V. N. Madakyan, R. K. Kazaryan, Sh. M. Manukyan, T. S. Kurtikyan, and M. B. Ordyan UDC 547.979.733.07:543.422

The reaction of p-dodecyloxybenzaldehyde and 3-pyridinaldehyde with pyrrole in propionic acid at reflux with subsequent column chromatography of the reaction mixture gives the statistically predicted isomeric porphyrins. The compounds obtained were characterized by PMR, IR, and electronic spectroscopy.

Metal complexes of meso-tetra-N-substituted pyridylporphyrins have marked antimicrobial activity [1-3]. Increasing the surface activity of such compounds by the introduction of lipophilic alkoxyphenyl groups at the meso positions may facilitate the penetration of the porphyrins through the lipid cell membranes and enhance their biological activity.

For this purpose, we synthesized I-VI by a reported procedure involving heating a mixture of p-dodecyloxybenzaldehyde, 3-pyridinaldehyde, and pyrrole in 1:3:4 ratio in propionic acid at reflux [4]. The reaction mixture was subjected to chromatography on an alumina column with CHCl<sub>3</sub> as the eluent. Repeated chromatography gave the following pure isomeric porphyrins: 5,10,15,20-tetra(4-dodecyloxyphenyl)porphin (I) [5], 5-(3-pyridyl)-10,15,20-tri-(4-dodecyloxyphenyl)porphin (II), 5,15-di(3-pyridyl)-10,20-di(4-dodecyloxyphenyl)porphin (III), 5,10-di(3-pyridyl)-15,20-di(4-dodecyloxyphenyl)porphin (IV), 5,10,15-tri(3-pyridyl)-20-(4-dodecyloxyphenyl)porphin (V), and 5,10,15,20-tetra(3-pyridyl)porphin (VI) [6].





Fig. 1. PMR spectra of II and IV in the range for  $\beta$ -pyrrole protons.



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Com- pound	Chemical shifts, $\delta$ , ppm; Coupling constants, J, Hz									
	NH, s	CH <sub>s</sub> , M	CH2, S	—СН <sub>2</sub> , т	—СН <sub>2</sub> , т	-CH <sub>2</sub>	benzene CH, d	pyrrole CH	pyridine CH	
I	-2,85	0,85 (12H)	1,25 (64H)	1,6 (8H)	1,95 (8H)	4,18 (8H)	7,26 (A) (8H); 8,02 (B) (8H);	8,87 <b>s</b> (8H)	_	
II	-2,84	0,85 (9H)	1,25 (48H)	1,6 (6H)	1,95 (6H)	4,18 (6H)	$J_{AB} = 8.5$ 7,25 (A) (6H); 8.03 (B) (6H); $J_{AB} = 8,5$	8,95 s. (4H): 8,82 (A') d (2H); 8,99 (B') d (2H); $J_{A'B'} = 5$	7,6 m (H <sub>a</sub> ) (1H); 8,48 m (H <sub>b</sub> ) (1H); 9,1 m (H <sub>c</sub> ) (1H); 9,55 m (H <sub>d</sub> ) (1H)	
III	- 2,84	0,85 (6H)	1,25 (32H)	1,6 (4H)	1,95 (4H)	4,20 (4H)	7,26 (A) (4H); 8,05 (B) (4H); $J_{AB}=8,5$	8,8 (A') d (4H); 8,97 (B') d (4H); $J_{\Lambda'B'}=5$	$(7,70 \text{ m} (H_a))$ (2H); 8,3 m (H <sub>b</sub> ) (2H); 9,1 m (H <sub>c</sub> ) (2H); 9,48 m (H <sub>c</sub> ) (2H)	
IV	- 2,85	0,85 (6H)	1,25 (32H)	1,6 (4H)	1,95 (4H)	4,20 (4H)	7,26 (A) (4H); 8,04 (B) (4H); $J_{AB}=8,5$	8,84 s (2H); 8,93 s (2H); 8,8 (A') (2H); 8,98 (B') (2H)	$(7,7 \text{ m} (H_a)$ (2H); 8,32 m (H <sub>b</sub> ) (2H); 9,12 m (H <sub>c</sub> ) (2H); 9,48 d (H <sub>c</sub> ) (2H)	
v	-2,85	0,85 (3H)	1,25 (16H)	1,6 (2H)	1,95 (2H)	4,2 (2H)	7,28 (A) (2H); 8,05 (B) (2H); $J_{AB}=9$	8,89 s (4H); 8,86 (A') (2H); 9,05 (B') (2H)	$(11_a)$ (211) 7,72 m (H <sub>a</sub> ) (3H): 8,35 m (H <sub>b</sub> ) (3H); 9,12 m (H <sub>c</sub> ) (3H); 9,55 d	
VI	-2,85	_	—		-		_	8,91 s (8H)	(11d) (311) 7,65 m (Ha) (4H); 8,45 m (Hb) (4H); 9,0 m (Hc) (4H); 9,5 d (Hd) (4H)	

