Article ID: 1001-3555(2015)02-0103-08

Lewis acid-Catalyzed Difunctionalization of Enol Ethers with Aminals and Alcohols to β-Amino Acetals

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Abstract: We have developed a Lewis acid catalyzed three-component reaction of enol ethers, aminals and alcohols. The reaction system can provide a facile one-step access to β-amino acetals from simple aminals, enol ethers and alcohols under mild conditions.

Key words: Lewis acid; enol ethers; aminals; alcohols; β-amino acetals; three-component reaction.

CLC number: O643.32 **Document code**: A

β-Amino aldehydes are crucial structural motifs that exist in numerous natural products and drug candidates possessing interesting biological activities[1-4]. Consequently, extensive efforts have been devoted to the development of rapid and efficient methods toward these compounds. Currently, the most common approaches for the synthesis of β-amino aldehydes rely primarily on selective reduction of amino acid derivatives or selective oxidation of amino alcohols[5-7]. However, the synthesis of the precursors of amino acid derivatives is often multi-step and inconvenient, and the controlling of the selectivities of oxidation and reduction is also a challenging task. Moreover, β-amino aldehydes usually have the tendency of polymerization, self-condensation, or elimination of the β-amino group under the conditions used for their preparation[8]. Given the importance of β-amino aldehydes in the synthesis of bioactive molecules, a general and practical protocol access to these molecules is highly desirable.

β-Amino acetals could be facilely transformed into β-amino aldehydes through hydrolysis under mild conditions, which could be viewed as surrogates of β-amino aldehydes[9]. Thus, the development of efficient methods for the synthesis of β-amino acetals would be an alternative access to β-amino aldehydes. In general, β-amino acetals are prepared by substitution of halogen substituted acetals with amines in the presence of base (Scheme 1a)[10-11]. However, the difficult preparation of halogenated acetals limits the substrate scope. On the other hand, transition-metal-catalyzed conjugated addition of dialkylzinc reagents to nitroalkenes and subsequent reduction provides another way to these compounds (Scheme 1b)[12]. However, the usage of a large quantity of organometallic reagents limits the applications of these synthetic processes. Therefore, further developments appear to be desired.

Recently, our research group has developed an efficient protocol for the synthesis of a wide range of β-amino acetals via palladium-catalyzed difunctionalization of enol ethers with aminals and alcohols[13]. Inspired by these results and in connection with our interest in the C-N activation[14-18], herein we report a practical and efficient approach to β-amino acetals using readily available Lewis acid as the catalyst via a three-component reaction of enol ethers with aminals and alcohols (Scheme 1c).

Received date: 2015-04-02; **Revised date**: 2015-04-16.

Foundation: 21222203, 21172226 and 21133011.

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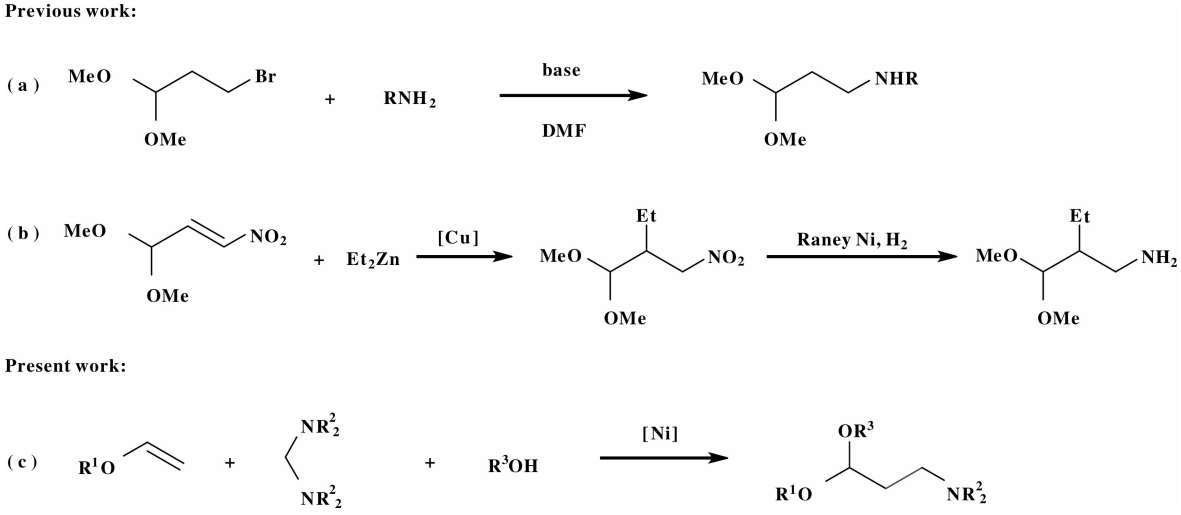


