Chinese Chemical Letters Vol. 12, No. 5, pp. 425 – 428, 2001 

# Synthesis of Glucoside Bonded Metal Porphyrins

Zao Ying LI*, Xun Jin ZHU, Li LI, Yue Ning ZHANG

Department of Chemistry, Wuhan University, Wuhan 430072

**Abstract:** The reactions of 5,10,15,20-tetrakis(*p*-hydroxyphenyl) porphyrin **1** and 5-(*p*-hydroxyphenyl)-10,15,20-tris(*p*-methoxyphenyl) porphyrin **2** with 1-bromo-2,3,4,6-O-acetyl-$\alpha$-*D*-glu-coside **3** respectively afforded 5,10,15,20-tetrakis[*p*-(2,3,4,6-O-acetyl-glucoside)-1-O-phenyl] porphyrin **4** and 5,10,15-tris(*p*-methoxyphenyl)-20-[*p*-(2,3,4,6-O-acetyl-glucoside)-1-O-phenyl] porphyrin **5**. Their metal complexes **$Co^{II}$(4)**, **$Mn^{II}$ (4)** and **$Co^{II}$(5)**, **$Mn^{II}$(5)** also have been prepared. These new compounds have been identified by IR, UV-visible, $^1$H NMR spectra and elemental analysis.

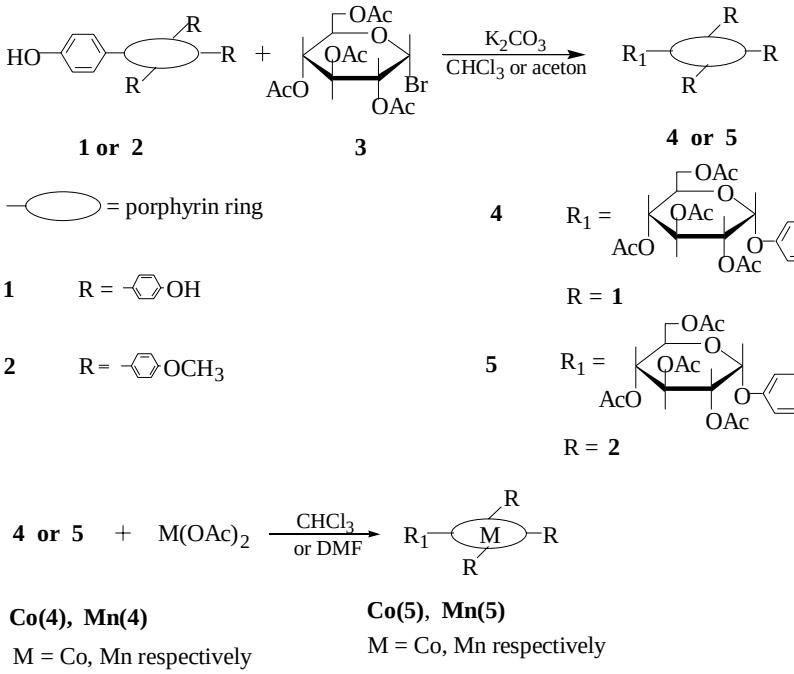
**Keywords:** Glucoside, metalloporphyrin, synthesis.

Enzyme catalyzed reaction often has high selectivity and efficiency under mild conditions. However, disadvantage of enzyme catalysts is the difficulty of recovery. Metalloporphyrin plays an important role in biological system such as redox reaction, electron transfer，oxygen transportation and charge separation *etc*.[1,2] Metalloporphyrins as superoxide dismutase (SOD) mimics have showed the ability of catalyzing the redox reaction of some harmful radicals , such as $O_2^{\cdot -}$, • OH. Grove and co-workers[3,4] reported [$Mn^{III}$TMPyP] and [$Fe^{III}$TMPyP] which have showed very efficient behavior as peroxynitrite reductase and can deplete $O_2^{\cdot -}$ during the reductase process, and the relevant mechanisms were also been put forward. Our research group[5] also found that different metalloporphyrins and their derivatives have the ability of eliminating the $O_2^{\cdot -}$, • OH and antilipid peroxidation. However, in the human body, most of the harmful radicals such as $O_2^{\cdot -}$, $NOO^-$ exist in water phase. But most porphyrins, natural or synthetic, are not sufficiently soluble in aqueous surroundings, at pH's near 7. The glucoside and its derivatives are very soluble in water, cheap, available in high purity, and nontoxic. So we are interested in the design and synthesis of novel porphyrins and metal porphyrins. Herein report the synthesis and characterization of glucoside bonded metallporphyrin, whose solubility in aqueous-phase has greatly improved. The study of biological activities on the glucoside bonded metalloporphyrins, as the two functional mimic enzyme models to eliminate harmful oxidants will be reported in another paper.

The 5-(*p*-hydroxyphenyl)-10,15,20-tris-(*p*-methoxyphenyl) porphyrin **2**[6] and 1-bromo-2,3,4,6-O-acetyl-$\alpha$-*D*-pyranoglucoside **3**[7] were prepared according to the litera-tures. The 5,10,15,20-tetrakis-(*p*-hydroxyphenyl) porphyrin **1** was prepared by a modification of literature procedure[8]: the reaction proceeded in $CH_2Cl_2$ at -15°C instead of at -80°C, also gave a high yield. The synthetic routes of new glucoside bonded

porphyrins and their metal complexes are summarized in **Scheme**.

