

## SUPPLEMENTARY INFORMATION

### **Phosphorus-nitrogen compounds. Part 41. Ferrocenyl pendant-armed spirocyclopiperidinocyclotriphosphazatrienes: Langmuir-Blodgett thin films and biological activity studies**

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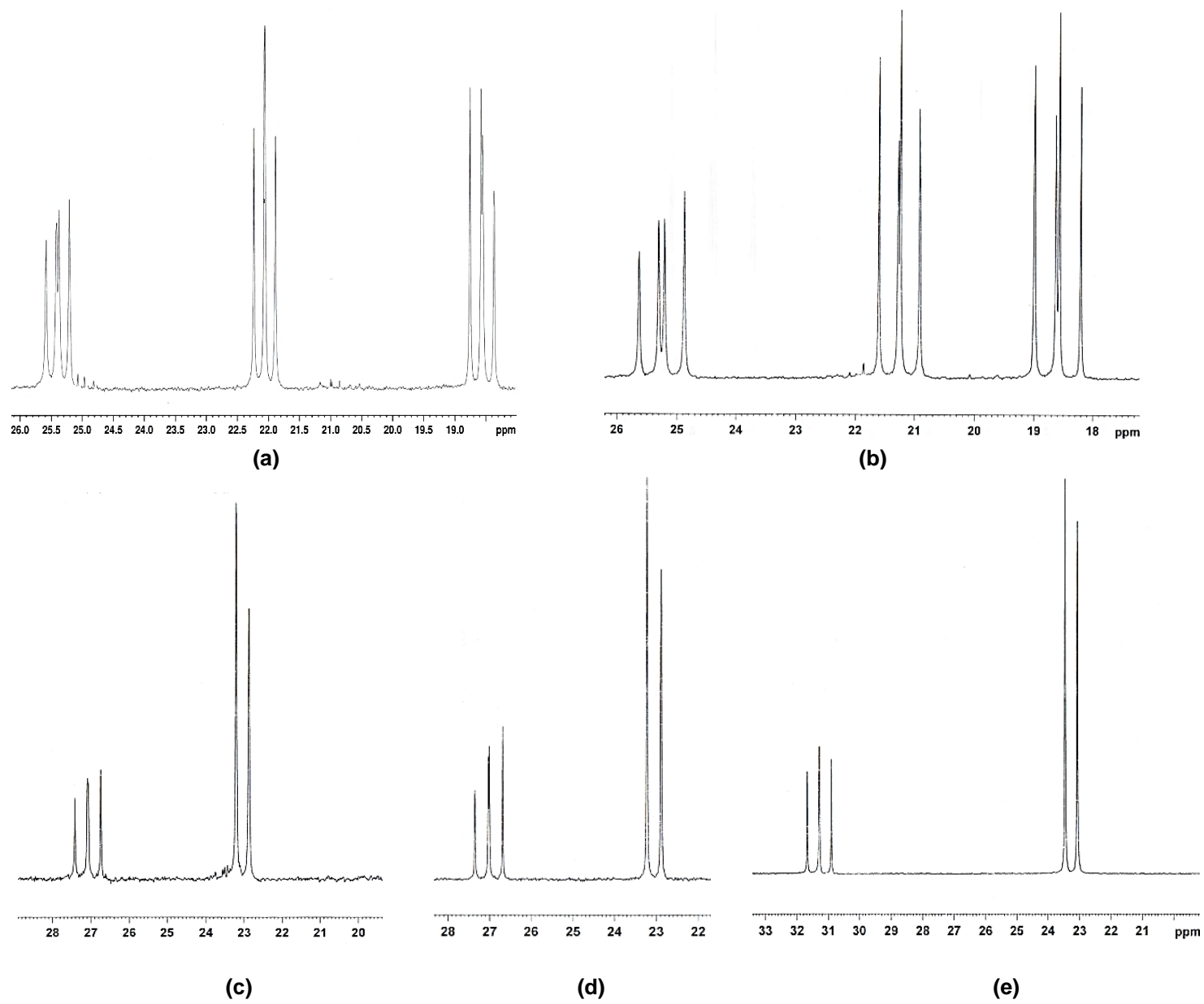
\*For correspondence