Scheme 1 Strategies for the synthesis of β-amino acetals

1 Experimental

1.1 General experiment

All non-aqueous reactions and manipulations were performed in a nitrogen atmosphere using standard Schlenk techniques. All solvents before use were dried and degassed by standard methods and stored under nitrogen. All reactions were monitored by TLC with silica gel-coated plates. NMR spectra were recorded on Bruker Avance III (400 MHz) spectrometers. Chemical shifts were reported in parts per million (ppm) down field from TMS with the solvent resonance as the internal standard. Coupling constants (J) were reported in Hz and referred to apparent peak multiplications. Enol ethers used here were known compounds and purchased from Alfa Aesar. Aminals used in the experiments were known compounds and synthesized according to the reported methods[13].

1.2 General procedure for the reaction

Enol ether (0.8 mmol), aminal (0.4 mmol), alcohol (4.0 mmol), $NiCl_2$ (0.04 mmol, 10%), toluene (1.5 mL) were added to a 25 mL flame-dried Young-type tube under nitrogen atmosphere. Then, the resulting mixture was stirred at 110 ℃ for 12 hours. After reaction solution was cooled to the room temperature, solvent was removed under reduced pressure; the residue was purified by flash column chromatography on silica gel using a mixture of ethyl acetate and petroleum ether (100∶1 ~ 1∶1) as the eluent to afford the desired product.

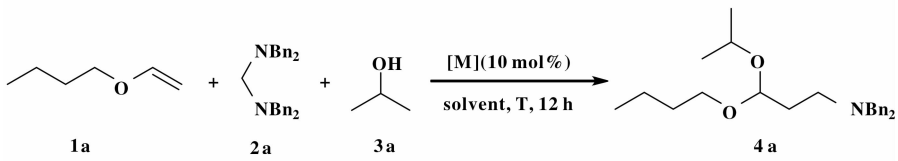
2 Results and discussion

2.1 Optimization of reaction conditions

With these considerations in mind, our initial work focused on the model reaction of 1-(vinyloxy)butane (**1a**) with *N*,*N*,*N*',*N*'-tetrabenzylmethanediamine (**2a**) and 2-PrOH (**3a**) to optimize the reaction conditions. The results are summarized in Table 1. It was observed that most of the Lewis acid catalysts such as $FeCl_3$, $AlCl_3$, $ZnCl_2$, $CuBr_2$, $Sc(OTf)_3$ and $NiCl_2$ could successfully promote the reaction, more than 30% yields were isolated for the desired products (Table 1, entries 1-7). To our delight, $NiCl_2$ showed to be the most efficient affording the product in 84% yield (Table 1, entry 7). A series of other nickel catalysts such as $Ni(OAc)_2$, $NiBr_2$, Ni_2SO_4, $Ni(acac)_2$ were also evaluated, but they exhibited lower reactivity compared with $NiCl_2$ (Table 1, entries 8-11). Virtually, the reaction almost could not occur when using $Ni(acac)_2$ as the catalyst (Table 1, entry 11). The effects of the temperature on the reaction were also investigated (Table 1, entries 12-14). When the reaction temperature was below 110 ℃, the yields reduced significantly, and only a trace amount of the desired product was obtained at 40 ℃ (Table 1, entry 14). Conducting the reaction in polar solvents (CH_3CN,

DCM, dioxane and THF) gave the desired products in lower yields (Table 1, entries 15-19). Control reactions demonstrated that only trace amount of amino acetal **4a** was obtained in the absence of nickel catalyst, which showed that the nickel catalyst was necessary for promoting this reaction smoothly (Table 1, entry 20).

