

Synthesis of β -methyl alcohols: influence of alkyl chain length on diastereoselectivity and new attractants of *Rhynchophorus ferrugineus*

Van-Dung Le^{1,2}, Chi-Hien Dang^{1,2*}, Cong-Hao Nguyen^{1,2}, Hong-Ung Nguyen³, and Thanh-Danh Nguyen^{1,2*}

¹Graduate University of Science and Technology, Vietnam Academy of Science and Technology, 18 Hoang Quoc Viet, Cau Giay, Hanoi, Vietnam.

²Institute of Chemical Technology, Vietnam Academy of Science and Technology, 1A, TL29, District 12, Ho Chi Minh City, Vietnam.

³Department of Agriculture and Aquaculture, Tra Vinh University. 126 Nguyen Thien Thanh Street, Ward 5, Tra Vinh City, Viet Nam.

*Correspondence: dangchihien@gmail.com (C.H. Dang), ntdanh@ict.vast.vn (T.D. Nguyen)

Supplementary Data

1. Experimental

1.1. General Methods

All manipulations were performed under a dry nitrogen atmosphere using Schlenk techniques. All of the materials were purchased from Acros (Belgium) or Sigma-Aldrich. Diethyl ether was dried with Na/benzophenone and freshly distilled prior to use. The other solvents were purchased from Fluka and used without further purification. Column chromatography was performed with Merck Kieselgel 60. Synthesis of ketones using IBX was carried out under microwave-assisted in SANYO EM-D9553N. GC-MS analyses were carried out using an Agilent Technologies 6890N (USA). ^1H (500 MHz) and ^{13}C (125 MHz) NMR were determined on a Bruker AVANCE 500 NMR spectrometer using CDCl_3 as solvent and tetramethylsilane (TMS) as internal standard. Chemical shifts are reported in δ relative to TMS.

1.2. General procedure for synthesis of alcohols by Grignard reactions (1a-15a)

To a 250 mL round bottom flask equipped with a reflux condenser was added magnesium shavings (60.0 mmol, 1440.0 mg). After alkyl bromides (48.0 mmol) in anhydrous diethyl ether (70 mL) is added slowly dropwise via cannula to the solution. After addition of the bromides was completed, the reaction mixture was stirred and refluxed for 1h in nitrogen atmosphere. A

solution of α -methyl aldehydes (40.0 mmol) in anhydrous diethyl ether (70 mL) was then added slowly to the solution of Grignard reagent cooled at 0°C and stirred for 1h. The mixture was stirred at ambient temperature for an additional 1h and poured into an aqueous solution of NH_4Cl . The organic layer was extracted with diethyl ether (30 mL x 3) and then washed with an aqueous solution of NaHCO_3 , water, brine and dried with anhydrous MgSO_4 . The solvent was removed and followed by column chromatography of the residue (*n*-hexane: Et_2O = 8:2) or distillation to afford the alcohols.

1.3. General procedure for reduction of ketones by LiAlH_4 (1c – 15c)

Ketones (40.0 mmol) in dry diethyl ether (100 mL) were added through a dropping funnel to LiAlH_4 (80.0 mmol) in dry diethyl ether (100 mL) at 0°C. The solution was allowed to warm to room temperature for 1h under stirring. The reaction was monitored by TLC. The mixture was poured to cold HCl acid (10%) and extracted with diethyl ether (3 x 30 mL). The organic layer was dried by anhydrous MgSO_4 and organic solvent evaporated. The crude product was purified by distillation or chromatography column (*n*-hexane: Et_2O = 8: 2) to afford alcohols.

(\pm)-4-methyl-3-hexanol (1a): 75 °C/60 mmHg; GC-MS, *m/z* 87, 69, 59 (100), 55, 53, 45, 43, 41, 39, 31, 27; ^1H NMR (500 MHz, CDCl_3): δ 3.44 (m, 2 H), 3.43 (m, ~ 1,17 H), 1.18-1.56 (m, ~ 24 H), 0.86-0.98 (m, ~ 32 H); ^{13}C NMR (125 MHz, CDCl_3): δ 77.3, 76.4, 40.2, 39.6, 27.3, 26.3, 26.1, 24.6, 14.8, 14.1, 13.1, 11.8, 11.6, 10.5, 10.3.

(±)-3-methyl-4-heptanol (2a): 85 °C/60 mmHg; GC-MS, m/z 87, 73, 69, 57, 55 (100), 45, 41, 39, 31, 29; ^1H NMR (500 MHz, CDCl_3): δ 3.53 (m, 2 H), 3.45 (m, \sim 1.11 H), 1.13-1.55 (m, \sim 37 H), 0.84-0.97 (m, \sim 35 H); ^{13}C NMR (125 MHz, CDCl_3): δ 75.5, 74.7, 40.6, 40.0, 36.7, 35.7, 26.0, 24.6, 19.4, 19.2, 14.8, 14.1, 14.1, 13.2, 11.9, 11.7.

(±)-3-methyl-4-octanol (3a): 91°C/60 mmHg; GC-MS, m/z 126, 111, 87, 85, 69 (100), 57, 55, 45, 43, 41, 39, 31, 29; ^1H NMR (500 MHz, CDCl_3): δ 3.50 (m, 1 H), 3.42 (m, \sim 0.56 H), 1.12-1.56 (m, \sim 15 H), 0.86-0.93 (m, \sim 14.9 H); ^{13}C NMR (125 MHz, CDCl_3): δ 75.8, 74.9, 40.5, 39.9, 34.2, 33.1, 28.5, 28.3, 26.0, 24.6, 22.8, 22.8, 14.8, 14.0, 13.1, 11.8, 11.7.

(±)-3-methyl-4-nonanol (4a): 62°C/6 mmHg; GC-MS, m/z 140, 111, 101, 87, 83 (100), 69, 55, 41, 31; ^1H NMR (500 MHz, CDCl_3): δ 3.51 (m, 2 H), 3.44 (m, \sim 1.23 H), 1.23-1.54 (m, \sim 39.6 H), 0.86-0.93 (m, \sim 29.3H). ^{13}C NMR (125 MHz, CDCl_3): δ 75.8, 74.9, 40.5, 39.9, 34.5, 33.4, 32.0, 31.9, 26.0, 25.9, 25.8, 24.6, 22.7, 14.8, 14.0, 13.2, 11.9, 11.7.

(±)-3-methyl-4-decanol (5a): 82°C/5 mmHg; GC-MS, m/z 115, 97, 87, 85, 81, 69, 57, 55 (100), 53, 45, 41, 39, 31, 29, 27; ^1H NMR (500 MHz, CDCl_3): δ 3.51 (m, 2 H), 3.43 (m, \sim 1.18 H), 1.13-1.54 (m, \sim 46 H), 0.86-0.93 (m, \sim 29 H); ^{13}C NMR (125 MHz, CDCl_3): δ 75.8, 75.0, 40.6, 40.0, 34.6, 33.5, 31.9, 29.4, 29.4, 26.2, 26.1, 24.6, 22.6, 14.8, 14.0, 13.2, 11.9, 11.7.

(±)-3-methyl-4-undecanol (6a): 102°C/5 mmHg; GC-MS, m/z 129, 111, 97, 83, 73, 69 (100), 57, 55, 41, 39, 29; ^1H NMR (500 MHz, CDCl_3): δ 3.51 (m, 2H), 3.44 (m, \sim 1.06 H), 1.15-1.52 (m, \sim 51.4 H), 0.86-0.94 (m, \sim 28.2 H); ^{13}C NMR (125 MHz, CDCl_3): δ 75.8, 75.0, 40.6, 40.0, 34.6, 33.5, 31.9, 29.7, 29.7, 29.3, 26.3, 26.1, 26.1, 24.6, 22.6, 14.8, 14.1, 13.2, 11.9, 11.7.

(±)-3-methyl-4-dodecanol (7a): 128°C/5 mmHg; GC-MS, m/z 182, 143, 125, 111, 97, 87, 83, 69 (100), 55, 41, 29; ^1H NMR (500 MHz, CDCl_3): δ 3.51 (m, 2 H), 3.44 (m, 1 H), 1.17-1.51 (m, \sim 58.2 H), 0.86-0.93 (m, \sim 28.4

H); ^{13}C NMR (125 MHz, CDCl_3): δ 75.8, 74.9, 40.6, 40.0, 34.6, 33.5, 31.9, 29.8, 29.8, 29.6, 29.3, 26.3, 26.1, 26.1, 24.6, 22.7, 14.8, 14.1, 13.2, 11.9, 11.7.

(\pm)-4-methyl-3-heptanol (8a): 87°C/60 mmHg; GC-MS, m/z 101, 86, 83, 70, 59 (100), 55, 45, 41, 39, 39, 31, 27; ^1H NMR (500 MHz, CDCl_3): δ 3.41 (m, 2 H), 3.35 (m, 1.15 H), 1.16-1.55 (m, \sim 27.4 H), 0.86-0.98 (m, \sim 30 H); ^{13}C NMR (125 MHz, CDCl_3): δ 77.6, 76.7, 38.2, 37.5, 35.7, 34.1, 27.2, 26.2, 20.4, 20.4, 15.3, 14.3, 14.3, 13.4, 10.5, 10.3.

