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Scientific paper

Synthesis, Crystal Structures and Urease Inhibition of 4-Bromo-*N*'-(1-(pyridin-2-yl)ethylidene)benzohydrazide and Its Dinuclear Copper(II) Complex

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Abstract

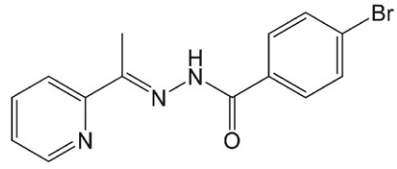
A new dinuclear copper(II) complex $[Cu_2(\mu\text{-}Br)_2L_2] \cdot 0.5MeOH$ with the benzohydrazone ligand 4-bromo-*N*'-(1-(pyridin-2-yl)ethylidene)benzohydrazide (HL) has been synthesized and characterized by elemental analysis, IR and UV-Vis spectroscopic studies. Single crystal structures of the complex and the benzohydrazone compound were studied. The Cu atoms in the complex are coordinated by two benzohydrazone ligands and two Br bridging groups, forming square pyramidal coordination. The complex has good inhibitory activity on *Jack bean* urease, with IC_{50} value of 1.38 $\mu mol \cdot L^{-1}$.

Keywords: Benzohydrazone; copper complex; crystal structure; urease inhibitory activity

1. Introduction

Urease (urea amidohydrolase; E.C.3.5.1.5) is a nickel-containing enzyme that catalyzes the rapid hydrolysis of urea to form ammonia.[1] It is harmful for environment, agriculture and human health. In the last few years, urease inhibitors have attracted much attention and numerous urease inhibitors have been reported.[2] Among the known urease inhibitors, hydroxamic acids, phosphoramides and thiols are the best recognized species. Because the low efficiency and negative side effect of the present urease inhibitors, the discovery of new and more efficient urease inhibitors is of high urgency.

Hydrazones constitute a class of famous ligands that have attracted much attention for their versatile coordination behavior toward various metal ions,[3] and wide applications especially in biological fields such as antibacterial,[4] antitumor,[5] anti-inflammatory[6] and cytotoxic,[7] *etc.* Interestingly, hydrazone compounds have been reported to have urease inhibitory activities.[8] Some vanadium complexes with hydrazone ligands also show effective biological activities, like antibacterial and urease inhibitory aspects.[9] In the last few years, a number of Schiff bases and their complexes have shown effective urease inhibitory activities.[10] Among the complexes, those with copper atoms are of particularly attention due to their high activities on urease.[11] In continuation of our work,[12] and aiming at obtaining new copper based urease inhibitors, in this work, a new benzohydraone compound 4-bromo-*N*'-(1-(pyridin-2-yl) ethylidene)benzohydrazide (HL, Scheme 1), and its copper(II) complex, $[Cu_2(\mu\text{-}Br)_2L_2] \cdot 0.5MeOH$, are presented.



Scheme 1. The hydrazone HL

2. Experimental

2. 1. Materials and Methods

2-Acetylpyridine and 4-bromobenzohydrazide with analytical grade were purchased from TCI. All other chemicals were obtained from Xiya Chemical Co. Ltd. All

the starting materials were used as received. Elemental analyses (CHN) were performed on a Perkin-Elmer 240 C elemental analyzer. Infrared spectra were recorded on a Jasco FT/IR-4000 spectrophotometer in the region 4000–400 cm^{-1} using KBr pellets. Electronic absorption spectra were recorded with a Lambda 35 spectrophotometer. ^1H NMR and ^{13}C NMR spectra for the benzohydrazone compound were recorded on a Bruker 500 MHz spectrometer. Single crystal X-ray diffraction was carried out with a Bruker SMART 1000 CCD diffractometer.

2. 2. Synthesis of 4-Bromo-*N*'-(1-(pyridin-2-yl)ethylidene)benzohydrazide (HL)

2-Acetylpyridine (1.21 g, 0.01 mol) was dissolved in 50 mL methanol, to which was added 50 mL methanol solution of 4-bromobenzohydrazide (0.21 g, 0.01 mol). The mixture was stirred and refluxed for 1 h. Then, the solvent was removed by distillation under reduced pressure. The white solid residue was re-crystallized from methanol to obtain colorless single crystals. Yield 2.9 g (76%).

Anal. Calcd for $C_{14}H_{12}BrN_3O$: C, 52.8; H, 3.8; N, 13.2%. Found: C, 53.0; H, 3.9; N, 13.0%. FT-IR data (KBr, cm^{-1}): ν(NH) 3283, ν(C=O) 1659, ν(C=N) 1587. UV data [10^{-3} mol L^{-1} in methanol, λ/nm (ε/L mol^{-1} cm^{-1})]: 245 (15,300), 298 (18,100), 365 (7,600). ^1H NMR (500 MHz, d^6-DMSO, ppm) δ 10.92 (s, 1H, N*H*), 8.61 (d, 1H, Py*H*), 8.11 (d, 1H, Py*H*), 7.84-7.71 (m, 6H, Py*H* + Ar*H*), 2.46 s (3H, CH_3). ^{13}C NMR (126 MHz, d^6-DMSO, ppm) δ 163.19, 154.98, 148.56, 147.71, 136.54, 132.04, 130.11, 129.58, 125.22, 124.81, 120.36, 12.63.

