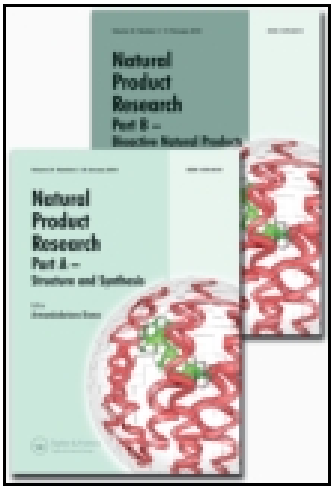


Natural Product Research: Formerly Natural Product Letters
Publication details, including instructions for authors and subscription information:
http://www.tandfonline.com/loi/gnpl20

Synthesis of 8-methyl-1-tetralone, a potential intermediate for (±)-platyphyllide

Po S. Poon[a], Liadis Bedoya[a], Gabriel J. Churio[a] & Ajoy K. Banerjee[a]
[a] Centro de Química, Instituto Venezolano de Investigaciones Científicas (IVIC), Apartado-21827, Caracas, 1020A, Venezuela
Published online: 11 Aug 2014.

To cite this article: Po S. Poon, Liadis Bedoya, Gabriel J. Churio & Ajoy K. Banerjee (2014) Synthesis of 8-methyl-1-tetralone, a potential intermediate for (±)-platyphyllide, Natural Product Research: Formerly Natural Product Letters, 28:20, 1747-1753, DOI: 10.1080/14786419.2014.945171

To link to this article: http://dx.doi.org/10.1080/14786419.2014.945171

Natural Product Research, 2014
Vol. 28, No. 20, 1747–1753, http://dx.doi.org/10.1080/14786419.2014.945171

Synthesis of 8-methyl-1-tetralone, a potential intermediate for (±)-platyphyllide

Po S. Poon, Liadis Bedoya, Gabriel J. Churio and Ajoy K. Banerjee*

Centro de Química, Instituto Venezolano de Investigaciones Científicas (IVIC), Apartado-21827, Caracas 1020A, Venezuela

(*Received 23 April 2014; final version received 13 July 2014*)

An alternative method for the synthesis of the 8-methyl-1-tetralone from the commercially available 5-methoxy-1-tetralone has been developed. The transformation involves eight steps and affords an overall yield 25%.

Keywords: 5-methoxy-1-tetralone; bromination; methylation; cyanation; hydrogenolysis; platyphyllide; 8-methyl-1-tetralone

1. Introduction

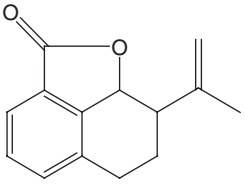
Substituted 1-tetralones have been extensively utilised for the synthesis of several terpenoid compounds (Poon et al. 2008). In relation to our studies on the syntheses of substituted 1-tetralones (Cabrera & Banerjee 2010; Cabrera et al. 2011), an attempt was made towards the synthesis of 8-methyl-1-tetralone **3** whose transformation to ester **4** and (±)-platyphyllide **1** (Bohlmann & Eickeler 1979) can be achieved without any difficulty (Figure 1). Platyphyllide **1** (Figure 1) is a norsesquiterpene lactone that was isolated from *Senecio platyphylloides* in 1977 by Bohlmann and collaborators who also determined its structure, including the relative configuration (Bohlmann et al. 1977). Three racemic syntheses of platyphyllide **1** (Bohlmann & Eickeler 1979; Hayakawa et al. 1986; Ho & Ho 1999) have been published. The asymmetric total synthesis (Nagashima et al. 1995) and catalytic enantioselective total synthesis (Hiraoka et al. 2010) of platyphyllide **1** have also been reported. The transformation of Wieland–Miescher ketone **2** to 8-methyl-1-tetralone **3** and its conversion to ester **4** was reported by us (Banerjee et al. 1999). The ester **4** prepared by an alternative procedure was utilised in the total synthesis of platyphyllide **1** (Bohlmann & Eickeler 1979) (Figure 2).

