form under reflux in 87% yield. Ester group of **5** was easily hydrolyzed by lithium hydroxide in a mixed solvent of methanol and water at room temperature in 96% yield. Carboxylic acid **6** was converted to acyl chloride by refluxing in thionyl chloride for 3 h, and then, reacted with 2-amino-2, 3-dimethyl butyramide in acetonitrile to give the amide product. The cyclization of the amide was achieved by sodium hydroxide treatment in a mixed solvent of ethanol and water with heating for 2 h to afford the imidazolinone **7** in 63% overall yield. Lithium-bromine exchange of **7** with *n*-butyllithium and the subsequent carboxylation by treatment with carbon dioxide afforded the target molecule **1**.[7]

In summary, thermally induced 1,3-dipolar cycloaddition reaction of *N*-methylsydnone (**3**) with methyl propiolate gave methyl 1-methyl-3-pyrazolecarboxylate with good regioselectivity and a new pyrazolylimidazolinone **1** has been synthsized using the cycloaddut **4** as a key intermediate. Further studies on the synthesis of other pyrazolylimidazolinone derivatives and their herbicidal activity evaluation are in progress.

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7. The ^{1}H NMR data of the key intermediary products are as follows; **1** (200 MHz, MeOH-d_4): δ 8.41 (1H, s, Ar), 4.13 (3H, s, N-CH$_3$), 2.17 (1H, quintet, *J*=7 Hz), 1.53 (3H, s, -CH$_3$), 1.17 (3H, d, *J*=7 Hz, -CH$_3$), 0.94 (3H, d, *J*=7 Hz, -CH$_3$). **4** (200 MHz, CDCl$_3$): δ 7.39 (1H, d, *J*= 2.4 Hz), 6.82 (1H, d, *J*=2.4 Hz), 3.98 (3H, s, O-CH$_3$), 3.92 (3H, s, N-CH$_3$). **5** (200 MHz, CDCl$_3$): δ 7.49 (1H, s, Ar), 3.98 (3H, s, O-CH$_3$), 3.95 (3H, s, N-CH$_3$). **7** (200 MHz, CDCl$_3$): δ 8.31 (1H, brs, NH), 7.49 (1H, s, Ar), 3.93 (3H, s, N-CH$_3$), 2.08 (1H, quintet, *J*=7 Hz), 1.40 (3H, s, -CH$_3$), 1.04 (3H, d, *J*=7 Hz, -CH$_3$), 0.89 (3H, d, *J*=7 Hz, -CH$_3$).

(Salen)Mn(III) Catalyzed Oxidation of Alcohols Using Sodium Hypochlorite as an Oxidant

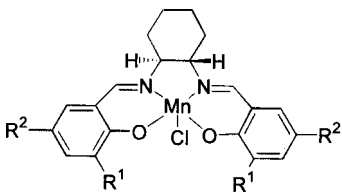Nam Ho Lee*, Jong Seok Baik, and Sung-bin Han

Department of Chemistry, Cheju National University, Ara-1, Cheju 690-756, Korea

Recently, (salen)Mn(III) complexes have attracted attention as efficient catalysts for the epoxidation of olefins.[1] Most of the studies in this area has been devoted to utilize chiral (salen)Mn complexes to effect enantioselective olefin epoxidation with different types of oxidants. Even though (salen)Mn complexes have a high potential in organic synthesis primarily due to their easy preparation and handling, relatively few results have been reported on the subjects other than epoxidation chemistry.[2] Recently, we have reported that benzylic hydrocarbons can be oxidized to the corresponding carbonyl compounds using (salen)Mn catalysts.[3] In this procedure, we assumed that the carbonyl compounds were formed through the alcohols as the intermediates. Therefore, we were forced to examine alcohols as the substrates in (salen)Mn-mediated oxidation process.

The alcohol oxidation was conducted using sodium hypochlorite[4] which is regarded as the most pratical oxidant in (salen)Mn mediated oxidation procedure. In Table 1, the results of the different reaction conditions for the conversion of 1-phenylethanol to acetophenone are summarized.

