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Synthesis and Characterization of Chiral Nitrobenzaldehyde - Schiff Base Ligands

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Abstract: Three chiral nitrobenzaldehyde/Schiff base ligands (**2a-c**) were prepared by the reaction of *ortho*, *meta*, and *para*-NO_2 substituted benzaldehydes (**1a-c**) with (1R,2R)-(-)-1,2-diaminocyclohexane. The structures of ligands **2a-c** were characterized by IR, ^{1}H-NMR, ^{13}C-NMR and elemental analysis.

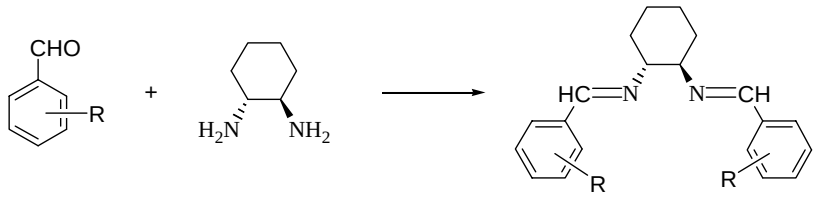
Keywords: Synthesis, chiral, Schiff base, ligand, nitro-group, benzaldehyde.

Introduction

It is well known that the preparation of new ligands is perhaps the most important step in the development of metal complexes which exhibit unique properties and novel reactivity. Changes in the electronic, steric, and geometric properties of the ligand alter the orbitals at the metal center and thus affect its properties. In asymmetric catalyst systems, small changes in the donating ability of the

ligand or the size of its substituents can have a dramatic effect a catalyst's efficiency and enantioselectivity [1-6]. The nitro group is a strong electron withdrawing group and, due to its steric effects, has played an important role in affecting the reactivities and enantioselectivities in asymmetric cyclopropanation and allylic alkylation reactions [7,8]. Jacobsen *et al*. have investigated the actions of various chiral benzaldehyde/Schiff base ligands in the asymmetric azirination of olefins [9]. The best result (75% yield and 98% e.e) was achieved with the 2,3-dichlorobenzaldehyde/Schiff base ligand. To the best of our knowledge, however, nitrobenzaldehyde/Schiff base ligands have never been applied in an asymmetric catalytic system, although some of them have been mentioned in recent publications [10,11]. Thus, in order to investigate their catalytic properties, *ortho*, *meta*, and *para*-NO_2 substituted benzaldehydes **1a-c** were used to prepare the Schiff base ligands **2a-c** by reaction with chiral 1,2-diaminecyclohexane (Scheme 1).

Scheme 1



1a-c **2a-c**

2a R=o-NO_2
2b R=m-NO_2
2c R=p-NO_2

Results and Discussion

NO_2 substituted benzaldehydes **1a-c** were dissolved in absolute ethanol and then an ethanol solution containing 0.5 molar equivalent of (1R,2R)-(-)-1,2-diaminocyclohexane was added to the reaction mixture at room temperature. After 30~36 hours at reflux the reaction mixtures were cooled to room temperature and diluted with water. As a result, ligands **2a-c** were obtained in yields of 76.4%, 94.4%, and 74.5%, respectively. Their structures were characterized by spectroscopy and elemental analysis. The absorption peak corresponding to the amino group disappeared in the IR, which showed that the amino groups in 1,2-diaminocyclohexane had participated completely in the reactions. ^{1}H-NMR, ^{13}C-NMR and elemental analysis data for ligands **2a-c** were also consistent with the formulation indicated in Scheme 1.

As a model reaction the ligands **2a-c** were used in the asymmetric catalytic cyclopropanation of 2,5-dimethyl-2,4-hexadiene with L-menthyl diazoacetate. The results are shown in Table 1. It can be seen from the data that the observed enantioselectivities were not satisfactory, although the activities were moderate. The examination of these ligands in other catalytic asymmetric reactions is in progress.

