Total Syntheses of Balsacone B and Balsacone C

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Abstract: The first total syntheses of Balsacone C (16) and Balsacone B (17), mainly based on a convergent strategy, were described. The crucial step of this strategy was the alkylation of trihydroxydihydrochalcone derivatives 7 and 8 with cinnamyl bromide derivative 13. For this, compounds 7 and 8 were prepared starting from trihydroxyacetophenone (1) in four steps. Then compound 13 was prepared starting from coumaric acid (9) in four steps.

Keywords: Synthesis; natural product; Balsacone B; Balsacone C.

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INTRODUCTION

Due to the increasing antibiotic resistance among bacterial species, there is an increasing demand to discover new antibacterial compounds (1). Although microbial secondary metabolites, to date, are the major source of new antibiotics, only two novel antibiotic classes have led to the development of alternative strategies within the last 50 years (2). Natural products originating from plants are considered as the source of new compounds with potential antibiotic properties (3). The use of herbal sources for the treatment of bacterial infections has been a very common practice in traditional medicine worldwide (4-7).

*Populus balsamifera* L. belonging to the *Salicaceae* family is a tree growing in almost all regions in North America. There are many studies reporting the use of *P. balsamifera* L. buds by native Canadians in traditional medicine. For example, these plant species have been used for treating dermatological and gastrointestinal conditions (8). Moreover, the Canadian native population has prepared ointment from the buds of this plant, used it for treating wounds, and reported that this ointment has protective effects against infections (8). Phytochemical studies that were previously conducted on the buds of this plant have led to the identification of alkanes (9), fatty acids (10), terpenes (10), phenols (11), flavonoids (11-12), chalcones (11-12), carbohydrates (13), and prostaglandins (13).

Balsacones B and C, the total syntheses of which were performed within the scope of this study, were first isolated as antibacterial compounds from *P. balsemifera* L. by Lavoie *et al.* in 2013 (8). Each of these natural products was tested against *Escherichia coli* (gram negative) and *Staphylococcus aureus* (gram positive), and both were reported to exert significant activity against *S. aureus* (Table 1) (8).

<table>
<thead>
<tr>
<th>Compounds</th>
<th>MIC&lt;sup&gt;a&lt;/sup&gt; (µM)</th>
<th>IC&lt;sub&gt;50&lt;/sub&gt; (µM)</th>
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<tr>
<td>E. coli</td>
<td>S. aureus</td>
<td>WS1</td>
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<tr>
<td>16</td>
<td>&gt;200</td>
<td>3.1</td>
</tr>
<tr>
<td>17</td>
<td>&gt;200</td>
<td>6.3</td>
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<tr>
<td>Gentamicin&lt;sup&gt;c&lt;/sup&gt;</td>
<td>0.04</td>
<td>0.02</td>
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<sup>a</sup> Minimum inhibitory concentration.

<sup>b</sup> Not tested.

<sup>c</sup> Positive control.
In recent studies, the extracts of *Populus* species have been reported to have antimicrobial, antioxidant, and cytotoxic activities (14-16). The structures of natural products for which total syntheses were performed are shown in Figure 1.

![Figure 1: Structures of synthesized compounds.](image)

**EXPERIMENTAL**

**Chemicals and Instrumentation**

Chemicals and reagents were purchased from Sigma Aldrich and used without further purification. THF was purified and distilled over Na. All other solvents and reagents were used as received. The progress of the reaction was monitored via TLC, using TLC Merck silica gel 60 F254. The $^1$H-NMR and $^{13}$C-NMR spectra were recorded over 400 (100) MHz Varian spectrometer using CDCl$_3$, CD$_3$OD and Acetone-d$_6$. Column chromatography was performed on silica gel 60 (70–230 mesh ASTM). Infrared (IR) spectra were obtained from solutions in 0.1-μm cells with a Perkin-Elmer spectrometer (Waltham, MA).