2. 3. Synthesis of $[Cu_2(\mu\text{-}Br)_2L_2] \cdot 0.5MeOH$

The benzohydrazone HL (0.32 g, 1.0 mmol) was dissolved in methanol (30 mL), to which was added solid $CuBr_2$ (0.22 g, 1.0 mmol). The mixture was stirred at room temperature for 30 min. The solution was filtered to remove minor unresolved residues. The filtrate was kept in air for several days to give blue block-shaped single crystals of the complex. Yield: 183 mg (40%).

Anal. Calcd for $C_{28.5}H_{24}Br_4Cu_2N_6O_{2.5}$: C, 36.5; H, 2.6; N, 9.0. Found: C, 36.3; H, 2.5; N, 9.2%. FT-IR data (KBr, cm^{-1}): ν(C=O) 1648; ν(C=N) 1591; 1446, 1373, 1160, 1077, 947, 855, 543, 522. UV data [10^{-3} mol L^{-1} in methanol, λ/nm (ε/L mol^{-1} cm^{-1})]: 272 (12,300), 380 (13,100). Λ_M (10^{-3} M in methanol): 25 Ω^{-1} cm^2 mol^{-1}.

2. 4. X-Ray Crystallography

The X-ray data of the benzohydrazone compound and the copper complex were collected at 298(2) K on a

Table 1. Crystal data for the benzohydrazone compound (HL) and the copper complex

	HL	**$[Cu_2(\mu\text{-}Br)_2L_2] \cdot 0.5MeOH$**
Formula	$C_{14}H_{12}BrN_3O$	$C_{28.5}H_{24}Br_4Cu_2N_6O_{2.5}$
FW	318.2	937.2
Crystal shape/colour	block/colorless	block/blue
Crystal size /mm	0.10 × 0.07 × 0.06	0.20 × 0.20 × 0.15
Crystal system	Triclinic	Triclinic
Space group	*P*$\bar{1}$	*P*$\bar{1}$
a (Å)	4.0153(15)	8.7406(11)
b (Å)	11.0020(19)	9.3175(13)
c (Å)	15.6170(15)	11.5701(15)
α (°)	85.102(2)	75.321(2)
β (°)	87.249(2)	80.994(2)
γ (°)	89.880(2)	64.845(2)
V (Å^3)	686.6(3)	823.79(19)
Z	2	1
λ (MoK***α***) (Å)	0.71073	0.71073
T (K)	298(2)	298(2)
μ (Mo*K****α***) (cm^{-1})	2.989	6.176
T_{min}	0.7543	0.3714
T_{max}	0.8410	0.4199
R_{int}	0.0482	0.0184
Reflections/parameters	4028/176	4423/209
Unique reflections	2527	3057
Observed reflections [$I \geq 2\sigma(I)$]	1332	2227
Restraints	1	13
Goodness of fit on F^2	0.974	1.053
R_1, wR_2 [$I \geq 2\sigma(I)$]	0.0660, 0.1656	0.0427, 0.1014
R_1, wR_2 (all data)	0.1324, 0.2132	0.0710, 0.1155

Table 2. Selected bond lengths (Å) and angles (°) for the copper complex

Cu1-N2	1.928(4)	Cu1-O1	1.950(4)
Cu1-N1	2.001(4)	Cu1-Br1A	2.3966(9)
Cu1-Br1	2.8263(10)		
N2-Cu1-O1	79.9(2)	N2-Cu1-N1	80.4(2)
O1-Cu1-N1	160.3(2)	N2-Cu1-Br1A	157.5(2)
O1-Cu1-Br1A	98.6(1)	N1-Cu1-Br1A	100.0(1)
N2-Cu1-Br1	107.1(1)	O1-Cu1-Br1	94.7(1)
N1-Cu1-Br1	90.1(1)	Br1-Cu1-Br1A	95.4(1)

Bruker SMART 1000 CCD diffractometer with graphite-monochromated Mo Kα radiation (0.71073 Å) from a classical sealed tube. The intensity data were reduced with SAINT.[13] The multi-scan absorption correction was performed with SADABS.[14] Structures of the benzohydrazone compound and the copper complex were solved with SHELXTL by direct methods and refined against F^2 by full-matrix least-squares method.[15] All non-hydrogen atoms of the compounds were refined anisotropically. The hydrogen atoms were placed in calculated positions and constrained to ride on their parent atoms. Crystallographic data for the benzohydrazone compound and the copper complex are summarized in Table 1. Selected bond lengths and angles are given in Table 2.

