Scientific paper

Syntheses, X-Ray Single Crystal Structures and Biological Activities of Cobalt(III) Complexes with Reduced Schiff Base Ligands

Xiao-Qiang Luo,1,2 Qiao-Ru Liu,1 Yong-Jun Han1 and Ling-Wei Xue1,2,*

1 School of Chemical and Environmental Engineering, Pingdingshan University, Pingdingshan Henan 467000, P.R. China
2 Henan Key Laboratory of Research for Central Plains Ancient Ceramics, Pingdingshan University, Pingdingshan Henan 467000, P.R. China
* Corresponding author: E-mail: pdsuchemistry@163.com
Received: 06-08-2019

Abstract
A new mononuclear cobalt(III) complex, [Co(HL1)2]Cl (1), derived from the reduced Schiff base 2,2'-((ethane-1,2-diylbis(azanediyl))bis(methylene))diphenol (H2L1), and a new dinuclear cobalt(III) complex, [Co2(L2)2] ∙ 2H2O (2), derived from the reduced Schiff base 6,6'-(2-hydroxypropane-1,3-diyl)bis(azanediyl)bis(methylene)bis(2-bromo-4-chlorophenol) (H2L2), were synthesized and characterized by infrared and electronic spectroscopy, and single crystal X-ray diffraction techniques. The ligands were synthesized first, and then bound to the Co(III) centre. Compound 1 contains a mononuclear [Co(HL1)2]+ cation and a chloride anion. The cationic moiety possesses crystallographic inversion center symmetry. Compound 2 contains a dinuclear [Co2(L2)2] molecule and two water hydrate molecules. The Co atoms in the complexes are in octahedral coordination. Both complexes showed potential antimicrobial activity.

Keywords: Cobalt complex; reduced Schiff base ligand; crystal structure; antimicrobial activity

1. Introduction
Schiff bases derived from the condensation reactions of carbonyl containing compounds with primary amines have received tremendous attention in coordination chemistry because of their facile coordination ability to a large number of metals.1 Schiff bases have various biological applications.2 A number of complexes with Schiff base ligands have presented interesting biological properties, such as antibacterial, antifungal, antitumor, and enzymatic catalytic property.3 The Schiff bases have good complexing ability and their biological activity increases on complex with metal ions.4 Multi-dentate Schiff base ligands containing both nitrogen and oxygen donor atoms, derived from the condensation of salicylaldehyde and various diamines have intensely been studied, due to their ability to stabilize a great variety of coordination numbers and coordination geometries.5 Cobalt(III) Schiff base complexes are also important in bioinorganic chemistry for important biological processes like antibacterial, antitumor, and antifungal activities.6 However, Schiff bases are not very stable in acid condition due to the azomethine groups. Reduced Schiff bases are in general more stable than Schiff bases. In this paper, two new cobalt(III) complexes, [Co(HL1)2]Cl (1) and [Co2(L2)2] ∙ 2H2O (2), where HL1 and L2 are the monoanionic form of the reduced Schiff base 2,2'-((ethane-1,2-diylbis(azanediyl))bis(methylene))diphenol (H2L1) and the trianionic form of the reduced Schiff base 6,6'-(2-hydroxypropane-1,3-diyl)bis(azanediyl)bis(methylene)bis(2-bromo-4-chlorophenol) (H2L2), were synthesized and characterized by infrared and electronic spectroscopy, and single crystal X-ray diffraction techniques. The ligands were synthesized first, and then bound to the Co(III) centre. Compound 1 contains a mononuclear [Co(HL1)2]+ cation and a chloride anion. The cationic moiety possesses crystallographic inversion center symmetry. Compound 2 contains a dinuclear [Co2(L2)2] molecule and two water hydrate molecules. The Co atoms in the complexes are in octahedral coordination. Both complexes showed potential antimicrobial activity.