**2,4-Bis(methoxymethoxy)-6-hydroxyacetophenone (2)**

To a solution of trihydroxyacetophenone (1) (4.8 g, 28.5 mmol) in DCM (20 mL, dry) was added DIPEA (13 mL, 82.5 mmol) dropwise at 0 °C under N$_2$. The resulting mixture was stirred for 20 min, then MOMCl (5 mL, 82.5 mmol) was added to the mixture at the same temp. After being stirred for additional 20 min at 0 °C, the reaction mixture was diluted with EtOAc (200 mL), washed with water (50 mL), dried (Na$_2$SO$_4$) and concentrated. Purification of the crude product by silica gel chromatography using EtOAc/Hexane as eluent (25%) afforded the known compound 2 as a colorless liquid (5.15 g, 71%). $R_f$ = 0.53 (40%, EtOAc/Hexanes). $^1$H-NMR (400 MHz, CDCl$_3$) δ 13.72 (s, 1H), 6.27 (d, 1H, $J$ = 2.4 Hz), 6.25 (d, 1H, $J$ = 2.4 Hz), 5.26 (s, 2H), 5.17 (s, 2H), 3.52 (s, 3H), 3.47 (s, 3H), 2.65 (s, 3H). $^1$H-NMR spectrum of compound 2 was in agreement with the data given in the literature (17).

**2(2E)-1-[2-Hydroxy-4,6-bis(methoxymethoxy)phenyl]-3-phenyl-2-propen-1-one (3)**

To a solution of 2 (645 mg, 2.52 mmol) in MeOH (10 mL) was added sequentially 50% KOH solution (8 mL) and benzaldehyde (0.26 mL, 2.52 mmol) and stirred for 18 h at room
temperature. After 18 h, the reaction mixture was diluted with EtOAc (60 mL), washed with 2M HCl solution (5 mL), dried (Na$_2$SO$_4$) and concentrated. Purification of the remaining residue by column chromatography over silica gel using gradient elution with EtOAc and hexanes afforded the known compound 3 as a yellow solid (830 mg, 95%). Rf = 0.5 (40%, EtOAc/Hexanes). M.P. = 97-98 °C. $^1$H-NMR (400 MHz, CDCl$_3$) δ 13.82 (s, 1H), 7.93 (d, 1H, J = 15.6 Hz), 7.79 (d, 1H, J = 15.6 Hz), 7.60 (dd, 2H, J = 7.4, J = 2.1 Hz), 7.46 – 7.33 (m, 3H), 6.32 (d, 1H, J = 2.3 Hz), 6.25 (d, 1H, J = 2.3 Hz), 5.29 (s, 2H), 5.19 (s, 2H), 3.54 (s, 3H), 3.49 (s, 3H). $^{13}$C-NMR (100 MHz, CDCl$_3$) δ 193.2, 167.6, 163.7, 160.1, 142.7, 135.7, 130.4, 129.2, 128.5, 127.6, 97.7, 95.4, 94.9, 94.3, 57.1, 56.7. IR (neat cm$^{-1}$) 2924, 1629.

**(2E)-1-[2-Hydroxy-4,6-bis(methoxymethoxy)phenyl]-3-(4-methoxyphenyl)-2-propen-1-one (4)**

To a solution of 2 (200 mg, 0.78 mmol) in MeOH (5 mL) was added sequentially 50% KOH solution (1.25 mL) and p-methoxybenzaldehyde (0.2 mL, 1.56 mmol) and stirred for 18 h at room temp. After 18 h, the reaction mixture was diluted with EtOAc (100 mL), washed with 2M HCl solution (5 mL), dried (Na$_2$SO$_4$) and concentrated. Purification of the remaining residue by column chromatography over silica gel using gradient elution with EtOAc and hexanes afforded the known compound 4 as a yellow solid (247 mg, 84%). Rf = 0.5 (40%, EtOAc/Hexanes). M.P. = 100-101 °C. $^1$H-NMR (400 MHz, CDCl$_3$) δ 13.92 (s, 1H), 7.88 – 7.73 (m, 2H), 7.56 (d, 2H, J = 8.8 Hz), 6.93 (d, 2H, J = 8.8 Hz), 6.32 (d, 1H, J = 2.4 Hz), 6.24 (d, 1H, J = 2.4 Hz), 5.29 (s, 2H), 5.19 (s, 2H), 3.85 (s, 3H), 3.54 (s, 3H), 3.48 (s, 3H). $^{13}$C-NMR (100 MHz, CDCl$_3$) δ 193.1, 167.5, 163.5, 161.7, 160.0, 142.9, 130.3, 128.4, 125.2, 114.6, 107.8, 97.7, 95.4, 94.9, 94.23, 57.1, 56.7, 55.6. IR (neat cm$^{-1}$) 2957, 2836, 1625.

