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A protecting group-free divergent synthesis of natural benzofurans via one-pot synthesis of 2-bromo-6-hydroxybenzofurans

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Abstract: 2-Bromo-6-hydroxybenzofurans are potentially versatile intermediates for the divergent synthesis of numerous benzofuran-based natural products and their analogues. Herein we report the first one-pot strategy for the efficient synthesis of 2-Bromo-6-hydroxybenzofurans. The present protocol provide shorter routes for the synthesis of moracins M, N, O and P; gramniphenols F and G; and morunigrol C using a protecting group-free approach.

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Introduction

Natural benzofurans and their analogues are privileged structures in the field of medicinal chemistry due to their wide range of biological and pharmacological properties. Different classes of benzofuran compounds like moracins, ribisins, stemofurans, gramniphenols and homoegonol-related compounds exhibiting diverse biological activities have been isolated from plants, marine sources and bacterial or fungal metabolites etc.[1a–c] Among the variety of powerful methodologies that have been well established for the construction of benzofuran scaffolds, a number of them requires additional protection-deprotection steps to avoid complications due to the phenolic group in the coupling partner. Additionally, most of these strategies involve the convergent synthesis of individual benzofuran skeletons.[2a–p] New efficient and common pooled strategies for the synthesis of this class of compounds are highly desirable since these compounds are of keen interest in the field of drug discovery.

Earlier, we reported the total synthesis of moracin O and P which exhibited potent *in vitro* inhibitory activity against HIF-1, a key mediator to tumor hypoxia. Furthermore, the synthesis and biological evaluation of novel moracins O and P analogues was also carried out.[3a–c] Continuing our interest in the synthesis of natural benzofurans and their derivatives, we planned an approach involving a fewer number of steps, a broad substrate scope and the non-usage of pyrophoric reagents.

Previously, the synthesis of substituted 2-bromobenzofuran compounds from the intra molecular cyclization of *gem*-dibromoalkenes has been reported which in turn, could be synthesized by the condensation of the aldehydes with CBr_4 (Ramirez olefination).[4a–d] Kim et al.[5a] and Damodar et

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al.[5b] reported the synthesis of natural benzofurans using Suzuki coupling as a key step via 2-bromobenzofurans obtained from the intramolecular cyclization of protected/modified *gem*-dibromoalkenes. Rao et al. utilized functional group maneuvering techniques for tuning the stability and reactivity of *gem*-dibromides for the synthesis of benzofuran-based natural products.[6a,b] The aforementioned methods require additional protection-deprotection techniques and are less divergent. However, the preparation of *gem*-dibromoalkenes containing two phenolic groups has seldom been reported.

We envisioned that a divergent-pooled route for benzofuran analogues could be developed using 2-bromo-6-hydroxybenzofurans, which could serve as potentially versatile intermediates due to their high reactivity and ease of derivatization. Hence, a direct method for the synthesis of 2-bromo-6-hydroxybenzofurans and their applications in the synthesis of benzofuran analogues is highly needed. Herein, we report our findings on how to gain access to the desired 2-bromo-6-hydroxybenzofurans by using modified Ramirez olefination and its subsequent selective intramolecular cyclization in a one-pot synthesis.

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Results and discussion

The Ramirez olefination of 2,4-dihydroxybenzaldehyde (**1a**) was investigated to identify a protecting group-free conditions for the synthesis of 2-bromo-6-hydroxybenzofuran/2-bromobenzofuran-6-ol (**3a**). Initial attempts to prepare 4-(2,2-dibromovinyl)benzene-1,3-diols (**2**) according to the standard Ramirez olefination procedure [CBr_4 (6 equiv), triphenylphosphine (PPh_3; 6 equiv), triethylamine (TEA; 12 equiv), DCM, 0 °C to room temperature (rt)] were futile owing to its poor stability.[7] Although *gem*-dibromoalkene **2** was found to decompose on isolation, it exhibited considerable stability in the solvated state even at elevated temperatures. Hence, a one-pot strategy for the synthesis of **3a** from **1a** via *gem*-dibromoalkene (**2**) was envisaged.

We suitably modified the Ramirez olefination for the subsequent one-pot synthesis of **3a** as shown in Table 1. Since the isolated yields of **2** could not be compared for every reaction, the conversion of aldehyde **1a** was monitored by thin layer chromatography. Zn powder was used as a molecular scavenger in place of TEA to reduce the amount of CBr_4 and PPh_3 required, as has been reported.[8] The initial efforts focused on complete conversion of aldehyde **1a** to *gem*-dibromoalkene **2** using solvents like DCM, DCE, and THF failed to give the desired results. However, efficient conversion was observed when ACN was employed. Hence, in our procedure a solution of CBr_4 (4 equiv) in ACN was added dropwise to a stirred suspension of aldehyde (1 equiv), PPh_3 (4 equiv) and Zn (4 equiv) powder at rt and stirred for an additional 30 min (Table 1). Solid NH_4Cl was used to cleave the scavenger bonding at the end of the reaction contrary to previously reported procedures which use aqueous NH_4Cl or 1N HCl solution. Thus, Ramirez olefination in ACN using the

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aforementioned conditions turned out to be excellent as it could be performed at rt due to its low exothermic nature and also served as a suitable solvent for the subsequent cyclization reaction.

With this improved synthesis of 4-(2,2-dibromovinyl)benzene-1,3-diol (**2**) suitable for the one-pot synthesis of 2-bromo-6-hydroxybenzofuran (**3a**) in hand, various reaction conditions were screened for the subsequent selective intramolecular cross-coupling. Although cyclization was not observed in the presence of Cs_2CO_3 (3 equiv) as a base at rt (Table 1, entry 1), the promising results were obtained when the reaction was carried out at 85 °C, yielding **3a** in 25% (entry 2). This finding encouraged us to optimize the reaction parameters to improve the yield of **3a** and accordingly, a variety of cyclization conditions were explored, the results of which are summarized in Table 1.

The use of 5 equiv of Cs_2CO_3 moderately improved the reaction yields in 5 hours (entry 3). Many different copper species including CuI (5 mol%) have been reported as effective catalysts for the selective intramolecular coupling of *gem*-dibromovinylphenols to yield 2-bromobenzofurans.[4a] Hence, the model reaction was screened with varying amounts of base and CuI as the catalyst (entries 4–6). The best results were obtained using Cs_2CO_3 (3.5 equiv) and CuI (5 mol%) at 85 °C, giving the desired **3a** with complete selectivity in 65% yield (entry 4).

The choice of base was also important as the selected commercially available bases (K_2CO_3, Na_2CO_3, K_3PO_4, and CsF) failed to improve the yields in the above reaction (entries 7–10). During the course of further optimization, we also studied the effect of solvents in the cyclization. For this purpose, the *gem*-dibromoalkene (**2**) solution in ACN was evaporated nearly to dryness and the

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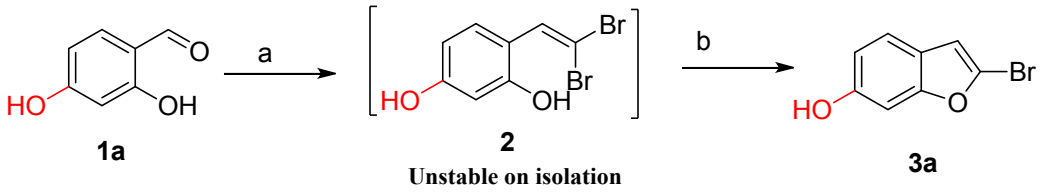
cyclization was performed in solvents like THF and EtOH. However, no significant improvement in product yield was observed (entries 11–13). Tetra-*n*-butylammonium fluoride (TBAF) promoted metal-free cyclization was also found to be ineffective (entry 14).[4b] The present one-pot synthesis greatly simplified the work-up procedure and enabled purification to be accomplished by simple filtration of the reaction mixture through silica gel.