Table 1 Optimization of the reaction conditions [a]



1a　　2a　　3a　　4a

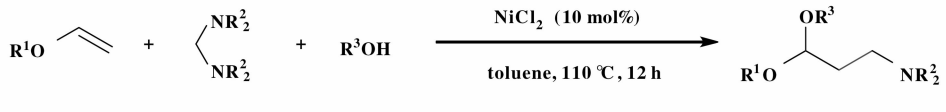
Entry	Catalyst	Solvent	T/℃	Yield/% [b]
1	$FeCl_3$	toluene	110	30
2	$AlCl_3$	toluene	110	72
3	$ZnCl_2$	toluene	110	73
4	$CuBr_2$	toluene	110	64
5	$Bi(OTf)_3$	toluene	110	trace
6	$Sc(OTf)_3$	toluene	110	64
7	$NiCl_2$	toluene	110	84
8	$Ni(OAc)_2$	toluene	110	60
9	$NiBr_2$	toluene	110	75
10	$NiSO_4$	toluene	110	61
11	$Ni(acac)_2$	toluene	110	trace
12	$NiCl_2$	toluene	80	49
13	$NiCl_2$	toluene	60	35
14	$NiCl_2$	toluene	40	trace
15	$NiCl_2$	CH_3CN	110	30
16	$NiCl_2$	DCM	110	54
17	$NiCl_2$	THF	110	66
18	$NiCl_2$	dioxane	110	78
19	$NiCl_2$	xylene	110	66
20	–	toluene	110	trace

a. Reaction conditions: **1a** (0.8 mmol), **2a** (0.4 mmol), **3a** (4.0 mmol), [M] (0.04 mmol, 10 mol%), solvent (1.5 mL), N_2, 12 h; b. Isolated yield.

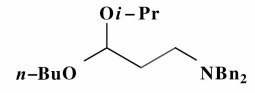
2.2 Substrate scope of enol ethers, aminals, and alcohols

With the optimized conditions in hand, the scope of the enol ethers, aminals, and alcohols was investigated (Table 2). Alkyl vinyl ethers **1a-1e** could be smoothly transformed into the desired products in good to excellent yields. Particularly, the long-chain dodecyl vinyl ether **1d** gave the product **4d** in good yield under the current reaction conditions. However, cyclic vinyl ethers such as 2,3-dihydrofuran (**1f**), 3,4-dihydro-2H-pyran (**1g**) and N-Boc-2,3-pyrroline (**1h**) did not work in this procedure. In fact, cyclic vinyl ethers (**1f**, **1g**, **1h**) could be smoothly transformed into the corresponding products in the presence of palladium catalyst[13], which indicated that this reaction mechanism was entirely different from that of palladium-catalyzed reaction.

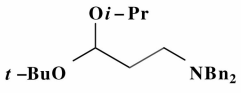
Table 2 Substrate scope of Ni-catalyzed reaction of enol ethers with aminals and alcohols [a]