**2',4',6'-Trihydroxychalcone (5)**

To a solution of 3 (738 mg, 2.14 mmol) in MeOH (10 mL) was added 12 M HCl solution (0.27 mL) drop by drop at room temp. Reaction mixture was stirred for 23 h. After 23 h, the reaction mixture was diluted with EtOAc (100 mL), washed with H$_2$O (10 mL), dried (Na$_2$SO$_4$) and concentrated. Purification of the remaining residue by column chromatography over silica gel using gradient elution with EtOAc and hexanes (40% EtOAc/Hexanes) afforded compound 5 as a yellow solid (438.3 mg, 80%). Rr = 0.2 (40%, EtOAc/Hexanes). $^1$H-NMR (400 MHz, CD$_3$OD) 8.23 (d, 1H, J = 15.8 Hz), 7.74 (d, 1H, J = 15.8 Hz), 7.38–7.62 (m, 5H), 5.85 (s, 2H). $^1$H-NMR spectrum of compound 5 was in agreement with the data given in the literature (18).
2',4',6'-Trihydroxy-4-methoxychalcone (6)

To a solution of 4 (1.5 g, 4.00 mmol) in MeOH (20 mL) was added 12 M HCl solution (0.3 mL) drop by drop at room temp. Reaction mixture stirred for 23 h. After 23 h reaction mixture was diluted with EtOAc (100 mL), washed with H₂O (10 mL), dried (Na₂SO₄) and concentrated. Purification of the remaining residue by column chromatography over silica gel using gradient elution with EtOAc and hexanes (40% EtOAc/Hexanes) afforded compound 6 as a yellow solid (938 mg, 82%). Rᵣ = 0.16 (40%, EtOAc/Hexanes). ¹H-NMR spectrum of compound 6 was in agreement with the data given in the literature (19).

2',4',6'-Trihydroxydihydrochalcone (7)

To a solution of trihydroxychalcone 5 (435 mg, 1.69 mmol) in MeOH (15 mL), Pd/C (10%) was added. The reaction flask was purged with hydrogen gas three times before being allowed to stir under a hydrogen balloon for 4 h at room temp. Then, the reaction mixture was filtered and concentrated in vacuo to yield compound 7 as a pale yellow solid (337 mg, 77%). Rᵣ = 0.36 (60%, EtOAc/Hexanes). ¹H-NMR (400 MHz, Acetone) δ 11.73 (s, 2H), 9.23 (s, 1H), 7.43 – 7.13 (m, 5H), 5.95 (s, 2H), 3.45 – 3.37 (m, 2H), 3.03 – 2.96 (m, 2H). ¹H-NMR spectrum of compound 7 was in agreement with the data given in the literature (20).

2',4',6'-Trihydroxy-4-methoxydihydrochalcone (8)

To a solution of trihydroxychalcone 6 (938 mg, 3.27 mmol) in MeOH (15 mL), Pd/C (10%) was added. The reaction flask was purged with hydrogen gas three times before being allowed to stir under a hydrogen balloon for 4 h at room temp. Then, the reaction mixture was filtered and concentrated in vacuo to yield compound 8 as a white solid (862 mg, 61%). Rᵣ = 0.2 (40%, EtOAc/Hexanes). ¹H-NMR (400 MHz, CD₂OD) δ 7.11 (d, 2H, J = 8.7 Hz), 6.79 (d, 2H, J = 8.7 Hz), 5.82 (s, 2H), 3.72 (s, 3H), 3.29 – 3.24 (m, 2H), 2.94 – 2.83 (m, 2H). ¹³C-NMR (100 MHz, CD₂OD) δ 205.1, 164.9, 164.6, 158.1, 133.9, 129.1, 113.6, 104.2, 94.6, 54.5, 45.9, 30.2. ¹H-NMR and ¹³C-NMR spectra of compound 8 were in agreement with the data given in the literature (21).

