Synthesis of 2-(hetero)arylquinazolinones in aqueous media

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Abstract
Mechanochemical treatment of *N*-unsubstituted or *N*-methyl anthranilamide with benzaldehyde yielded their Schiff bases derivatives which could be easily cyclized to the corresponding 2-phenyl-2,3-dihydroquinazolinones *via* thermal rearrangement in water. On the basis of the above findings, an eco-friendly method was applied to prepare quinazolin-4(1*H*)-one derivatives from anthranilamides and a number of (hetero)aryl aldehydes. Heating the aqueous mixture of starting compounds to 90 °C resulted in the products in 81–94% yields. All products precipitated from the reaction mixture and were isolated by simply filtration. No further work-up or purification was necessary.

Keywords: Environmentally friendly methods, aqueous, mechanochemical, ball-milling reactions, chromatography-free

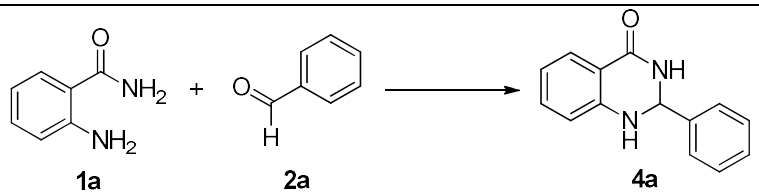
Introduction

2,3-Dihydroquinazolines (DHQZ) are effective substances in medicinal chemistry that possess a broad spectrum of biological activities, including MAO-A[1] and Shiga toxin[2] inhibitor, diuretic[3] or anti-inflammatory[4] activities. Among the various DHQZ derivatives, 2-aryl quinazolinone hybrids have been found to be good candidates for the inhibition of both tubulin polymerization and the [illegible] position 2 of the [illegible]al[7] (*Spodoptera frugiperda*) agents. Some 2-spirooxindole dihydroquinazolinones demonstrate anti-bacterial activity *in vitro*.[8]

Several methods have been reported for the preparation of 2-substituted 2,3-dihydroquinazolin-4(1*H*)-ones, based mainly on the cyclocondensation of anthranil(onitrile)amides with aldehydes in the presence of various catalysts such as cyanuric chloride,[9] citric acid[10], $ZnCl_2$,[11] *p*-TSA[12] and sulfamic acid[13]. Moreover, many of these protocols

are associated with the application of exotic catalyst systems, extended reaction times and tedious work-up procedures. For example, some classical and modern methods reported in the literature for the synthesis of 2-phenyl-2,3-dihydroquinazolin-4-(1*H*)-one (**4a**) *via* the reaction of anthranilamide (**1a**) and benzaldehyde (**2a**) are outlined in Table 1.

Table 1. Synthesis of 2-phenyl-2,3-dihydroquinazolin-4(1*H*)-one (**4a**)



1a **2a** **4a**

Entry	Solvent	Temp. [°C]	Time [h]	Catalyst	Benzaldehyde equiv.	Isolated yield [%][work up]	Ref.
1	PEG	25	0.25	MCM-41-dtz-Ni	1	98[e,rc]	14
2	ethanol	78	1	Fe_3O_4/Cu(II)-Schiff base	1	99[w]	15
3	methanol	25	2	Indion-Ina 225 H	1	98[ch]	16
4	toluene	110	18	–	1	100[–]	17
5	water	120	16	–	1	100[e,ch]	18
6	ethanol	78	0.83	Boehmite SSA	1	96[e,rc]	19
7	acetonitrile	25	0.33	L-proline nitrate	1	96[rc]	20
8	water	25	0.03	1-*i*Pr-1,2,4-triazol.HOTf	1	96[w]	21
9	–	MW	0.17	Co-CNTs	1	98[w,rc]	22
10	dichloromethane	40	48–72	–	1.3	98	23
11	water	70	0.58	MNPs-PSA	1	97[e,rc]	24
12	water	25	0.33	Graphene Oxide	1	94[rc]	25
13	ethanol	25	1.5	$Y(OTf)_3$	0.91	93[rc]	26
14	water	70	1	SuSa	1	94[rc]	27
15	water	25	0.3	*p*-SAC	1	94[rc]	28
16	water	50	0.42	*β*-CD-SO_3H	1	96[rc]	29