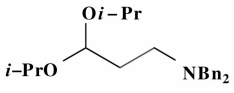
1 2 3 4



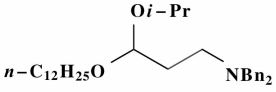
4a, 84%



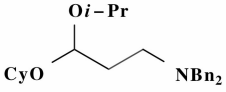
4b:4c (34:66)[b], 63%



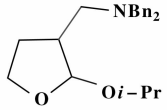
4c, 80%



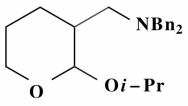
4d, 84%



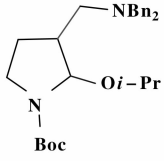
4e, 70%



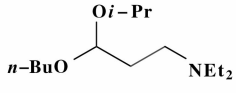
4f, trace



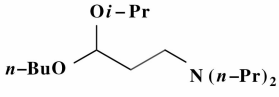
4g, trace



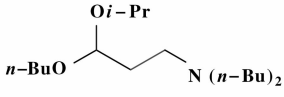
4h, trace



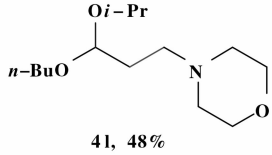
4i, 31%



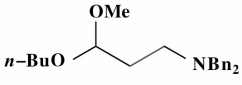
4j, 67%



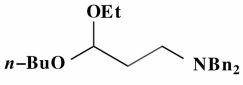
4k, 40%



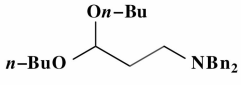
4l, 48%



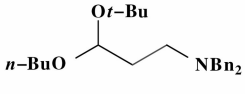
4m, 74%



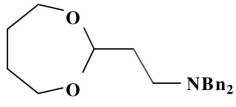
4n, 78%



4o, 88%



4p/4o (89:11)[b], 91%



4q, 53%[c]

a. Reaction conditions: **1** (0.8 mmol), **2** (0.4 mmol), **3** (4.0 mmol), and $NiCl_2$(0.04 mmol), toluene (1.5 mL), N_2, 110 ℃, 12 h; Isolated yield; b. The ratio was determined by ^1H NMR; c. 24 h

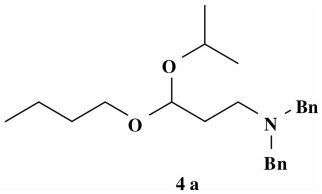
Several aminals derived from diethylamine, dipropylamine, dibutylamine and morpholine were effective substrates, providing products **4i-4l** in moderate to good yields. As for the aminal derived from diethyl amine, the result was disappointing, which gave a moderate yield. To our delight, the reaction of 1-(vinyloxy)butane (**1a**) with the aminal derived from morpholine could also run smoothly, giving the desired product in 48% yield.

Subsequently, several alcohols including MeOH, EtOH, *n*-BuOH and *t*-BuOH were investigated. To our delight, all the alcohols investigated here could be successfully transformed into the desired products in good to excellent yields. In addition, the larger sterically hindered *t*-BuOH reacted successfully with 1-(vinyloxy)butane (**1a**) and aminal (**2a**), affording a mixture of **4p** and **4o** in 91% yield. Furthermore, the challenging 4-(vinyloxy)butan-1-ol could also be ap-

plied to this difunctionalization reaction in the absence of alcohols, producing the desired product **4q** in good yield.

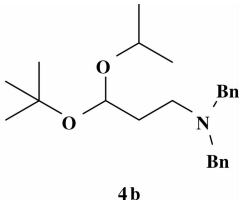
2.3 Experimental characterization data for products

All the products are known compounds and the structures of them are characterized by NMR. The data for the products have been listed below.



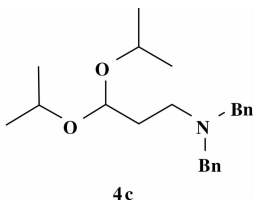
4a

***N*, *N*-dibenzyl-3-butoxy-3-isopropoxypropan-1-amine** (**4a**). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.34-7.35 (m, 4H), 7.27-7.31 (m, 4H), 7.19-7.23 (m, 2H), 4.55 (t, *J* = 5.6 Hz, 1H), 3.71-3.78 (m, 1H), 3.54 (s, 4H), 3.39-3.45 (m, 1H), 3.24-3.29 (m, 1H), 2.49-2.53 (m, 2H), 1.78-1.84 (m, 2H), 1.38-1.45 (m, 2H), 1.26-1.31 (m, 2H), 1.13 (d, *J* = 6.4 Hz, 3H), 1.00 (d, *J* = 6.0 Hz, 3H), 0.87 (t, *J* = 7.2 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 139.7, 128.8, 128.1, 126.7, 100.2, 68.4, 64.2, 58.3, 49.2, 31.9, 31.9, 23.3, 22.3, 19.3, 13.9.



