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Synthesis of Chiral Macrocycles: V.[1] Synthesis of Some *cyclo*-(N^{α}-Dinicotinoyl)aromatic Octapeptides and *cyclo*-(N^{α}-Dinicotinoyl)pentapeptide Lysine Schiff Bases[2]

A. M. Naglah[a,b], A. E. Amr[a,c], N. M. Khalifa[a,d], and M. A. Al-Omar[a]

[a] *Pharmaceutical Chemistry Department, Drug Exploration & Development Chair (DEDC), College of Pharmacy, King Saud University, Riyadh 11451, Saudi Arabia*
e-mail: aeamr1963@yahoo.com

[b] *Peptide Chemistry Department, Chemical Industries Research Division, National Research Centre, 12622-Dokki, Cairo, Egypt*

[c] *Applied Organic Chemistry Department, National Research Center, Cairo, Dokki 12622, Egypt*

[d] *Theripeutical Chemistry Department, National Research Centre, 12622-Dokki, Cairo, Egypt*

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Abstract—A series of octa bridged peptide and macrocyclic pentapeptide Schiff base derivatives were synthesized from tetrapeptide hydrazide and macrocyclic pentapeptide ester. Condensation of hydrazide with acid anhydrides upon refluxing in acetic acid afforded the corresponding 3,5-bis-tetraimide pyridine and macrocyclic octapeptide derivatives. Treatment of macrocyclic pentapeptide ester with hydrazine hydrate gave the corresponding acid hydrazide derivative. Condensation of the latter with aromatic aldehydes led to the corresponding cyclic pentapeptide Schiff bases.

Keywords: synthesis, macrocyclic penta- and octa peptides, Schiff bases

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Earlier synthetic macrocyclic peptides were the subject of intensive study with respect to their therapeutic applications [2] and binding properties [3]. Schiff base derivatives were reported to exhibit diverse biological activities, such as anti-inflammatory [4–6] and antibacterial [7–10]. Specifically, peptidopyridines were used as general ionophoric agents [11] and novel thiocyanate-selective membrane sensors [12]. Recently we have reported the synthesis of several linear and macrocyclic peptide candidates [1, 13]. Some of those were tested as anticancer [17] and anti-inflammatory [18] agents.

Herein we report synthesis of several macrocyclic octa bridged peptide and macrocyclic pentapeptide Schiff base derivatives using 3,5-bis(tetrapeptide hydrazide)pyridine (**2**) and the macrocyclic pentapeptide ester **3** prepared according to the previously published procedures [15, 17] (Scheme 1).

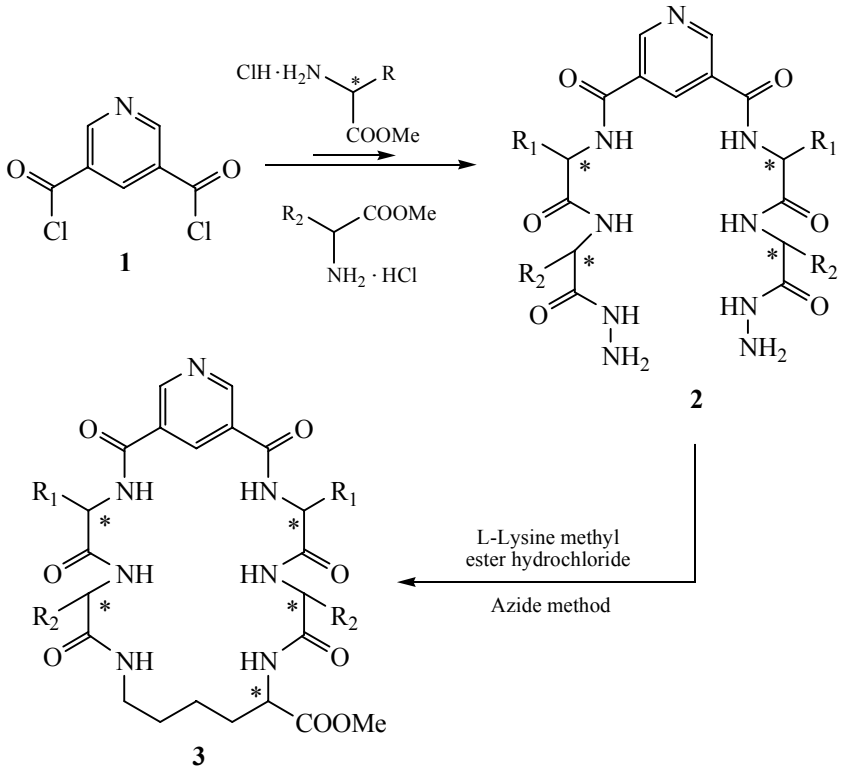
Condensation of the compound **2** with acid anhydrides upon refluxing in acetic acid (Scheme 2) gave the corresponding 3,5-bis{L-leucyl-L-phenylalanyl-(1*H*-benzo[*de*]isoquinoline)-3-carboxamido}pyridine (**3**), 3,5-bis(L-leucyl-L-phenylalanyl)benzene cyclic octa bridged peptide **5** and 3,5-bis[L-leucyl-L-phenylalanyl)naphthalene cyclic octa bridged peptide **6**.

