Electronic Supplementary Material (ESI) for New Journal of Chemistry.

Supplementary information

Mixed-ligand copper(II) complexes of guanidine derivatives containing ciprofloxacin: Synthesis, characterization, DFT calculations, DNA interactions and biological activities

Prangtip Nonkuntod,[a] Atittaya Meenongwa,[b] Thanaset Senawong,[c] Chaiyaporn Soikum,[d] Prapansak Chaveerach,[d] Athis Watwiangkham,[e] Suwit Suthirakun,[e] Unchulee Chaveerach*[a]

[a] *Materials Chemistry Research Centre, Department of Chemistry and Centre of Excellence for Innovation in Chemistry, Faculty of Science, Khon Kaen University, Khon Kaen 40002, Thailand.* E-mail: sunchul@kku.ac.th

[b] *Health Science and Aesthetic Program, Department of Science, Faculty of Science and Technology, Rajamangala University of Technology Krungthep, Bangkok 10120, Thailand.*

[c] *Department of Biochemistry, Faculty of Science, Khon Kaen University, Khon Kaen 40002, Thailand.*

[d] *Department of Veterinary Public Health, Faculty of Veterinary Medicine, Khon Kaen University, Khon Kaen 40002, Thailand.*

[e] *School of Chemistry, Institute of Science, Suranaree University of Technology, Nakhon Ratchasima 30000, Thailand.*

Table S1 Band assignment of vibrational modes for ciprofloxacin, the starting compounds (**1** and **2**) and the mixed-ligand complexes (**1Cip** and **2Cip**).

Ciprofloxacin	**Frequency (cm^{-1})**				**Assignments**
	1	**2**	**1Cip**	**2Cip**	
3363br	3370s-3180s	3375br-3142w	3358br	3238br	ν(OH), ν(NH), $\nu(NH_2)$
3044m-2845m		2961w, 2856w	2951w, 2838m	2947w, 2836w	ν(CH), ν(=C-H)
	1689s	1650s			ν(C=C), ν(C=N), $\delta(NH_2)$
	1654s	1552s			ν(C=C), ν(C=N), $\delta(NH_2)$
1615s			1613s	1613s	$\nu_{as}(C=O)_{py}$
1586s					$\nu_{as}(C=O)_{carb}$
			1577s	1579s	$\nu_{as}(CO_2)_{carb}$
1547s	1547s	1525s	1513w	1523s	$\nu(C=C)_{benzene\ ring}$, ν(C=N), $\delta(NH_2)$
	1507m	1494m		1479m	ν(C=N), $\nu(C\text{-}NH_2)$, $\delta(NH_2)$
1474m-1451m	1473m-1452m		1476s-1457s	1459m	ν(C-N), δ(C-H)
			1376s	1374m	$\nu_s(CO_2)_{carb}$
1371s					ν(C-H), $\nu(C\text{-}O)_{carb}$
1307m		1355m-1323m	1302m	1352w, 1335w	$\nu(CH)_{ring}$
			1254s	1259s	$\nu(CO_2)_{carb}$
	1196s-1117m	1210m-1056m		1192m-1095w	ν(ring), $\rho(NH_2)$, ν(C-O)
1174m-1075w	1076w	1018w	1196w-1112w	1050m	$\nu(C\text{-}H)_{ring}$
1035s-1023s			1043w-1027m	1019w	ν(C-F)
978w			946s	946m	δ(NH)
940m-706w	948	929w	896w-701m	898w	γ(=C-H), $\delta(NH_2)$
652w-621s	645m	610m	655m-629m		$\delta(ring)_{aromatic}$, NH_2 wagging

Abbreviation: s, strong; m, medium; w, weak; br, broad; ν_{as}*, asymmetric* stretching; ν_s, symmetric stretching; δ, bending.

Table S2. Selected bond lengths [Å] and angles [°] for the optimized geometries of **1Cip** and **2Cip** complexes at B3LYP/def2-TZVP level of theory.

	1Cip			**2Cip**		
	1A	1B	1C	2A	2B	2C
Cu–O1	1.970	1.980	2.294	1.971	1.979	2.291
Cu–O2	1.918	1.956	1.924	1.919	1.961	1.923
Cu–N1	1.954	2.004	2.076	1.954	1.998	2.082
Cu–N2	1.947	–	2.021	1.947	–	2.013
Cu–Cl	–	2.250	2.295	–	2.251	2.296
O1–Cu–O2	93.42	89.78	87.43	93.31	89.79	86.92
N1–Cu–N2	88.49	–	84.15	88.68	–	84.35

Table S3 The cell cycle distribution of HeLa and MCF-7 cells treated with cisplatin (25 μg mL^{-1}), **1**, **2**, **1Cip** and **2Cip** (50 μg mL^{-1} with Tris-buffer containing 0.3% DMSO) on each phase of cell cycle. All data are the mean and standard errors obtained from three independent experiments.