Table 1. The effect of a base or an additive on the intramolecular cyclization of 4-(2,2-dibromovinyl)benzene-1,3-diol (**2**)[a]



1a **2** **Unstable on isolation** **3a**

Entry	Base (equiv)	Additive (mol%)	Solvent	Temp (°C)	Time (h)	Yield (%)
1	Cs_2CO_3 (3)	----	ACN	rt	16	NR
2	Cs_2CO_3 (3)	----	ACN	85	16	25
3	Cs_2CO_3 (5)	----	ACN	85	5	40
4	Cs_2CO_3 (3.5)	CuI (5)	ACN	85	3	65
5	Cs_2CO_3 (2.5)	CuI (5)	ACN	85	3	40
6	Cs_2CO_3 (3.5)	CuI (10)	ACN	85	3	65

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7	K_2CO_3 (3.5)	CuI (5)	ACN	85	3	45
8	Na_2CO_3 (3.5)	CuI (5)	ACN	85	3	35
9	K_3PO_4 (3.5)	CuI (5)	ACN	85	16	20
10	CsF (3.5)	CuI (5)	ACN	85	16	NR
11	Cs_2CO_3 (3.5)	CuI (5)	THF	70	3	42[b]
12	Cs_2CO_3 (3.5)	CuI (5)	EtOH	80	2	26[b]
13	K_3PO_4 (3.5)	CuI (5)	THF	70	3	44[b]
14	TBAF in THF (5)	----	ACN	85	16	NR

[a]Reagents and conditions: (a) all reactions were performed with **1a** (1.5 mmol), CBr_4 (6.0 mmol), PPh_3 (6.0 mmol), Zn (6.0 mmol), ACN (15 ml), rt, 1 h; followed by NH_4Cl (9.0 mmol), rt, 0.5 h.; and then (b) base (2.5-5 equiv), additive (5–10 mol%) at T °C in a solvent (15 mL) under an N_2 atmosphere. [b]Reactions were performed in a new solvent after concentrating ACN to the minimum volume.

After having established our approach for the preparation of **3a**, the scope of the reaction was evaluated under the optimized conditions. A variety of reported 2,4-dihydroxy benzaldehydes (**1a–m, Supporting Information**) possessing different substituents on the benzene rings were examined (Table 2). Electron donating substituents at C-6 resulted in improved yields (entries 2 and 3), while a slight *ortho*-position effect was observed in the reaction for substituents at C-3

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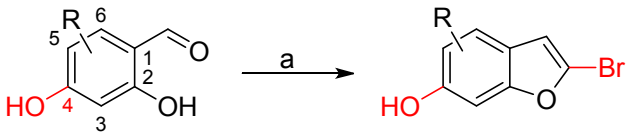
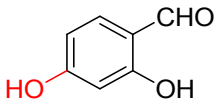
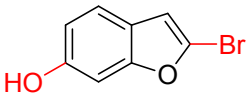
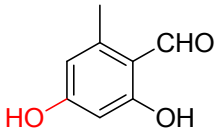
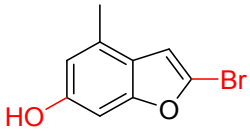
(entries 4 and 5). In general, the substituents at C-5 gave lower yields (entries 6–9) with the effects being more predominant when strongly electron withdrawing $–NO_2$ was present (entry 9). Halogen substituents (either Cl or Br) as well as either mono-halogen or di-halogens on the benzene rings underwent clean conversions and afforded good yields of the corresponding di- or multi-halogenated benzofurans, which are essential building blocks for further transformation through selective transition metal-catalyzed cross-coupling reactions with various nucleophiles (entries 10–12). Under the optimized conditions, 2,4-dihydroxyacetophenone also reacted to give 2-bromo-3-methyl-6-hydroxybenzofuran in good yields (entry 13).

Table 2. Synthesis of substituted 2-bromo-6-hydroxybenzofurans (**3a**–**m**) through one pot strategy.



1a-m **3a-m**

Entry	Substrate	Product	Yield (%)
1	 **1a**	 **3a**	65
2	 **1b**	 **3b**	65

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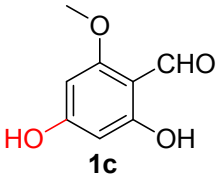
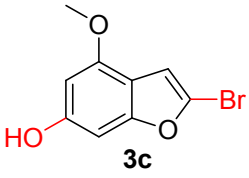
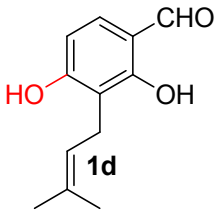
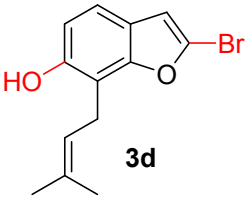
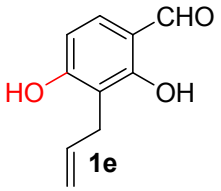
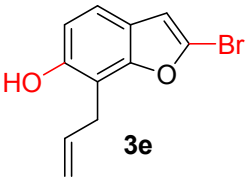
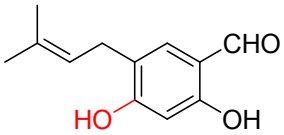
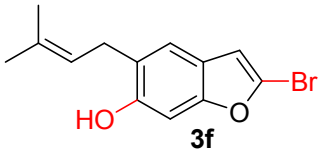
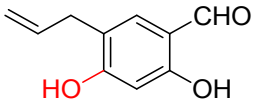
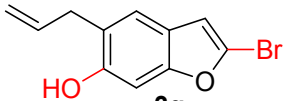
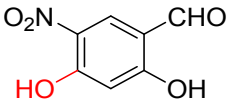
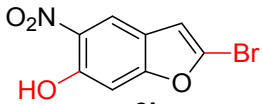
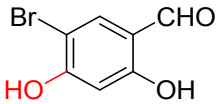
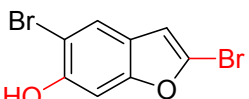
3	 **1c**	 **3c**	69
4	 **1d**	 **3d**	59
5	 **1e**	 **3e**	60
6	 **1f**	 **3f**	40[b]
7	 **1g**	 **3g**	42
8	 **1h**	 **3h**	10
9	 **1i**	 **3i**	44

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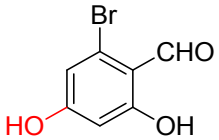
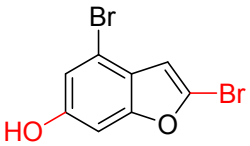
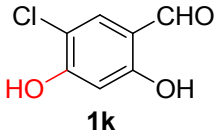
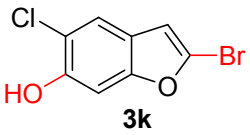
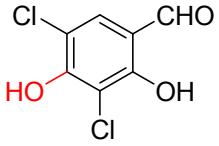
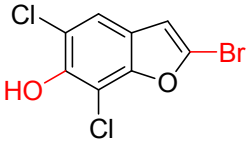
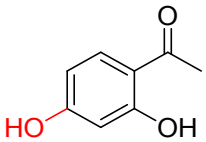
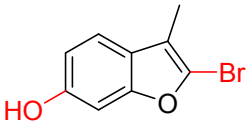
10	 **1j**	 **3j**	56
11	 **1k**	 **3k**	40
12	 **1l**	 **3l**	45
13	 **1m**	 **3m**	40[b]

[a]Reagents and conditions: (a) i) **1a**–**m** (1.5 mmol), CBr_4 (6.0 mmol), PPh_3 (6.0 mmol), Zn (6.0 mmol), ACN (15 ml), rt, 1 h; followed by NH_4Cl (9.0 mmol), rt, 0.5 h.; and then ii) Cs_2CO_3 (5.25 mmol), CuI (5 mol%) at 80 °C in ACN (15 mL) under an N_2 atmosphere.