TABLE 1. PMR Spectra of I-VI

TABLE 2. Characteristics of Porphyrins I-VI

Com- pound	Chemical formula	mp, °C	R <sub>f</sub> * (system)	Electronic spectra, $\lambda_{\max}$ , nm ( $\varepsilon \cdot 10^{-3}$ )	Yield, %
I	C <sub>92</sub> H <sub>126</sub> N <sub>4</sub> O <sub>4</sub>	132 133	0,39 (A)	653 (4,8), 596 (4,2), 560 (9,5), 523 (13.0), 425 (364)**	0,6
II	C <sub>79</sub> H <sub>101</sub> N <sub>5</sub> O <sub>3</sub>	103 104	0,61 <b>(B)</b>	(53) $(4,2)$ , $595$ $(4,0)$ , $558$ $(8,2)$ , $522$	1,6
III	$C_{66}H_{76}N_6O_2$	163 164	0,55 <b>(C)</b>	$(12,5), 424 (344)^{**}$ 650 (4,4), 592 (4,8), 556 (8,6), 519 (15.0) 423 (360)**	0,5
IV	C <sub>66</sub> H <sub>76</sub> N <sub>6</sub> O <sub>2</sub>	7273	0,26 (C)	(12,0), 125, (300), (4,5), 556, (7,8), 521	1,1
v	C <sub>53</sub> H <sub>51</sub> N <sub>7</sub> O	121 122	0,42 (D)	$(13,3), 423 (340)^{-1}$ 649 (4,4), 591 (5,8), 552 (8,4), 518 $(16.8), 422 (376)^{**}$	1,6
VI	$C_{40}H_{26}N_8$	>360	0,33 (E)	(10,0), 1422 (010) 648 (2,2), 591 (4,8), 550 (6,0), 517 $(16,2), 419 (352)^{**}$	3,4
	1				-

\*A) 4:3 heptane-benzene; B) 10:1 benzene-acetone; C) 10:2 benzene-acetone; D) 2:1 chloroform-acetone; E) 10:1 chloroform-methanol. \*\*Soret band.

The structures of these compounds were supported by elemental analysis, IR, PMR, and electronic spectroscopy, and mass spectrometry.

The PMR spectral data and the ratio of the integral intensities of the aromatic and aliphatic protons of I-VI (Table 1) readily provided for determination of the extent of substitution. The splitting of the signals for the  $\beta$ -pyrrole protons is also very diagnostic for determining the position of the substituents and extent of substitution in meso-substituted porphyrins [7]. However, in our case, the spectral pattern is somewhat complicated by the close approximation of the signals of the  $\beta$ -pyrrole protons facing the phenyl and pyridyl rings and the additional superposition of a multiplet from one of the pyridyl protons. Nevertheless, the PMR data permit a clear distinction between isomers III and IV (the iden-

tification of I and VI which give a single narrow signal for the  $\beta$ -pyrrole protons and II and V using the integral curves does not present any difficulty). Figure 1 gives the fragments of the spectra of III and IV in the  $\beta$ -pyrrole proton region. The spectrum of III is an A'B' system with  $\Delta \delta_A' B' = 0.18$  ppm and  $J_A' B' = 5$  Hz and should be ascribed to the trans isomer of the disubstituted porphyrin, while the spectrum of IV should be interpreted as the superpositioning of singlets at 8.84 and 8.93 ppm for the  $\beta$ -pyrrole protons located in a symmetrical environment in an A'B' system as expected for the cis isomer IV. The IR spectra also support these assignments. In going from VI to V, new IR bands arise related to vibrations of the  $-C_6H_4-O(CH_2)_{11}CH_3$  fragment, including bands for stretching vibrations at 2800-3000  $cm^{-1}$  and deformational vibrations of the hydrocarbon chain at 1300-1500 cm<sup>-1</sup>, symmetrical (1052 cm<sup>-1</sup>) and antisymmetrical vibrations of the ether group (1245 cm<sup>-1</sup>), and a band characteristic for the skeletal vibrations of a para-substituted benzene ring at 1512 and 1613 cm<sup>-1</sup>. The relative intensity of these bands steadily increases with an increase in the number of long-chain substituents. Significant discrepancies are found in the spectra of III and IV. Although apparently paradoxical, when imine hydrogen atoms are present, the trans isomer has lower effective symmetry  $(C_2)$  than the cis isomer  $(C_{2y})$ . This should be seen in the vibrational spectrum in a decrease in the total number of bands (related to the action of stricter selection rules in the case of  $C_{2V}$  symmetry) in going from the trans to cis isomer. In our case, the spectrum for III had more bands and this compound was identified as the trans isomer.

