Pd/C Catalyzed Cascade Synthesis of 2-Arylquinazolinones from 2-Iodoacetanilides Employing Ammonia and CO Precursors

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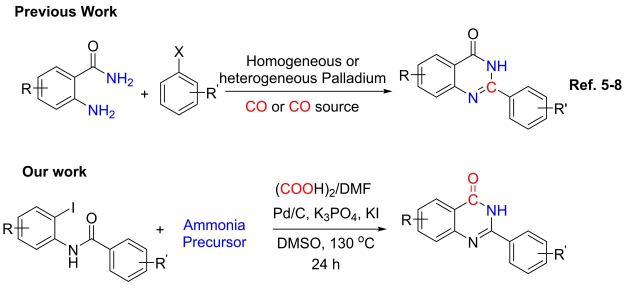
An efficient and straightforward approach has been demonstrated for 2-aryl quinazolinones synthesis from 2-iodoacetanilides using ammonium carbamate/ammonium carbonate and oxalic acid under heterogeneous Pd/C catalyzed conditions. Herein, we have carried out the reactions employing oxalic acid and ammonium carbamate or ammonium carbonate as two gaseous precursors i.e. CO and NH_3 respectively for the synthesis of desired quinazolinones in appreciable yields. The protocol followed cascade aminocarbonylation and cyclization under optimized reaction conditions. The protocol exhibited wide functional group tolerance under set reaction conditions and delivered the respective 2-aryl quinazolinones with great diversity. The heterogeneous Pd/C catalyst was found to be recyclable up to four consecutive runs without significant decrease in catalytic activity.

Introduction

Nitrogen containing heterocycles are diversely distributed in natural products and act as pharmacophore in various pharmaceutically and industrially important molecules.[1] Due to their diverse abundance and wide significance in nature, development of new and efficient strategies for construction of nitrogen containing heterocycles is an important area in organic synthesis. Among all known heterocycles, quinazolinones are of great interest due to their antibacterial,[2b] anticonvulsant,[2c] anti-cancer,[2d] anti-inflammatory,[2e] anti-malarial[2f] and anti-hypertensive properties.[2g] In this regard, various catalytic and non-catalytic protocols have been established by researchers for the synthesis of diversely substituted quinazolinones over past few years.[3] However, majority of catalytic processes utilized homogeneous reaction conditions, application of expensive and air or moisture sensitive ligands and excess of oxidants/additives.

Carbon monoxide (CO) is an important and simplest C1 source and can be incorporated into parent molecules to synthesize wide range of important carbonylated products.[4] Therefore, considering the importance of the CO in the field of heterocyclic chemistry, it is interesting to explore the CO as C1 source in heterocycles preparation. In this context of 2-arylquinazolinones synthesis, Beller and co-workers have synthesized 2-substituted quinazolinones through palladium catalyzed aminocarbonylation of 2-aminobenzamides[5] or 2-aminobenzonitriles[6] and aryl bromides followed by cascade cyclization using $Pd(OAc)_2$/ $BuPAd_2$ under CO atomsphere.[5] After their work, 2-aminobenzamides/benzonitriles have been employed as major substrates or nitrogen components for the synthesis of 2-aryl quinazolinones following above mentioned strategies under various homogeneous[7] or heterogeneous catalytic conditions (Scheme 1).[8]

Zhu *et al.* synthesized quinazolinones from *N*-arylamidines following palladium catalyzed intramolecular C(sp^2)-H carboxamidation strategy.[9] According to literature, aminocarbonylation was considered as major step for the synthesis of quinazolinones. In 2014, Wu *et al.* developed a $Pd(OAc)_2$/$BuPAd_2$ catalyzed protocol for the synthesis of quinazolinones from 2-bromoformanilides with nitrobenzenes using $Mo(CO)_6$ as multiple promoter i.e., CO source, reducing agent and cyclization agent.[10] In similar lines, multi-component synthesis from 2-iodoanilines, aryl/alkyl amines and trimethyl orthoformate under CO atmosphere and amines using homogeneous[11] as well as heterogeneous[12] palladium catalyzed conditions have also been described by researchers. In aforementioned strategies, researchers have employed highly reactive aryl/alkyl primary amines for aminocarbonylation steps. However, ammo-



Scheme 1. Comparative study of previous protocols for 2-aryl quinazolinones synthesis.

