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SYNTHESIS OF 5,6,10,11-TETRAHYDRO-4*H*,8*H*-PYRANO[4`,3`:4,5]PYRROLO [3,2,1-*IJ*]QUINOLIN-8-ONES; 3,4,8,9-TETRAHYDRO-1*H*-PYRANO[3`,4`:2,3] INDOLO[1,7-*AB*][1]BENZAZEPIN-1-ONES AND 7,11-DIHYDROPYRANO[4`,3`:4,5] PYRROLO[3,2-*C*]QUINOLIN-10(8*H*)-ONES

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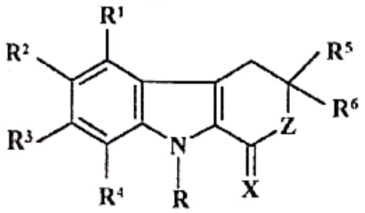
ABSTRACT

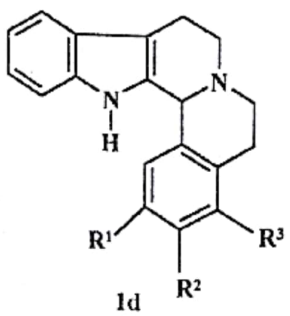
The synthesis of 5,6,10,11-tetrahydro-4*H*,8*H*-pyrano[4`,3`:4,5] pyrrolo[3,2,1-*ij*]quinolin-8-ones **5a-b**; 3,4,8,9-tetrahydro-1*H*-pyrano [4`,3`:2,3] indolo[1,7-*ab*][1]benzazepin-1-ones **9a-b** and 7,11-dihydropyrano[4`,3`:4,5]pyrrolo[3,2-*c*]quinolin-10(8*H*)-ones **13c-f** via Fischer-indolization method is described.

INTRODUCTION

The synthesis of various pyranoindolones **1a** by Fischer-cyclization of the corresponding hydrazones has been reported[1-6]. These lactones have been used for the synthesis[2,5,7,8] of numerous β-carbolines **1c** by reduction of the corresponding lactams **1b**. They were also utilized[9] to reduce the steps required for the synthesis of the naturally occurring indole alkaloids, *viz.*, hexahydrobenzo[*a*]indolo[2,3-*h*]quinolizines **1d** which are reported to be prepared in twelve steps. In connection with ongoing work, we planned to synthesize other new lactone ring systems, which combine the features of pyranopyrrole and quinoline or pyranoindole and benzazepine.