[b]Reaction were performed in an ACN:DCM (4:1) mixture for efficient conversion.

After successfully establishing the protecting group-free synthesis of the 2-bromo-6-hydroxybenzofurans, we focused on the synthesis of bioactive benzofuran compounds using this divergent-pooled strategy. We opted for a few of the 2-arylbenzofuran-based natural products (**4**–**11**) to illustrate the synthetic applications of the 2-bromo-6-hydroxybenzofurans (Figure 1).

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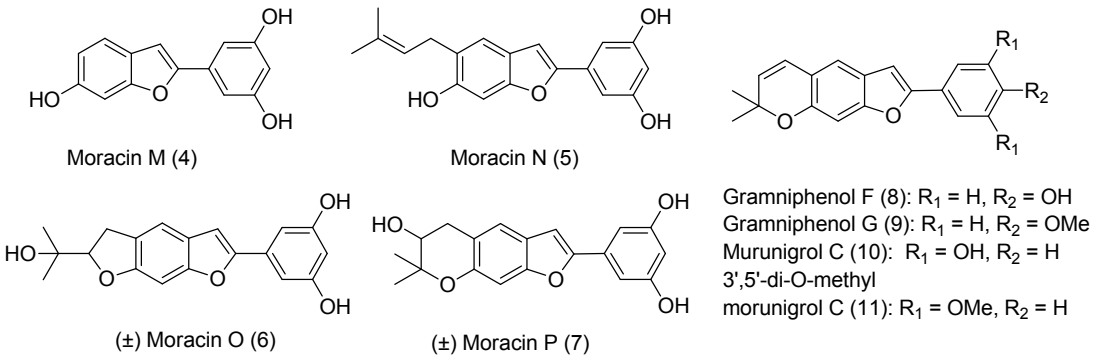
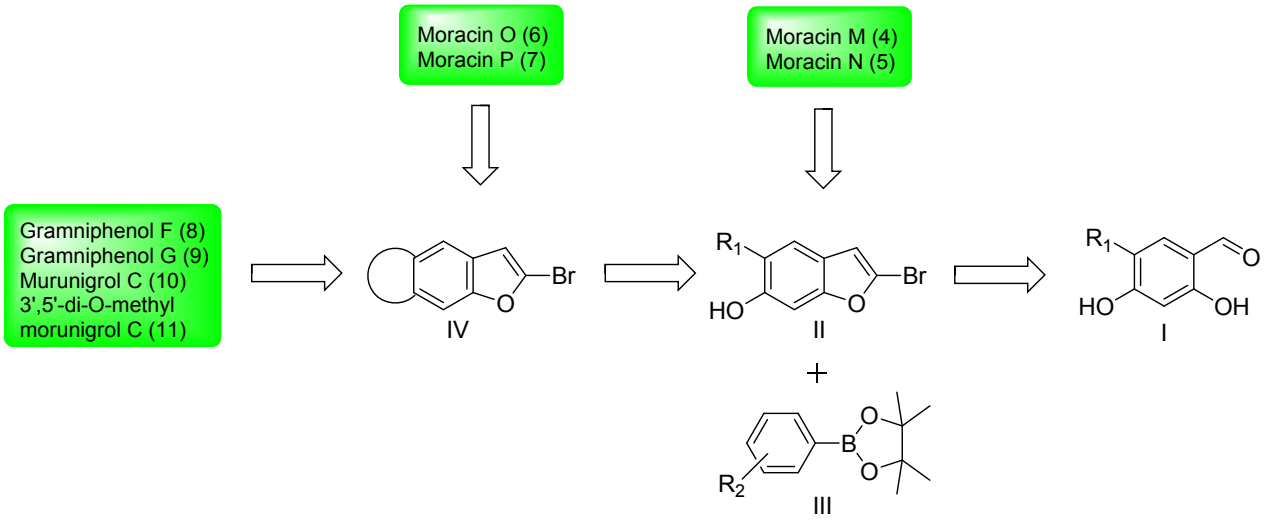


Figure 1. 2-arylbenzofuran-based natural products.

A retrosynthetic analysis for these benzofurans (**4**–**11**) involves the synthesis of two major building blocks; substituted 2-bromo-6-hydroxybenzofurans (**II**) and boronic ester/acid (**III**). The tricyclic fused compounds (**IV**) could be synthesized by the subsequent cyclization reactions from **II**, which could be obtained by the one-pot synthesis from the corresponding aldehydes (**I**) (Scheme 1).



Scheme 1. The retrosynthetic approach.

Moracins M (**4**) and N (**5**) possessing anticancer activity were first isolated from the root bark of *Morus alba* and dried leaves of mulberry leaves, respectively.[9a–c] Earlier syntheses of moracins M

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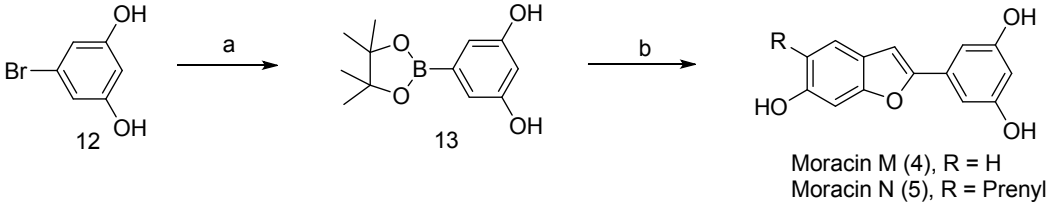
and N have been achieved using protection-deprotection techniques or under drastic reaction conditions.[6b,10a–e] Boronic ester **13** required for the synthesis of these natural products was obtained from 3,5-dihydroxybromobenzene (**12**) using Mayura borylation,[11] as shown in Scheme 2. Furthermore, varying reaction conditions for the Suzuki coupling to give moracin M were screened (Table 1, Supporting Information). The best results were achieved using DMF:H_2O (4:1) as the solvent with Pd(dppf)Cl_2.DCM and K_3PO_4 (entry 4, Table 1, Supporting Information). Using the optimized conditions, moracins M (**4**) and N (**5**) were synthesized from **3a** and **3f** with overall yields of 54% and 7.7%, respectively (Scheme 2).



Scheme 2. The synthesis of moracins M (**4**) and N (**5**). Reagents and conditions: (a) bis(pinacolato)diboron, KOAc, Pd(dppf)Cl_2.DCM, 1,4-dioxane, 100 °C, 2 h, 88%; (b) **3a** or **3f**, K_3PO_4, Pd(dppf)Cl_2.DCM, DMF:H_2O (4:1), 70 °C, 1 h 83% (**4**) and 51% (**5**).