**Scheme**




## Experimental

Preparation of compound **4:** To a solution of 5,10,15,20-tetrakis (*p*-hydroxyphenyl) porphyrin **1** (35 mg, 0.052 mmol) in acetone (90 mL) was added 1-bromo-2,3,4,6-acetyl-*α-D*-glucoside **3** (125 mg, 0.30 mmol) and anhydrous $K_2CO_3$(60 mg, 0.43 mmol). The mixture was stirred for 24 h at 60°C under $N_2$, cooled to room temperature, then filtered. The filtrate was concentrated under vacuum. The crude product was purified with column chromatography using silica gel as solid support, chloroform/acetyl acetate (10/1, V/V) as eluent, and the first band was collected. Removal of solvent yielded a violet solid(42 mg, 41%). $^1$H NMR($CDCl_3$, $\delta_{ppm}$): 8.84(s, 8H, $H_\beta$)*; 8.21~8.19(m, 8H, $H_o$); 7.22~7.17(m, 8H, $H_m$); 5.44~5.13(m, 16H, $C_{1\sim4}$ H); 4.67~4.66(d, 8H, J = 4.2 Hz, $C_6$ H); 4.25~4.19(m, 4H, $C_5$ H); 1.9~2.3(m, 48H, $CH_3$); -2.78(s, 2H, N H). IR(ν, KBr, $cm^{-1}$): 2923, 2854(C-H), 1753(C=O), 1603, 1504(-ph-), 1223, 1167, 1040(shoulder peak of sugar ring). UV-vis($\lambda_{max}$ ,$CHCl_3$): 416(Soret band), 516, 553, 594 and 652 nm. Anal. for $C_{100}H_{102}N_4O_{40}\cdot H_2O$ Calcd: C, 59.51; H, 5.19; N, 2.77. Found: C, 59.61; H, 5.37; N, 2.36.

Preparation of compound **5**: The 5,10,15-tris-(*p*-methoxyphenyl)-20-(*p*-hydroxyphenyl) porphyrin **2** (30 mg, 0.041 mmol) and $K_2CO_3$(20 mg, 0.14 mmol) were dissolved in 30 mL of chloroform. The mixture was stirred, and then 1-bromo-2,3,4,6-acetyl-O-acetyl-*α-D*-glucose(40 mg, 0.097 mmol) was added. The reaction solution kept stirring for 24 h at 60°C under $N_2$. It was cooled to room temperature and

filtered. The filtrate was concentrated and chromatographed on silica gel with chloroform/acetyl acetate(10/1, V/V) as eluent and the first band was collected. Removal of the solvent yielded a violet solid(31 mg, 72 %). $^1$H NMR($CDCl_3$, $\delta_{ppm}$): 8.97(s, 8H, $H_\beta$); 8.23(d, 8H, J = 8.46 Hz, $H_o$); 7.40(d, 8H, J = 8.46 Hz, $H_m$); 4.21(s, 9H, $OCH_3$); 5.40~5.13(m, 4H, $C_{1\sim4}$ H); 4.67~4.69(d, 2H, J = 4.2 Hz, $C_6$ H); 4.25~4.19(m, 1H, $C_5$ H); 2.45(s, 12H, $CH_3$); -2.65(s, 2H, N H). IR(ν, KBr, $cm^{-1}$): 2923, 2854(C-H), 1753(C=O), 1603, 1504(-ph-), 1223, 1167, 1040(shoulder peak of sugar ring), 1248(O-$CH_3$). UV-vis($\lambda_{max}$, $CHCl_3$): 418(Soret band), 520, 552, 591 and 646 nm. Anal. for $C_{61}H_{54}N_4O_{13}$ Calcd: C, 69.83; H, 5.00; N, 5.34. Found: C, 69.31; H, 5.17; N, 5.27.

Preparation of complex **Co(4):** The compound **4** (30 mg, 0.015 mmol) and $Co(OAc)_2$ (27 mg, 0.15 mmol) were dissolved in 40 mL of chloroform. The mixture was refluxed for 1 hr. The crude product was purified with column chromatography using silica gel as solid support, and $CHCl_3$ as eluent, and collected the second band. Removal of solvent yielded red solid **Co(4)** (23 mg, 75 %). $^1$H NMR($CDCl_3$, $\delta_{ppm}$): 15.85(br, 8H, $H_\beta$); 13.09(br, 8H, $H_o$); 9.64(br, 8H, $H_m$); 5.50~5.11(m, 16H, $C_{1\sim4}$ H); 4.29~4.27(d, 8H, J = 4.2 Hz, $C_6$ H); 4.15~4.10(m, 4H, $C_5$ H); 3.30(s, 48H, $CH_3$). IR (ν, KBr, $cm^{-1}$): 2924, 2855(C-H), 1753(C=O), 1603, 1504(-ph-), 1223, 1167, 1042(shoulder peak of sugar ring), 1002 (OSMB)**. UV-vis($\lambda_{max}$, $CHCl_3$): 418(Soret band), 538 nm. Anal. for $C_{100}H_{100}N_4O_{40}Co$ Calcd: C, 58.39; H, 4.90; N, 2.72. Found: C, 58.43; H, 5.20; N, 2.84.