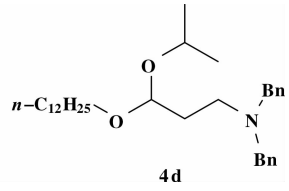
4b

***N*, *N*--dibenzyl-3-*tert*-butoxy-3-isopropoxypropan-1-amine** (**4b**) (**4b/4c = 34/66**). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.34-7.36 (m, 4H), 7.27-7.31 (m, 4H), 7.20-7.24 (m, 2H), 4.65 (t, *J* = 5.2 Hz, 0.34H), 4.56 (t, *J* = 5.2 Hz, 0.66H), 3.70-3.77 (m, 1.57H), 3.52-3.59 (m, 4H), 2.50-2.54 (m, 2H), 1.77-1.82 (m, 2H), 1.24 (d, *J* = 8.8 Hz, 1H), 1.15 (s, 3.20H), 1.11 (d, *J* = 6.0 Hz, 3.64H), 1.08 (d, *J* = 6.0 Hz, 1.09H), 1.00 (d, *J* = 6.1 Hz, 4.88H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 139.7, 139.7, 128.9, 128.8, 128.2, 128.1, 126.8, 126.8, 99.1, 95.3, 73.4, 67.7, 66.5, 58.4, 58.3, 57.7, 49.5, 49.4, 34.2, 33.2, 28.9, 28.0, 23.6, 23.4, 23.1, 22.6.



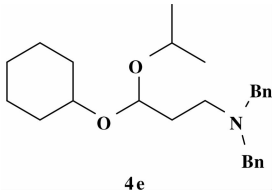
4c

***N*, *N*-dibenzyl-3, 3-diisopropoxypropan-1-amine** (**4c**). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.34-7.36 (m, 4H), 7.28-7.31 (m, 4H), 7.20-7.25 (m, 2H), 4.56 (t, *J* = 5.6 Hz, 1H), 3.69-3.78 (m, 2H), 3.55 (s, 4H), 2.53 (t, *J* = 6.8 Hz, 2H), 1.77-1.82 (m, 2H), 1.11 (d, *J* = 6.4 Hz, 6H), 1.00 (d, *J* = 6.0 Hz, 6H); ^{13}C NMR (100 MHz, $CDCl_3$) δ139.7, 128.9, 128.1, 126.8, 99.1, 67.7, 58.3, 49.4, 33.1, 23.3, 22.5.



4d

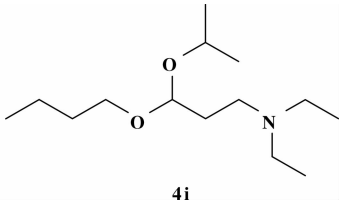
***N*,*N*-dibenzyl-3-(dodecyloxy)-3-isopropoxypropan-1-amine** (**4d**). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.34-7.36 (m, 4H), 7.26-7.31 (m, 4H), 7.20-7.23 (m, 2H), 4.55 (t, *J* = 5.6 Hz, 1H), 3.72-3.78 (m, 1H), 3.55 (s, 4H), 3.38-3.43 (m, 1H), 3.23-3.29 (m, 1H), 2.49-2.53 (m, 2H), 1.78-1.86 (m, 2H), 1.41-1.44 (m, 2H), 1.25 (s, 18H), 1.13 (d, *J* = 6.4 Hz, 3H), 1.00 (d, *J* = 6.0 Hz, 3H), 0.88 (t, *J* = 6.40 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 139.7, 128.9, 128.2, 126.8, 100.2, 68.5, 64.6, 58.3, 49.2, 32.0, 31.9, 29.9, 29.7, 29.7, 29.6, 29.5, 29.4, 26.2, 23.3, 22.7, 22.3, 14.2.