The synthesis of tetralone **3** from ketone **2** involved the use of thionyl chloride whose purchase is prohibited in this country. Therefore, we tried to develop an alternative synthesis of the tetralone **3**. To the best of our knowledge, only three syntheses (Liu et al. 1988; Banerjee et al. 1999; Heidelbaugh et al. 2005) of the tetralone **3** have been so far published. The overall yield of the published procedures were 16%, 18% (from the Wieland–Miescher ketone) and 8% yield, respectively. Our alternative route for the tetralone **3** is described in Figure 3.

2. Results and discussions

The commercially available 5-methoxy-1-tetralone **5** (scheme 2) was selected as starting material. Bromination (Poon & Banerjee 2009) of the tetralone **5** with *N*-bromosuccinimide (NBS) in acetonitrile yielded the bromotetralone **6** with 97% yield, already reported (Macharla

*Corresponding author. Email: aabanerje@gmail.com



(1)

Figure 1. Chemical structure of platyphyllide.

et al. 2012) by a different procedure. Heating with cuprous cyanide in dimethylformamide (Jones et al. 1981) led to the formation of cyanotetralone **7** with 92% yield, which is reported as patent (Gmuender, 1972). Reduction of the tetralone **7** with DIBAL-H in toluene furnished the aldehyde **8** with 77% yield which was subjected to hydrogenation to obtain the tetralol **9**. Microwave-assisted Huang-Minlon reaction (Minlon 1946; Jaisankar et al. 2002) of the compound **8** was also attempted but the hydrogenation was preferred owing to ecofriendly condition. Oxidation of tetralol **9** with pyridinium chlorochromate provided tetralone **10** with 86% yield (Cocker et al. 1950) that was easily converted to the already known tetralone **11** with 96% yield (Tobias 1970) on reaction with hydrobromic acid–acetic acid. Tetralone **10** has proved to be a potential intermediate for the synthesis of bioactive sesquiterpene cacalol (Garofalo et al. 1999). An oxidation/demethoxylation strategy was previously tried in the transformation of tetralol **9** to tetralone **11** using sodium perborate–hydrobromic acid as oxidant, but a low yield of **11** (38%) was observed. The successful conversion of tetralone **11** to the target tetralone **3** required an efficient method for the deoxygenation of the phenolic hydroxyl group of the compound **11**. Two methods were tried to realise the objective. The first method which consisted of the conversion of the hydroxyl group of **11** to the corresponding 5-phenyltetrazolyl ether **12** (Beyerman et al. 1976) and subsequent heterogeneous hydrogenolysis of **12** afforded the target tetralone **3** in 44% yield (two steps). The other method consisted of the activation of phenol **11** as triflate and subsequent heterogeneous Pd/C-catalysed deoxygenation of aryl triflate **13** with triethylamine (Sag et al. 1990) to obtain the 8-methyl-1-tetralone **3** with 64% yield (two steps). Its spectroscopic data (IR, ^{1}H and ^{13}C NMR, MS) agreed well with that of the assigned structure.

3. Experimental

3.1. *General*

Unless otherwise stated, IR spectra were obtained with a Nicolet FT spectrometer. NMR spectra were recorded on a Bruker 300 MHz spectrometer in $CDCl_3$ and CD_3CN using TMS as internal standard. Mass spectra were recorded on Kratos MS25RFA and on gas chromatography Hewlett Packard 5890 Quadrupolar 5972 Series S. Microwave irradiations were carried out using a CEM Discovery Labmate microwave oven (2.45 GHz, 300 W), using flask (100 mL) of made of Pyrex

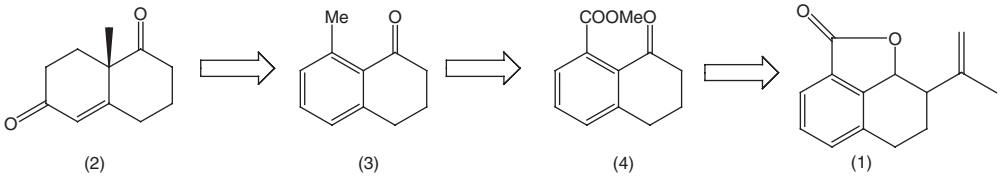


Figure 2. Transformation of Wieland–Miescher **2** ketone into ester **4**.