Table 1 (continued)

17	water	90	2	–	1	91	present work
18*	water	90	1	–	–	93	present work

[ch] column chromatography; [e] extraction; [rc] recrystallization; [w] washing with organic solvent; [*] from Schiff base **3a**

We have previously described eco-friendly methods for the preparation of quinazolin-4(1*H*)-ones in aqueous[30] or solventless medium from **1a**[31] or 2-amino-benzhydrazides[32] and a number of aldehydes[33] and ketones.[34] Inspired by the excellent results of the mechanochemical and in/on water syntheses, we decided to extend the ring closure of **1a** and 2-amino-*N*-methylbenzamide (**1b**) with the reactions of a number of (hetero)aromatic aldehydes under either aqueous or ball-milling conditions.

Results and Discussion

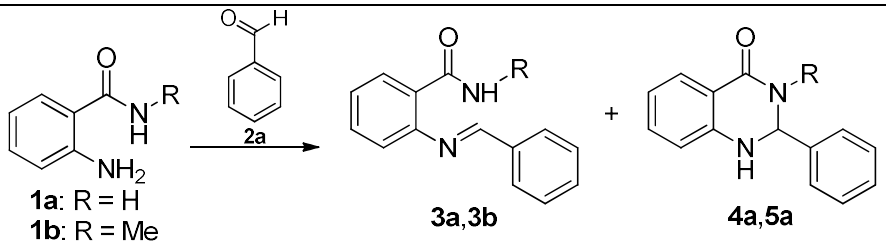
We initially studied the influence of solventless and catalyst-free conditions in the reaction of anthranilamides **1a** and **1b** with benzaldehyde (**2a)** as model reaction. The liquid–solid condensations of **1a** and **1b** with **2a** were carried out in a mixing ball-mill. The reactants in a stoichiometric ratio were placed in a stainless-steel jar with two stainless-steel balls, the vessel was closed, and milling was started at rt at 25 Hz. After a 1-h milling only 10% of the starting compounds remained unconsumed (monitored by TLC). Milling was continued for an additional 1 h, during which eutectic melt products were obtained. ^{1}H NMR spectroscopy of crude products demonstrated that the yields of melt-like compounds were nearly quantitative. Interestingly, under this reaction condition, mixtures both of kinetic (**3a**, **3b**) and thermodinamic (**4a**, **5a**) products were formed (Table 2, Entry 1 and 2). Successful separation of the material in the jar was achieved when the reaction mixtures were dissolved in methanol. After evaporation of methanolic solution to small volume under reduced pressure at rt, followed by the addition of a mixture of Et_2O–*n*-hexane, crystalline imines **3a** and **3b** were separated out, characterized by FT-IR and ^{1}H NMR analysis. The ^{13}C NMR data on **3a** and **3b** were described by the utilization of 2D HSQC and HMBC NMR spectra because of the quick intramolecular cyclization of Schiff bases to **4a** and **5a** on standing in d_6-DMSO.

Rao et al. reported that intramolecular cyclization of **3b** to **5a** is facile and apparently an irreversible process, both in free-state and in acetic acid.[36] In view of above observation, we decided to investigate the rearrangement of **3a** and **3b** in aqueous medium. After stirring for 1 h at 90 °C, precipitated **4a** and **5a** were isolated by simple filtration in a yield of 91–93% and high

purity (97–99%). Compounds were obtained as pale yellow solids, their physical and spectroscopic data were in good agreement with the literature.[21,38]

In order to test our in/on water protocol, we first explored cyclization of a stoichiometric amount of **1a** and **1b** with **2a** at rt. After stirring for 6 h a mixture of **3a**/**4a** or **3b**/**5a** precipitating was filtered off and dried. The ratio of inseparable mixture of constitutional isomers was determined by ^{1}H MNR spectroscopy (Table 2, Entry 3 and 4).