4e

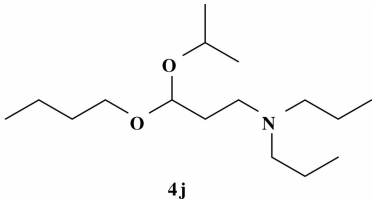
***N*, *N*-dibenzyl-3-(cyclohexyloxy)-3-isopropoxypropan-1-amine** (**4e**). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.34-7.36 (m, 4H), 7.27-7.31 (m, 4H), 7.20-7.25 (m, 2H), 4.59 (t, *J* = 5.2Hz, 1H), 3.72-3.78 (m, 1H), 3.55 (s, 4H), 3.36-3.41 (m, 1H), 2.53 (t, *J* = 7.2 Hz, 2H), 1.77-1.82 (m, 3H), 1.63-1.68 (m, 3H), 1.47-1.50 (m, 1H),

1.17-1.28 (m, 3H), 1.11-1.15 (m, 5H), 1.00 (d, J = 6.0 Hz, 3H), ^{13}C NMR (100 MHz, $CDCl_3$) δ 139.7, 128.9, 128.2, 126.8, 99.0, 73.7, 67.7, 58.4, 49.5, 33.5, 33.2, 32.8, 25.7, 24.4, 24.2, 23.4, 22.5.



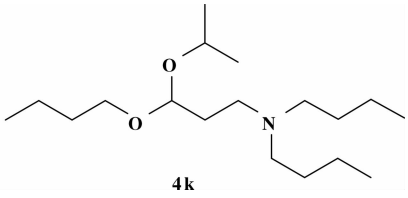
4i

3-butoxy-*N*, *N*-diethyl-3-isopropoxypropan-1-amine (**4i**). ^{1}H NMR (400 MHz, $CDCl_3$) δ 4.60 (t, J = 5.6 Hz, 1H), 3.84-3.90 (m, 1H), 3.51-3.57 (m, 1H), 3.40-3.46 (m, 1H), 2.49-2.54 (m, 6H), 1.68-1.82 (m, 2H), 1.51-1.58 (m, 2H), 1.34-1.43 (m, 2H), 1.19 (d, J = 6.0 Hz, 3H), 1.13 (d, J = 6.4 Hz, 3H), 1.02 (t, J = 7.2 Hz, 6H), 0.92 (t, J = 7.6 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 100.4, 68.4, 64.2, 48.2, 46.8, 32.0, 31.4, 23.3, 22.3, 19.4, 13.9, 11.7.



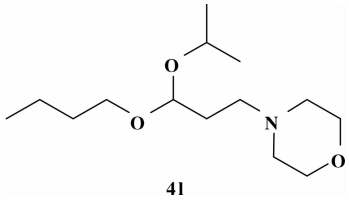
4j

3-butoxy-3-isopropoxy-*N*, *N*-dipropylpropan-1-amine (**4j**). ^{1}H NMR (400 MHz, $CDCl_3$) δ 4.61 (t, J = 6.0 Hz, 1H), 3.82-3.91 (m, 1H), 3.51-3.56 (m, 1H), 3.39-3.45 (m, 1H), 2.43-2.55 (m, 2H), 2.32-2.37 (m, 4H), 1.67-1.81 (m, 2H), 1.49-1.58 (m, 2H), 1.34-1.49 (m, 6H), 1.19 (d, J = 6.4 Hz, 3H), 1.13 (d, J = 6.4 Hz, 3H), 0.92 (t, J = 7.2 Hz, 3H), 0.87 (t, J = 7.2 Hz, 6H); ^{13}C NMR(100 MHz, $CDCl_3$) δ 100.4, 68.4, 64.2, 56.2, 49.6, 32.1, 31.7, 23.4, 22.3, 20.3, 19.5, 14.0, 12.0.