1a X = Z = O
1b X = O Z = N-R^7
1c X = H_2 Z = N-R^7

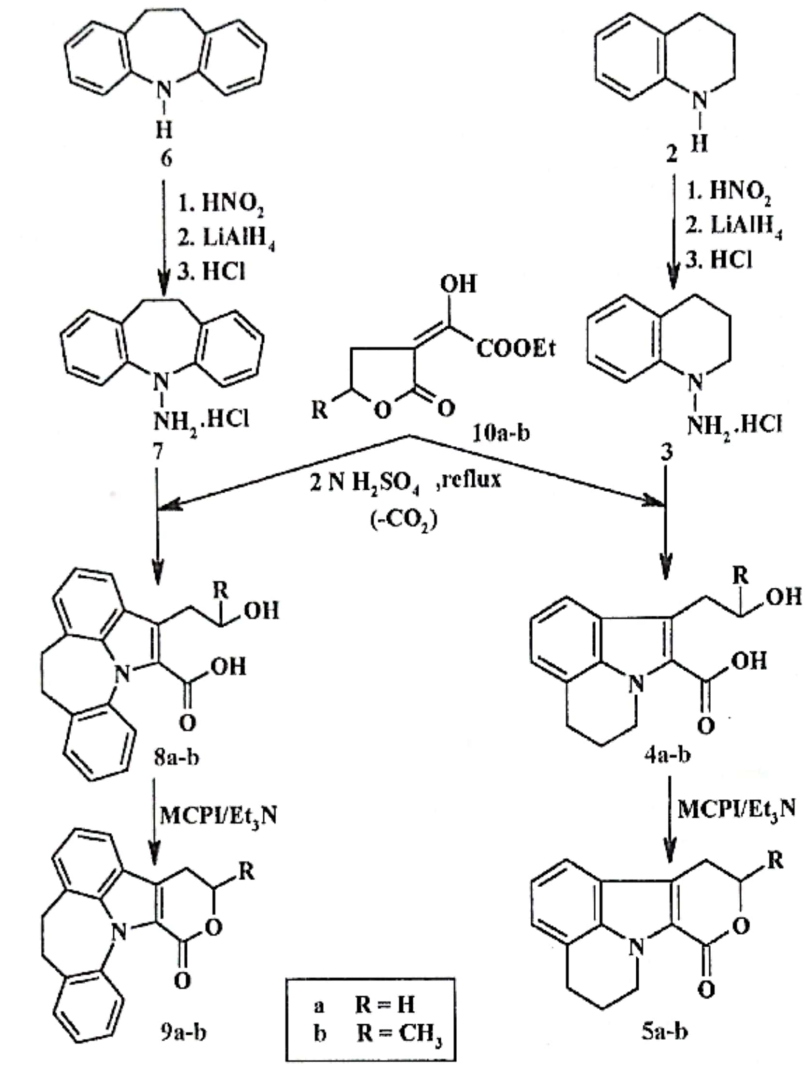


1d

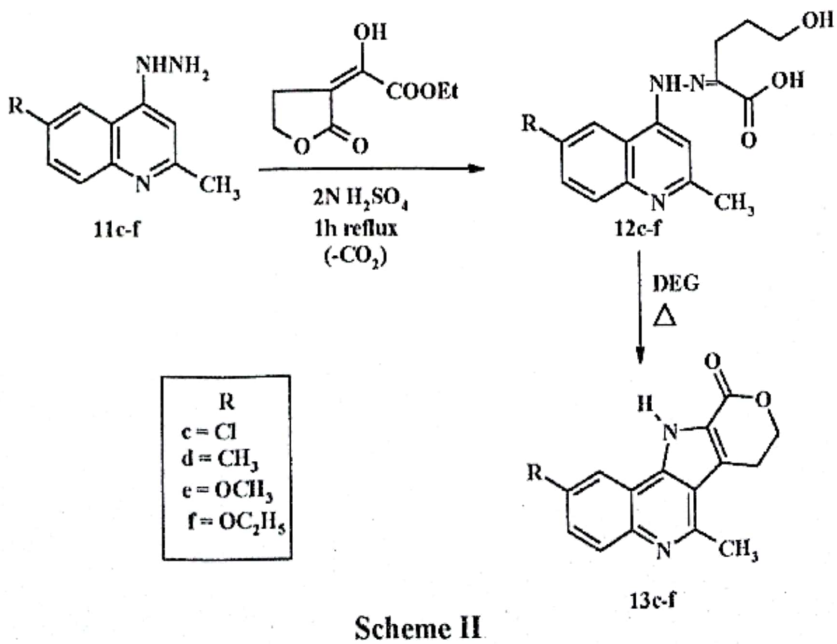
RESULTS AND DISCUSSION

Scheme I, comprises the synthesis of 5,6,10,11-tetrahydro-4*H*,8*H*-pyrano[4`,3`:4,5]pyrrolo[3,2,1-*ij*]quinolin-8-ones **(5a,b)** and 3,4,8,9-tetrahydro-1*H*-pyrano [4`,3`:2,3]indolo[1,7-*ab*][1]benzazepin-1-ones **(9a, b)**. Treatment of the 3-ethoxallyl-γ-lactones **10a,b** with hot 2N sulfuric acid for one hour results in ring cleavage and decarboxylation yielding a mixture of compounds with 2-hydroxytetrahydrofuran-2-carboxylic acid as a main product. Heating of 1-amino-1,2,3,4-tetrahydroquinoline hydrochloride **3** or 5-amino-10,11-dihydro-5*H*-dibenzo[*b,f*]azepine hydrochloride **7** in ethanol under reflux with the ether extract of the hydrolyzed-decarboxylated products of **10a-b** gave the corresponding hydroxy-acids **4a,b** and **8a,b** respectively. Attempted lactonization of **4a,b** or **8a,b** using hydrochloric or acetic acid led to decomposition and tarry materials. Therefore, lactonization proceeded smoothly upon using 1-methyl-2-chloropyridinium iodide (MCPI)[10] in triethylamine as dehydrating agent. Structure of the new lactones 5a,b was assigned from IR, PMR and microanalysis.

Scheme II, comprises the synthesis of 7,11-dihydropyrano [4`,3`:4,5]pyrrolo[2,3-*c*]quinolin-10(8*H*)-ones **13c-f**. The hydrazones **12c-f** were initially obtained by condensation of the 4-hydrazinoquinolines **11c-f** with the ether extract of the hydrolyzed-decarboxylated products of ethoxalyl-lactone **10a**. Initial attempts to cyclize these hydrazones using acids such as hydrochloric acid, sulfuric acid, polyphosphoric acid, acetic acid, and a mixture of hydrochloric and acetic acid, failed. The failure of cyclization has been previously observed and reported in the abortive attempts of the synthesis of azaindoles[11]. The Fischer indole synthesis succeeded when thermal cyclization[12] was used. Therefore, heating of the hydrazones under reflux in diethylene glycol over a period of one hour resulted in the formation of the lactones **13c-f** in 23-33 % yields. The lactones **13c-f** were identified by spectral methods in addition to elemental analyses.