Keywords: Cobalt complex; reduced Schiff base ligand; crystal structure; antimicrobial activity

1. Introduction
Schiff bases derived from the condensation reactions of carbonyl containing compounds with primary amines have received tremendous attention in coordination chemistry because of their facile coordination ability to a large number of metals.1 Schiff bases have various biological applications.2 A number of complexes with Schiff base ligands have presented interesting biological properties, such as antibacterial, antifungal, antitumor, and enzymatic catalytic property.3 The Schiff bases have good complexing ability and their biological activity increases on complex with metal ions.4 Multi-dentate Schiff base ligands containing both nitrogen and oxygen donor atoms, derived from the condensation of salicylaldehyde and various diamines have intensely been studied, due to their ability to stabilize a great variety of coordination numbers and coordination geometries.5 Cobalt(III) Schiff base complexes are also important in bioinorganic chemistry for important biological processes like antibacterial, antitumor, and antifungal activities.6 However, Schiff bases are not very stable in acid condition due to the azomethine groups. Reduced Schiff bases are in general more stable than Schiff bases. In this paper, two new cobalt(III) complexes, [Co(HL1)2]Cl (1) and [Co2(L2)2] ∙ 2H2O (2), where HL1 and L2 are the monoanionic form of the reduced Schiff base 2,2'-((ethane-1,2-diylbis(azanediyl))bis(methylene))diphenol (H2L1) and the trianionic form of the re-
duced Schiff base 6,6’-(2-hydroxypropane-1,3-diyl)bis(azanediyl)bis(methylene)bis(2-bromo-4-chlorophenol) (H2L2; Scheme 1), were synthesized and studied on their antibacterial potential.

2. Experimental

2.1. General Methods and Materials

All reagents and solvents were purchased from the commercial sources and used as received. Elemental (C, H and N) analyses were performed on a Perkin-Elmer 2400 II analyzer. IR spectra were recorded in the region 4000–400 cm–1 on a Perkin Elmer RXI spectrometer with samples as KBr disks. UV-Vis spectra were recorded on a Shimadzu UV-3600 spectrophotometer. Molar conductivity was measured at 25 °C with a DDS-11A conductivity meter. The NMR spectra were recorded on a Bruker spectrometer at 300 MHz. X-ray diffraction was carried out on a Bruker Apex II CCD diffractometer.

2.2. Synthesis of H2L1

To salicylaldehyde (1.22 g, 10 mmol) diluted by MeOH (50 mL), 1,2-diaminoethane (0.30 g, 5 mmol) diluted by MeOH (50 mL) was added with stirring. The reaction mixture was refluxed for 1 h and cooled by ice-water bath. Then, NaBH4 (1.0 g, 25 mmol) was added. The mixture was stirred for another 1 h and filtered. The solvent was removed by distillation. The residue was treated with MeOH (50 mL), 1,2-diaminoethane (0.30 g, 5 mmol) diluted by MeOH (50 mL). The solution was treated with 3 M HCl and the aqueous solution of 1 M NaOH (50 mL) and extracted was removed by distillation. The residue was treated with chloroform. The solution was stirred for another 1 h and filtered. The solvent was removed by distillation. Then, NaBH4 (1.0 g, 25 mmol) was added. The mixture was refluxed for 1 h and cooled by ice-water bath. Then, NaBH4 (1.0 g, 25 mmol) was added. The mixture was stirred for another 1 h and filtered. The solvent was removed by distillation. The residue was treated with MeOH (50 mL), 1,2-diaminoethane (0.30 g, 5 mmol) diluted by MeOH (50 mL). The solution was treated with 3 M HCl and the aqueous solution of 1 M NaOH (50 mL) and extracted was removed by distillation. The residue was treated with chloroform. The solution was stirred for another 1 h and filtered. The solvent was removed by distillation. Then, NaBH4 (1.0 g, 25 mmol) was added. The mixture was refluxed for 1 h and cooled by ice-water bath. Then, NaBH4 (1.0 g, 25 mmol) was added. The mixture was stirred for another 1 h and filtered. The solvent was removed by distillation. Then, NaBH4 (1.0 g, 25 mmol) was added. The mixture was refluxed for 1 h and cooled by ice-water bath. Then, NaBH4 (1.0 g, 25 mmol) was added. The mixture was stirred for another 1 h and filtered. The solvent was removed by distillation. Then, NaBH4 (1.0 g, 25 mmol) was added. The mixture was refluxed for 1 h and cooled by ice-water bath. Then, NaBH4 (1.0 g, 25 mmol) was added. The mixture was stirred for another 1 h and filtered. The solvent was removed by distillation.

