JOC The Journal of Organic Chemistry

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Metal- and Oxidant-Free Synthesis of Quinazolinones from β-Ketoesters with *o*-Aminobenzamides via Phosphorous Acid-Catalyzed Cyclocondensation and Selective C−C Bond Cleavage

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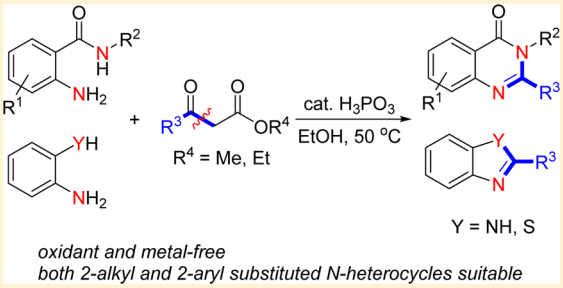
Supporting Information

ABSTRACT: A general and efficient phosphorous acid-catalyzed cyclocondensation of β-ketoesters with *o*-aminobenzamides via selective C−C bond cleavage leading to quinazolinones is developed. This reaction proceeds smoothly under metal- and oxidant-free conditions, giving both 2-alkyl- and 2-aryl-substituted quinazolinones in excellent yields. This strategy can also be applied to the synthesis of other *N*-heterocycles, such as benzimidazoles and benzothiazoles.



INTRODUCTION

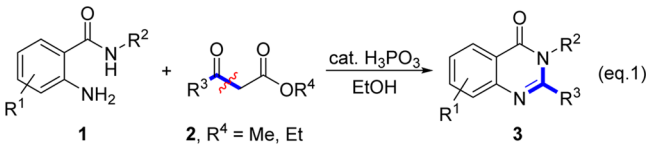
N-Heterocyclic compounds are the most abundant and integral scaffolds that occur ubiquitously in a large number of bioactive natural products, synthetic drugs, pharmaceuticals, and agrochemicals.[1] Among the various *N*-heterocycles, quinazolinones are a privileged class of compounds with a diverse spectrum of biological activities and therapeutic potential.[2,3] Quinazolinones are commonly prepared by the condensation of *o*-aminobenzamides with aldehydes[4] using oxidants or carboxylic acid derivatives[5] under harsh conditions. Recently, oxidative condensations of the alcohol,[6] methylarene,[7] or amines[8] with *o*-aminobenzamides have also been developed. However, despite these notable advances,[9] they generally suffer from one or more drawbacks, such as requirement of stoichiometric or excess amounts of strong oxidants, high temperatures, and transition metal catalysts. Thus, undesired side reactions inevitably take place, which decrease the selectivity to quinazolinones. For example, most of the procedures are not well suited for 2-alkyl-substituted quinazolinones,[4−8] because aliphatic aldehydes or the in situ-generated aliphatic aldehydes are chemically unstable under harsh conditions. In addition, transition metal catalyzed syntheses of quinazolinones starting from other substrates have also been extensively studied.[9,10] Transition metals are toxic and must be carefully removed from the products, especially for the drug and pharmaceutical industry. In this respect, a metal- and oxidant-free strategy would be a promising choice, but it has not been frequently used for the synthesis of quinazolinones.[11] Although oxidants and/or metals are also generally required for the synthesis of other *N*-heterocycles, metal- and oxidant-free methods have been developed, especially for benzothiazoles and benzimidazoles.[12] A notable case is reported by Yu, Bao, and coworkers,[12a] in which a convenient TsOH-catalyzed cyclization of 2-amino-thiophenols/anilines with β-diketones for the synthesis of benzothiazoles and benzimidazoles has been explored. However, the protocol is not well suited for 2-aryl-substituted *N*-heterocycles. Therefore, highly general and metal- and oxidant-free syntheses of quinazolinones or other *N*-heterocycles, especially with broad substrate scope, still remain highly desirable.

The C−C bond is the most fundamental bond and is widespread in organic compounds. C−C bond cleavage is a topic of significant importance in organic synthesis, which allows the construction of a new C−C bond directly from inert starting materials. Hence, many strategies, such as strained molecules (three- or four-membered ring compounds) and chelation assistance, have been employed for this purpose.[13] Although significant advances have been made in the past decades, the development of selective C−C bond cleavage by a catalytic reaction is a challenging problem in organic chemistry, especially for the cleavage of unstrained C−C bonds. To meet this challenge, transition metals are frequently employed.[14] However, it is particularly of interest to achieve C−C bond cleavage by metal-free strategies, which are still scarce.[12a,15]

Herein, in continuation of our ongoing research on the synthesis of *N*-heterocycles,[7b,16] we report a general and efficient method for the preparation of quinazolinones from the readily available β-ketoesters via phosphorous acid-catalyzed cyclocondensation and selective C−C bond cleavage eq 1. This reaction takes place under mild conditions to produce both 2-alkyl-substituted and 2-aryl-substituted quinazolinones in excellent yields with a high tolerance to a variety of functional groups.

Received: April 26, 2015
Published: September 4, 2015

DOI: 10.1021/acs.joc.5b00937
J. Org. Chem. 2015, 80, 9392−9400

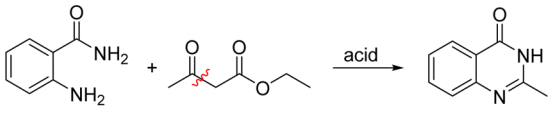


1 2, R^4 = Me, Et 3

RESULTS AND DISCUSSION

In a typical experiment, 2-aminobenzamide **1a** (0.2 mmol) was treated with ethyl acetoacetate **2a** (0.26 mmol) in the presence of H_3PO_3 (50 wt % aqueous solution, 0.02 mmol) in ethanol (0.5 mL) at 25 °C. After 60 h, 2-methylquinazolin-4(3*H*)-one **3a** was produced in 80% yield with 20% **1a** recovered (GC yield; Table 1, entry 1). The higher reaction temperature could shorten the reaction time (Table 1, entries 2−5). For example, when the reaction was carried out at 50 °C for 15 h, the desired product **3a** was produced in nearly quantitative yield. Various Brønsted acids could catalyze the reaction without the aid of any ligand, additive, or metal, and H_3PO_3 showed the highest efficiency (Table 1, entries 6−9). When the catalyst loading was decreased to 5 mol %, **3a** was obtained in 87% yield (Table 1, entry 10). A further decrease of H_3PO_3 (1 mol %) resulted in relatively low yield of **3a** (74%; Table 1, entry 11). H_3PO_3 is crucial for the current catalytic system, and only a trace of **3a** was detected in the absence of acid catalyst, even at high temperature (Table 1, entries 12 and 13). Phosphorous acid is a relatively weak inorganic acid. It is water-miscible, easily separable from organic product, and environmentally acceptable. Thus, phosphorous acid is preferable to organic acid as catalyst. However, to the best of our knowledge, phosphorous acid catalyzed systems are rarely reported.[17] Solvents also played an important role in this reaction. When aprotic solvents such as toluene, hexane, CH_3CN, $CHCl_3$, dioxane, and DMF were used, low yields of **3a** were observed (Table 1, entries 14−19). In sharp contrast, the protic solvents such as ethanol and methanol provided **3a** in excellent yields (Table 1, entries 2 and 20). Notably, the reaction could take place smoothly in water at 100 °C, producing **3a** in 93% yield (Table 1, entry 22). Accounting for miscibility with the catalyst and organic substrates, lower temperature, higher yield, and environmental acceptance, ethanol was chosen as the best solvent for the next reactions.