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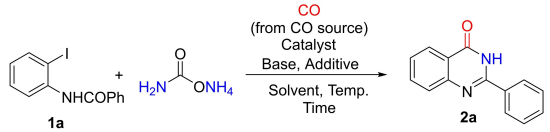
nia (NH_3) being industrially important and economic molecule could be considered as an excellent source of nitrogen component for heterocycles synthesis. Ma and co-workers developed a protocol for 1-benzimidazoles and 1,3-dihydrobenzimidazol-2-one's synthesis via coupling of aq. ammonia with 2-iodoacetanilides and 2-iodophenylcarbamates utilizing CuI/L-proline catalytic conditions.[13] But, the direct utilization of ammonia along with transition metals complexes is challenging as it may cause poisoning of the catalyst or it undergo ligand exchange with transition metal catalysts or may result in Werner's complex formation which could lower the activity of the catalyst.[14] Hence development of ammonia sources and its application in organic synthesis is promising area. However, the synthesis of quinazolinones employing ammonia as nitrogen component following aminocarbonylation and cascade cyclization is still under-explored. Hence, provoked by these studies, herein, we intend to explore the properties of both ammonia gas as nitrogen component and CO as C1 source in preparation of nitrogen containing heterocycles i.e., 2-aryl quinazolinones. However, the concomitant issues of using NH_3 and CO gases simultaneously such as toxicity, hazardous nature, cumbersome storage and handling problems, use of sophisticated instruments and sensors, could complicate the reaction protocol. To evade these deficiencies, we employed solid, economic and bench stable NH_3 and CO sources, which on thermal decomposition release NH_3 and CO gases respectively.

From the green and sustainable point of view, our group is continuously up-surging the area of carbonylation reactions employing oxalic acid as an efficient, economic and sustainable C1 source.[15] Furthermore, we have successfully explored oxalic acid as an CO or C1 source for various heterocycles synthesis.[16] In our earlier report, we have reported Pd@PS catalyzed primary amides synthesis, where we have demonstrated the necessity of imidazole as additive for aminocarbonylation.[15a] Continuing to our work, herein, we have envisaged imidazole free 2-aryl quinazolinones synthesis under commercially available and heterogeneous Pd/C conditions via cascade aminocarbonylation and cyclization strategy utilizing oxalic acid as CO source and ammonium carbamate or ammonium carbonate as nitrogen component.

Results and Discussion

For the optimization of the reaction conditions, we commenced our study using Double-Vial (DV) system where the inner Vial charged with *N*-(2-iodophenyl)benzamide (**1a**, 1 equiv.) or 2-iodoacetanilide, ammonium carbamate (3 equiv.), 5 wt% Pd/C (3 mol%) and K_2CO_3 (2 equiv.) in DMSO (2 mL) and outer Vial with oxalic acid (6 equiv.) in DMF (0.5 mL). Delightfully, we got 30% yield of our desired 2-arylquinazolinone product **2a**. In pursuit to get maximum yield of the targeted product i.e., 2-arylquinazolinone (**2a**), we considered various reactions with variable catalyst loading, base, additive and solvent conditions. Initially, we started with screening of different organic and inorganic bases such as NEt_3, Cs_2CO_3, KO^tBu and K_3PO_4 (Table 1, entries 2–5). Fortunately, in case of K_3PO_4 (2 equiv.) the desired

Table 1. Optimization of the reaction for 2-arylquinazolinones synthesis.



