d, $J = 8.8$ Hz, 2 H), 7.09-7.30 (m, 9 H); ^{13}C NMR (CDCl_3 , 100 MHz) δ 15.7, 34.3, 50.1, 55.7, 56.2, 114.4, 114.6, 125.8, 125.9, 127.4, 128.2, 128.4, 129.1, 133.0, 136.1, 141.0, 141.6, 142.0, 151.8. HRMS, calcd for $\text{C}_{26}\text{H}_{30}\text{NO}$: 371.2249, Found m/z (relative intensity): 372.23 ($\text{M}+1^+$, 19), 371.2259 (M^+ , 69).



(E)-4-methoxy-N-(1-(4-methoxyphenyl)-3-methyl-5-phenylpent-3-enyl)benzenamine (3d): IR (neat) 3384 (w), 2833~3026 (m), 1610 (w), 1512 (s), 1240 (s), 1035 (m) cm^{-1} ; ^1H NMR (CDCl_3 , 400 MHz) δ 1.75 (s, 3 H), 2.33 (dd, $J = 13.5, 9.9$ Hz, 1 H), 2.49 (dd, $J = 13.5, 4.7$ Hz, 1 H), 3.34 (dd, $J = 15.4, 7.4$ Hz, 1 H), 3.43 (dd, $J = 15.4, 7.4$ Hz, 1 H), 3.68 (s, 3 H), 3.78 (s, 3 H), 3.85 (br s, 1 H), 4.26 (dd, $J = 9.9, 4.7$ Hz, 1 H), 5.49 (br t, $J = 7.4$ Hz, 1 H), 6.35 (d, $J = 9.0$ Hz, 2 H), 6.50 (d, $J = 9.0$ Hz, 2 H), 6.50 (d, $J = 9.0$ Hz, 2 H), 6.83 (d, $J = 8.8$ Hz, 1 H), 7.14 (d, $J = 7.2$ Hz, 2 H), 7.20 (t, $J = 7.2$ Hz, 1 H), 7.27 (d, $J = 8.8$ Hz, 2 H), 7.28 (t, $J = 7.2$ Hz, 2 H); ^{13}C NMR (CDCl_3 , 100 MHz) δ 15.7, 34.3, 50.1, 55.2, 55.7, 56.0, 113.9, 114.5, 114.6, 125.8, 127.1, 127.4, 128.2, 128.4, 133.0, 136.6, 141.0, 142.0, 151.8, 158.3. HRMS, calcd for $\text{C}_{26}\text{H}_{29}\text{NO}_2$: 387.2198, Found m/z (relative intensity): 387.2195 (M^+ , 100).



(E)-N-(1-(furan-2-yl)-3-methyl-5-phenylpent-3-enyl)-4-methoxybenzenamine (3e): IR (neat) 3396 (w), 2831~3026 (w), 1603 (w), 1514 (s), 1238 (m), 1037 (w) cm^{-1} ; ^1H NMR (CDCl_3 , 400 MHz) δ 1.68 (s, 3 H), 2.52 (dd, $J = 13.4, 8.5$ Hz, 1 H), 2.65 (dd, $J = 13.4, 5.9$ Hz, 1 H), 3.33 (dd, $J = 15.1, 7.3$ Hz, 1 H), 3.39 (dd, $J = 15.1, 7.3$ Hz, 1 H), 3.71 (s, 3 H), 4.47 (dd, $J = 8.5, 5.9$ Hz, 1 H), 5.47 (t, $J = 7.2$ Hz, 1 H), 6.13 (d, $J = 3.2$ Hz, 1 H), 6.26 (dd, $J = 3.2, 1.7$ Hz, 1 H), 6.48 (d, $J = 8.9$ Hz, 2 H), 6.71 (d, $J = 8.9$ Hz, 2 H), 7.12 (d, $J = 7.3$ Hz, 2 H), 7.18 (t, $J = 7.3$ Hz, 1 H), 7.26 (t, $J = 3.3$ Hz, 2 H), 7.32 (d, $J = 1.7$ Hz, 1 H); ^{13}C NMR (CDCl_3 , 100 MHz) δ 15.8, 34.3, 45.7, 51.3, 55.7, 105.7, 110.0, 114.6, 114.8, 125.7, 127.4, 128.1, 128.3, 132.3, 141.0, 141.1, 141.4, 152.2, 156.5. HRMS, calcd for $\text{C}_{23}\text{H}_{25}\text{NO}_2$: 347.4501, Found m/z (relative intensity): 347.1869 (M^+ , 100).