Solvent-Free Synthesis of 6-Arylbenzimidazo[1,2-*c*]quinazolines under Microwave Irradiation

Hernán Pessoa-Mahana,*[a] C. David Pessoa-Mahana,[b] Ricardo Salazar,[a] Jaime A. Valderrama,[c] Edmundo Saez,[b] Ramiro Araya-Maturana[a]

[a] Departamento de Química Orgánica y Fisicoquímica, Facultad de Ciencias Químicas y Farmacéuticas, Universidad de Chile, Casilla 233, Santiago 1, Chile
Fax +56(2)6782868; E-mail: hpessoa@ciq.uchile.cl

[b] Departamento de Farmacia, Pontificia Universidad Católica de Chile, Casilla 306, Santiago, Chile

[c] Departamento de Química Orgánica, Facultad de Química, Pontificia Universidad Católica de Chile, Casilla 306, Santiago, Chile

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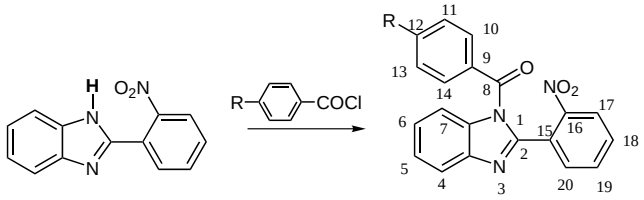
Abstract: The syntheses of 2-(2-nitrophenyl)-1-benzoyl-1*H*-benzimidazole derivatives **5**–**9** and their reduction to the corresponding 2-benzimidazoylbenzamides **10**–**13** are described. Compounds **10**–**13** were cleanly and efficiently converted to the corresponding 6-arylbenzimidazo[1,2-*c*]quinazolines **17**–**20** by microwave activation using SiO_2-MnO_2 as solid inorganic support.

Key words: benzimidazoles, heterocyclization, microwaves, benzimidazoquinazolines, solvent-free reactions

The synthesis of compounds belonging to benzimidazo[1,2-*c*]quinazoline series[1,2] constitutes an important area of research due to their interesting DNA binding properties.[3–5] In a previous paper we reported that the reaction of 1-acetyl-2-(2-nitrophenyl)benzimidazole (**1**) with iron in acetic acid–ethanol–water afforded a mixture of benzimidazoquinazoline **2** and 2-arylbenzimidazole **3** (Figure 1).[6] The formation of compounds **2** and **3** was interpreted assuming the participation of an dihydrobenzimidazoquinazoline intermediate.

In continuation of our work, we wish to report a novel and interesting approach for the synthesis of 6-arylbenzimidazo[1,2-*c*]quinazolines **17**–**20** as sole products, using microwave activation on the precursor *N*-[2-(1*H*-benzimidazol-2-yl)phenyl]benzamides **10**–**13**. Compounds **10**–**13** were obtained from the corresponding **5**–**9** benzoylbenzimidazole derivatives under reductive conditions.

The starting benzimidazole **4** required for the study was prepared from *o*-nitrobenzaldehyde by using our previously reported procedure.[6] Compound **4** was reacted with a range of 4-substituted benzoyl chlorides at 0 °C in THF using triethylamine for trapping the hydrogen chloride (Equation 1). This treatment provided the corresponding amides **5**–**9** in good yields (Table 1). The numbering of the general formulas of compounds **5**–**9**, **10**–**13**, and **17**–**20** in Equations 1–3 does not follow IUPAC rules, but makes interpretation of NMR spectra easier.



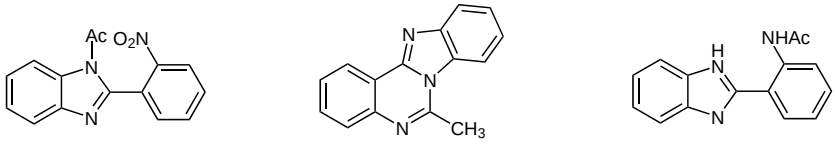
4 **5-9**

Equation 1

Table 1 1-Benzoylbenzoimidazoles **5**–**9** Prepared by Reaction of **4** with Benzoyl Chlorides

Product	R	Yield (%)
5	H	76
6	Cl	92
7	F	91
8	MeO	86
9	NO_2	77

Amides **5**–**9** were subjected to reduction with iron in acetic acid–ethanol–water solution at 45–50 °C (Equation 2). This afforded the corresponding rearranged products **10**–