(\pm)-5-methyl-4-octanol (9a): 90°C/60 mmHg; GC-MS, m/z 126, 101, 83, 73, 57, 55 (100), 45, 43, 41, 39, 31, 27; ^1H NMR (500 MHz, CDCl_3): δ 3.51 (m, 2.14 H), 3.45 (m, 1 H), 1.10-1.55 (m, \sim 35 H), 0.86-0.95 (m, \sim 30 H); ^{13}C NMR (125 MHz, CDCl_3): δ 75.8, 75.0, 38.6, 38.0, 36.7, 35.6, 35.6, 34.2, 20.5, 20.4, 19.4, 19.3, 15.2, 14.4, 14.3, 14.2, 13.6.

(\pm)-4-methyl-5-nonanol (10a). [1] 99°C/30 mmHg; GC-MS, m/z 140, 111, 101, 87, 83, 69 (100), 67, 59, 55, 53, 45, 43, 41, 39, 31, 29, 27.

(\pm)-4-methyl-5-decanol (11a): 155°C/80 mmHg; GC-MS, m/z 154, 111, 101, 83 (100), 69, 55, 41, 31; ^1H NMR (500 MHz, CDCl_3): δ 3.49 (m, 2 H), 3.43 (m, \sim 1.02 H), 1.09-1.52 (m, \sim 56.8 H), 0.85-0.92 (m, \sim 32.8 H). ^{13}C NMR (125 MHz, CDCl_3): δ 76.1, 75.2, 38.6, 37.9, 35.6, 34.5, 34.1, 33.4, 32.0, 31.9, 25.9, 25.8, 22.7, 20.5, 20.4, 15.2, 14.4, 14.3, 14.0, 13.5.

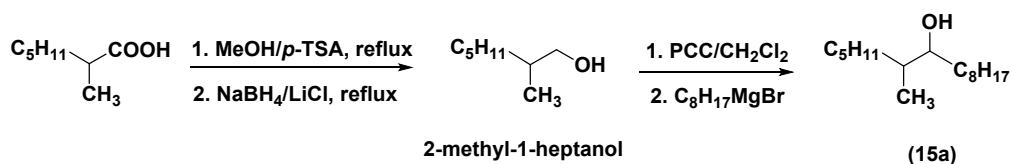
(\pm)-4-methyl-5-undecanol (12a): 110°C/5 mmHg; GC-MS, m/z 168, 140, 128, 115, 101, 97, 83, 69, 55 (100), 43, 29; ^1H NMR (500 MHz, CDCl_3): δ 3.49 (m, 2 H), 3.43 (m, \sim 1.07 H), 1.09-1.52 (m, \sim 52 H), 0.86-0.92 (m, \sim 28.1 H); ^{13}C NMR (125 MHz, CDCl_3): δ 76.1, 75.2, 38.6, 37.9, 35.6, 34.5, 34.2, 33.4, 31.9, 29.4, 29.4, 26.3, 26.1, 22.6, 20.5, 20.4, 15.3, 14.4, 14.3, 14.1, 13.5.

(\pm)-4-methyl-5-dodecanol (13a): 130°C/5 mmHg; GC-MS, m/z 129, 111, 97, 83, 73, 69 (100), 57, 55, 41, 39, 31, 29; ^1H NMR (500 MHz, CDCl_3): δ 3.49 (m, 2 H), 3.43 (m, 1.15 H), 1.09-1.51 (m, \sim 62 H), 0.85-0.92 (m, \sim 30.5

H); ^{13}C NMR (125 MHz, CDCl_3): δ 76.1, 75.2, 38.6, 37.9, 35.7, 34.5, 34.2, 33.4, 31.9, 29.7, 29.7, 29.3, 26.3, 26.2, 22.7, 20.5, 20.4, 15.3, 14.4, 14.3, 14.1, 13.5.

(\pm)-4-methyl-5-tridecanol (14a): 140°C/2 mmHg; GC-MS, m/z 196, 143, 125, 111, 101, 97, 83 (100), 69, 55, 41, 29; ^1H NMR (500 MHz, CDCl_3): δ 3.48 (m, 2 H), 3.43 (m, \sim 1.10 H), 1.08-1.53 (m, \sim 63.3 H), 0.85-0.92 (m, \sim 28 H); ^{13}C NMR (125 MHz, CDCl_3): δ 76.1, 75.2, 37.6, 37.9, 35.6, 34.5, 34.1, 33.4, 31.9, 29.8, 29.8, 29.6, 29.3, 26.3, 26.1, 22.7, 20.5, 20.4, 15.3, 14.4, 14.3, 14.1, 13.5.

Synthesis of 6-methyl-7-pentadecanol (15a) from (\pm)-2-methylheptanoic acid



Synthesis of (\pm)-2-methyl-1-heptanol.

In a round-bottom flask equipped with a condenser, 2-methylheptanoic acid (10.0 g, 69.0 mmol) and *p*-TSA (0.2 g, 1.0 mmol) were stirred with methanol (160 mL). The resulting mixture was refluxed for 6h and then the solvent was evaporated. The mixture was extracted with ethyl ether (3 \times 50 mL). The combined organic layer was washed with saturated NaHCO_3 solution (100 mL), brine (100 mL), dried over MgSO_4 , filtered and concentrated in vacuo to give the desired ester as a colorless oil (9.8 g, 89%). The crude product was used directly for next reaction without further purification.

A 500 mL three-necked round-bottom flask equipped with a magnetic stir was charged with ester (6.0 g, 38.0 mmol), NaBH₄ (5.8 g, 152.0 mmol) and 5 mol % of LiCl (0.2 g, 4.7 mmol) in THF (100 mL) at room temperature. The resulting suspension was stirred at 65°C for 15 min. Methanol (100 mL) was then added dropwisely and the reaction mixture was refluxed for 4 h. After cooling to room temperature, the reaction mixture was quenched in 10% HCl (100 mL). The organic layer was separated and the aqueous phase extracted with diethyl ether (3 x 50 mL). The combined organic layer was washed with saturated NaHCO₃ solution (100 mL), brine (100 mL), dried over MgSO₄ and concentrated to obtain a colorless oil. Further distillation under reduced pressure (104-109°C, 60 mmHg) gave 2-methyl-1-heptanol as a colorless oil (4.4 g, 89%). GC-MS, *m/z* 112, 98, 83, 70, 57 (100), 41, 31; ¹H NMR (500 MHz, CDCl₃): δ 3.51 (m, 1 H), 3.41 (m, 1 H), 1.61 (m, 1 H), 1.24-1.39 (m, 8 H), 0.92 (*d*, *J* = 7 Hz, 3 Hz, 3 H), 0.88 (m, 1 H). ¹³C NMR (125 MHz, CDCl₃): δ 68.4, 35.8, 34.7, 34.5, 33.1, 32.1, 31.6, 26.6, 25.3, 22.6, 20.7, 16.6, 14.1, 14.0, 11.4.

(±)-6-methyl-7-pentadecanol (15a)

In a 500 mL round-bottomed flask fitted with a reflux condenser was suspended 18.7 g (115.0 mmol) of pyridinium chlorochromate (PCC) in 150 mL of anhydrous CH₂Cl₂ in nitrogen atmosphere. Then 2-methyl-1-heptanol (5.6 g, 43.0 mmol) in 20 mL of CH₂Cl₂ was added in one portion to the magnetically stirred solution. After 1.5 h, dry ether (200 mL) was added and

the supernatant decanted from the black gum. The insoluble residue was washed thoroughly 3 times with 50 mL portions of anhydrous ether whereupon it became a black granular solid. The combined organic solution was passed through a silica gel column chromatography and the solvent was removed by distillation to give 2-methylpentanal as a yellow oil. The crude product was purified by distillation under reduced pressure to afford a colorless oil (4.5 g, 82%). The obtained α -methyl aldehyde was used for synthesis of alcohol **15a** as the general procedure. 209°C/7 mmHg; GC-MS, m/z 224, 143, 129, 111, 97, 83, 69 (100), 55, 41, 31; ^1H NMR (500 MHz, CDCl_3): δ 3.49 (m, 2 H), 3.43 (m, \sim 1.12 H), 1.08-1.51 (m, \sim 78.8 H), 0.85-0.90 (m, \sim 28.7). ^{13}C NMR (125 MHz, CDCl_3): δ 76.1, 75.2, 38.8, 38.2, 34.5, 33.4, 33.3, 32.2, 32.1, 31.9, 31.8, 29.8, 29.7, 29.7, 29.3, 27.1, 27.0, 26.3, 26.1, 22.7, 15.3, 14.1, 14.0, 13.6.

1.4. General procedure for synthesis of ketones under microwave-assistance (1b-15b)

o-iodoxybenzoic acid (IBX) (30.0 mmol) was dissolved in CH_3CN (30 mL) in a thick-walled Pyrex screw-cap tube. After addition of the alcohols (20.0 mmol, **1a-15a**) in CH_3CN (30 mL) was completed, the reaction mixture was carried out in microwave for 20 min. The reaction mixture was poured into HCl solution (10%, 30 mL) and extracted with Et_2O (3x 30 mL). The organic layer was washed with NaHCO_3 solution, dried with anhydrous MgSO_4 and

the solvent evaporated. The crude product was purified by distillation or flash chromatography (*n*-hexane:EtOAc= 9:1) to give ketones (**1b-15b**).