3. Results and Discussion

3. 1. Synthesis

The benzohydazone compound was facile synthesized by reaction of 2-acetylpyridine and 4-bromobenzohydrazide in methanol. The copper complex was readily prepared by the self-assembly reaction of the benzohydrazone compound with copper bromide in methanol. Single crystals of the ligand and the copper complex were formed by typical slow evaporation method. Molar conductivity of the copper complex in methanol with a concentration of 1.0×10^{-3} mol · L^{-1} is 25 Ω^{-1}·cm^2 · mol^{-1}, indicating the non-electrolytic nature of the complex.[16]

3. 2. Structure Description of the Benzohydrazone Compound (HL)

The molecular structure of the benzohydrazone compound is shown in Figure 1. The molecule shows *E* configuration with respect for the ethylidene group (C=N). The bond (C6–N2) with distance of 1.289(7) Å, confirms a typical double bond. In addition, the C8–N3 bond is shorter than usual, while the C8=O1 bond is longer than usual; suggest there are conjugation effects in the molecule. All the bond lengths are within normal values.[9c,17] The pyridine and benzene rings form a dihedral angle of 57.5(5)°. In the crystal structure of the complex, the adjacent two

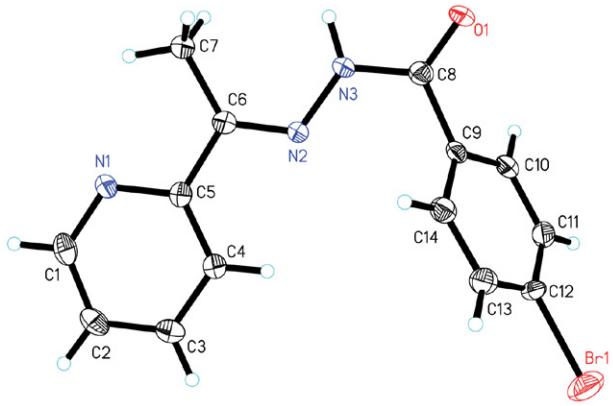
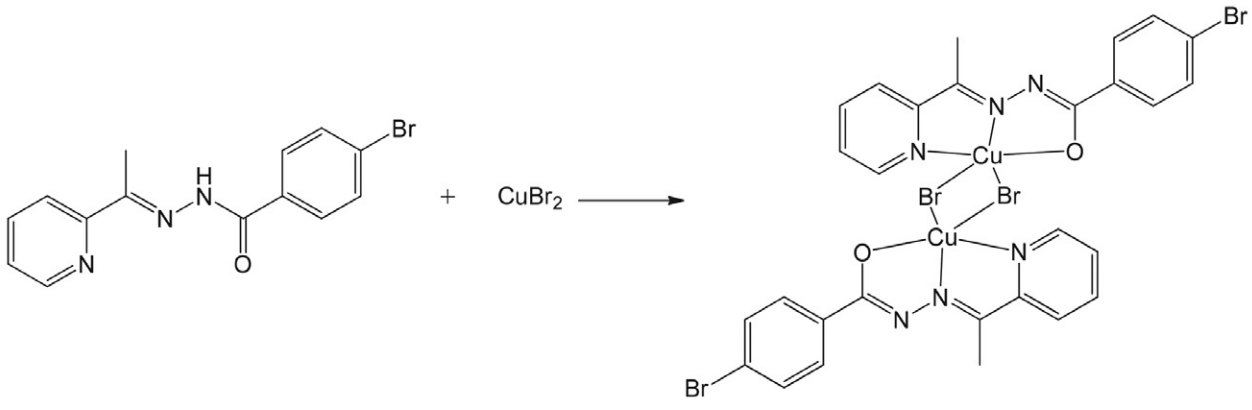


Figure 1. Molecular structure of the benzohydrazone compound, showing the atom-numbering scheme. Displacement ellipsoids are drawn at the 30% probability level.



Scheme 2. The synthetic procedure for the copper complex

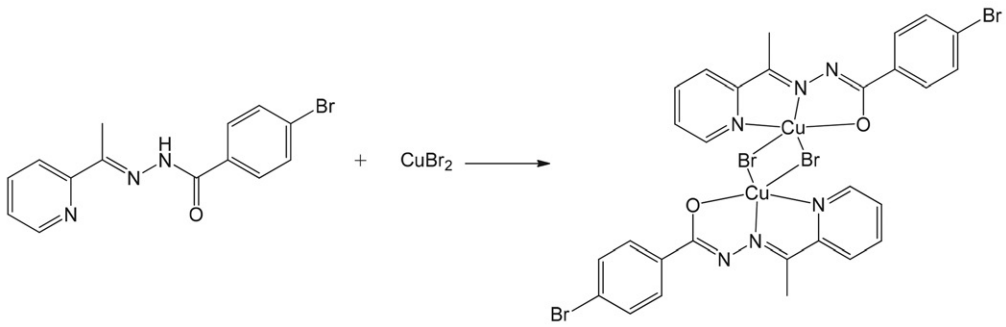


Figure 2. Molecular packing structure of the benzohydrazone compound, viewed down the *a* axis. Hydrogen bonds are drawn as dotted lines.

molecules are linked through intermolecular N–H···O hydrogen bonds (Table 3), to generate a dimeric structure (Figure 2).