Table 1. Asymmetric cyclopropanation of 2,5-dimethyl-2,4-hexadiene with L-menthyl diazoacetate using $Cu(CH_3CN)_4ClO_4$/ ligands **2a-c** catalysts *in situ*.

Entry[a]	Ligand	trans:cis	e.e/%(trans/cis)	Yield/%
1	**2a**	72:28	4.5/8.6	57.9
2	**2b**	75:25	5.6/7.6	69.8
3	**2c**	73:27	1.3/8.9	74.0

The reactions were carried out at 85ºC, $Cu(CH_3CN)_4ClO_4$/ligand molar ratio 1/1.2, catalyst/L-menthyl diazoacetate molar ratio 1/100.

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Experimental

General

Melting points were determined on a WRS-1B Digital Melting Point Apparatus and are uncorrected. Infrared spectra were recorded as KBr pellets on an FTIR-8400 instrument. NMR spectra were recorded on a Mercury 400 spectrometer and chemical shifts are expressed in ppm using TMS as internal standard. Elemental analysis was performed on a PE-2400 elemental analyzer. The optical rotations were recorded by means of Horiba Sepa-200 high sensitivity polarimeter.

Synthesis of ligand **2a**

o-Nitrobenzaldehye (**1a,** 2.5g, 16.56mmol) was added to a solution of (1R,2R)-(-)-1,2-diaminocyclohexane (966mg, 8.47mmol) in absolute ethanol (8mL). The resulting mixture was refluxed for 36 h. After cooling to room temperature, water (40mL) was added and the

resulting mixture was stirred for 14 hours. The white precipitate formed was filtered off, washed with water and dried to afford the title compound as white needles after recrystallization from absolute ethanol (yield: 2.460g, 76.4%); mp: 78~79ºC; $[\alpha]_D^{27}$= -3.56° (C=1 in EtOH); IR ν_{max} (cm^{-1}): 1640 (C=N), 1530, 1345 (NO_2), 2930, 2860, 750(Ar-H ring); ^{1}H-NMR, δ_H: 8.67 (s, 2H, CH=N), 7.96 (d, 2H, J=7.76 Hz, Ar-$H_{3,3'}$), 7.93 (d, 2H, J=10.68 Hz, Ar-$H_{6,6'}$), 7.60 (t, 2H, J=7.64 Hz, 7.48 Hz, Ar-$H_{5,5'}$), 7.47 (t, 2H, J=7.80 Hz, 7.76 Hz, Ar-$H_{4,4'}$), 3.56 (t, 2H, CH), 1.90~1.51 (m, 8H, CH_2CH_2); ^{13}C-NMR, δ_C: 170.72 (C=N), 163.54 (Ar-C_2), 132.24 (Ar-C_4), 128.27 (Ar-C_6), 119.11 (Ar-C_1), 118.36 (Ar-C_5), 117.00 (Ar-C_3), 62.84 (NCH), 32.23 (CH_2), 24.06 (CH_2); Anal. Cald. for $C_{20}H_{20}N_4O_4$: C, 63.15; H, 5.30; N, 14.73; Found: C, 62.98; H, 5.16; N, 14.55.

Synthesis of ligand **2b**

Compound **2b** was synthesized by the method described above in 94.4% yield. White needles, mp: 92~93ºC; $[\alpha]_D^{29}$= -255.00° (C=1 in EtOH); IR ν_{max} (cm^{-1}): 1652 (C=N), 1534, 1352 (NO_2), 2928, 2862, 748(Ar-H ring); ^{1}H-NMR, δ_H: 8.47 (s, 2H, CH=N), 8.28 (s, 2H, Ar-$H_{3,3'}$), 8.17 (dd, 2H, J=6.12 Hz, J=2.00 Hz Ar-$H_{4,4'}$), 7.91 (d, 2H, J=7.68 Hz, Ar-$H_{6,6'}$), 7.50 (t, 2H, J=7.92 Hz, Ar-$H_{5,5'}$), 3.49 (dd, 2H, J=5.00 Hz, J=2.28 Hz, CH), 1.92~1.51 (m, 8H, CH_2CH_2); ^{13}C-NMR, δ_C: 158.23 (C=N), 148.43 (Ar-C_3), 137.76 (Ar-C_1), 133.57 (Ar-C_6), 129.46 (Ar-C_5), 124.75 (Ar-C_4), 122.38 (Ar-C_2), 73.69 (NCH), 32.62 (CH_2), 24.19 (CH_2); Anal. Cald. for $C_{20}H_{20}N_4O_4$: C, 63.15; H, 5.30; N, 14.73; Found: C, 63.01; H, 5.13; N, 14.57.