Refluxing of pentapeptide methyl ester **3** with hydrazine hydrate (80%) in methanol gave the corresponding acid hydrazide derivative **7**. The latter **7** was condensed with aromatic aldehydes (benzaldehyde, *p*-methyl-, *p*-methoxy-, *p*-chloro-, *p*-flouro-, or *p*-bromobenzaldehyde) in absolute ethanol to give the corresponding cyclic pentapeptide Schiff bases **8a–8f**, respectively (Scheme 3). IR spectrum of the product **7** demonstrated no bands of C=O (ester) but the bands assigned to N–H stretching vibrations (amide and hydrazide groups) centered at 3435–3325 cm^{-1}.

[1] For communication IV, see [1].

[2] The text was submitted by the authors in English.

Scheme 1. Synthetic route for starting compounds **2** and **3**.



$R_1 = CH_2CH(CH_3)_2$; $R_2 = CH_2Ph$.

EXPERIMENTAL

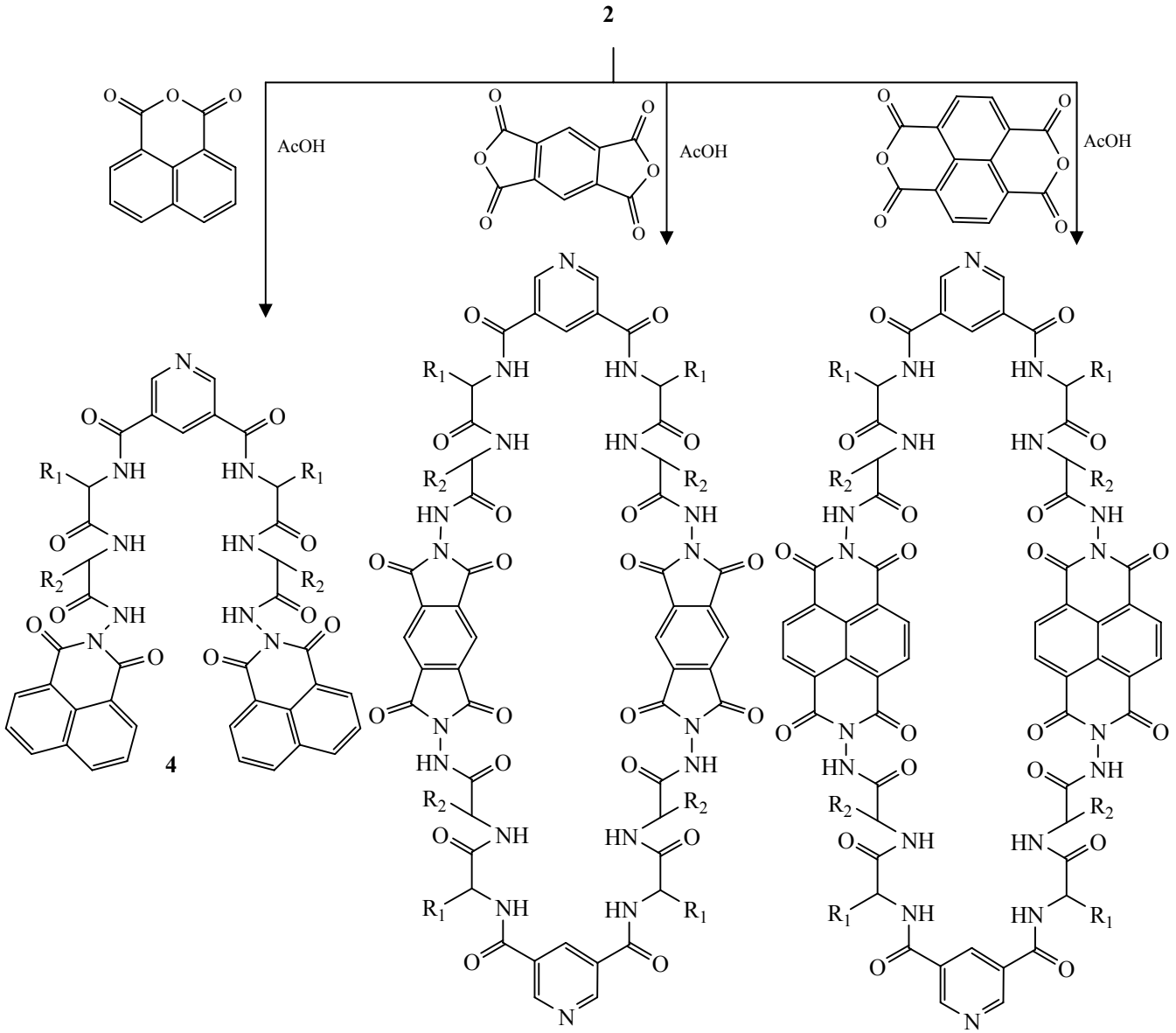
Melting points were determined in open glass capillary tubes with an Electro Thermal Digital melting point apparatus (IA9100). CHN analysis was carried out with a Microanalytical Unit. IR spectra (KBr) were recorded on a Nexus 670 FTIR Nicolet, Fourier Transform spectrophotometer. ^1H and ^{13}C NMR spectra were recorded in DMSO-d_6 by a Jeol 500 MHz spectrometer. Mass spectra were measured on a MAT Finnigan SSQ 7000 spectrometer using the electron impact technique (EI). Analytical TLC was performed on silica gel, 60 F254 (E. Merck).