1 **2** **3**

Figure 1 Compounds **1**–**3**

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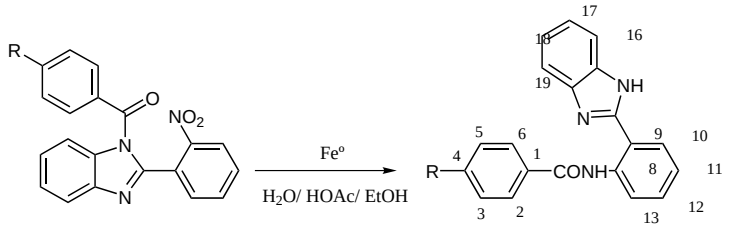


5-9 **10-13**

Equation 2

13 in good yields and no benzimidazo[1,2-*c*]quinazolines were detected by ^{1}H NMR analysis of the crude reaction products. Reduction of **9** gave a complex reaction mixture and no efforts were made to isolate the products. The results are summarized in Table 2.

Table 2 Products **10**–**13** Formed by Reduction of 1-Benzoylbenzimidazoles **5**–**8** with Iron

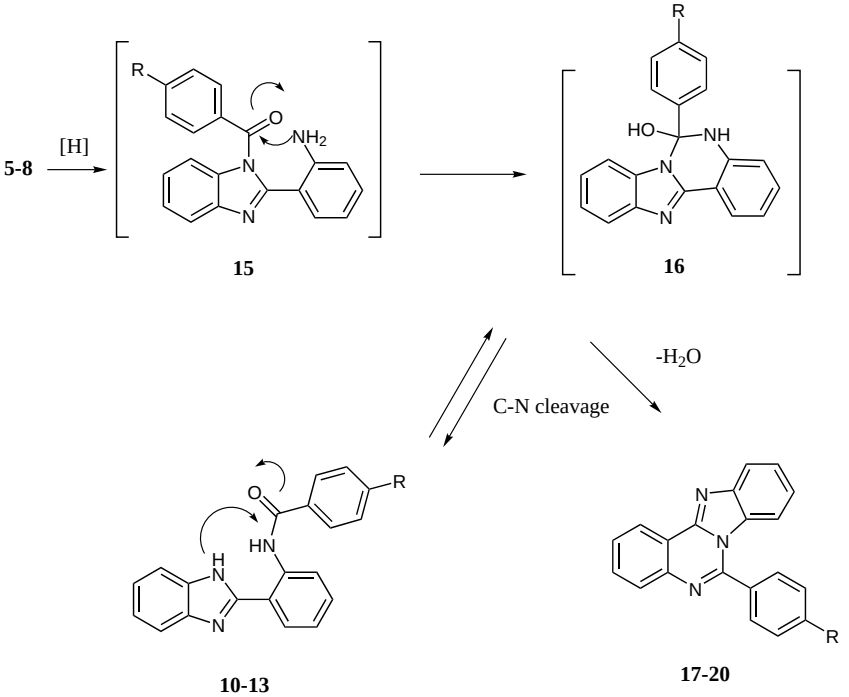
Product	R	Yield (%)
10	H	82
11	Cl	86
12	F	90
13	MeO	93

The results indicate that cyclization of amides to the corresponding benzimidazo[1,2-*c*]quinazoline derivatives under reductive conditions is an unfavorable process relative to the transposition reaction.

Table 3 6-Phenylbenzimidazo[1,2-*c*]quinazolines Prepared by Microwave-Induced Cyclization of Benzimidazoles **10**–**13**

Product	R	Time (min)	Yield (%)
17	H	30	41
18	Cl	40	54
19	F	30	56
20	MeO	45	37

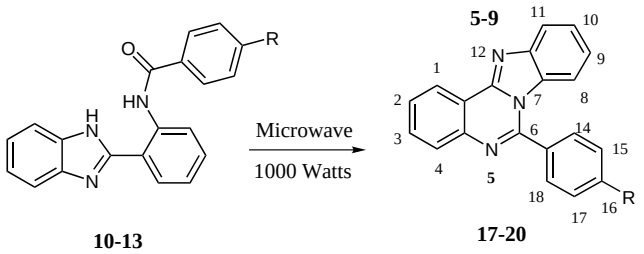
The formation of products **10**–**13** from **5**–**8** probably involves intermediates **15** and **16**, as depicted in Scheme 1. According to this mechanism, the formation of tetracyclic compounds by dehydration reaction of **16** could be favorable in a nonaqueous medium. Based on this assumption and on the dipolar transition state[7] involved in the formation of intermediates **16** by cyclization from the respective precursors **10**–**13** (Scheme 1), we planned to use microwave stimulation to induce the formation of tetracyclic compounds **17**–**20** from **10**–**13**. Heterocyclization of com-