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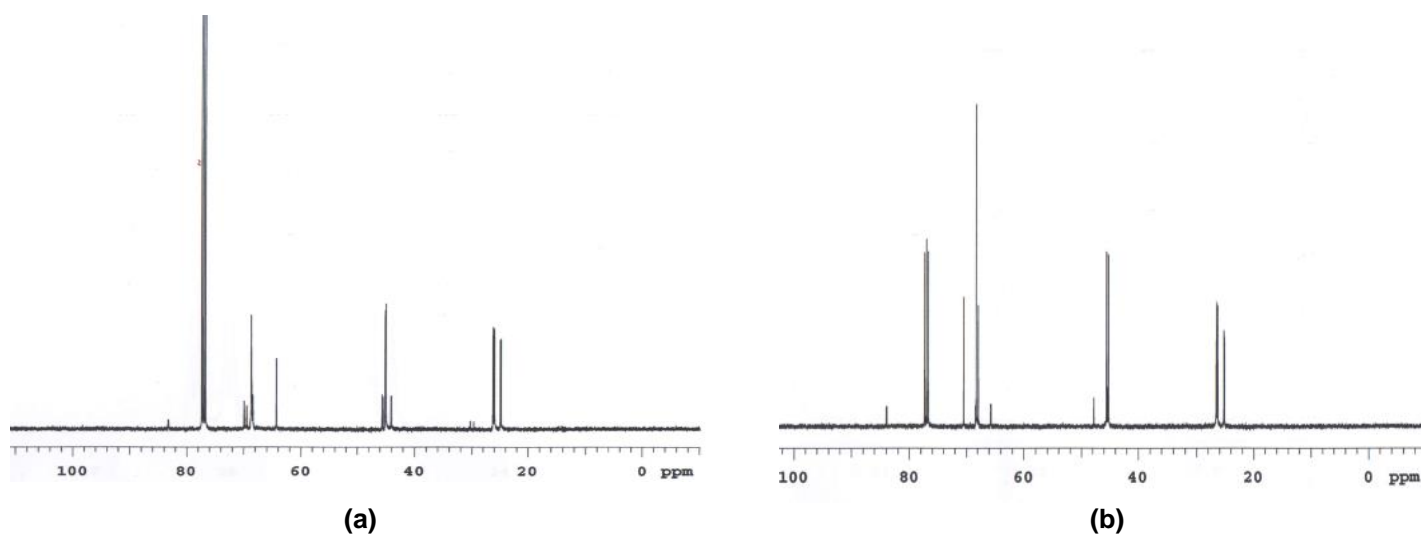
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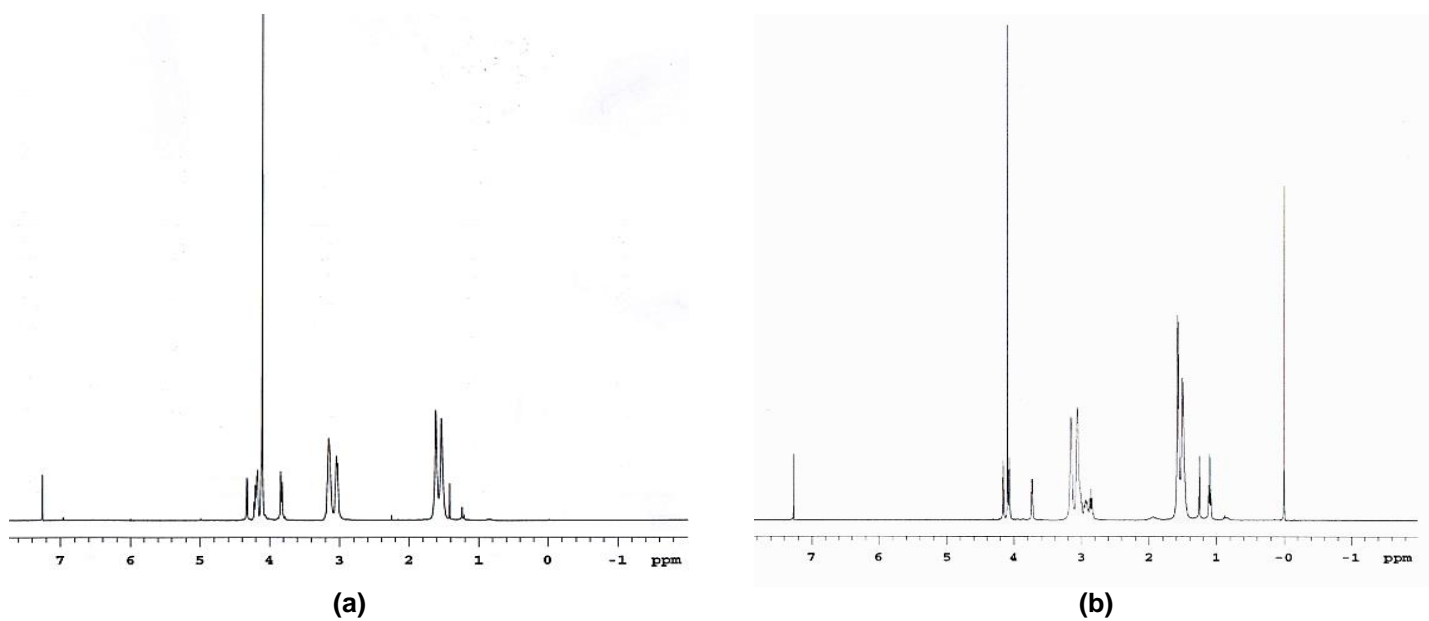