2.3. Synthesis of H2L2

H2L2 was prepared by the same method as described for H2L1, with salicylaldehyde replaced by 3-bromo-5-chlorosalicylaldehyde (2.34 g, 10 mmol), and with 1,2-diaminoethane replaced by 1,3-diaminopropan-2-ol (0.45 g, 5 mmol). Yield 0.9 g (66%). IR data (ν, cm–1): 3337, 3212, 3061, 2983, 2930, 2855, 1600, 1481, 1075. UV-Vis data (MeOH; λmax, nm): 210, 263, 317, 372. Anal. Calcd. (%) for C16H20N2O2: C, 70.56; H, 7.40; N, 10.29. Found (%): C, 70.45; H, 7.47; N, 10.23.

2.4. Synthesis of Complex 1

A solution of H2L1 (54.4 mg, 0.20 mmol) in MeOH (10 mL) was added dropwise with stirring at room temperature to a solution of CoCl2 · 6H2O (23.8 mg, 0.10 mmol) in MeOH (10 mL). The solution immediately became deep brown and was stirred for 1 h. Single crystals suitable for X-ray diffraction were obtained after 11 days by slow evaporation of the reaction solution. Yield: 23 mg (36%). IR data (ν, cm–1): 3245, 1218, 1073. UV-Vis data (MeOH; λmax, nm): 280, 372. ΛM (103 mol L–1 in MeOH): 151 Ω–1 cm2 mol–1. Anal. Calcd. (%) for C32H38ClCoN4O4: C, 60.33; H, 6.01; N, 8.79. Found (‰): C, 60.46; H, 6.12; N, 8.76.

2.5. Synthesis of Complex 2

Complex 2 was prepared by the same method as described for complex 1, with H2L1 replaced by H2L2 (52.9 mg, 0.10 mmol), and with CoCl2 · 6H2O replaced by Co(CH3 COO)2 · 4H2O (24.9 mg, 0.10 mmol). Single crystals suitable for X-ray diffraction were obtained after 3 days by slow evaporation of the reaction solution. Yield: 23 mg (38%). IR data (ν, cm–1): 3419, 3246, 1587, 1443, 1303, 1274, 1213, 1169, 1085, 861, 730, 605. UV–Vis data (MeOH; λmax, nm): 210, 263, 317, 372. ΛM (103 mol L–1 in MeOH): 21 Ω–1 cm2 mol–1. Anal. Calcd. (%) for C34H34Br4Cl4Co2N4O9: C, 33.42; H, 2.80; N, 4.59. Found (‰): C, 33.56; H, 2.87; N, 4.47.

2.6. X-ray Crystallography

The crystallographic data for the complexes are summarized in Table 1. Diffraction data of the complexes were collected on a Bruker APEX II CCD diffractometer at 298(2) K using graphite-monochromated Mo Kα radiation (λ = 0.71073 Å). For data processing and absorption correction the packages SAI NT and SADAB S were used. The structures were solved by direct and Fourier methods and refined by full-matrix least-squares based on F2 using SHELXTL and SHELXL-97 packages. The non-hydrogen atoms were refined anisotropically. The hydrogen atoms on water molecules and the amino groups of complex 2 were located from a Fourier difference map and refined isotropically, with O–H, N–H and H···H distances restrained to 0.85(1), 0.90(1) and 1.37(2) Å, respectively. The structure of complex 2 containing solvent accessible voids of 236 Å3 may accommodate disordered solvent molecules. The remaining hydrogen atoms were inserted on geometrical calculated positions with fixed thermal parameters and were refined isotropically.