Table 1. Optimization of the Reaction Conditions[a]



1a 2a 3a

entry	catalyst	solvent (mL)	temp (°C)	time (h)	yield[b] (%)
1	50%H_3PO_3	EtOH	25	60	80
2	50%H_3PO_3	EtOH	50	15	>99
3	50%H_3PO_3	EtOH	80	10	>99
4	50%H_3PO_3	EtOH	100	8	>99
5	50%H_3PO_3	EtOH	120	5	>99
6	TsOH·H_2O	EtOH	50	15	82
7	50%HCl	EtOH	50	15	57
8	$Ph_2P(O)OH$	EtOH	50	15	88
9	50%H_3PO_4	EtOH	50	15	91
10[c]	50%H_3PO_3	EtOH	50	15	87
11[d]	50%H_3PO_3	EtOH	50	15	74
12	none	EtOH	50	15	trace
13	none	EtOH	100	15	trace
14	50%H_3PO_3	Toluene	50	15	8
15	50%H_3PO_3	Hexane	50	15	34
16	50%H_3PO_3	CH_3CN	50	15	30
17	50%H_3PO_3	$CHCl_3$	50	15	27
18	50%H_3PO_3	Dioxane	50	15	63
19	50%H_3PO_3	DMF	50	15	68
20	50%H_3PO_3	MeOH	50	15	>99
21	50%H_3PO_3	H_2O	50	15	39
22	50%H_3PO_3	H_2O	100	15	93

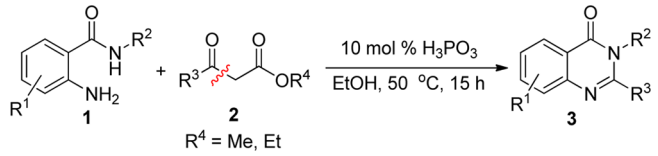
[a]Reaction conditions: 2-aminobenzamide **1a** (0.2 mmol), ethyl acetoacetate **2a** (0.26 mmol), acid catalyst (0.02 mmol, 10 mol %), solvent (0.5 mL) in 5 mL Schlenk tube. [b]GC yield. [c]H_3PO_3 (0.01 mmol, 5 mol %). [d]H_3PO_3 (0.002 mmol, 1 mol %).

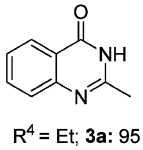
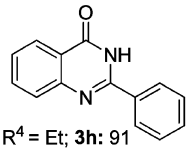
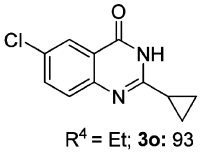
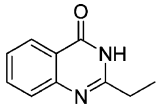
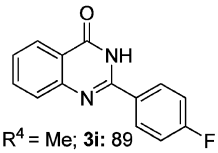
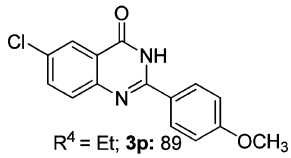
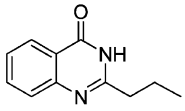
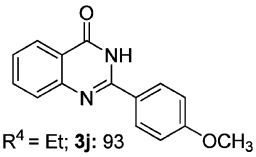
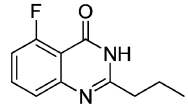
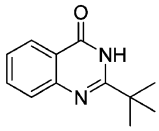
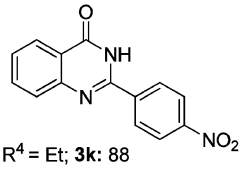
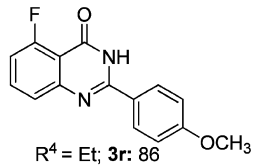
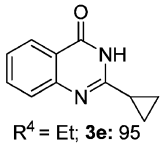
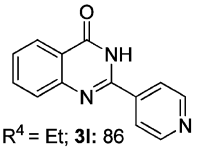
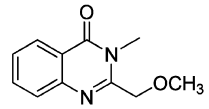
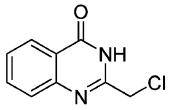
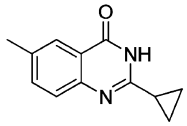
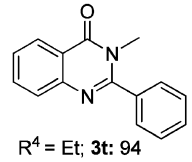
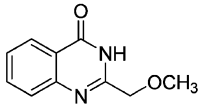
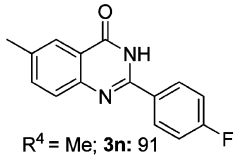
As shown in Table 2, this phosphorous acid-catalyzed cyclocondensation could be applied to a variety of β-ketoesters to produce the corresponding quinazolinones **1** in excellent yields via R(CO)−C(α) bond cleavage, regardless of the steric hindrance and electronic effect of the substituents. Aliphatic β-ketoesters **2a−2d** reacted smoothly with 2-aminobenzamide **1a** to produce the corresponding alkyl-substituted quinazolinones **3a−3d** in excellent yields (89−95%; Table 2, entries 1−4). Remarkably, when ethyl 3-cyclopropyl-3-oxopropanoate **2e** was employed as the substrate, 2-cyclopropyl-substituted quinazolinone **3e** was elaborated in 95% yield, with the strained cyclopropyl group untouched (Table 2, entry 5). Functional groups such as chloro and ether were also tolerable in this acid catalytic system, generating the corresponding quinazolinones **3f** and **3g** in 89% and 92% yields, respectively (Table 2, entries 6 and 7). When aryl-substituted β-ketoesters **2h−2k** were employed as the substrates, 2-aryl functionalized quinazolinones **3h−3k** were readily elaborated in excellent yields (88−93%; Table 2, entries 8−11). We were excited to find that heteroaryl β-ketoester **2l** was applicable to the present transformation, and the corresponding 2-heteroaryl-substituted quinazolinone **3l** was obtained in 86% yield (Table 2, entry 12). As for 2-aminobenzamides **1**, in addition to the simplest **1a**, the methyl-substituted **1b**, chloro-substituted **1c**, and fluoro-substituted **1d** also served as good substrates to produce the cyclocondensation products efficiently (86−95% yields Table 2, entries 13−18). Furthermore, the cyclocondensation of the substituted *N*-methylbenzamide **1e** with β-ketoesters **2g** and **2h** also proceeded smoothly in the presence of 10 mol % H_3PO_3, affording the corresponding quinazolinones **3s** and **3t** in 95% and 94% yields, respectively (Table 2, entries 19 and 20). It was noted that all of the consumed 2-aminobenzamides were completely transformed into corresponding quinazolinones in this phosphorous acid-catalyzed reaction system.

Compared with β-ketoesters, β-diketones were subjected to this reaction system. Aliphatic β-diketones **4a−4c** worked well with 2-aminobenzamide **1a** to produce the corresponding quinazolinones **3a**, **3b**, and **3u** in 91% to 96% yields (Table 3, entries 1−3). The reaction of bulky substituted β-diketone **4d** should be carried out at a higher temperature (Table 3, entry 4). Substituted 2-aminobenzamides **1b−1e** were also applicable to the transformation, giving the corresponding products **3v−3z**[3] in excellent yields (90−96%; Table 3, entries 5−12), whereas when 1-methyl-3-phenyl-1,3-dione **4e**, an unsymmetric β-diketone, was examined, only $CH_3C(O)$-C bond cleavage took place to afford the 2-alkyl-substituted quinazolinone **3a** (Table 3, entry 13). The PhC(O)-C bond was stable in this catalytic system, which was further confirmed by the treatment of 1,3-diphenylpropane-1,3-dione (**4f**) at high temperature

DOI: 10.1021/acs.joc.5b00937
J. Org. Chem. 2015, 80, 9392−9400

Table 2. H_3PO_3-Catalyzed Cyclocondensation Reactions of 2-Aminobenzamides with β-Ketoesters[a]