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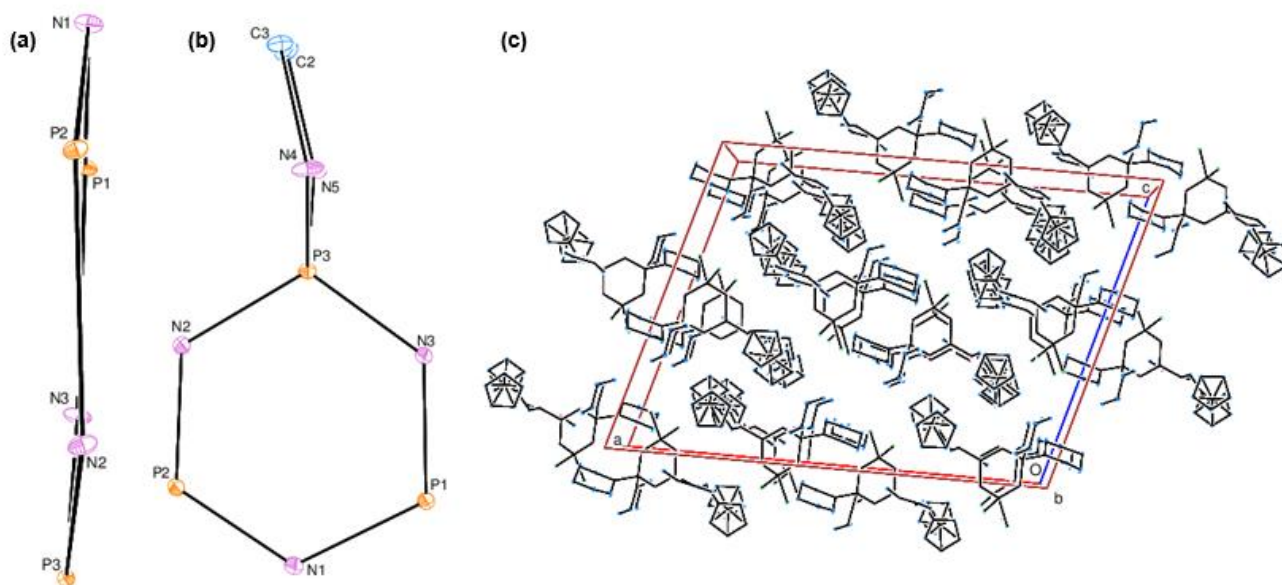
**Figure S1.** The  $^{31}\text{P}$  NMR spectra of the phosphazenes (a) **6**, (b) **7**, (c) **11**, (d) **12** and (e) **14**.