4-methyl-3-hexanone (1b) [2]. Yield: 65%; 60°C/30 mmHg; GC-MS, *m/z* 114, 99, 85, 57 (100), 43, 41, 39, 29, 27.

3-methyl-4-heptanone (2b). Yield: 62%; 75°C/30 mmHg; GC-MS, *m/z* 128, 113, 100, 85, 71 (100), 57, 43, 41, 39, 29.

3-methyl-4-octanone (3b): Yield: 66%; 80°C/30 mmHg; GC-MS, *m/z* 142, 85, 71, 57 (100), 43, 41, 39, 29, 27, 15; ¹H NMR (500 MHz, CDCl₃): δ 2.40-2.47 (m, 3 H), 1.65-1.7 (m, 2 H), 1.52-1.58 (m, 2H), 1.27-1.40 (m, 2 H), 1.06 (*d*, *J* = 7 Hz, 3 H), 0.89-0.92 (*t*, *J* = 7 Hz, 3 H), 0.86-0.88 (*t*, *J* = 7.5 Hz, 3 H); ¹³C NMR (125 MHz, CDCl₃): δ 215, 47.9, 40.9, 25.9, 25.8, 22.4, 15.9, 13.9, 11.7.

3-methyl-4-nonanone (4b): Yield: 65%; 92°C/30 mmHg; GC-MS, *m/z* 156, 113, 99, 85, 71, 57, 43 (100), 41, 39.

3-methyl-4-decanone (5b): Yield: 60%; 75°C/5 mmHg; GC-MS, *m/z* 170, 155, 141, 127, 113 (100), 99, 85, 71, 57, 43; ¹H NMR (500 MHz, CDCl₃): δ 2.34-2.46 (m, 3H); 1.54-1.7 (m, 4H); 1.26 -1.40 (m, 6H); 1.05 (*d*, *J* = 7 Hz, 3H); 0.89 (*t*, *J* = 6.5 Hz, 3H); 0.87 (*t*, *J* = 7.5 Hz, 3H); ¹³C NMR (125 MHz, CDCl₃): δ 215.0, 47.9, 41.2, 31.6, 29.0, 25.9, 23.7, 22.5, 15.9, 14.0, 11.7.

3-methyl-4-undecanone (6b): Yield: 72%; 90°C/5 mmHg; GC-MS, *m/z* 184, 169, 142, 127, 109, 86, 72, 57 (100), 41; ¹H NMR (500 MHz, CDCl₃): δ 2.39-2.46 (m, 3 H), 1.64-1.70 (m, 2 H), 1.53-1.58 (m, 2 H), 1.24-1.40 (m, 8 H), 1.05 (*t*, *J* = 7 Hz, 3H), 0.88 (*t*, *J* = 7 Hz, 3H), 0.86 (*t*, *J* = 7.5 Hz, 3H); ¹³C

NMR (125 MHz, CDCl₃): δ 215.0, 47.9, 41.2, 31.7, 29.1, 29.3, 26.0, 23.7, 22.6, 15.9, 14.0, 11.7.

3-methyl-4-dodecanone (7b): Yield: 83%; 110°C/5 mmHg; GC-MS, m/z 198, 183, 169, 155, 141 (100), 123, 101, 85, 71, 57, 41, 29; ¹H NMR (500 MHz, CDCl₃): δ 2.39-2.46 (m, 3 H), 1.64-1.70 (m, 2 H), 1.54-1.57 (m, 2 H), 1.25-1.40 (m, 10 H), 1.05 (*d*, J = 7 Hz, 3 H), 0.88 (*t*, J = 7 Hz, 3 H), 0.86 (*t*, J = 7 Hz, 3 H); ¹³C NMR (125 MHz, CDCl₃): δ 215.0, 47.9, 41.2, 31.8, 29.4, 29.3, 29.2, 26.0, 23.7, 22.6, 16.0, 14.1, 11.7.

4-methyl-3-heptanone (8b): Yield: 68%; 74°C/40 mmHg; GC-MS, m/z 128, 99, 86, 71, 57 (100), 55, 53, 43, 41, 39, 29, 27, 15; ¹H NMR (500 MHz, CDCl₃): δ 2.43-2.56 (m, 3 H), 1.60-1.63 (m, 2 H), 1.25-1.29 (m, 2 H), 1.06 (*d*, J = 7 Hz, 3 H), 0.89 (*t*, J = 6 Hz, 3 H), 0.88 (*t*, J = 7.3 Hz); ¹³C NMR (125 MHz, CDCl₃): δ 215.4, 45.9, 35.3, 34.2, 20.5, 16.4, 14.1, 7.8.

5-methyl-4-octanone (9b): Yield: 63%; 80°C/40 mmHg; GC-MS, m/z 142, 100, 71 (100), 69, 55, 43, 41, 39, 29, 27, 15; ¹H NMR (500 MHz, CDCl₃): δ 2.50-2.52 (m, 1 H), 2.39-2.42 (m, 2 H), 1.54-1.61 (m, 2 H), 1.24-1.31 (m, 4 H), 1.05 (*d*, J = 7 Hz, 3 H), 0.91 (*t*, J = 7 Hz, 3 H), 0.89 (*t*, J = 6 Hz, 3 H).

4-methyl-5-decanone (11b): Yield: 73%; 84°C/5 mmHg; GC-MS, m/z 170, 156, 142, 128, 114, 99, 85, 71 (100), 57, 43, 41, 39. ¹H NMR (500 MHz, CDCl₃): δ 2.50-2.54 (m, 1 H), 2.40-2.43 (m, 2 H), 1.53-1.62 (m, 4 H), 1.24-1.34 (m, 6 H), 1.05 (*d*, J = 6.5 Hz, 1 H), 0.90 (*t*, J = 7 Hz, 3 H), 0.89 (*t*, J = 7.5 Hz, 3 H).

^{13}C NMR (125 MHz, CDCl_3): δ 215.1, 46.1, 41.1, 35.2, 31.5, 23.4, 22.5, 20.5, 16.3, 14.1, 13.9.

4-methyl-5-undecanone (12b): Yield: 74%; 90°C/5 mmHg; GC-MS, m/z 184, 170, 156, 142, 127, 113 (100), 99, 85, 71, 57, 43, 29; ^1H NMR (500 MHz, CDCl_3): δ 2.50-2.55 (m, 1 H), 2.40-2.43 (m, 2 H); 1.61-1.63 (m, 2 H), 1.54-1.57 (m, 2 H), 1.24-1.33 (m, 8 H), 1.05 (*d*, $J = 7$ Hz, 3 H), 0.90 (*t*, $J = 7$ Hz, 3 H), 0.87 (*t*, $J = 7$ Hz, 3 H); ^{13}C NMR (125 MHz, CDCl_3): δ 215.1, 46.1, 41.2, 35.2, 31.7, 29.0, 23.7, 22.5, 20.5, 16.4, 14.1, 14.0.

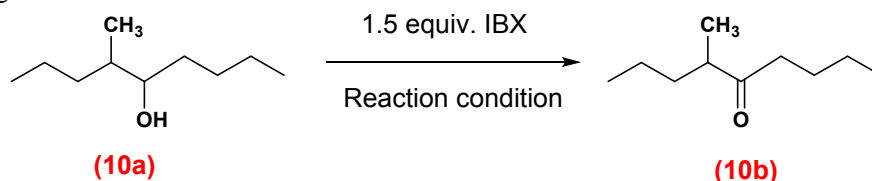
4-methyl-5-dodecanone (13b): Yield: 80%; 112°C/5 mmHg; GC-MS, m/z 198, 184, 170, 156, 141, 127, 113, 99, 85, 71, 57 (100), 43; ^1H NMR (500 MHz, CDCl_3): δ 2.50-2.54 (m, 1 H), 2.40-2.43 (m, 2 H), 1.61-1.63 (m, 2 H), 1.54-1.58 (m, 2 H), 1.26-1.31 (m, 10 H), 1.05 (*d*, $J = 7$ Hz, 3 H), 0.90 (*t*, $J = 7$ Hz, 3 H), 0.87 (*t*, $J = 7.5$ Hz, 3 H); ^{13}C NMR (125 MHz, CDCl_3): δ 215.0, 46.1, 41.1, 35.2, 31.7, 29.3, 29.1, 23.7, 22.6, 20.5, 16.3, 14.1, 14.0.

4-methyl-5-tridecanone (14b): Yield: 82%; 120°C/2 mmHg; GC-MS, m/z 212, 198, 184, 170, 155, 141, 123, 99, 85, 71 (100), 57, 43, 29; ^1H NMR (500 MHz, CDCl_3): δ 2.50-2.54 (m, 1H), 2.39-2.43 (m, 2H), 1.54-1.64 (m, 4 H), 1.24-1.33 (m, 12 H), 1.05 (*d*, $J = 6.5$ Hz, 3H), 0.90 (*t*, $J = 7$ Hz, 3H), 0.87 (*t*, $J = 7.5$ Hz, 3 H); ^{13}C NMR (125 MHz, CDCl_3): δ 215.1, 46.1, 41.1, 35.2, 31.8, 29.4, 29.3, 29.1, 23.7, 22.6, 20.5, 16.3, 14.1, 14.1.