Entry	Yield[b] (%)	Entry	Yield[b] (%)	Entry	Yield[b] (%)
1	 R4 = Et; **3a:** 95	8[c]	 R4 = Et; **3h:** 91	15	 R4 = Et; **3o:** 93
2	 R4 = Me; **3b:** 93	9[c]	 R4 = Me; **3i:** 89	16[c]	 R4 = Et; **3p:** 89
3	 R4 = Me; **3c:** 92	10[c]	 R4 = Et; **3j:** 93	17[d]	 R4 = Me; **3q:** 92
4	 R4 = Me; **3d:** 89	11[c]	 R4 = Et; **3k:** 88	18[d]	 R4 = Et; **3r:** 86
5	 R4 = Et; **3e:** 95	12[d]	 R4 = Et; **3l:** 86	19	 R4 = Me; **3s:** 95
6	 R4 = Me; **3f:** 89	13	 R4 = Et; **3m:** 95	20	 R4 = Et; **3t:** 94
7	 R4 = Me; **3g:** 92	14[c]	 R4 = Me; **3n:** 91		

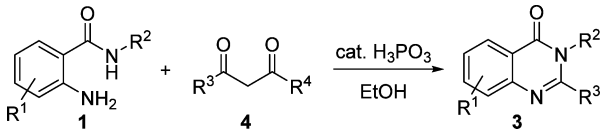
[a]Reaction conditions: 2-aminobenzamide **1** (0.2 mmol), β-ketoester **2** (0.26 mmol), 50% H_3PO_3 (10 mol %, 0.02 mmol), EtOH (0.5 mL) in 5 mL Schlenk tube, 50 °C, 15 h. [b]Isolated yield. [c]80 °C, 24 h. [d]100 °C, 24 h.

(130 °C; Table 3, entry 14). The above results showed that reactions using β-diketones as the substrates were sensitive to the steric hindrance of the substrates and the aryl-substituted β-diketones were inactive in this cyclocondensation reaction (vide infra).

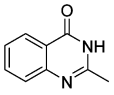
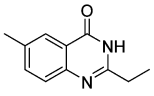
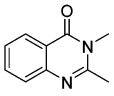
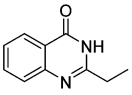
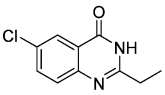
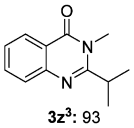
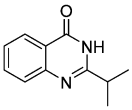
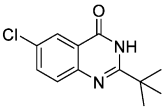
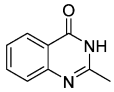
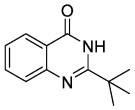
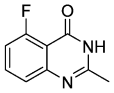
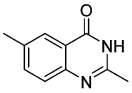
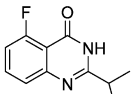
In addition to quinazolinones, this strategy was also applicable to the formation of other *N*-heterocycles such as benzimidazoles **7** and benzothiazoles **8**. As shown in Table 4, *o*-phenylenediamine **5** and *o*-aminothiophenol **6** readily reacted with various β-ketoesters via cyclocondensation and selective C−C bond cleavage to produce both 2-alkyl- and 2-aryl-substituted benzothiazoles **7** and benzothiazoles **8** in excellent yields, respectively. As described above, Bao has reported a similar method for the synthesis of benzothiazoles and benzimidazoles using β-diketones as the substrates.[12a] Although the strong Brønsted acid was used, low efficiency was observed for the substrates with bulky substituents. Release of half of the substituents, especially for bulky substituents, was another drawback of the protocol. In contrast to the reported method, this phosphorous acid-catalyzed reaction system employs β-

DOI: 10.1021/acs.joc.5b00937
J. Org. Chem. 2015, 80, 9392−9400

Table 3. H_3PO_3-Catalyzed Cyclocondensation of 2-Aminobenzamides with β-Diketones[a]

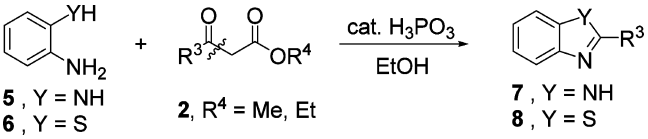


1 4 3

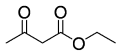
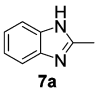
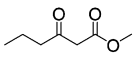
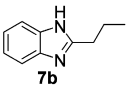
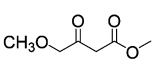
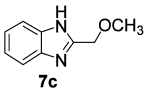
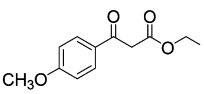
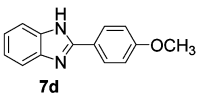
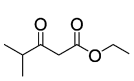
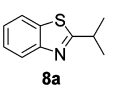
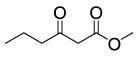
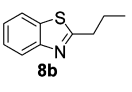
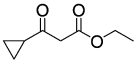
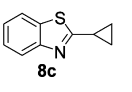
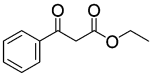
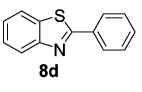
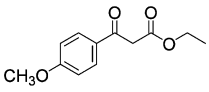
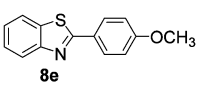
Entry	Yield[b] (%)	Entry	Yield[b] (%)	Entry	Yield[b] (%)
1	 3a: 96	6	 3w: 94	11	 3z[2]: 96
2	 3b: 95	7[c]	 3x: 94	12[c]	 3z[3]: 93
3	 3u: 91	8[c]	 3y: 91	13	 R[3] = methyl, R[4] = Ph; 3a: 94 For others, R[3] = R[4]
4[c]	 3d: 90	9[d]	 3z: 93	14[e]	NR R[3] = R[4] = Ph
5	 3v: 95	10[d]	 3z[1]: 90		

[a]Reaction conditions: 2-aminobenzamide **1** (0.2 mmol), β-diketone **4** (0.26 mmol), 50% H_3PO_3 (10 mol %, 0.02 mmol), EtOH (0.5 mL) in 5 mL Schlenk tube, 50 °C, 15 h. [b]Isolated yield. [c]80 °C, 24 h. [d]100 °C, 24 h. [e]130 °C, 24 h.

Table 4. Synthesis of Benzimidazoles and Benzothiazoles[a]



5, Y = NH
6, Y = S
2, R[4] = Me, Et
7, Y = NH
8, Y = S

Entry	Substrate	Substrate	Product	Yield[b] (%)
1	 5		 7a	95
2	5		 7b	93
3	5		 7c	91
4[c]	5		 7d	95
5	 6		 8a	93
6	6		 8b	94
7	6		 8c	92
8[c]	6		 8d	94
9[c]	6		 8e	93

[a]Reaction conditions: *o*-substituted aniline **5** or **6** (0.2 mmol), β-ketoester **2** (0.26 mmol), 50% H_3PO_3 (10 mol %, 0.02 mmol), EtOH (0.5 mL) in 5 mL Schlenk tube, 50 °C, 15 h. [b]Isolated yield. [c]80 °C, 24 h.

ketoesters as the substrates, and the C−C cleavage is selectively occurred to incorporate the bulky substituents into *N*-heterocycles highly efficiently, with only the small groups released. Furthermore, this protocol is not sensitive to the steric hindrance of the substituents, and is applicable to 2-aryl-substituted *N*-heterocycles. Therefore, the present finding shows many advantages over the previously reported method, especially in terms of green reagent, high compatibility with aryl-substitutes, and high atom-economy.

