

## Green synthesis of isoquinoline derivatives using multicomponent reaction of phthalaldehyde

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Received: February 2019; Revised: April 2019; Accepted: April 2019

**Abstract:** A simple and proficient method for the synthesis of isoquinoline derivatives *via* four-component reaction of salicylaldehyde, phthalaldehyde, methyl amine and isocyanide under solvent-free conditions at room temperature is reported.

**Keywords:** Salicylaldehyde, Isocyanide, Phthalaldehyde, Four-component reaction.

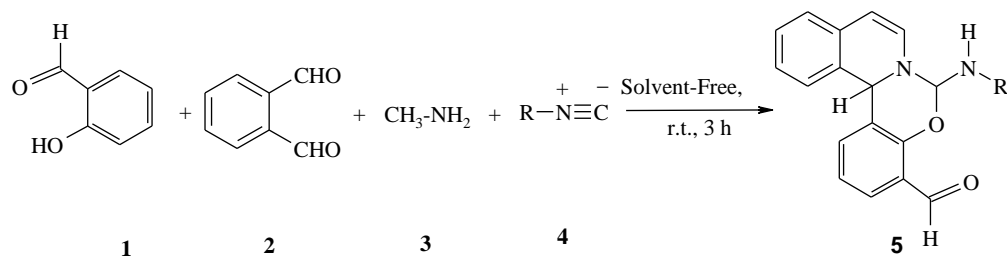
### Introduction

Procedures of green chemistry are imperative for care for resources and reducing prices [1-3]. The creation of extremely economical reactions with a low number of synthetic process and short reaction times is a chief topic in advanced synthetic chemistry. Over the last decade multicomponent reactions (MCRs) are very important kind of reaction because of in these reactions three or more reactants mixed in one-pot procedure and generated a single product [4-10] that in comparison to multi-step methods, MCRs are economically useful and environmentally secure. In the multistep reaction generally due to multiple stages of separation of product generate large amounts of waste that often involve the employ of pricey, poisonous or unsafe solvents in each step. MCRs are very appealing for combinatorial library preparation and they are utilized in lead detection of new drugs and agrochemicals [11-18].

The one-pot preparation of different and complex compounds with small heterocycles shows a influential instrument in synthetic chemistry [19].

Also, the isoquinoline skeleton is found in a large number of naturally occurring and synthetic biologically active heterocyclic compounds [20-25]. Continuing our efforts directed towards the simple preparation of biologically active target molecules through multi-component reactions and our interest in isocyanide-based multi-component reactions [26-29], we performed the synthesis of isoquinoline derivatives **4** *via* the reaction of salicylaldehyde **1**, phthalaldehyde **2**, methyl amine **3** and isocyanide **4** under solvent-free conditions at room temperature (Scheme 1).

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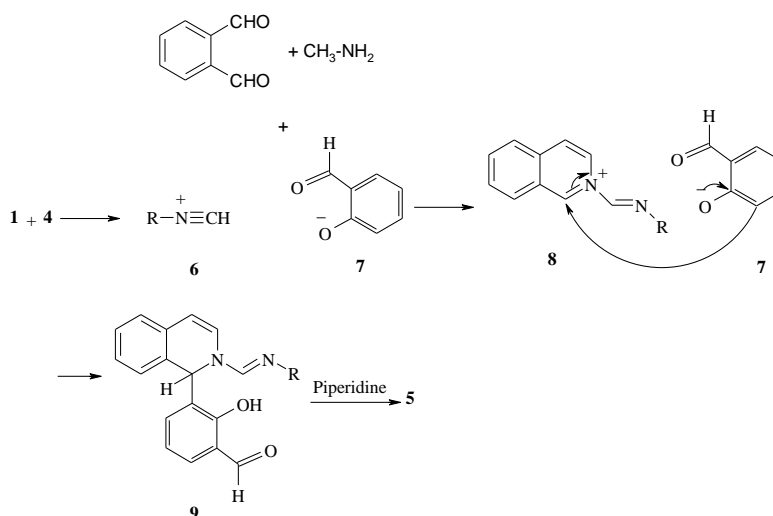
5	R	Yield (%) of 5
a	<sup>t</sup> Bu	85
b	Cyclohexyl	80
c	1,1,3,3-tetramethylbutyl	80
d	CH <sub>2</sub> CO <sub>2</sub> Et	75
e	2,6-Dimethyl phenyl	83
f	Bn	78
g	2-nitrophenyl	65