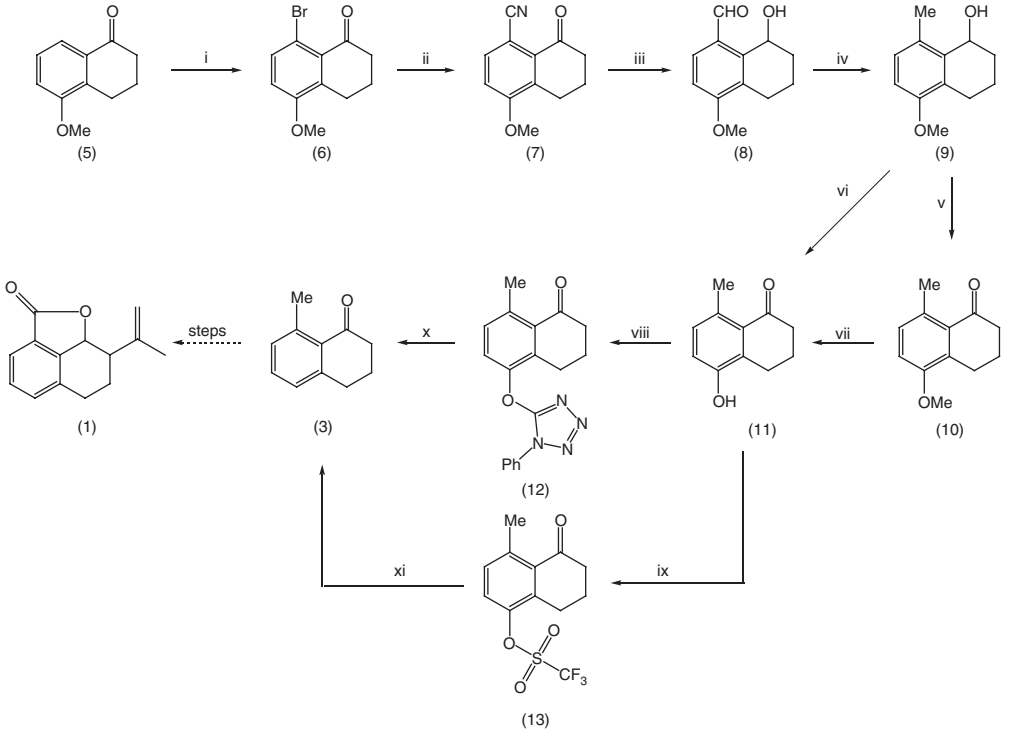


Figure 3. Synthesis of 8-methyl-1-tetralone **3** (i) NBS, MeCN; (ii) CuCN, DMF; (iii) DIBALH, CH_2Cl_2; (iv) H_2, Pd/C 10%, $CH_3CO_2CH_3$, 1 atm; (v) PCC, CH_2Cl_2; (vi) HBr, $NaBO_3H_2O$, CH_3CO_2H; (vii) HBr, CH_3CO_2H; (viii) 5-chloro-1-phenyl-1H-tetrazole, K_2CO_3, Me_2CO; (ix) $(CF_3SO)_2O$, Et_3N, CH_2Cl_2; (x) 100 psi H_2, Pd/C 5%, EtOH; (xi) 100 psi H_2, Pd/C 10%, Et_3N, MeOH.

glass (No 4320), size 24/40 mm. All organic extracts were dried over $MgSO_4$ and evaporated under reduced pressure. Column chromatography was carried out on Silica gel 60 (Merck, grade 60, 70–230 mesh) and TLC plates were coated with silica gel 60 F_{254}, layer thickness 0.2 mm, and the spots were located by exposing the plate to UV light. Micro-analyses were carried out on a Carlo-Erba 1108 elemental analyser in the Chemistry Center, IVIC.

