



Highly regioselective three-component palladium-catalyzed synthesis of 5-vinyloxazolidin-2-ones from 2,3-allenyl amines, organic iodides, and carbon dioxide

Suhua Li^a, Juntao Ye^a, Weiming Yuan^b, Shengming Ma^{a,b,*}

^a State Key Laboratory of Organometallic Chemistry, Shanghai Institute of Organic Chemistry, Chinese Academy of Sciences, 345 Lingling Lu, Shanghai 200032, PR China

^b Shanghai Key Laboratory of Green Chemistry and Chemical Process, Department of Chemistry, East China Normal University, 3663 North Zhongshan Lu, Shanghai 200062, PR China

ARTICLE INFO

Article history:

Received 23 August 2013

Received in revised form 24 September 2013

Accepted 27 September 2013

Available online 3 October 2013

Keywords:

Allenes

Carbon dioxide

Oxazolidinone

Organic iodides

Palladium

ABSTRACT

A highly regioselective Pd(0)-catalyzed synthesis of 5-vinyloxazolidin-2-ones from 2,3-allenic amines, organic iodides, and CO₂ under mild conditions has been developed.

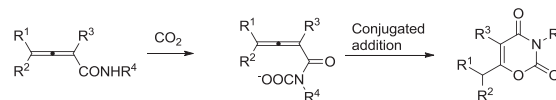
© 2013 Elsevier Ltd. All rights reserved.

1. Introduction

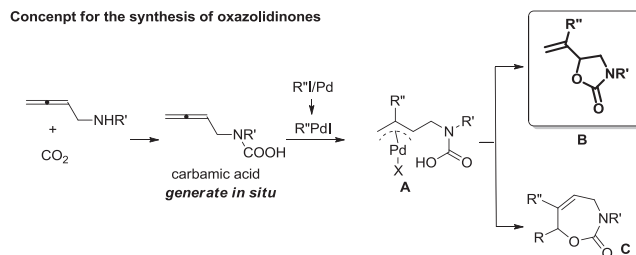
During the last 10 years, more and more attention has been paid to the study on CO₂-activation for the environmental reasons and its abundant, inexpensive, nontoxic, and environmentally benign feature as a C₁ synthon.¹ Challenges are its thermodynamic and kinetic stability. However, amines can readily react with CO₂ to form carbamic acid easily (Scheme 1).^{2–8} On the other hand, oxazolidin-2-ones are an important class of compounds that are widely used in organic synthesis and pharmaceutical industry (Scheme 2).⁹ Recently, we developed an efficient method for the synthesis of 1,3-oxazine-2,4-diones from CO₂ and 2,3-allenamides (Scheme 1).^{8a} On the basis of this work, we envisioned that 5-vinyloxazolidin-2-one **2** may be accessed from carbamic acid in situ generated from 2,3-allenic amine **1** and CO₂ in the presence of palladium catalyst and organic iodides (Scheme 1). However, there may be a challenge in this transformation: both five- and seven-membered ring may be formed

via carboxylic anion attack at the π-allylic palladium moiety. Herein, we would like to report a highly regioselective synthesis of 5-vinyloxazolidin-2-ones via a palladium-catalyzed cyclization of 2,3-allenic amines with organic iodides and CO₂ under mild conditions.

Our previous work

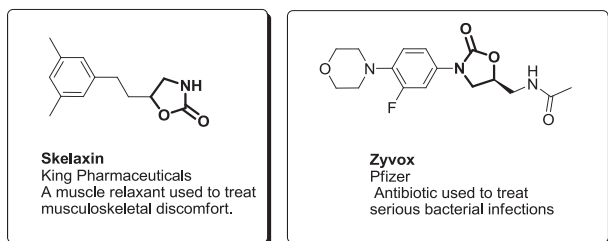


Concept for the synthesis of oxazolidinones



Scheme 1. Previous work and our concept for the synthesis of oxazolidinones **B**.

* Corresponding author. Tel./fax: +86 21 62609305; e-mail address: masm@sioc.ac.cn (S. Ma).



Scheme 2. Best-selling drugs bearing the oxazolidin-2-one substructure.

2. Results and discussion

Initially, 2,3-butadienyl benzyl amine **1a** was chosen to test the feasibility of our hypothesis. Gratifyingly, our expected product 5-vinylloxazolidin-2-one **2aa** was obtained in 77% NMR yield by using 5 mol % of Pd(PPh₃)₄, 1.2 equiv of PhI, and 2.0 equiv of K₂CO₃ in DMF at 80 °C in the presence of a CO₂ balloon (Table 1, entry 1). Encouraged by this result, optimization on the reaction conditions was carried out subsequently. As shown in Table 1, DMSO is superior to other solvents such as THF, toluene, and CH₃CN (entries 5–8) while comparable to DMF (entries 2 and 5). Reducing the base or catalyst loading led to a decrease in the NMR yield of **2aa** (entries 9 and 10). Interestingly, a 45% yield of **2aa** was obtained when the reaction was carried out in the absence of external CO₂ (entry 11), where the CO₂ may come from the decomposition of the in situ generated KHCO₃ formed from K₂CO₃ and HI. Thus, 2,3-allenic amine reacting with 5 mol % of Pd(PPh₃)₄, 1.2 equiv of PhI, and 2.0 equiv of K₂CO₃ in DMSO with a balloon of CO₂ at 70 °C was established as the standard conditions of this reaction.