After completing the synthesis of moracins M and N, we then focused on the synthesis of natural HIF-1 inhibitors moracins O (**6**) and P (**7**), which have been isolated from *Morus alba*. Kaur et al. reported the first total synthesis of these from 2,4-dihydroxybenzaldehyde (**1a**) utilizing Corey-Fuchs reaction and Sonogashira coupling as key transformations over 10 steps with overall yields of 2.21% and 2.27%, respectively.[3a] Considering the longer synthetic route employing pyrophoric reagents in the aforementioned method, we designed a shorter route using prenyl intermediate **3f**

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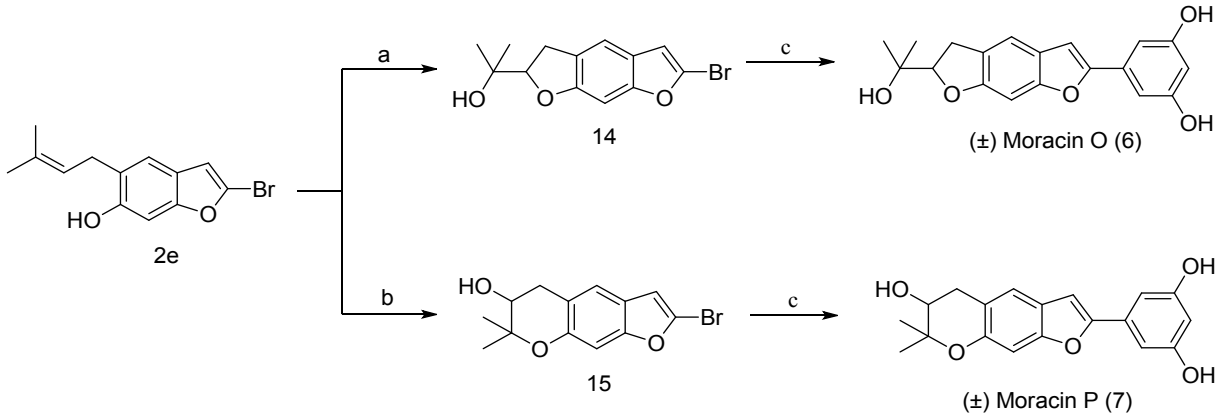
obtained from 2,4-dihydroxybenzaldehyde (**1a**) in two steps with an overall yield of 15% (Table 2). The construction of five (**14**) and six (**15**) membered cyclic compounds was carried out from **3f** using *insitu* epoxidation followed by cyclization. For the synthesis of moracin O (**6**), epoxidation with *m*-CPBA followed by [5-exo-tet]-cyclization under basic condition gave mixture of **14** and **15** in a ratio of 3:1, which were then separated by column chromatography. Although *in situ* epoxidation with *m*-CPBA followed by ring closure under acidic conditions (*p*-TSA) has been reported to give six-membered cyclic compound **15**,[3a] selective [6-endo-trig]-closure was also observed without using an acid catalyst to yield **15** as the sole product when we employed oxone for the epoxidation. From these two intermediates (**14** and **15**), direct Suzuki coupling with **13** afforded (±) moracins O (**6**) and P (**7**) in five steps with overall yields of 6.8% and 9.2%, respectively.



Scheme 3. The synthesis of moracins O (**6**) and P (**7**). Reagents and conditions: (a) i) *m*-CPBA, DCM, 0 °C to rt; ii) LiOH, MeOH, rt, 1 h, 57%; (b) oxone, ACN:H_2O (4:1), rt, 3 h, 76%; (c) boronic ester **13**, K_3PO_4, Pd(dppf)Cl_2.DCM, DMF:H_2O (4:1), 70 °C, 1 h, 80% (**6**) and 81% (**7**).

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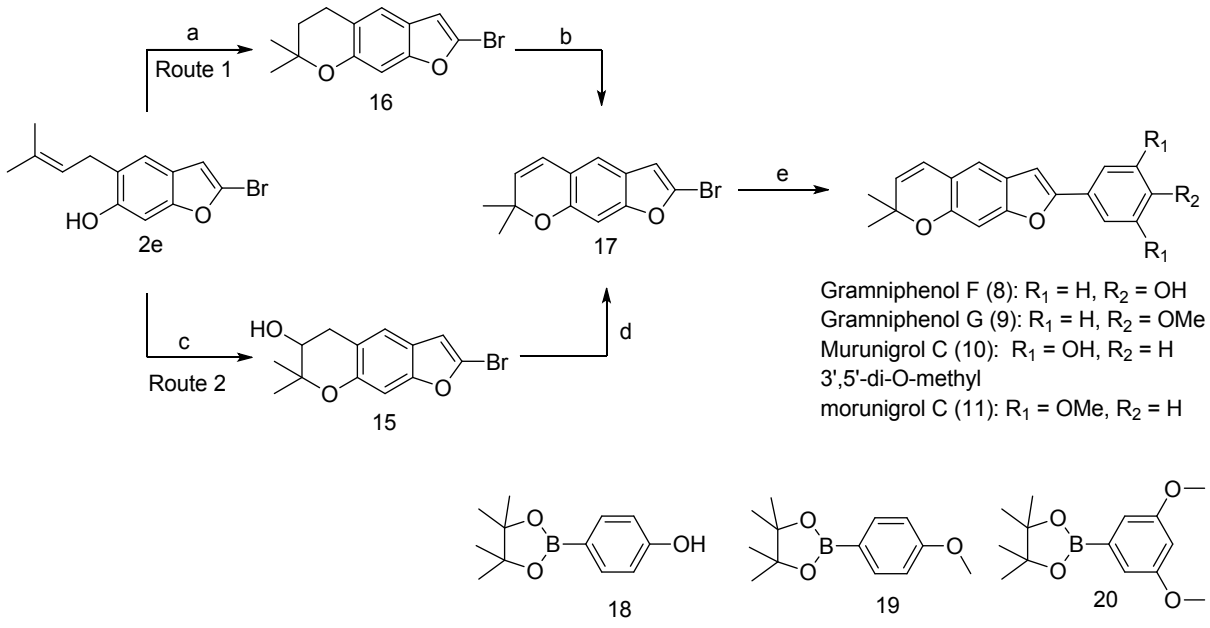
Gramniphenols F (**8**) and G (**9**) exhibiting anti-tobacco mosaic virus activity isolated from the plant *Arundina Graminfolia*[12] and morunigrol C (**10**) isolated from the bark of *Morus nigra*[13] have already been synthesized.[5b,6b] Owing to their structural similarity to moracin P, we planned a unified route for these natural products from **3f**. Initial attempts using $BF_3.Et_2O$ cyclization followed by DDQ oxidation yielded desired intermediate **17** in low yield.[14a–c] Hence, to improve the yield, an alternate route involving the already established intermediate **15** was designed. The dehydration of **15** under Appel conditions gave **17** in good yield.[15] After the successful generation of benzofuran **17**, it was directly coupled with the corresponding boronic esters (**13** and **18–20**) to give natural products gramniphenols F (**8**) and G (**9**), morunigrol C (**10**), and 3',5'-di-*O*-methyl morunigrol C (**11**) with overall yields of 7.3%, 7.8%, 7.3%, and 7.8% respectively (Scheme 4).



Scheme 4. The synthesis of gramniphenols F (**8**) and G (**9**), morunigrol C (**10**) and 3',5'-di-*O*-methyl morunigrol C (**11**). Reagents and conditions: (a) $BF_3.Et_2O$, DCE, rt, 2 h, 50%; (b) DDQ,

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dioxane, 16 h, 100 °C, 37%; (c) oxone, ACN:H_2O (4:1), rt, 3 h, 76%; (d) PPh_3, CCl_4:ACN (1:1), 80 °C, 85%; (e) boronic esters (**13** and **18–20**), K_3PO_4, Pd(dppf)Cl_2.DCM, DMF:H_2O (4:1), 1 h, 70 °C, 76% (**8**), 80% (**9**), 75% (**10**), and 80% (**11**).

Conclusions

In conclusion, we report the improved and divergent synthesis of moracins M (**4**), N (**5**), O (**6**), P (**7**), gramniphenols F (**8**) and G (**9**), morunigrol C (**10**), and its derivative (**11**). A common pooled strategy for benzofuran compounds using an efficient one-pot synthesis of versatile intermediate 2-bromo-6-hydroxybenzofurans was successfully established. The fewer number of steps and the broad substrate scope in this strategy provides a new and practical straightforward route to numerous benzofuran-based natural products and their derivatives via transition-metal-catalyzed cross-coupling reactions.