Methyl 4-hydroxycinnamate (10)

A solution of 9 (1 g, 6.1 mmol) in MeOH (20 mL) was treated with p-TSA (cat. amount) and refluxed for 17 h. The reaction mixture was quenched by the addition of NaHCO₃ (30 mL) and extracted with EtOAc (3 x 50 mL). The combined extracts were dried (Na₂SO₄) and the solvent concentrated in vacuo to give the known compound 10 as a white solid (1 g, 92%). ¹H-NMR (400 MHz, CDCl₃) δ 7.64 (d, 1H, J = 16.0 Hz), 7.44 (d, 2H, J = 8.6 Hz),
6.85 (d, 2H, J = 8.6 Hz), 6.31 (d, 1H, J = 16.0 Hz), 5.22 (s, 1H), 3.80 (s, 3H). ¹H-NMR spectrum of compound 10 was in agreement with the data given in the literature (22).

(E)-Methyl 3-(4-(tert-butyldimethylsilyloxy)phenyl)acrylate (11)

To a solution of 10 (500 mg, 2.8 mmol) and TBDMSCl (634 mg, 4.21 mmol) in DCM (5 mL, dry), stirred at 0 °C, added TEA (0.6 mL, 4.21 mmol) in dropwise under N₂. The reaction mixture was slowly warmed up to ambient temp. After the completion of reaction monitored by TLC analysis, the reaction mixture was diluted with DCM (150 mL), washed with of NH₄Cl (20 mL, saturated aqueous solution) and brine, dried (Na₂SO₄), and concentrated. After filtration, the known compound 11 was obtained as a colorless liquid (766.3 mg, 99%)). ¹H-NMR (400 MHz, CDCl₃) δ 7.42 (d, 1H, J = 16.0 Hz), 7.20 (d, 2H, J = 8.6 Hz), 6.62 (d, 2H, J = 8.6 Hz), 6.08 (d, 1H, J = 16.0 Hz), 3.57 (s, 3H), 0.77 (s, 9H), 0.00 (s, 6H). ¹H-NMR spectrum of compound 11 was in agreement with the data given in the literature (23).

(E)-3-(4-(tert-Butyldimethylsilyloxy)phenyl)prop-2-en-1-ol (12)

To a solution of 11 (408 mg, 1.39 mmol) in DCM (10 mL), stirred at -78 °C, was added a DIBAL- H solution (3 mL of 1.5 M toluene solution) in dropwise through 30 min. After 30 min stirring at -78 °C, the reaction mixture was quenched by the dropwise addition of MeOH and slowly warmed up to ambient temp. Then, NaCl (10 mL, saturated aqueous solution) was added to the reaction mixture and the resulted emulsion was stirred at ambient temperature until the emulsion was clear-up. The organic material was extracted with DCM (3 x 50 mL), and the combined organic layers were washed with brine, dried (Na₂SO₄) and concentrated to give known compound 12 as a colorless liquid (365 mg, 99% yield). Rf = 0.53 (40%, EtOAc/Hexanes). ¹H-NMR (400 MHz, CDCI₃) δ 7.06 (d, 2H, J = 8.5 Hz), 6.60 (d, 2H, J = 8.5 Hz), 6.38 (d, 1H, J = 15.9 Hz), 6.04 (dt, 1H, J = 15.5, 7.8 Hz), 4.10 (t, 2H, J = 5.9 Hz), 0.78 (s, 9H), 0.00 (s, 6H). ¹H-NMR spectrum of compound 12 was in agreement with the data given in the literature (23).

4-(tert-Butyldimethylsiloxy)cinnamyl bromide (13)

A solution of alcohol 12 (320 mg, 1.21 mmol) in Et₂O (10 mL) was cooled to 0 °C, and PBr₃ (0.04 mL, 0.38 mmol) was added with a syringe. This mixture was stirred for half an hour. After monitoring with TLC, NaCl (15 mL, saturated aqueous solution) was added to the mixture. The organic layer was then separated and concentrated. The crude product was dissolved in DCM (50 mL), dried (MgSO₄) and concentrated to afford known compound 13 as a white solid (120 mg, 96%). ¹H-NMR (400 MHz, CDCl₃) δ 7.07 (d, 2H, J = 8.5 Hz), 6.60 (d, 2H, J = 8.5 Hz), 6.38 (d, 1H, J = 15.6 Hz), 6.06 (dt, 1H, J = 15.5, 7.8 Hz), 3.97

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1H-NMR spectrum of compound 13 was in agreement with the data given in the literature (24).