Cell	Treatment	Cell cycle distribution (means ± SD)%			
		sub-G1	**G0/G1**	**S**	**G2/M**
HeLa	Solvent control	2.8±0.72	60.8±1.23	13.2±0.98	20.2±1.22
	Cisplatin	24.9±0.88*	42.2±1.20	16.9±0.54*	13.4±0.28
	1	5.1±1.32*	32.3±1.23	19.7±0.87	40.9±1.11*
	2	3.3±0.89	37.0±0.97	19.6±0.23	39.6±1.41*
	1Cip	10.5±0.65*	50.9±1.04	18.3±0.57*	16.9±0.99
	2Cip	10.9±0.99*	52.2±0.95	19.9±0.89*	17.0±0.36
MCF-7	Solvent control	6.0±0.86	52.7±0.55	16.5±0.99	20.9±1.14
	Cisplatin	42.4±0.78*	30.9±0.87	18.2±1.17*	7.5±1.18
	1	11.1±0.71*	50.5±1.12	12.9±0.55	24.3±1.30*
	2	13.0±0.54*	50.7±1.25	12.2±0.30	22.7±1.15*
	1Cip	16.4±0.32*	58.0±0.82*	11.0±0.91	14.8±0.98
	2Cip	15.8±0.98*	53.9±0.62*	13.7±0.20	15.6±0.99

*$P < 0.01$ significant difference between samples and solvent control.

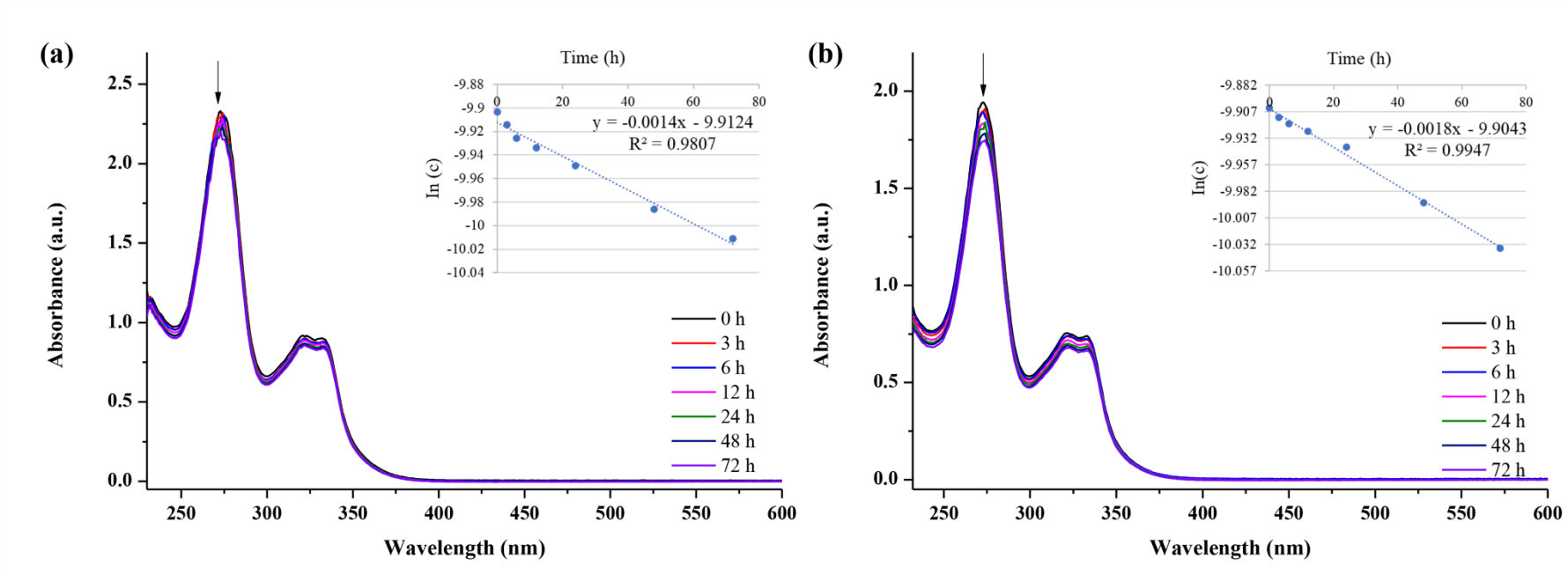

Fig. S1 Absorption spectra of (a) **1Cip** and (b) **2Cip** (50 μM) in Tris-buffer containing 0.3% DMSO at room temperature. The absorbance values at 273 nm for **1Cip** and 274 nm for **2Cip** were used for the calculation of *k* (slope of the linear fit) and $t_{1/2}$ ($t_{1/2} = \ln(2)/k$) values.