Table 2. Condensation of anthranilamides with benzaldehyde under various conditions



Entry	R	Solvent	Temp. [° C]	Time [h]	Product/ (ratio)	**Conversion**/Yield [%]	Mp. [° C]
1*	H	–	25	2	**3a** : **4a** (95 : 5)[a]	**98**[a]/68(**3a**)[b]	163–165[b] (217)[35]
2*	Me	–	25	2	**3b** : **5a** (91 : 9)[a]	**97**[a]/61(**3b**)[b]	124–126[b] (76)[36]
3	H	water	25	6	**3a** : **4a** (79 : 21)[a]	83[c]	–
4	Me	water	25	6	**3b** : **5a** (30 : 70)[a]	80[c]	–
5	H	water	90	2	**4a**	88[c]	224–226[c] (225–227)[37]
6	Me	water	90	2	**5a**	90[c]	168–170[c] (159–161)[38]

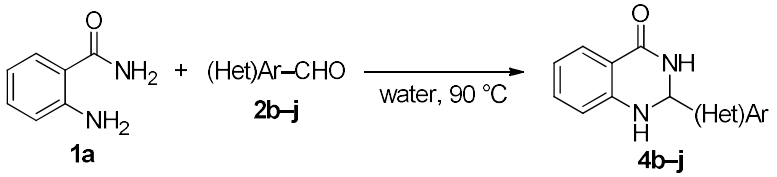
*Ball-milling at 25 Hz for 2 h; [a] On the basis of ^{1}H NMR; [b] From MeOH/Et_2O/*n*-hexane; [c] From aqueous suspension.

To optimize the catalyst-free reaction conditions, in addition to the variation in temperature and reaction time, stirring the starting compounds in water and heating (90 °C, 2 h) were found to afford the corresponding **4a** and **5a** in excellent yields and purity (96–98%, Entry 5 and 6).

With a successful procedure available, we further examined the aqueous condensation of **1a** with aldehydes **2b**–**2j**. The mixture of 4 mmol of **1a** and 1 equivalent of **4b**–**4j** in 10 ml of water was stirred at 90 °C for 2–4 h. Cyclic products **4a**–**4e** and **4h**–**4j** were isolated by filtration. Under

neutral conditions, the corresponding quinazolinones were obtained in 85-94% yields (Table 3). The poorly water-soluble **2g** gave an excellent product yield of **4g** only under reflux in a mixture of ethanol/water (1:2). With slight modification, the reaction of **1a** with **2f** was complete in the presence of 1 ml of 1% I_2/KI (Lugol's solution)[34] (Entry 6 and 5).

Table 3. Syntheses of 2-(hetero)aryl-2,3-dihydroquinazolin-4(1*H*)-ones (**4b–4j**) in aqueous media



1a **4b–j**

Entry	(Het)Ar	Time [h]	Product	Yield [%][a]	Mp [°C][b] (lit.)[ref]
1	4-MeC_6H_4	3	**4b**	85	229–232 (232–234)[27]
2	4-FC_6H_4	3	**4c**	92	205–207 (203–204)[22]
3	4-ClC_6H_4	2	**4d**	89	209–212 (206–208)[20]
4	4-BrC_6H_4	3	**4e**	91	202–205 (198–199)[20]
5	4-CNC_6H_4	4	**4f**	88[c]	Mp > 320 (350–351)[40]
6	4-$NO_2C_6H_4$	2	**4g**	90[d]	194–198 (199–201)[39]
7	2-naphthyl	3	**4h**	94	223–226 (225–226)[22]
8	2-furyl	3	**4i**	86	167–170 (167–168)[20]
9	3-piridyl	2	**4j**	93	230–233 (225–227)[41]

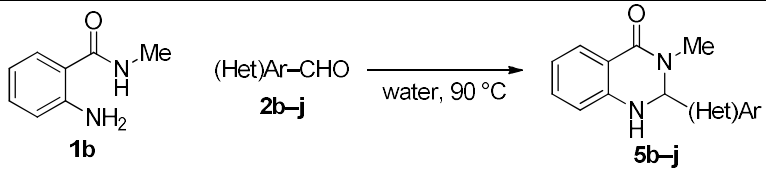
[a] Isolated yields; [b] from aqueous suspension; [c] 1 mol% I_2/KI; [d] from EtOH–H_2O (1:2);

The products were characterized by their spectral data and melting points. ^{1}H NMR data of the crude reaction products correlated well with literature values.