Scheme 1

pounds **10**–**13** using microwave induction was explored under solvent-free conditions using a solid inorganic matrix.[8] Due to the fact that MnO_2 has a large capacity to transfer the dielectric heating[9] we used a 95:5 mixture of silica gel-manganese dioxide as solid support. Compounds **10**–**13** were impregnated on the support and then irradiated at 1000 W for an appropriate time (Table 3).

The treatment of **10**–**13** under microwave irradiation afforded the expected 6-phenylbenzimidazo[1,2-*c*]quinazolines **17**–**20** in moderate yields (Equation 3). The reaction proceeded within 30–45 minutes, meanwhile purely thermal conditions (reflux in anhydrous *m*-xylene over 15 h) gave a mixture of starting materials **10**–**13** and tetracyclic 6-phenylbenzimidazo[1,2-*c*]quinazolines **17**–**20**. Attempts to cyclize compound **11** to the corresponding phenylbenzimidazo[1,2-*c*]quinazolines **18** using only silica gel were unsuccessful, indicating therefore the efficiency of manganese dioxide for the microwave transfer energy.



Equation 3

In summary, the syntheses of 6-arylbenzimidazo[1,2-*c*]quinazolines have been accomplished by employing the reduction of 2-(2-nitrophenyl)-1-(4-substituted benzoyl)-1*H*-benzimidazoles followed by heterocyclization of the corresponding benzimidazoylbenzamides, under solvent-free microwave irradiation. This new approach firmly confirms the great utility of microwave stimulation in heterocyclization reactions for preparing complex polycyclic systems.

All reagents were obtained commercially and used without further purification. Melting points were determined on a Kofler hot-stage apparatus and are uncorrected. IR spectra were recorded with a FT Bruker spectrometer in KBr optics. ^{1}H NMR and ^{13}C NMR spectra were obtained with a Bruker DRX-300 and a Bruker ACP-200 spectrophotometers. The chemical shifts are expressed in ppm (δ scale) downfield from TMS, *J* values are given in Hertz for solutions in $CDCl_3$ unless otherwise indicated. Microanalyses were determined on a Fisons EA 1108 instrument. Silica gel Merck 60 (70–230 mesh) and DC-Alufolien 60 F_{254} were normally used for column and TLC chromatography, respectively. The microwave-assisted procedures were carried out in a domestic microwave oven operating at 1000 W. $MnO_2$was prepared by our reported procedure.[10] The solid support was preparing by heating a 95:5 mixture of silica gel (70–230 mesh) and MnO_2 at 300 °C for 2 h. Petroleum ether used had bp 70–90 °C.

1-Benzoyl-1*H*-benzimidazole Derivatives 5–9; 1-(4-Fluorobenzoyl)-2-(2-nitrophenyl)-1*H*-benzimidazole (7); Typical Procedure

4-Fluorobenzoyl chloride (330 mg, 2.09 mmol) was slowly added to a stirred solution of 2-(2-nitrophenyl)-1*H*-benzimidazole (**4**; 500 mg, 2.09 mmol), Et_3N (210 mg, 2.09 mmol) and anhyd THF (50 mL) under N_2 at 0 °C. The mixture was maintained at r.t. with stirring for 4 h and then poured into H_2O (100 mL). The mixture was extracted with EtOAc (3 × 50 mL) and the combined organic layers were dried ($MgSO_4$). Removal of the solvent afforded **7**; yield (crude): 687 mg (91%); mp 165–166 °C (EtOH).

IR: 3032, 1703, 1534, 1302 cm^{-1}.