CCDC 1906730 and 1946056 contain the supplementary crystallographic data for the complexes 1 and 2, respectively. The data can be obtained free of charge via http://www.ccdc.cam.ac.uk/conts/retrieving.html, or from...
2. 7. Antibacterial Activity

The antibacterial activities were tested against *B. subtilis*, *E. coli*, *P. fluorescence* and *S. aureus* using MH medium (Mueller–Hinton medium). The MICs (minimum inhibitory concentrations) of the test compounds were determined by a colorimetric method using the dye MTT [3-(4,5-dimethylthiazol-2-yl)-2,5-diphenyltetrazolium bromide]. A stock solution of the synthesized compound (50 μg mL⁻¹) in DMSO was prepared and quantities of the test compounds were incorporated in specified quantity of sterilized liquid MH medium. A specified quantity of the

| Table 1. Crystallographic and refinement data for the complexes |
| --- |
| 1 | 2 |
| Formula | C₃₂H₃₂ClCoN₄O₄ | C₃₄H₃₄Br₄Cl₂Co₂N₄O₉ |
| FW | 637.04 | 1221.95 |
| Crystal system | Monoclinic | Monoclinic |
| Space group | C₂/c | P₂₁/c |
| a (Å) | 23.905(1) | 15.732(2) |
| b (Å) | 7.376(1) | 12.478(2) |
| c (Å) | 17.745(1) | 23.992(3) |
| β (°) | 95.753(1) | 103.727(2) |
| V (Å³) | 3113.2(6) | 4575.2(9) |
| Z | 4 | 4 |
| μ (MoKα) (cm⁻¹) | 0.679 | 4.504 |
| Collected reflections | 8606 | 26672 |
| Unique reflections | 2861 | 8507 |
| Observed reflections \( [I ≥ 2σ(I)] \) | 1591 | 4823 |
| Parameters | 192 | 514 |
| Restraints | 0 | 6 |
| Goodness of fit on \( F² \) | 0.947 | 1.039 |
| \( R₁, wR₂ \) \( [I ≥ 2σ(I)] \) | 0.0532, 0.1031 | 0.0718, 0.2049 |
| \( R₁, wR₂ \) (all data) | 0.1275, 0.1307 | 0.1345, 0.2399 |

Scheme 2. The synthetic procedure of the complexes.
medium containing the compound was poured into micro-titration plates. A suspension of the microorganism was prepared to contain approximately $10^5$ cfu mL$^{-1}$ and applied to micro-titration plates with serially diluted compounds in DMSO to be tested and incubated at 37 °C for 24 h. After the MICs were visually determined on each of the micro-titration plates, 50 μL of PBS containing 2 mg of MTT per millilitre was added to each well. Incubation was continued at room temperature for 4–5 h. The content of each well was removed and 100 μL of isopropanol containing hydrochloric acid was added to extract the dye. After 12 h of incubation at room temperature, the optical density (OD) was measured with a micro-plate reader at 550 nm.

3. Results and Discussion

3.1. Chemistry

The cobalt(III) complexes 1 and 2 were prepared by the reaction of CoCl$_2$ · 6H$_2$O with the reduced Schiff base H$_2$L$^1$ and Co(CH$_3$COO)$_2$ · 4H$_2$O with the reduced Schiff base H$_3$L$^2$, respectively in MeOH (Scheme 2). The aerial oxidation of cobalt(II) to cobalt(III) and metal assisted deprotonation of the phenolic moieties took place during the formation of the complexes. Molar conductivity values of complexes 1 and 2 measured in MeOH indicate the 1:1 electrolytic nature of complex 1 and non-electrolytic nature of complex 2.