**Scheme 1:** Reaction of phthalaldehyde, isocyanide and 2-hydroxyacetophenone.

## Results and discussion

The data obtained from elemental analysis, IR, <sup>1</sup>H NMR and <sup>13</sup>C NMR spectra confirmed all of the proposed products. The <sup>1</sup>H NMR spectrum of **5a** displayed one singlet at 1.38 ppm for the *tert*-butyl group, two singlet at 2.10 and 2.54 ppm for methyl protons, two singlet at 5.30 and 5.85 for CH protons, one singlet at 8.74 ppm for NH proton and two set of doublet for vicinal methine protons at 4.78 and 5.73 ppm which appeared as with <sup>2</sup>J<sub>HH</sub> of 3.5 Hz. One single resonance at δ = 196.2 ppm is observed in the <sup>13</sup>C NMR spectrum of **5a**, which is attributed to the

carbonyl group. A proposed mechanism for the formation of compound **5** is shown in Scheme 2. It is conceivable that the initial event is the formation of acid–base complex **6** from the isocyanide **4** and the 2-salicylaldehyde **1**. Complex **6** activates the isocyanide functional group sufficiently for further nucleophilic attack by *in-situ* produced isoquinoline to produce intermediate **8**. Finally, nucleophilic attack of the conjugated base of the 2-hydroxyacetophenone **7** on **8** affords intermediate **9** that converted to **5** by cyclization in the presence of piperidine.



**Scheme 2:** Proposed mechanism for the formation of **5**.

## Conclusion

In conclusion, we have described a new and successful strategy for the convenient synthesis of 1,3-benzoxazine *via* three-component condensation reaction of a salicylaldehyde, phthalaldehyde, methyl amine and isocyanide. The method offers few advantages including high yields of products and an easy experimental work-up procedure.

## Experimental Section

### General

Melting points were taken on a Kofler hot stage apparatus and are uncorrected.  $^1\text{H}$ ,  $^{13}\text{C}$  and  $^{31}\text{P}$  NMR spectra were obtained with a Bruker FT-500 spectrometer in  $\text{CDCl}_3$ , and tetramethylsilane (TMS) was used as an internal standard or 85%  $\text{H}_3\text{PO}_4$  as external standard. Mass spectra were recorded with a Finnigan Mat TSQ-70 spectrometer. Infrared (IR) spectra were acquired on a Nicolet Magna 550-FT spectrometer. Elemental analyses were carried out with a Perkin-Elmer model 240-C apparatus. The results of elemental analyses (C, H, N) were within  $\pm 0.4\%$  of the calculated values. Acetylenic ester, phenacyl bromide or its derivatives and triphenylphosphine were obtained from Fluka and were used without further purification.

### General procedure for preparation of compounds 5:

To a magnetically stirred mixture of salicylaldehyde **1**, phthalaldehyde **2**, methyl amine **3** after 30 min isocyanide **4** (2 mmol) was added slowly. The reaction mixture was stirred for 3h. After completion of reaction (monitored by TLC), 15 mL  $\text{H}_2\text{O}$  was poured to mixture of reaction. The reaction mixture was filtered and the solid residue was crystallized from ethyl acetate to afford **5**.

*7-(tertbutylamino)-2-isopropenyl-14bH-furo[2,3-f]isoquino[2,1-c][1,3]benzoxazine-5-carboxylic acid (5a):*