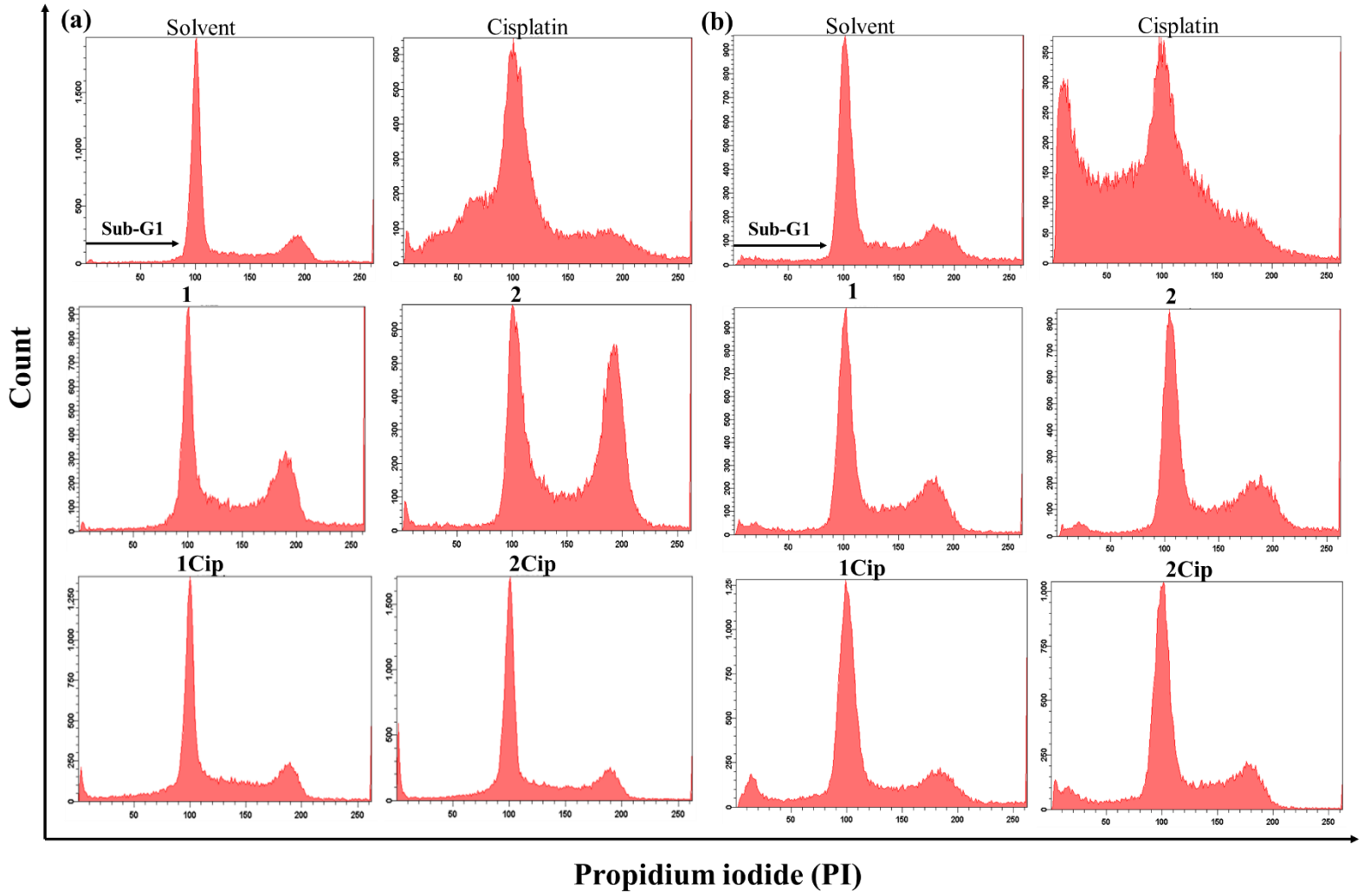

Fig. S2 Distribution of (a) HeLa and (b) MCF-7 cells treated by **1, 2, 1Cip** and **2Cip** (50 μg mL^{-1}). Cisplatin was used as a positive control and the solvent control was Tris-buffer containing 0.3 % DMSO. The data given are means ± SD of three independent experiments.