Synthesis of ligand **2c**

Compound **2c** was synthesized by the above method in 74.5% yield. Yellow needles, mp: 110~112ºC; $[\alpha]_D^{29}$= -384.10° (C=1 in CH_2Cl_2); IR ν_{max} (cm^{-1}): 1648 (C=N), 1526, 1350 cm (NO_2), 2921, 2858, 752 (Ar-H ring); ^{1}H-NMR, δ_H: 8.28 (s, 2H, CH=N), 8.15 (d, 4H, J=8.56 Hz, Ar-$H_{3,3',5,5'}$), 7.76 (d, 4H, J=8.72 Hz, Ar-$H_{2,2',6.6'}$), 3.50 (t, 2H, J=4.96 Hz, J=4.88 Hz, CH), 1.92~1.52 (m, 8H, CH_2CH_2); ^{13}C-NMR, δ_C: 158.55 (C=N), 148.73 (Ar-C_4), 141.46 (Ar-C_1), 128.44 (Ar-$C_{2,6}$), 123.66 (Ar-$C_{3,5}$), 73.88 (NCH), 32.48 (CH_2), 24.10 (CH_2); Anal. Cald. for $C_{20}H_{20}N_4O_4$: C, 63.15; H, 5.30; N, 14.73; Found: C, 63.02; H, 5.10; N, 14.26.

References

1. Morrrison, J.D., Ed. *Asymmetric Synthesis;* Academic Press: New York, 1983
2. Bosnich, B. *Asymmetric Catalysis;* Martinus Nijhoff Publishers: Dordrecht, The Netherlands, 1986

3. Whitesell, J.K. *Chem. Rev*. **1989**, *89*, 1581~1615
4. Brunner, H.; Zettlmeier, W., Eds. *Handbook of Enantioselective Catalysis*; VCH: New York, 1993
5. Ojima, I., Ed. *Catalytic Asymmetric Synthesis*; VCH: New York, 1994
6. Norori, R. *Asymmetric Catalysis in Organic Synthesis*; Wiley: New York, 1993
7. Qiu, M.; Liu, G.S.; Yao, X.Q. Chiral copper(II)-Schiff base complexes as catalysts for asymmetric cyclopropanation of styrene, *Chin. J. Catal. (China)* **2001**, *22*(1), 77-80
8. Hu, X.P. Doctoral Dissertation, Dalian Institute of Chemical Physics, Chinese Academy of Science, **2002**
9. Li, Z.N; Conser, K.R.; Jacobsen, E.N. Asymmetric alkene aziridination with readily available chiral diimine-based catalysts, *J. Am. Chem. Soc*. **1993**, *115*, 5326-5327
10. Renard, S.L.; Kee, T.P. Electronic effects on the acidity of phosphorus(III) triflates, *J. Organomet. Chem.* **2002**, *643-644*, 516-521
11. Karame, I.; Tommasino, M.L.; Faure, R.; Lemaire, M. Easy synthesis of new chiral tetradentate N_4 Schiiff bases and their use as ligands for metal complexes, *Eur. J. Org. Chem*. **2003**, 1271-1276

Sample Availability: Samples of the ligands **2a, 2b** and **2c** are available from MDPI.