S.No.	Catalyst (mol%)	Base (equiv.)	Additive (equiv.)	Solvent	Yield (%)[a]
1	Pd/C (3)	K_2CO_3 (2)	-	DMSO	30
2	Pd/C (3)	NEt_3 (2)	-	DMSO	nd
3	Pd/C (3)	Cs_2CO_3(2)	-	DMSO	25
4	Pd/C (3)	KO^tBu (2)	-	DMSO	40
5	Pd/C (3)	K_3PO_4 (2)	-	DMSO	50
6	Pd/C (3)	K_3PO_4 (2)	KI (0.75)	DMSO	58
7	Pd/C (3)	K_3PO_4 (2)	KI (1.5)	DMSO	65
8	Pd/C (3)	K_3PO_4 (2)	LiI (1.5)	DMSO	50
9	Pd/C (3)	K_3PO_4 (2)	LiCl (1.5)	DMSO	65
10	Pd/C (3)	K_3PO_4 (2.5)	KI (1.5)	DMSO	75
11	**Pd/C (5)**	**K_3PO_4 (2.5)**	**KI (1.5)**	**DMSO**	**84**
12	Pd/C (5)	K_3PO_4 (2.5)	KI (1.5)	DMF	70
13	Pd/C (5)	K_3PO_4 (2.5)	KI (1.5)	Xylene	nr
14	Pd/C (5)	K_3PO_4 (2.5)	KI (1.5)	PEG-400	nr
15	Pd/C (5)	K_3PO_4 (2.5)	KI (1.5)	NMP	20
16[b]	Pd/C (5)	K_3PO_4 (2.5)	KI (1.5)	DMSO	42
17[c]	Pd/C (5)	K_3PO_4 (2.5)	KI (1.5)	DMSO	80
18[d]	Pd/C (5)	K_3PO_4 (2.5)	KI (1.5)	DMSO	30
19[e]	Pd/C (5)	K_3PO_4 (2.5)	KI (1.5)	DMSO	Traces
20[f]	Pd/C (5)	K_3PO_4 (2.5)	KI (1.5)	DMSO	Traces
21[g]	Pd/C (5)	K_3PO_4 (2.5)	KI (1.5)	DMSO	nr
22	Pd@PS (3)	K_3PO_4 (2.5)	KI (1.5)	DMSO	82
23[h]	Pd/Al_2O_3 (5)	K_3PO_4 (2.5)	KI (1.5)	DMSO	40
24[i]	$Pd(OAc)_2/PPh_3$	K_3PO_4 (2.5)	KI (1.5)	DMSO	25

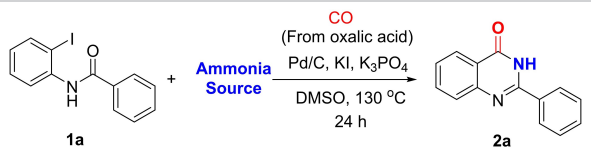
Reaction conditions: **1**\ (1 equiv.), ammonium carbamate (3 equiv.), 5 wt% Pd/C (5 mol%), K_3PO_4 (2.5 equiv.), KI (1.5 equiv.), DMSO (1.5 mL); Outer vial oxalic acid (6 equiv.) in DMF (0.5 mL) stirred at 130 °C for 24 h; [a] Isolated yield; [b] Reaction stirred at 120 °C; [c] Reaction performed at 140 °C; [d] 4 equiv. of oxalic acid; [e] Formic acid as CO source; [f] Paraformaldehyde as CO source; [g] No CO source; [h] 5 wt%; [i] 10 mol% PPh_3.

quinazolinone (**2a**) was formed in 50% yield in addition to dehalogenation of **1a** as side product. It was found that inorganic bases performed well as compared to organic bases. However, on addition of KI (0.75 equiv.), the dehalogenation product decreases and yield of **2a** increased to 58%. On further increasing the quantity of KI from 0.75 to 1.5 equiv., the yield reached up to 65% (Table 1, entries 6–7). Inspired by this, we have also tried other additives to enhance the yield of **2a** i.e., LiI and LiCl (Table 1, entries 8–9). It was found that LiCl was equally compatible as that of KI. Furthermore, on increasing the equivalency of base from 2 to 2.5, the desired quinazolinone **2a** was formed in 75%. Moreover, on increasing the catalyst quantity up to 5 mol%, the yield of product **2a** increased to 84% (Table 1, entry 11). Curiously, various polar and non-polar solvents (DMF, xylene, PEG-400 and NMP) systems were also tested for the same reaction and it was observed that polar solvents such as DMF procured product in 70% yield than non-polar solvents (Table 1, entries 12–15). To study the effect of temperature, we stirred the reaction at 120 and 140 °C. We obtained 42% yield of **2a** at 120 °C while slight decrease in yield at 140 °C was noticed (Table 1, entries 16–17). We have