Synthesis of N^{α}-(dinicotinoyl)-bis[L-leucyl-L-phenylaninyl]naphthalene diimide derivative (4). A mixture of hydrazide **2** (1 mmol) and naphthalene-1,8-dicarboxylic acid anhydride (2 mmol) was refluxed in glacial acetic acid (30 mL) for 4 h with stirring. Upon cooling the reaction mixture was poured into ice water. The solid was filtered off, washed with water, dried and recrystallized from dimethylformamide to give the corresponding diimide derivative **4**. Yield 80%, mp 276–278°C. IR spectrum, ν, cm^{-1}: 3460–3350 (NH), 1653, 1534, 1253 (C=O, amide I, II and III). ^1H NMR spectrum (DMSO-d_6), δ_H, ppm: 0.85–0.94 m (12H, $4CH_3$), 1.65–1.72 m (4H, $2CH_2$), 2.12–2.18 m (2H, 2CH), 3.34 d (4H, $2CH_2$), 4.22–4.30 m (2H, 2CH), 4.52–4.60 m (2H, 2CH), 7.05–7.90 m (22H, Ar-H), 8.38 m, 9.08 m (3H, pyr-H), 8.62 s, 8.75 s, 9.18 s (6H, 6NH, exchangeable with D_2O). ^{13}C NMR spectrum (DMSO-d_6), δ_C, ppm: 18.05, 18.52 (4C, 4 CH_3), 23.72 (2C, 2CH), 40.16 (2C, $2CH_2$), 41.22 (2C, $2CH_2$), 52.76, 53.14 (4C, 4CH), 123.54, 125.12, 128.32, 130.32, 137.15, 137.78 (20C, naphtha-C), 124.18, 128.14, 129.35, 138.76 (12C, 2Ph-C), 131.45, 140.15, 152.04 (5C, pyr-C), 164.73, 169.86, 171.34 (6C, 6CO-amide), 168.75 (4C, 4CO-imide). MS: *m/z* 1076 $[M]^+$. Found, %: C 68.00; H 5.28; N 11.62. $C_{61}H_{57}N_9O_{10}$. Calculated, %: C 68.08; H 5.34; N 11.71.

Synthesis of cyclo (N^{α}-dinicotinoyl)-bis[L-leucyl-L-phenylaninyl]-benzene or naphthalene tetraimide derivatives **5, 6** was based on the above procedure using 1,2,4,5-benzenetetracarboxylic dianhydride or 1,4,5,8-naphthylenetracarboxylic dianhydride (2 mmol).