In order to clarify the reaction pathway, the reaction of 2-aminobenzamide **1a** (0.2 mmol) with ethyl acetoacetate **2a** (0.26 mmol) was traced by GC and GC-Mass under the optimum conditions (Scheme 1). After 6 h, quinazolinone **3a** and imine **Ia** were observed in 36% and 57% yields, respectively. By prolonging the reaction time to 15 h, the imine **Ia** was completely converted to **3a**. Therefore, imine **Ia** probably served as the reaction intermediate.

As shown in Scheme 2, this reaction probably proceeds via a typical Brønsted acid-catalyzed mechanism,[18] which is similar to that of Bao's work.[12a] Initially, in the presence of H_3PO_3, the condensation reaction of **1** with **2** takes place to generate imine intermediate **I**, followed by protonation to give ketiminium **II**. The intramolecular nucleophilic addition of **II** produces the adduct **III**. Finally, the desired product **3** was obtained by the C−C bond cleavage under acidic conditions. At this stage, the reason for the highest performance of phosphorous acid remains unclear, which is an ongoing research in our laboratory.

In conclusion, by the use of easily available phosphorous acid and ketoesters, we have developed a general and efficient method for the preparation of quinazolinones under metal- and oxidant-free conditions, which features a broad range of substrate scope. The available substrates, ease of operation, excellent yield, and selectivity make it very practical for the synthesis of *N*-heterocycles.

EXPERIMENTAL SECTION

General Information. Except where otherwise noted, all reactions were carried out in Schlenk tubes under N_2 atmosphere. Reagents were used as received unless otherwise noted. ^1H and ^{13}C NMR spectra were recorded on a 400 MHz spectrometer (400 MHz for ^1H and 100 MHz for ^{13}C NMR spectroscopy). $CDCl_3$ or DMSO-d_6 was used as the solvent.

DOI: 10.1021/acs.joc.5b00937
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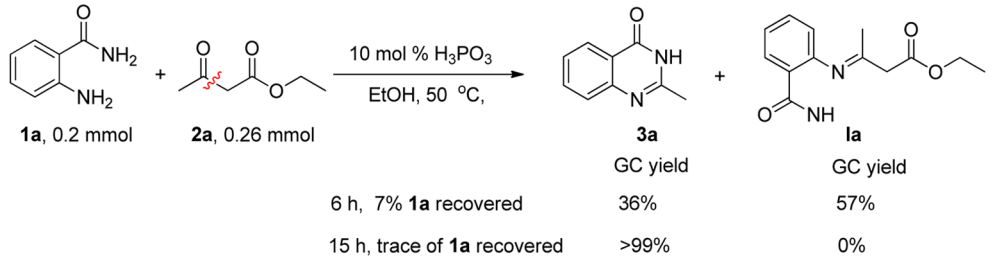
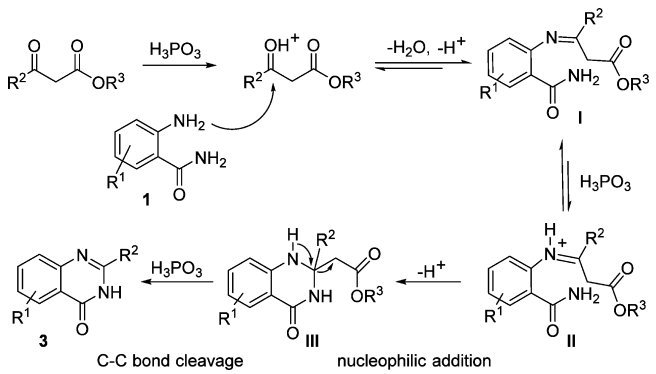
Scheme 1. Control Reaction



Scheme 2. Proposed Mechanism



Chemical shifts for ^{1}H NMR are referred to internal Me_4Si (0 ppm) and reported as follows: chemical shift (δ ppm), multiplicity, integration, and coupling constant (Hz). Data for ^{13}C NMR are reported in ppm relative to the center line of a triplet at 77.0 ppm for chloroform-*d*. The electron ionization (EI) method was used as the ionization method for the HRMS measurement, and the mass analyzer type is TOF for EI.

General Experimental Procedure for the Synthesis of *N*-Heterocycle Derivatives. A 5 mL Schlenk tube equipped with a magnetic stir bar was charged with *o*-aminophenyl derivative (**1**, **5**, or **6** 0.2 mmol), β-diketone/ketoester (**2** or **4** 0.26 mmol), H_3PO_3 (0.02 mmol, 10 mol %), and ethanol (0.5 mL). The reaction mixture was stirred at 50 °C for 15 h. The reaction was monitored by GC or GC-MS. After completion of the reaction, the resulting solution was cooled to room temperature, and neutralized with saturated solution of $NaHCO_3$. The product was extracted with EtOAc, dried over anhydrous Na_2SO_4, and concentrated in vacuo. The crude product was purified by flash column chromatography(eluent: ethyl acetate/petroleum ether = 1/2−1/5) on silica gel to afford the desired product.

^{1}H and ^{13}C Spectral Data of the Products. *2-Methylquinazolin-4(3H)-one* (***3a***).[16a] Following the general procedure, the crude product was purified by column chromatography on silica gel and eluted with ethyl acetate/petroleum ether (1/4) to afford a white solid. Yield: 30.4 mg, 95%; mp: 236−238 °C. ^{1}H NMR (400 MHz, $CDCl_3$) δ 12.17 (s, br, 1H), 8.28 (d, J = 7.9 Hz, 1H), 7.77 (t, J = 7.5 Hz, 1H), 7.68 (d, J = 8.1 Hz, 1H), 7.47 (t, J = 7.3 Hz, 1H), 2.61 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 164.4, 153.3, 149.4, 134.9, 127.0, 126.4, 126.2, 120.2, 22.1.

2-Ethylquinazolin-4(3H)-one (***3b***).[10i] Following the general procedure, the crude product was purified by column chromatography on silica gel and eluted with ethyl acetate/petroleum ether (1/4) to afford a white solid. Yield: 32.4 mg, 93%; mp: 228−230 °C. ^{1}H NMR (400 MHz, $CDCl_3$) δ 11.95 (s, br, 1H), 8.29 (d, J = 7.3 Hz, 1H), 7.77 (t, J = 7.6 Hz 1H), 7.71 (d, J = 7.9 Hz, 1H), 7.47 (t, J = 7.4 Hz, 1H), 2.85 (q, J = 7.6 Hz, 2H), 1.46 (t, J = 7.6 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 164.4, 157.6, 149.5, 134.8, 127.2, 126.3, 126.2, 120.5, 29.1, 11.5.

2-Propylquinazolin-4(3H)-one (***3c***).[10i] Following the general procedure, the crude product was purified by column chromatography on silica gel and eluted with ethyl acetate/petroleum ether (1/4) to afford a white solid. Yield: 34.6 mg, 92%; mp: 202−204 °C. ^{1}H NMR (400 MHz, $CDCl_3$) δ 11.81 (s, br, 1H), 8.29 (d, J = 8.0 Hz, 1H), 7.77 (t, J = 7.6 Hz, 1H), 7.71 (d, J = 7.8 Hz, 1H), 7.47 (t, J = 7.4 Hz, 1H), 2.79 (t, J = 7.2 Hz, 2H,); 1.90−1.96 (m, 2H), 1.08 (t, J = 7.4 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 164.2, 156.8, 149.3, 134.8, 127.1, 126.4, 126.2, 120.5, 37.7, 21.0, 13.7.