Experimental section

All the commercial chemicals were of reagent grade and were used without further purification. Solvents were dried with standard procedures. All the reactions were carried out under an atmosphere of dried argon in flame-dried glassware. Melting points were measured on Thermo Scientific-9200 apparatus. Infrared (IR) spectra were recorded on an FT-IR Nicolet iS5 spectrometer (ThermoFisher Scientific, Madison, WI, U.S.A.). The proton nuclear magnetic resonance (^{1}H-NMR) spectra were determined on a Varian (400 or 600 MHz) spectrometer (Varian Medical Systems, Inc., Palo Alto, CA, USA). ^{13}C-NMR spectra were recorded on a Varian (100 or 150 MHz) spectrometer. The chemical shifts are provided in parts per million (ppm) downfield

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with coupling constants in hertz (Hz). The mass spectra were recorded using high-resolution mass spectrometry (HRMS) (electron ionization MS) obtained on a JMS-700 mass spectrometer (Jeol, Japan). The products from all of the reactions were purified by flash column chromatography using silica gel 60 (230−400 mesh Kieselgel 60). Additionally, thin layer chromatography on 0.25 mm silica plates (E. Merck; silica gel 60 F_{254}) was used to monitor reactions. Spots were detected by viewing under UV light and colorized with charring after dipping in 2,4-DNP or basic $KMnO_4$ solution.

General procedure for the one–pot synthesis of 2-bromo-6-hydroxybenzofurans (3a-m): A solution of CBr_4 (4 equiv) in ACN was added drop wise to a suspension of aldehyde (1 equiv), PPh_3 (4 equiv) and Zn powder (4 equiv) in ACN. The reaction mass was stirred at rt for 30 min (for **3m** reaction mass was stirred at 60 °C for 30 min). NH_4Cl (5 equiv) was added to the reaction mass and stirred vigorously till it becomes a clear solution. To this solution Cs_2CO_3 (3.5 equiv) and CuI (5 mol%) were added and the reaction mass was heated to reflux for 3 h. Reaction mixture was cooled to rt, filtered through celite and concentrated in *vacuo.* Residue was purified by silica gel column chromatography (hexane:EtOAc). The isolated compounds were stored at 0-5 °C.

2-Bromobenzofuran-6-ol (3a). Purification by silica gel column chromatography (0 to 10% EtOAc in hexane) afforded **3a** (0.21 g, 65%) as off white solid. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.32 (d, J = 8.4 Hz, 1H), 6.94 (d, J = 2.0 Hz, 1H), 6.77 (dd, J = 8.4, 2.0 Hz, 1H), 6.63 (s, 1H), 4.91 (s, 1H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 156.36, 153.33, 126.29, 122.34, 120.32, 112.37, 108.01, 98.16; IR (neat) ν_{max} 3372.41, 1626.09, 1491.58, 1060.09, 592.17 cm^{-1}; HRMS (ESI) *m/z* calcd for $C_8H_6BrO_2$ $[M+H]^+$ 212.9551; found 212.9545.

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2-Bromo-4-methylbenzofuran-6-ol (3b). Purification by silica gel column chromatography (0 to 10% EtOAc in hexane) afforded **3b** (0.22 g, 65%) as off white solid. ^{1}H NMR (400 MHz, DMSO-d_6) δ 9.59 (brs, 1H), 7.00 (s, 1H), 6.73 (d, J = 2.0 Hz, 1H), 6.57 (d, J = 2.0 Hz, 1H), 2.34 (s, 3H); ^{13}C NMR (100 MHz, DMSO-d_6) δ 156.42, 155.89, 130.82, 124.33, 120.67, 113.55, 107.71, 95.26, 18.55; IR (neat) ν_{max} 3195.48, 1603.56, 1494.46, 1039.63, 587.22 cm^{-1}; HRMS (ESI) *m/z* calcd for $C_9H_8BrO_2$ $[M+H]^+$ 226.9708; found 226.9709.

2-Bromo-4-methoxybenzofuran-6-ol (3c). Purification by silica gel column chromatography (0 to 10% EtOAc in hexane) afforded **3c** (0.25 g, 69%) as off white solid. ^{1}H NMR (400 MHz, DMSO-d_6) δ 9.68 (s, 1H), 6.89 (s, 1H), 6.53 (d, J = 1.6 Hz, 1H), 6.30 (d, J = 1.6 Hz, 1H), 3.82 (s, 3H); ^{13}C NMR (100 MHz, DMSO-d_6) δ 157.35, 157.19, 152.63, 123.28, 110.79, 106.10, 95.57, 90.71, 55.89; IR (neat) ν_{max} 3232.65, 1621.99, 1498.11, 1136.41, 1059.60, 538.91 cm^{-1}; HRMS (ESI) *m/z* calcd for $C_9H_8BrO_3$ $[M+H]^+$ 242.9657; found 242.9653.

2-Bromo-7-(3-methylbut-2-en-1-yl)benzofuran-6-ol (3d). Purification by silica gel column chromatography (0 to 8% EtOAc in hexane) afforded **3d** (0.25 g, 59%) as white solid. ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.19 (d, J = 7.8 Hz, 1H), 6.76 (d, J = 7.8 Hz, 1H), 6.62 (s, 1H), 5.34 (t, J = 7.2 Hz, 1H), 5.25 (s, 1H) 3.62 (d, J = 7.2 Hz, 2H), 1.85 (s, 3H), 1.77 (s, 3H); ^{13}C NMR (150 MHz, $CDCl_3$) δ 154.91, 152.06, 135.72, 125.97, 121.91, 120.62, 117.67, 112.95, 110.33, 108.42, 25.78, 23.00, 17.93; IR (neat) ν_{max} 3340.70, 2969.76, 2919.09, 1619.64, 1416.49, 1062.25, 909.08, 535.93 cm^{-1}; HRMS (ESI) *m/z* calcd for $C_{13}H_{14}BrO_2$ $[M+H]^+$ 281.0177; found 281.0185.

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7-Allyl-2-bromobenzofuran-6-ol (3e). Purification by silica gel column chromatography (0 to 9% EtOAc in hexane) afforded **3e** (0.23 g, 60%) as white solid. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.22 (d, J = 8.0 Hz, 1H), 6.78 (d, J = 8.0 Hz, 1H), 6.63(s, 1H), 6.10–6.00(m, 1H), 5.21 (dd, J = 16.0, 2.8 Hz, 1H), 5.18 (dd, J = 10.0, 2.8 Hz, 1H), 5.05(s, 1H), 3.67(d, J = 6.4 Hz, 2H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 154.98, 151.81, 135.03, 126.15, 122.09, 118.12, 116.69, 112.94, 108.79, 108.49, 28.06; IR (neat) ν_{max} 3445.22, 1622.31, 1413.76, 1147.33, 1058.01, 905.19, 546.09 cm^{-1}; HRMS (ESI) *m/z* calcd for C_{11} H_{10} O_2 Br $[M+H]^+$ 252.9864; found 252.9865.

2-Bromo-5-(3-methylbut-2-en-1-yl)benzofuran-6-ol (3f). The reaction was carried out in ACN:DCM (4:1) mixture. Purification by silica gel column chromatography (0 to 7% EtOAc in hexane) afforded **3f** (0.17 g, 40%) as light yellow oil. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.18 (s, 1H), 6.92 (s, 1H), 6.58 (s, 1H),5.31(t, J = 6.8 Hz, 1H), 5.21 (s, 1H), 3.40(d, J = 6.8 Hz, 2H),1.79(s, 6H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 155.21, 152.29, 135.11, 125.80, 123.92, 122.08, 121.82, 119.98, 107.84, 98.36, 29.96, 25.81, 17.88; IR (neat) ν_{max} 3449.06, 2978.02, 2910.2, 1625.54, 1447.90, 1063.06, 913.82, 596.64 cm^{-1}; HRMS (ESI) *m/z* calcd for $C_{13}H_{14}BrO_2$ $[M+H]^+$ 281.0177; found 281.0164.