also scrutinized the equivalency of CO source and other CO surrogates. However, we have found that on decreasing the equivalency of oxalic acid to 4 equiv., the yield of **2a** decreased to 30% (Table 1, entry 18). Furthermore, on substituting oxalic acid with formic acid and paraformaldehyde, the desired quinazolinone **2a** was formed in traces (Table 1, entries 19–20). However, we didn't observe formation of **2a** in absence of oxalic acid (Table 1, entry 21). Interestingly, other homogeneous and heterogeneous catalysts were also examined, and we noticed that Pd@PS also resulted the product **2a** in 82% yield and found to be in harmonious with developed reaction conditions (Table 1, entries 22–24). Hence, **1a** (1 equiv.), Pd/C (5 mol%), K_3PO_4 (2.5 equiv.), KI (1.5 equiv.) in DMSO (inner vial) and oxalic acid (6 equiv.) in DMF (outer vial) were found to be most suitable conditions for the synthesis of targeted 2-arylquinazolinones.

Intriguingly, other ammonium surrogates or nitrogen components and their equivalency were also searched to get maximum yield of desired 2-arylquinazolinone **2a**. In order to check the effect of various ammonia sources on synthesis of **2a**, we have tested various ammonia components such as $(NH_4)_2CO_3$, NH_4HCO_3, CH_3COONH_4, $HCOONH_4$, urea and aq. NH_3, results summarized in Table 2. Fortunately, we obtained 81% yield of desired quinazolinone **2a** on employing ammonium carbonate as ammonia source (Table 2, entry 1). Furthermore, other ammonia sources also furnished the product in moderate to good yields of **2a** i.e. 35–63% (Table 2, entries 2–6). Further, we have also checked the equivalency of ammonium carbamate compatible for synthesis of desired product in maximum yield. On decreasing the equivalency of ammonia source to 2 equiv., the yield of **2a** reduced to 42% (Table 2, entry 8). We have observed that 3 equiv. of ammonium carbamate was sufficient to obtain **2a** in maximum yield. Hence, ammonium carbamate or ammonium carbonate was found to be the best suitable ammonia source for the synthesis of 2-aryl quinazolinones.

Table 2. Optimization of NH_3 sources for 2-arylquinazolinones synthesis.



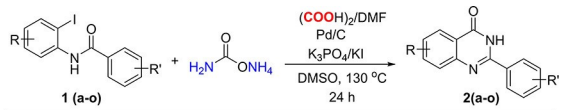
S.No.	Ammonia source (equiv.)	Yield of **2a** (%)[a]
1	$(NH_4)_2CO_3$ (3)	81
2	NH_4HCO_3 (3)	45
3	CH_3COONH_4 (3)	60
4	$HCOONH_4$ (3)	35
5	NH_2CONH_2 (3)	57
6	aq. NH_3 (3)	63
7	NH_2COONH_4 (3)	84
8	NH_2COONH_4 (2)	42

Reaction conditions: **1** (1 equiv.), ammonia source (3 equiv.), 5 wt% Pd/C (5 mol%), K_3PO_4 (2.5 equiv.), KI (1.5 equiv.), DMSO (1.5 mL); Outer Vial: Oxalic acid (6 equiv.) in DMF (0.5 mL) stirred at 130 °C for 24 h; [a] Isolated yield; [b] 30% aq. solution of NH_3