2-tert-Butylquinazolin-4(3H)-one (***3d***).[1c] Following the general procedure, the crude product was purified by column chromatography on silica gel and eluted with ethyl acetate/petroleum ether (1/4) to afford a white solid. Yield: 36.0 mg, 89%; mp: 207−208 °C. ^{1}H NMR (400 MHz, $CDCl_3$) δ 11.18 (s, br, 1H), 8.29 (d, J = 7.8 Hz, 1H), 7.76 (t, J = 8.2 Hz 1H), 7.72 (d, J = 8.4 Hz, 1H), 7.46 (t, J = 7.2 Hz, 1H), 1.50 (s, 9H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 163.8, 162.1, 149.2, 134.5, 127.7, 126.3, 126.1, 120.6, 37.5, 28.3.

2-Cyclopropylquinazolin-4(3H)-one (***3e***).[1c] Following the general procedure, the crude product was purified by column chromatography on silica gel and eluted with ethyl acetate/petroleum ether (1/4) to afford a white solid. Yield: 35.3 mg, 95%; mp: 231−234 °C. ^{1}H NMR (400 MHz, $CDCl_3$) δ 12.23 (s, br, 1H), 8.26 (d, J = 7.9 Hz, 1H), 7.72 (t, J = 7.5 Hz, 1H), 7.60 (d, J = 8.2 Hz, 1H), 7.40 (t, J = 7.5 Hz, 1H), 2.06−2.00 (m, 1H), 1.42−1.29 (m, 2H), 1.21−1.06 (m, 2H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 164.3, 158.3, 149.8, 134.7, 126.9, 126.2, 125.6, 120.3, 14.6, 9.8.

2-Chloromethylquinazolin-4(3H)-one (***3f***).[19] Following the general procedure, the crude product was purified by column chromatography on silica gel and eluted with ethyl acetate/petroleum ether (1/1) to afford a yellow solid. Yield: 34.5 mg, 89%; mp: 249−252 °C. ^{1}H NMR (400 MHz, DMSO-d_6) δ 12.64 (s, br, 1H), 8.18 (d, J = 7.9 Hz, 1H), 7.90 (t, J = 7.6 Hz, 1H), 7.74 (d, J = 8.1 Hz, 1H), 7.61 (t, J = 7.5 Hz, 1H), 4.61 (s, 2H); ^{13}C NMR (100 MHz, DMSO-d_6) δ 162.0, 152.8, 148.7, 135.2, 127.8, 127.4, 126.4, 121.7, 43.7.

2-Methoxymethylquinazolin-4(3H)-one (***3g***).[20] Following the general procedure, the crude product was purified by column chromatography on silica gel and eluted with ethyl acetate/petroleum ether (1/4) to afford a white solid. Yield: 35.0 mg, 92%; mp: 188−190 °C. ^{1}H NMR (400 MHz, $CDCl_3$) δ 10.15 (s, 1H), 8.30 (d, J = 7.9 Hz, 1H), 7.77 (t, J = 7.6 Hz, 1H), 7.67 (d, J = 8.1 Hz, 1H), 7.48 (t, J = 7.5 Hz, 1H), 4.51 (s,

DOI: 10.1021/acs.joc.5b00937
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2H), 3.56 (s, 3H); ^{13}C NMR (100 MHz, $CHCl_3$) δ 161.8, 152.7, 148.6, 134.7, 127.0, 126.8, 126.5, 121.5, 71.1, 59.3.

2-Phenylquinazolin-4(3H)-one (**3h**).[6b] Following the general procedure, the crude product was purified by column chromatography on silica gel and eluted with ethyl acetate/petroleum ether (1/4) to afford a white solid. Yield: 40.4 mg, 91%; mp: 235−236 °C. ^{1}H NMR (400 MHz, $CDCl_3$) δ 12.09 (s, br, 1H), 8.33 (d, J = 8.4 Hz, 1H), 8.30 (dd, J = 6.5, 3.0 Hz, 2H), 7.85 (d, J = 7.9 Hz, 1H), 7.83−7.77 (m, 1H), 7.62−7.55 (m, 3H), 7.51 (t, J = 7.4 Hz, 1H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 164.0, 151.8, 149.5, 134.9, 132.8, 131.6, 129.0, 128.0, 127.5, 126.7, 126.3, 120.8.

2-(4-Fluorophenyl)quinazolin-4(3H)-one (**3i**).[6b] Following the general procedure, the crude product was purified by column chromatography on silica gel and eluted with ethyl acetate/petroleum ether (1/3) to afford a white solid. Yield: 42.7 mg, 89%; mp: 291−294 °C. ^{1}H NMR (400 MHz, DMSO-d_6) δ 8.28−8.23 (m, 2H), 8.16 (d, J = 7.9 Hz, 1H), 7.84 (t, J = 7.0 Hz, 1H), 7.74 (d, J = 8.0 Hz, 1H), 7.53 (t, J = 7.5 Hz, 1H), 7.40 (t, J = 8.8 Hz, 2H); ^{13}C NMR (100 MHz, DMSO-d_6) δ 164.5 (d, J_{C-F} = 247.7 Hz), 162.7, 151.9, 149.1, 135.1, 130.9 (d, J_{C-F} = 8.9 Hz), 129.7, 127.9, 127.1, 126.3, 121.4, 116.1 (d, J_{C-F} = 21.7 Hz).

2-(4-Methoxyphenyl)quinazolin-4(3H)-one (**3j**).[6b] Following the general procedure, the crude product was purified by column chromatography on silica gel and eluted with ethyl acetate/petroleum ether (1/4) to afford a white solid. Yield: 46.9 mg, 93%; mp: 276−280 °C. ^{1}H NMR (400 MHz, DMSO-d_6) δ 12.41 (s, br, 1H), 8.19 (d, J = 8.9 Hz, 2H), 8.13 (dd, J = 7.9, 1.0 Hz, 1H), 7.84−7.77 (m, 1H), 7.70 (d, J = 8.0 Hz, 1H), 7.48 (t, J = 7.5 Hz, 1H), 7.08 (d, J = 8.9 Hz, 2H), 3.84 (s, 3H); ^{13}C NMR (100 MHz, DMSO-d_6) δ 162.8, 162.3, 152.3, 149.4, 135.0, 129.9, 127.8, 126.6, 126.3, 125.3, 121.2, 114.5, 55.9.

2-(4-Nitrophenyl)quinazolin-4(3H)-one (**3k**).[6b] Following the general procedure, the crude product was purified by column chromatography on silica gel and eluted with ethyl acetate/petroleum ether (1/1) to afford a yellow solid. Yield: 47.0 mg, 88%; mp: >300 °C. ^{1}H NMR (400 MHz, DMSO-d_6) δ 12.79 (s, br, 1H), 8.43−8.37 (m, 4H), 8.19 (d, J = 7.7 Hz, 1H), 7.89 (t, J = 7.4 Hz, 1H), 7.80 (d, J = 8.0 Hz, 1H), 7.59 (t, J = 7.4 Hz, 1H); ^{13}C NMR (100 MHz, DMSO-d_6) δ 162.5, 151.2, 149.5, 148.8, 139.0, 135.3, 129.8, 128.2, 127.8, 126.4, 124.1, 121.7.

2-(4-Pyridinyl)quinazolin-4(3H)-one (**3l**).[1c] Following the general procedure, the crude product was purified by column chromatography on silica gel and eluted with ethyl acetate/petroleum ether (1/2) to afford a pale yellow solid. Yield: 38.4 mg, 86%; mp: 281−284 °C. ^{1}H NMR (400 MHz, DMSO-d_6) δ 12.65 (s, br, 1H), 8.79 (d, J = 5.5 Hz, 2H), 8.19 (d, J = 7.5 Hz, 1H), 8.12 (d, J = 5.9 Hz, 2H), 7.88 (t, J = 7.1 Hz, 1H), 7.79 (d, J = 8.0 Hz, 1H), 7.59 (t, J = 7.4 Hz, 1H); ^{13}C NMR (100 MHz, DMSO-d_6) δ 162.5, 151.0, 150.7, 148.7, 140.3, 135.2, 128.2, 127.8, 126.4, 122.0, 121.9.