**Figure S2.** The  $^{13}\text{C}$  NMR spectra of the phosphazenes (a) **9** and (b) **15**.



**Figure S3.** The  $^1\text{H}$  NMR spectra of the phosphazenes (a) **10** and (b) **14**.



**Figure S4.** The conformations of (a) the phosphazene ring and (b) the five-membered spiro-ring. (c) The packing diagram of **6**.

**Table S1.** Selected bond lengths (Å) and angles (deg) for **6**.

P1– N1	1.617(3)
P1– N3	1.598(3)
P2– N1	1.553(3)
P2– N2	1.562(3)
P3– N2	1.616(3)
P3– N3	1.579(3)
P3– N4	1.634(3)
P3– N5	1.637(3)
N1– P1– N3	115.46(16)
N1– P2– N2	121.70(16)
N2– P3– N3	113.18(15)
P1– N1– P2	119.92(19)
P2– N2– P3	122.26(18)
P1– N3– P3	126.94(19)
N4– P3– N5	93.24(15)

**Table S2.** The antimicrobial activities of **6, 7, 9, 10, 11, 12, 14** and **15** at 2500  $\mu$ M concentration expressed as inhibition zones (mm). (Antibiotics; Amp = Ampicillin, C = Chloramphenicol and Antifungal; K = Ketoconazole, NS: Not studied). The diameter of inhibition zone was measured in millimeters.

Test Bacteria/ Compounds	6	7	9	10	11	12	14	15	Amp	C	K
<i>E. coli</i> ATCC 25922 G(-)	-	-	12.0 $\pm$ 1.0	15.0 $\pm$ 0.0	-	15.7 $\pm$ 1.5	10.0 $\pm$ 0.0	12.3 $\pm$ 0.6	18.0 $\pm$ 0.0	25.0 $\pm$ 0.0	NS
<i>E. coli</i> ATCC 35218 G(-)	12.3 $\pm$ 0.6	-	15.0 $\pm$ 0.0	12.0 $\pm$ 1.0	-	12.3 $\pm$ 0.6	-	12.7 $\pm$ 2.1	-	8.0 $\pm$ 0.0	NS
<i>S. aureus</i> ATCC 25923 G(+)	10.3 $\pm$ 0.6	-	11.3 $\pm$ 0.6	-	-	10.7 $\pm$ 1.2	-	-	44.0 $\pm$ 1.0	24.0 $\pm$ 1.0	NS
<i>P. aeruginosa</i> ATCC 27853 G(-)	-	-	-	13.3 $\pm$ 0.6	-	16.0 $\pm$ 1.7	14.3 $\pm$ 1.2	18.7 $\pm$ 1.2	60.0 $\pm$ 0.0	34.0 $\pm$ 0.0	NS
<i>B. cereus</i> NRRLB-3711 G(+)	-	-	-	-	-	-	13.0 $\pm$ 1.4	-	-	-	NS
<i>B. subtilis</i> ATCC 6633 G(+)	8.7 $\pm$ 0.6	9.5 $\pm$ 0.7	-	11.0 $\pm$ 1.0	8.7 $\pm$ 0.6	10.7 $\pm$ 0.6	-	10.7 $\pm$ 0.6	23.0 $\pm$ 1.0	21.0 $\pm$ 0.0	NS
<i>S. typhimurium</i> ATCC 14028 G(-)	-	-	-	-	-	-	10.0 $\pm$ 1.0	-	19.0 $\pm$ 1.0	38.0 $\pm$ 1.0	NS
<i>K. pneumoniae</i> ATCC 13883 G(-)	-	11.0 $\pm$ 0.0	11.7 $\pm$ 0.5	11.0 $\pm$ 0.0	11.0 $\pm$ 1.7	11.7 $\pm$ 0.6	18.7 $\pm$ 2.3	18.3 $\pm$ 2.9	-	31.0 $\pm$ 1.0	NS
<i>C. albicans</i> ATCC 10231	-	-	14.7 $\pm$ 0.6	-	11.3 $\pm$ 0.6	10.3 $\pm$ 0.6	-	11.3 $\pm$ 1.5	NS	NS	11.0 $\pm$ 1.0
<i>C. tropicalis</i> Y-12968	-	-	-	-	15.0 $\pm$ 0.0	10.7 $\pm$ 2.5	-	-	NS	NS	18.0 $\pm$ 1.0
<i>C. krusei</i> ATCC 6258	-	-	11.7 $\pm$ 0.6	12.7 $\pm$ 1.2	9.7 $\pm$ 1.5	-	-	-	NS	NS	34.0 $\pm$ 2.0