**Balsacone C (16)**

To a solution of 7 (211 mg, 0.82 mmol) in THF (5 mL) was added NaH (41 mg, 1.02 mmol) under N2 at room temperature. After stirring 5 min, compound 13 (335 mg, 1.02 mmol) was added to the mixture and the reaction was stirred at room temperature for 2 days. After monitoring with TLC, the reaction was stopped and the solvent was removed. The crude product was diluted with EtOAc (150 mL) and 2 M HCl solution was added until pH 1-2. The organic layer was dried (Na2SO4) and the solvent was concentrated to afford compound 14. Compound 14 was used for the next step without further purification. For this, compound 14 was dissolved in THF (3 mL) and TBAF (0.38 mL, 0.38 mmol) was added to the mixture under N2 at 0 °C. The reaction mixture was stirred for 30 min. at the same temperature. After monitoring with TLC, the reaction was stopped and the solvent was removed. 2 M HCl solution was added until pH 1-2 and then the mixture was extracted with EtOAc (3 x 50 mL). The combined organic phases were dried (Na2SO4) and the solvent was concentrated. Purification of the crude product by column chromatography (silica gel, DCM/MeOH 19:1) afforded Balsacone C (16) as a white solid (89.58 mg, 28% for two steps). Rf = 0.33 (5%, MeOH/DCM).

![Balsacone C](image)

1H-NMR (400 MHz, CD3OD) δ 7.28 - 7.19 (m, 5H), 7.12 (d, 2H, J = 8.6 Hz), 6.66 (d, 2H, J = 8.6 Hz), 6.26 (d, 1H, J = 15.8 Hz), 6.10 (dt, 1H, J = 15.8, J = 6.4 Hz), 5.94 (s, 1H), 3.38 - 3.28 (m, 4H), 2.97 - 2.92 (m, 2H). 13C-NMR (100 MHz, CD3OD) δ 204.9 (C-9), 163.9 (C-4”), 162.7 (C-2”), 160.6 (C-6”), 156.1 (C-4”), 142.1 (C-1), 130.1 (C-1”), 128.9 (C-7”), 128.3 (C-2 and C-6), 128.2 (C-3 and C-5), 126.9 (C-2” and C6”), 125.6 (C-4), 125.6 (C-8”), 114.9 (C-3” and C-5”), 105.5 (C-3”), 104.0 (C-1”), 93.7 (C-5”), 45.9 (C-8), 31.2 (C-7), 25.2 (C-9”). IR (neat cm⁻¹) 3322.63, 2924.36, 1609.71, 1512.30, 1435.43, 1218.47, 833.16.

**Balsacone B (17)**

To a solution of 8 (320 mg, 1.11 mmol) in THF (5 mL) was added NaH (55 mg, 1.39 mmol) under N2 at room temperature. After stirring 5 min., compound 13 (456 mg, 1.39 mmol) was added to the mixture and the reaction was stirred at room temperature for 22 h. After monitoring with TLC, the reaction was stopped and the solvent was removed. The crude product was diluted with EtOAc (150 mL) and 2 M HCl solution was added until pH becomes...
1-2. The organic phase was dried (Na$_2$SO$_4$) and the solvent was concentrated to afford compound 15. Compound 15 was used for the next step without further purification. For this, compound 15 was dissolved in THF (6 mL) and TBAF (0.28 mL, 0.28 mmol) was added to the mixture under N$_2$ at 0 °C. The reaction mixture was stirred for 30 min. at the same temp. After monitoring with TLC, the reaction was stopped and the solvent was removed. 2 M HCl solution was added until pH 1-2 and then the mixture was extracted with EtOAc (3 x 50 mL). The combined organic phases were dried (Na$_2$SO$_4$) and the solvent was concentrated. Purification of the crude product by column chromatography (silica gel, DCM/MeOH 19:1) afforded Balsacone B (17) as a white solid (109.24 mg, 23% for two steps). R$_f$ = 0.33 (5%, MeOH/DCM).

$^{1}$H-NMR (400 MHz, CD$_3$OD) δ 7.12 (d, 4H, J = 8.4 Hz), 6.79 (d, 2H, J = 8.6 Hz), 6.66 (d, 2H, J = 8.6 Hz), 6.25 (d, 1H, J = 15.8 Hz), 6.10 (dt, 1H, J = 15.7, J = 6.4 Hz), 5.94 (s, 1H), 3.73 (s, 3H), 3.35 (d, 2H, J = 5.7 Hz), 3.32 – 3.25 (m, 2H), 2.90 – 2.86 (m, 2H).