pale yellow powder, m.p. 145-147 °C, 0.73 g, yield 85%. IR (KBr) ( $\nu_{\text{max}}/\text{cm}^{-1}$ ): 1727, 1675, 1548, 1228  $\text{cm}^{-1}$ . Anal. Calcd for  $\text{C}_{27}\text{H}_{28}\text{N}_2\text{O}_3$  (428.53): C, 75.68; H, 6.59; N, 6.54%. Found: C, 75.54; H, 6.46; N, 6.47%.  $^1\text{H}$  NMR (500 MHz,  $\text{CDCl}_3$ ):  $\delta$  1.38 (9 H, s,  $\text{Me}_3\text{C}$ ), 2.10 (3 H, s, Me), 2.54 (3 H, s, Me), 4.78 (1 H, d,  $^2J = 3.5$  Hz, CH), 5.30 (1 H, s, CH), 5.73 (1 H, d,  $^2J = 3.5$  Hz, CH), 5.85 (1 H, s, CH), 6.42 (1 H, d,  $^3J_{\text{HH}} = 5.8$  Hz, CH), 7.54 (1 H, d,  $^3J_{\text{HH}} = 7.6$  Hz, CH), 7.69 (1 H, t,  $^3J_{\text{HH}} = 7.2$  Hz, CH), 7.73 (1 H, t,  $^3J_{\text{HH}} = 7.2$  Hz, CH), 7.82 (1 H, s, CH), 7.93 (1 H, d,  $^3J_{\text{HH}} = 7.5$  Hz, CH),

8.74 (1 H, s, NH), 8.69 (1 H, d,  $^3J_{\text{HH}} = 7.5$  Hz, CH), 9.31 (1 H, d,  $^3J_{\text{HH}} = 7.6$  Hz, CH) ppm.  $^{13}\text{C}$  NMR (125.7 MHz,  $\text{CDCl}_3$ ):  $\delta$  18.6 (Me), 27.3 (Me), 29.5 ( $\text{Me}_3\text{C}$ ), 48.7 (C), 52.7 (CH), 78.4 (CH), 107.8 (CH), 110.5 (C), 112.7 (CH), 114.3 ( $\text{CH}_2$ ), 117.6 (C), 121.0 (C), 121.8 (C), 122.4 (CH), 124.9 (CH), 126.1 (CH), 128.4 (CH), 129.5 (CH), 130.7 (CH), 136.8 (C), 138.2 (C), 154.5 (C), 157.6 (C), 159.4 (C), 196.2 (C=O). MS,  $m/z$  (%): 428 ( $\text{M}^+$ , 10), 371 (88), 299 (68), 129 (100), 57 (86).

*7-(cyclohexylamino)-2-isopropenyl-14bH-furo[2,3-f]isoquino[2,1-c][1,3]benzoxazine-5-carboxylic acid (5b):*

White powder, m.p. 152-154 °C, 0.73 g, yield 80%. IR (KBr) ( $\nu_{\text{max}}/\text{cm}^{-1}$ ): 1728, 1685, 1487, 1348, 1257, 1129  $\text{cm}^{-1}$ . Anal. Calcd for  $\text{C}_{29}\text{H}_{30}\text{N}_2\text{O}_3$  (454.56): C, 76.63; H, 6.65; N, 6.16%. Found: C, 76.74; H, 6.72; N, 6.25%.  $^1\text{H}$  NMR (500 MHz,  $\text{CDCl}_3$ ):  $\delta$  1.35 (2 H, m,  $\text{CH}_2$ ), 1.43 (2 H, m,  $\text{CH}_2$ ), 1.48 (2 H, m,  $\text{CH}_2$ ), 1.65 (2 H, m,  $\text{CH}_2$ ), 1.84 (2 H, m,  $\text{CH}_2$ ), 2.14 (3 H, s, Me), 2.52 (3 H, s, Me), 3.80 (1 H, m, N-CH), 4.82 (1 H, d,  $^2J = 3.0$  Hz, CH), 5.25 (1 H, s, CH), 5.70 (1 H, d,  $^2J = 3.0$  Hz, CH), 5.82 (1 H, s, CH), 6.45 (1 H, d,  $^3J_{\text{HH}} = 6.0$  Hz, CH), 7.49 (1 H, d,  $^3J_{\text{HH}} = 7.6$  Hz, CH), 7.65 (1 H, t,  $^3J_{\text{HH}} = 7.3$  Hz, CH), 7.68 (1 H, t,  $^3J_{\text{HH}} = 7.3$  Hz, CH), 7.78 (1 H, s, CH), 7.86 (1 H, d,  $^3J_{\text{HH}} = 7.5$  Hz, CH), 8.65 (1 H, d,  $^3J_{\text{HH}} = 7.5$  Hz, CH), 8.78 (1 H, s, NH), 9.27 (1 H, d,  $^3J_{\text{HH}} = 7.6$  Hz, CH) ppm.  $^{13}\text{C}$  NMR (125.7 MHz,  $\text{CDCl}_3$ ):  $\delta$  18.8 (Me), 24.5 ( $\text{CH}_2$ ), 24.7 ( $\text{CH}_2$ ), 25.6 ( $\text{CH}_2$ ), 27.6 (Me), 33.4 ( $\text{CH}_2$ ), 33.7 ( $\text{CH}_2$ ), 48.7 (CH), 53.4 (CH), 80.2 (CH), 108.0 (CH), 112.2 (C), 113.4 (CH), 115.0 ( $\text{CH}_2$ ), 118.5 (C), 121.4 (C), 122.0 (C), 122.8 (CH), 125.0 (CH), 126.7 (CH), 128.7 (CH), 130.4 (CH), 131.2 (CH), 137.4 (C), 139.0 (C), 155.0 (C), 158.3 (C), 160.2 (C), 194.0 (C=O). MS,  $m/z$  (%): 454 ( $\text{M}^+$ , 15), 371 (54), 325 (78), 129 (100), 81 (48).