Scheme 1



Scheme II

EXPERIMENTAL

Melting points were determined on a Gallenkamp apparatus and are uncorrected. Infrared spectra were scanned on Beckmann IR 33 and Shimadzu IR 435 spectrophotometers. Proton magnetic resonance spectra were measured on EM 360 (60 MHz), WH-90 (90 MHz, Fa. Bruker) and Jeol-FX 90Q (90 MHz) spectrometers using TMS as internal standard. Elemental analyses were carried out at the Microanalytical Unit, Cairo University and CHN-Autoanalyzer, Chemisches Institut, der Universität Bonn. Mass spectra were recorded using Hewlett-Packard HP 5988 spectrometer at an ionization potential of 70 *eV*.

1-Amino-1,2,3,4-tetrahydroquinoline (3)

To a mechanically stirred solution of $LiAlH_4$ (8.74 g, 0.2 mole) in anhydrous ether (300 ml) under nitrogen atmosphere and temperature remained at 5-10°C, a solution of 1-nitrosotetrahydro- quinolin (32.4 g, 0.2 mole) in anhydrous ether (150 ml) was added, dropwise over a period of 2 hr. After complete addition, the reaction mixture was heated for 30 min at reflux temperature. The reaction mixture was cooled and the excess $LiAlH_4$ and the complex were decomposed by dropwise addition of cold water (10 ml). The ether extract was separated by filtration, dried (Na_2SO_4) and distilled under vacuum. The fraction boiled at b_{17} 152-155°C was collected[cf.13], m.p.: 55 °C (pet. ether 40/60), yield: 27 g (91%).

Its hydrochloride melted at 185-187°C (ethanol). *Analysis Calcd.* for $C_9H_{13}ClN_2$ (184.5), C, 58.54, H, 7.05, N, 15.18. Found, C, 58.30, H, 6.80, N, 15.20. PMR (DMSO-d_6, δ, ppm): 1.8-2.2 (m, 2H, CH_2), 2.7 (t, 2H, CH_2), 3.5 (t, 2H, CH_2-N), 6.8-7.4 (m, 4H, Ar-H), 10.55 (br s, 3H, NH_3, D_2O exchangeable).