6-methyl-7-pentadecanone (15b): Yield: 85%; 132°C/2 mmHg; GC-MS, m/z 240, 184, 170, 155, 141, 127, 113, 72, 57 (100), 43, 41, 39. ^1H NMR (500

MHz, CDCl₃): δ 2.48-2.52 (m, 1 H), 2.39-2.43 (m, 2 H), 1.54-1.65 (m, 4 H), 1.24-1.30 (m, 16 H), 1.05 (*d*, *J* = 6.5 Hz, 3 H), 0.88 (*t*, *J* = 7 Hz, 6 H). ¹³C NMR (125 MHz, CDCl₃): δ 215.1, 46.3, 41.1, 33.0, 31.9, 31.8, 29.4, 29.3, 29.2, 26.9, 23.7, 22.6, 22.5, 16.4, 14.1, 13.9.

Table S1. Exploring conditions for the oxidation of 4-methyl-5-nonanone, **10a** using IBX



Entry	Solvent	Condition	Yield (%) ^a
1	β -CD in water/acetone	Reflux, stirred, 24h	trace
2	No solvent	MW, 20 min	15
2	Acetone	Reflux, stirred, 6h	40
3	Acetone	MW, 20 min	50
5	DMF	Reflux, stirred, 6h	30
6	DMF	MW, 20min	51
7	CH ₃ CN	Reflux, stirred, 6h	51
8	CH ₃ CN	MW, 20 min	70
9	DMSO	Reflux, stirred, 6h	35
10	DMSO	MW, 20 min	40
11	THF	Reflux, Stirred, 6h	39
11	THF	MW, 20 min	38
12	CHCl ₃	Reflux, Stirred, 6h	41
13	CHCl ₃	MW, 20 min	34

^aIsolated yield of pure product

2. Field Trials

Field experiments were conducted to coconut tree at Chau Thanh district, Ben Tre province, Vietnam (10°18'06.0"N 106°17'22.0"E). Pitfall traps prepared from polypropylene plastic bucket (5L, diameters of 26 and 30

cm, height of 36 cm) covered with a lip possessed four openings (4 cm x 8 cm) with a distance of 10 cm from the top (Figure S1). Traps were added soap water and put under the ground (about 20 cm).

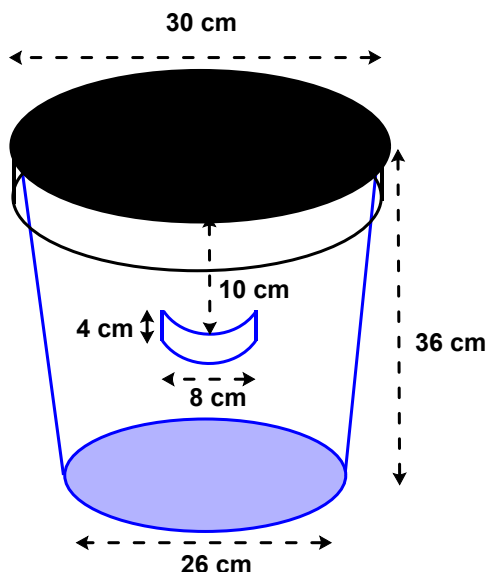


Figure S1. Trap design of field trials

For preparation of baits, the synthesized compounds (10 mg) were placed in 1 mL Eppendorf tube. The Eppendorf tubes had four 1 mm diameter holes and were suspended at center of the bucket lip with a distance of 10 cm from the top. In the traps, the weevils searched to the bait, walked to window and then fell into the trap where were drown in the soap water. The empty Eppendorf was used as negative controls in all experiments.

The synthesized compounds (**1b-15b**) and (**1c-15c**) were used to prepare the bait and trials of each compounds were observed during a week. the baits (10 mg) were prepared from pure compounds or blending alcohols

and corresponding ketone in comparison with their pheromone which were mixture of 4-methyl-5-nonanone (**10b**) and 4-methyl-5-nonanol (**10c**) in a ratio of 10:1 (v/v). The experiments were carried out during January to July during two years 2019 and 2020. The experiment was arranged in randomized block design in coconut farm with five replicates. Each block included three traps and distance between the traps were at interval of 15 m while a distance of 30-40m were maintained between the blocks. The results were described in mean number of the captured weevils per 3 traps per week.

Analysis of collected data was performed Duncan's Multiple Range Test (DMRT) software package. All significant differences in doses with respect to tested pheromone or analogue components were calculated by means of the paired Student's t-test with 95% ($P \leq 0.05$) and 99% ($P \leq 0.01$) confidence level.

Table S2. Screening the attractiveness of the synthesized compounds

Comp.	Captured weevils (mean \pm SD)	Comp.	Captured weevils (mean \pm SD)
1c	0	1b	0
2c	0	2b	0
3c	0	3b	0
4c	1.0 \pm 0.70	4b	1.0 \pm 0.70
5c	0	5b	3.6 \pm 0.54
6c	0	6b	0
7c	0	7b	0
8c	0	8b	0
9c	0	9b	0
10c	1.4 \pm 0.45	10b	1.4 \pm 0.45

11c	1.6 ± 0.54	11b	1.0 ± 0.70
12c	0	12b	0
13c	0	13b	0
14c	0	14b	0
15c	0	15b	0
Pher	2.2 ± 0.45	control	0

All experiments were compared with negative control.

3. Spectra and diastereomers

Figure S2. ¹H NMR spectrum of **1a** (CDCl₃)

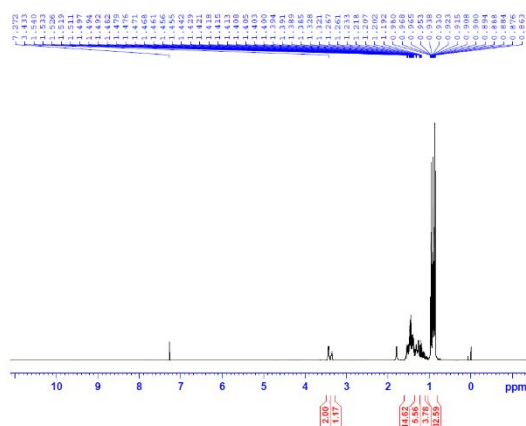


Figure S3. ^{13}C NMR spectrum of **1a** (CDCl_3)

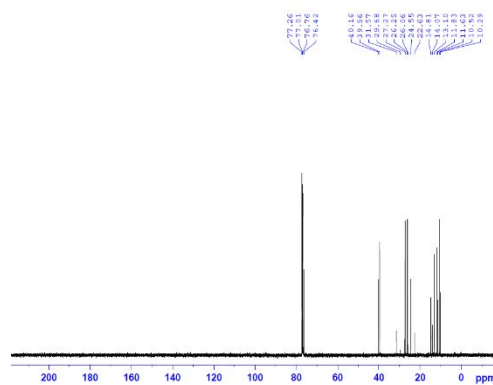


Figure S4. ^1H NMR spectrum of **2a** (CDCl_3)

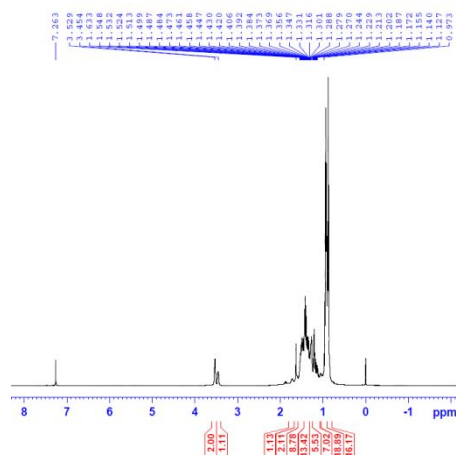


Figure S5. ^{13}C NMR spectrum of **2a** (CDCl_3)

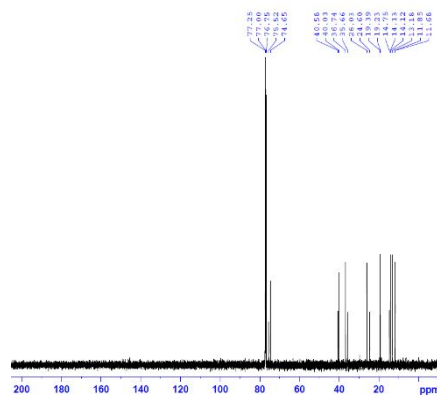


Figure S6. ^1H NMR spectrum of **3a** (CDCl_3)

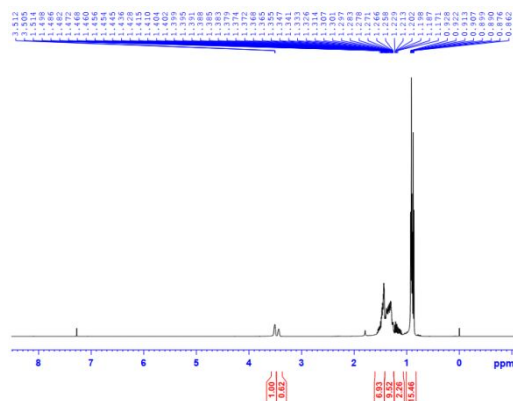


Figure S7. ^{13}C NMR spectrum of **3a** (CDCl_3)