5-Allyl-2-bromobenzofuran-6-ol (3g). Purification by silica gel column chromatography (0 to 12% EtOAc in hexane) afforded **3g** (0.16 g, 42%) as light yellow oil. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.21 (s, 1H), 6.95 (s, 1H), 6.60 (s, 1H), 6.07–5.98 (m, 1H), 5.18 (dd, J = 10.0, 2.8 Hz, 1H), 5.14 (dd, J = 16.0, 2.8 Hz, 1H), 5.05(s, 1H),3.47(d, J = 6.4 Hz, 2H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 155.6, 152.02, 136.41, 126.07, 122.34, 122.20, 120.60, 116.75, 107.82, 98.57, 35.37; IR (neat)

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ν_{max} 3416.07, 1625.31, 1469.27, 1238.50, 1085.9, 913.72, 596.74 cm^{-1}; HRMS (ESI) *m/z* calcd for $C_{11}H_{10}O_2Br$ $[M+H]^+$ 252.9864; found 252.9875.

2-Bromo-5-nitrobenzofuran-6-ol (3h). Purification by silica gel column chromatography (100% hexane) afforded **3h** (39.0 mg, 10%) as yellow solid. ^1H NMR (400 MHz, $CDCl_3$) δ 10.72 (s, 1H), 8.31 (s, 1H), 7.17 (s, 1H), 6.74 (s, 1H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 160.16, 153.54, 130.94, 122.49, 116.96, 108.37, 108.38, 100.91; IR (neat) ν_{max} 3115.45, 1633.72, 1526.84, 1426.00, 1324.54, 1128.61, 892.62, 598.32 cm^{-1}; HRMS (ESI) *m/z* calcd for $C_8H_4NO_4NaBr$ $[M+Na]^+$ 279.9221; found 279.9224.

2,5-dibromobenzofuran-6-ol (3i). Purification by silica gel column chromatography (0 to 5% EtOAc in hexane) afforded **3i** (0.19 g, 44%) as off white solid. ^1H NMR (400 MHz, $CDCl_3$) δ 7.59 (s, 1H), 7.14 (s, 1H), 6.60 (s, 1H), 5.55 (s, 1H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 155.80, 149.49, 127.70, 123.40, 122.08, 107.31, 106.74, 98.75; IR (neat) ν_{max} 3464.27, 1620.83, 1421.22, 1339.33, 1259.03, 1064.98, 914.44, 596.39 cm^{-1}; HRMS (ESI) *m/z* calcd for $C_8H_5Br_2O_2$ $[M+H]^+$ 290.8656; found 290.8651.

2,4-dibromobenzofuran-6-ol (3j). Purification by silica gel column chromatography (0 to 5% EtOAc in hexane) afforded **3j** (0.25 g, 56%) as off white solid. ^1H NMR (400 MHz, DMSO-d_6) δ 10.11 (brs, 1H), 6.98 (s, 2H), 6.93 (s, 1H); ^{13}C NMR (100 MHz, DMSO-d_6) δ 156.70, 156.22, 126.81, 122.09, 116.04, 112.10, 108.35, 97.74; IR (neat) ν_{max} 3334.94, 1591.79, 1406.95, 1281.90, 1082.45, 915.20, 597.64 cm^{-1}; HRMS (ESI) *m/z* calcd for $C_8H_5Br_2O_2$ $[M+H]^+$ 290.8656; found 290.8651.

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2-Bromo-5-chlorobenzofuran-6-ol (3k). Purification by silica gel column chromatography (0 to 7% EtOAc in hexane) afforded **3k** (0.15 g, 40%) as off white solid. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.44 (s, 1H), 7.13 (s, 1H), 6.60 (s, 1H), 5.58 (s, 1H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 155.14, 148.78, 127.67, 122.71, 119.15, 116.84, 107.55, 98.84; IR (neat) ν_{max} 3444.81, 1541.95, 1424.59, 1339.32, 1258.90, 1067.59, 788.93, 597.00 cm^{-1}; HRMS (ESI) *m/z* calcd for $C_8H_5BrClO_2$ $[M+H]^+$ 246.9161; found.246.9154.

2-Bromo-5,7-dichlorobenzofuran-6-ol (3l). Purification by silica gel column chromatography (0 to 10% EtOAc in hexane) afforded **3l** (0.19 g, 44%) as off white solid. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.40 (s, 1H), 6.66 (s, 1H), 5.82 (brs, 1H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 151.01, 145.41, 128.52, 122.55, 117.82, 117.60, 108.31, 104.17; IR (neat) ν_{max} 3461.15, 1542.30, 1413.92, 1345.58, 1149.97, 1066.24, 798.10, 730.68, 596.73 cm^{-1}; HRMS (ESI) *m/z* calcd for $C_8H_4BrCl_2O_2$ $[M+H]^+$ 280.8772; found.280.8763.

2-Bromo-3-methylbenzofuran-6-ol (3m). The reaction was carried out in ACN:DCM (4:1) mixture. Purification by silica gel column chromatography (0 to 10% EtOAc in hexane) afforded **3m** (0.14 g, 40%) as off white semi solid (Thermally unstable and rapidly decomposing on complete drying). ^{1}H NMR (400 MHz, DMSO-d_6) δ 9.64 (brs, 1H), 7.34 (d, J = 8.0 Hz, 1H), 6.88 (d, J = 2.0 Hz,1H), 6.75 (dd, J = 8.0, 2.8 Hz, 1H), 2.10 (s, 3H). ^{13}C NMR (100 MHz, DMSO-d_6) δ 156.13, 155.89, 123.24, 121.30, 119.70, 115.38, 112.77, 97.83, 8.84 IR (neat) ν_{max} 3363.92, 1625.57, 1489.33, 1251.12, 1079.32, 628.82 cm^{-1}; HRMS (ESI) *m/z* calcd for $C_9H_8BrO_2$ $[M+H]^+$ 226.9708; found 226.9707.

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5-(4,4,5,5-tetramethyl-1,3,2-dioxaborolan-2-yl)benzene-1,3-diol (13). Pd(dppf)Cl_2.DCM (0.19 g, 0.27 mmol) was added to a degassed solution of 5-bromobenzene-1,3-diol (**12**) (1.00 g, 5.32 mmol), bis(pinacolato)diboron (2.02 g, 7.98 mmol) and KOAc (0.89 g, 7.98 mmol) in 1,4-dioxane.The reaction mass was heated to 100 °C for 2 h. Reaction mass was cooled to rt, filtered through celite and concentrated in *vacuo.* Purification by silica gel column chromatography (0 to 25% EtOAc in hexane) afforded **13** (1.10 g, 88%) as off white solid. m.p. 224–226 °C; ^{1}H NMR (400 MHz, DMSO-d_6) δ 9.13 (brs, 2H), 6.53 (d, J = 2.0 Hz, 2H), 6.53 (d, J = 2.0 Hz, 1H), 1.25 (s, 12H); ^{13}C NMR (100 MHz, DMSO-d_6) δ 158.46, 112.46, 105.98, 83.77, 25.09; IR (neat) ν_{max} 3326.11, 2967.44, 1606.18, 1377.39, 1139.65, 1010.68 cm^{-1}; HRMS (ESI) *m/z* calcd for $C_{12}H_{18}BO_4$ $[M+H]^+$ 237.1298; found 237.1304.