1-(2-Hydroxyalkyl)-5,6-dihydro-4*H*-pyrrolo[3,2,1-*ij*]quinoline-2-carboxylic acids (4a-b)

Ethoxallyllactone **10a-b** (0.13 mol) in 2N H_2SO_4 (600 ml) was heated for one hour at reflux temperature. After cooling, the mixture was extracted with ether (2 x 150 ml). The ether extract was dried (Na_2SO_4) and evaporated in vacuum. To the ether extract, 1-aminotetrahydroquinoline hydrochloride (14.76 g, 0.08 mole) in absolute ethanol (80 ml) was added and the mixture was heated for 30 min at reflux temperature. The alcohol was removed by distillation in vacuum, and the dark precipitated solid was treated with water (150 ml) and recrystallized from ethanol/charcoal.

1-(2-Hydroxyethyl)-5,6-dihydro-4*H*-pyrrolo[3,2,1-*ij*]quinoline-2-carboxylic acid (4a)

m.p.: 193-195 °C, yield: 8.8 g (45%). *Analysis Calcd.* for $C_{14}H_{15}NO_3$ (245), C, 68.57, H, 6.12, N, 5.71, Found, C, 68.90, N, 6.40, N, 5.60. IR (KBr, ν, cm^{-1}): 3360-2500 (OH association), 1670 (C=O). PMR (DMSO-d_6, δ, ppm): 1.88-2.23 (m, 2H, CH_2), 2.9 (t, 2H, CH_2), 3.25 (t, 2H, CH_2), 3.6 (t, 2H, CH_2-N), 4.45 (t, 2H, CH_2-O), 4.45 (overlapped, 1H, OH, D_2O exchangeable), 6.88-7.13 (m, 3H, Ar-H), 12.85 (br s, 1H, OH, D_2O exchangeable).

1-(2-Hydroxypropyl)-5,6-dihydro-4*H*-pyrrolo-[3,2,1-*ij*]quinoline-2-carboxylic acid (4b)

m.p.: 145-147°C, yield: 7.5 g (36%). *Analysis Calcd.* for $C_{15}H_{17}NO_3$ (259): C, 69.50, H, 6.56, N, 5.41, Found: C, 69.30, H, 6.30, N, 5.50. IR (KBr, ν, cm^{-1}): 3410-2500 (OH association), 1665 (C=O). PMR (DMSO-d_6, δ, ppm): 1.05 (d, 3H, CH_3), 1.9-2.3 (m, 2H, CH_2), 2.9 (t, 2H, CH_2), 3.1 (d, 2H, CH_2), 3.8 (t, 2H, CH_2-N), 3.8-4.4 (m, 1H, CH), 3.8-4.4 (overlapped, 1H, OH, D_2O exchangeable), 6.9-7.55 (m, 3H, Ar-H), 12.75 (br s, 1H, OH, D_2O exchangeable).

5,6,10,11-Tetrahydro-4*H*,8*H*-pyrano[4`,3`:4,5]-pyrrolo[3,2,1-*ij*] quinolin-8-ones (5a-b)

To a solution of 1-methyl-2-chloropyridinium iodide (1.04 g, 8 mmole) in dry acetonitrile (50 ml) was continuously and uniformly added a solution of the hydroxy-acid **4a-b** (2 mmole) and triethylamine (1.62 g, 16 mmole) in dry acetonitrile (50 ml) over a period of 8 hr. The reaction mixture was heated for an additional 30 min at reflux temperature after addition was completed. The mixture was cooled and most of the solvent was evaporated under reduced pressure. The residue was treated with water (50 ml) and extracted with methylene chloride (2 x 50 ml). The organic layer extracts was washed with 2N HCl (10 ml) and then with water (50 ml), dried (Na_2SO_4) and finally evaporated to dryness in vacuum. The residue was purified on silica-gel column chromatography using CH_2Cl_2 as eluent.