3.2. Spectral Characterization

In the IR spectra of the complexes, the bands corresponding to the azomethine groups (–CH=N–) are not observed, instead, new bands indicative of the C–N groups are observed at 1073–1085 cm$^{-1}$, indicating the reduction of the –CH=N– double bonds to the –CH$_2$–NH– single bonds. The complexes show medium bands at 1213–1218 cm$^{-1}$ due to the presence of Ar–O stretching. Weak and sharp bands for the spectra of the complexes located at 3245 cm$^{-1}$ indicates the presence of amino groups. The weak and broad band centered at 3419 cm$^{-1}$ for complex 2 can be assigned to the stretching vibration of water molecules.

The UV-Vis spectra of the complexes were measured in MeOH. There are two bands centered at 280 and 372 nm for 1 and four bands centered at 210, 263, 317 and 372 nm for 2. The bands arise due to internal ligand transition or ligand to metal charge transfer. The complexes exhibit low intensity bands at 615–630 nm which are due to the $d$-$d$ transition of Co$^{III}$ center.

3.3. Structure Description of the Complexes

Selected bond lengths and bond angles in the coordination environment of the metal center are listed in Table 2. Complex 1 contains a mononuclear [Co(HL$^1$)$_2$]$^+$ cation and a chloride anion (Fig. 1). The cationic moiety possesses a crystallographic inversion symmetry. The Co atom, lying on the inversion center, is coordinated by two phenolate O and four amino N atoms from two HL$^1$ ligands, forming octahedral coordination. The Co–O and Co–N bond lengths in the complex are in the range 1.906(3)–1.991(3) Å, which are very close to those reported in literature. The cisoid (85.8(1)–94.1(1)°) and transoid angles (180°) in the complex are almost near to the ideal values.

Fig. 1. The mononuclear complex cationic moiety of 1. The chloride anion is omitted for clarity. Displacement ellipsoids are drawn at the 30% probability level and H atoms are shown as small spheres of arbitrary radii.
In the crystal structure, the complex cations are linked by chloride anions through intermolecular hydrogen bonds of types N–H⋯Cl, N–H⋯O and O–H⋯Cl (Table 3), to form two-dimensional network along the bc plane (Fig. 2).

Complex 2 contains a dinuclear [Co₂(L²)₂] molecule and two water hydrate molecules (Fig. 3). The Co₁ atom is coordinated by two phenolate O, two amino N, and two hydroxy O atoms from two L² ligands, forming octahedral coordination. The Co₂ atom is coordinated by two pheno-
late O, two amino N, and one hydroxy O atoms from one L$^2$ ligand, and by one water O atom, forming octahedral coordination. The Co–O and Co–N bond lengths in the complex are in the range 1.871(6)–1.957(6) Å, which are very close to those reported in literature. The cisoid (81.9(3)–95.3(3)$^\circ$ for Co1 and 82.1(3)–95.0(3)$^\circ$ for Co2) and transoid angles (174.8(3)–176.9(3)$^\circ$ for Co1 and 173.3(4)–175.9(3)$^\circ$ for Co2) in the complex are almost near to the ideal values.

In the crystal structure, the complex molecules and the water molecules are linked through intermolecular hydrogen bonds of types O–H∙∙∙O, O–H∙∙∙N and N–H∙∙∙O (Table 3), to form two-dimensional network along the ab plane (Fig. 4).