Preparation of complex **Mn(4):** To a solution of compound **4** (30 mg, 0.015 mmol) in 40 mL of chloroform was added a solution of Mn $(OAc)_2$(30 mg, 0.17 mmol) in 5 mL ethanol. The mixture was refluxed for 4 hr. The solution was cooled, and then filtered. The crude product was purified with column chromatography using silica gel as solid support, and $CHCl_3$ as eluent. Removal of solvent yielded deep green solid **Mn(4)** (20 mg, 65 %). IR(ν, KBr, $cm^{-1}$): 2924, 2855(C-H), 1753(C=O), 1603, 1504(-ph-), 1223, 1167, 1042 (shoulder peak of sugar ring) 1008 (OSMB). UV-vis($\lambda_{max}$, $CHCl_3$): 472 (Soret band), 620 nm. Anal. For $C_{100}H_{100}N_4O_{40}Mn$ Calc d: C, 58.51; H, 4.91; N, 2.73. Found: C, 58.13; H, 5.40; N, 2.34.

Preparation of complex **Co(5)** and **Mn(5)**: The complex **Co(5)** and **Mn(5)** were prepared by the same method. Their yield was around 65~75%. Their $^1$H NMR, UV-vis and IR spectral data are also the similar as those of **Co(4)** and **Mn(4).** The complex **Co(5)**: red solid. **(**~71 %). Anal. Calcd for $C_{61}H_{52}N_4O_{13}Co$: C, 66.12; H, 4.73; N, 5.06. Found: C, 66.01; H, 5.02; N, 4.92. The complex **Mn(5)**: deep green solid.**(**~65 %). Anal Calcd. for $C_{61}H_{52}N_4O_{13}Mn$: C, 66.36; H, 4.75; N, 5.08. Found: C, 66.45; H, 4.90; N, 5.21.

These new compounds have been identified by IR, UV-visible, $^1$H NMR spectra and elemental analysis. The two groups of proton resonance signals of the porphyrin ring and glucose ring in compound **4** (or **5**) were clearly observed. The proton resonance of porphyrin ring is located at 7~9 ppm, and proton resonance of the glucose ring is at 3~4 ppm. For a certain porphyrin ligand, the complexes with different metal exhibit nearly the same proton resonance signal of porphyrin ring and glucose ring. In the IR spectra, the N-H stretching band at about 3300 $cm^{-1}$ disappeared, and a strong and

sharp peak at about 1000 $cm^{-1}$, which is the oxidation state market band (OSMB) of metal. The OSMB frequencies of **Co(4)**[or **Co(5)**] is 1002 $cm^{-1}$, and **Mn(4)** [or **Mn(5)**] is 1008 $cm^{-1}$. UV-vis. spectra of metal complex are distinct from free-base porphyrin. The UV-vis spectra of metal porphyrins showed that the Soret band blue shifted from 416 to 413 nm, and the B band turns from four bands(516, 553, 594 and 652) to one band (528 nm) for complex **Co(4).**

We don't report the melting point of these porphyrins and their metal complexes because their melting temperatures are too high to measure. It is also difficult to obtain the optical rotation values of chiral glucose bonded porphyrins and their metal complexes due to the low transmissivities in solution.

**Acknowledgment**

This work was supported by the National Natural Science Foundation of China (projects No. 29972035).

**References and notes**

1. S. Kugimiya, *J. Chem. Soc., Chem. Commun.*, **1990**, *5*, 432.
2. L. R Milgrom, *The Colours of Life: An Introduction to the Chemistry of Porphyrins and Related Compounds*, Oxford University Press, **1997**.
3. J. B. Lee, J. A. Hunt, J. T. Groves, *J. Am. Chem. Soc.*, **1998**, *120* (24), 6053.
4. J. B. Lee, J. A. Hunt, J. T. Groves, *J. Am. Chem. Soc.*, **1998,** *120* (30), 7493.
5. Z. Y. Li, C. Li, Q. Feng, *J. Wuhan Univ. (Nat. Sci. Ed.)*, **2000,** *46* (2), 150.
6. S. Q. Huang, L. M. Sun, C. Ye, *Chemical J. of Chinese Universities*, **1983**, *4* (3), 381**.**
7. H. Y. Liu, Y. Chen, H. X. Zhao, *Wuhan Univ. J. of Nature Sciences*, **1998,** *3* (1), 81.
8. L. R. Milgrom, *J. Chem. Soc., Perkin Trans. I*, **1983,** 2538.

*: $H_o$, $H_m$, : the protons of *othro, meta, para* in phenyl of porphyring ring;
$H_\beta$: the proton of pyrrole ring in porphyrin ring
**: OSMB: Oxidation State Market Band.

Received 20 October, 2000