crystals

MDPI

Supplementary Data

Synthesis, X-ray Structure, Hirshfeld Analysis of Biologically Active Mn(II) Pincer Complexes Based on *s*-triazine Ligands

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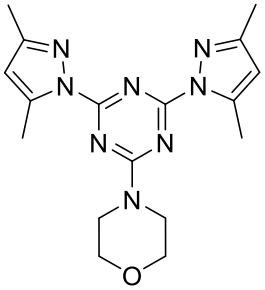
Method S1: General Method for Preparation of Ligands

The two ligands were prepared following the reported method [32] as follows:

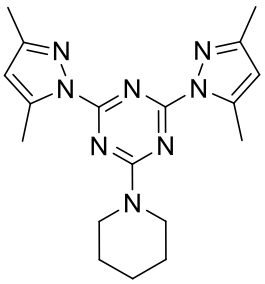
1,3,5-Triazine dihydrazino derivative (10 mmol) was dissolved in 20 mL DMF and then acetyl acetone (25 mmol) was added followed by addition of triethylamine (14 mmol) in 10 mL DMF with stirring at room temperature. The reaction mixture was heated at 80 °C for 6–8 h. After completion of the reaction, the solution was allowed to cool down to room temperature and then ice cold water was added with continues stirring. The reaction mixture kept in an ice bath for 2 h and the product was collected by filtration, washed with cold water (3 × 20 mL), and then dried under vacuum. The crude product was recrystallized from ethanol to afford the target products.

4-(4,6-bis(3,5-dimethyl-1H-pyrazol-1-yl)-1,3,5-triazin-2-yl)morpholine, ^{Morph}***BPT***

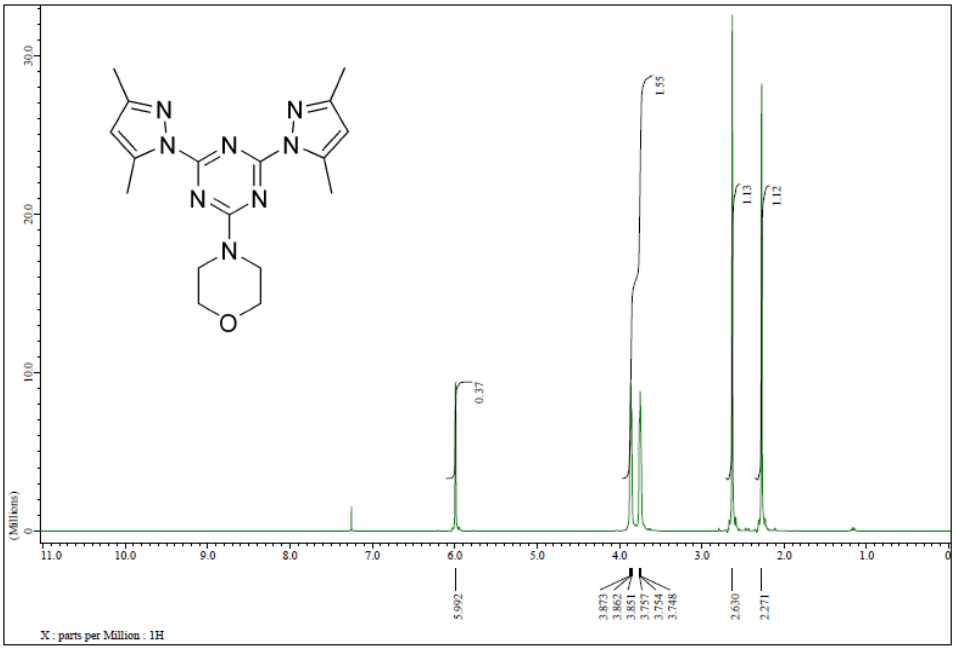


White crystals, mp = 187–188 °C, in yield 70%; ^{1}H NMR (δ ppm, $CDCl_3$): 2.27 (s, 6H, $2CH_3$), 2.632 (s, 6H, $2CH_3$), 3.56 (t, 4H, *J* = 2.4 Hz, $2CH_2$), 3.86 (t, 4H, *J* = 4.4 Hz, $2CH_2$), 5.97 (s, 2H, 2CH). ^{13}C NMR (δ ppm, $CDCl_3$): 10.7, 12.9, 41.2, 63.4, 108.1, 140.5, 149.0, 160.5, 162.4.