*7-(1,1,3,3-tetramethylbutylamino)-2-isopropenyl-14bH-furo[2,3-f]isoquino[2,1-c][1,3]benzoxazine-5-carboxylic acid (5c):*

Yellow crystals, m.p. 162-164 °C, 0.77 g, yield 80%. IR (KBr) ( $\nu_{\text{max}}/\text{cm}^{-1}$ ): 1735, 1674, 1528, 1457, 1364, 1229  $\text{cm}^{-1}$ . Anal. Calcd for  $\text{C}_{31}\text{H}_{36}\text{N}_2\text{O}_3$  (484.64): C, 76.83; H, 7.49; N, 5.78%. Found: C, 76.92; H, 7.56; N, 5.84%.  $^1\text{H}$  NMR (500 MHz,  $\text{CDCl}_3$ ):  $\delta$  1.03 (9 H, s,  $\text{CMe}_3$ ), 1.55 (3 H, s, Me), 1.62 (3 H, s, Me), 1.83 (2 H, s,  $\text{CH}_2$ ), 2.17 (3 H, s, Me), 2.48 (3 H, s, Me), 4.75 (1 H, d,  $^2J = 2.7$  Hz, CH), 5.32 (1 H, s, CH), 5.74 (1 H, d,  $^2J = 2.7$  Hz, CH), 5.93 (1 H, s, CH), 6.57 (1 H, d,  $^3J_{\text{HH}} = 5.5$  Hz, CH), 7.53 (1 H, d,  $^3J_{\text{HH}} = 7.4$  Hz, CH), 7.72 (1 H, t,  $^3J_{\text{HH}} = 7.2$  Hz, CH), 7.78 (1 H, t,  $^3J_{\text{HH}} = 7.3$  Hz, CH), 7.82 (1 H, s, CH), 7.90 (1 H, d,  $^3J_{\text{HH}} = 7.4$  Hz,

CH), 8.72 (1 H, d,  $^3J_{\text{HH}} = 7.6$  Hz, CH), 8.83 (1 H, s, NH), 9.28 (1H, d,  $^3J_{\text{HH}} = 7.6$  Hz, CH) ppm.  $^{13}\text{C}$  NMR (125.7 MHz,  $\text{CDCl}_3$ ):  $\delta$  19.2 (Me), 28.3 (Me), 29.7 (C), 31.6 ( $\text{CMe}_3$ ), 31.9 (2 Me), 50.4 (C), 51.2 (CH), 55.0 ( $\text{CH}_2$ ), 81.4 (CH), 108.6 (CH), 112.5 (C), 113.7 (CH), 115.4 ( $\text{CH}_2$ ), 119.2 (C), 121.8 (C), 122.5 (C), 123.0 (CH), 125.6 (CH), 127.2 (CH), 129.3 (CH), 130.8 (CH), 131.7 (CH), 137.6 (C), 139.4 (C), 155.3 (C), 159.2 (C), 160.6 (C), 196.7 (C=O). MS,  $m/z$  (%): 484 ( $\text{M}^+$ , 10), 371 (62), 129 (100), 113 (52).