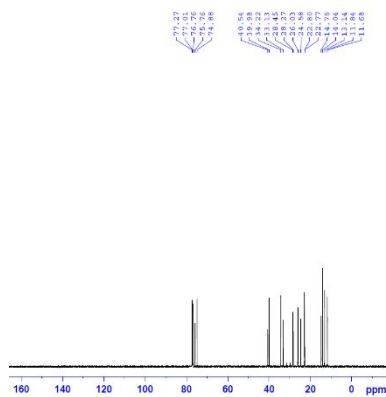


Figure S8. ^1H NMR spectrum of **4a** (CDCl_3)

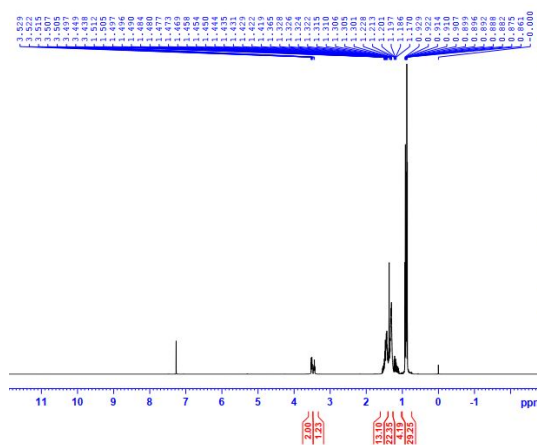


Figure S9. ^{13}C NMR spectrum of **4a** (CDCl_3)

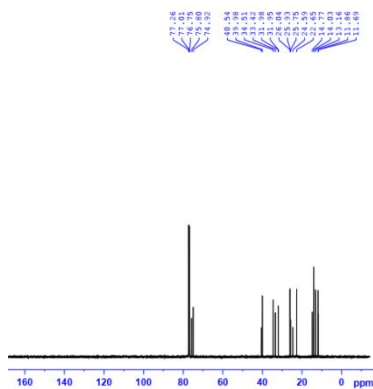


Figure S10. ^1H NMR spectrum of **5a** (CDCl_3)

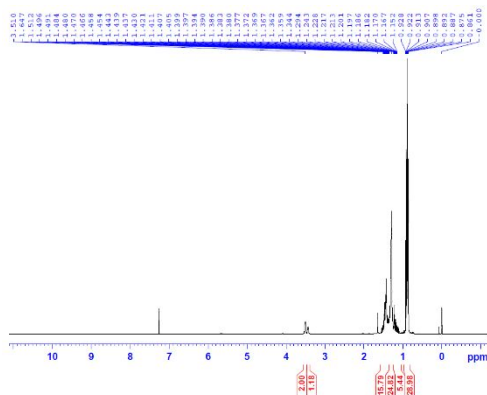


Figure S11. ^{13}C NMR spectrum of **5a** (CDCl_3)

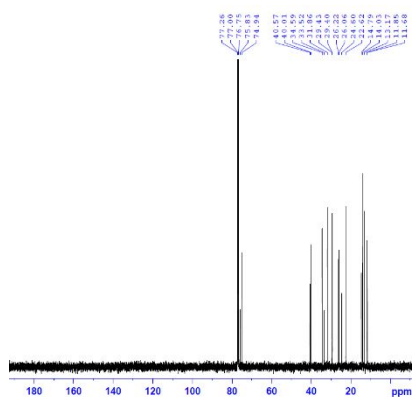


Figure S12. ^1H NMR spectrum of **6a** (CDCl_3)

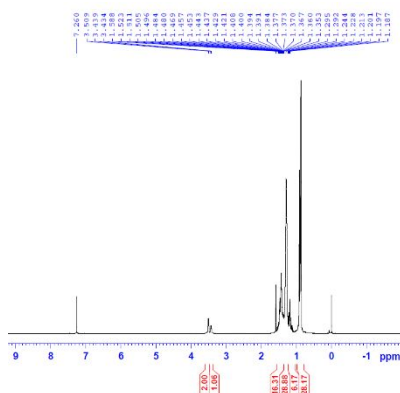


Figure S13. ^{13}C NMR spectrum of **6a** (CDCl_3)

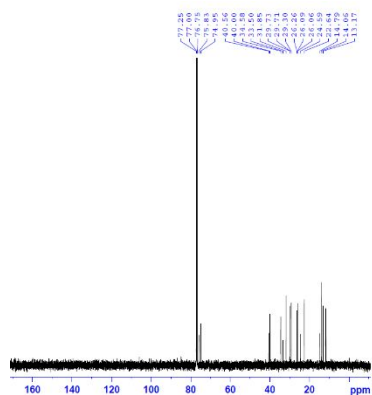


Figure S14. ^1H NMR spectrum of **7a** (CDCl_3)

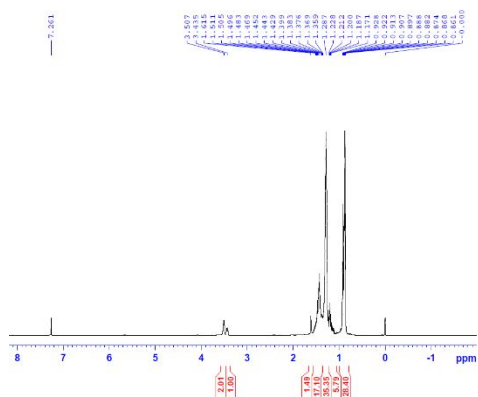


Figure S15. ^{13}C NMR spectrum of **7a** (CDCl_3)

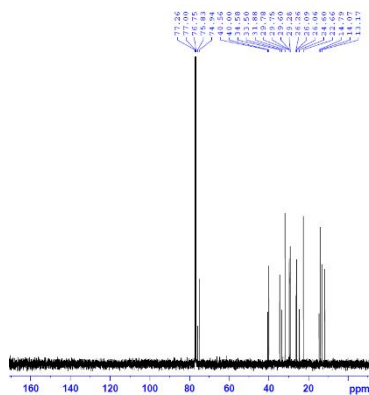


Figure S18. ^1H NMR spectrum of **9a** (CDCl_3)

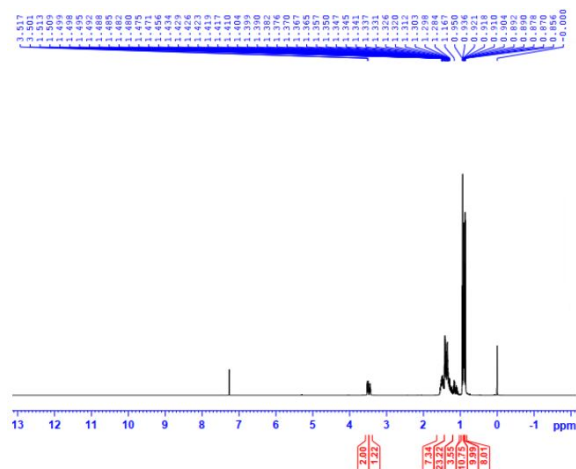


Figure S19. ^{13}C NMR spectrum of **9a** (CDCl_3)

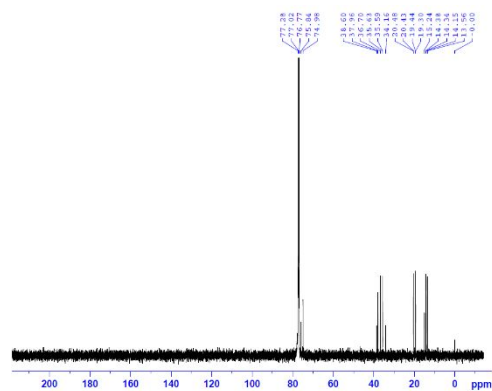


Figure S20. ^1H NMR spectrum of **11a** (CDCl_3)

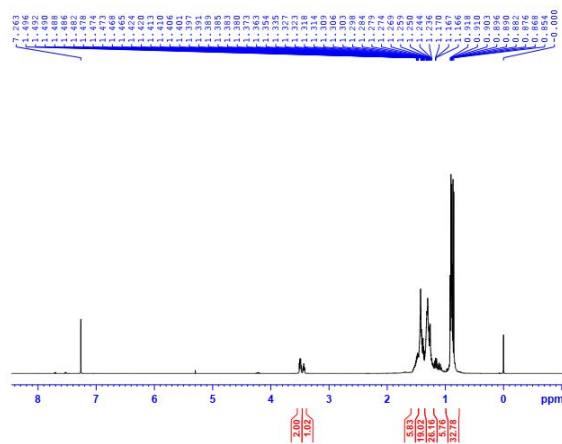


Figure S21. ^{13}C NMR spectrum of **11a** (CDCl_3)

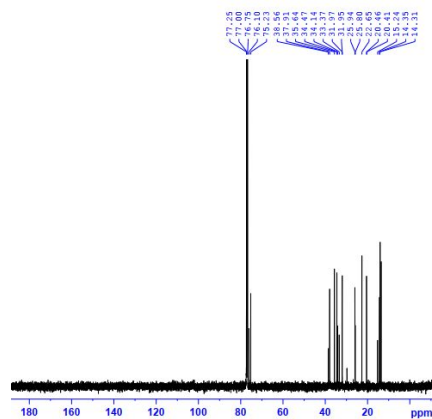


Figure S22. ^1H NMR spectrum of **12a** (CDCl_3)