Inspired by the successful attempt with **1a**, we extended the aqueous cyclocondensation of **2b**–**2j** with 2-amino-*N*-methylbenzamide (**1 b**). All of these reactions were carried out essentially under the same conditions as described above, except that reaction times were shorter for **5f** and **5h** (Table 4, Entry 5 and 7). In the green procedure, *N*-methyl-quinazolinones **5b**–**5j** were obtained in

good to excellent yields (81–93%). Products **5b**, **5d** and **5g** were characterized by comparion of their spectral data and melting points with those reported in the literature. Although **5e**[42] can be found as a known chemical substance its physical and spectroscopic properties have not been fully studied. In this work we report characterization of **5c**, **5e**, **5f** and **5h–j** in the Experimental Section.

Table 4. Syntheses of 2-(hetero)aryl-3-methyl-2,3-dihydroquinazolin-4(1*H*)-one (**5b–5j**) in aqueous media



Entry	(Het)Ar	Time [h]	Product	Yield [%][a]	Mp [°C][b] (lit.)[ref]
1	4-MeC_6H_4	3	**5b**	88	167–169 (150–152)[38]
2	4-FC_6H_4	3	**5c**	90	200–201 –
3	4-ClC_6H_4	2	**5d**	93	202–204 (196)[36]
4	4-BrC_6H_4	3	**5e**	89	198–200 –
5	4-CNC_6H_4	3	**5f**	81[c]	179–182 –
6	4-$NO_2C_6H_4$	2	**5g**	92[d]	190–194 (196–198)[39]
7	2-naphthyl	2	**5h**	93	219–221 –
8	2-furyl	3	**5i**	89	156–159 –
9	3-pyridyl	2	**5j**	91	177–178 –

[a] Isolated yields; [b] from aqueous suspension; [c] 1 mol% I_2/KI; [d]from EtOH–H_2O (1:2);

In conclusion, we have developed an aqueous green synthesis of known and new 2-(hetero)aryl-quinazolinones. The condensations of (*N*-methyl)anthranilamide with (hetero)aromatic aldehydes proceeded efficiently in/on water to provide a convenient synthesis of **4a**–**4j** or **5a**–**5j** in excellent yields without the need for further work-up. We have also shown that Schiff bases prepared by high-energy ball milling resulted in heterocycles **4a** and **5a** in water at 90 °C. This method has a number of advantages over other methods: the reaction techniques are

very simple, and the syntheses occur under mild, green reaction conditions without the need for costly, highly sensitive catalysts.

Experimental Section

General Procedures. Products **4a–j**, **5a**, **5b**, **5d** and **5g** are known compounds and their physical data and ^{1}H NMR spectra were essentially identical with those of authentic samples. Other products, which are new, were characterized by IR, ^{1}H, and ^{13}C NMR spectroscopy and elemental analysis. ^{1}H- (400 Hz), ^{13}C- (100 MHz) and 2D NMR spectra were recorded in d_6-DMSO on a Bruker Avance DRX 400 spectrometer with TMS as internal reference. Analytically pure samples of **3a**, **3b** and new compounds (**5c**, **5e**, **5f** and **5h–j**) were prepared by crystallization from MeOH/Et_2O/*n*-hexane or EtOH.

Melting points were determined on a Kofler apparatus and are uncorrected. FT-IR spectra were recorded in KBr pellets on a Perkin-Elmer 100 FT-IR spectrometer. Elemental analyses were carried out on a Perkin-Elmer 2400 elemental analyser.

The ball-milling experiments were performed in a Retsch MM400 mixer mill with two stainless-steel balls 15 mm in diameter in a stainless-steel jar (25 mL) at 25 Hz at rt.