### 3.4. Antibacterial Activity

The free reduced Schiff base ligands and their cobalt(III) complexes were screened for antibacterial activity against two Gram-positive bacterial strains (B. subtilis and S. aureus) and two Gram-negative bacterial strains (E. coli and P. fluorescence) by the MTT method. The MIC values of the compounds against these bacteria are presented in Table 4. Penicillin G and kanamycin were assayed as references. H$_2$L$^1$ is inactive against two Gram-positive bacterial strains B. subtilis and S. aureus, and has weak activity against the Gram-negative bacterial strains E. coli and P. fluorescence with MIC values of 25 μg mL$^{-1}$. H$_3$L$^2$ is inactive against the Gram-negative bacterial strain P. fluorescence, and has weak activity against the Gram-negative bacterial strain E. coli and the Gram-positive bacterial strain S. aureus, with MIC values of 25 μg mL$^{-1}$. H$_3$L$^2$ is active against the Gram-positive bacterial strain B. subtilis, with MIC value of 12.5 μg mL$^{-1}$. The cobalt(III) complexes, in general, showed a wide range of bactericidal activities against all the Gram-positive and Gram-negative bacteria. Complex I has good activity against the Gram-positive bacterial strain B. subtilis and medium activity against

---

**Table 2.** Selected bond lengths (Å) and angles (°) for the complexes

|     | Bond Lengths  | Angles          |
|-----|---------------|-----------------|
| 1   | Co1–O2 1.906(3) | Co1–N2 1.951(3) |
|     | Co1–N1 1.991(3) |                  |
|     | O2–Co1–O2$^a$ 180 | O2–Co1–N2$^a$ 85.9(1) |
|     | O2–Co1–N2 94.1(1) | N2–Co1–N2$^a$ 180 |
|     | O2–Co1–N1 93.8(1) | O2–Co1–N1$^a$ 86.2(1) |
|     | N2–Co1–N1$^a$ 93.7(1) | N2–Co1–N1 86.3(1) |
| 2   | Co1–O4 1.893(6) | Co1–O6 1.905(7) |
|     | Co1–N4 1.922(7) | Co1–O5 1.931(6) |
|     | Co1–N3 1.942(7) | Co1–O3 1.957(6) |
|     | Co2–O1 1.869(7) | Co2–N1 1.895(9) |
|     | Co2–O2 1.892(7) | Co2–O3 1.929(6) |
|     | Co2–O7 1.932(9) | Co2–N2 1.932(9) |
|     | O4–Co1–O6 95.3(3) | O4–Co1–N4 176.9(3) |
|     | O6–Co1–N4 81.9(3) | O6–Co1–N3 88.6(3) |
|     | O6–Co1–O5 175.8(3) | N4–Co1–O5 94.2(3) |
|     | O4–Co1–N3 94.3(3) | O6–Co1–N3 85.5(3) |
|     | N4–Co1–N3 87.0(3) | O5–Co1–N3 92.7(3) |
|     | O4–Co1–O3 90.1(3) | O6–Co1–O3 91.4(3) |
|     | N4–Co1–O3 88.5(3) | O5–Co1–O3 90.1(3) |
|     | N3–Co1–O3 174.8(3) | O1–Co2–N1 91.4(3) |
|     | O1–Co2–O2 89.4(3) | N1–Co2–O2 175.8(4) |
|     | O1–Co2–O3 173.3(4) | N1–Co2–O3 87.5(3) |
|     | O2–Co2–O3 92.2(3) | O1–Co2–O7 92.9(3) |
|     | N1–Co2–O7 90.3(4) | O2–Co2–O7 85.5(3) |
|     | O3–Co2–O7 93.8(3) | O1–Co2–N2 91.2(4) |
|     | N1–Co2–N2 89.1(4) | O2–Co2–N2 95.0(3) |
|     | O3–Co2–N2 82.1(3) | O7–Co2–N2 175.9(3) |

Symmetry code for #1: –x, –y, 1 – z.
S. aureus, with MIC values of 3.12 and 12.5 μg mL⁻¹, respectively. Complex 2 has good activity against both Gram-positive bacterial strains B. subtilis and S. aureus, with MIC values of 0.78 and 6.25 μg mL⁻¹, respectively. As for the two Gram-negative bacterial strains E. coli and P. fluorescence, both complexes have excellent activities with MIC values of 1.56 and 0.78 μg mL⁻¹ for 1, and 3.12 and 6.25 μg mL⁻¹ for 2, respectively, which are stronger than the reference drug kanamycin.