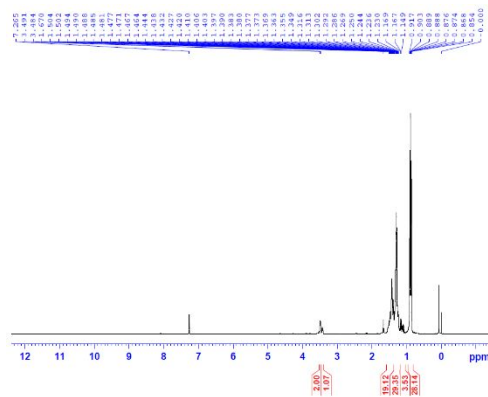


Figure S23. ^{13}C NMR spectrum of **12a** (CDCl_3)

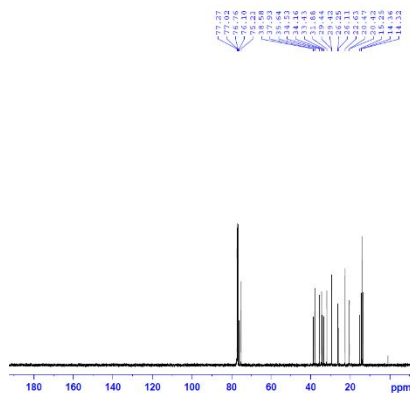


Figure S24. ^1H NMR spectrum of **13a** (CDCl_3)

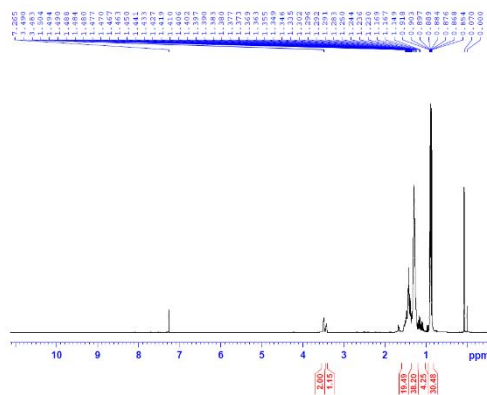


Figure S25. ^{13}C NMR spectrum of **13a** (CDCl_3)

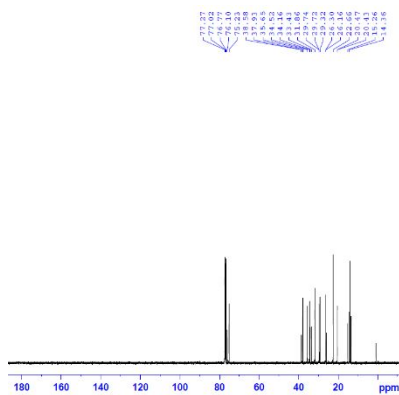


Figure S26. ^1H NMR spectrum of **14a** (CDCl_3)

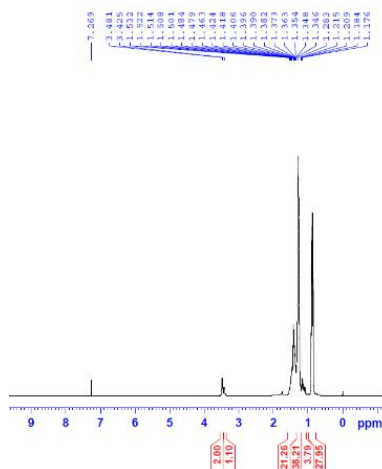


Figure S27. ^{13}C NMR spectrum of **14a** (CDCl_3)

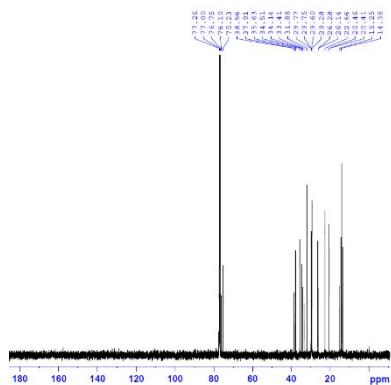


Figure S28. ^1H NMR spectrum of **15a** (CDCl_3)

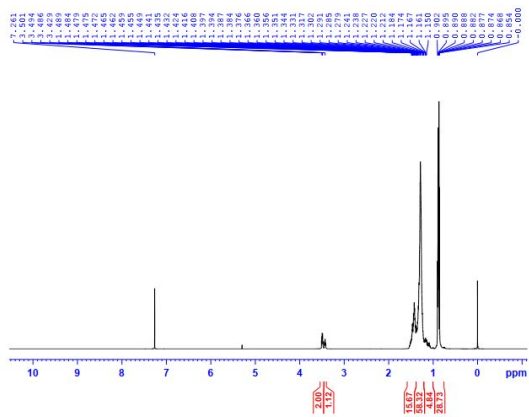


Figure S29. ^{13}C NMR spectrum of **15a** (CDCl_3)