With intend to examine the generality and applicability of the developed strategy, we scrutinized diversely substituted *N*-(2-iodophenyl)benzamide or 2-iodoacetanilides for the synthesis of corresponding quinazolinones under optimal reaction conditions, results tabulated in Table 3. Initially, we have selected electron donating substrates e.g. *N*-(2-iodophenyl)-4-methylbenzamide (**1b**) and *N*-(2-iodophenyl)-4-propylbenzamide (**1c**) for cascade aminocarbonylation and cyclization under set reaction conditions and obtained respective substituted quinazolinone, **2b** and **2c** in good yields i.e. 73–75% respectively. However, on applying ammonium carbonate as ammonia component not much deviation in yield was observed. In the similar lines, in order to check the electronic and steric effect, we have also attempted 4-OMe, 3-OMe (**1d** and **1e**) and 2-OMe substituted substrates to get respective quinazolinones. We obtained 65% yield of 4-OMe (**2d**) product and 71% yield of product in case of 3-OMe (**2e**), while we ended up with complex reaction mixture in case of *ortho*-substituted compound. This difference in the yield of products might be due to electronic and steric factors respectively. Interestingly, reaction of **1d** in presence of ammonium carbonate as ammonia component resulted in slightly higher yield i.e., 68% yield. However, in case of di-methoxy substitution (**1f**), we got moderate yield of the product **2f**. Thereafter, we have attempted 4-F and 4-Cl halogen substrates (**1g** and **1h**) and obtained corresponding products **2g** and **2h** in good yields i.e. 70–72%. However, we have not noticed any change in the yield of product **2g** in case of ammonium carbonate. Then, we shifted our focus towards thiophene substituted compound **1i** and the reaction also ended with desired quinazolinone product **2i** in 69% yield. In pursuit to expand more substrate scope, *N*-(2-iodo-4-methylphenyl)benzamide (**1j**) delivered **2j** in 74% yield. Encouraged by these results, halogen substituted compounds (**1k–n**) were also targeted for synthesis of substituted 2-arylquinazolinones. We obtained moderate to good yields of products **2k–m** in case of 4-F, 4-Cl and 4-Br substituents. However, in case of 5-Cl substituted compound, we obtained excellent yield of product **2n** in 77% yield and 75% yield with ammonium carbonate.

Furthermore, electron withdrawing substrate *i.e.*, methyl 4-benzamido-3-iodobenzoate (**1o**) resulted the desired 2-arylquinazolinone in appreciable yield but somewhat lower yield in case of ammonium carbonate as ammonium component. To further check the effect of developed strategy on di-substituted compounds, we checked *N*-(2-iodo-4-methylphenyl)-4-methylbenzamide (**1p**) and *N*-(4-fluoro-2-iodophenyl)-4-methylbenzamide (**1q**) under set reaction conditions. Fortunately, the respective substrates procured the desired products in 60 and 68% yields respectively. Intriguingly, *N*-(2-iodophenyl)-2-phenylacetamide (**1r**) was also subjected for the synthesis of quinazolinones, but we obtained the product in 42% yield. Although, application of ammonium carbonate didn't change in the yield of desired product. Furthermore, substrate with longer carbon chain length i.e., *N*-(2-iodophenyl)-3-phenylpropanamide was also attempted but delivered the anticipated quinazolinone in very low yield.

Table 3. Substrate scope for 2-arylquinazolinones synthesis.



S.No.	1	Product	Yield(%)
1	**1b**, R= -H, R'= 4-CH_3	**2b**	75 (74)
2	**1c**, R= -H, R'= 4-propyl	**2c**	73 (71)
3	**1d**, R= -H, R'= 4-OCH_3	**2d**	65 (68)
4	**1e**, R= -H, R'= 3-OCH_3	**2e**	71
5	**1f**, R= -H, R'= 3, 4-OCH_3	**2f**	40
6	**1g**, R= -H, R'= 4-F	**2g**	70 (70)
7	**1h**, R= -H, R'= 4-Cl	**2h**	72
8	**1i**, R= -H, R'= -thiophene	**2i**	69 (65)
9	**1j**, R= 4-CH_3, R'= -H	**2j**	74 (75)
10	**1k**, R= 4-F, R'= -H	**2k**	62
11	**1l**, R= 4-Cl, R'= -H	**2l**	64
12	**1m**, R= 4-Br, R'= -H	**2m**	57
13	**1n**, R= 5-Cl, R'= -H	**2n**	77 (75)
14	**1o**, R= 4-COOMe, R'= -H	**2o**	63 (59)
15	**1p**, R= 4-CH_3, R'= 4-CH_3	**2p**	60 (62)
16	**1q**, R= 4-F, R'= 4-CH_3	**2q**	68
17	**1r**, R= -H, R'= -CH_2Ph	**2r**	42 (42)

Reaction conditions: [a] **1** (1 equiv.), ammonium carbamate (3 equiv.), 5 wt% Pd/C (0.05 equiv.), K_3PO_4 (2.5 equiv.), KI (1.5 equiv.), DMSO (1.5 mL); Outer vial: oxalic acid (6 equiv.) in DMF (0.5 mL) stirred at 130 °C for 24 h; Yield in parenthesis () represent isolated yield when $(NH_4)_2CO_3$ (3 equiv.) was used as ammonia source.