5,6,10,11-Tetrahydro-4*H*,8*H*-pyrano[4`,3`:4,5]-pyrrolo[3,2,1-*ij*] quinolin-8-one (5a)

m.p.: 91-92 °C, Yield: 0.34 g (76 %). *Analysis Calcd.* for $C_{14}H_{13}NO_2$ (227): C, 74.01, H, 5.73, N, 6.17. Found: C, 74.40, N, 5.90, N, 6.10. IR (KBr, ν, cm^{-1}): 1705 (C=O). PMR (DMSO-d_6, δ, ppm): 2.15 (m, 2H, CH_2), 2.9 (t, 2H, CH_2), 3.1 (t, 2H, CH_2), 4.4 (t, 2H, CH_2N), 4.5 (t, 2H, CH_2O), 6.8-7.4 (m, 3H, Ar-H).

5,6,10,11-Tetrahydro-10-methyl-4*H*,8*H*-pyrano-[4`,3`:4,5]pyrrolo [3,2,1-*ij*]quinolin-8-one (5b)

m.p.: 129-130 °C, yield: 0.43 (90%). *Analysis Calcd.* for $C_{15}H_{15}NO_2$ (241): C, 74.69, H, 6.22, N, 5.81. Found: C, 74.80, H, 6.30, N, 5.60. IR (KBr, ν, cm^{-1}): 1720 (C=O). PMR (DMSO-d_6, δ, ppm): 1.6 (d, 3H, CH_3), 2.1 (m, 2H, CH_2), 2.9 (t, 2H, CH_2), 3.2 (d, 2H, CH_2), 4.4 (t, 2H, CH_2-N), 4.7-5.15 (m, 1H, CH), 6.8-7.5 (m, 3H, Ar-H).

5-Amino-10,11-dihydro-5H-dibenzo[b,f]azepine (7)

This compound was prepared according to the published procedure[14].

2-(2-Hydroxyalkyl)-6,7-dihydroindolo[1,7-ab][1]-benzazepine-1-carboxylic acid (8a-b)

They were obtained using **7** as hydrochloride (49.3 g, 0.2 mole) and following up the procedure adopted for the preparation of **4a-b**

2-(2-Hydroxyethyl)-6,7-dihydroindolo[1,7-ab]-[1]benzoazepine-1- carboxylic acid (8a)

m.p. 231-233 °C, yield 23.3 g (38 %). *Analysis Calcd.* for $C_{19}H_{17}NO_3$ (307): C, 74.27, H, 5.54, N, 4.56. Found: C, 73.90, H, 5.70, N, 4.30. IR (KBr, ν, cm^{-1}): 3410-2500 (OH association), 1690 (C=O). PMR (DMSO-d_6, δ, ppm): 3.0-3.5 (m, 6H, 3 CH_2), 3.8 (t, 2H, CH_2-O), 4.4 (br s, 1H, OH, D_2O exchangeable), 7.1-7.8 (m, 7H, Ar-H), 12.7 (br s, 1H, OH, D_2O exchangeable).

2-(2-Hydroxypropyl)-6,7-dihydroindolo[1,7-ab][1]-benzoazepine-1-carboxylic acid (8b)

m.p. 212-214 °C, yield 21.2 g (33 %). *Analysis Calcd.* for $C_{20}H_{19}NO_3$ (321): C, 74.77, H, 5.92, N, 4.36. Found: C, 75.00, H, 5.60, N, 4.00. IR (KBr, ν, cm^{-1}): 3420-2500 (OH association), 1680 (C=O). PMR (DMSO-d_6, δ, ppm): 1.4 (d, 3H, CH_3), 2.7-3.5 (m, 6H, 3 CH_2), 4.8-5.4 (m, 1H, CH), 4.8-5.4 (overlapped, 1H, OH, D_2O exchangeable), 7.1-7.7 (m, 7H, Ar-H), 12.6 (br s, 1H, OH, D_2O exchangeable).