Preparation of Schiff bases 3a and 3b

1a or **1b** (4.0 mmol), freshly distilled **2a** (0.42 g, 0.40 mL, 4.0 mmol) and two stainless-steel balls 15 mm in diameter were placed in a stainless-steel jar. The vessel was vibrated at 25 Hz for 2 h. The reaction progress was monitored by TLC. 10 mL of MeOH was added to the reaction mixture in the jar. The suspension was mixed at 25 Hz for 5 min, filtered, the filtrate was evaporated to ca. 2 ml at rt. After addition of 10 mL of Et_2O–*n*-hexane (1 : 1), crystalline products **3a** and **3b** were filtered off, washed with diethyl ether (2 mL) and dried. Analytical and spectroscopic data on **3a** and **3b** are given below.

2-(Benzylideneamino)benzamide (3a). Pale yellow crystals, mp 163–165 °C (MeOH–Et_2O–*n*-hexane); IR (cm^{-1}): 3384, 3193, 3054, 2894, 1626, 1591, 1452, 1372, 769; ^{1}H NMR δ (ppm): 7.23 (d, J = 7.8 Hz), 1H, ArH), 7.35 (m, 1 H, ArH), 7.52–7.64 (m, 5H, ArH and NHCO), 7.90–8.00 (m, 3H, ArH), 8.21 (br s, 1H, NHCO), 8.61 (s, 1H, N=CH); ^{13}C NMR (HMBC) δ (ppm): 119.0, 125.7, 128.9 (4×C), 129.8, 131.9, 132.1, 135.4, 149.1, 149.3, 162.2, 167.0; Anal. calcd. for $C_{14}H_{12}N_2O$ (224.26) (%): C, 74.98; H, 5.39; N, 12.49. Found: C, 74.75; H, 5.51; N, 12.21;

2-(Benzylideneamino)-*N*-methylbenzamide (3b). Pale yellow needles, mp 124–126 °C (MeOH–Et_2O–*n*-hexane); IR (cm^{-1}): 3292, 3064, 3039, 2937, 1631, 1614, 1589, 1394, 750; ^{1}H NMR δ (ppm): 2.82 (d, J = 4.8 Hz, 3H, CH_3) 7.25 (d, J = 7.6 Hz, 1H, ArH), 7.34 (m, 1H, ArH), 7.49–7.63 (m, 4H, ArH), 7.85 (dd, J = 7.8 Hz, J = 1.3 Hz, 1H, ArH), 7.95–8.00 (m, 2H, ArH), 8.61 (s, 1H, N=CH), 8.65 (br m, 1H, NHCO); ^{13}C NMR (HMBC) δ (ppm): 25.7, 118.9, 125.5, 128.7 (4×C), 129.8, 131.9, 132.1, 135.4, 148.9, 149.0, 162.0, 166.4; Anal. calcd. for $C_{15}H_{14}N_2O$ (238.28) (%): C, 75.61; H, 5.92; N, 11.76. Found: C, 75.74; H, 5.71; N, 11.51;

Preparation of quinazolinones 4a and 5a

Schiff base **3a** (0.22 g, 1 mmol) or **3b** (0.24 g, 1 mmol) was heated in 5 mL of water at 90 °C for 1 h. From the cooled suspension, product **4a** or **5a** was precipitated, filtered off and dried.

2-Phenyl-2,3-dihydroquinazolin-4(1*H*)-one (4a): white powder, mp 224–226 °C. ^{1}H NMR spectrum was identical with that of an authentic sample.

3-Methyl-2-phenyl-2,3-dihydroquinazolin-4(1*H*)-one (5a): white powder, mp 168–170 °C. ^{1}H NMR spectrum was identical with that of an authentic sample.