3.2. *8-Bromo-5-methoxy-1-tetralone (6)*

A mixture of 5-methoxy-1-tetralone **5** (2 g, 11.35 mmol), NBS (2.02 g, 11.35 mmol) and dry MeCN (12 mL) was stirred at room temperature for 18 h. The solvent was evaporated and chromatographed (hexane/ether, 7:3) to yield the bromotetralone **6** (2.67 g, 92%) as yellow solid, m.p. 52–53°C (Poon & Banerjee 2009); ν_{max} (cm^{-1}) 1694 (CO); ^{1}H NMR δ: 7.46 (d, 1H, $J = 8.7$ Hz), 6.79 (d, $J = 8.7$ Hz), 3.82 (s, 3H, OMe), 2.87 (t, 2H, $J = 6.25$ Hz), 2.63 (t, 2H, $J = 6.6$ Hz), 2.05 (q, 2H, $J = 6.5$ Hz); ^{13}C NMR δ: 197.25, 156.01, 135.99, 133.38, 131.51, 114.44, 111.41, 55.87, 39.88, 23.65, 22.01; MS *m/z* (%): 256 (98), 254 (100), 239 (23), 228 (49), 198 (67); anal. calcd for $C_{11}H_{11}BrO_2$: C, 51.79; H, 4.35; found: C, 51.45; H, 4.35.

3.3. *8-Cyano-5-methoxy-1-tetralone (7)*

To a solution of bromotetralone **6** (0.81 g, 3.19 mmol) in anhydrous dimethylformamide (4 mL) was added CuCN (0.58 g, 6.49 mmol) and heated to 140°C for 2 h under nitrogen atmosphere. The reaction mixture was cooled to 100°C, hydrochloric acid containing aqueous ferric chloride

(10%, 15 mL) was added dropwise and heated under reflux for 20 min. The reaction mixture was cooled, diluted with water and extracted with dichloromethane. The combined organic extracts were washed with brine, dried and evaporated under reduced pressure. The resulting oil was chromatographed (hexane/ethyl acetate, 7:3) to yield the cyanotetralone **7** (0.59 g, 92%) as yellow solid, m.p 124–125°C; ν_{max} (cm^{-1}) 2222 (CN), 1687 (CO); ^{1}H NMR δ: 7.61 (d, 1H, $J = 8.4$ Hz), 7.02 (d, 1H, $J = 8.5$ Hz), 3.91 (s, 3H, OMe), 2.87–2.84 (m, 2H), 2.65–2.62 (m, 2H), 2.10–2.06 (m, 2H); ^{13}C NMR δ: 195.65, 159.94, 135.46, 135.15, 134.61, 118.96 (CN), 113.14, 101.98, 56.15, 38.58, 22.87, 21.73; MS *m/z* (%): 201 (100), 186 (26), 173 (74), 145 (82); anal. calcd for $C_{12}H_{11}NO_2$: C, 71.63; H, 5.51; N, 6.96; found: C, 71.87; H, 5.68; N, 7.10.

3.4. *8-Formyl-1-methoxy-1-tetralol (8)*

To a solution of the cyanotetralone **7** (0.1 g, 0.49 mmol) in dry dichloromethane (3 mL), cooled in ice was added dropwise diisobutylaluminium hydride (DIBAL-H 1 M, 2.5 mL, 2.5 mmol) in dichloromethane. The reaction mixture was stirred at room temperature overnight and then quenched with water and hydrochloric acid (2 M) until pH = 1. The solution was diluted with water and extracted with dichloromethane. The combined extracts were washed with brine, dried and evaporated. The residual oil was chromatographed to yield the formyl tetralol **8** (77 mg, 76%) as solid, m.p. 91–93°C; ν_{max}(cm^{-1}) 3387 (OH), 1656 (CO), 1528; ^{1}H NMR δ: 9.86 (s, 1H, CHO), 7.66 (d, 1H, $J = 8.4$ Hz), 6.87 (d, 1H, $J = 8.4$ Hz), 5.07 (m, 1H), 4.56 (d, 1H, $J = 3.7$ Hz, OH), 3.89 (s, 3H, OMe), 2.86–2.81 (m, 1H), 2.41–2.37 (m, 1H), 2.13–2.09 (m, 1H), 1.92–1.86 (m, 1H), 1.79–1.76 (m, 2H); ^{13}C NMR δ: 194.09 (CHO), 162.28, 141.54, 137.42, 128.21, 128.08, 107.77, 63.05, 55.73, 30.21, 23.80, 16.78; MS *m/z* (%): 206 (78), 188 (91), 177 (100); anal. calcd for $C_{12}H_{14}O_3$: C, 69.88; H, 6.84; found: C, 69.95; H, 7.03.