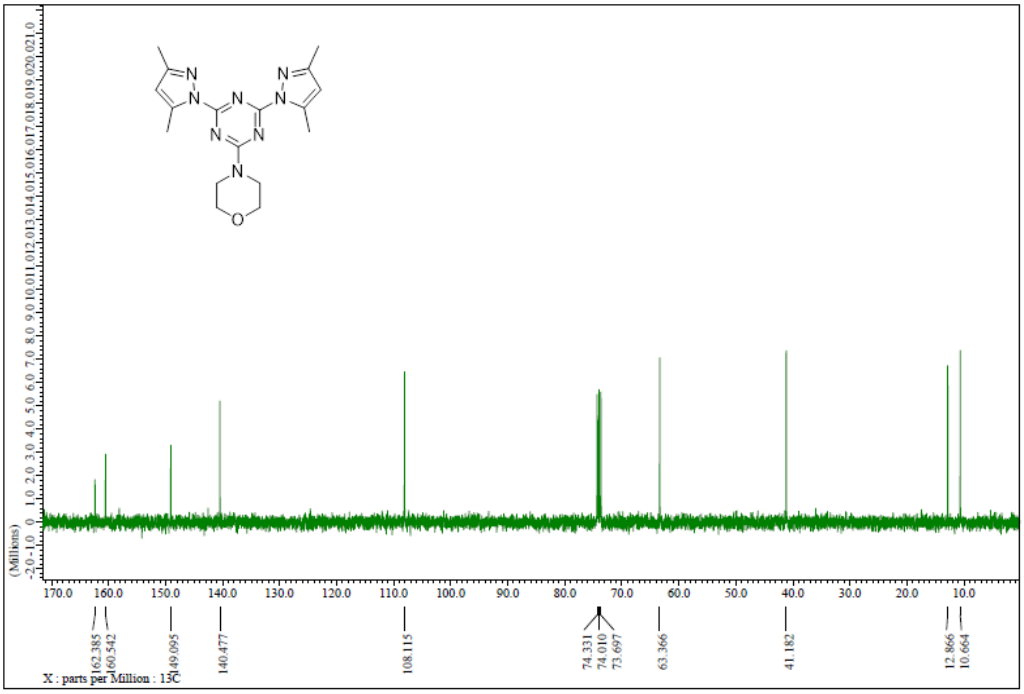
2,4-bis(3,5-dimethyl-1H-pyrazol-1-yl)-6-(piperidin-1-yl)-1,3,5-triazine, ^{Pip}***BPT***



White crystals, mp = 141–142 °C, in yield 73%; ^{1}H NMR (δ ppm, $CDCl_3$): 1.60 (m, 6H, $3CH_2$), 2.27 (s, 6H, $2CH_3$), 2.62 (s, 6H, $2CH_3$), 3.78 (t, 4H, *J* = 4.4 Hz, $2CH_2$), 5.97 (s, 2H, 2CH). ^{13}C NMR (δ ppm, $CDCl_3$): δ 13.5, 15.8, 24.3, 25.5, 45.1, 110.8, 143.3, 151.7, 163.5, 164.7.