^{1}H NMR (300 MHz): δ= 7.07 (d, 1 H, *J* = 8.2 Hz, 7-H), 7.23 (t, 2 H, *J* = 8.4 Hz, 11-H, 13-H), 7.36 (t, 1 H, *J* = 7.5 Hz, 6 -H or 5-H), 7.49 (t, 1 H, *J* = 7.5 Hz, 5-H or 6-H), 7.72–7.92 (m, 5 H, 4-H, 18-H, 19-H and 10-H, 14-H), 7,96 (d, *J* = 8.0 Hz, 1 H, 17-H), 8.28 (d, *J* = 8.0 Hz, 1 H, 20-H).

^{13}C NMR (75.47 MHz) : δ = 113.7, 116.1 (d, 2 C, ^2J = 22.1 Hz) 120.7, 124.6 (d, 2 C, ^3J = 8.9 Hz), 125.0, 127.3, 128.4 (d, ^4J = 2.9 Hz), 130.8, 132.8, 132.9, 133.0, 133,4 133.6, 142.8, 147.2, 150.3, 165.9 (d, ^1J = 257 Hz), 166.6.

Anal. Calcd for $C_{20}H_{12}FN_3O_3$: C, 66.47; H, 3.35; N, 11.63. Found: C, 66.10; H, 3.46; N, 11.51.

1-Benzoyl-2-(2-nitrophenyl)-1*H*-benzimidazole (5)

Prepared from **4** (420 mg, 1.75 mmol) and benzoyl chloride (246 mg,1.75 mmol); yield (crude): 457 mg (76%); mp 154.5–155,5 °C (EtOH).

IR: 3030, 1697, 1524, 1306 cm^{-1}.

^{1}H NMR (300 MHz): δ = 6.93 (d, 1 H, *J* = 8.2 Hz, 7-H), 7.25 (t, 1 H, *J* = 8.2 Hz, 5-H or 6-H), 7.37 (t, 1 H, *J* = 8.2 Hz, 6-H or 5-H), 7.43 (t, 2 H, *J* = 8.0 Hz, 18-H and 19-H), 7.56–7.76 (m, 6 H, 4-H, and C_6H_5CO), 7.85 (d, *J* = 8.0 Hz, 1 H, 17-H), 8.16 (d, *J* = 8.2 Hz, 1 H, 20-H).

^{13}C NMR (75 MHz): δ = 114.0, 120.6, 124.4, 124.6, 124.9, 127.5, 128.7 (2 C), 130.0 (2 C), 130.7, 132.4, 132.9, 133.4, 133.5, 133.8, 142.8, 147.2, 150.4, 167.8.

Anal. Calcd for $C_{20}H_{13}N_3O_3$: C, 69.95; H, 3.82; N, 12.24. Found: C, 69.91; H, 3.93; N, 12.11.

1-(4-Chlorobenzoyl)-2-(2-nitrophenyl)-1*H*-benzimidazole (6)

Prepared from **4** (462 mg, 1.93 mmol) and 4-chlorobenzoyl chloride (338 mg, 1.93 mmol); yield (crude): 670 mg (92%); mp 278.2–279.0 °C (EtOH).

IR: 3030, 1710, 1530, 1352 cm^{-1}.

^{1}H NMR (300 MHz): δ = 6.95 (d, 1 H, *J* = 8.3 Hz, 7-H), 7,26 (t, 1 H, *J* = 8.0 Hz, 5-H or 6-H), 7.38–7.42 (m, 3 H, 6-H or 5-H, 11-H and 13-H), 7.62–7.79 (m, 5 H, 4-H, 18-H, 19-H and 10-H, 14-H), 7.85 (d, *J* = 8.0 Hz, 1 H, 17-H), 8.17 (d, *J* = 8.0 Hz, 1 H, 20-H).

^{13}C NMR (75 MHz): δ = 113.8, 120.7, 124.6, 124.7, 125.0, 127.3, 129.1 (2 C), 130.6, 130.8, 131.5 (2 C), 132.9, 133.3, 133.6, 140.4, 142.8, 147.2, 150.3, 166.7.

Anal. Calcd for $C_{20}H_{12}ClN_3O_3$: C, 63.55; H, 3.21; N, 11.14. Found: C 63.37; H, 3.38; N, 11.16.

1-(4-Methoxybenzoyl)-2-(2-nitrophenyl)-1*H*-benzimidazole (8)

Prepared from **4** (380 mg, 1.59 mmol) and 4-methoxybenzoyl chloride (271 mg, 1.59 mmol); yield (crude): 511 mg (86%); mp 128–129 °C (EtOH).

IR: 3030, 1700, 1525, 1348 cm^{-1}.