2-(6-bromo-2,3-dihydrobenzo[1,2-b:5,4-b']difuran-2-yl)propan-2-ol (14). 3-Chloroperoxybenzoic acid (0.14 g, 0.80 mmol) was added to a solution of 2-bromo-5-(3-methylbut-2-en-1-yl)benzofuran-6-ol (**3f**) (0.15 g, 0.53 mmol) in DCM at 0 °C and the mixture was stirred for 0.5 h. Reaction mass distilled to dryness, residue was re-dissolved in MeOH and LiOH (38.0 mg, 1.60 mmol) was added to it. Resulting mixture was stirred at rt for another 2 h. Reaction mass was distilled to dryness, partitioned between EtOAc and water. Organic layers washed with brine, dried over sodium sulfate and concentrated in *vacuo.* Purification by silica gel column chromatography (0 to 8% EtOAc in hexane) afforded **14** (90.0 mg, 57%) as off white solid. m.p. 80–83 °C; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.20 (s, 1H), 6.86 (s, 1H), 6.58 (s, 1H), 4.66 (t, J = 8.8 Hz, 1H), 3.25–3.15 (m, 2H), 1.89(s, 1H), 1.35 (s, 3H), 1.22 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 157.73, 155.78, 125.37, 123.96, 122.26, 115.18, 108.07, 92.85, 90.25, 71.78, 30.25,

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26.19, 24.03; IR (neat) ν_{max}.3195.46, 2916.58, 1603.56, 1494.46, 1301.76, 1120.02, 1039.63,567.22 cm^{-1}; HRMS (ESI) *m/z* calcd for $C_{13}H_{14}BrO_3$ $[M+H]^+$ 297.0126; found 297.0139.

2-Bromo-7,7-dimethyl-6,7-dihydro-5H-furo[3,2-g]chromen-6-ol (15).

Oxone (0.22 g, 1.42 mmol) was added to a solution of 2-bromo-5-(3-methylbut-2-en-1-yl)benzofuran-6-ol (**3f**) (0.20 g, 0.71 mmol) in ACN:H_2O (4:1) at 0 °C and the mixture was stirred for 3h slowly raising to rt. Reaction mass was partitioned between EtOAc and water. Organic layers washed with brine, dried over sodium sulfate and concentrated in *vacuo.* Purification by silica gel column chromatography (0 to 10% EtOAc in hexane) afforded **15** (0.16 g, 76%) as off white solid**.** m.p. 96–99 °C; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.15 (s, 1H), 6.93 (s, 1H), 6.57 (s, 1H), 3.85–3.80 (m, 1H), 3.15 (dd, J = 16.4, 5.6 Hz, 1H), 2.86 (dd, J = 16.4, 5.6 Hz, 1H), 1.74 (d, J = 7.6 Hz, 1H), 1.37 (s, 3H), 1.33 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 155.44, 150.69, 126.51, 122.60, 120.17, 115.56, 107.54, 104.52, 99.44, 69.62, 31.54, 24.75, 22.20; IR (neat) ν_{max} 3375.57, 2971.8, 2924.96, 1630.96, 1457.67, 1142.50, 1101.77, 1049.94, 594.62 cm^{-1}; HRMS (ESI) *m/z* calcd for $C_{13}H_{14}BrO_3$ $[M+H]^+$ 297.0126; found 297.0165.

2-Bromo-7,7-dimethyl-6,7-dihydro-5H-furo[3,2-g]chromene (16). $BF_3.Et_2O$ (45.0 mg, 0.31 mmol) was added to a solution of 2-bromo-5-(3-methylbut-2-en-1-yl)benzofuran-6-ol (**3f**) (60.0 mg, 0.21 mmol) in DCE at 0°C and the mixture was stirred for 1 h. Reaction mass was partitioned between DCM and saturated $NaHCO_3$ solution. Organic layers washed with brine, dried over sodium sulfate and concentrated in *vacuo.* Purification by silica gel column chromatography (100% hexane) afforded **16** (35.0 mg, 59%) as colourless oil. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.12 (s, 1H),

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6.86 (s, 1H), 6.54 (s, 1H), 2.85 (t, J = 6.8 Hz, 2H), 1.82 (t, J = 6.8 Hz, 2H), 1.39 (s, 6H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 155.54, 152.00, 125.86, 121.66, 119.36, 117.72, 107.50, 99.21, 74.48, 32.84, 26.83, 22.67; HRMS (ESI) *m/z* calcd for $C_{13}H_{14}BrO_2$ $[M+H]^+$ 281.0177; found 281.0174.

2-Bromo-7,7-dimethyl-7H-furo[3,2-g]chromene (17). PPh_3 (0.18 g, 0.68 mmol) was added to a solution of 2-bromo-7,7-dimethyl-6,7-dihydro-5H-furo[3,2-g]chromene (**15**) (0.1 g, 0.34 mmol) in ACN:CCl_4 (1:1) and the reaction mixture was heated to 80 °C for 1h. Reaction mass was cooled to rt and concentrated in *vacuo.* Purification by silica gel column chromatography (100% hexane) afforded **17** (80.0 mg, 85%) as colourless oil. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.05 (s, 1H), 6.88 (s, 1H), 6.57 (s, 1H), 6.38 (d, J = 10.0 Hz, 1H), 5.63 (d, J = 10.0 Hz, 1H), 1.43 (s, 6H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 156.20, 151.23, 130.51, 126.07, 122.44, 122.30, 118.61, 116.74, 107.99, 99.48, 76.37, 27.78; IR (neat) ν_{max} 2974.28, 2934.57, 1625.79, 1541.61, 1462.62, 1263.54,1113.53, 914.89, 590.72 cm^{-1}; HRMS (ESI) *m/z* calcd for $C_{13}H_{12}BrO_2$ $[M+H]^+$ 279.0021; found 279.0019.

General Procedure for Suzuki Coupling: Pd(dppf)Cl_2.DCM (5 mol%) was added to a degassed solution of aryl bromide (1 equiv), boronic ester/acid (1.2 equiv) and K_3PO_4 (2.0 equiv) in DMF:H_2O (4:1). The reaction mixture was heated 70 °C for 1 h. Reaction mass was cooled to rt, filtered through celite and partitioned between EtOAc and water. Organic layers washed with brine, dried over sodium sulfate and concentrated in *vacuo*. Residue was purified by silica gel column chromatography (hexane:EtOAc).

Moracin M (4). Purification by silica gel column chromatography (0 to 55% EtOAc in hexane) afforded **4** (45.0 mg, 83%) as off white solid. m.p. 264–266 °C; ^{1}H NMR (400 MHz, DMSO-d_6) δ

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9.44 (brs, 3H), 7.38 (d, J = 8.0 Hz, 1H), 7.08 (s, 1H), 6.92 (d, J = 2.0 Hz, 1H), 6.74 (dd, J = 8.4, 2.0 Hz, 1H), 6.68 (d, J = 2.0 Hz, 2H), 6.21 (t, J = 2.0 Hz, 1H); ^{13}C NMR (100 MHz, DMSO-d_6) δ 159.22, 156.16, 155.68, 154.38, 132.10, 121.56, 121.21, 112.88, 103.06, 102.72, 101.99, 97.89. IR (neat) ν_{max} 3252.77, 1604.30, 435.61, 1351.42, 1138.01, 1000.09, 814.45 cm^{-1}; HRMS (ESI) *m/z* calcd for $C_{14}H_{11}O_4$ $[M+H]^+$ 243.0658; found 243.0567.

Moracin N (5). Purification by silica gel column chromatography (0 to 40% EtOAc in hexane) afforded **5** (25.0 mg, 51%) as off white solid. m.p. 183–185 °C; ^{1}H NMR (600 MHz, Methanol-d_4) δ 7.18 (s, 1H), 6.87(s, 1H), 6.85 (s, 1H), 6.74 (s, 2H), 6.22 (s, 2H), 5.35 (t, J = 7.8 Hz, 1H), 3.33 (d, J = 7.8 Hz, 2H), 1.74 (s, 3H), 1.72 (s, 3H); ^{13}C NMR (150 MHz, Methanol-d_4) δ 158.49, 154.29, 154.13, 153.18, 132.59, 131.38, 124.75, 122.98, 121.33, 119.97, 102.41, 101.90, 100.81, 96.42, 28.08, 24.55, 16.39; IR (neat) ν_{max} 3283.67, 2967.36, 2911.33, 1599.06, 1467.32, 1352.85, 1147.58, 1091.58 cm^{-1}; HRMS (ESI) *m/z* calcd for $C_{19}H_{19}O_4$ $[M+H]^+$ 311.1283; found 311.1281.