Control experiment showed that the (salen)Mn catalysts were essential for the oxidation of 1-phenylethanol under the reaction conditions (entry 1). Among the racemic (salen) Mn complexes[5] examined, the complex **1** was found to be the most efficient catalyst for the oxidation of the alcohol (entries 2-5). Although the higher reactivity of (salen)Mn **1** compared to other complexes is not clear, but the combination of electronic and steric environments around the salen ligand would account for the reactivity difference.[6] This reaction was also found to be dependent on the amount of catalysts and oxidant employed. With the catalytic amount (8 mol %) of the complex **1**, it was observed that four equivalent of the oxidant was necessary to achieve the complete conversion of the starting material. This could be explained by assuming that, because this reaction proceeds under biphasic conditions, the mass transport of the aqueous HOCl into the organic layer becomes the rate-determining step, as already shown in the analogous epoxidation procedure.[7] Thus, excess amount of the aqueous oxidant facilitates the catalytic cycle, which makes the reac-

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Table 1. Examination of the reaction conditions for the oxidation of 1-phenylethanol in the presence of racemic (salen)Mn complexes as the catalysts

1 : R¹ = -H   R² = -H
2 : R¹ = -ᵗBu R² = -ᵗBu
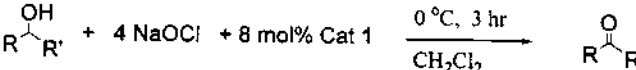3 : R¹ = -H   R² = -Cl
4 : R¹ = -Cl   R² = -Cl

$$\underset{OH}{Ph} + NaOCl + Catalyst \xrightarrow[CH_2Cl_2]{0\,°C,\ 3\ hr} \underset{O}{Ph}$$
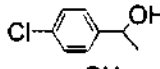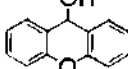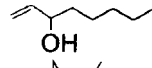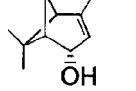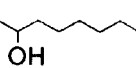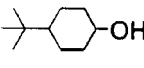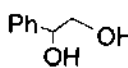
Entry	Catalyst	Equiv of NaOCl	Equiv of Catalyst	Product Yield (%)ᵃ
1	no	4	0.04	<2
2	1	4	0.04	78
3	2	4	0.04	17
4	3	4	0.04	19
5	4	4	0.04	21
6	1	2	0.04	67
7	1	2	0.08	72
8	1	4	0.08	92

ᵃ GC yield using dodecane as an internal standard.

tion complete faster. Otherwise, the catalyst is slowly deactivated with extended reaction time possibly through the oxidative degradation.
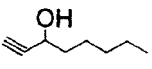
With the reslts in Table 1 at hand, we examined the oxidation of a variety of alcohols in the presence of the catalyst 1 with four equivalent of NaOCl.[7] The results are summarized in Table 2. This procedure proved to be efficient for the oxidation of alcohols, especially of secondary alcohols. As shown in entries 1-5 in Table 2, secondary benzylic alcohols were cleanly transformed to the corresponding carbonyl compounds under the reaction conditions. Secondary propargylic alcohol such as 1-octyn-3-ol was also easily oxidized to give the corresponding ketone in 92% yield (entry 9). Saturated secondary alcohols were also appeared to be good substrates for this oxidation procedure (entries 10 and 11). However, due to relatively low reactivities, more excess amount of oxidant (10 equivalent) was required to complete the reaction. Employing typical four equivalent of NaOCl, 2-octanol and 4-ᵗbutylcyclohexanol were converted in only 54 and 67% yields, which indicates that maintaining sufficient amount of oxidant is important for this biphasic reaction system. On the other hand, oxidation of primary alcohol was less efficient. As shown in entry 6, benzyl alcohol was oxidized to the aldehyde in only 52% yield, together with over-oxidized benzoic acid in 4% yield. Saturated primary alcohol such as 1-decanol was also found to be far less reactive in this oxidation procedure to give the aldehyde in lower yield (entry 12). This reaction also provided small amount of corresponding caboxylic acid as an over-oxidized side product. Taking advantage of the above reactivity difference, trial of the selective oxidation was made under the same reaction conditions with 1-phenyl-1,2-ethanediol, which contains both benzylic and saturated primary hydroxy groups (entry 13). TLC analysis showed two clear spots other than starting material, where the major

Table 2. NaOCl-mediated oxidation of alcohols using the complex 1 as the catalyst

$$\underset{R'}{\overset{OH}{R}} + 4\ NaOCl + 8\ mol\%\ Cat\ 1 \xrightarrow[CH_2Cl_2]{0\,°C,\ 3\ hr} \underset{R'}{\overset{O}{R}}$$