Table 1
Optimization of reaction conditions^a

Entry	Solvent	Temp (°C)	Time (h)	Yield of 2aa ^b (%)
1	DMF	80	8	77
2	DMF	70	9.5	94
3	DMF	60	14.5	92
4	DMF	50	14.5	86
5	DMSO	70	8	96
6	THF	70	8	34 ^c
7	Toluene	70	14	40
8	CH ₃ CN	70	13	62
9 ^d	DMSO	70	10	86
10 ^e	DMSO	70	10	89
11 ^f	DMSO	70	6.7	45

^a The reaction was carried out with 0.3 mmol of **1a**, 0.36 mmol of PhI, 0.6 mmol of K₂CO₃, 0.015 mmol of Pd(PPh₃)₄, and a balloon of CO₂ (about 1 L) in 2 mL of the indicated solvent at the indicated temperature.

^b NMR yield.

^c Compound **1a** (12%) was recovered.

^d K₂CO₃ (1 equiv) was used.

^e Pd(PPh₃)₄ (2 mol %) was used.

^f The reaction was carried out in the absence of the CO₂ balloon.

With the optimized conditions in hand, the scope of the organic iodides was first examined and results are summarized in Table 2. As can be seen in Table 2, different types of organic iodide, including aryl iodides with electron-donating group (entries 2–7) or electron-withdrawing group in the phenyl ring (entries 8–12), heteroaryl iodide (entry 15), and vinyl iodides (entries 16 and 17) are compatible with the reaction. It's noteworthy that aryl iodides with an acidic free OH are also tolerable under the reaction conditions (entries 13 and 14). To check the practicality, this reaction

Table 2
The reaction of **1a** with organic iodides^a

Entry	R	Time (h)	Product	Yield of 2 ^b (%)
1	Ph	8	2aa	91
2	<i>p</i> -MeC ₆ H ₄	5	2ab	92
3	<i>m</i> -MeC ₆ H ₄	11	2ac	81
4	<i>p</i> -MeOC ₆ H ₄	4	2ad	93
5	<i>p</i> - ^t PrC ₆ H ₄	3.5	2ae	94
6	3,4-Me ₂ C ₆ H ₃	3	2af	82
7	3,4-(OCH ₂ CH ₂ O)C ₆ H ₃	3.5	2ag	84
8	<i>p</i> -AcC ₆ H ₄	5	2ah	82
9	<i>p</i> -FC ₆ H ₄	8	2ai	91
10	<i>p</i> -F ₃ CC ₆ H ₄	11	2aj	85
11	<i>p</i> -EtOCC ₆ H ₄	7	2ak	86
12	<i>p</i> -NO ₂ C ₆ H ₄	4	2al	72
13	<i>p</i> -HOCC ₆ H ₄	3.2	2am	73
14	<i>p</i> -HOCC ₆ H ₄	11	2an	78 ^c
15	3-Thienyl	4	2ao	94
16	(<i>E</i>)-1-Hexenyl	7	2ap	82
17	Cinnamenyl	3.5	2aq	83

^a The reaction was carried out with 0.3 mmol of **1a**, 0.36 mmol of RI, 0.6 mmol of K₂CO₃, 0.015 mmol of Pd(PPh₃)₄, and a balloon of CO₂ (about 1 L) in 2 mL of DMSO at 70 °C.

^b Isolated yield after column chromatography unless otherwise indicated.

^c Yield after column chromatography and recrystallization.

was scaled up to 1 g (6.5 mmol) affording **2aa** in 94% yield [Eq. 1]. The structure of the product was confirmed unambiguously by X-ray diffraction study of **2ab** (Fig. 1).¹⁰

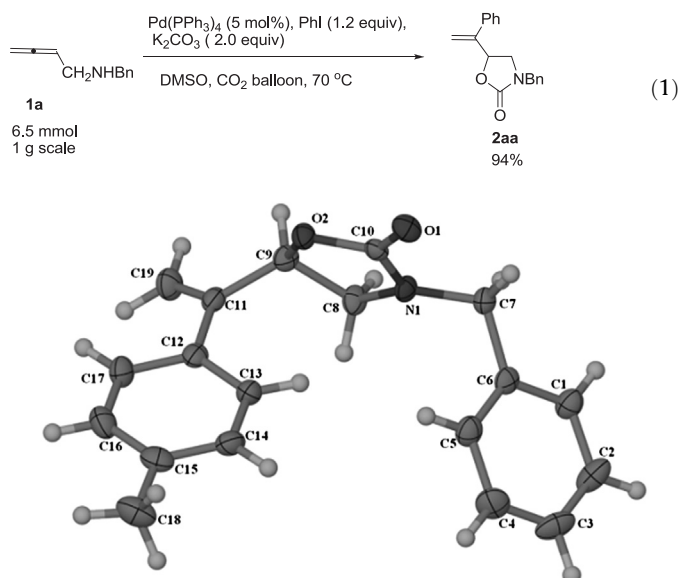


Fig. 1. ORTEP representation of **2ab**.

Further study leads to the observation that the basicity of 2,3-allenic amines is crucial to the reaction. The PMB-protected 2,3-allenic amine **1b**, which has a similar basicity with benzyl-protected **1a**, produced **2ba** in 88% yield (Table 3, entry 1). While the less basic phenyl-protected 2,3-allenic amine **1c** was less effective (Table 3, entry 2), thus, a stronger base Cs₂CO₃ was required to afford the product **2ca** in 55% yield (Table 3, entry 3).

Download English Version:

<https://daneshyari.com/en/article/5217497>

Download Persian Version:

<https://daneshyari.com/article/5217497>

[Daneshyari.com](https://daneshyari.com)