### Table 3. Hydrogen bond distances (Å) and bond angles (°) for the complexes

| D–H···A   | d(D–H) | d(H···A) | d(D···A) | \( \angle (D–H···A) \) |
|----------|--------|---------|---------|-----------------------|
| 1        |        |         |         |                       |
| N2–H2···Cl1#1 | 0.89   | 2.50    | 3.246(3)| 142                   |
| N1–H1···O1   | 0.90   | 2.45    | 3.011(4)| 120                   |
| O1–H1A···Cl1 | 0.84   | 2.24    | 3.068(3)| 171                   |
| 2        |        |         |         |                       |
| O7–H7A···O6  | 0.85(1)| 1.68(3)| 2.507(10)| 162(9)               |
| O9–H9A···N2  | 0.85(1)| 2.28(6)| 3.048(17)| 151(11)              |
| N4–H4···O2   | 0.90(1)| 1.88(4)| 2.741(10)| 159(11)              |
| N2–H2···O9   | 0.90(1)| 2.15(2)| 3.048(17)| 177(11)              |
| O8–H8B···O5#2| 0.85(1)| 2.18(5)| 2.966(11)| 154(10)              |
| N3–H3···O8#3 | 0.90(1)| 2.23(7)| 2.999(12)| 143(10)              |

Symmetry codes: #1: -x, -y, -z; #2: x, y, z; #3: -x, 3/2+y, 3/2-z.

### Table 4. MIC values (μg mL⁻¹) of the compounds

|         | B. subtilis | S. aureus | E. coli | P. fluorescence |
|---------|-------------|-----------|---------|----------------|
| 1       | 3.12        | 12.5      | 1.56    | 0.78           |
| 2       | 0.78        | 6.25      | 3.12    | 6.25           |
| H₂L¹    | >100        | >100      | 25      | 25             |
| H₂L²    | 12.5        | 25        | 25      | >100           |
| Penicillin G | 0.78 | 3.13     | >100    | >100           |
| Kanamycin | 0.39       | 1.56      | 6.25    | 6.25           |

4. Conclusion

Two new cobalt(III) complexes with reduced Schiff base ligands 2,2′-((ethane-1,2-diylbis(azanediyl))bis(methylene))diphenol and 6,6′-((2-hydroxypropane-1,3-diyl)bis(azanediyl))bis(methylene))bis(2-bromo-4-chlorophenol) have been synthesized and structurally characterized. One complex is in mononuclear and the other one is in dinuclear. The Co atoms are in octahedral coordination. The complexes showed potential antimicrobial activities against two Gram-positive bacterial strains (B. subtilis and S. aureus) and two Gram-negative bacterial strains (E. coli and P. fluorescence).

5. References

1. (a) J. L. Pratihar, P. Mandal, C. K. Lai, S. Chattopadhyay, Polyhedron 2019, 161, 317–324. DOI:10.1016/j.poly.2019.01.002

(b) V. S. Zanon, J. A. Lima, T. Cuya, F. R. S. Lima, A. C. C. da Fonseca, J. G. Gomez, R. R. Ribeiro, T. C. C. Franca, M. D. Vargas, Inorg. Biochem. 2019, 191, 183–193. DOI:10.1016/j.inorgbio.2018.11.019

(c) M. M. Duan, Y. M. Li, L. Y. Xu, H. L. Yang, F. W. Luo, Y. X. Guan, R. T. Zhang, C. L. Jing, Z. L. You, Inorg. Chem. Commun. 2019, 100, 27–31. DOI:10.1016/j.inoche.2018.12.009