***cyclo*-(N^{α}-Dinicotinoyl)-bis[L-leucyl-L-phenylaninyl]benzene tetraimide derivative (5).** Yield 68%, mp 275–277°C. IR spectrum, ν, cm^{-1}: 3465–3348

Scheme 2. Synthetic route for compounds **4–6.**

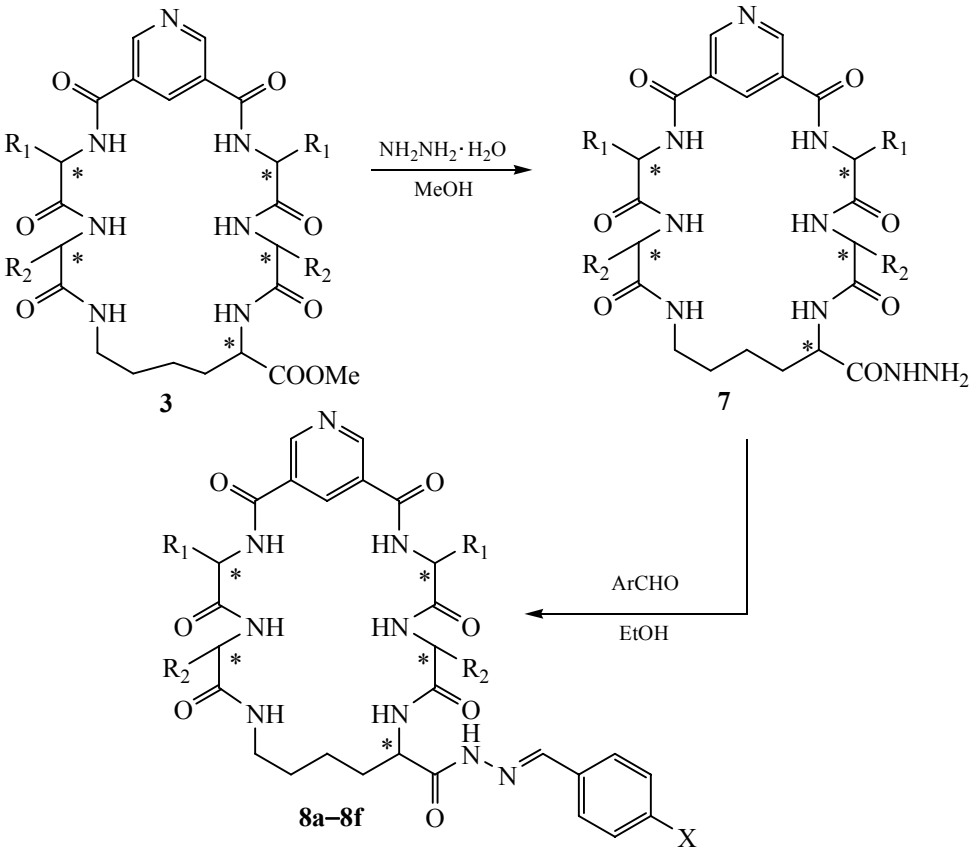


$R_1 = CH_2CH(CH_3)_2$; $R_2 = CH_2Ph$.

(NH), 1656, 1532, 1250 (C=O, amide I, II and III). ^{1}H NMR spectrum (DMSO-d_6), δ_H, ppm: 0.85–0.97 m (24H, 8CH_3), 1.68–1.72 m (8H, 4CH_2), 2.05–2.12 m (4H, 4CH), 3.52 d (8H, 4CH_2), 4.24–4.30 m (4H, 4CH), 4.56–4.65 m (4H, 4CH), 7.02–7.52 m (20H, 4Ph-H), 8.75 s (4H, Ar-H), 8.38, 9.10 m (6H, 2pyr-H), 8.62 s, 8.82 s, 9.14 s (12H, 12NH, exchangeable with D_2O). ^{13}C NMR spectrum (DMSO-d_6), δ_C, ppm: 18.05, 18.40 (8C, 8CH_3), 23.75 (4C, 4CH), 40.32 (4C, 4CH_2), 41.45 (4C, 4CH_2), 53.56, 57.25 (8C, 8CH), 124.96, 135.24 (12C, benzene-C), 124.35, 128.45, 129.52, 138.70 (24C, 4Ph-C), 131.45, 140.22, 152.35 (10C, 2pyr-C), 164.75, 173.36, 174.12 (12C, 12CO-amide), 164.65 (8C, 8CO-imide). MS: *m/z* 1796 $[M]^+$. Found, %: C 62.80; H 5.20; N 13.95. $C_{94}H_{94}N_{18}O_{20}$. Calculated, %: C 62.87; H 5.28; N 14.04.