## Section S1

### Antimicrobial activity

The antimicrobial activities of compounds were studied against both types of Gram-positive (*Bacillus cereus* NRRL B-3711, *Bacillus subtilis* ATCC 6633, *Staphylococcus aureus* ATCC 25923) and Gram-negative bacteria (*Escherichia coli* ATCC 35218, *Escherichia coli* ATCC 25922, *P. Aeruginosa* ATCC 27853, *Klebsiella pneumoniae* ATCC 13883, *Salmonella typhimurium* ATCC 14028,) and yeast (*Candida albicans* ATCC 10231, *Candida krusei* ATCC 6258, *Candida tropicalis* Y-12968). Microorganism strains used were obtained from the collections of Gazi University Molecular Biology Culture Collection, Turkey. For comparison, ampicillin (10  $\mu$ g), Chloramphenicol (30  $\mu$ g), (antibacterial) and Ketoconazole (50  $\mu$ g), (antifungal) were used as the standard antimicrobial agents. Test strains were incubated on nutrient agar plates at 37 °C for 24 h for bacteria. The yeast cells were cultured on Sabouraud Dextrose agar medium (SDA) and incubated at 30 °C for 48 h. After incubation, bacterial suspensions were adjusted to a turbidity of 0.5 McFarland. Mueller Hinton agar (MHA) (for bacterial strains) and SDA mixed with 1% culture suspension and poured into plates. Wells were prepared with a 6.0 mm diameter and the solution (50  $\mu$ L) of the 2000  $\mu$ M test compound was poured into the well. The diameter of the inhibition zone was measured in millimeters. The MIC is the lowest concentration of antimicrobial agent that completely inhibits bacterial growth. The MIC value of the extract was determined as the lowest concentration that completely inhibited bacterial growth after 48 hr of incubation at 37°C.

## **Section S2**

### **Determination of the DNA interaction with the compounds**

The interaction of the compounds with plasmid DNA was studied by agarose gel electrophoresis. The decreasing concentrations of the compounds ranging from 2500  $\mu\text{M}$  to 312  $\mu\text{M}$  were incubated with plasmid DNA at 37 °C for 24 h. The aliquots of the DNA/compound mixtures were mixed with the loading buffer and loaded onto the 1% agarose gel. Electrophoresis was carried out under TAE buffer for 3 h at 70 V. The gel was stained with ethidium bromide (0,5  $\mu\text{g}/\text{mL}$ ), visualized under UV light using a transilluminator (BioDoc Analyzer, Biometra) and the image was captured with a video camera as a TIFF file. The experiments were repeated three times.