$^{13}$C-NMR (100 MHz, CD$_3$OD) δ 205.2 (C-9), 163.9 (C-4'), 162.7 (C-2'), 160.7 (C-6'), 158.1 (C-4), 156.1 (C-4''), 134.1 (C-1), 130.2 (C-1''), 129.4 (C-2 and C-6), 128.3 (C-7''), 128.2 (C-2' and 6''), 126.9 (C-8''), 114.9 (C-3' and 5''), 113.6 (C-3 and C-5), 105.5 (C-3'), 104.5 (C-1'), 93.4 (C-5'), 54.4 (OMe), 46.4 (C-8), 30.4 (C-7), 25.4 (C-9''). IR (neat cm$^{-1}$) 3321.50, 2929.97, 1609.40, 1512.59, 1245.92, 826.36.

RESULTS AND DISCUSSION

The natural products, Balsacone B (17) and Balsacone C (16), contain key fragments in which simple disconnection approaches can be pursued to achieve a possible synthetic pathway. In analyzing the structures of these products we devised a strategy to first access the core trihydroxy-dihydrochalcone unit. Our synthesis is based on a convergent strategy in which the related trihydroxy-dihydrochalcone derivatives 7 and 8 were first prepared and further alkylated to yield the Balsacone structure. To the best of our knowledge, there are no reports on the total synthesis of Balsacone B (17) and Balsacone C (16). The preparation of the related dihydrochalcone derivatives is shown in Scheme 1. For this, methoxymethyl (MOM)-protected trihydroxy-acetophenone (2) was condensed with the related benzaldehydes to give MOM-protected chalcone derivatives 3 and 4. After
deprotection, trihydroxy-dihydrochalcone derivatives 7 and 8 were prepared by Pd-C catalyzed hydrogenation.

Scheme 1. (i) MOMCl, DIPEA, DCM, 0-25 °C, 6 h, 71%; (ii) a) benzaldehyde, KOH, MeOH, 25 °C, 18 h, 95%; b) p-methoxybenzaldehyde, KOH, MeOH, 25 °C, 18 h, 84%; (iii) a) conc. HCl, MeOH, 25 °C, 23 h, 80%; b) conc. HCl, MeOH, 25 °C, 23 h, 82%; (iv) a) H\textsubscript{2} (gas), Pd-C (cat.), MeOH, 25 °C, 4 h, 77%; b) H\textsubscript{2} (gas), Pd-C (cat.), MeOH, 25 °C, 4 h, 61%.

tert-Butyldimethylsilyl (TBDMS)-protected cinnamyl bromide (13) was synthesized in four steps starting from p-hydroxycinnamic acid (9). Acid-catalyzed esterification of the p-hydroxycinnamic acid (9) with MeOH gave the ester derivative 10. TBDMS-protection of ester 10 gave compound 11. The reduction of the TBDMS-protected cinnamic ester 11 with DIBAL-H afforded cinnamyl alcohol 12, which was converted to cinnamyl bromide 13 via treatment with PBr\textsubscript{3} (Scheme 2).

Scheme 2. (i) p-TSA, MeOH, reflux, 17 h, 92%; (ii) TBDMScI, TEA, dry DCM, 0 °C, 1,5 h 99%; (iii) DIBAL-H, dry DCM, -78 °C, 0,5 h, 99%; (iv) PBr\textsubscript{3}, diethylether, 0 °C, 0,5 h, 96.
The final step of our synthetic strategy was the alkylation of trihydroxy-dihydrochalcone derivatives 7 and 8 with compound 13. For this, alkylation of compound 7 and 8 with compound 13 in the presence of NaH gave compounds 14 and 15. After deprotection in the presence of TBAF, the target compounds Balsacone C (16) and Balsacone B (17) were obtained in a yield of 55% and 50% respectively (Scheme 3).

**CONCLUSION**

In summary, the first ever syntheses of natural products Balsacone B (17) and Balsacone C (16) were realized within this work. The key factor in synthesizing these natural products rested on harnessing the Friedel-Crafts alkylation reaction between cinnamylbromide 13 and dihydrochalcone derivatives 7 and 8. A straightforward alkylation in the presence of base afforded a clean product without any by-products allowing for a relatively facile approach. We envision that this method can be used to access a variety of compounds with a similar backbone and allows for simple preparation of antibacterial property containing natural products.
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