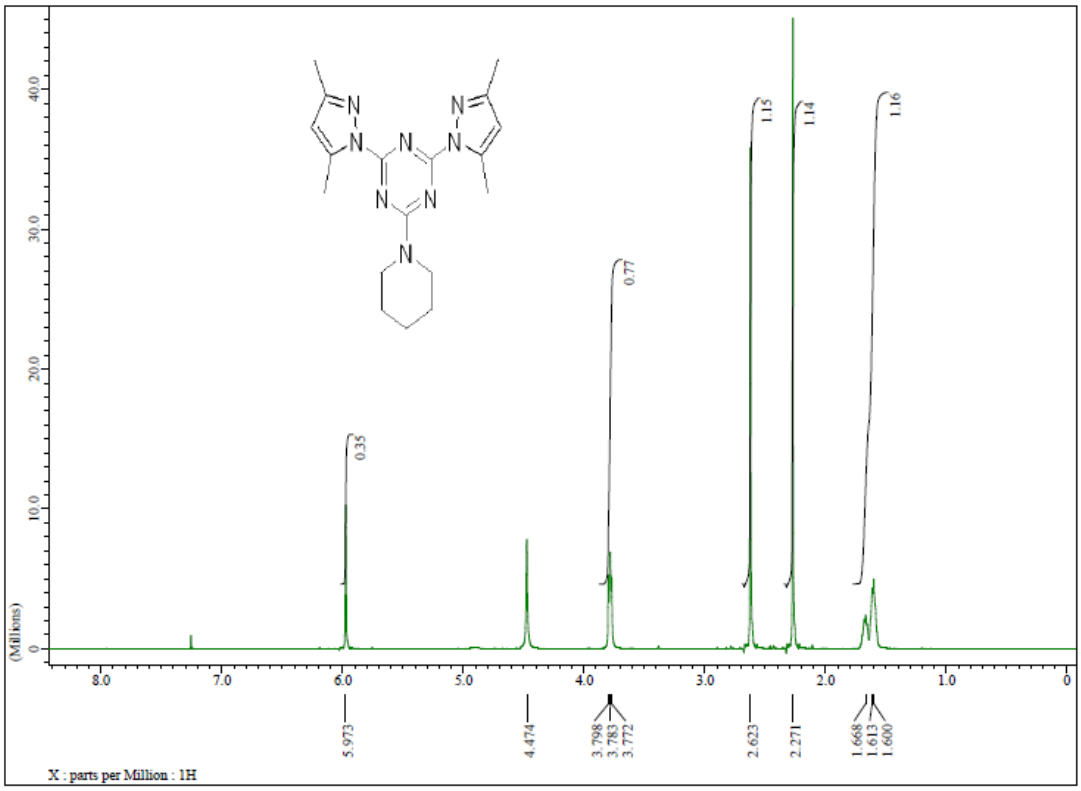


(**a**)

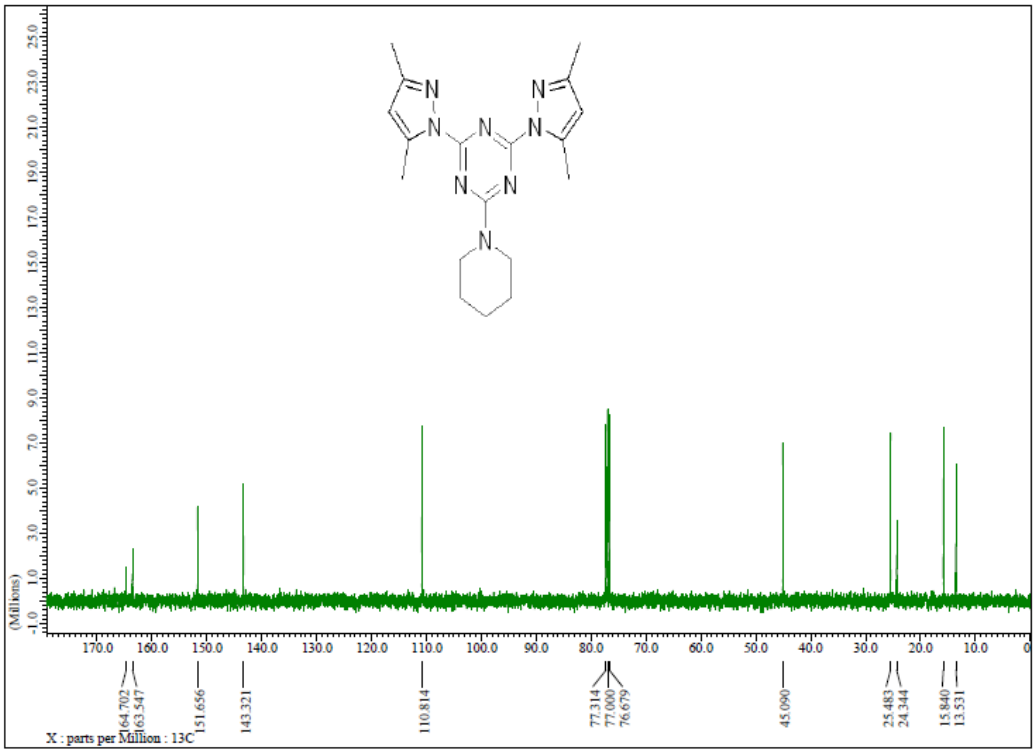


(**b**)

Figure S1. ^{1}H NMR (**a**) and ^{13}C NMR (**b**) of compound ligand ^{Morph}**BPT**.