Synthesis of 2-(hetero)aryl-2,3-dihydroquinazolin-4(1*H*)-ones 4b–4j and 5b–5j. To a stirred mixture of **1a** or **1b** (4.0 mmol), and in 10 mL of water (for **4b-e**,**h**,**j** and **5b-e**,**h**,**j**) or 10 mL of water and 1 mL of 1% I_2/KI (for **4f** and **5f**) or in 10 mL of EtOH–water (1 : 2) (for **4g** and **5g**) **2b–2j** (4 mmol) was added in portions. After vigorous stirring at rt for 10 min the aqueous suspension was heated at 90 °C for 2–4 h. After cooling to room temperature the precipitates **4b**–**4j** and **5b**–**5j** were collected by filtration, washed with water (3 mL) and dried. Crude **4b**–**4j**, **5b**, **5c** and **5g** were characterized by the melting points and ^{1}H NMR spectra. Analytically pure samples of **5c**, **5e**, **5f** and **5h–j** were prepared by crystallization from EtOH. Analytical and spectroscopic data of new compounds are given below.

2-(4-Fluorophenyl)-3-methyl-2,3-dihydroquinazolin-4(1*H*)-one (5c). Colorless crystals, mp 200–201 °C (EtOH); IR (cm^{-1}): 3292, 3113, 3064, 2939, 2820, 1633, 1613, 1508, 1488, 1391, 1225, 753; ^{1}H NMR δ (ppm): 2.84 (s, 3H, CH_3), 5.85 (d, J = 2.3 Hz, CH), 6.61–6.70 (m, 2H, ArH), 7.16–7.24 (m, 3H, ArH), 7.28 (d, J = 2.2 Hz, 1H, NH), 7.33–7.41 (m, 2H, ArH), 7.65 (dd, J = 7.7 Hz, J = 1.5 Hz, 1H, ArH); ^{13}C NMR δ (ppm): 31.8, 71.3, 114.1, 114.3, 115.3, 115.5, 117.0, 127.3, 128.2, 128.3, 133.2, 136.9 (2×C), 146.2, 160.8, 162.4, 163.3; Anal. calcd. for $C_{15}H_{13}FN_2O$ (256.27) (%): C, 70.30; H, 5.11; N, 12.49. Found: C, 70.55; H, 5.21; N, 12.30;

2-(4-Bromophenyl)-3-methyl-2,3-dihydroquinazolin-4(1*H*)-one (5e). Colorless crystals, mp 198–200 °C (EtOH); IR (cm^{-1}): 3292, 3064, 2935, 2819, 1633, 1612, 1594, 1485, 1390, 756; ^{1}H NMR δ (ppm): 2.86 (s, 3H, CH_3), 5.84 (d, J = 2.4 Hz, CH), 6.61–6.70 (m, 2H, ArH), 7.18–7.30 (m, 3H, ArH), 7.32 (d, J = 2.3 Hz, 1H, NH), 7.54–7.59 (m, 2H, ArH), 7.65 (dd, J = 7.8 Hz, J = 1.5 Hz, 1H, ArH); ^{13}C NMR δ (ppm): 32.0, 71.2, 114.1, 114.3, 117.1, 121.6, 127.3, 128.2 (2×C), 131.5 (2×C), 133.2, 140.0, 146.1, 162.4; Anal. calcd. for $C_{15}H_{13}BrN_2O$ (317.18) (%): C, 56.80; H, 4.13; N, 8.83. Found: C, 56.58; H, 4.21; N, 8.50;

4-(1,2,3,4-Tetrahydro-3-methyl-4-oxo-2-quinazolyl)-benzonitrile (5f). Colorless crystals, mp 179–182 °C (EtOH); IR (cm^{-1}): 3330, 3056, 2930, 2229, 1634, 1612, 1506, 1487, 1392, 751; ^{1}H NMR δ (ppm): 2.91 (s, 3H, CH_3), 5.96 (d, J = 2.6 Hz, CH), 6.60–6.71 (m, 2H, ArH), 7.21 (m, 1H, ArH), 7.44 (d, J = 2.5 Hz, 1H, NH), 7.46–7.52 (m, 2H, ArH), 7.66 (dd, J = 7.8 Hz, J = 1.3 Hz, 1H, ArH), 7.80–7.88 (m, 2H, ArH); ^{13}C NMR δ (ppm): 32.2, 71.2, 111.2, 114.2, 114.4, 117.3, 118.4, 127.0 (2×C), 127.4, 132.6 (2×C), 133.4, 145.9 (2×C), 162.3; Anal. calcd. for $C_{16}H_{13}N_3O$ (263.29) (%): C, 72.99; H, 4.98; N, 15.96. Found: C, 73.18; H, 5.21; N, 15.70;