The visible spectra (Table 2) also indicate regular changes in going from VI to I. An increase in the number of alkoxyphenyl substituents leads to a bathochromic shift of both the visible bands and the Soret band. The relative intensity of the longest-wavelength band steadily increases and becomes becomes stronger than the adjacent band in II and I, thereby distorting the typical etiotype [8] of the spectrum.

Molecular ions in the mass spectra of I-VI are observed only for V and VI. The mass spectra of the other porphyrins provide indirect evidence for their structures (the masses of the fragmentary ions indicate the loss of  $OC_{12}H_{25}$  substituents).

## EXPERIMENTAL

The IR spectra were measured on a UR-20 spectrometer in KBr pellets or Vaseline mull. The electronic spectra at 350-800 nm were taken on a Specord UV-VIS spectrophotometer in anhydrous chloroform. The PMR spectra were taken on a Varian T-60 spectrometer with TMS as the internal standard. The mass spectra were taken on an MS-50 mass spectrometer with 70-eV ionizing voltage. The sample inlet temperature was 440-450°C. The melting points were determined on a Boetius microblock. Thin-layer chromatography was carried out using Silufol UV-254 plates, which chromatography was carried out on a column packed with Brockman grade II alumina.

A sample of p-dodecylbenzaldehyde was obtained according to Gray and Jones [9]. The major characteristics of the compounds synthesized are given in Tables 1 and 2.

The elemental analysis data for C, H, and N correspond to the calculated values.

<u>5,10,15,20-Tetra(4-dodecyloxyphenyl)porphin (I).</u> A sample of 11 g (38 mmoles) of pdodecylbenzaldehyde and 12.1 g (113 mmoles) of 3-pyridinaldehyde were added to 700 ml propionic acid at reflux and then 10.25 g (153 mmoles) of pyrrole is added dropwise over 5 min. The mixture was heated at reflux for 2 h. After cooling, the reaction mixture was evaporated to dryness on a rotary evaporator. The oily product was dissolved in 500 ml chloroform and subjected to chromatography on a  $4 \times 80$ -cm alumina column to give fractions containing mixtures of isomeric porphyrins and tarry products: a) I; b) I, II; c) II, III; d) III, IV, tarry product; e) IV, V, tarry product; f) V, tarry product; g) V, VI, tarry product; h) VI, tarry product.

<u>Porphyrin I</u> was isolated by additional purification of fractions a and b on an alumina column using benzene as eluent. The product obtained was recrystallized from 1:4 benzene-methanol. The product yield was 0.3 g.

<u>5-(3-Pyridyl)-10,15,20-tri(4-dodecyloxyphenyl)porphin (II)</u> was isolated from fractions b and c analogously to I with benzene as the eluent and recrystallized from heptane. The product yield was 0.7 g.

5,15-Di(3-pyridy1)-10,20-di(4-dodecyloxypheny1)porphin (III) was isolated from fractions c and d analogously to I with 10:10:3:0.5 benzene-chloroform-acetone-methanol as the eluent. Recrystallization from heptane gave 0.2 g.

5,10-Di(3-pyridyl)-15,20-di(4-dodecyloxyphenyl)porphin (IV) was isolated from fractions d and e and recrystallized analogously to III. The product yield was 0.4 g.

5,10,15-Tri(3-pyridy1)-20-(4-dodecyloxyphenyl)porphin (V) was isolated from fractions e-g analogously to I using 5:1 chloroform-acetone as the eluent. Recrystallization from heptane gave 0.5 g product.

5,10,15,20-Tetra(3-pyridy1)porphin (VI) was isolated from fractions g and h analogously to I using 20:1 chloroform-methanol as the eluent. Recrystallization from 1:4 chloroformheptane gave 0.8 g product.

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