^{1}H NMR (300 MHz): δ = 3.81 (s, 3 H, OCH_3), 6.87 (d, 2 H, *J* = 8.8 Hz, 11-H and 13-H), 7.02 (d, 1 H, *J* = 8.0 Hz, 7-H), 7,21 (t,1 H,

J = 7.7 Hz, 5-H or 6-H), 7.33 (t, 1 H, *J* = 7.7 Hz, 6-H or 5-H), 7.57 (td, 1 H, *J* = 7.6, 2.1 Hz, 18-H or 19-H), 7,64–7.76 (m, 4 H, 4-H, 10-H, 14-H and 19-H, or 18-H), 7,84 (d, *J* = 8.1 Hz, 1 H, 17-H), 8.11 (d, *J* = 8.0 Hz, 1 H, 20-H).

^{13}C NMR (DMSO-d_6, 75 MHz): δ = 56.2, 114.4, 114.7 (2 C), 120.6, 124.4, 124.8, 124.9, 125.3, 126.8, 131.8, 133.1 (2 C), 133.3, 134.1, 134.3, 142.9, 148.0, 150.1, 164.4, 167.1.

Anal. Calcd for $C_{21}H_{15}N_3O_4$: C, 67.54; H, 4.05; N, 11.26. Found: C, 67.86; H, 4.18; N, 11.34.

1-(4-Nitrobenzoyl)-2-(2-nitrophenyl)-1*H*-benzimidazole (9)
Prepared from **4** (470 mg, 1.97 mmol) and 4-nitrobenzoyl chloride (365 mg, 1.97 mmol); yield (crude): 585 mg (77%); mp 178.5–179 °C (EtOH).

IR: 3030, 1702, 1524, 1306 cm^{-1}.

^{1}H NMR (DMSO-d_6, 300 MHz): δ = 7.29 (d, 1 H, *J* = 7.7 Hz, 7-H), 7.36 (dt, 1 H, *J* = 7.6, 1.2 Hz, 5-H or 6-H), 7.43 (dt, 1 H, *J* = 7.8, 1.2 Hz, 6-H or 5-H), 7.69 (dt, 1 H, *J* = 7.7, 1,7 Hz, 18-H or 19-H), 7.77 (dt, 1 H, *J* = 7.5, 1.1 Hz, 19-H or 18-H), 7.82–7.87 (m, 2 H, 17-H and 4-H), 7,90 (d, 2 H, *J* = 8.8 Hz, 10-H, and 14-H), 8.11 (dd, 1 H, *J* = 8.1, 1.0 Hz, 20-H), 8.21 (d, 2 H, *J* = 8.8 Hz, 11-H and 13-H).

^{13}C NMR (DMSO-d_6, 75 MHz): δ = 115.3, 120.7, 124.2 (2 C), 125.0, 125.5, 125.9, 126.8, 131.2 (2 C), 132.0, 133.6 (2 C), 134.5, 138.6, 143.0, 147.8, 150.0, 150.2, 166.6.

Anal. Calcd for $C_{20}H_{12}N_4O_5$: C, 61.84; H, 3.12; N, 14.43. Found: C, 61.56; H, 3.39; N, 14.40.

***N*-[2-(1*H*-Benzimidazol-2-yl)phenyl]benzamides 10–13; *N*-[2-(1*H*-Benzimidazol-2-yl)phenyl]benzamide (10); Typical Procedure**
A stirred suspension of 1-benzoyl-2-(2-nitrophenyl)-1*H*-benzimidazole (**5**; 328 mg, 0.96 mmol), powder iron (1 g, 17.86 mmol) and AcOH–EtOH–H_2O (80 mL, 1:1:1) was heated at 50–60 °C for 1 h. The mixture was then diluted with H_2O (30 mL), neutralized with $NaHCO_3$ and extracted with EtOAc (3 × 70 mL). The combined organic layers were dried (Na_2SO_4) and the solvent was evaporated in vacuo to give **10** as a white pale solid; yield (crude): 246 mg (82%). Further purification of the crude by column chromatography on silica gel ($CHCl_3$–EtOACc, 1:1) followed by recrystallization from EtOAc afforded **10** (207 mg, 69%); mp 257–258 °C (EtOH).

IR: 3274, 3030, 1634, 1595 cm^{-1}.