*7-(2-ethoxy-2-oxoethylamino)-2-isopropenyl-14bH-furo[2,3-f]isoquino[2,1-c][1,3]benzoxazine-5-carboxylic acid (5d):*

Yellow powder, m.p. 158-160 °C, 0.69 g, yield 75%. IR (KBr) ( $\nu_{\text{max}}/\text{cm}^{-1}$ ): 1732, 1683, 1565, 1434, 1358, 1235  $\text{cm}^{-1}$ . Anal. Calcd for  $\text{C}_{27}\text{H}_{26}\text{N}_2\text{O}_3$  (458.51): C, 70.73; H, 5.72; N, 6.11%. Found: C, 70.65; H, 5.67; N, 6.02%.  $^1\text{H}$  NMR (500 MHz,  $\text{CDCl}_3$ ):  $\delta$  1.31 (3 H, t,  $^3J = 7.4$  Hz, Me), 2.14 (3 H, s, Me), 2.50 (3 H, s, Me), 4.20 (2 H, s,  $\text{CH}_2$ ), 4.25 (2 H, q,  $^3J = 7.3$  Hz,  $\text{CH}_2\text{O}$ ), 4.75 (1 H, d,  $^2J = 2.8$  Hz, CH), 5.34 (1 H, s, CH), 5.75 (1 H, d,  $^2J = 2.8$  Hz, CH), 5.87 (1 H, s, CH), 6.62 (1 H, d,  $^3J_{\text{HH}} = 5.6$  Hz, CH), 7.58 (1 H, d,  $^3J_{\text{HH}} = 7.5$  Hz, CH), 7.74 (1 H, t,  $^3J_{\text{HH}} = 7.4$  Hz, CH), 7.82 (1 H, t,  $^3J_{\text{HH}} = 7.5$  Hz, CH), 7.87 (1 H, s, CH), 7.95 (1 H, d,  $^3J_{\text{HH}} = 7.5$  Hz, CH), 8.75 (1 H, d,  $^3J_{\text{HH}} = 7.5$  Hz, CH), 8.85 (1 H, s, NH), 9.24 (1H, d,  $^3J_{\text{HH}} = 7.6$  Hz, CH) ppm.  $^{13}\text{C}$  NMR (125.7 MHz,  $\text{CDCl}_3$ ):  $\delta$  14.1 (Me), 18.5 (Me), 28.4 (Me), 50.2 ( $\text{CH}_2$ ), 51.7 (CH), 60.7 ( $\text{CH}_2\text{O}$ ), 81.6 (CH), 108.5 (CH), 112.7 (C), 114.0 (CH), 115.8 ( $\text{CH}_2$ ), 119.6 (C), 122.4 (C), 122.8 (C), 123.7 (CH), 126.3 (CH), 127.8 (CH), 129.6 (CH), 131.2 (CH), 132.3 (CH), 138.0 (C), 139.7 (C), 155.6 (C), 159.8 (C), 159.4 (C), 167.2 (C=O), 195.2 (C=O). MS,  $m/z$  (%): 458 ( $\text{M}^+$ , 10), 329 (58), 129 (100), 43 (86).

*7-(2,6-dimethylphenylamino)-2-isopropenyl-14bH-furo[2,3-f]isoquino[2,1-c][1,3]benzoxazine-5-carboxylic acid (5e):*