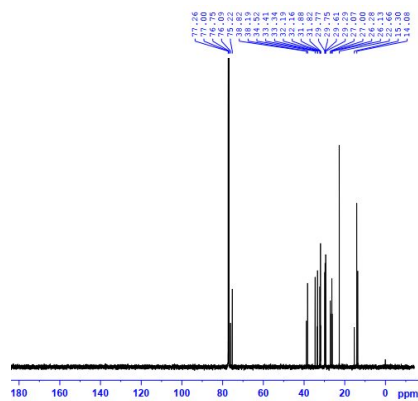
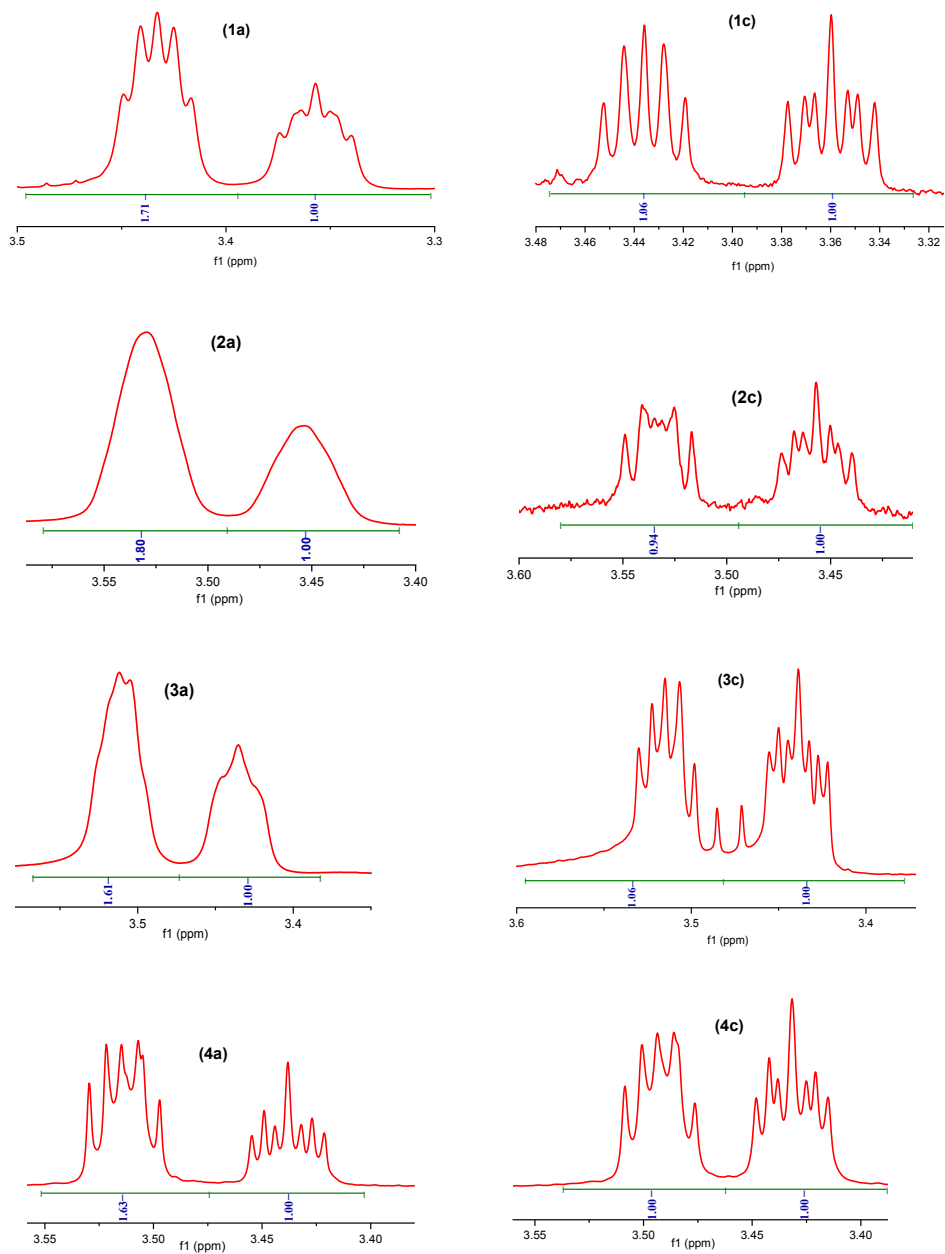
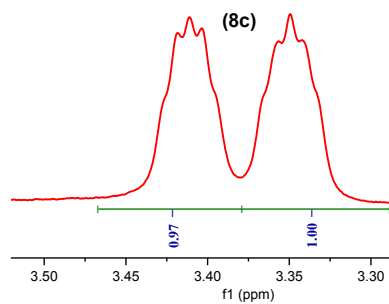
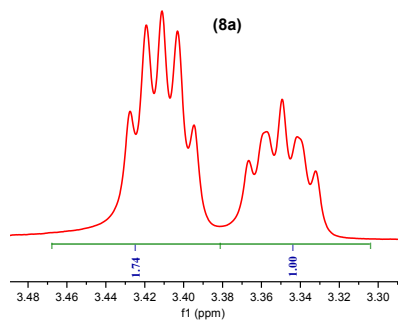
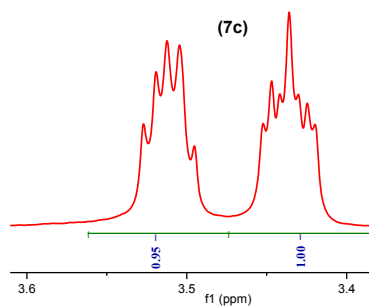
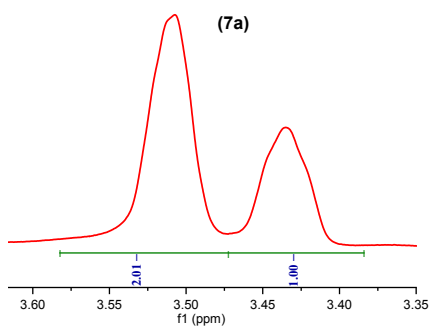
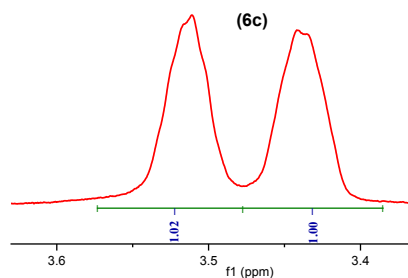
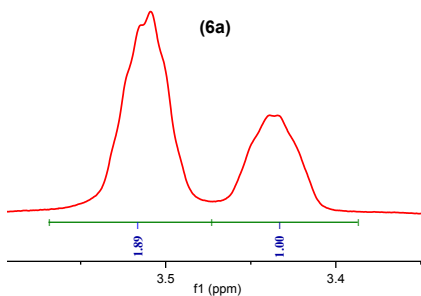
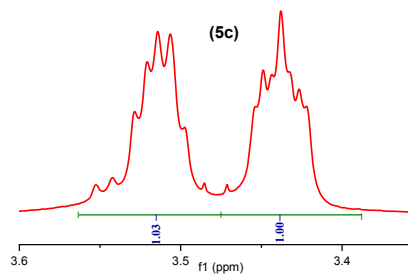
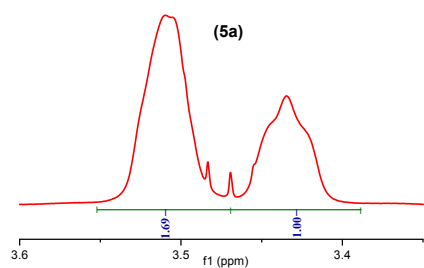
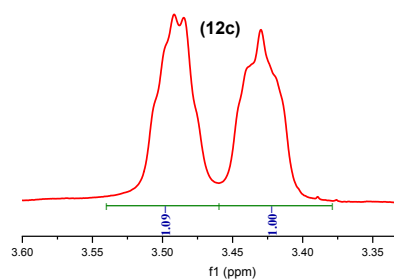
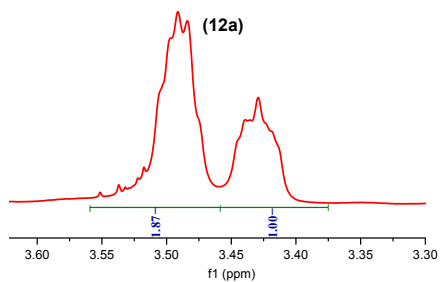
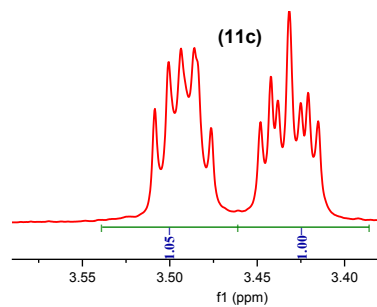
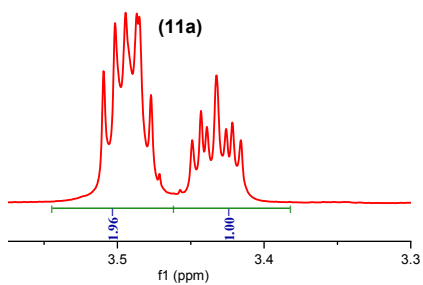
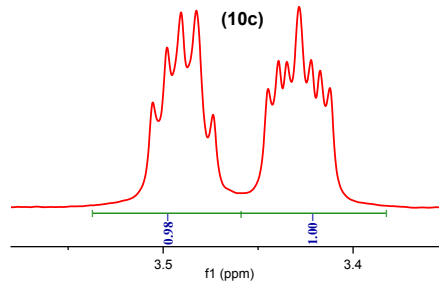
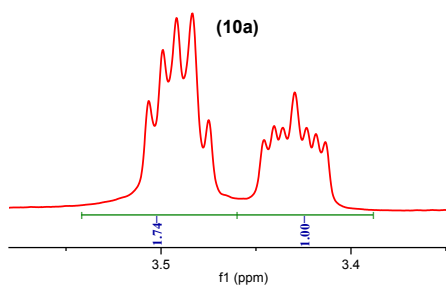
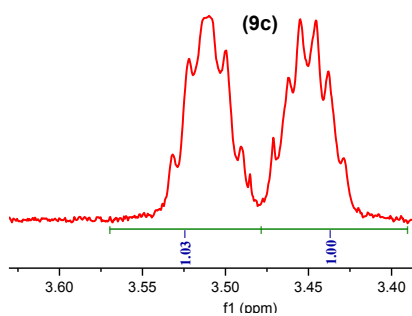
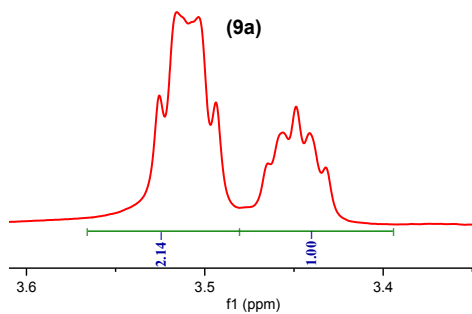


Figure S30. Diastereomer ratios of **1a-15a** and **1c-15c**







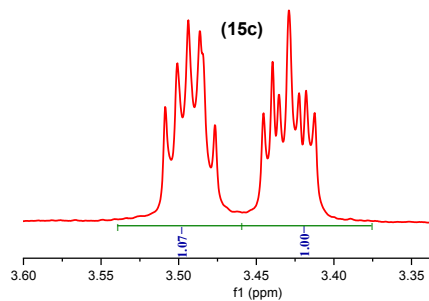
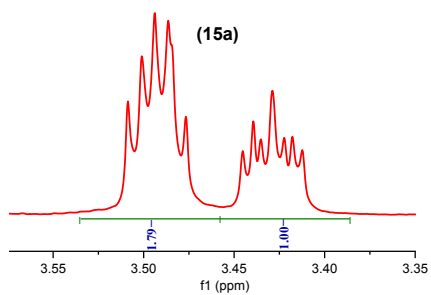
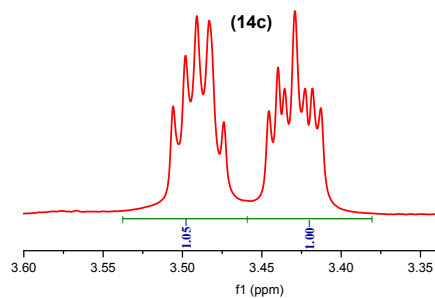
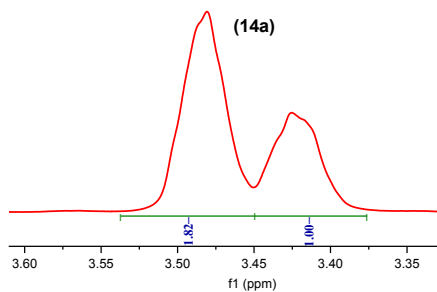
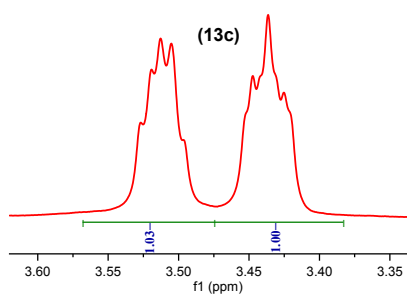
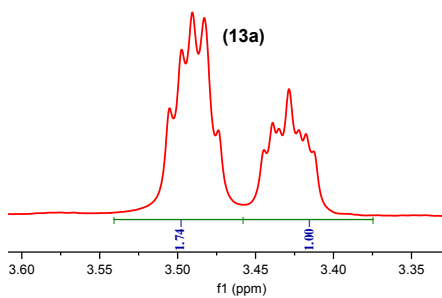