3,4,8,9-Tetrahydro-1H-pyrano[3`,4`:2,3]indolo[1,7-ab][1]benzazepin-1-ones (9a-b)

They were obtained using **8a-b** (2 mmole) and following up the procedure adopted for the preparation of **5a-b**

3,4,8,9-Tetrahydro-1H-pyrano[3`,4`:2,3]indolo[1,7-ab][1]benzazepin-1-one (9a)

m.p.: 236-238°C, yield: 0.54 g (93 %). *Analysis Calcd.* for $C_{19}H_{15}NO_2$ (289): C, 78.89, H, 5.19, N, 4.84. Found: C, 79.10, H, 5.10, N, 5.00. IR (KBr, ν, cm^{-1}): 1710 (C=O). PMR (DMSO-d_6, δ, ppm): 3.0-3.6 (m, 6H, 3 CH_2), 4.75 (t, 2H, CH_2-O), 7.1-7.7 (m, 7H, Ar-H).

3,4,8,9-Tetrahydro-3-methyl-1H-pyrano[3`,4`:2,3]-indolo[1,7-ab][1]benzazepin-1-one (9b)

m.p.: 188-190°C, yield: 0.53 g (87 %). *Analysis Calcd.* for $C_{20}H_{17}NO_2$ (303): C, 79.21, H, 5.61, N, 4.62. Found: 79.00, H, 5.60, N, 4.60. IR (KBr, ν, cm^{-1}): 1710 (C=O). PMR (DMSO-d_6, δ, ppm): 1.5 (d, 3H, CH_3), 2.8-3.5 (m, 6H, 3 CH_2), 4.8-5.2 (m, 1H, CH), 7.0-7.6 (m, 7H, Ar-H).

5-Hydroxy-2-[(6-substituted 2-methylquinolin-4-yl)hydrazono]pentanoic acids (12c-f)

Ethoxalyllactone **10a** (24.2 g, 0.13 mole) in 2N H_2SO_4 (450 ml) was heated for one hour at reflux temperature. After cooling, the mixture was extracted with ether (2 x 150 ml). The ether extract was dried (Na_2SO_4) and evaporated in vacuum. To the ether extract, the respective 4-hydrazinoquinoline **11c-f** (0.08 mole) in absolute ethanol (80 ml) was added and the mixture was heated for 30 min at reflux temperature. After cooling, the precipitated product was filtered, washed with water (100 ml) and recrystallized from DMF/EtOH (2:1).

2-[(6-Chloro-2-methylquinolin-4-yl)hydrazono]-5-hydroxypentanoic acid (12c)

m.p. 240-242°C, yield: 22.6 g (88%). *Analysis Calcd.* for $C_{15}H_{16}ClN_3O_3$ (321.5): C, 55.99, H, 4.98, N, 13.06. Found: C, 55.80, H, 4.60, N, 12.80. IR (KBr, ν, cm^{-1}): 3300 (NH), 3000-2500 (OH association), 1640 (C=O), 1605 (C=N).

2-[(2,6-Dimethylquinolin-4-yl)hydrazono]-5-hydroxypentanoic acid (12d)

m.p.: 248-250°C, yield: 19.3 g (80 %). *Analysis Calcd.* for $C_{16}H_{19}N_3O_3$ (301): C, 63.79, H, 6.31, N, 13.95. Found: C, 63.40, H, 6.70, N, 13.70. IR (KBr, ν, cm^{-1}): 3350 (NH), 3000-2500 (OH association), 1645 (C=O), 1600 (C=N).

5-Hydroxy-2-[(6-methoxy-2-methylquinolin-4-yl)-hydrazono]pentanoic acid (12e)

m.p.: 262-264°C, yield: 18.8 g (74%). *Analysis Calcd.* for $C_{16}H_{19}N_3O_4$ (317): C, 60.57, H, 5.99, N, 13.25. Found: C, 60.40, H, 6.30, N, 13.50. IR (KBr, ν, cm^{-1}): 3300 (NH), 3000-2500 (OH association), 1630 (C=O), 1600 (C=N).