Yellow powder, m.p. 164-166 °C, 0.79 g, yield 83%. IR (KBr) ( $\nu_{\text{max}}/\text{cm}^{-1}$ ): 1734, 1684, 1576, 1425 1374, 1247, 1129  $\text{cm}^{-1}$ . Anal. Calcd for  $\text{C}_{31}\text{H}_{28}\text{N}_2\text{O}_3$  (476.57): C, 78.13; H, 5.92; N, 5.88%. Found: C, 78.24; H, 6.04; N, 5.94%.  $^1\text{H}$  NMR (500 MHz,  $\text{CDCl}_3$ ):  $\delta$  2.10 (3 H, s, Me), 2.24 (3 H, s,  $\text{CH}_3$ ), 2.27 (3 H, s,  $\text{CH}_3$ ), 2.52 (3 H, s, Me), 4.80 (1 H, d,  $^2J = 2.6$  Hz, CH), 5.28 (1 H, s, CH), 5.78 (1 H, d,  $^2J = 2.6$  Hz, CH), 5.83 (1 H, s, CH), 6.48 (1 H, d,  $^3J_{\text{HH}} = 5.5$  Hz, CH), 7.43 (1 H, d,  $^3J_{\text{HH}} = 7.4$  Hz, CH), 7.46 (1 H, d,  $^3J_{\text{HH}} = 7.5$  Hz, CH), 7.57 (1 H, t,  $^3J_{\text{HH}} = 7.3$  Hz, CH), 7.64 (1 H, t,  $^3J_{\text{HH}} = 7.2$  Hz, CH), 7.66 (2 H, d,  $^3J_{\text{HH}} = 7.4$  Hz, 2 CH), 7.78 (1 H, s,

CH), 7.82 (1 H, d,  $^3J_{\text{HH}} = 7.4$  Hz, CH), 8.82 (1 H, s, NH), 8.92 (1 H, d,  $^3J_{\text{HH}} = 7.6$  Hz, CH), 9.27 (1 H, d,  $^3J_{\text{HH}} = 7.6$  Hz, CH) ppm.  $^{13}\text{C}$  NMR (125.7 MHz,  $\text{CDCl}_3$ ):  $\delta$  18.3 (Me), 18.5 (Me), 18.7 (Me), 27.5 (Me), 53.0 (CH), 78.6 (CH), 108.2 (CH), 110.7 (C), 113.4 (CH), 114.8 ( $\text{CH}_2$ ), 118.4 (C), 121.5 (C), 122.3 (C), 122.7 (CH), 125.4 (CH), 126.6 (CH), 127.3 (2 C), 128.5 (CH), 129.2 (2 CH), 130.2 (CH), 130.7 (CH), 134.0 (CH), 137.2 (C), 138.4 (C), 154.6 (C), 155.2 (C), 157.8 (C), 159.8 (C), 196.5 (C=O). MS,  $m/z$  (%): 476 ( $\text{M}^+$ , 15), 347 (68), 129 (100), 43 (86).

*7-(benzylamino)-2-isopropenyl-14bH-furo[2,3-f]isoquino[2,1-c][1,3]benzoxazine-5-carboxylic acid (5f):*

Yellow powder, m.p. 174-176 °C, 0.72 g, yield 78%. IR (KBr) ( $\nu_{\text{max}}/\text{cm}^{-1}$ ): 1735, 1678, 1556, 1367 1284  $\text{cm}^{-1}$ . Anal. Calcd for  $\text{C}_{30}\text{H}_{26}\text{N}_2\text{O}_3$  (462.55): C, 77.90; H, 5.67; N, 6.06%. Found: C, 77.84; H, 5.73; N, 6.14%.  $^1\text{H}$  NMR (500 MHz,  $\text{CDCl}_3$ ):  $\delta$  2.15 (3 H, s, Me), 2.58 (3 H, s, Me), 4.71 (2 H, s,  $\text{CH}_2$ ), 4.83 (1 H, d,  $^2J = 2.8$  Hz, CH), 5.32 (1 H, s, CH), 5.76 (1 H, d,  $^2J = 2.8$  Hz, CH), 5.87 (1 H, s, CH), 6.52 (1 H, d,  $^3J_{\text{HH}} = 5.4$  Hz, CH), 7.25 (2 H, t,  $^3J_{\text{HH}} = 7.8$  Hz, 2 CH), 7.45 (1 H, t,  $^3J_{\text{HH}} = 7.4$  Hz, CH), 7.58 (1 H, d,  $^3J_{\text{HH}} = 7.5$  Hz, CH), 7.64 (2 H, d,  $^3J_{\text{HH}} = 7.6$  Hz, 2 CH), 7.74 (1 H, t,  $^3J_{\text{HH}} = 7.4$  Hz, CH), 7.75 (1 H, t,  $^3J_{\text{HH}} = 7.6$  Hz, CH), 7.80 (1 H, s, CH), 7.95 (1 H, d,  $^3J_{\text{HH}} = 7.5$  Hz, CH), 8.78 (1 H, s, NH), 8.94 (1 H, d,  $^3J_{\text{HH}} = 7.5$  Hz, CH), 9.35 (1 H, d,  $^3J_{\text{HH}} = 7.5$  Hz, CH) ppm.  $^{13}\text{C}$  NMR (125.7 MHz,  $\text{CDCl}_3$ ):  $\delta$  19.2 (Me), 28.4 (Me), 51.9 ( $\text{CH}_2$ ), 53.4 (CH), 79.0 (CH), 108.4 (CH), 111.2 (C), 112.8 (CH), 114.7 ( $\text{CH}_2$ ), 118.3 (C), 122.0 (C), 122.7 (C), 123.4 (CH), 125.4 (CH), 126.7 (CH), 128.2 (2 CH), 128.6 (CH), 129.1 (2 CH), 130.4 (CH), 131.2 (CH), 134.0 (CH), 137.0 (C), 138.5 (C), 139.3 (C), 154.6 (C), 158.3 (C), 158.8 (C), 197.3 (C=O).