3.5. *8-Methyl-5-methoxy-1-tetralol (9)*

Method A: a solution of the compound **8** (0.14 g, 0.69 mmol) in ethyl acetate (20 mL) was stirred for 14 h with 10% palladium–charcoal (65 mg) under hydrogen at 15 psi. Removal of catalyst by filtration and solvent under reduced pressure yielded an oily residue which on chromatographic purification (hexane/ether, 7:3) afforded tetralol **9** as a white solid (96.7 mg, 73%), m.p. 101–102°C; ν_{max}(cm^{-1}): 3421 (OH), 3005, 2933, 1587; ^{1}H NMR δ: 6.99 (d, 1H, $J = 8.2$ Hz), 6.68 (d, 1H, $J = 8.2$ Hz), 4.86 (s, 1H), 3.78 (s, 3H), 2.92–2.88 (m, 1H), 2.40–2.33 (m, 2H), 2.38 (s, 3H, OMe), 2.10–2.07 (m, 1H), 1.84–1.68 (m, 3H), 1.61 (s, 1H, OH); ^{13}C NMR δ: 155.40, 136.75, 129.45, 128.06, 126.45, 108.86, 64.45, 55.38, 31.33, 23.31, 18.04, 16.16; MS: *m/z* (%): 192 (41), 174 (100), 159 (75); anal. calcd for $C_{12}H_{16}O_2$: C, 74.97; H, 8.39; found: C, 74.85; H, 8.71.

Method B: a mixture of the tetralol **8** (0.30 g, 1.45 mmol) in toluene (9 mL), 80% hydrazine hydrate (1.5 g, 3 mmol) and powdered sodium hydroxide (1.08 g) was taken in a flask and placed in a microwave oven. After irradiation for 1 h at 280 W, the reaction mixture was cooled to room temperature, neutralised with aqueous HCl (5%) and extracted with chloroform. The combined extracts were washed successively with brine, water and dried. After removal of the solvent under reduced pressure, column chromatography of the residue on silica gel (hexane/ether, 7:3) produced the product **9** (0.212 g, 74%). Spectroscopic data were identical with that of obtained by method A.

3.6. *8-Methyl-5-methoxy-1-tetralone (10)*

To pyridinium chlorochromate (0.17 g, 0.78 mmol) suspended in dichloromethane (1.5 mL) was added dropwise a solution of the tetralol **9** (0.10 g, 0.52 mmol) in dichloromethane (1 mL). The mixture was stirred at room temperature for 1 h and then filtered through a short pad of Celite.

The filtrate was washed with water, dried and evaporated to yield an oil which on chromatographic purification (hexane/ether, 8:2) produced the tetralone **10** (85 mg, 86%) as colourless liquid which on long standing got solidified, a low melting solid, m.p. 30–32°C (31–33°C, Cocker et al. 1950); ν_{max} (cm^{-1}) 3002, 2925, 1680 (CO), 1536; ^{1}H NMR δ: 7.02 (d, 1H, $J = 8.4$ Hz), 6.88 (d, 1H, $J = 8.3$ Hz), 3.81 (s, 3H, OMe), 2.87 (t, 2H, $J = 6.3$ Hz), 2.59 (t, 2H, $J = 6.4$ Hz), 2.54 (s, 3H), 2.04 (q, 2H, $J = 6.4$ Hz); ^{13}C NMR: δ: 200.66 (CO), 154.81, 134.25, 132.35, 131.85, 130.01, 113.77, 55.69, 40.80, 23.59, 22.58, 22.38; MS *m/z* (%): 190 (100), 175 (23), 162 (62), 134 (81); anal. calcd for $C_{12}H_{14}O_2$: C, 75.76; H, 7.42; found: C, 75.33; H, 7.14.

