

METALLOPORPHIRINS CATALYZE REGIO AND CHEMOSELECTIVE Silylation OF HYDROXY GROUPS WITH HEXAMETHYLDISILAZANE (HMDS)[☆]

*Firouzabadi, Habib**

Khayat, Zohreh

Sardarian, Ali Reza

Tangestaninejad, Shahram

*Department of Chemistry, Faculty of Science, Shiraz University,
Postcode 71454, Shiraz, Iran.*

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ABSTRACT: *Metalloporphirins; Cu(TPP), Mn(TPP)Cl, Co(TPP), Fe(TPP)Cl, Zn(TPP), and Mn(OBP)Cl catalyze regio and chemoselective silylation of hydroxy groups with HMDS. Fe(TPP)Cl is the most effective catalyst and silylation occurs immediately in its presence at room temperature.*

KEY WORDS: *Metalloporphirin, Silylation, Catalysis, Hydroxy groups, Protection, Regio and Chemoselective, Hexamethyldisilazane.*

The importance of hydroxy group functionality in organic chemistry is reflected by the continuous appearance of methods for developing complex structures based on the chemical interconversion of oxygenated functional groups in the literature. A severe limiting factor in some cases arises in the

presence of more than one oxygen function of comparable reactivity in the molecule to be transformed. This difficulty is circumvented by the use of protective groups, a practice which in theory allows free manipulation of the desired functionality.

One of the common ways to protect hydroxy

[☆] This paper is dedicated to Professor Ali Akbar Moshfeqh the founder of the chemistry department of Shiraz University on the occasion of his 70th birthday.

* To whom correspondence should be addressed

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groups is their transformation to their corresponding silyl ethers [1]. For this purpose reagents have been developed such as; trimethylchlorosilane (TMSC) in the presence of amines [2,3] or lithium sulfide [4]; hexamethyldisilazane (HMDS) [5] and hexamethyldisiloxane (HMDSO) [6] in acidic media; allylsilanes [7,8], and etc [9,10] to introduce trimethylsilyl group in the molecule.

HMDS is a cheap and a commercially available reagent. Its handling does not need special precaution and the work-up of the reaction mixture is not time consuming. The main drawback of this reagent is its poor silylating power which needs forceful conditions in many instances. Silylations with this reagent requires prolonged heating and continuous removal of ammonia. Several catalysts such as trimethylchlorosilane [11], sulfonic acids, amines, trimethylsilylated amides [12], and imidazole [13] have been introduced in the literature for the silylation of amines, carboxylic acids, 1,3-dicarbonyl compounds, and 1,2-diols with HMDS. Although these methods provide improvements, in many cases, reaction times of several hours are still necessary and also poor regio and chemoselectivity in multifunctional groups molecules are observed.

Recently, we have reported that HMDS, in presence of a catalytic amount of anhydrous $ZnCl_2$, silylates alcohols in presence of amines and thiols [14]. $ZnCl_2$ is hygroscopic and its use for the moisture and acid-sensitive compounds requires precautions.

Biomimetic compounds; metalloporphirins, have found important applications, as catalysts, in organic synthesis [15-17]. In this communication we wish to report that metalloporphirins are also able to catalyze silylation of hydroxy compounds with HMDS. We have studied the catalytic effects of $Cu(TPP)$, $Mn(TPP)Cl$, $Co(TPP)$, $Fe(TPP)Cl$, $Zn(TPP)$, and $Mn(OBP)Cl$ and have found that all these compounds catalyze the reaction and among them $Fe(TPP)Cl$ is the most effective catalyst (Table 1). $Fe(TPP)Cl$ catalyzes silylation of hydroxy groups (Table 2) in presence of thiols and amines with absolute chemoselectivity.

HMDS in presence of this catalyst discriminates primary versus secondary hydroxy groups, (Scheme 1).

Table 1: Silylation of 1-octanol with HMDS at room temperature in presence of various metalloporphirins.

Entry No.	Catalyst	Substrate/HMDS/ Catalyst molar ratios	Reaction time min. (Yield%)
1	Co(TPP)	1/0.7/0.06	20(77)
2	Mn(TPP)Cl	1/0.7/0.06	20(83)
3	Fe(TPP)Cl	1/0.7/0.06	- ^a (100)
4	Mn(OBP)Cl	1/0.7/0.06	20(60)
5	Cu(TPP)	1/0.7/0.06	20(56)
6	Zn(TPP)	1/0.7/0.06	20(51)

a: Immediate reaction

Table 2: Silylation of compounds with labile hydrogen atoms by HMDS in dry acetonitrile at room temperature in presence of $Fe(TPP)Cl$.