Moracin O (6). Purification by silica gel column chromatography (0 to 50% EtOAc in hexane) afforded **6** (26.0 mg, 80%) as off white solid. m.p. 235–237 °C; ^{1}H NMR (400 MHz, Methanol-d_4) δ 7.29 (s, 1H), 6.89(s, 1H), 6.85 (s, 1H), 6.73 (d, J = 2.4 Hz, 2H), 6.22 (t, J = 2.4 Hz, 1H), 4.64 (t, J = 9.2 Hz 1H), 3.23 (d, J = 7.6 Hz 1H), 3.21 (d, J = 8.8 Hz 1H), 1.27 (s, 3H), 1.24 (s, 34); ^{13}C NMR (100 MHz, Methanol-d_4) δ 158.53, 158.43, 154.94, 154.78, 132.40, 123.68, 122.55, 115.56, 102.37, 101.99, 100.93, 91.79, 89.95, 71.08, 29.74, 23.92, 23.83; IR (neat) ν_{max} 3325.14, 2990.35, 1700.68, 1608.44, 1443.51, 1356.31, 1136.63, 1090.87, 997.00, 946.77 cm^{-1}; HRMS (ESI) *m/z* calcd for $C_{19}H_{19}O_5$ $[M+H]^+$ 327.1232; found 327.1234.

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Moracin P (7). Purification by silica gel column chromatography (0 to 50% EtOAc in hexane) afforded **7** (27.0 mg, 81%) as off white solid. m.p. 133–136 °C; ^{1}H NMR (400 MHz, Methanol-d_4) δ 7.22 (s, 1H), 6.88 (s, 1H), 6.85 (s, 1H), 6.75 (d, J = 2.4 Hz, 2H), 6.24 (t, J = 2.0 Hz, 1H), 3.78 (dd, J = 7.6, 5.6 Hz,1H), 3.11 (dd, J = 16.4, 5.2 Hz, 1H), 2.82 (dd, J = 16.8, 7.6 Hz, 1H), 1.27 (s, 3H), 1.23 (s, 3H); ^{13}C NMR (100 MHz, Methanol-d_4) δ 160.01, 156.63, 155.96, 152.60, 133.74, 124.24, 121.82, 117.73, 104.04, 103.69, 101.85, 99.72, 78.26, 70.64, 32.48, 26.03, 21.12; IR (neat) ν_{max} 3319.02, 2922.89, 1604.03, 1459.38, 1351.54, 1139.25, 1104.48, 1053.26, 1000.74, 944.82 cm^{-1}; HRMS (ESI) *m/z* calcd for C_{19} H_{19} O_5 $[M+H]^+$ 327.1232; found 327.1243.

Gramniphenol F (8). Purification by silica gel column chromatography (0 to 10% EtOAc in hexane) afforded **8** (20.0 mg, 76%) as off white solid. m.p. 168–170 °C; ^{1}H NMR (400 MHz, Methanol-d_4) δ 7.64 (d, J = 7.2 Hz, 2H), 7.11 (s, 1H), 6.85 (s, 1H), 6.84 (d, J = 7.2 Hz, 2H), 6.79 (s, 1H), 6.42 (d, J = 9.6 Hz, 1H), 5.66 (d, J = 9.6 Hz, 1H), 1.41 (s, 6H); ^{13}C NMR (100 MHz, Methanol-d_4) δ 155.56, 155.34, 155.22, 151.10, 129.92, 126.19, 123.86, 123.07, 122.84, 118.17, 117.31, 115.68, 99.48, 76.24, 27.79; IR (neat) ν_{max} 3419.52, 2968.90, 2931.59, 1573.74, 1506.67, 1346.82,1236.92, 1125.88 cm^{-1}; HRMS (ESI) *m/z* calcd for $C_{19}H_{17}O_3$ $[M+H]^+$ 293.1178; found 293.1166.

Gramniphenol G (9). Purification by silica gel column chromatography (0 to 10% EtOAc in hexane) afforded **9** (22.0 mg, 80%) as off white solid. m.p. 179–181 °C; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.72 (d, J = 9.2 Hz, 2H), 7.10 (s, 1H), 6.95 (d, J = 9.2 Hz, 2H), 6.94 (s, 1H), 6.74 (s, 1H), 6.41 (d, J = 10.0 Hz, 1H), 5.62 (d, J = 10.0 Hz, 1H), 3.84 (s, 3H), 1.45 (s, 6H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 159.62, 155.36, 151.07, 129.89, 125.95, 123.57, 123.12, 122.85, 118.15, 117.28,

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114.21, 99.49, 76.21, 55.37, 27.79; IR (neat) ν_{max} 2976.04, 2934.13, 16.15.14, 1586.95, 1503.59, 1458.24, 1246.13, 1123.40, 1033.06 cm^{-1}; HRMS (ESI) *m/z* calcd for $C_{20}H_{19}O_3$ $[M+H]^+$ 307.1334; found 307.1332.

Morunigrol C (10). Purification by silica gel column chromatography (0 to 20% EtOAc in hexane) afforded **10** (26.0 mg, 75%) as off white solid. m.p. 104–106 °C; ^1H NMR (600 MHz, Methanol-d_4) δ 7.16 (s, 1H), 6.90 (s, 1H), 6.85 (s, 1H), 6.74 (s, 2H), 6.44 (d, J = 10.2 Hz, 1H), 6.24 (s, 1H), 5.68 (d, J = 10.2 Hz, 1H), 1.42 (s, 6H); ^{13}C NMR (150 MHz, Methanol-d_4) δ 158.61, 155.36, 151.39, 132.10, 129.69, 122.85, 122.33, 118.31, 117.34, 102.56, 102.29, 100.75, 98.52, 75.95, 26.65; IR (neat) ν_{max} 3269.50, 2973.95, 1612.61, 1350.62, 1122.38 cm^{-1}; HRMS (ESI) *m/z* calcd for $C_{19}H_{17}O_4$ $[M+H]^+$ 309.1127; found 309.1118.

3',5'-di-*O*-methylmorunigrol C (11). Purification by silica gel column chromatography (0 to 5% EtOAc in hexane) afforded **11** (24.0 mg, 80%) as off white solid. m.p. 115–117 °C; ^1H NMR (400 MHz, $CDCl_3$) δ 7.13 (s, 1H), 6.96 (s, 1H), 6.95 (d, J = 2.0 Hz, 2H), 6.87 (s, 1H), 6.43 (t, J = 2.0 Hz, 1H), 6.41 (d, J = 9.6 Hz, 1H), 5.63 (d, J = 9.6 Hz, 1H), 3.86 (s, 6H), 1.45 (s, 6H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 161.09, 155.51, 154.99, 151.61, 132.38, 130.09, 122.76, 118.37, 117.64, 102.59, 101.70, 100.61, 99.54, 76.33, 55.51, 27.83; IR (neat) ν_{max} 2965.38, 2929.18, 1596.99, 1574.19, 1452.45, 1345.99, 1120.26 cm^{-1}; HRMS (ESI) *m/z* calcd for $C_{21}H_{21}O_4$ $[M+H]^+$ 337.1440; found 337.1423.

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Conflicts of interest

"There are no conflicts to declare".

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