3.7. *8-Methyl-5-hydroxy-1-tetralone (11)*

Method A: to a solution of the tetralone **10** (0.16 g, 0.84 mmol) in glacial acetic acid (1.5 mL) was added slowly hydrobromic acid (4.4 mL, 48%) at room temperature and then heated under reflux for 1 h. The reaction mixture was cooled, diluted with water and extracted with dichloromethane. The organic extracts were washed with sodium bicarbonate solution (5%), water, dried and evaporated. The residue was chromatographed (hexane/ether, 7:3) to yield the tetralone **11** (0.14 g, 96%), m.p. 189–190°C, (189–190°C, Corey & Suggs 1975); $\nu_{(max)}$ (cm^{-1}) 3035 (OH), 1625 (CO); ^{1}H NMR (CD_3CN) δ: 6.98 (s br, 1H, OH), 6.93 (d, 1H, $J = 8.7$ Hz), 6.89 (d, 1H, $J = 8.4$ Hz), 2.82 (t, 2H, $J = 6.2$ Hz), 2.54 (t, 2H, $J = 6.5$ Hz), 2.46 (s, 3H), 2.01 (q, 2H, $J = 6.4$ Hz); ^{13}C NMR (CD_3CN) δ 201.17 (CO), 153.05, 133.20, 132.87, 132.33, 130.91, 119.37, 41.36, 24.24, 23.16, 22.60; MS *m/z* (%):176 (82), 161 (23), 148 (100), 120 (83). anal. calcd for $C_{11}H_{12}O_2$: C, 74.98; H, 6.86; found: C, 74.79; H, 6.59.

Method B: a solution containing tetralol **9** (0.12 g, 0.62 mmol), sodium perborate monohydrate (0.14 g, 1.42 mmol) and hydrobromic acid 48% (0.1 mL) in acetic acid (20 mL) was heated to 50°C for 1 h. To the mixture was then added hydrobromic acid 48% (2 mL) and refluxed for 5 h. Upon cooling to room temperature, the reaction mixture was diluted with water and extracted with chloroform. The combined organic extracts were washed, dried and evaporated. The residue on chromatographic purification (hexane/ether, 7:3) afforded the tetralone **11** (41 mg, 38%). Spectroscopic data were identical with that obtained by method A.

3.8. *8-Methyl-5-[(2-phenyl-2H-tetrazol-5-yl)oxy]-1-tetralone (12)*

A mixture of tetralone **11** (0.15 g, 0.85 mmol), 5-chloro-1-phenyl-1H-tetrazole (0.15 g, 0.85 mmol) and potassium carbonate (0.23 g, 1.70 mmol) in acetone (5 mL) was heated under reflux for 9 h. The reaction mixture was cooled, diluted with water and extracted with dichloromethane. The organic extract was washed, dried and evaporated. The residue on chromatographic purification (hexane/ether, 7:3) yielded the derivative **12** (0.24 g, 88%), m.p. 119–120°C; ν_{max} (cm^{-1}) 1675 (CO); ^{1}H NMR δ: 7.81–7.80 (m, 2H), 7.60–7.56 (m, 2H), 7.52-7.49 (m, 1H), 7.41 (d, 1H, $J = 8.4$ Hz), 7.18 (d, 1H, $J = 8.4$ Hz), 2.85 (t, 2H, $J = 6.2$ Hz), 2.64-2.62 (m, 2H), 2.63 (s, 3H, Me), 2.06 (q, 2H, $J = 6.4$ Hz); ^{13}C NMR δ: 198.91, 159.46, 149.11, 140.38, 135.97, 133.06, 132.55, 131.26, 129.86, 129.59, 123.77, 122.04, 40.43, 24.00, 23.03, 21.98; MS *m/z* (%): 321 ($M^+ + 1$, 24), 175 (30), 159 (100), 147 (60); anal. calcd for $C_{18}H_{16}N_4O_2$: C, 67.49; H, 5.03; N, 17.49; found: C, 67.58; H, 5.20; N, 17.61.