2-Cyclopropyl-6-methylquinazolin-4(3H)-one (**3m**). Following the general procedure, the crude product was purified by column chromatography on silica gel and eluted with ethyl acetate/petroleum ether (1/4) to afford a white solid. Yield: 38.0 mg, 95%; mp: 252−256 °C. ^{1}H NMR (400 MHz, $CDCl_3$) δ 11.81 (s, br, 1H),8.04 (s, 1H), 7.54 (d, J = 8.4 Hz, 1H), 7.50 (d, J = 8.3 Hz, 1H), 2.47 (s, 3H), 2.02−1.95 (m, 1H), 1.32−1.28 (m, 2H), 1.15−1.09 (m, 2H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 164.1, 157.1, 147.8, 136.2, 135.7, 126.8, 125.6, 120.1, 21.2, 14,6, 9.5. HRMS (EI) m/z: $[M]^+$ calcd. for $C_{12}H_{12}N_2O$ 200.0950; found 200.0936.

2-(4-Fluorophenyl)-6-methylquinazolin-4(3H)-one (**3n**). Following the general procedure, the crude product was purified by column chromatography on silica gel and eluted with ethyl acetate/petroleum ether (1/4) to afford a white solid. Yield: 46.2 mg, 91%; mp: 280−283 °C. ^{1}H NMR (400 MHz, DMSO-d_6) δ 12.51 (s, br, 1H), 8.28−8.21 (m, 2H), 7.96 (s, 1H), 7.70−7.62 (m, 2H), 7.44−7.35 (m, 2H), 2.47 (s, 3H); ^{13}C NMR (100 MHz, DMSO-d_6) δ 164.5 (d, J_{C-F} = 247.8 Hz), 162.7, 151.2, 147.2, 136.9, 136.5, 130.7 (d, J_{C-F} = 8.8 Hz), 129.8 (d, J_{C-F} = 2.8 Hz), 127.9, 125.8, 121.1, 116.2 (d, J_{C-F} = 21.9 Hz), 21.4. HRMS (EI) m/z: $[M]^+$ calcd. for $C_{15}H_{11}FN_2O$ 254.0847; found 254.0854.

2-Cyclopropyl-6-chloroquinazolin-4(3H)-one (**3o**).[10a] Following the general procedure, the crude product was purified by column chromatography on silica gel and eluted with ethyl acetate/petroleum ether (1/4) to afford a white solid. Yield: 40.9 mg, 93%; mp: 292−295 °C. ^{1}H NMR (400 MHz, DMSO-d_6) δ 12.49 (s, br, 1H), 7.96 (d, J = 2.5 Hz, 1H), 7.71 (d, J = 8.7 Hz, 1H), 7.48 (d, J = 8.7 Hz, 1H), 2.00−1.94 (m, 1H), 1.10−1.06 (m, 2H), 1.04−1.01 (m, 2H); ^{13}C NMR (100 MHz, DMSO-d_6) δ 161.8, 160.9, 149.4, 134.6, 129.6, 129.0, 125.2, 122.3, 14.2, 10.1.

6-Chloro-2-(4-methoxyphenyl)quinazolin-4(3H)-one (**3p**).[10c] Following the general procedure, the crude product was purified by column chromatography on silica gel and eluted with ethyl acetate/petroleum ether (1/3) to afford a white solid. Yield: 50.9 mg, 89%; mp: 290−292 °C. ^{1}H NMR (400 MHz, DMSO-d_6) δ 12.56 (s, br, 1H), 8.18 (d, J = 8.7 Hz, 2H), 8.05 (d, J = 2.1 Hz, 1H), 7.82 (d, J = 8.7 Hz, 1H), 7.71 (d, J = 8.7 Hz, 1H), 7.09 (d, J = 8.7 Hz, 2H), 3.86 (s, 3H); ^{13}C NMR (100 MHz, DMSO-d_6) δ 162.5, 161.9, 152.8, 148.2, 135.1, 130.7, 130.1, 125.3, 125.0, 122.4, 114.5, 56.0.

5-Fluoro-2-propylquinazolin-4(3H)-one (**3q**). Following the general procedure, the crude product was purified by column chromatography on silica gel and eluted with ethyl acetate/petroleum ether (1/5) to afford a white solid. Yield: 37.9 mg, 92%; mp: 216−220 °C. ^{1}H NMR (400 MHz, $CDCl_3$) δ 11.81 (s, 1H), 7.68 (dd, J = 13.6, 8.0 Hz, 1H), 7.49 (d, J = 8.2 Hz, 1H), 7.15−7.05 (m, 1H), 2.75 (t, J = 7.6 Hz, 2H), 1.96−1.86 (m, 2H), 1.07 (t, J = 7.3 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 161.8, 161.3 (d, J_{C-F} = 263.8 Hz), 158.0, 151.5, 135.1 (d, J_{C-F} = 10.4 Hz), 123.1, 112.8 (d, J_{C-F}= 20.3 Hz),110.4, 37.5, 20.8, 13.6. HRMS (EI) m/z: $[M]^+$ calcd. for $C_{11}H_{11}FN_2O$: 206.0856, found 206.0849.

5-Fluoro-2-(4-methoxyphenyl)quinazolin-4(3H)-one (**3r**).[5e] Following the general procedure, the crude product was purified by column chromatography on silica gel and eluted with ethyl acetate/petroleum ether (1/2) to afford a white solid. Yield: 46.4 mg, 86%; mp: 289−292 °C. ^{1}H NMR (400 MHz, DMSO-d_6) δ 12.42 (s, br, 1H), 8.19 (d, J = 8.8 Hz, 2H), 7.78 (dd, J = 13.9, 8.2 Hz, 1H), 7.52 (d, J = 8.2 Hz, 1H), 7.22 (dd, J = 10.7, 8.4 Hz, 1H), 7.10 (d, J = 8.9 Hz, 2H), 3.85 (s, 3H); ^{13}C NMR (100 MHz, DMSO-d_6) δ 162.6, 161.0 (d, J_{C-F} = 261.1 Hz), 160.1, 153.3, 151.6, 135.5 (d, J_{C-F} = 10.6 Hz), 130.1, 124.7, 123.8 (d, J_{C-F} = 4.0 Hz), 114.5, 112.9 (d, J_{C-F} = 20.4 Hz), 110.6, 56.0.

2-(Methoxymethyl)-3-methyl-quinazolin-4(3H)-one (**3s**). Following the general procedure, the crude product was purified by column chromatography on silica gel and eluted with ethyl acetate/petroleum ether (1/4) to afford a pale yellow liquid. Yield: 38.8 mg, 95%. ^{1}H NMR (400 MHz, $CDCl_3$) δ

DOI: 10.1021/acs.joc.5b00937
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8.28−8.23 (m, 1H), 7.71 (t, J = 7.5 Hz, 1H), 7.67 (d, J = 7.3 Hz, 1H), 7.46 (t, J = 6.8 Hz, 1H), 4.55 (s, 2H), 3.67 (s, 3H), 3.45 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 162.3, 152.5, 146.7, 134.1, 127.3, 127.2, 126.7, 120.8, 73.8, 58.5, 30.3. HRMS (EI) m/z: $[M]^+$ calcd. for $C_{11}H_{12}N_2O_2$ 204.0886; found 204.0876.