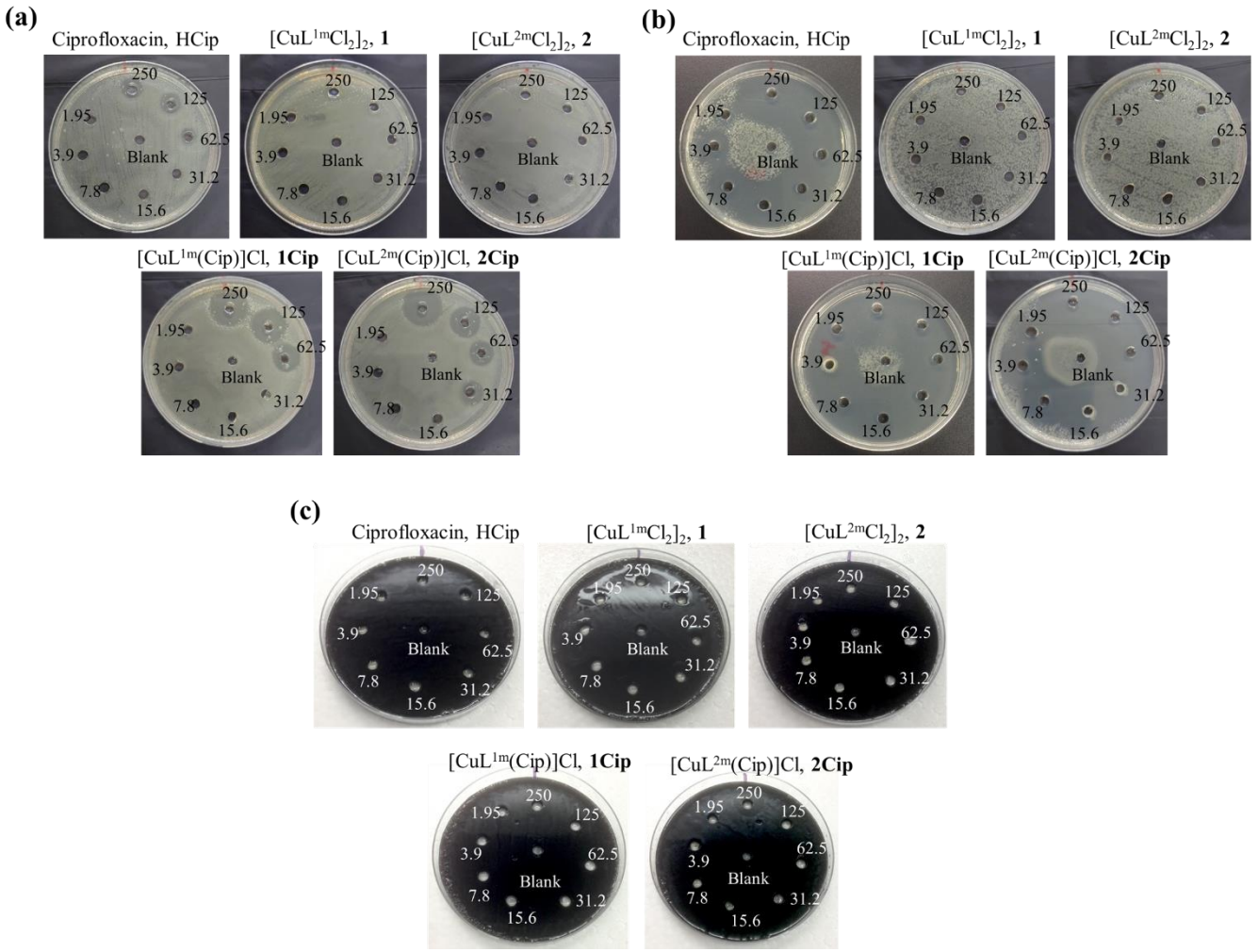

Fig. S3 Antibacterial activity of the complexes in a concentrations of 1.95, 3.9, 7.8, 15.6, 31.2, 62.5, 125 and 250 μg mL^{-1} against (a) *E. coli*, (b) *Salmonella*, (c) *Campylobacter* by disc diffusion method.