(d) A. Banerjee, S. Chattopadhyay, Polyhedron 2019, 159, 1–11. DOI:10.1016/j.poly.2018.10.059

(e) S. Kumari, K. Maddipoti, B. Das, S. Ray, Inorg. Chem. 2019, 58, 1527–1540. DOI:10.1021/acs.inorgchem.8b03031

2. (a) F. Tok, B. Kocyigit-Kamyakcioglu, B. N. Saglik, S. Levent, Y. Ozkay, Z. A. Kaplancikli, Bioorg. Chem. 2019, 84, 41–50. DOI:10.1016/j.bioorg.2018.11.016

(b) G. Kapoor, D. P. Pathak, R. Bhutani, A. Husain, S. Jain, M. A. Iqbal, Bioorg. Chem. 2019, 84, 478–492. DOI:10.1016/j.bioorg.2018.11.016

(c) P. T. Todorov, P. N. Peneva, S. I. Georgieva, R. I. Rusew, B. L. Shivachev, A. H. Georgiev, New J. Chem. 2019, 43, 2740–2751. DOI:10.1039/C8NJ05748F

3. (a) D. Majumdar, D. Das, S. S. Sreejith, S. Das, J. K. Biswas, M. Mondal, D. Ghosh, K. Bankura, D. Mishra, Inorg. Chim. Acta 2019, 489, 244–254. DOI:10.1016/j.ica.2019.02.022

(b) O. L. Cifuentes-Vaca, J. Andrades-Lagos, J. Campanini-Salinas, A. Laguna, D. Vasquez-Velasquez, M. C. Gimeno, Inorg. Chim. Acta 2019, 489, 275–279. DOI:10.1016/j.ica.2019.02.033

(c) M. Karmakar, T. Basak, S. Chattopadhyay, New J. Chem. 2019, 43, 4432–4443. DOI:10.1039/C8NJ06549G

(d) H. Bahron, S. S. Khaidir, A. M. Tajuuddin, K. Ramasamy, B. M. Yamin, Polyhedron 2019, 161, 84–92. DOI:10.1016/j.poly.2018.12.055

(e) F. Forouzandeh, H. Keypour, M. H. Zebjarjadian, M. Mahmoudabadi, L. Hosseinzadeh, R. Karamian, M. A. Khoei, R. W. Gable, Polyhedron 2019, 160, 238–246. DOI:10.1016/j.poly.2018.12.052

(f) K. Jana, S. Das, H. Puschmann, S. C. Debnath, A. Shukla, A. K. Mahanta, M. Hossain, T. Maity, B. C. Samanta, Inorg. Chim. Acta 2019, 487, 128–137. DOI:10.1016/j.ica.2018.12.007
Povzetek

Sintetizirali smo nov enojedrni kobaltov(III) kompleks, [Co(HL1)2]Cl (1), z uporabo reducirane Schiffove baze 2,2'-(etan-1,2-diilbis(azandiil))bis(metilen)difenol (H2L1), in nov dvojedrni kobaltov(III) kompleks, [Co2(L2)2] ∙ 2H2O (2), z uporabo reducirane Schiffove baze 6,6'-(2-hidroksipropan-1,3-diil)bis(azandiil)bis(metilen)bis(2-bromo-4-chlorofenol) (H2L2). Kompleksa smo okarakterizirali z infrardečo in elektronsko spektroskopijo ter rentgensko monokristalno analizo. Predhodno smo sintetizirali ligande ter jih nato vezali na Co(III) centre. Spojina 1 vsebuje enojedrne [Co(HL1)2]+ kation in kloridni anion. Kation leži na kristalografskem centru inverzije. Spojina 2 vsebuje dvojedrne [Co2(L2)2] molekule in dve molekuli hidratne vode. V kompleksih je Co atom oktaedrično koordiniran. Oba kompleksa izkazujeta potencialne protimikrobne lastnosti.