3.9. *8-Methyl-1-trifluoromethylsulfonyloxy-1-tetralone (13)*

Triethylamine (0.36 mL, 2.63 mmol) was added to tetralol **11** (0.25 g, 1.31 mmol) in dichloromethane (8 mL) under an atmosphere of argon. Triflic anhydride (0.33 mL, 1.7 mmol) was added dropwise at −5°C, and the reaction mixture was stirred at 0°C for 2 h. The solvent was removed *in vacuo*, and the residue was chromatographed (hexane/ether 9:1) to obtain triflate

13 (0.39 g, 97%) as a colourless oil. ν_{max} (cm^{-1}) 1652 (CO); ^1H NMR δ: 7.28 (d, 1H, $J = 8.5$ Hz), 7.16 (d, 1H, $J = 8.5$ Hz), 2.98 (t, 2H, $J = 6.2$ Hz), 2.66 (t, 2H, $J = 6.3$ Hz), 2.64 (s, 3H, Me), 2.10 (q, 2H, $J = 6.3$ Hz); ^{13}C NMR δ: 198.50, 145.30, 141.97, 137.75, 132.90, 131.37, 124.69, 119.87, 40.31, 24.42, 23.02, 21.96; MS *m/z*: 308 (M^+); anal. calcd for $C_{12}H_{11}F_3O_4S$: C, 46.75; H, 3.60; found: C, 46.51; H, 3.39.

3.10. *8-Methyl-1-tetralone (3)*

Method A: a solution of the derivative **12** (0.20 g, 0.62 mmol) dissolved in ethanol (4 mL) was hydrogenated over 5% Pd/C (30 mg) at 100 psi for 8 h. The mixture was filtered and the filtrate concentrated under vacuum. The product obtained on chromatographic purification (hexane/ether, 8:2) yielded the tetralone **3** (50 mg, 50%) as colourless oil; ν_{max} (cm^{-1}): 1677 (CO), ^1H NMR δ: 7.28 (t, 1H, $J = 7.6$ Hz), 7.09 (d, 1H, $J = 7.6$ Hz), 7.06 (d, 1H, $J = 7.8$ Hz), 2.93 (t, 2H, $J = 6.5$ Hz), 2.62 (s, 3H), 2.63 (m, 2H), 2.06 (q, 2H, $J = 6.6$ Hz); ^{13}C NMR δ: 200.21 (CO), 145.67, 141.47, 132.18, 131.24, 130.47, 126.76, 41.00, 31.00, 23.29, 22.99; MS *m/z* (%): 161 ($M^+ + 1$, 10), 143 (15), 105 (100); anal. calcd for $C_{11}H_{12}O$: C, 82.46; H, 7.55; found: C, 82.28; H, 7.32.

Method B: the heterogeneous mixture resulting from mixing a methanolic solution (15 mL) of triflate **13** (0.32 g, 1.03 mmol), triethylamine (0.35 mL, 2.56 mmol), and 10% Pd/C (0.3 g) was hydrogenated (100 psi) for 6 h. The mixture was filtered and the filtrate concentrated under vacuum. The product obtained on chromatographic purification (hexane/ether 8:2) yielded the tetralone **3** (108 mg, 66%) as colourless oil. Spectroscopic data were identical with that obtained by method A.

4. Conclusions

In summary, a new and convenient procedure has been developed for the synthesis of 8-methyl-1-tetralone **3** using deoxygenation of phenol derivative as the key step. The overall yield (25%) is superior to the reported methods. An alternative synthesis of the tetralone **10**, a potential intermediate for the bioactive sesquiterpene cacalol, has been accomplished. The transformation of the tetralone **3** to platyphyllide **1** and its derivatives will be attempted shortly.

Supplementary material

Supplementary material relating to this article are available online, alongside Figures S1–S18.

References

Banerjee AK, Azocar JA, Vera W. 1999. Synthesis of an intermediate for (±)-platyphyllide through thionyl chloride-pyridine mediated rearrangement. Synth Commun. 29:2995–3001.

Beyerman HC, Burrman E, Lie TS, Matt L. 1976. Selective removal of phenolic hydroxyl groups of morphinan derivatives. Synthesis of rac. *N*-formyl-3-methoxy-6-oxomorphinan. Rec Trav Chim Pays-Bas. 95:43–44.

Bohlmann F, Eickeler E. 1979. Naturally occurring terpene derivatives. 212. Synthesis of platyphyllide. Chem. Ber. 112:2811–2814.