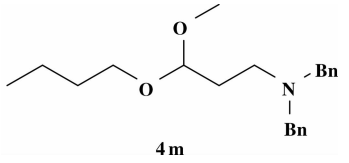
4k

***N*-(3-butoxy-3-isopropoxypropyl)-*N*-butylbutan-1-amine** (**4k**). ^{1}H NMR (400 MHz, $CDCl_3$) δ 4.61 (t, J = 5.6 Hz, 1H), 3.83-3.88 (m, 1H), 3.50-3.57 (m, 1H), 3.39-3.46 (m, 1H), 2.46-2.51 (m, 2H), 2.36-2.40 (m, 4H), 1.66-1.80 (m, 2H), 1.51-1.58 (m, 2H), 1.36-1.44 (m, 6H), 1.24-1.34 (m, 4H), 1.19 (d, J = 6.4 Hz, 3H), 1.13 (d, J = 6.0 Hz, 3H), 0.89-0.94 (m, 9H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 100.4, 68.4, 64.2, 53.9, 49.6, 32.1, 31.6, 29.3, 23.3, 22.3, 20.8, 19.5, 14.1, 13.9.



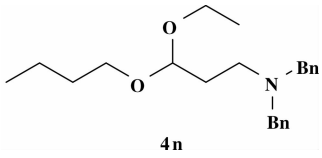
4l

4-(3-butoxy-3-isopropoxypropyl)morpholine (**4l**). ^{1}HNMR (400 MHz, $CDCl_3$) δ 4.62 (t, J =5.6 Hz, 1H), 3.80-3.90 (m, 1H), 3.69 (t, J = 4.4 Hz, 4H), 3.49-3.54 (m, 1H), 3.39-3.44 (m, 1H), 2.37-2.42 (m, 6H), 1.70-1.84 (m, 2H), 1.49-1.56 (m, 2H), 1.31-1.41 (m, 2H), 1.17 (d, J = 6.0 Hz, 3H), 1.11 (d, J = 5.6 Hz, 3H), 0.90 (t, J = 7.6 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 99.9, 68.5, 67.0, 64.2, 54.4, 53.7, 32.0, 31.3, 23.3, 22.2, 19.4, 13.9.



4m

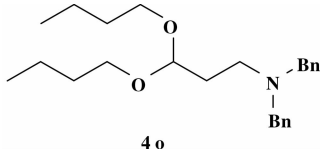
***N*, *N*-dibenzyl-3-butoxy-3-methoxypropan-1-amine** (**4m**). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.34-7.36 (m, 4H), 7.28-7.31 (m, 4H), 7.20-7.25 (m, 2H), 4.45 (t, J = 5.6 Hz, 1H), 3.55 (s, 4H), 3.44-3.49(m, 1H), 3.24-3.29 (m, 1H), 3.20 (s, 3H), 2.50 (t, J = 6.8 Hz, 2H), 1.78-1.83 (m, 2H), 1.41-1.48 (m, 2H), 1.27-1.33 (m, 2H), 0.88 (t, J = 7.2 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 139.7, 128.8, 128.1, 126.8, 102.4, 65.5, 58.4, 52.6, 49.0, 31.9, 30.9, 19.4, 13.9.



4n

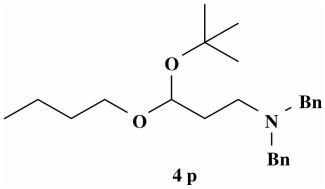
***N*, *N*-dibenzyl-3-butoxy-3-ethoxypropan-1-amine**

(**4n**). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.34-7.36 (m, 4H), 7.27-7.31 (m, 4H), 7.19-7.23 (m, 2H), 4.52 (t, J = 5.6 Hz, 1H), 3.44-3.58 (m, 6H), 3.24-3.37 (m, 2H), 2.49-2.53 (m, 2H), 1.80 (q, J_1 = 13.2 Hz, J_2 = 6.8 Hz, 2H), 1.40-1.47 (m, 2H), 1.24-1.34 (m, 2H), 1.09 (t, J = 7.2 Hz, 3H), 0.88 (t, J = 7.6 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 139.8, 128.9, 128.2, 126.8, 101.7, 65.3, 61.1, 58.4, 49.1, 32.0, 31.4, 19.4, 15.3, 14.0.