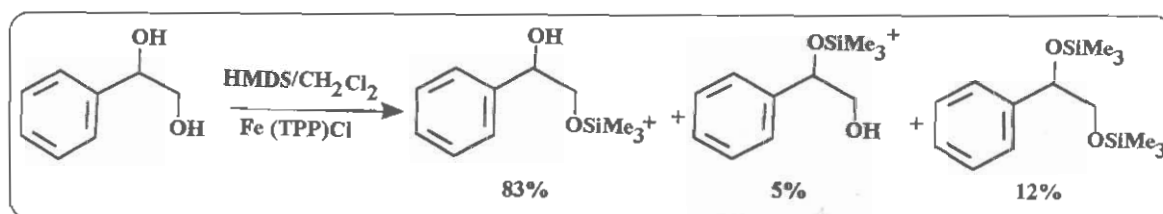
Entry No.	Substrate	Substrate/HMDS/ $Fe(TPP)Cl$	Reaction time min. (Yield %)
1	Benzyl alcohol	1/0.7/0.06	- ^a (100)
2	Cinnamyl alcohol	1/0.7/0.06	- ^a (93)
3	1-Octanol	1/0.7/0.06	- ^a (100)
4	2-Octanol	1/0.7/0.06	90(45) ^b
5	2-Octanol	1/1.7/0.06	5(94) ^b
6	4-Chloroaniline	1/0.8/0.06	90(0)
7	Benzene thiol	1/0.8/0.06	90(0) ^c
8	phenol	1/0.7/0.06	- ^a (90)

a: Immediate reaction.

b: Yield and the rate enhancements were observed by increasing HMDS molar ratio.

c: Reaction was monitored by TLC.

The catalytic activity of $Fe(TPP)Cl$ was measured for the silylation of 1-octanol for ten different runs. Retardation in the rate of the reaction was in the limit of the experimental error. Comparison of electronic spectra before and after the reaction indicates that the catalyst survives in the reaction mixture [18]. In this preliminary report we have explored an unsuspected property and a new catalytic application for metalloporphirins specially, $Fe(TPP)Cl$ for the selective silylation of hydroxy groups. Further studies in this subject are under investigate in our laboratories.



HMDS / ROH / Fe(III)(TPP)Cl: 0.7/1/0.06

Scheme 1

EXPERIMENTAL

Silylation of 1-octanol in presence of $\text{Fe}^{\text{III}}(\text{tpp})(\text{Cl})$ as a typical procedure for metalloporphyrin catalyzed silylations with HMDS

In a round-bottomed flask (50 mL) equipped with a drying tube and a magnetic stirrer, a solution of 1-octanol (520 mg, 4 mmol) in dry CH_3CN (20 mL) was prepared. $\text{Fe}^{\text{III}}(\text{tpp})(\text{Cl})$ (169 mg, 0.24 mmol) was then added to the solution and was stirred at room temperature while HMDS (0.6 mL, 2.8 mmol) was added to the resulting mixture over a period of 2-4 minutes. The progress of the reaction was monitored by GLC. After completion of the reaction, the mixture was extracted with hexane in three portions (3×15 mL). The extract was concentrated on a rotary evaporator, and then filtered through a silica gel pad. The filter cake was washed with CCl_4 three times (3×12 mL). The filtrates were added together and the solvent was evaporated under diminished pressure to yield the corresponding silyl ether, yield, 735 mg, 91%.

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REFERENCES

- [1] Lalonde, M. and Chan, T. H., *Synthesis*, 817 (1985).
- [2] Corey, E. J. and Snider, B. B., *J. Am. Chem. Soc.*, **94**, 2549 (1972).
- [3] Haslam, E., *Tetrahedron*, **36**, 2409 (1980).
- [4] Olah, G. A., Gupta, B. G. B., Narang, S. C. and Molhotra, R., *J. Org. Chem.*, **44**, 4272 (1979).
- [5] Goldschmidt, A. G., *German Patent* 2758884; *Chem. Abst.*, **90**, 63300 (1979).
- [6] Pinnick, H. W., Bal, B. S. and Lazis, N. H., *Tetrahedron Lett.*, 4261 (1978).
- [7] Morita, T., Okamoto, Y. and Sakurai, H., *Tetrahedron Lett.*, 835 (1980).
- [8] Olah, G. A., Husain, A., Gupta, B. G., Salem, G. F. and Narang, S. C., *J. Org. Chem.*, **46**, 5212 (1981).
- [9] Evans, D. A., Hoffman, J. M. and Truesdale, L. K. J., *J. Am. Chem. Soc.*, **95**, 5822 (1973).
- [10] Lipshutz, B. H., Burgess-Henry, J. and Roth, G. P., *Tetrahedron Lett.*, **34**, 995 (1993).
- [11] Cossy, J. and Pale, P., *Tetrahedron Lett.*, 6039 (1987).
- [12] Bruyness, C. A. and Jurriens, T. K., *J. Org. Chem.*, **47**, 3966 (1982) and references cited therein.
- [13] Ainsworth, C. and Torkelson, S., *Synthesis*, 722 (1976).
- [14] Firouzabadi, H. and Karimi, B., *Synth. Commun.*, **23**, 1633 (1993).
- [15] Kuroda, Y., Suzuki, Y. and Ogoshi, H., *Tetrahedron Lett.*, 749 (1994) and references cited therein.
- [16] Mohajer, D. and Tangestaninejad, S., *J. Chem. Soc., Chem. Commun.*, 240 (1993) and references cited therein.
- [17] Bartoli, J. F., Battioni, P., De Foor, W. R. and Mansuy, D., *J. Chem. Soc., Chem. Commun.*, 23 (1994).
- [18] Huheey, J. E., *Inorganic Chemistry*, Harper and Row Publishers N. Y., (1983).