*7-(2-nitrophenylamino)-2-isopropenyl-14bH-furo[2,3-f]isoquino[2,1-c][1,3] benzoxazine-5-carboxylic acid (5g):*

Yellow powder, m.p. 158-160 °C, 0.32 g, yield 65%. IR (KBr) ( $\nu_{\text{max}}/\text{cm}^{-1}$ ): 1738, 1656, 1587, 1447 1364, 1337, 1295  $\text{cm}^{-1}$ . Anal. Calcd for  $\text{C}_{29}\text{H}_{23}\text{N}_3\text{O}_5$  (493.51): C, 70.58; H, 4.70; N, 8.51%. Found: C, 70.62; H, 7.76; N, 8.57%.  $^1\text{H}$  NMR (500 MHz,  $\text{CDCl}_3$ ):  $\delta$  2.12 (3 H, s, Me), 2.54 (3 H, s, Me), 4.78 (1 H, d,  $^2J = 3.2$  Hz, CH), 5.17 (1 H, s, CH), 5.72 (1 H, d,  $^2J = 3.2$  Hz, CH), 5.76 (1 H, s, CH), 6.52 (1 H, d,  $^3J_{\text{HH}} = 6.2$  Hz, CH), 7.45 (2 H, d,  $^3J_{\text{HH}} = 7.5$  Hz, 2 CH), 7.48 (1 H, d,  $^3J_{\text{HH}} = 7.5$  Hz, CH), 7.62 (1 H, t,  $^3J_{\text{HH}} = 7.4$  Hz, CH), 7.65 (1 H, t,  $^3J_{\text{HH}} = 7.5$  Hz, CH), 7.72 (2 H, d,  $^3J_{\text{HH}} = 7.4$  Hz, 2 CH), 7.75

(1 H, s, CH), 7.82 (1 H, d,  $^3J_{\text{HH}} = 7.4$  Hz, CH), 8.75 (1 H, s, NH), 8.87 (1 H, d,  $^3J_{\text{HH}} = 7.5$  Hz, CH), 9.25 (1 H, d,  $^3J_{\text{HH}} = 7.8$  Hz, CH) ppm.  $^{13}\text{C}$  NMR (125.7 MHz,  $\text{CDCl}_3$ ):  $\delta$  18.5 (Me), 27.8 (Me), 52.6 (CH), 78.7 (CH), 108.6 (CH), 111.2 (C), 113.6 (CH), 115.2 ( $\text{CH}_2$ ), 118.7 (C), 122.0 (C), 123.4 (C), 123.6 (CH), 125.7 (CH), 127.2 (CH), 127.8 (2 C), 128.6 (CH), 129.5 (2 CH), 130.4 (CH), 131.2 (CH), 133.8 (CH), 137.5 (C), 139.2 (C), 154.7 (C), 155.6 (C), 158.2 (C), 160.0 (C), 195.7 (C=O).

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