(**a**)



(**b**)

Figure S2. ^{1}H NMR (**a**) and ^{13}C NMR (**b**) of compound ligand ^{Pip}**BPT.**

Method S2: Antimicrobial Studies

a) Tested Pathogenic Microbes

The antibacterial activity of the studied ligands and their Mn(II) complexes were evaluated against Gram-positive bacteria, namely *Staphylococcus aureus* (ATCC 29213), and Gram-negative bacteria, namely, *Escherichia coli* (ATCC 25922). Gentamycin was used as a standard antibacterial agent. The samples maintained in Brain heart infusion (BHI) at 20 °C; 300 mL of each stock–culture was added to 3 mL of BHI broth. Overnight cultures were kept for 24 h at 37 °C ± 1 °C and the purity of cultures was checked after 24 h of incubation. After 24 h of incubation, bacterial suspension was diluted with sterile physiological solution, for the diffusion and indirect bioautographic tests, to 108 CFU/mL (turbidity = McFarland barium sulfate standard 0.5), in case of fungus *Candida albicans* (ATCC 60193), the used medium in antagonistic activity against tested fungi is Potato Dextrose Agar, where Fluconazole was used standard antifungal agent.

b) Agar Well Diffusion Method

Synthetic compounds were prepared at concentration 2 mg/mL dissolved in DMSO as stock solutions. Preparation of sterilized Mueller Hinton agar plates seeded with tested pathogenic bacteria occurred. The wells were done by a sterilized cork borer in size 6 mm and, hence, 200 μg of the synthetic compound was poured in each well comparably with DMSO as control. The plates were incubated at 37 °C for 24 h after incubation period; antimicrobial activity was determined by inhibition zones.

c) Inhibition Percentage of Target Microbe's Growth at Different Concentrations of Tested Synthetic Compounds

The antibacterial activity of synthetic compounds was studied by employing a micro dilution method, using nutrient broth. The inoculum was prepared as described previously. Serial dilutions were performed in 96–well plate to reach concentrations ranging from 150 to 2.50 μg/mL, additionally as well as control (containing nutrient broth plus microbe, without antimicrobial substance and no DMSO) and blank samples (containing nutrient broth plus DMSO, without microbe and no antimicrobial substance). Each test and control well was inoculated with 5.0 μL of a microbial suspension (108 CFU/mL). Microplate reader measured the results at 630 nm wavelength.

d) Minimum Inhibitory Concentration (MIC) and Minimum Bactericidal Concentration (MBC)

Different dilutions of the compounds were inoculated with tested pathogenic microbes. After an incubation period (of 96-well microplate), the results were measured using microplate reader. To determine what level the MIC and MBC endpoint was established; subculture of test samples at different concentrations occurred in nutrient agar plates.

X-Ray Single Crystal Structure Solution Details

APEX3 software was used for preliminary determination of the unit cell. Determination of integrated intensities and unit cell refinement were performed using SAINT.

The structure was solved with SHELXS and subsequent structure refinements were performed with SHELX2014/7. Absorption corrections were performed by SADABS. In complex **1,** the central nitrogen atoms of the disordered nitrate groups are located on inversion centers in the triclinic unit cell. The oxygen atoms adopt six positions around the central atom, thus, forming two trigonal nitrate units, which are rotated by—at least roughly—120°.

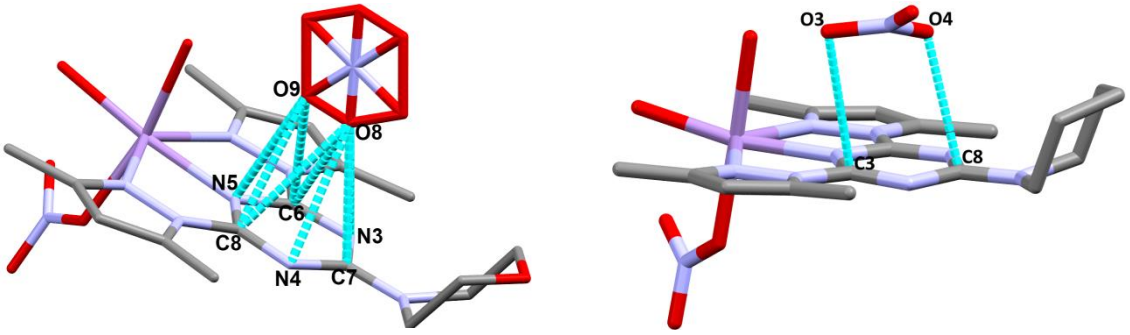


Figure S3. Anion-π interactions in **1** and **2** (for details, see **Table 5**).