3-Methyl-2-phenylquinazolin-4(3H)-one (**3t**).[16a] Following the general procedure, the crude product was purified by column chromatography on silica gel and eluted with ethyl acetate/petroleum ether (1/4) to afford a white solid. Yield: 44.4 mg, 94%; mp: 134−138 °C. ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.33 (d, J = 7.8 Hz, 1H), 7.78−7.73 (m, 2H), 7.57−7.52 (m, 2H), 7.51−7.48 (m, 4H), 3.50 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 162.7, 156.1, 147.3, 135.3, 134.3, 130.1, 128.9, 127.9, 127.5, 127.0, 126.7, 120.5, 34.2.

2-(1-Methylethyl)quinazolin-4(3H)-one (**3u**).[10i] Following the general procedure, the crude product was purified by column chromatography on silica gel and eluted with ethyl acetate/petroleum ether (1/4) to afford a white solid. Yield: 34.2 mg, 91%; mp: 224−226 °C. ^{1}H NMR (400 MHz, $CDCl_3$) δ 11.57 (s, br, 1H), 8.30 (d, J = 7.1 Hz, 1H), 7.77 (t, J = 7.5 Hz, 1H), 7.72 (d, J = 7.4 Hz, 1H), 7.46 (t, J = 7.4 Hz, 1H), 3.05 (m, 1H), 1.45 (d, J = 7.0 Hz, 6H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 164.1, 160.8, 149.5, 134.7, 127.4, 126.3, 126.2, 120.7, 34.9, 20.4.

2,6-Dimethylquinazolin-4(3H)-one (**3v**).[1c] Following the general procedure, the crude product was purified by column chromatography on silica gel and eluted with ethyl acetate/petroleum ether (1/4) to afford a white solid. Yield: 33.1 mg, 95%; mp: 248−250 °C. ^{1}H NMR (400 MHz, $CDCl_3$) δ 12.16 (s, br, 1H), 8.06 (s, 1H), 7.57 (s, br, 2H), 2.58 (s, 3H), 2.48 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 164.4, 152.5, 147.4, 136.5, 136.3, 126.8, 125.5, 120.0, 21.9, 21.2.

2-Ethyl-6-methylquinazolin-4(3H)-one (**3w**).[16a] Following the general procedure, the crude product was purified by column chromatography on silica gel and eluted with ethyl acetate/petroleum ether (1/4) to afford a white solid. Yield: 35.3 mg, 94%; mp: 224−226 °C. ^{1}H NMR (400 MHz, $CDCl_3$) δ 11.86 (s, br, 1H), 8.07 (s, 1H), 7.61 (d, J = 8.2 Hz, 1H), 7.59 (d, J = 1.8 Hz, 1H), 2.82 (q, J = 7.6 Hz, 2H), 2.49 (s, 3H), 1.45 (t, J = 7.6 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 164.3, 156.7, 147.5, 136.5, 136.2, 127.0, 125.6, 120.2, 29.0, 21.2, 11.6.

6-Chloro-2-ethylquinazolin-4(3H)-one (**3x**).[16a] Following the general procedure, the crude product was purified by column chromatography on silica gel and eluted with ethyl acetate/petroleum ether (1/3) to afford a white solid. Yield: 38.9 mg, 94%; mp: 253−256 °C. ^{1}H NMR (400 MHz, DMSO-d_6) δ 12.12 (s, br, 1H), 8.01 (s, 1H), 7.78 (s, 1H), 7.62 (s, 1H), 2.63 (s, 2H), 1.25 (s, 2H), ^{13}C NMR (100 MHz, DMSO-d_6) δ 161.7, 159.9, 148.2, 134.7, 130.4, 129.4, 125.1, 122.5, 11.7.

2-(tert-Butyl)-6-chloroquinazolin-4(3H)-one (**3y**). Following the general procedure, the crude product was purified by column chromatography on silica gel and eluted with ethyl acetate/petroleum ether (1/3) to afford a white solid. Yield: 42.9 mg, 91%; mp: 228−232 °C. ^{1}H NMR (400 MHz, $CDCl_3$) δ 10.84 (s, br, 1H), 8.22 (d, J = 1.5 Hz, 1H), 7.69 (dd, J = 8.9, 2.3 Hz, 1H), 7.67 (d, J = 4.9 Hz, 1H), 1.48 (s, 9H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 162.6, 162.3, 147.7, 134.9, 132.1, 129.4, 125.5, 121.6, 37.5, 28.2. HRMS (EI) m/z: $[M]^+$ calcd. for $C_{12}H_{13}ClN_2O$ 236.0711; found 236.0704.

5-Fluoro-2-methylquinazolin-4(3H)-one (**3z**).[1c] Following the general procedure, the crude product was purified by column chromatography on silica gel and eluted with ethyl acetate/petroleum ether (1/5) to afford a white solid. Yield: 33.1 mg, 93%; mp: 243−245 °C. ^{1}H NMR (400 MHz, DMSO-d_6) δ 12.22 (s, br, 1H), 7.73 (dd, J = 13.9, 7.8 Hz, 1H), 7.38 (d, J = 8.2 Hz, 1H), 7.24−7.13 (m, 1H), 2.33 (s, 3H); ^{13}C NMR (100 MHz, DMSO-d_6) δ 161.0 (d, J_{C-F} = 260.8 Hz), 159.5, 155.9, 151.7, 135.3 (d, J_{C-F} = 10.5 Hz), 123.1, 112.6 (d, J_{C-F}= 20.3 Hz), 110.6, 21.7.

5-Fluoro-2-(1-methylethyl)quinazolin-4(3H)-one (**3z^1**). Following the general procedure, the crude product was purified by column chromatography on silica gel and eluted with ethyl acetate/petroleum ether (1/5) to afford a white solid. Yield: 37.1 mg, 90%; mp: 212−214 °C; ^{1}H NMR (400 MHz, $CDCl_3$) δ 11.16 (s, br, 1H), 7.70−7.64 (m, 1H), 7.50 (d, J = 8.2 Hz, 1H), 7.11−7.05 (m, 1H), 3.05−2.94 (m, 1H), 1.42 (d, J = 7.0 Hz, 6H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 161.8, 161.4 (d, J_{C-F} = 263.7 Hz), 161.4 (d, J_{C-F} = 3.0 Hz), 151.5, 134.9 (d, J_{C-F} = 10.3 Hz), 123.3 (d, J_{C-F} = 4.2 Hz), 112.8 (d, J_{C-F}= 20.4 Hz), 110.5, 34.8, 20.3. HRMS (EI) m/z: $[M]^+$ calcd. for $C_{11}H_{11}FN_2O$ 206.0848; found 206.0851.

2,3-Dimethylquinazolin-4(3H)-one (**3z^2**).[16a] Following the general procedure, the crude product was purified by column chromatography on silica gel and eluted with ethyl acetate/petroleum ether (1/4) to afford a white solid. Yield: 33.4 mg, 96%; mp: 112−114 °C. ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.23 (d, J = 8.0 Hz, 1H), 7.69 (t, J = 7.6 Hz, 1H), 7.59 (d, J = 8.1 Hz, 1H), 7.42 (t, J = 7.5 Hz, 1H), 3.60 (s, 3H), 2.60 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 162.2, 154.4, 147.2, 134.1, 126.7, 126.5, 126.3, 120.2, 31.0, 23.6.