5-Hydroxy-2-[(6-ethoxy-2-methylquinolin-4-yl)-hydrazono]pentanoic acid (12f)

m.p.: 250-252°C, yield: 19 g (72 %). *Analysis Calcd.* for $C_{17}H_{21}N_3O_4$ (331): C, 61.63, H, 6.34, N, 12.69. Found: C, 61.30, H, 6.60, N, 12.80. IR (KBr, ν, cm^{-1}): 3300 (NH), 3000-2500 (OH association), 1630 (C=O), 1600 (C=N).

2-Substituted 6-methyl-7,11-dihydropyrano[4`,3`:4,5]pyrrolo[3,2-c]quinolin-10(8*H*)-ones (13c-f)

A mixture of the respective hydrazone **12c-f** (5 mmole) in diethylene glycol (5 ml) was heated slowly to 100°C for 10 min to drive off any of volatile materials. Afterwards the temperature was allowed to rise and the reaction mixture was heated under reflux for a further period of one hour. The mixture was cooled and diluted with water (10 ml). The precipitate was filtered, thoroughly washed with water to remove the solvent, dried in oven at 100°C and then recrystallized from ethanol.

2-Chloro-6-methyl-7,11-dihydropyrano[4`,3`:4,5]-pyrrol[3,2-c] quinolin-10(8H)-one (13c)

m.p.: 323-326°C, yield: 0.47 g (33%). *Analysis Calcd.* for $C_{15}H_{11}ClN_2O_2$ (286.5): C, 62.83, H, 3.84, N, 9.77. Found: C, 62.60, H, 3.60, N, 9.90. IR (KBr, ν, cm^{-1}): 3240 (NH), 1700 (C=O). PMR (DMSO-d_6, δ, ppm): 2.88 (s, 3H, CH_3), 3.23 (t, 2H, CH_2), 4.9 (t, 2H, CH_2-O), 7.9-9.2 (m, 3H, Ar-H), 13.82 (br s, 1H, NH, D_2O exchangeable). MS (m/z, % relative abundance): 286/288 (100/30.8), 242/244 (25.2/8.0), 228/230 (52.7/14.7), 193 (29.3), 164 (10.8), 140 (10.3), 99 (10.5), 74 (15.4), 63 (12.1), 51 (18.8).

2,6-Dimethyl-7,11-dihydropyrano[4`,3`:4,5]-pyrrolo[3,2-c]quinolin- 10(8H)-one (13d)

m.p.: 308-310°C, yield: 0.30 g (23 %). *Analysis Calcd.* for $C_{16}H_{14}N_2O_2$ (266): C, 72.18, H, 5.26, N, 10.53. Found: C, 72.50, H, 5.60, N, 10.80. IR (KBr, ν, cm^{-1}): 3280 (NH), 1710 (C=O). PMR (DMSO-d_6, δ, ppm): 2.55 (s, 3H, CH_3), 2.9 (s, 3H, CH_3), 3.4 (t, 2H, CH_2), 4.84 (t, 2H, CH_2), 7.8-8.9 (m, 3H, Ar-H), 13.8 (br s, 1H, NH, D_2O exchangeable). MS (m/z, % relative abundance): 266 (100), 221 (39.2), 208 (40.1), 193 (20.2), 139 (10.9), 63 (12.3), 51 (12.3).