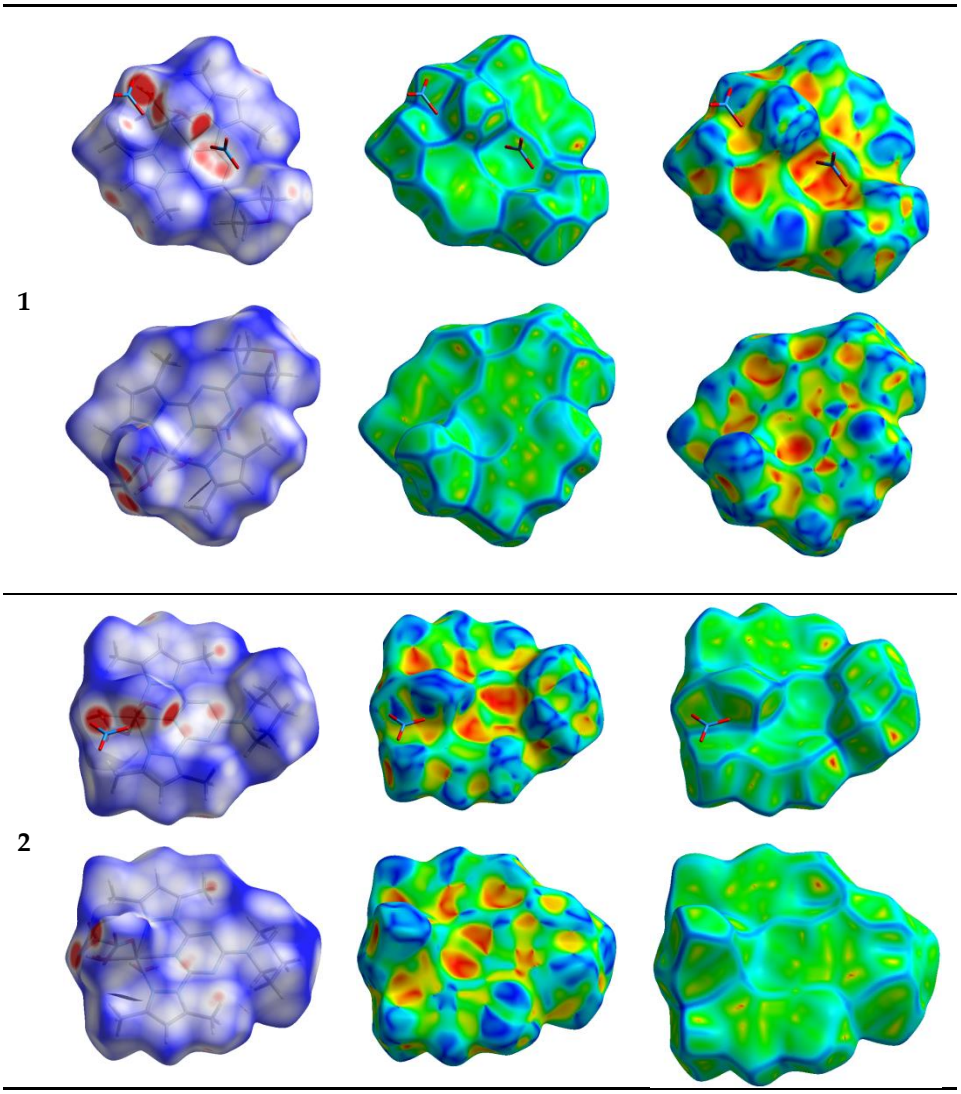


Figure S4. Hirshfeld surfaces mapped over d_{norm}, shape index and curvedness.

References

1. APEX3 Version 2016.5 (Bruker AXS Inc.)
2. SAINT Version 8.32B (Bruker AXS Inc., 2013)
3. SADABS Version 2012/1 (Sheldrick, Bruker AXS Inc.)
4. XS Version 2013/1 (George M. Sheldrick, *Acta Cryst.* (2008). A**64**, 112–122)
5. Sheldrick, G. M. SHELXTL Version 2014/7