Synthesis of β-Cyclodextrin Bonded Metal Porphyrins

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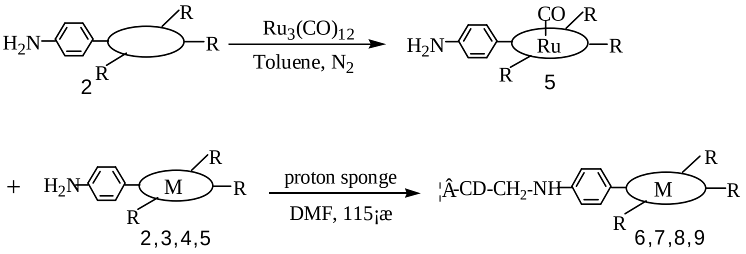
Abstract: 6-Deoxy- 6-iodo-β-cyclodextrin (**1**) reacted with 5-(*p*-aminophenyl)-10,15,20-triphenyl porphyrin(**2**), 5-(*p*-aminophenyl)-10,15,20-triphenyl nickel(II) porphyrin [Ni^{II} $TPP_{NH2}P$] (**3**), 5-(*p*-aminophenyl)-10,15,20-triphenyl manganese(Ⅲ) porphyrin [Mn^{III} $TPP_{NH2}P$] (**4**) and 5-(*p*-aminophenyl)-10,15,20-triphenyl carbonyl ruthenium porphyrin [$Ru^{II}(CO)TPP_{NH2}P$] (**5**) to generate the compounds **6-9,** respectively. Those new compound **5-9** have been identified by ^1H NMR, IR, MS and UV-visible spectra and elemental analysis.

Keywords: β-Cyclodextrin, metal porphyrins, synthesis.

In recent years study on developing novel mimic enzyme models that have both $ONOO^-$ decomposition and $O_2^{\bullet -}$ (or •OH) dismutase ability is a very active research field[1,2]. These models show very important effect in providing protection from tissue damage associated with various types of inflammatory diseases. Metalloporphyrins as superoxide dismutase (SOD) mimics have showed the ability to catalyst these harmful radicals. Grove and co-workers reported [Mn(Ⅲ)TMPyP] and [Fe(Ⅲ)TMPyP] which have showed very efficient behavior as peroxynitrite reductase and can deplete $O_2^{\bullet -}$ during the reductase process, and the relevant mechanisms were also been put forward. Our research group also found that different carbonyl ruthenium porphyrins and their derivative have the ability to eliminate the $O_2^{\bullet -}$, •OH and anti lipid peroxidation[3]. In the human body, most of the harmful radicals such as $O_2^{\bullet -}$, $ONOO^-$ exist in water phase. But most porphyrins, native or synthetic, are not sufficiently soluble in aqueous surroundings, particularly at or near neutral pH’s. The CD derivative express the ability to be very soluble in water, cheap, available in high purity, nontoxic, even in high doses in chronic treatment[4]. We report the synthesis and characterization of β-cyclodextrin bonded metalloporphyrin **7-9**, whose soluble ability in aqueous-phase has greatly improved. The cyclodextrin bonded metalloporphyrins as the novel two functional mimic enzyme models with more efficient ability to eliminate harmful oxidants can be established.

The compound **1** was prepared by literature 5. The solution of compound **2** and $M(OAc)_2$ (M = Ni and Mn) in chloroform was refluxed with stirring for 20 h. After then, column chromatograph on silica gel, with ethanol:chloroform (100∶3, v/v) as eluent afforded the complexes **3** and **4**. Complex **5** was made by literature 6. The synthesis procedures of compound **6-9** are according to literature 7. Treatment **2 (3, 4, 5,)** with compound **1** in dry DMF under N_2 at 115℃ for 3h, the solution was cooled to r.t. and added dropwise to a large amount of acetone to generate the precipitate, which was redissolved in warm water and extracted 3 times with chloroform. Acetone was added to aqueous layer to give the compound **6-9**. The synthetic routes are listed below.



M = 2H, (**2, 6**), Ni, (**3, 7**), Mn, (**4, 8**), Ru-CO, (**5, 9**).

Compound **5**, yield: 76%, Anal.Calcd for $C_{45}H_{29}N_5RuO$: C, 71.42; H, 3.86; N, 9.25. Found: C, 70.81; H, 3.58; N, 8.87. ^1H NMR (δ, ppm)($CDCl_3$): 8.83(s, 8H, H_β); 8.14~8.02 (m, 8H, H_o $H_{o'}$)*; 7.78~7.64 (m, 11H, H_m,H_p $H_{m'}$); 3.86(s, 2H, NH_2). UV-vis λ_{max} 416 nm (Soret band). IR, υ (KBr): 3320 (N-H), 1593, 1477 (-Ar-). MS (ESI): *m/z* 756.5. Compound **6**, yield: 43%, Anal.Calcd for $C_{86}H_{99}N_5O_{34}$: C, 59.16; H, 5.71; N, 4.01. Found: C, 58.78; H, 5.98 N, 3.84. ^1H NMR (δ, ppm)(DMSO): 8.67(s, 8H, H_β); 8.20~7.97 (m, 8H, H_o $H_{o'}$); 7.74~7.71 (m, 11H, H_m ,H_p, $H_{m'}$); 4.84(s, 7H, C_1-H); 3.66~3.57(m, 28H, $C_{3,5,6}$ H); 3.38~3.30(14H, $C_{2,4}$ H); UV-visible λ_{max} 417 nm (Soret band). IR υ (KBr): 2927 (C-H), 1595, 1508 (-Ar-), 1115, 1031(C-C). MS (ESI): *m/z* 1746.7. Compound **7**: yield: 41%, Anal.Calcd for $C_{86}H_{97}O_{34}N_5Ni$: C, 57.28; H, 5.42; N, 3.88. Found: C, 57.58; H, 5.62; N, 3.54. ^1H NMR (δ, ppm)(DMSO): 8.77(s, 8H, H_β); 8.20~8.16 (m, 8H, H_o $H_{o'}$); 7.83~7.78 (m, 11H, H_m ,H_p, $H_{m'}$); 4.84(s, 7H, C_1 H); 3.65~3.52(m, 28H, $C_{3,5,6}$ H); 3.35~3.31(14H, $C_{2,4}$-H); UV-vis λ_{max} 418 nm (Soret band). IR, υ (KBr): 2925 (C-H), 1595, 1508, (-Ar-), 1113, 1031(C-C), 1003(OSMB). The characteristic data of compounds **8, 9** are similar to compound **7**. Compounds **8**: yield, 38%, UV-vis λ_{max} 476 nm (Soret band). IR, υ (KBr): 1006(OSMB). Compounds **9**: yield, 43%, UV-vis λ_{max} 410 nm (Soret band). IR, υ (KBr): 1001(OSMB).* H_o H_m H_p: the protons of *ortho*, *meta*, *para* in triphenyl of porphyrin ring; $H_{o'}$ $H_{m'}$: The protons of *ortho* and *meta* in 4-aminophenyl of porphyrin ring. OSMB: Oxidation State Market Band

Acknowledgment

This work was supported by the National Natural Science Foundation of China (projects No. 29972035) and Natural Science Foundation of Hubei Province (projects No. 98J043).

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Received 20 January 2000