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Cyclic amins from aldehydes and “roofed” mono-*N*-sulfonyl *cis*-diamines

(アルデヒドと屋根付きモノ-*N*-スルホニル シス型ジアミンとの環状アミナル)

Most popular strategy for optical resolution (resolution of enantiomers) is based on the different physical properties of diastereomers. New mono-*N*-sulfonyl *cis*-diamine reagents were created as chiral derivatizing reagents for racemic aldehydes in this research. Racemic aldehydes are converted into mixture of diastereomers by using the new roofed *cis*-diamine reagents. Most of resulting five-membered diastereomeric amins are stable on silica-gel TLC plate and separated by silica-gel chromatography very easily. The absolute configuration of aldehyde moiety in each separated diastereomer is determined by two-dimensional NMR analyses. The new reagents react smoothly with aldehydes under mild and neutral or a little acidic condition.

1. New synthetic process for roofed *cis*-diamine skeleton

The roofed *cis*-diamine skeleton (*rel*-(11*R*,12*S*)-9,10-dihydro-9,10-ethanoanthracene-11,12-diamine hydrochloride (1:2) **1**) was synthesized conventionally by Diels–Alder reaction of anthracene and cyclic urea (1,3-diacetyl-2-imidazolone) as the first step. The bicyclic imidazolidinone was converted to the roofed *cis*-diamine hydrochloride **1** through five serial reactions.

The cyclic urea was replaced to a cyclic amination derivative (1,3-diacetyl-2,3-dihydro-1*H*-Imidazole) in this research. By Diels–Alder reaction of anthracene and the cyclic amination derivative to afford a new intermediate (roofed 1,3-diacetyl-2-imidazolidine), which was hydrolyzed under refluxing in conc. HCl/MeOH solution to give the same roofed *cis*-diamine hydrochloride **1** in high yield (94 %).

2. Preparation of mono-*N*-sulfonyl *cis*-diamine reagents and diastereomeric amins from aldehydes and the reagents

The mono-*N*-sulfonyl *cis*-diamine reagents (**2**: Ms, **3**: Ts, **4**: 1-naphthylsulfonyl, **5**: 2-naphthylsulfonyl) were prepared from *cis*-diamine hydrochloride **1** and corresponding

sulfonyl chlorides.

Those mono-*N*-sulfonyl *cis*-diamine reagents were reacted with isobutyraldehyde to form cyclic amins (2' from 2, 3' from 3, 4' from 4, and 5' from 5). The chemical shifts of geminal proton and carbon signals in amins are as follows.

¹H NMR (δ); 2': -0.01, 0.82 (Δδ=0.83), 3': 0.03, 0.79 (Δδ=0.76), 4': 0.02, 0.82 (Δδ=0.80), 5': 0.05, 0.81 (Δδ=0.76).

¹³C NMR (δ); 2': 11.18, 19.44 (Δδ=8.26), 3': 11.73, 19.50 (Δδ=8.13), 4': 11.29, 19.60 (Δδ=8.31), 5': 11.41, 19.53 (Δδ=8.21).

One methyl proton signal in each amina is apt to shift upfield. The chemical shift differences of geminal carbon signals in 4 amins are more than 8 ppm. In the stable conformation of amins, the methine proton (the smallest substitution group) is face to sulfonyl moiety. As the result, one methyl group will get closer to one benzene ring of the reagent. Due to the diamagnetic effect of the benzene ring, the methyl proton signal should appear upfield. NOE experimental data supports the conformation.

3. Preparation of chiral reagents (2-5) and diastereomeric amins from chiral and racemic aldehydes

Aldehydes 6-9 (6; (1*R*)-(-)-myrtenal, 7; (±)-2-methylbutanal, 8; (±)-2-phenylpropanal, 9; (±)-2-Methyl-3-(4-*tert*-butylphenyl)propanal) were reacted with reagents (2-5) to afford diastereomeric amins. These diastereomers were well separated on silica-gel TLC plates. Chiral reagents were obtained by acidic hydrolysis of amins which were prepared from (1*R*)-(-)-myrtenal 6 and racemic reagents. The whole structures of amins with 6 were determined by two-dimensional NMR analyses.

The developing pattern of a pair of diastereomeric amins can be explained by the steric and electronic interactions between amins and silica-gel stationary phase. Hydrogen bonds will predominantly occur between silica-gel particle (Si-OH) and the -SO₂- and -NH- sites of amina. As a result, the substrate adsorbs silica-gel particle at one side. When the substitution group (A) of aldehyde moieties is near side of the silica-gel particle, the properties of A like bulkiness and polarity affect the strength of adsorption. The other diastereomer will interact with silica-gel particle on the other substitution group (B). So, by comparison with the chemical property of A and that of B, the developing pattern will be predicted.