3-Methyl-2-(1-methylethyl)quinazolin-4(3H)-one (**3z^3**). Following the general procedure, the crude product was purified by column chromatography on silica gel and eluted with ethyl acetate/petroleum ether (1/4) to afford a white solid. Yield: 37.6 mg, 93%; mp: 79−82 °C. ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.24 (d, J = 8.8 Hz, 1H), 7.69 (t, J = 7.6 Hz, 1H), 7.63 (d, J = 7.5 Hz, 1H), 7.40 (t, J = 8.0 Hz, 1H), 3.66 (s, 3H), 3.24−3.14 (m, 1H), 1.37 (d, J = 6.7 Hz, 6H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 162.8, 161.1, 147.3, 133.9, 127.1, 126.6, 126.1, 120.2, 32.1, 30.0, 20.8. HRMS (EI) m/z: [M]+ calcd. for $C_{12}H_{14}N_2O$ 202.1148; found 202.1156.

2-Methyl-1H-benzo[d]imidazole (**7a**).[12a] Following the general procedure, the crude product was purified by column chromatography on silica gel and eluted with ethyl acetate/petroleum ether (1/50) to afford a white solid. Yield: 25.1 mg, 95%; mp: 179−181 °C. ^{1}H NMR (400 MHz, $CDCl_3$) δ 9.69 (s, br, 1H), 7.56 (dd, J = 6.0, 3.2 Hz, 2H), 7.22 (dd, J = 6.0, 3.2 Hz, 2H), 2.66 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 151.4, 138.7, 122.1, 114.4, 14.9.

2-Propyl-1H-benzo[d]imidazole (**7b**).[16a] Following the general procedure, the crude product was purified by column chromatography on silica gel and eluted with ethyl acetate/petroleum ether (1/50) to afford a white solid. Yield: 29.8 mg, 93%; mp: 158−160 °C. ^{1}H NMR (400 MHz, $CDCl_3$) δ 11.05 (s, 1H), 7.56 (dd, J = 5.8, 3.1 Hz, 2H), 7.21 (dd, J = 5.9, 3.1 Hz, 2H), 2.96 (t, J = 7.5 Hz, 2H), 1.96−1.84 (m, 2H), 0.98 (t, J = 7.3 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 155.6, 138.5, 122.1, 114.5, 31.1, 21.7, 13.8.

2-(Methoxymethyl)-1H-benzo[d]imidazole (**7c**).[10b] Following the general procedure, the crude product was purified by column chromatography on silica gel and eluted with ethyl acetate/petroleum ether (1/50) to afford a white solid. Yield: 29.5 mg, 91%; mp: 142−144 °C. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.60 (dd, J = 5.8, 3.1 Hz, 2H), 7.25 (dd, J = 6.0, 3.1 Hz, 2H), 4.78 (s, 2H), 3.47 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 151.5, 122.5, 115.1, 68.3, 59.0.

DOI: 10.1021/acs.joc.5b00937
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*2-(4-Methoxyphenyl)-1H-benzo[d]imidazole (**7d**).*[16b] Following the general procedure, the crude product was purified by column chromatography on silica gel and eluted with ethyl acetate/petroleum ether (1/100) to afford a white solid. Yield: 42.6 mg, 95%; mp: 233−236 °C. ^{1}H NMR (400 MHz, DMSO-d_6) δ 8.16 (d, J = 8.7 Hz, 2H), 7.62 (dd, J = 5.9, 3.2 Hz, 2H), 7.25 (dd, J = 6.0, 3.1 Hz, 2H), 7.13 (d, J = 8.8 Hz, 2H), 3.85 (s, 3H); ^{13}C NMR (100 MHz, DMSO-d_6) δ 161.7, 151.3, 138.2, 129.0, 123.1, 121.5, 115.0, 55.9.

*2-Isopropylbenzo[d]thiazole (**8a**).*[12a] Following the general procedure, the crude product was purified by column chromatography on silica gel and eluted with ethyl acetate/petroleum ether (1/50) to afford a yellow liquid. Yield: 32.9 mg, 93%. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.98 (d, J = 8.1 Hz, 1H), 7.82 (d, J = 8.0 Hz, 1H), 7.43 (t, J = 7.7 Hz, 1H), 7.32 (t, J = 7.6 Hz, 1H), 3.47−3.36 (m, 1H), 1.47 (d, J = 6.9 Hz, 6H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 178.5, 153.1, 134.6, 125.7, 124.5, 122.5, 121.4, 34.0, 22.8.

*2-Propylbenzo[d]thiazole (**8b**).*[10b] Following the general procedure, the crude product was purified by column chromatography on silica gel and eluted with ethyl acetate/petroleum ether (1/50) to afford a yellow liquid. Yield: 33.3 mg, 94%. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.97 (d, J = 8.1 Hz, 1H), 7.83 (d, J = 7.9 Hz, 1H), 7.44 (t, J = 7.7 Hz, 1H), 7.34 (t, J = 7.1 Hz, 1H), 3.09 (t, J = 15.2 Hz, 2H), 1.96−1.86 (m, 2H), 1.06 (t, J = 7.4 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 172.2, 153.2, 135.1, 125.8, 124.6, 122.5, 121.4, 36.2, 23.1, 13.7.

*2-Cyclopropylbenzo[d]thiazole (**8c**).*[5c] Following the general procedure, the crude product was purified by column chromatography on silica gel and eluted with ethyl acetate/petroleum ether (1/50) to afford a yellow liquid. Yield: 32.2 mg, 92%. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.89 (d, J = 8.1 Hz, 1H), 7.75 (d, J = 7.9 Hz, 1H), 7.39 (t, J = 7.7 Hz, 1H), 7.27 (t, J = 7.6 Hz, 1H), 2.40−2.32 (m, 1H), 1.20−1.77(m, 4H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 174.3, 153.2, 134.0, 125.7, 124.1, 121.9, 121.2, 15.1, 11.6.

*2-Phenylbenzo[d]thiazole (**8d**).*[12a] Following the general procedure, the crude product was purified by column chromatography on silica gel and eluted with ethyl acetate/petroleum ether (1/50) to afford a pale white solid. Yield: 39.7 mg, 94%; mp: 112−114 °C. ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.12−8.05 (m, 3H), 7.88 (d, J = 8.0 Hz, 1H), 7.49−7.46 (m, 4H), 7.36 (t, J = 7.6 Hz, 1H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 168.0, 154.1, 135.0, 133.6, 130.9, 129.0, 127.5, 126.3, 125.1, 123.2, 121.6.

*2-(4-Methoxyphenyl)benzo[d]thiazole (**8e**).*[16b] Following the general procedure, the crude product was purified by column chromatography on silica gel and eluted with ethyl acetate/petroleum ether (1/50) to afford a pale yellow solid. Yield: 44.8 mg, 93%; mp: 141−144 °C. ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.04 (dd, J = 8.8, 2.5 Hz, 3H), 7.86 (d, J = 7.9 Hz, 1H), 7.47 (t, J = 7.7 Hz, 1H), 7.35 (t, J = 7.6 Hz, 1H), 6.99 (d, J = 8.8 Hz, 2H), 3.86 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 167.8, 161.8, 154.2, 134.8, 129.0, 126.4, 126.1, 124.7, 122.7, 121.4, 114.3, 55.4.

■ ASSOCIATED CONTENT

Supporting Information

The Supporting Information is available free of charge on the ACS Publications website at DOI: 10.1021/acs.joc.5b00937.

Control reaction and copies of ^{1}H and ^{13}C NMR spectra for products (PDF)

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Notes

The authors declare no competing financial interest.

■ ACKNOWLEDGMENTS

Financial supports by National Natural Science Foundation of China (Grant Nos. 21172062, 21273066, 21273067), and Doctoral Fund of Ministry of Education of China (20110161120008) are gratefully appreciated.

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