

A Novel Synthesis of N-Methyl-N-aryl Carbamates from Aromatic Amines and Dimethyl Carbonate Catalyzed by K_2CO_3/Bu_4NBr

Zhen Lu SHEN, Xuan Zhen JIANG*

Department of Chemistry, Zhejiang University, Hangzhou 310027

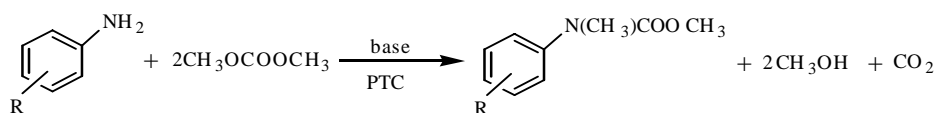
Abstract: A facile synthesis of N-methyl-N-aryl carbamates from aromatic amines and dimethyl carbonate (DMC) has been achieved with high yields in the presence of potassium carbonate (K_2CO_3) and tetrabutylammonium bromide (Bu_4NBr) under solvent-free conditions.

Keywords: Carbamate, aromatic amines, dimethyl carbonate, tetrabutylammonium bromide.

Organic carbamates and their derivatives are valuable intermediates in the production of dyestuffs, pharmaceuticals, herbicides, fungicides and insecticides^{1,2}. Initially N-methyl-N-aryl carbamates were almost synthesized exclusively by the reaction of N-methyl aromatic amines with chloroformate which was prepared from phosgene^{3,4}. While classical procedures for the preparation of N-methyl aromatic amines were based on mono-N-methylation of aromatic amines by dimethyl sulfate or methanol⁵. Now, N-methoxycarbonylation of aromatic amines with dimethyl carbonate instead of chloroformate and mono-N-methylation of aromatic amines with dimethyl carbonate instead of dimethyl sulfate or methanol have attracted extensive attention⁶⁻¹⁰.

In the context of this ongoing research, we report herein a novel environmentally friendly methodology for a direct one-pot synthesis of methyl N-methyl-N-aryl carbamates from primary aromatic amines and dimethyl carbonate in solvent-free conditions using base and phase transfer catalyst (PTC) as a novel catalytic system with high yields (**Scheme 1**). To the best of our knowledge, it is the first report on the simultaneous reaction of N-methoxycarbonylation and N-methylation of aromatic amines.

Scheme 1



* E-mail: chejiang@public.zju.edu.cn

In order to search the most efficient catalytic system, various catalyst combinations have been tested in the reaction of aniline and DMC. It was revealed that at the same experimental conditions K_2CO_3/Bu_4NBr (yield 83%) was more efficient than K_2CO_3/Bu_4NI (yield 76%), K_2CO_3/Et_4NBr (yield 44%) and $KHCO_3/Bu_4NBr$ (yield 58%).

Several reactions between primary aromatic amines and dimethyl carbonate catalyzed by K_2CO_3/Bu_4NBr were examined. The results were given in **Table 1**. Except 4- $CH_3O-C_6H_4NH_2$ (entry 9), in all the cases, the reactions proceeded smoothly to give the corresponding carbamates in good yields. The different reactivities were dependent on the substituents of the benzene ring. The benzene ring with electron-withdrawing groups gave excellent yields (entry 2,3,4,6). On the contrary, the presence of electron-donating groups on the benzene ring would prolong reaction times and decrease the yields (entry 5,7,8). The main by-products were N-methyl aromatic amines and N,N-dimethyl aromatic amines. The K_2CO_3 alone was unable to cause the reaction (entry 10). However Bu_4NBr alone can act as a catalyst, but the yield of the carbamate was obviously reduced (entry 11). The yield of methyl N-methyl-N-phenyl carbamate was only 67% by reacting N-methylaniline, methanol and carbon monoxide in the presence of copper(II) chloride, oxygen and a dehydrating agent¹¹. Y. Wakita *et al.* reported that methyl N-methyl-N-phenyl carbamate with the yield of 66% was obtained from lithium bis(carbamoyl)cuprate and oxamide was the main by-product¹². Obviously, the synthetic method achieved in this study exhibits more advantage than other methods.