2-Methoxy-6-methyl-7,11-dihydropyrano[4`,3`: 4,5]pyrrolo[3,2-c] quinolin-10(8H)-one (13e)

m.p.: 290-292°C, yield: 0.4 g (28 %). *Analysis Calcd.* for $C_{16}H_{14}N_2O_3$ (282): C, 68.09, H, 4.96, N, 9.93. Found: C, 68.40, H, 4.60, N, 10.20. IR (KBr, ν, cm^{-1}): 3240 (NH), 1705 (C=O). PMR (DMSO-d_6, δ, ppm): 2.77 (s, 3H, CH_3), 3.4 (t, 2H, CH_2), 4.1 (s, 3H, OCH_3), 4.74 (t, 2H, CH_2), 7.3-8.1 (m, 3H, Ar-H), 13.7 (br s, 1H, NH, D_2O exchangeable). MS (m/z, % relative abundance): 282 (84.7), 283 (100, $[M+1]^+$), 267 (19.0), 239 (14.4), 238 (12.8), 224 (9.3), 223 (10.0), 209 (8.9), 193 (11.7), 179 (6.3), 140 (6.5), 126 (6.2), 63 (6.9), 51 (5.3).

2-Ethoxy-6-methyl-7,11-dihydropyrano[4`,3`: 4,5]pyrrolo[3,2-c] quinolin-10(8H)-one (13f)

m.p.: 284-286°C, yield: 0.36 g (24 %). *Analysis Calcd.* for $C_{17}H_{16}N_2O_3$ (296): C, 68.92, H, 5.41, N,9.46. Found: C, 68.70, H, 5.60, N, 9.70. IR (KBr, ν, cm^{-1}): 3240 (NH), 1705 (C=O). PMR (DMSO-d_6, δ, ppm): 1.5 (t, 3H, CH_3), 2.8 (s, 3H, CH_3), 3.5 (t, 2H, CH_2), 4.1 (q, 2H, CH_2), 4.8 (t, 2H, CH_2), 7.4-8.7 (m, 3H, Ar-H), 13.8 (br s, 1H, NH, D_2O exchangeable). MS (m/z, % relative abundance): 296 (100), 268 (65.6), 267 (23.5), 239 (18.4), 223 (23.8), 211 (10.4), 210 (22.4), 193 (13.9), 181 (9.6), 166 (10.4), 77 (10.6), 63 (12.7), 51 (7.8).

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تشييد ٥و٦و١٠و١١-رباعي هيدرو-٤يد٨يد-بيرانو|٤`و٣`: ٤و٥|بيرولو|٣و٢و١- ij|كينولين-٨-أونات ؛ ٣و٤و٨و٩-رباعي هيدرو-١يد-بيرانو|٣`و٤`: ٢و٣|إندولو|١و٧- ab|بنزأزبين-١-أونات؛ ٧و١١-ثنائي هيدرو بيرانو|٤`و٣`: ٤و٥|بيرولو|٣و٢- c|كينولين-١٠(٨يد) أونات

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عن طريق الحلقنة بطريقة فيشر المستخدمة لبناء حلقة الإندول من الهيدرازونات المقابلة تم في هذا البحث تشييد بعض اللاكتونات الجديدة التي تحمل في تركيبها البنائي حلقة البيرانوبيرول مع حلقة الكينولين أو حلقةالبيرانوإندول مع حلقة البنزأزبين. واللاكتونات الجديدة هي : ٥و٦و١٠و١١-رباعي هيدرو-٤يد٨يد-بيرانو|٤`و٣`: ٤و٥| بيرولو|٣و٢و١- ij|كينولين-٨- أونات 5a-b ؛ ٣و٤و٨و٩-رباعي هيدرو-١يد-بيرانو|٣`و٤`: ٢و٣|إندولو|١و٧- ab|بنزأزبين-١-أونات 9a-b ؛ ٧و١١-ثنائي هيدرو بيرانو|٤`و٣`: ٤و٥|بيرولو|٣و٢- c|كينولين-١٠(٨يد) أونات 13c-f.

وقد تم إثبات التركيب البنائي للمركبات التي تم تحضيرها بالتحاليل الدقيقة والأشعة تحت الحمراء والرنين النووي المغناطيسي وطيف الكتلة.