3. 3. Structure Description of the Copper Complex

Molecular structure of the dinuclear copper(II) complex is shown in Figure 3. The compound contains a copper complex molecule and half of a methanol molecule. The Cu···Cu distance is 3.528(2) Å. The complex possesses crystallographic inversion center symmetry. The center is located at the central site of the two Cu atoms. The ligand coordinates to the Cu atom through the imino N, pyridine N, and enolate O atoms, generating five-membered chelate rings with bite angles of 79.9(2)° and 80.4(2)°. The Cu atom is in square pyramidal coordination, with the three donor atoms of the hydrazone ligand,

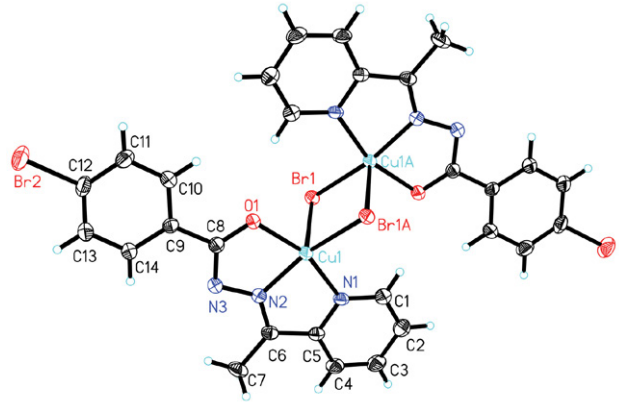


Figure 3. Molecular structure of the complex, showing the atom-numbering scheme. Displacement ellipsoids are drawn at the 30% probability level. Atoms labeled with the suffix A and unlabeled atoms are related to the symmetry operation *-x, -y,* 1*-z*. The methanol molecule is omitted for clarity.

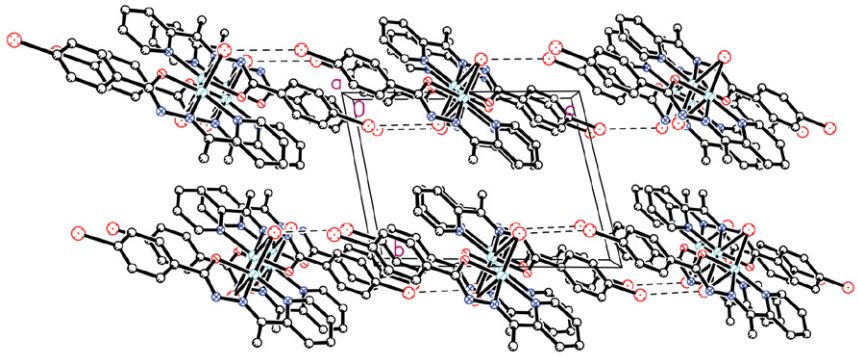


Figure 4. Molecular packing structure of the complex, viewed down the *a* axis. Hydrogen bonds are drawn as dotted lines.

Table 3. Hydrogen bond distances (Å) and bond angles (°) for HL and the complex

D–H···*A*	*d*(*D*–H)	*d*(H···*A*)	*d*(*D*···*A*)	Angle (*D*–H···*A*)
HL				
N3–H3···O1$^{\#1}$	0.90(1)	2.07(2)	2.963(6)	173(6)
The complex				
C1–H1···O1$^{\#2}$	0.93	2.60(3)	3.400(5)	145(5)
C4–H4···Br1$^{\#3}$	0.93	2.89(3)	3.778(5)	160(5)

Symmetry codes: #1: 2 – *x*, 1 – *y*, – *z*; #2: – *x*, – *y*, 1 – *z*; #3: – *x*, 1 – *y*, 1 – *z*.

and one Br atom located at the basal plane, and with the other Br atom at the apical site. The Cu atom deviates by 0.237(1) Å from the basal plane. The bond lengths around the Cu atom are within normal values with the reported copper(II) complexes derived from hydrazones.[18] The square pyramidal geometry is distorted, which are demonstrated from the *cis* and *trans* bond angles of 79.9(2)–107.1(2)° and 157.5(2)–160.3(2)°, respectively. The pyridine and benzene rings form dihedral angle of 6.6(5)° in the hydrazone ligand.

The neighboring molecules of the complex are connected by hydrogen bonds (Table 3), to form dimeric structure (Figure 4). There exists C–H···π interactions between C1 atom and the Br1-Cu1-Br1A-Cu1A ring, with the distance of 2.79(2) Å.