***cyclo*-(*N*$^{\alpha}$-Dinicotinoyl)-bis[L-leucyl-L-phenylaninyl]naphthalene tetraimide derivative (6).** Yield 75%, mp 284–286°C. IR spectrum, ν, cm^{-1}: 3454–

Scheme 3. Synthetic route for compounds **7** and **8a–8f**.



R_1 = $CH_2CH(CH_3)_2$; R_2 = CH_2Ph; X = H (**a**), X = Me (**b**), X = OMe (**c**), X = Cl (**d**), X = F (**e**), X = Br (**f**).

3334 (NH), 1655, 1536, 1252 (C=O, amide I, II and III). ^{1}H NMR spectrum (DMSO-d_6), δ_H, ppm: 0.89–0.95 m (24H, 8CH_3), 1.62–1.70 m (8H, 4CH_2), 2.08–2.15 m (4H, 4CH), 3.46 d (8H, 4CH_2), 4.26–4.32 m (4H, 4CH), 4.55–4.62 m (4H, 4CH), 6.98–7.56 m (20H, 4Ph-H), 8.12–8.16 m (8H, naphtha-H), 8.42 m, 9.14 m (6H, 2pyr-H), 8.65 s, 8.78 s, 9.12 s (12H, 12NH, exchangeable with D_2O). ^{13}C NMR spectrum (DMSO-d_6), δ_C, ppm: 17.96, 18.42 (8C, 8CH_3), 23.68 (4C, 4CH), 40.18 (4C, 4CH_2), 41.28 (4C, 4CH_2), 52.79, 53.14 (8C, 8CH), 119.98, 135.14, 139.75 (20C, naphtha-C), 124.22, 128.26, 129.38, 138.70 (24C, 4Ph-C), 131.32, 140.10, 152.12 (10C, 2pyr-C), 164.68, 169.80, 171.24 (12C, 12CO-amide), 158.78 (8C, 8CO-imide). MS: *m/z* 1896 $[M]^+$. Found, %: C 64.50; H 5.10; N 13.22. $C_{102}H_{98}N_{18}O_{20}$. Calculated, %: C 64.62; H 5.21; N 13.30.

Synthesis of *cyclo*-(*N*$^{\alpha}$-dinicotinoyl)-bis[L-leucyl-L-phenylaninyl]-L-lysinylhydrazide (7). Anhydrous hydrazine hydrate (0.35 mL, 10 mmol, 80%) was added to a solution of cyclic pentapeptide methyl ester **3** (1 mmol). The reaction mixture was refluxed for 4 h, concentrated under reduced pressure and poured into ice water. The solid was separated by filtration, washed with water, dried, and crystallized from dioxane to afford the corresponding cyclic pentapeptide hydrazide **7**. Yield 78%, mp 256–258°C. IR spectrum, ν, cm^{-1}: 3435–3325 (NH, NH_2), 1657, 1530, 1242 (C=O, amide I, II and III). ^{1}H NMR spectrum (DMSO-d_6), δ_H, ppm: 0.85–0.95 m (12H, 4CH_3), 1.30–1.35 m (4H, 2CH_2), 1.40–1.45 m (4H, 2CH_2), 1.50–1.60 m (4H, 2CH_2), 2.18–2.32 m (2H, 2CH), 2.80–2.90 d (4H, 2CH_2), 4.15–4.20 m (1H, CH), 4.34 br.s (2H, NH_2, D_2O exchangeable), 4.40–4.45 m (4H, 4CH), 7.10–7.42 m (10H, 2Ph-H), 8.40 s, 9.02 s (3H, pyr-H), 8.32 s, 8.78 s, 8.92 s, 9.18 s (7H, 7NH, exchangeable with D_2O). ^{13}C NMR spectrum (DMSO-d_6), δ_C, ppm: 17.34, 18.67 (4C, CH_3), 21.98, 28.33, 29.89, 38.14 (4C, 4CH_2), 23.56 (2C, 2CH), 42.03 (2C, 2CH_2), 42.45 (2C, 2CH_2), 52.44, 52.82 (4C, 4CH), 55.40 (1C, CH-hydrazide), 123.92, 128.15, 129.40, 138.72 (12C, 2Ph-C), 130.86, 140.23, 151.94 (5C, pyr-C), 170.34 (1C, CO, hydrazide), 163.55, 169.12, 170.65 (6C,

6CO, amide). MS: *m/z* 812 $[M]^+$. Found, %: C 63.50; H 7.00; N 15.46. $C_{43}H_{57}N_9O_7$. Calculated, %: C 63.61; H 7.08; N 15.53.