Entry	Alcohol	Conversion (%)ᵃ	Product Yield (%)
1	Ph OH	100	91ᵇ
2	Ph OH	100	96ᵇ
3	Ph OH Ph	100	90ᵇ
4	Cl—⟨⟩—OH	91	71ᵇ
5	OH (xanthene)	100	85ᵇ
6	PhCH₂OH	91	52ᶜ
7ᵇ	OH	Not Determined	29ᵇ
8	OH	100	67ᵇ
9	OH	100	92ᶜ
10ᵉ	OH	93	87ᶜ
11ᵉ	⟨⟩—OH	100	96ᵇ
12	1-decanol	44	27ᶜ
13	Ph OH OH	Not Determined	40ᵇ·ᶠ

ᵃ Determined by GC analysis. ᵇ Isolated yields. ᶜ GC yields using dodecane as an internal standard. ᵈ Starting material was recovered in 46% yield. ᵉ 10 equivalents of NaOCl was used. ᶠ Product referred to α-hydroxyacetophenone.

spot was identified as the mono-oxidized product at the benzylic position, and which was isolated in 40% yield. In the case of allylic alcohols as the substrates, this procedure caused a problem related to the competition between the alcoholic oxidation and olefinic epoxidation. For example, subjection of 1-octen-3-ol to the reaction conditions provided a mixture of alcohol and olefinic oxidized products in about 1 to 1 ratio; i.e. enone (28% yield) and epoxidized

NaOCl ⤸ (Salen)Mn 1 ⤸ Ph–C(=O)–CH₃ + H₂O
NaCl   ⤹ (Salen)Mn=O ⤹ Ph–CH(OH)–CH₃
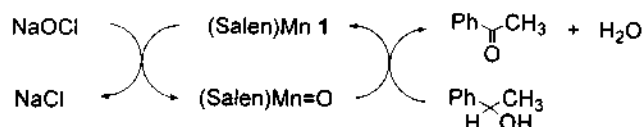
Scheme 1. A proposed reaction pathway for (salen)Mn(III)-catalyzed oxidation of an alcohol.

products (29% yield) were obtained along with the recovered starting material (46% yield) (entry 7). On the other hand, (*S*)-verbenol showed better reactivity and selectivity, *i.e.* alcohol oxidation predominates over the olefin epoxidation to provide enone and epoxy ketone in 67% and 20% yield, respectively. This preference could be explained by assuming the difficulty of the catalyst approaching to the sterically congested trisubstituted C=C bond in (*S*)-verbenol.

This reaction is considered to proceed via electrophilic Mn^V=O intermediate, which is proposed in the related epoxidation chemistry (Scheme 1).[9] The active Mn=O species abstract H atom next to hydroxy group, which is followed by the rebound of manganese hydroxide to the radical or cationic intermediate. This rebound step should be very fast, considering that no cyclopropyl rearranged product was observed in the oxidation of 1-phenyl-1-cyclopropanemehanol (see entry 2 in Table 2). In addition, the low reactivity of the primary alcohols could be ascribed to the low electron density around α-carbon to hydroxy group. Studies on the further reaction mechanism are in progress.

We have shown that the (salen)Mn(III) complex 1 can be used as a catalyst for the oxidation of various alcohols. This oxidation is effected under mild reaction conditions utilizing bleach (aq. NaOCl) as the oxidant. Due to its simple waste disposal together with low toxicity and cost, NaOCl consists of a favorable oxidant over the other typical oxidants such as Cr(VI) and Mn(VI).[10] This work introduces a new method which can utilize a commercial bleach as an oxidant for the oxidation of alcohols. Easy preparation and handling of the catalyst 1 coupled with practical reaction conditions will make this procedure useful in organic synthesis.

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Synthesis of (+)-Tashiromine and (+)-5-Epitashiromine Utilizing the Diastereoselective Alkylation of (S)-4-Carbethoxymethyl-2-oxazolidinone

Deok-Chan Ha*, Sung-Ho Park, Kwang-Sun Choi, and Chang-Soo Yun

Department of Chemistry, Korea University, 5-1-2 Anam-Dong, Seoul 136-701, Korea
Received April 2, 1998

Tashiromine (1) is an indolizidine alkaloid isolated from subtropical Asian deciduous shrub, *Maackia tashiroi*.[1] The optical rotation was not measured due to the shortage of the isolated material and, thus, the absolute stereochemistry remains unknown. Although racemic[2] and (-)-tashiromine[3] were synthesized by several research groups, synthesis of the (+)-enantiomer has not been reported.

In our previous report, we studied the diastereoselective