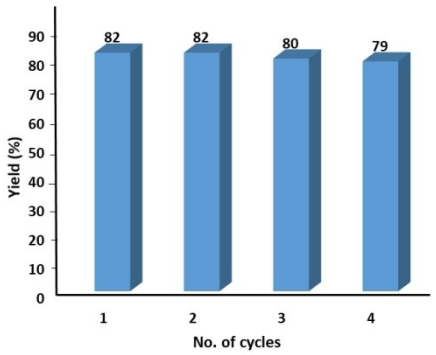
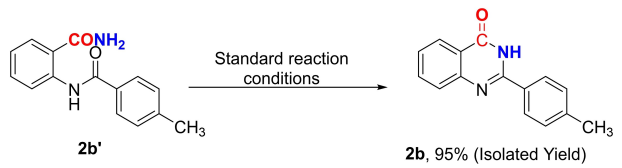


Figure 1. Recyclability testing of Pd/C catalyst using *N*-(2-iodophenyl) benzamide as model substrate under standard conditions.

Additionally, we have also carried out the gram scale reaction of *N*-(2-iodophenyl)-4-methylbenzamide (**1 b**, 1.350 g, 4 mmol) under standard reaction conditions and obtained the anticipated product **2 b** in 69% yield.

Moreover, the recyclability studies of the Pd/C catalyst were performed on compound **1 a** under optimized reaction conditions as shown in Figure 1. The recyclability experiments were carried out using *N*-(2-iodophenyl)benzamide (**1 a**) as model substrate under optimized reaction conditions. After completion of reaction, the reaction mixture was allowed to cool and Pd/C catalyst was separated using centrifugation technique. Afterwards, the catalyst was washed 3–4 times with distilled water and then with acetone or methanol to remove traces of organic contents. The catalyst was dried and further reused for next catalytic cycle. The Pd/C catalyst was found to be recyclable up to four consecutive runs without significant decrease in catalytic activity. Additionally, true heterogeneous nature of the Pd/C catalyst was also revealed by Hg poisoning and hot filtration tests (ESI).

During the reaction, we have successfully detected intermediate **2b'** and isolated through column chromatography. We have characterized **2b'** through NMR and ESI-MS techniques (ESI). Further, we subjected intermediate **2b'** for cyclization under set reaction conditions to gain the insight of mechanism. Fortunately, we obtained the desired quinazolinone **2 b** in 95% isolated yield, validating the cascade aminocarbonylation and



Scheme 2. Control Experiment.

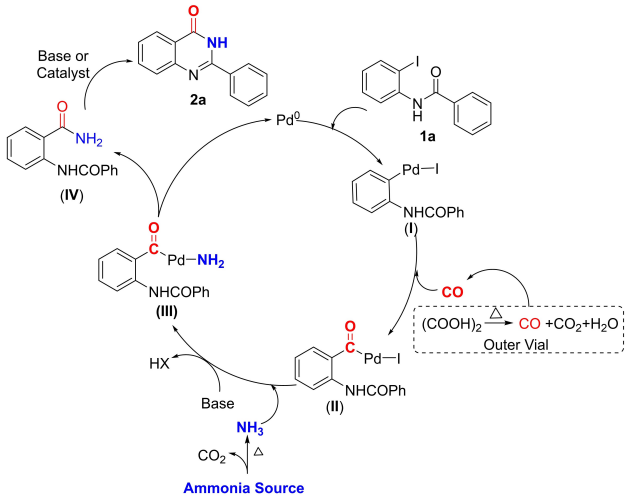


Figure 2. Plausible reaction mechanism for 2-arylquinazolinones synthesis.

cyclization pathway for the developed methodology (Scheme 2).

Based upon the control experiment and literature reports, the plausible reaction mechanism was proposed for the synthesis of 2- arylquinazolinones (**2 a**) from 2-iodoacetanilides (**1 a**) under Pd/C catalyzed conditions, illustrated in Figure 2. Initially, oxidative addition took place on palladium through insertion of C–X bond of **1 a** to give intermediate (**I**).[17] Subsequently, intermediate (**I**) converted to acyl palladium intermediate (**II**) via CO insertion which was released due to the decomposition of oxalic acid under thermal conditions. Similarly, ammonium carbamate/ ammonium carbonate also generated ammonia easily under set reaction conditions during the reaction. Consequently, under the assistance of base, simultaneous nucleophilic metalloamination and dehydrohalogenation took place and afforded the intermediate (**III**).[15c] Thereafter, intermediate (**III**) procured intermediate (**IV**) through reductive elimination which on simultaneous cyclization via condensation in the presence of base or catalyst gave final product **2 a**.[10]