^{1}H NMR (DMSO-d_6, 300 MHz): δ = 7.28–7.34 (m, 3 H, 18-H, 17-H and 12-H or 11-H), 7.55 (t, 1 H, *J* = 8.0 Hz, 11-H or 12-H), 7.61 (d, 1 H, *J* = 7.9 Hz, 16-H or 19-H), 7.66–7.72 (m, 3 H, 3-H, 4-H and 5-H), 7.79 (d, 1 H, *J* = 6.9 Hz, 19-H or 16-H), 8.18 (d, 1 H, *J* = 7.8 Hz, 13-H), 8.23–8.26 (m, 2 H, 2-H, and 6-H), 8.92 (d, 1 H, *J* = 8.2 Hz, 10-H), 13.27 (s, 1 H, NH), 14.05 (s, 1 H, NHCO).

^{13}C NMR (DMSO-d_6, 75 MHz): δ = 112.1, 116.1, 118.7, 120.5, 123.0, 123.6, 124.1, 127.8 (3 C), 129.5 (2 C), 131.3, 132.6, 133.9, 135.3, 138.9, 142.4, 151.4, 166.5.

Anal. Calcd for $C_{20}H_{15}N_3O$: C, 76.65; H, 4.83; N, 13.42. Found: C, 76.42; H, 4.84; N, 13.48.

***N*-[2-(1*H*-Benzimidazol-2-yl)phenyl]-4-chlorobenzamide (11)**
Prepared from **6** (361 mg, 0.96 mmol); yield (crude): 285 mg (86%); mp 337–338 °C (EtOH).

IR: 3296, 3030, 1636, 1593 cm^{-1}.

^{1}H NMR (DMSO-d_6, 300 MHz): δ = 7.28–7.35 (m, 3 H, 18-H, 17-H and 12-H or 11-H), 7.54 (td, 1 H, *J* = 7.9, 1.2 Hz, 11-H or 12-H), 7.62–7.59 (m, 1 H, 16-H, or 19-H), 7.78 (d, 2 H, *J* = 8.6 Hz, 3-H and 5-H), 7.84–7.87 (m, 1 H, 19-H or 16-H), 8.18 (dd, 1 H, *J* = 7.9, 1.2 Hz, 13-H), 8.24 (d, 2 H, *J* = 8.6 Hz, 2-H, and 6-H), 8.92 (dd, 1 H, *J* = 8.4, 0.8 Hz, 10-H), 13.26 (s, 1 H, NH), 14.11 (s, 1 H, NHCO).

^{13}C NMR (DMSO-d_6, 75.47 MHz): δ = 112.0, 116.2, 119.0, 120.4, 123.0, 123.8, 124.2, 127.8, 129.6 (2 C), 129.7 (2 C), 131.4, 133.8, 134.1, 137.5, 138.8, 142.3, 151.4, 164.3.

Anal. Calcd for $C_{20}H_{14}ClN_3O$: C, 69.15; H, 4.07; N, 12.10. Found: C, 69.12; H, 4.18; N, 11.93.

***N*-[2-(1*H*-Benzimidazol-2-yl) phenyl]-4-fluorobenzamide (12)**
Prepared from **7** (382 mg, 1.06 mmol); yield (crude): 314 mg (90%); mp 301–302 °C (EtOH).

IR: 3295, 3030, 1636, 1602 cm^{-1}.

^{1}H NMR (DMSO-d_6, 300.13 MHz): δ = 7.26–7.37 (m, 3 H, 18-H, 17-H and 12-H or 11-H), 7.52–7.59 (m, 3 H, 3-H, 5-H, and 11-H or 12-H), 7.61 (d, 1 H, *J* = 7.1 Hz, 16-H or 19-H), 7.85 (d, 1 H, *J* = 6.9 Hz, 19-H or 16-H), 8.19 (d, 1 H, *J* = 7.1 Hz, 13-H), 8.28–8.33 (m, 2 H, 2-H, and 6-H), 8.91 (d, 1 H, *J* = 7.7 Hz, 10-H), 13.30 (s, 1 H, NH), 14.10 (s, 1 H, NHCO).

^{13}C NMR (DMSO-d_6, 75 MHz): δ = 112.0, 116.0, 116.4 (d, 2 C, ^2J = 22 Hz), 118.8, 120.3, 122.8, 123.6, 124.0, 127.6, 130.4 (d, 2 C, ^3J = 9.3 Hz), 131.2, 131.7 (d, ^4J = 2.9 Hz), 133.7, 138.8, 142.2, 151.3, 164.2, 164.7 (d, ^1J = 249.7 Hz).