Synthesis of *cyclo*-(*N*$^{\alpha}$-dinicotinoyl)-bis[L-leucyl-L-phenylaninyl]-L-lysinylhydrazone derivatives (8a–8f). A mixture of hydrazide derivative **7** (1 mmol), one of the aldehydes (benzaldehyde, *p*-methyl-, *p*-methoxy-, *p*-flouro-, *p*-chloro-, or *p*-bromo-benzaldehyde) (2 mmol), absolute ethanol (25 mL), and few drops of piperidine was refluxed for 4–6 h. The reaction mixture was concentrated under reduced pressure and poured into ice water. Thus obtained precipitate was filtered off, washed with water and crystallized from a proper solvent to afford the corresponding pentapeptide hydrazones (Schiff bases) **8a–8f**.

***cyclo*-(*N*$^{\alpha}$-Dinicotinoyl)-bis[L-leucyl-L-phenylaninyl]-L-lysinyl-phenylhydrazone (8a)**. Yield 82%, mp 256–258°C. IR spectrum, ν, cm^{-1}: 3435–3365 (NH), 1655, 1534, 1231 (C=O, amide I, II and III). ^{1}H NMR spectrum (DMSO-d_6), δ_H, ppm: 0.89–0.98 m (12H, $4CH_3$), 1.25–1.48 m (4H, $2CH_2$), 1.57–1.95 m (6H, $3CH_2$), 2.18–2.24 m (2H, 2CH), 3.15–3.26 m (2H, CH_2), 3.42 d (4H, $2CH_2$), 4.10–4.24 m (4H, 4CH), 4.40–4.48 m (1H, CH), 7.10–7.78 m (16H, 3Ph-H, CH=N), 8.37 s, 9.12 s (3H, pyr-H), 8.50 s, 8.76 s, 8.88 s, 9.25 s (7H, 7NH, exchangeable with D_2O). ^{13}C NMR spectrum (DMSO-d_6), δ_C, ppm: 17.72, 18.54 (4C, $4CH_3$), 23.68 (2C, 2CH), 24.30, 29.34, 32.05, 45.95 (4C, $4CH_2$), 40.78, 41.82 (4C, $4CH_2$), 52.36, 52.80 (4C, 4CH), 57.95 (1C, CH), 125.12, 127.84, 128.62, 129.18, 129.10, 131.02, 133.68, 138.88 (18C, 3Ph-C), 142.90 (1C, C=N), 131.55, 140.15, 152.24 (5C, pyr-C), 164.76, 169.24, 170.65 (6C, 6CO, amide), 177.86 (1C, CO-hydrazone). MS: *m/z* 900 (24) $[M]^+$. Found, %: C 66.64; H 6.75; N 13.94. $C_{50}H_{61}N_9O_7$. Calculated, %: C 66.72; H 6.83; N 14.01.

***cyclo*-(*N*$^{\alpha}$-Dinicotinoyl)-bis[L-leucyl-L-phenylaninyl]-L-lysinyl-*p*-methylphenylhydrazone (8b).** Yield 75%, mp 232–234°C. IR spectrum, ν, cm^{-1}: 3415–3335 (NH), 1655, 1534, 1232 (C=O, amide I, II and III). ^{1}H NMR spectrum (DMSO-d_6), δ_H, ppm: 0.92–0.97 m (12H, $4CH_3$), 1.21–1.45 m (4H, $2CH_2$), 1.56–1.94 m (6H, $3CH_2$), 2.17–2.25 m (2H, 2CH), 2.36 s (3H, CH_3), 3.16–3.22 m (2H, CH_2), 3.40 d (4H, $2CH_2$), 4.12–4.25 m (4H, 4CH), 4.42–4.45 m (1H, CH), 7.05–7.65 m (15H, 3Ph-H + CH=N), 8.35 s, 9.08 s (3H, pyr-H), 8.54 s, 8.78 s, 8.86 s, 9.22 s (7H, 7NH, exchangeable with D_2O). ^{13}C NMR spectrum (DMSO-d_6), δ_C, ppm: 18.12, 18.62 (4C, $4CH_3$), 23.70 (2C, 2CH), 24.12 (1C, CH_3), 24.40, 29.35, 32.16, 45.92 (4C, $4CH_2$), 40.77, 41.80 (4C, $4CH_2$), 52.42, 52.84 (4C, 4CH), 57.96 (1C, CH), 125.18, 127.85, 128.68, 129.22, 129.34, 131.05, 138.94, 140.60 (18C, 3Ph-C), 142.78 (1C, C=N), 131.42, 140.26, 152.29 (5C, pyr-C), 164.70, 169.35, 170.68 (6C, 6CO, amide), 177.82 (1C, CO-hydrazone). MS: *m/z* 914 (8) $[M]^+$. Found, %: C 66.80; H 6.90; N 13.70. $C_{51}H_{63}N_9O_7$. Calculated, %: C 67.01; H 6.95; N 13.79.