Bohlmann F, Knoll KH, Zdro C, Mahanta PC, Grenz M, Suwita A, Ehlers D, Le-Van N, Abraham WR, Natu AA. 1977. Naturally-occurring terpene derivatives. Part 100. Terpene derivatives from *Senecio* species. Phytochemistry. 16:965–968.

Cabrera EV, Banerjee AK. 2010. A simple synthesis of 8-methoxy-1-tetralone. Org Prep Proc Int. 42:499–502.

Cabrera EV, Sánchez JL, Banerjee AK. 2011. A practical synthesis of 7,8-dimethoxy-2-tetralone. Org Prep Proc Int. 43:364–367.

Cocker W, Lipman C, Whyte DRA. 1950. Synthesis of 4-methyl-5,6,7,8-tetrahydro-1-naphthol. Chem Ind. :237.

Corey EJ, Suggs JW. 1975. Pyridinium chlorochromate. Efficient reagent for oxidation of primary and secondary alcohols to carbonyl compounds. Tetrahedron Lett. 31:2647–2650.

Garofalo AW, Litvak J, Wang L, Dubenko LG, Cooper R, Bierer DE. 1999. Total synthesis of cacalol. J Org Chem. 64:3369–3372.

Gmuender J. 1972. Verfahren zur Herstellung neuer Benzo(de)cinnoline. Patentschrift (Switz), CH 526554 A 197220815.

Hayakawa K, Ohsuki S, Kanetmatsu K. 1986. General approach for the stereocontrolled synthesis of tricyclic lactones via allene intramolecular cycloaddition. An application to the synthesis of (±)-platyphyllide. Tetrahedron Lett. 27:947–950.

Heidelbaugh TM, Chow K, Nguyen P, Gil D, Donello JE. 2005 Apr 7. 4-(2-Methyl-5,6,7,8-Tetrahydro-quino-lin-7-ylmethyl)-1,3-dihydro-imidaz-ole-2-thione as specific alpha 2B agonist and methods of using the same. US Patent Appl Publ. 20050075366.

Hiraoka S, Harada S, Nishida A. 2010. Catalytic enantioselective total synthesis of (−)-platyphyllide and its structural revision. J Org Chem. 75:3871–3874.

Ho TL, Ho MF. 1999. A stereoselective synthesis of platyphyllide. J Chem Soc Perkin Trans 1. 13:1823–1826.

Jaisankar P, Pal B, Giri VS. 2002. Microwave assisted McFadyen-Stevens and Huang-Minlon reactions. Synth Commun. 32:2569–2573.

Jones TH, Blum MS, Fales HM. 1981. A facile synthesis of 2-hydroxy-6-methylacetophenone. Synth Commun. 11:889–894.

Liu HJ, Ngooi TK, Browne ENC. 1988. Diels Alder reactions of 2-carbomethoxy-2-cyclohexen-1-one. Can J Chem. 66:3143–3152.

Macharla AK, Chozhiyath R, Marri MR, Peraka S, Nama N. 2012. Oxidative bromination of ketones using ammonium bromide and oxone. Tetrahedron Lett. 53:191–195.

Minlon H. 1946. Simple modification of the Wolff-Kishner reduction. J Am Chem Soc. 68:2487–2488.

Nagashima S, Ontsuka H, Shiro M, Kanematsu K. 1995. A synthesis of optically active platyphyllide; determination of its absolute configuration. Heterocycles. 41:245–248.

Poon PS, Banerjee AK. 2009. An efficient synthesis of 7-methoxy-8-methyl-α-tetralone. J Chem Res. 12:737–738.

Poon PS, Banerjee AK, Vera WJ, Mora HD, Laya MS, Bedoya L, Cabrera EV, Melean CE. 2008. Use of 5-methoxy, 6-methoxy and 7-methoxy-α-tetralones in the synthesis of diterpenes, sesquiterpenes and other natural products. J Chem Res. 4:181–187.

Sag JM, Dopico M, Martorell G, García-Raso A. 1990. Deoxygenation of highly hindered phenols. J Org Chem. 55:991–995.

Tobias MA. 1970. 3-(5-Methyl-2-furyl)cycloalkanones. Synthesis of bicyclic dionenes. J Org Chem. 35:267–269.