Figure S31. ^1H NMR spectrum of **3b** (CDCl_3)

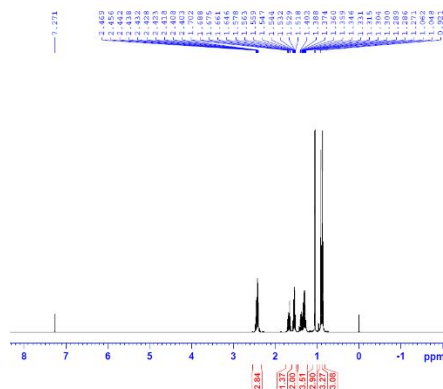


Figure S32. ^{13}C NMR spectrum of **3b** (CDCl_3)

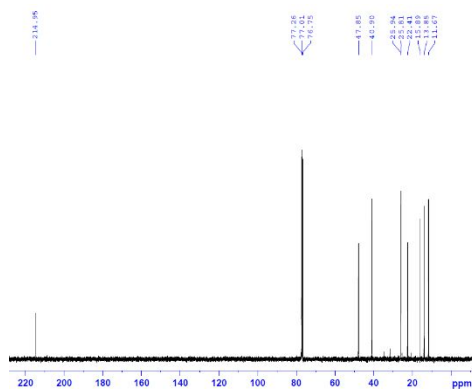
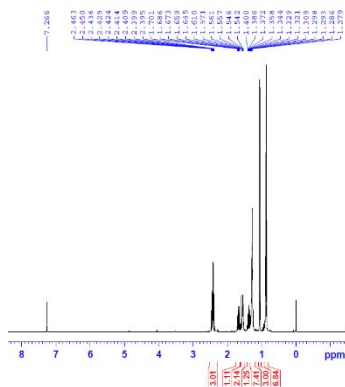


Figure S33. ^1H NMR spectrum of **5b** (CDCl_3)



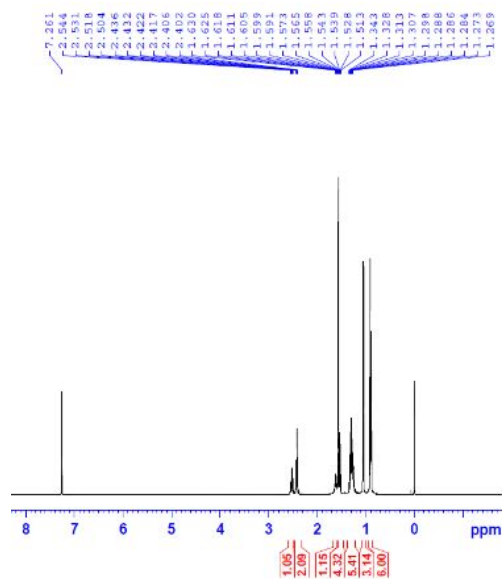


Figure S43. ^{13}C NMR spectrum of **11b** (CDCl_3)

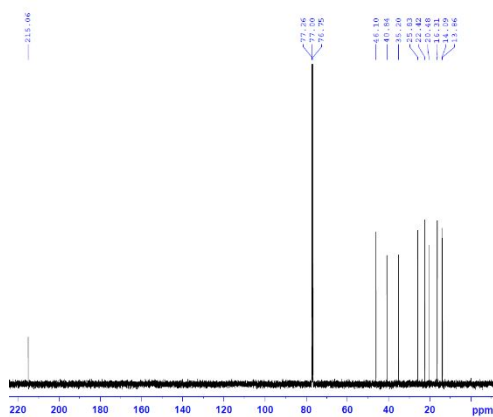


Figure S44. ^1H NMR spectrum of **12b** (CDCl_3)

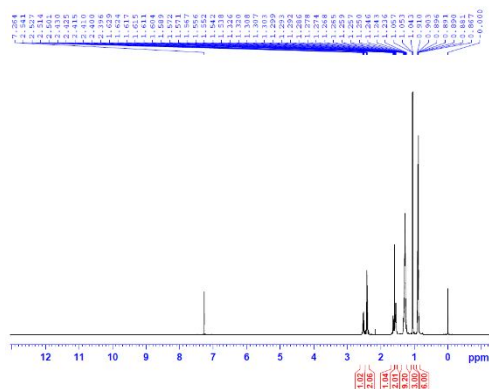


Figure S45. ¹³C NMR spectrum of **12b** (CDCl₃)

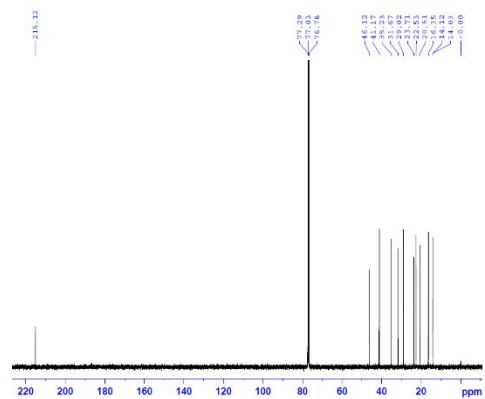
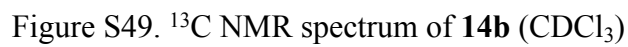
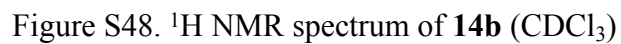
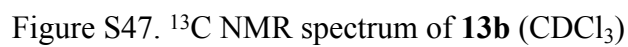


Figure S46. ¹H NMR spectrum of **13b** (CDCl₃)



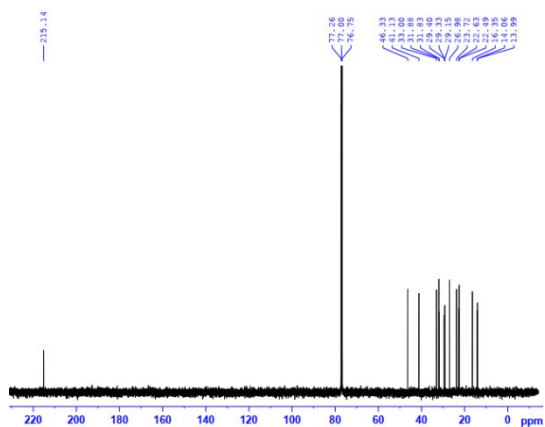


Figure S52. ¹H NMR spectrum of 2-methyl-1-heptanol (CDCl₃)

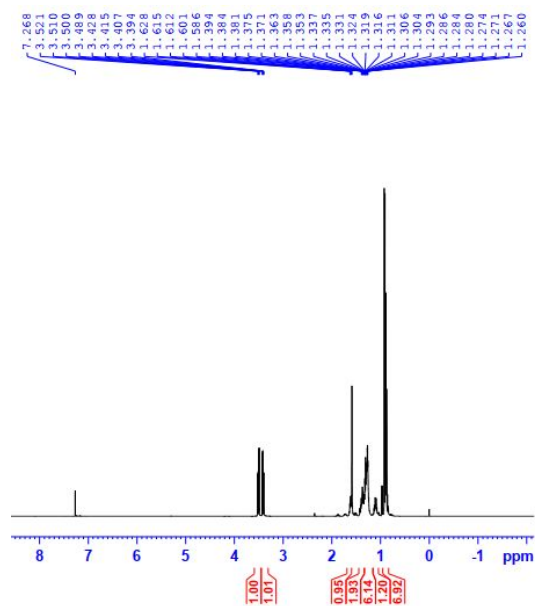
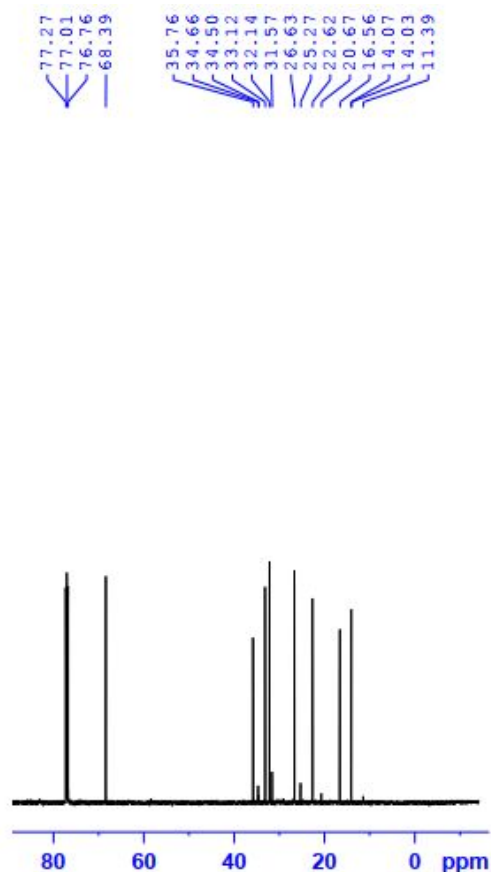


Figure S53. ^{13}C NMR spectrum of 2-methyl-1-heptanol (CDCl_3)



1. Dang, C.H.; Le, V.D.; Nguyen, C.H.; Nguyen T.D. *Arkivoc*, **2017**, 2017 (v), 187-195.
2. Jones, T. H.; Meinwald, J.; Hicks, K.; Eisner, T. *Proc. Natl. Acad. Sci.*, **1977**, 74, 419-422.