***cyclo*-(*N*$^{\alpha}$-Dinicotinoyl)-bis[L-leucyl-L-phenylaninyl]-L-lysinyl-*p*-methoxyphenylhydrazone (8c).** Yield 80%, mp. 214–216°C. IR spectrum, ν, cm^{-1}: 3444–3354 (NH), 1652, 1532, 1233 (C=O, amide I, II and III). ^{1}H NMR spectrum (DMSO-d_6), δ_H, ppm: 0.94–0.98 m (12H, $4CH_3$), 1.20–1.48 m (4H, $2CH_2$), 1.55–1.92 m (6H, $3CH_2$), 2.14–2.26 m (2H, 2CH), 3.14–3.20 m (2H, CH_2), 3.42 d (4H, $2CH_2$), 3.66 s (3H, OCH_3), 4.15–4.24 m (4H, 4CH), 4.40–4.46 m (H CH), 6.82–7.54 m (15H, 3Ph-H, CH=N), 8.30 s, 9.14 s (3H, pyr-H), 8.55 s, 8.75 s, 8.85 s, 9.25 s (7H, 7NH, exchangeable with D_2O). ^{13}C NMR spectrum (DMSO-d_6), δ_C, ppm: 18.18, 18.64 (4C, $4CH_3$), 23.68 (2C, 2CH), 55.72 (1C, OCH_3), 24.42, 29.38, 32.19, 45.90 (4C, $4CH_2$), 40.76, 41.81 (4C, $4CH_2$), 52.40, 52.87 (4C, 4CH), 57.92 (1C, CH), 125.34, 126.85, 128.74, 139.18 (12C, 2Ph-C), 114.28, 126.80, 129.68, 163.22 (6C, Ph-C), 142.65 (1C, C=N), 131.55, 140.34, 152.48 (5C, pyr-C), 164.80, 169.42, 170.65 (6C, 6CO, amide), 177.85 (1C, CO-hydrazone). MS: *m/z* 930 (24) $[M]^+$. Found, %: C 65.80; H 6.80; N 13.50. $C_{51}H_{63}N_9O_8$. Calculated, %: C 65.86; H 6.83; N 13.55.

***cyclo*-(*N*$^{\alpha}$-Dinicotinoyl)-bis[L-leucyl-L-phenylaninyl]-L-lysinyl-*p*-chlorophenylhydrazone (8d).** Yield 72%, mp 256–258°C. IR spectrum, ν, cm^{-1}: 3434–3318 (NH), 1651, 1532, 1235 (C=O, amide I, II and III). ^{1}H NMR spectrum (DMSO-d_6), δ_H, ppm: 0.87–0.96 m (12H, $4CH_3$), 1.24–1.45 m (4H, $2CH_2$), 1.55–1.92 m (6H, $3CH_2$), 2.16–2.25 m (2H, 2CH), 3.18–3.27 m (2H, CH_2), 3.43 d (4H, $2CH_2$), 4.11–4.26 m (4H, 4CH), 4.45–4.49 m (1H, CH), 7.20–7.72 m (15H, 3Ph-H + CH=N), 8.35 s, 9.10 s (3H, pyr-H), 8.50 s, 8.76 s, 8.88 s, 9.25 s (7H, 7NH, exchangeable with D_2O). ^{13}C NMR spectrum (DMSO-d_6), δ_C, ppm: 17.85, 18.50 (4C, $4CH_3$), 23.69 (2C, 2CH), 24.30, 29.38, 32.07, 45.94 (4C, $4CH_2$), 40.79, 41.80 (4C, $4CH_2$), 52.30, 52.76 (4C, 4CH), 57.92 (1C, CH), 125.44, 126.83, 128.75, 139.12 (12C, 2Ph-C), 128.24, 129.80, 131.36, 136.25 (6C, Ph-C), 142.82 (1C, C=N), 131.43, 140.26, 152.34 (5C, pyr-C), 164.70, 169.42, 170.70 (6C, 6CO, amide), 177.87 (1C, CO-hydrazone). MS:

m/z 934 (45) $[M]^+$. Found, %: C 64.20; H 6.40; Cl, 3.70; N 13.40. $C_{50}H_{60}ClN_9O_7$. Calculated, %: C 64.26; H 6.47; Cl, 3.79; N 13.49.