3-Methyl-2-(2-naphthalenyl)-2,3-dihydroquinazolin-4(1*H*)-one (5h). Colorless crystals, mp 219–221 °C (EtOH); IR (cm^{-1}): 3350, 3062, 2909, 1624, 1609, 1519, 1486, 1390, 821, 757, 750;

^{1}H NMR δ (ppm): 2.91 (s, 3H, CH_3), 6.01 (s, 1H, CH), 6.62–6.72 (m, 2H, ArH), 7.21 (m, 1H, ArH), 7.38 (s, 1H, NH), 7.47–7.58 (m, 3H, ArH), 7.71 (dd, *J* = 8.0 Hz, *J* = 1.5 Hz, 1H, ArH), 7.79 (m, 1H, ArH), 7.86–7.96 (m, 3H, ArH); ^{13}C NMR δ (ppm): 31.9, 72.3, 114.0, 114.3, 117.0, 124.0, 125.1, 126.4, 126.5, 127.4, 127.5, 127.9, 128.6, 132.4, 132.9, 133.2, 137.9, 146.4, 162.6; Anal. calcd. for $C_{19}H_{16}N_2O$ (288.34) (%): C, 79.14; H, 5.59; N, 9.72. Found: C, 79.18; H, 5.31; N, 9.83;

2-(2-Furanyl)-3-methyl-2,3-dihydroquinazolin-4(1*H*)-one (5i). Pale red–brown crystals, mp 156–159 °C (EtOH); IR (cm^{-1}): 3237, 3128, 3103, 3060, 3028, 2918, 1626, 1612, 1524, 1485, 1399, 1151, 1138, 1014, 914, 882, 749; ^{1}H NMR δ (ppm): 2.97 (s, 3H, CH_3), 5.90 (d, *J* = 2.8 Hz, 1H, CH), 6.22 (d, *J* = 3.3 Hz, 1H, furyl-H), 6.36 (m, 1H, furyl-H), 6.66–6.78 (m, 2H, ArH), 7.24 (m, 1H, ArH), 7.36 (d, *J* = 2.5 Hz 1H, NH), 7.58 (m, 1H, furyl-H), 7.67 (m, 1H, ArH); ^{13}C NMR δ (ppm): 32.0, 66.0, 107.4, 110.2, 114.3, 114.8, 117.3, 127.3, 133.1, 143.0, 146.4, 153.0, 162.5; Anal. calcd. for $C_{13}H_{12}N_2O_2$ (228.25) (%): C, 68.41; H, 5.30; N, 12.27. Found: C, 68.58; H, 5.39; N, 12.03;

3-Methyl-2-(3-pyridinyl)-2,3-dihydroquinazolin-4(1*H*)-one (5j). Colorless crystals, mp 177–178 °C (EtOH); IR (cm^{-1}): 3283, 3058, 3034, 2999, 2932, 2821, 1634, 1613, 1594, 1579, 1504, 1486, 1418, 1390, 782, 767; ^{1}H NMR δ (ppm): 2.89 (s, 3H, CH_3), 5.94 (d, *J* = 2.6 Hz, 1H, CH), 6.62–6.73 (m, 2H, ArH), 7.22 (m, 1H, ArH), 7.35–7.41 (m, 2H, pyridyl-H and NH), 7.64–7.70 (m, 2H, pyridyl- and ArH), 8.50–8.56 (m, 2H, pyridyl-H, ArH); ^{13}C NMR δ (ppm): 32.0, 70.0, 114.3, 114.5, 117.4, 123.7, 127.4, 133.3, 133.6, 135.9, 146.1, 147.6, 149.7, 162.5; Anal. calcd. for $C_{14}H_{13}N_3O$ (239.27) (%): C, 70.28; H, 5.48; N, 17.56. Found: C, 70.58; H, 5.21; N, 17.42;

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