3. 4. IR and UV Spectra

The N-H and C=O absorptions of the free hydrazone HL are observed at 3283 cm^{-1} and 1659 cm^{-1}. The C=O absorption is shifted to lower wave number, *viz.* 1648 cm^{-1} for the complex, indicates it participates in coordination. The C=N absorptions of HL and the complex are located at about 1590 cm^{-1}.[9c,19]

The UV spectra of the free hydrazone and the complex displayed strong bands in the region 270–300 nm, which are assigned to the π–π^* transition. The charge transfer LMCT bands of the complexes are located in the region 350–400 nm.[20]

3. 5. Pharmacology Study

The assay of the urease inhibitory activity was in accordance with the literature method.[21] The free hydrazone HL has weak activity, with inhibition rate of 13.5% at concentration of 100 $\mu mol \cdot L^{-1}$. However, the copper complex has stronger activity than HL, with inhibition rate of 93.5% at the same concentration, and with IC_{50} value of 1.38 $\mu mol \cdot L^{-1}$. The complex has even better activity than the reference drug acetohydroxamic acid (IC_{50} = 28.1 $\mu mol \cdot L^{-1}$) and the copper perchlorate (IC_{50} = 8.8 $\mu mol \cdot L^{-1}$).

3. 6. Molecular Docking Study of the Complex

The molecular docking technique was used to study the binding effects of the complex with the *Jack bean* urease. The binding models are shown in Figures 5 and 6. It is clear that the complex molecule fits very well with the urease active pocket. Detailed interactions were established in a variety of conformations of the complex molecule with the amino acid residues of the urease. The docking score is –7.13, which is lower than the reference drug acetohydroxamic acid (–5.01). There are hydrogen bonds between the complex molecule and the amino acid residue *His*323. Moreover, there are hydrophobic interactions between the complex molecule and the amino acid residues of the urease. The results indicate that the copper complex may be served as a potential urease inhibitor.

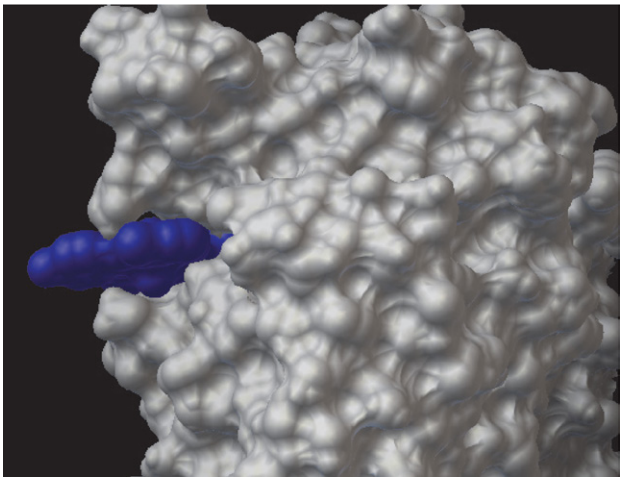


Figure 5. Binding mode of the complex with *Jack bean* urease. The enzyme is shown as surface, and the complex is shown as filling model.

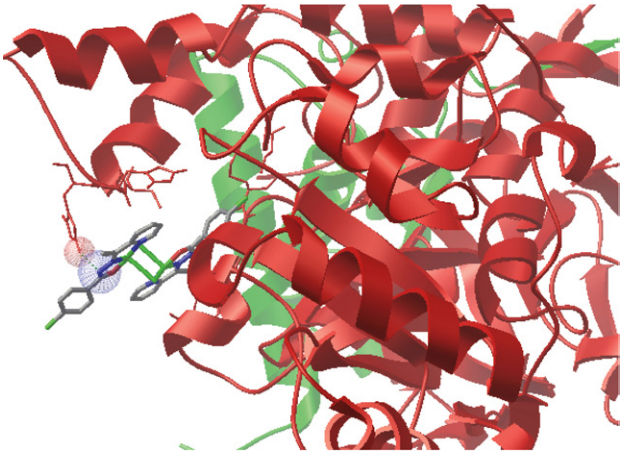


Figure 6. Binding mode of the complex with *Jack bean* urease. The enzyme is shown as ribbons, and the complex is shown as sticks.

4. Conclusion

The present study reports the synthesis, characterization and crystal structures of a hydrazone compound 4-bromo-*N*'-(1-(pyridin-2-yl)ethylidene)benzohydrazide and its dinuclear copper complex. The hydrazone compound coordinates to the Cu atoms through the pyridine nitrogen, imino nitrogen and enolate oxygen. The Cu atom in the complex is in square pyramidal coordination. The complex has interesting biological activity, with good urease inhibitory activity.

Supplementary Data

CCDC 1878329 (HL), 1874306 (the complex) contain the supplementary crystallographic data for this paper. These

data can be obtained free of charge *via* http://www.ccdc.cam.ac.uk/conts/retrieving.html, or from the Cambridge Crystallographic Data Centre, 12 Union Road, Cambridge CB2 1EZ, UK; fax: (+44) 1223-336-033; or e-mail: deposit@ccdc.cam.ac.uk.