Anal. Calcd for $C_{20}H_{14}FN_3O$: C, 72.48; H, 4.26; N, 12.69. Found: C, 72.09; H, 4.35; N, 12.36.

***N*-[2-(1*H*-Benzimidazol-2-yl)phenyl]-4-methoxybenzamide (13)**
Prepared from **8** (523 mg, 1.40 mmol); yield (crude): 446 mg (93%); mp 257–258 °C (EtOH).

IR: 3277, 3030, 1653, 1595 cm^{-1}.

^{1}H NMR (DMSO- d_6, 300 MHz): δ = 3.89 (s, 3 H, OCH_3), 7.22 (d, 2 H, *J* = 8.6 Hz, 3-H and 5-H), 7.27–7.32 (m, 3 H, 18-H, 17-H, and 12-H or 11-H), 7.52 (t, 1 H, *J* = 7.7 Hz, 11-H, or 12-H), 7.60 (d, 1 H, *J* = 6.1 Hz, 16-H or 19-H), 7.86 (d, 1 H, *J* = 6.2 Hz, 19-H or 16-H), 8.17 (d, 1 H, *J* = 7.8 Hz, 13-H), 8.22 (d, 2 H, *J* = 8.6 Hz, 2-H, and 6-H), 8.92 (d, 1 H, *J* = 8.3 Hz, 10-H), 13.23 (s, 1 H,NH), 13.93 (s, 1 H, NHCO).

^{13}C NMR (DMSO- d_6, 75.47 MHz): δ = 56.0, 112.0, 114.7 (2 C), 115.9, 118.9, 120.4, 122.9, 123.3, 124.1, 127.4, 127.7, 129.8 (2 C), 131.3, 133.9, 139.2, 142.4, 151.5, 162.8, 165.0.

Anal. Calcd for $C_{21}H_{17}N_3O_2$: C, 73.44; H, 4.99; N, 12.24. Found: C, 73.23; H, 4.73; N, 12.34.

Benzimidazo[1,2-*c*]quinazolines 17–20; 6-Phenylbenzimidazo[1,2-*c*]quinazoline (17); Typical Procedure
To a solution of *N*-[2-(1*H*-benzimidazol-2-yl)phenyl]benzamide (**10**; 70.4 mg, 0.225 mmol) in CH_2Cl_2 (15 mL) was added the inorganic support (55 g) and the suspension was vigorously stirred for 15 min at r.t. The solvent was removed in vacuo and the solid was irradiated at 1000 W for an appropriate time (Table 3), until TLC showed the disappearance of the starting material. The solid was thoroughly washed with acetone followed by removal of the solvent to afford **17**; yield (crude): 27 mg (41%). A pure sample of **17** was obtained by column chromatography on silica gel eluting with CH_2Cl_2 (21 mg, 32%); mp 231–233 °C (EtOH–petroleum ether, 2:1).

IR: 3056, 1626, 1592 cm^{-1}.

^{1}H NMR (200 MHz): δ = 6.62 (d, 1 H, *J* = 8.4 Hz, 8-H), 7.12 (td, 1 H, *J* = 7.8, 1.2 Hz, 9-H or 10-H), 7.48 (td, 1 H, *J* = 7.8, 1.1 Hz, 10-H or 9-H), 7.62–7.86 (m, 7 H, C_6H_5, and 2-H, 3-H), 7.96–8.04 (m, 2 H, 4-H and 11-H), 8.77 (dd, 1 H, *J* = 7.7 Hz, 1.4 Hz, 1-H).

^{13}C NMR (50 MHz): δ = 114.7, 120.2, 122.9, 124.5, 125.9, 127.4, 128.5, 128.6 (2 C), 128.9, 129.6 (3 C), 131.3, 132.1, 134.5, 142.7, 144.6, 148.3, 148.8.

Anal. Calcd for $C_{20}H_{13}N_3$: C, 81.34; H, 4.44; N, 14.23. Found: C, 81.62; H, 4.60; N, 14.56.

6-(4-Chlorophenyl)benzimidazo[1,2-*c*]quinazoline (18)
Prepared from **11** (66.6 mg, 0.202 mmol); yield (crude): 34.1 mg (54%); mp 240–241.5 °C (EtOH–petroleum ether, 2:1).