Table 1 Synthesis of carbamate catalyzed by K_2CO_3/Bu_4NBr using different aromatic amines as the substrates^{a)}

Entry	Substrate	Product [Ar-N(CH ₃)COOCH ₃]	Time(h)	Yield(%)
1	C ₆ H ₅ NH ₂	Ar: C ₆ H ₅	16	67 ^{d)} , 66 ^{e)} , 83
2	2-Cl-C ₆ H ₄ NH ₂	Ar: 2-Cl-C ₆ H ₄	15	98
3	3-Cl-C ₆ H ₄ NH ₂	Ar: 3-Cl-C ₆ H ₄	14	97
4	4-Cl-C ₆ H ₄ NH ₂	Ar: 4-Cl-C ₆ H ₄	16	93
5	4-CH ₃ -C ₆ H ₄ NH ₂	Ar: 4-CH ₃ -C ₆ H ₄	35	65 ^{e)} , 67
6	2-NO ₂ -C ₆ H ₄ NH ₂	Ar: 2-NO ₂ -C ₆ H ₄	5	94
7	2-CH ₃ O-C ₆ H ₄ NH ₂	Ar: 2-CH ₃ O-C ₆ H ₄	25	71
8	3-CH ₃ O-C ₆ H ₄ NH ₂	Ar: 3-CH ₃ O-C ₆ H ₄	24	80
9	4-CH ₃ O-C ₆ H ₄ NH ₂	Ar: 4-CH ₃ O-C ₆ H ₄	30	52
10	C ₆ H ₅ NH ₂ ^{b)}	Ar: C ₆ H ₅	16	0
11	C ₆ H ₅ NH ₂ ^{c)}	Ar: C ₆ H ₅	16	51

^{a)} Reaction conditions: T= 92°C; aromatic amine: DMC: K_2CO_3 : Bu_4NBr =1:15:0.75:0.5 (mol)

^{b)} the reaction was catalyzed by K_2CO_3 alone

^{c)} the reaction was catalyzed by Bu_4NBr alone

^{d)} yield reported by J. S. H. Kesling *et al.*¹¹

^{e)} yield reported by Y. Wakita *et al.*¹²

General procedure

A mixture of aromatic amine (0.02 mol), DMC (0.30 mol), K_2CO_3 (0.015 mol) and Bu_4NBr (0.010 mol) were heated to reflux (at 92 °C) under N_2 atmosphere until the aromatic amine was converted completely (monitored by GC-9790 equipped with a OV-101 capillary column). At the end of the reaction, K_2CO_3 was simply recovered by filtration and the filter liquor was analyzed by HP 5890 GC/MS. The Bu_4NBr was separated by liquid/liquid extraction with an aqueous hydrochloric acid and *t*-butyl methyl ether as described in elsewhere¹³.

References

1. P. Y. Chong, S. Z. Janicki, P. A. Petillo, *J. Org. Chem.*, **1998**, 63(23), 8515.
2. P. Adams, F. A. Baron, *Chem. Rev.*, **1965**, 65(5), 567.
3. H. Babad, A. G. Zeiler, *Chem. Rev.*, **1973**, 73(1), 75.
4. L. Cotarca, P. Delogu, A. Nardelli, V. Sunjic, *Synthesis*, **1996**, (5), 553.
5. M. A. Aramendia, V. Borau, C. Jimenez, *et al.*, *Applied catalysis A*, **1999**, 183(1), 73.
6. T. Sima, S. Guo, F. Shi, Y. Deng, *Tetrahedron Lett.*, **2002**, 43(45), 8145.
7. T. Baba, M. Fujiwara, A. Oosaku, *et al.*, *Applied catalysis A*, **2002**, 227(1-2), 1.
8. M. Curini, F. Epifano, F. Maltese, O. Rosati, *Tetrahedron Lett.*, **2002**, 43(28), 4895.
9. K. Sreekumar, T. M. Jyothi, T. Mathew, *et al.*, *J. Mol. Catal. A*, **2002**, 159(2), 327.
10. M. Selva, A. Bomben, P. Tundo, *J. Chem.Soc., Perkin Trans.1*, **1997**, (7), 1041.
11. J. S. H. Kesling, P. D. Hill, *US* 4251667, **1981**.
12. Y. Wakita, S. Y. Noma, M. Maeda, M. Kojima, *J. Organomet. Chem.*, **1985**, 297(3), 379.
13. S. Ouk, S. Thiebaud, E. Borredon, P. L. Gars, *Applied catalysis A*, **2003**, 241(1-2), 227.

Received 8 July, 2003