Acknowledgments

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5. References

1. (a) P. A. Karplus, M. A. Pearson, R. P. Hausinger, *Acc. Chem. Res.* **1997**, *30*, 330–337; **DOI:**10.1021/ar960022j
(b) Z.-P. Xiao, Z.-Y. Peng, J.-J. Dong, R.-C. Deng, X.-D. Wang, H. Ouyang, P. Yang, J. He, Y.-F. Wang, M. Zhu, X.-C. Peng, W.-X. Peng, H.-L. Zhu, *Eur. J. Med. Chem.* **2013**, *68*, 212–221; **DOI:**10.1016/j.ejmech.2013.07.047
(c) Z.-P. Xiao, Z.-Y. Peng, J.-J. Dong, J. He, H. Ouyang, Y.-T. Peng, C.-L. Lu, W.-Q. Lin, J.-X. Wang, Y.-P. Xiang, H.-L. Zhu, *Eur. J. Med. Chem.* **2013**, *63*, 685–695. **DOI:**10.1016/j.ejmech.2013.03.016
2. (a) W.-W. Ni, H.-L. Fang, Y.-X. Ye, W.-Y. Li, C.-P. Yuan, D.-D. Li, S.-J. Mao, S.-E. Li, Q.-H. Zhu, H. Ouyang, Z.-P. Xiao, H.-L. Zhu, *Future Med. Chem.* **2020**, *12*, 1633–1645; **DOI:**10.4155/fmc-2020-0048
(b) Q. Liu, W.-K. Shi, S.-Z. Ren, W.-W. Ni, W.-Y. Li, H.-M. Chen, P. Liu, J. Yuan, X.-S. He, J.-J. Liu, P. Cao, P.-Z. Yang, Z.-P. Xiao, H.-L. Zhu, *Eur. J. Med. Chem.* **2018**, *156*, 126–136; **DOI:**10.1016/j.ejmech.2018.06.065
(c) W.-W. Ni, Q. Liu, S.-Z. Ren, W.-Y. Li, L.-L. Yi, H. Jing, L.-X. Sheng, Q. Wan, P.-F. Zhong, H.-L. Fang, H. Ouyang, Z.-P. Xiao, H.-L. Zhu, *Bioorg. Med. Chem.* **2018**, *26*, 4145–4152; **DOI:**10.1016/j.bmc.2018.07.003
(d) W.-K. Shi, R.-C. Deng, P.-F. Wang, Q.-Q. Yue, Q. Liu, K.-L. Ding, M.-H. Yang, H.-Y. Zhang, S.-H. Gong, M. Deng, W.-R. Liu, Q.-J. Feng, Z.-P. Xiao, H.-L. Zhu, *Bioorg. Med. Chem.* **2016**, *24*, 4519–4527; **DOI:**10.1016/j.bmc.2016.07.052
(e) Z.-P. Xiao, W.-K. Shi, P.-F. Wang, W. Wei, X.-T. Zeng, J.-R. Zhang, N. Zhu, M. Peng, B. Peng, X.-Y. Lin, H. Ouyang, X.-C. Peng, G.-C. Wang, H.-L. Zhu, *Bioorg. Med. Chem.* **2015**, *23*, 4508–4513. **DOI:**10.1016/j.bmc.2015.06.014
3. (a) K.-H. Yang, *Acta Chim. Slov.* **2014**, *61*, 629–636;
(b) M. Sutradhar, E. C. B. A. Alegria, K. T. Mahmudov, M. F. C. G. da Silva, A. J. L. Pombeiro, *RSC Advances* **2016**, *6*, 8079–8088; **DOI:**10.1039/C5RA25774C
(c) P. Wang, Y.-S. Wu, X.-M. Han, S.-S. Zhao, J. Qin, *Acta Chim. Slov.* **2017**, *64*, 431–437; **DOI:**10.17344/acsi.2017.3268
(d) Y.-J. Cai, Y.-Y. Wu, F. Pan, Q.-A. Peng, Y.-M. Cui, *Acta Chim. Slov.* **2020**, *67*, 896–903; **DOI:**10.17344/acsi.2020.5895
(e) Y. Tan, *Acta Chim. Slov.* **2020**, *67*, 1233–1238. **DOI:**10.17344/acsi.2020.6136
4. (a) M. V. Angelusiu, S. F. Barbuceanu, C. Draghici, G. L. Almajan, *Eur. J. Med. Chem.* **2010**, *45*, 2055–2062; **DOI:**10.1016/j.ejmech.2010.01.033
(b) O. O. Ajani, C. A. Obafemi, O. C. Nwinyi, D. A. Akinpelu, *Bioorg. Med. Chem.* **2010**, *18*, 214–221; **DOI:**10.1016/j.bmc.2009.10.064
(c) Z.-Q. Sun, S.-F. Yu, X.-L. Xu, X.-Y. Qiu, S.-J. Qiu, *Acta Chim. Slov.* **2020**, *67*, 1281–1289; **DOI:**10.17344/acsi.2020.6236
(d) Y.-L. Sang, X.-S. Lin, W.-D. Sun, *Acta Chim. Slov.* **2020**, *67*, 581–585; **DOI:**10.17344/acsi.2019.5595
(e) H.-Y. Qian, *Acta Chim. Slov.* **2019**, *66*, 995–1001; **DOI:**10.4149/neo_2019_190112N36
(f) L.-W. Xue, Y.-J. Han, X.-Q. Luo, *Acta Chim. Slov.* **2019**, *66*, 622–628. **DOI:**10.17344/acsi.2019.5039
5. (a) Y. H. Zhang, L. Zhang, L. Liu, J. X. Guo, D. L. Wu, G. C. Xu, X. H. Wang, D. Z. Jia, *Inorg. Chim. Acta* **2010**, *363*, 289–293; **DOI:**10.1016/j.ica.2009.08.017
(b) T. Horiuchi, J. Chiba, K. Uoto, T. Soga, *Bioorg. Med. Chem. Lett.* **2009**, *19*, 305–308. **DOI:**10.1016/j.bmcl.2008.11.090
6. (a) M. A. A. El-Sayed, N. I. Abdel-Aziz, A. A. M. Abdel-Aziz, A. S. El-Azab, Y. A. Asiri, K. E. H. ElTahir, *Bioorg. Med. Chem.* **2011**, *19*, 3416–3424; **DOI:**10.1016/j.bmc.2011.04.027
(b) S. M. Sondhi, M. Dinodia, A. Kumar, *Bioorg. Med. Chem.* **2006**, *14*, 4657–4663. **DOI:**10.1016/j.bmc.2006.02.014
7. (a) P. Krishnamoorthy, P. Sathyadevi, A. H. Cowley, R. R. Btorac, N. Dharmaraj, *Eur. J. Med. Chem.* **2011**, *46*, 3376–3387; **DOI:**10.1016/j.ejmech.2011.05.001
(b) P. G. Avaji, C. H. V. Kumar, S. A. Patil, K. N. Shivananda, C. Nagaraju, *Eur. J. Med. Chem.* **2009**, *44*, 3552–3559. **DOI:**10.1016/j.ejmech.2009.03.032
8. K. M. Khan, F. Rahim, A. Khan, S. Ali, M. Taha, S. M. Saad, M. Khan, Najeebullah, A. Shaikh, S. Perveen, M. I. Choudhary, *J. Chem. Soc. Pak.* **2015**, *37*, 479–483.
9. (a) R. Ara, U. Ashiq, M. Mahroof-Tahir, Z. T. Maqsood, K. M. Khan, M. A. Lodhi, M. I. Choudhary, *Chem. Biodiversity* **2007**, *4*, 58–71; **DOI:**10.1002/cbdv.200790007
(b) H. Y. Qian, *Inorg. Nano-Met. Chem.* **2018**, *48*, 461–466; **DOI:**10.1080/24701556.2019.1569689
(c) H. Y. Qian, *Russ. J. Coord. Chem.* **2017**, *43*, 780–786; **DOI:**10.1134/S1070328417110070
(d) H.-Y. Qian, *Acta Chim. Slov.* **2019**, *66*, 995–1001. **DOI:**10.4149/neo_2019_190112N36
10. (a) W. Chen, Y. G. Li, Y. M. Cui, X. A. Zhang, H.-L. Zhu, Q. F. Zeng, *Eur. J. Med. Chem.* **2010**, *45*, 4473–4478; **DOI:**10.1016/j.ejmech.2010.07.007
(b) D. H. Shi, Z. L. You, *Russ. J. Coord. Chem.* **2010**, *36*, 535–540; **DOI:**10.1134/S1070328410070109
(c) N. Zhang, C.-Y. Huang, D.-H. Shi, Z.-L. You, *Inorg. Chem. Commun.* **2011**, *14*, 1636–1639; **DOI:**10.1016/j.inoche.2011.06.027
(d) J.-Q. Ren, Q.-Z. Jiao, Y.-N. Wang, F.-Y. Xu, X.-S. Cheng, Z.-L. You, *Chinese. J. Inorg. Chem.* **2014**, *30*, 640–648;
(e) D.-H. Shi, L. Zhang, L.-L. Ni, S. Bai, Z.-L. You, *Synth. Re-*