IR: 3060, 1635, 1592 cm^{-1}.

^1H NMR (200 MHz): δ = 6.75 (d, 1 H, *J* = 8.4 Hz, 8-H), 7.17 (td, 1 H, *J* = 7.3, 1.2 Hz, 9-H or 10-H), 7.50 (dt, 1 H, *J* = 7.2, 1.2 Hz, 10-H or 9-H), 7.63–7.85 (m, 6 H, 14-H, 15-H, 17-H, 18-H and 2-H, 3-H), 7.98–8.03 (m, 2 H, 4-H and 11-H), 8.75 (dd, 1 H, *J* = 7.8, 1.5 Hz, 1-H).

^{13}C NMR (50 MHz): δ = 114.2, 118.5, 120.2, 122.7, 124.3, 125.8, 128.2, 128.5, 129.1, 129.6 (2 C), 130.0 (2 C), 132.0, 132.7, 137.3, 142.3, 144.5, 147.4, 148.0.

Anal. Calcd for $C_{20}H_{12}ClN_3$: C, 72.93; H, 3.68; N, 12.77. Found: C, 72.82; H, 3.62; N, 12.56.

6-(4-Fluorophenyl)benzimidazo[1,2-*c*]quinazoline (19)
Prepared from **12** (100 mg, 0.30 mmol); yield (crude): 52.4 mg (56%); mp 223–223.5 °C (EtOH–petroleum ether, 2:1).

IR: 3070, 1628, 1597 cm^{-1}.

^1H NMR (200 MHz): δ = 6.69 (d, 1 H, *J* = 8.4 Hz, 8-H), 7.17 (td, 1 H, *J* = 7.9, 1.2 Hz, 9-H or 10-H), 7.32–7.41 (m, 2 H, 15-H, 17-H), 7.50 (td, 1 H, *J* = 7.7, 1.1 Hz, 10-H or 9-H), 7.68–7.86 (m, 4 H, 14-H, 18-H and 2-H, 3-H), 7.96–8.03 (m, 2 H, 4-H and 11-H), 8.75 (ddd, 1 H, *J* = 7.6, 1.3, 0.7 Hz, 1-H).

^{13}C NMR (50 MHz): δ = 114.1, 116.6 (d, 2 C, ^2J = 21.6 Hz), 118.5, 120.2, 122.7, 124.3, 125.8, 128.2, 128.5, 129.2, 130.5, 130.7 (d, 2 C, ^3J = 9.3 Hz), 132.0, 142.3, 144.4, 147.5, 148.1, 164.2 (d, ^1J = 248.5 Hz).

Anal. Calcd for $C_{20}H_{12}FN_3$: C, 76.24; H, 3.86; N, 13.41. Found: C, 76.37; H, 3.78; N, 13.34.

6-(4-Methoxyphenyl)benzimidazo[1,2-*c*]quinazoline (20)
Prepared from **13** (69.2 mg, 0.20 mmol); yield (crude): 24.4 mg (37%); mp 255–256 °C (EtOH–petroleum ether, 2:1).

IR: 3060, 1628, 1590,1451, 1361 cm^{-1}.

^1H NMR (200 MHz): δ = 3.97 (s, 3 H, OCH_3), 6.81 (d, 1 H, *J* = 8.4 Hz, 8-H), 7.11–7.18 (m, 3 H, 15-H, 17-H and 9-H or 10-H), 7.48 (td, 1 H, *J* = 7.7, 1.0 Hz, 10-H or 9-H), 7.66–7.84 (m, 4 H, 14-H, 18-H and 2-H, 3-H), 8.0 (d, 2 H, *J* = 8.1 Hz, 4-H and 11-H), 8.75 (dd, 1 H, *J* = 7.8, 1.3 Hz, 1-H).

^{13}C NMR (50 MHz): δ = 55.6, 114.5, 114.6 (2 C), 118.3, 120.0, 122.5, 124.2, 125.6, 126.7, 128.1 (2 C), 129.4, 130.0 (2 C), 131.8, 142.5, 144.4, 148.3, 148.5, 161.6.

Anal. Calcd for $C_{21}H_{15}N_3O$: C, 77.52; H, 4.65; N, 12.91. Found: C, 77.20; H, 4.92; N, 12.73.

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