Conclusion

In conclusion, we have demonstrated an efficient strategy for the synthesis of 2-arylquinazolinones from 2-iodoacetanilides under recyclable and heterogeneous Pd/C catalytic conditions using oxalic acid as CO and ammonium carbamate or ammonium carbonate as NH_3 source. Herein, we have simultaneously employed two gaseous components for the synthesis of heterocycles under operationally simple and bench stable conditions. Both CO and NH_3 sources are solid, economic, sustainable and decompose thermally under optimized reaction conditions without any additive or reagent. Following this method, we have successfully synthesized diverse range of 2-arylquinazolinones in considerably good yields. The developed protocol showed diverse range of functional group tolerance. Additionally, the Pd/C catalyst was found to be recyclable up to four consecutive cycles without significant reduction in catalytic activity.

Experimental Section

All the reactions were carried out by using Double-Vial (DV) system consisting of inner-Vial of 2 mL and outer-Vial of 5 mL and a PTFE solid black cap. In the inner-Vial of DV system, *N*-(2-iodophenyl) benzamide (50 mg, 0.154 mmol), ammonium carbamate (35 mg, 0.46 mmol) or ammonium carbonate (0.46 mmol, 44.5 mg), K_3PO_4 (82 mg, 0.38 mmol), KI (38 mg, 0.23 mmol) and DMSO were added while outer-Vial was charged with oxalic acid (0.92 mmol) in 0.5 mL DMF. After the completion of addition, the inner-Vial was placed carefully inside the outer-Vial having oxalic acid. The whole system was closed by tightening with a solid PTFE faced cap and Teflon tape. The system was further stirred in an oil bath heated at 130 °C for the required time. The progress of the reaction was monitored by TLC and after completion of the reaction, the inner-Vial was removed. The contents of the inner-Vial were transferred to a separatory funnel. Next, water was added to the reaction mixture and extracted with ethyl acetate. The combined organic layer was dried over anhydrous Na_2SO_4 and concentrated under reduced pressure. The crude mixture was further purified by silica gel (60:120 mesh) column chromatography using hexane:ethyl acetate (85:15) as the eluent, affording **2 a** as a white solid (29 mg, 84%); ^{1}H (600 MHz, DMSO-*d6*), δ (ppm) 7.51–7.61 (m, 4H), 7.76 (d, J= 8.0 Hz, 1H), 7.789–7.85 (m, 1H), 8.16-8.20 (m, 3H), 12.56 (s, 1H); ^{13}C (150 MHz, DMSO-*d6*) δ (ppm) 121.46, 126.32, 127.05, 127.98, 128.23, 129.07, 131.85, 133.15, 135.07, 149.21, 152.77, 162.70. ESI-MS calculated m/z calcd. for $C_{14}H_{11}N_2O^+$ $[M+H]^+$ 223.0866, found 223.0871.

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Conflict of Interest

The authors declare no conflict of interest.

Keywords: Aminocarbonylation · cascade cyclization · heterogeneous catalysis

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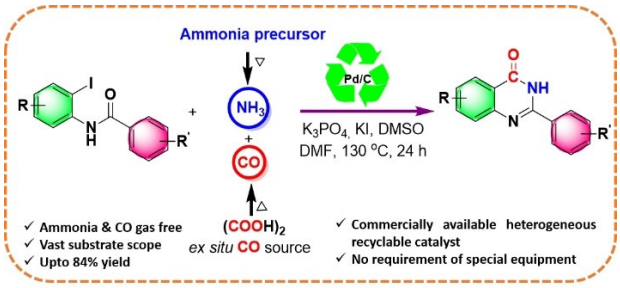

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Cascade synthesis: An efficient and straightforward approach has been demonstrated for 2-aryl quinazolinones synthesis from 2-iodoacetanilides via cascade aminocarbonylation and cyclization using ammonium carbamate or carbonate and oxalic acid as bench stable gaseous precursors under heterogeneous and recyclable Pd/C catalyzed conditions.