act. Inorg. Met.-Org. Nano-Met. Chem. **2010**, *40*, 359–363; **DOI:**10.1080/15533174.2010.487057
(f) Y.-T. Li, J.-W. Dong, Y. Lu, Y.-T. Gu, C.-N. Shang, F.-Y. Liu, Y. Xin, C.-L. Jing, Z.-L. You, *Chinese J. Inorg. Chem.* **2018**, *34*, 1192–1198;
(g) Z.-L. You, Y.-M. Cui, Y.-P. Ma, C. Wang, X.-S. Zhou, K. Li, *Inorg. Chem. Commun.* **2011**, *14*, 636–640; **DOI:**10.1016/j.inoche.2011.01.038
(h) Y.-M. Cui, W.-X. Yan, Y.-J. Cai, W. Chen, H.-L. Zhu, *J. Coord. Chem.* **2010**, *63*, 3706–3713; **DOI:**10.1080/00958972.2010.517268
(i) C. L. Jing, C. F. Wang, K. Yan, K. D. Zhao, G. H. Sheng, D. Qu, F. Niu, H. L. Zhu, Z. L. You, *Bioorg. Med. Chem.* **2016**, *24*, 270–276; **DOI:**10.1016/j.bmc.2015.12.013
(j) A. de Fatima, C. D. Pereira, C. R. S. D. G. Olimpio, B. G. D. Oliveira, L. L. Franco, P. H. C. da Silva, *J. Adv. Res.* **2018**, *13*, 113–126. **DOI:**10.1016/j.jare.2018.03.007