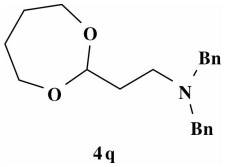
4o

***N*,*N*-dibenzyl-3,3-dibutoxypropan-1-amine** (**4o**). ^{1}H NMR (400MHz, $CDCl_3$) δ 7.33-7.36 (m, 4H), 7.27-7.30 (m, 4H), 7.19-7.22 (m, 2H), 4.50 (t, J = 5.6 Hz, 1H), 3.54 (s, 4H), 3.44-3.50 (m, 2H), 3.24-3.29 (m, 2H), 2.50 (t, J = 7.6 Hz, 2H), 1.80-1.85 (m, 2H), 1.40-1.47 (m, 4H), 1.24-1.34 (m, 4H), 0.88 (t, J = 7.6 Hz, 6H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 139.8, 128.9, 128.2, 126.8, 101.7, 65.3, 58.4, 49.1, 32.0, 31.3, 19.4, 14.0.



4p

***N*,*N*-dibenzyl-3-tert-butoxy-3-butoxypropan-1-amine** (**4p**) (**4p/4o = 89/11**). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.34-7.36 (m, 4H), 7.27-7.31 (m, 4H), 7.19-7.23 (m, 2H), 4.67 (t, J = 5.6 Hz, 0.89H), 4.22 (t, J = 5.6 Hz, 0.11H), 3.55 (s, 4H), 3.24-3.34 (m, 2H), 2.44-2.55 (m, 2H), 1.72-1.88 (m, 2H), 1.36-1.44 (m, 2H), 1.22-1.31 (m, 3H), 1.16 (s, 8H), 0.88-0.90 (m, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 139.7, 128.9, 128.2, 126.8, 95.9, 62.8, 58.3, 49.3, 32.6, 32.0, 28.8, 19.5, 14.0.



4q

***N*,*N*-dibenzyl-2-(1,3-dioxepan-2-yl) ethanamine** (**4q**). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.34-7.35 (m, 4H), 7.27-7.31 (m, 4H), 7.19-7.23 (m, 2H), 4.68 (t, J = 5.6 Hz, 1H), 3.76-3.79 (m, 2H), 3.55 (s, 4H), 3.47-3.51 (m, 2H), 2.52 (t, J = 6.8 Hz, 2H), 1.76-1.81 (m, 2H), 1.66-1.67 (m, 4H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 139.7, 128.8, 128.1, 126.7, 101.4, 66.0, 58.2, 49.1, 32.2, 29.2.

3 Conclusions

In conclusion, we have reported a facile method for the synthesis of β-amino acetals in high yields by a three-component reaction of enol ethers, aminals and alcohols using inexpensive $NiCl_2$ as the catalyst. The reaction proceeded smoothly and efficiently, affording a wide range of desired products in good to excellent yields under mild reaction conditions. On account of its great value in practical application, this study for the synthesis of β-amino acetals would be very valuable in the fields of academic research and bio-pharmaceutical. Further study focused on a deeper understanding of the reaction mechanism is currently underway in our laboratory.

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路易斯酸催化烯基醚与胺缩醛和醇反应合成β-氨基缩醛

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摘要: 发展了一种路易斯酸催化的烯基醚,胺缩醛和醇的3组分反应一步合成β-氨基缩醛的方法. 这一合成过程使用廉价的氯化镍作路易斯酸催化剂,反应条件温和,操作方便,得到的目标产物收率最高可达91%.

关键词: 路易斯酸; 烯基醚; 胺缩醛; 醇; β-氨基缩醛; 3组分反应