***cyclo*-(N^a-Dinicotinoyl)-bis[L-leucyl-L-phenylaninyl]-L-lysinyl-*p*-flourophenylhydrazone (8e).** Yield 72%, mp 204–208°C. IR spectrum, ν, cm^{-1}: 3456–3338 (NH), 1654, 1534, 1234 (C=O, amide I, II and III). ^1H NMR spectrum (DMSO-d_6), δ_H, ppm: 0.89–0.96 m (12H, $4CH_3$), 1.20–1.34 m (4H, $2CH_2$), 1.50–1.82 m (6H, $3CH_2$), 2.18–2.35 m (2H, 2CH), 3.15–3.29 m (2H, CH_2), 3.43 d (4H, $2CH_2$), 3.96–4.19 m (4H, 4CH), 4.42–4.48 m (1H, CH), 6.99–7.62 m (15H, 3Ph-H + CH=N), 8.45 s, 9.14 s (3H, pyr-H), 8.69 s, 8.87 s, 8.96 s, 9.20 s (7H, 7 NH, exchangeable with D_2O). ^{13}C NMR spectrum (DMSO-d_6), δ_C, ppm: 18.12, 18.96 (4C, $4CH_3$), 23.80 (2C, 2CH), 24.35, 29.42, 32.12, 45.90 (4C, $4CH_2$), 40.95, 41.76 (4C, $4CH_2$), 52.36, 52.82 (4C, 4CH), 58.44 (1C, CH), 125.52, 126.80, 128.78, 139.18 (12C, 2Ph-C), 115.24, 129.40, 130.16, 165.20 (6C, Ph-C), 142.72 (1C, C=N), 131.55, 140.47, 152.34 (5C, pyr-C), 163.75, 169.18, 170.67 (6C, 6CO, amide), 177.63 (1C, CO-hydrazone). MS: *m/z* 918 (16) $[M]^+$. Found, %: C 65.32; H 6.50; N 13.65. $C_{50}H_{60}FN_9O_7$. Calculated, %: C 65.41; H 6.59; N 13.73.

***cyclo*-(N^a-Dinicotinoyl)-bis[L-leucyl-L-phenylaninyl]-L-lysinyl-*p*-bromophenylhydrazone (8f).** Yield 72%, mp 262–264°C. IR spectrum, ν, cm^{-1}: 3412–3310 (NH), 1655, 1534, 1232 (C=O, amide I, II and III). ^1H NMR spectrum (DMSO-d_6), δ_H, ppm: 0.86–0.95 m (12H, $4CH_3$), 1.32–1.44 m (4H, $2CH_2$), 1.56–1.90 m (6H, $3CH_2$), 2.18–2.24 m (2H, 2CH), 3.22–3.28 m (2H, CH_2), 3.40 d (4H, $2CH_2$), 4.15–4.28 m (4H, 4CH), 4.46–4.52 m (1H, CH), 7.32–7.76 m (15H, 3Ph-H + CH=N), 8.36 s, 9.15 s (3H, pyr-H), 8.64 s, 8.75 s, 8.84 s, 9.24 s (7H, 7NH, exchangeable with D_2O). ^{13}C NMR spectrum (DMSO-d_6), δ_C, ppm: 17.98, 18.56 (4C, $4CH_3$), 23.71 (2C, 2CH), 24.35, 29.40, 31.95, 45.96 (4C, $4CH_2$), 40.74, 41.75 (4C, $4CH_2$), 52.42, 52.75 (4C, 4CH), 57.88 (1C, CH), 125.35, 126.80, 128.76, 139.16 (12C, 2Ph-C), 125.02, 130.00, 131.62, 132.12 (6C, Ph-C), 142.76 (1C, C=N), 131.40, 140.34, 152.42 (5C, pyr-C), 164.66, 169.40, 170.70 (6C, 6CO, amide), 177.64 (1C, CO-hydrazone). MS: *m/z* 979 (12) $[M]^+$. Found, %: C 61.30; H 6.10; N 12.80 $C_{50}H_{60}BrN_9O_7$. Calculated, %: C 61.34; H 6.18; N 12.88.

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