11. (a) F. Niu, K.-X. Yan, L. H. Pang, D. Qu, X. L. Zhao, Z. L. You, *Inorg. Chim. Acta* **2015**, *435*, 299–304; **DOI:**10.1016/j.ica.2015.07.014
(b) Z.-L. You, L. Zhang, D.-H. Shi, X.-L. Wang, X.-F. Li, Y.-P. Ma, *Inorg. Chem. Commun.* **2010**, *13*, 996–998; **DOI:**10.1016/j.inoche.2010.05.016
(c) Z. L. You, M. Y. Liu, C. F. Wang, G. H. Sheng, X. L. Zhao, D. Qu, F. Niu, *RSC Advances* **2016**, *6*, 16679–16690. **DOI:**10.1039/C6RA00500D
12. H. Zhao, X. P. Tan, Q. A. Peng, C. Z. Shi, Y. F. Zhao, Y. M. Cui, *Russ. J. Coord. Chem.* **2021**, *47*, 58–65. **DOI:**10.1134/S107032842011010X
13. Bruker, SMART (Version 5.628) and SAINT (Version 6.02); Bruker AXS: Madison, Wisconsin, USA, 1998.
14. G. M. Sheldrick, SADABS Program for Empirical Absorption Correction of Area Detector, University of Göttingen, Germany, 1996.
15. G. M. Sheldrick, *Acta Crystallogr.* **2008**, *A64*, 112–122. **DOI:**10.1107/S0108767307043930
16. W. J. Geary, *Coord. Chem. Rev.* **1971**, *7*, 81–120. **DOI:**10.1016/S0010-8545(00)80009-0
17. A. Barakat, F. F. El-Senduny, Z. Almarhoon, H. H. Al-Rasheed, F. A. Badria, A. M. Al-Majid, H. A. Ghabbour, A. El-Faham, *J. Chem.* **2019**, 9403908. **DOI:**10.1155/2019/9403908
18. (a) Z. You, H. Yu, B. Zheng, C. Zhang, C. Lv, K. Li, L. Pan, *Inorg. Chim. Acta* **2018**, *469*, 44–50; **DOI:**10.1016/j.ica.2017.09.011
(b) Z. You, H. Yu, Z. Li, W. Zhai, Y. Jiang, A. Li, S. Guo, K. Li, C. Lv, C. Zhang, *Inorg. Chim. Acta* **2018**, *480*, 120–126. **DOI:**10.1016/j.ica.2018.05.020
19. (a) H.-Y. Qian, *Inorg. Nano-Met. Chem.* **2018**, *48*, 615–619; **DOI:**10.1080/24701556.2019.1567542
(b) H. Y. Qian, *Russ. J. Coord. Chem.* **2018**, *44*, 32–38. **DOI:**10.1134/S1070328418010074
20. H.-Y. Qian, N. Sun, *Transit. Met. Chem.* **2019**, *44*, 501–506. **DOI:**10.1007/s11243-018-00296-x
21. T. Tanaka, M. Kawase, S. Tani, *Life Sci.* **2003**, *73*, 2985–2990. **DOI:**10.1016/S0024-3205(03)00708-2

Povzetek

Sintetizirali smo nov dvojedrni bakrov(II) kompleks $[Cu_2(\mu\text{-}Br)_2L_2] \cdot 0.5MeOH$ z benzohidrazonskim ligandom 4-bromo-*N*'-(1-(piridin-2-il)etiliden)benzohidrazid (HL) ter produkt karakterizirali z elementno analizo, IR in UV-Vis spektroskopijo. Preučevali smo monokristalne strukture kompleksa in benzohidrazonske spojine. Bakrovi atomi v kompleksu so koordinirani z dvema benzohidrazonskima ligandoma in dvema mostovnima bromidnima ligandoma v kvadratno planarni koordinaciji. Kompleks je pokazal dobro aktivnost kot inhibitor *Jack bean* ureaze, vrednost IC_{50} je znašala 1.38 $\mu mol \cdot L^{-1}$.

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